BENTHIC FORAMINIFERA FROM THE MODERN SEDIMENTS OF BERMUDA: IMPLICATIONS FOR HOLOCENE SEA-LEVEL STUDIES.

By

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A Jean-Christophe, mon amour, pour son aide, son soutien,

et ses encouragements dans les moments de doute et de stress,

et à Charline et Jérôme, mes deux enfants chéris;

à ces trois êtres qui m'apportent tant de bonheur et

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ABSTRACT

Study of surface sediment samples collected in Bermuda subtropical environments reveals foraminifera assemblages from lagoons, reefs, caves, mangroves, and ponds that are sufficiently different to serve in paleoenvironmental reconstructions. These assemblages are based on species diversity, suborder percentages, characteristic species and associations, and sediment types. Some subenvironments can even be recognized, such as outer/lagoonal reefs, open/semi-protected/protected lagoons, mangrove swamps/fringing mangroves, non-tidal marine landlocked ponds/mangroves and other ponds. The main factors controlling foraminifera distribution in Bermuda are salinity, sediment type, pH, water energy, oxygen content, and light penetration. Presence of phytal substrate is also very important but was not investigated in this more geological study of sediment assemblages.

Bermuda recent sediment hosts a benthic foraminifera fauna as diverse as in other subtropical and tropical areas, and the general trends of foraminifera distribution and morphology are similar despite some differences.

In Bermuda mangrove swamps, foraminifera distribution shows a zonation relative to higher high water level, that can be used in accurate paleosea-level reconstructions. The present work includes the first detailed measured transects carried out in mangrove swamps for foraminiferal studies. Study of vibracore and Davis core samples permitted the construction of a late Holocene sea-level curve for Bermuda. This curve shows a lowstand between 2,000 y BP and 1,000 y BP, and a relative sea level (RSL) acceleration in rise since about 500 y BP that preceded the onset of modern global warming. The lowstand occurred also in Connecticut and South Florida, but not in other areas, and coincided with a cool period (Early Medieval Ice Advances) also detected elsewhere, and possibly also with a displacement of the Bermuda High over Bermuda. This curve illustrates the high variability of late Holocene sea level and climate.

LIST OF ABBREVIATIONS AND SYMBOLS

^{0}C	Celsius Degree
%	percent
AD	Ante Datum
AMS	Accelerator Mass Spectrometer
C^{14}	Carbon 14
cc	cubic centimeter
$\_C^{13}$	correction for isotope fractionation
EMIA	Early Medieval Ice Advances
ESEM	Environmental scanning electron microscope
HHW	Higher High Water
ind.	individuals
LIA	Little Ice Age
M	Miliolina
MSL	Mean Sea Level
ppm	parts per million
R	Rotaliina
RSL	Relative Sea Level
S	Spirillinina
SEM	Scanning electron microscope

SLM	Scanning light microscope
sp.	species
T	Textulariina
y BP	years Before Present

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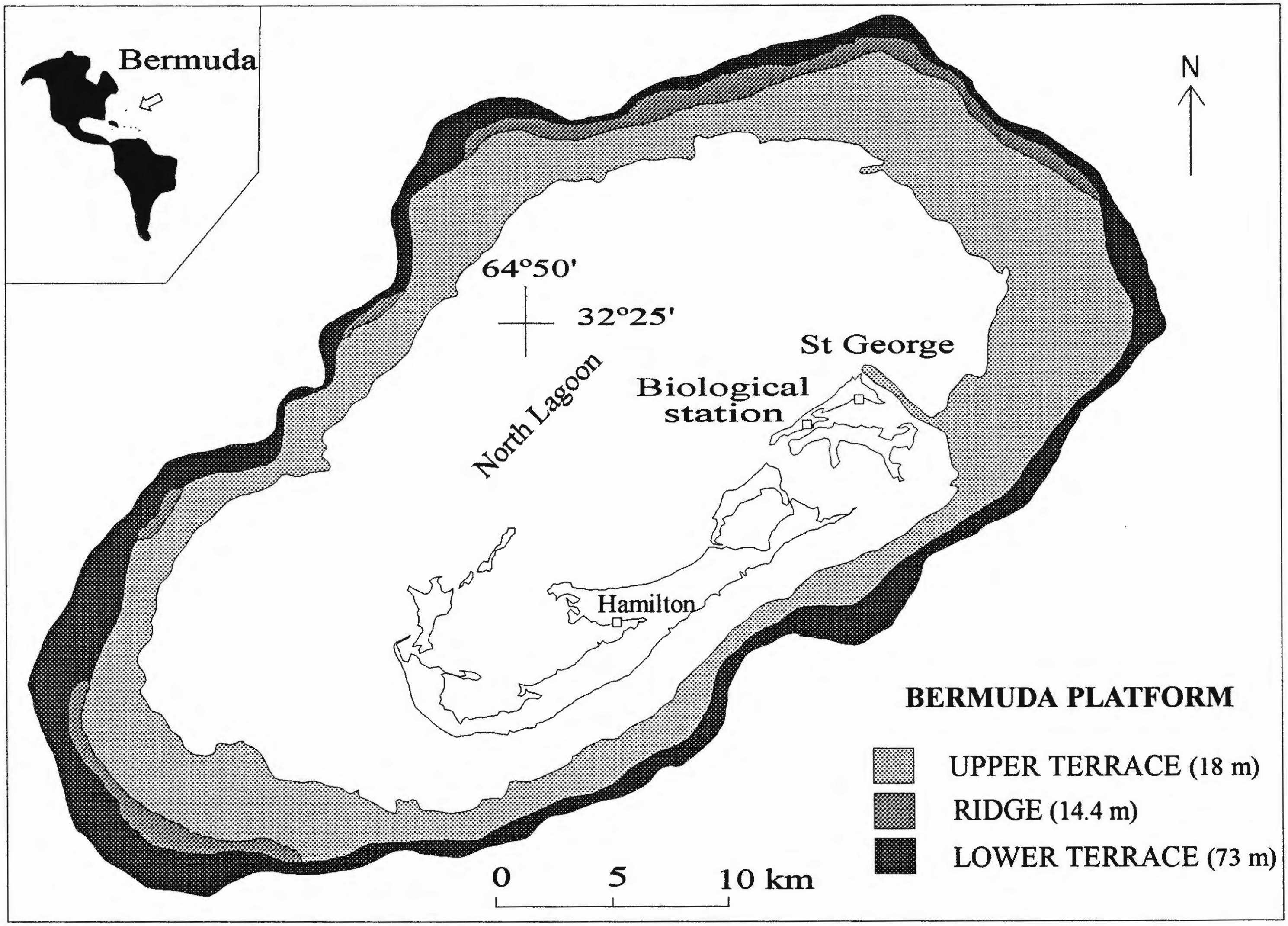
CHAPTER I: INTRODUCTION

1.1. Background

1.1.1. Study area

Bermuda is a chain of approximately 150 oceanic islands located at latitude 32°N and longitude 65°W in the northwest Atlantic Ocean. The islands lie on the Bermuda Seamount, a volcanic peak capped by Quaternary limestone. The islands are fossil aeolianite dunes, perched at the southeast margin of an elliptical submarine platform (shallower than 18 m) surrounded by reefs and enclosing a reef-filled lagoon. The seaward margin of the platform includes from the platform to the ocean: a rim of coral reefs and occasional algal-vermetid cup reefs (especially on the south side) enclosing the lagoon, a wide upper terrace at 18 m depth (relict aeolianite dunes), a ridge (fossil reef) at 14.4 m depth on the outer edge of the upper terrace, and a sediment-covered terrace at 73 m depth (relict aeolianite dunes) (fig. 1). These features are related to Quaternary glacio-eustatic and climatic oscillations (Stanley & Swift, 1968). The lower terrace is part of the fore-reef slope which lies between 20 and 200 meters depth and has a slope of 5 to 10°.

Figure 1. General map of Bermuda islands (modified from Stanley and Swift, 1968) showing submarine ridge and terraces (depths in meters).

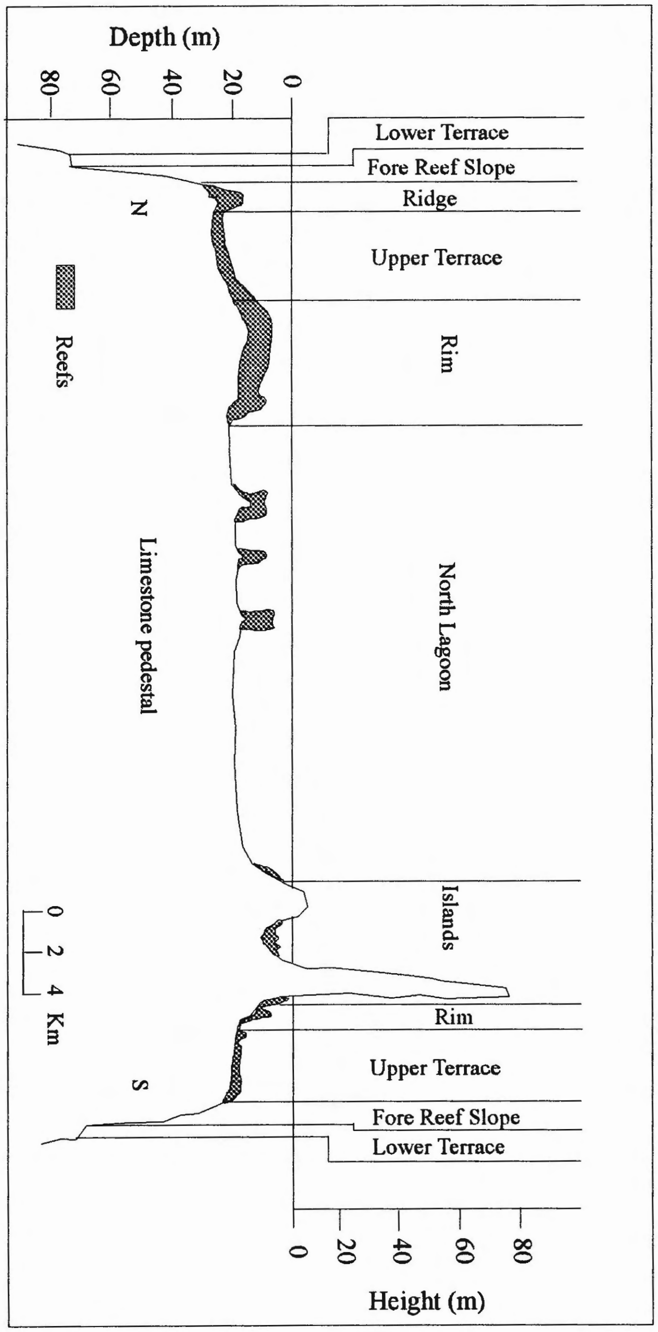

Bermuda
N
64°50'
32°25'
St George
Biological station
North Lagoon
Hamilton
BERMUDA PLATFORM
UPPER TERRACE (18 m)
RIDGE (14.4 m)
LOWER TERRACE (73 m)
0 5 10 km

Bermuda is a pseudoatoll (Verrill, 1900) rather than a true atoll, because its outer reefs are submerged instead of emerging at low tide as in Pacific atolls, the fore-reef slope is larger and less steep, and the islands are higher and larger (fig. 2).

The warm waters of the Gulf Stream cause the subtropical climate of the Bermuda islands. A northern equatorial current joins the Gulf Stream after passing on the east side of the Bahamas. Ocean temperatures off Bermuda vary between 16°C (Feb-March) and 29°C (Aug-Sept). Within more restricted environments, water temperature ranges between 16 and 37.5°C (Thomas and Logan, 1992). Salinity varies slightly around a mean of 36.5 ppm in open ocean and lagoons. In restricted ponds, salinity may vary between 6.5 and 42.5 ppm. Tides have a spring range of 1.3 meter and a neap range of 0.6 meter. The Bermuda islands are situated between the tradewind belt and the westerlies belt, and in the summer winds come from all points but southeasterlies predominate. In winter southwesterlies predominate and northerly gales blow from North American frontal systems (James and Schenk,1983). Tropical storms approach near the islands once a year, and severe hurricanes occur every four or five years (Morris et al., 1977).

The Bermuda carbonate platform includes a wide range of environments such as mangrove swamps, lagoons, landlocked marine ponds, marine caves, and reefs. The islands have no rivers. The mangrove swamps and the reefs of Bermuda are the most northerly in the Atlantic Ocean. The reefs are built by corals and algae, and are encrusted by numerous organisms including the foraminifera *Homotrema rubrum* (Lamarck). The

Figure 2. North-South profile of Bermuda platform (modified from Thomas and Logan, 1992).



Depth (m)
80
60
40
20
0
Lower Terrace
Fore Reef Slope
Ridge
Upper Terrace
Rim
North Lagoon
Islands
Rim
Upper Terrace
Fore Reef Slope
Lower Terrace
N
S
Reefs
Limestone pedestal
0 2 4 Km
0
20
40
60
80
Height (m)

Bermuda platform includes numerous types of reefs differing by their size, shape, and main builder organisms (corals or algae) (Logan, 1988). The reef organisms are less diverse than in their Florida and Caribbean counterparts. Mangrove swamps are almost exclusively concentrated along the north shore of the islands. The stronger southern winds result in high wave action along the south shores and prevent colonization by mangroves except in protected bays and around landlocked marine ponds. Because of the steep relief of the shores, most Bermuda mangrove systems are fringing mangrove swamps, consisting of a single line of trees and rooted in rock and rubble, rather than mud (Thomas and Logan, 1992). Mangrove swamps develop in very sheltered areas in bays, sounds, narrows and channels. Unfortunately most of the Bermuda mangrove swamps have been severely dredged except for the Hungry Bay area. The swamps are floristically similar those in the Gulf of Mexico at 23°N, and they are composed of the black mangrove (*Avicennia germinans*), the red mangrove (*Rhizopora mangle*), and the buttonwood (*Canocarpus erectus*), with the Brazil pepper tree (*Schinus portulacastrum*) invading the swamps. Algae and flowering plants are frequently associated with the mangrove trees. Thomas and Logan (1992) mapped the various mangrove swamps and marine ponds of Bermuda, listed their macroflora and macrofauna, and registered monthly variations of physical characteristics of some of these environments. Landlocked marine ponds are connected to the sea through underground fissures, tunnels, or caves (Thomas and Logan, 1992).

Physical characteristics such as temperature, salinity and tidal range vary greatly from one pond to another, depending on the types and number of connections to the sea.

In Bermuda, volcanic material lies immediately beneath the limestone. During Pleistocene low sea-level stands, large conduits developed at the limestone/basalt contact which has considerable relief (Mylroie, 1989). The conduits collapsed because of their large size and produced Bermuda caves. In these caves, the salinity and temperature of the water increase with depth. The presence of warmer deep cave waters may have permitted survival of some groups of invertebrates during Pleistocene glaciation. There is a 30% endemism among the cave invertebrate species of Bermuda caves (Iliffe et al., 1983).

The recent sediments are nearly 100% calcium carbonate, and are derived almost entirely from skeletal material of benthic invertebrates (corals, gorgonians, sponges, bivalves, gastropods, foraminifera) and calcareous algae, or from surrounding limestones (James and Schenk, 1983). Borers (bivalves, sponges such as *Cliona*, polychaete worms, and barnacles) produce the major portion of reef sediment. Grazers (parrot fishes, sea urchins, and chitons), and physical breakdown also contribute to the destruction of rock and reef. Land erosion is important only in nearshore and inshore environment (Morris et al., 1977). Upchurch (1970; summarized in Morris et al., 1977) carried out the most complete study of Bermuda sediment grain size and composition. He classified them into seven major biotopes defined by their sediment composition and by the relative abundance of different living organisms. The seven biotopes were characterized as follows:

1) the reef-front terrace biotope includes large coral heads as framework builders, encrusted by coralline algae and the foraminifera *Homotrema rubrum*, and is located around the platform at depths of less than 10 meters to more than 100 meters;

2) the north reef biotope occurs in the reef tract between North Rock and the northeastern Breakers. It comprises abundant corals, coralline algae, *Homotrema*, alcyonarians, and hydrozoans;

3) the central and south reef biotope includes small coral heads, large branching colonies of hydrocoral, and less *Homotrema*. It is a low energy environment located along the southwestern and southern edge of the reef tract and on the patch reefs of North lagoon;

4) the boiler reef biotope occurs along the south shore and at a few of the outermost breaking reefs along the northern reef tract. It is formed by Pleistocene aeolianite rock encrusted by coralline algae, vermetid gastropods, and other organisms;

5) the nearshore-sandy substrate biotope occurs as large sandy flats in North Lagoon, along the north shore, and in some inshore waters. It is covered by seagrass and algae beds, echinoids, bivalves, and a few coral colonies;

6) the nearshore-muddy biotope is composed of finer sediment -silts and clays- and include similar organisms to those of the sandy substrate biotope. It occurs in deeper parts of all protected inshore waters;

7) the basin center biotope is similar to the two previous biotopes but bivalves are more important and seagrasses are rare. It occupies the deeper parts of North lagoon.
The sediment is the coarsest in high energy environments at outer edges of the platform. Coarse- to medium-grained skeletal sands are present in reef tract and North Lagoon. The finest sands occupy deepest parts of North Lagoon and shallow protected areas. Silts and clays occur in protected inshore waters and a few areas in Great Sound. Beaches are made of reworked Pleistocene sands. The best sorted sands are found in the outer reef tract and the center of North Lagoon, whereas the poorest sorted sediments occur in protected harbors, sheltered areas of the reef tract, and deep water in front of the platform edge (James and Schenk,1983). Erlenkeuser et al. (1981) determined a sedimentation rate of 1cm/10y in Harrington Sound. Ellison (1993) found a similar rate of peat accretion in the mangrove swamp of Hungry Bay (8.5 to 10.6cm/100y for the last 2,000 years).

1.1.2. Recent distribution of benthic foraminifera

Foraminifera are unicellular organisms with a protoplasm enclosed in a uni- or multi-chambered shell (although a few have only an organic test). They are placed in the Class Sarcodina because they possess protoplasmic extensions termed pseudopodia, useful for feeding and locomotion. The test can be agglutinated (made from surrounding grains glued on a tectin lining), calcareous hyaline (with perforations), or calcareous porcelaneous. These organisms live in all marine and marginal-marine environments, from 0 to 5,000 meters depth, although a few genera can live in freshwater. The benthic (bottom-dwelling) forms have existed since Cambrian time, and the planktonic forms (floating in the water column) since the Mesozoic . They can reproduce by alternation of sexual and asexual phases, but mostly by asexual mode. Foraminifera can be herbivores, carnivores or both (omnivores). They are low on the marine food chain and serve as assimilators of energy from organic debris and bacteria, and as prey for microcarnivores and larger detrital feeders (Lipps and Valentine, 1970).

Foraminifera are also important sediment and carbonate producers, especially in subtropical and tropical carbonate shallow-water areas. In Bermuda, Barnhardt (1963) determined that foraminifera contributed to 3 to 5% of North Lagoon sediment, 30% of reef sediment, 16% of shelf sediment, and 13.5 to 22% of slope sediment. On the Florida platform, the tests of foraminifera comprised 17% of Florida Bay sediments, and 9% of Florida reefs sediments, in grain size above 1/8 mm (Ginsburg, 1956). In Florida, Hallock and Peebles (1993) estimated the production of sediment by the species *Archaias angulatus*. The living population varied from 5,000 to 15,000 ind./m^2 (winter and summer) and produced 60g $CaCO_3$/m/y. The highest rate of production is up to 1 kg/m^2/y in very shallow depths or turbulent reef flats, close to reef margins. In back reefs, lagoons, and reef slopes, the rate ranges between 50 and 600 g/m^2/y (Hallock et al., 1986). The rates of carbonate production by foraminifera are higher in the tropics than in the subtropics for the same species because the growth rates are faster and the generation lengths are shorter. These rates of carbonate production correspond to carbonate sediment accumulation ranging between 10mm/1,000 y to 100 mm/1,000 y, to 1m/1,000 y in exceptional circumstances (Hallock et al., 1986).

Coral reefs cover 0.17% of today's ocean surface, and produce 1/6 of carbonates in world ocean (900.10^6 tons/y) (Langer et al., 1997). Reef foraminifera represent 0.76% of carbonate production in world's ocean, or 43.10^6 tons/y, or 4.8% of the global carbonate reef budget. They play an important role in carbonate production of reef carbonates.

Generation times in larger foraminifera range from 3, 4 per year in *Amphistegina*, 1 per year in *Archaias*, or longer for other species, and asexual reproduction yields 50 to 2,000 young agamonts, depending on species (Hallock et al., 1986).

Foraminifera are classified according to their wall composition and microstructure, chamber arrangement, apertural characters, chamber form, life habits and habitats, protoplasmic characteristics, ontogenetic changes, reproductive processes, and geologic ranges (Loeblich and Tappan, 1964).

Foraminifera are very useful for a wide variety of studies in both recent and geological times. They have the potential to facilitate determination of paleodepths, paleotemperatures, paleochemistry of sea water, paleogeography and tectonic history, paleoclimates, paleosea-levels, biostratigraphy, short-term events (earthquakes, tsunami, and hurricanes) frequency, and evolution theories. In the recent, they have also been shown to be valuable as pollution indicators (Scott et al., 1998).

1.1.2.1. Recent distribution of benthic foraminifera in Bermuda

The distribution of benthic foraminifera in Bermuda has not been investigated in detail. Brady (1884) and Cushman (1918-1931) identified foraminifera species around Bermuda platform. Carman (1933) recognized 112 species of benthic foraminifera in Bermudan shallow waters (depths ranging from 0.9 to 18 m). The fauna is tropical and marks the northernmost extent of the warm-water West Indian Faunal Province. It was derived in part from the early Miocene of Florida and in part from the West Indian recent fauna. In her qualitative study, Carman (1933) examined the morphological variations of some Miliolids species.

Barnhard (1963) studied the distribution and composition of bottom sediments across a traverse from North Rock through North lagoon, Ferry Reach, Castle Harbor, and into deeper water southeast of Castle Harbor. The foraminiferal content (total assemblages) of 20 sediment samples was described quantitatively, but 300 to 400 foraminifera were arbitrarily picked in a "representative portion of the grab samples" with no volume or test size indication. Three foraminiferal assemblages have been recognized within the bottom sediments: a lagoon assemblage, a reef area assemblage, and a deeper-water assemblage. The common species in the lagoons (North Lagoon, Ferry Reach and Castle Harbor) belong to the genera *Quinqueloculina*, *Archaias*, and *Elphidium*, the Nonionidae being the most abundant family. The lagoon sediment is fine carbonate mud (Castle Harbor, 1.8-12.6 meters water depth), or fine to medium carbonate sand (North Lagoon, 5.4-12.6 meters depth). The reef foraminifera are mostly species of the genera *Archaias, Homotrema*, and *Amphistegina*. The reef sediment is coarse carbonate sand. Reef detritus is transported seaward, as shown by the distribution of the pink encrusting foraminifera *Homotrema rubrum*. The shelf-slope assemblage includes mostly species of *Amphistegina, Eponides*, and *Globorotalia*. Inner shelf sediments are medium to fine sand while outer shelf sand is coarse and includes an abundant fauna (*Archaias, Homotrema, Miniacina, Acervulina, Planorbulina*) transported from the reefs. Slope sediments are silt and clay-sized and include many planktonic foraminifera and some displaced shelf and lagoon foraminifera.

MacKenzie et al. (1965) found *Homotrema rubrum* living mainly on the outer shoals surrounding the Bermuda platform. Using *Homotrema rubrum* to study sediment transport, they noted that sand size fraction material was transported over considerable distance on the slope but only a short distance into the lagoon. Pestana (1983) reported the presence of the encrusting foraminifera *Carpenteria* in reef sediment of Bermuda. He suggested that *Carpenteria*, as *Homotrema*, is indicative of reef environment.

Lutze and Wefer (1980) studied the habitat and asexual reproduction of *Cyclorbulina compressa* in Harrington Sound.

In a qualitative study, Steinker (1980) listed 86 species from samples of sediment and marine plants collected from nearshore waters (water depth less than 1.07 m). The foraminifera (77% Miliolina, 22% Rotaliina, 1% Textulariina) live mainly upon vegetation rather than within the sediment. Steinker and Clem (1984), in a quantitative study of nearshore foraminifera from phytal and sediment samples, found a fauna dominated by Miliolids and similar to that of the nearshore zone in South Florida and the Bahamas. The following species were dominant in total assemblages: *Peneroplis proteus* (29%), *Archaias angulatus* (17%), *Planorbulina acervalis* (12.5%), *Triloculina rotunda* (6.5%), *Pyrgo subsphaerica* (5.5%), and *Rosalina floridana* (5%). Other species in the total assemblage occurred in frequencies of less than 1%. The authors observed a decreasing diversity of living species from infralittoral to subtidal zone, and from more restricted and variable to more open-water and stable environments. In quieter areas the thanathocoenosis (dead assemblage) within the sediment is generally similar to the biocoenosis (living assemblage) on the plants of the same area. In more turbulent environments, the thanathocoenosis is dominated by larger and more robust tests. The authors concluded that the thanathocoenosis may not necessarily be a true representation of the living fauna in a local area.

Steinker and Butcher (1981) found few living foraminifera in Bermuda mangrove environments (Coot pond, Mangrove Bay, Lovers Lake). They assumed that the other species were probably transported. The fauna includes 60% of the suborder Rotaliina, 30% of Miliolina, and 10% of Textulariina. *Discorinopsis aguayoi* and *Spiroloculina hyalina* appear to be more numerous high in the littoral zone, and *Helenina anderseni* and *Rosalina floridana* more common in the lower part. In an unpublished report, Steinker (pers. comm., 1993) listed 47 species from Bermuda caves.

Thus, studies concerning benthic foraminifera from Bermuda consist mainly of lists, more or less complete, from a small range of environments or from global environments (lagoon-reef-deep water), and from a small number of samples. The only detailed study of recent benthic foraminiferal species deals with nearshore waters shallower than 1.07 m (Steinker & Clem, 1984). However, in this quantitative study, only 100 rather than 300 individuals/sample were counted, and the sieve size and samples volume were not indicated. Barnhard (1963) determined quantitatively the global distribution (lagoon, reef, deep-water) of benthic foraminifera through the Bermuda platform, but only 20 samples were studied and the sieve and samples size were not reported. Only total assemblages were considered.

Detailed quantitative study of benthic foraminifera distribution in sediments of mangrove swamps, ponds, lagoons, caves, and reefs of Bermuda still remains to be done.

No published information was found on foraminifera from marine caves in Bermuda or in other areas of the world, or on foraminifera from Bermuda marine ponds.

1.1.2.2. Recent distribution of benthic foraminifera in other tropical/subtropical areas

Studies about recent distributions of benthic foraminifera from other tropical/subtropical settings are abundant. Lagoons and reefs are the main areas of study, although mangrove swamps have been investigated, mostly in Central and South America. A few studies report foraminifera distribution in saline ponds. No studies of foraminifera from karstic caves exist, to my knowledge. Tables 1 and 2 are compilations of the distributions of benthic foraminifera in other subtropical/tropical areas of the world. These foraminifera distributions will be compared in detail with Bermuda foraminifera distribution, in chapter 4.3. Because of local taxonomies, the number of reported species might be inflated. Lagoon, reef, and shelf studies are from Barnhardt, 1963; MacKenzie et al., 1965; Pestana, 1983; and Steinker and Clem, 1984, for Bermuda; Bock, 1971; Todd and Low, 1971; Rose and Lidz, 1977; Steinker and Steinker, 1976; Steinker et al., 1977; Levy, 1991; and Hallock and Peebles, 1993, for Florida and the Bahamas; Radford, 1974, for Tobago (South Caribbean); Martin and Liddell, 1988, for Jamaica; Todd & Bronniman, 1957; Saunders, 1958; and Drooger & Kaasschieter, 1958, for Trinidad (South Caribbean); Hedberg, 1934, for Venezuela (South Caribbean); Culver, 1990, for

Puerto Rico; Brazier, 1975a, 1975b; Radford, 1974, for Barbuda (North Caribbean); Bandy, 1964, for Cuba (North Caribbean); Wantland, 1975, for the Belize Shelf; Havach and Collins, 1997, for Panama; Sen Gupta and Schafer (1973), for St. Lucia (West Indies).

Mangrove studies are from Steinker and Clem, 1984, for Bermuda; Phleger, 1965; Goldstein, 1976; Rose and Lidz, 1977 and Hallock and Peebles, 1993, for Florida and the Bahamas; Radford, 1974, for Tobago; Todd and Bronniman, 1957; Saunders, 1957, 1958 and Drooger & Kaasschieter, 1958, for Trinidad; Culver, 1990, for Puerto Rico; Brazier, 1975a; Radford, 1974, for Barbuda; Zaninetti et al., 1977; 1979; Hiltermann et al., 1981, and Scott et al., 1990, for Brazil; Boltovskoy and Vidarte, 1977, for Ecuador; Boltovskoy and Hincapie de Matinez, 1983, for Columbia; Biswas, 1976, for the Sunda shelf (South China Sea); Gregory, 1973; and Hayward et al., 1996, for New Zealand; Debenay et al., 1989, for Senegal; Halicz et al., 1984, for Sinai; and Murray, 1965, for the Persian Gulf.

Murray (1991) reported species associations of tropical/subtropical foraminifera in lagoons, marshes and mangroves, and shelf/slope environments. Steinker (1977) summarized the foraminiferal studies done in South Florida and the Bahamas, which have a similar fauna to that of Bermuda although not as diverse. Most general environments have a particular assemblage of foraminifera (see tables 1 and 2), with some differences and similarities between the areas. Comparison between foraminifera assemblages from Florida patch reef and outer reef sediments show small differences in diversity (Weis and

Steinker, 1977). However, the proportions of occurrence of the most common species can be used to discriminate between the two faunae.

Few papers deal with foraminifera from saline ponds. Resig (1974) studied the foraminiferal fauna from a brackish Hawaian lake. Among the 41 species encountered, *Trochammina inflata* was the most abundant, followed by *Haplophragmoides wilberti, Haplophragmoides manilaensis, Discorinopsis aguayoi, Ammonia tepida, Cibicides lobatulus, Hauerina pacifica, Quinqueloculina distorqueata, Triloculina oblonga*, and *Miliammina fusca*. After comparison with the other few studies reporting the occurrences of foraminifera in inland brackish waters, Resig (1974) concluded that inland waters contain the same species as do coastal environments. Foraminifera were probably transported inland by birds or humans. In North Carolina brackish-water ponds, Lefurgey and St. Jean (1976) observed the occurrence of *Ammonia beccarii, Miliammina fusca, Ammotium salsum*, and *Elphidium spp.* as the most common species. Scott (1976b) reported a range of species from several isolated ponds in Southern California that contained *Polysaccammina ipohalina, Trochammina macrescens*, and *Trochammina inflata*. Cann and de Dekker (1981) reported the occurrence of five living species of foraminifera in athalassic saline lakes from southern Australia; *Elphidium sp.* and *Trochammina macrescens* in ephemeral lakes, and *Elphidium sp., Ammonia beccarii, Discorinopsis aguayoi*, and a miliolid in permanent lakes. Patterson and McKillop (1991) reported a new agglutinated species (*Annectina viriosa*), associated with *Trochammina* *macrescens*, and *Polysaccammina ipohalina* in a temperate nonmarine brackish pond from Manitoba. Almogin-Labin et al. (1995) studied the distribution of *Ammonia beccarii tepida* in saline ponds from Israel.

Factors that influence the distribution of foraminifera (Radford,1974) are salinity fluctuations, nature and stability of substrate, food supply, and degree of separation from the sea. Other important factors are vegetation and predation (Brasier, 1975a), and depth and hydrodynamic regime (Wantland, 1975). Lynts (1966) concluded that although assemblages are controlled by the interaction of physicochemical and biological parameters, there is no simple linear relationship between the foraminifera distribution and environmental factors.

Very few foraminifera are found alive in coarse sediment, but many are living in finer sediment where there is a higher organic content or food supply (Brasier, 1975a). However in mangrove areas where there is a high organic content, the standing crop is low because of accumulation of toxins or oxygen depletion (Brasier, 1975a).

Diversity is lower in areas with low or variable salinity, restricted circulation, and a low habitat diversity (especially the absence of marine plants) (Wantland, 1975). Maximum diversity is reached in areas with normal marine salinity, free circulation, and a high diversity of benthic habitat.

Rose and Lidz (1977) established diagnostic assemblages of recent foraminifera in bottom sediment from the Florida-Bahamas carbonate platform. Five major environments are characterized by distinct foraminiferal assemblages: Upper Slope, Platform Margin, Open Interior, Restricted Interior, and Brackish Interior. Currents and wave action affect the local distribution of foraminifera but do not affect the five major assemblages. These assemblages are more constant, both quantitatively and qualitatively, on a regular, even, bottom topography. Specimen abundance decreases and the number of species increases with increasing hydrodynamic regime. However, the number of species is higher in the transitional zone between major environments. Rose and Lidz (1977) concluded that aspects of both similar test structure and systematic affiliation must be considered in paleoecology.

Bock (1971) catalogued 235 species of foraminifera from South Florida area. He recognized five major assemblages: Straits fauna, back-reef fauna, brackish-water fauna, Gulf fauna, and Bay fauna. The Straits and Gulf faunae are controlled by depth, the back-reef and bay faunae by temperature and salinity, and the brackish-water fauna by salinity. Secondary control on the Bay fauna is exerted by wave and current action.

1.1.3. Holocene sea-level changes

Holocene sea-level studies have produced smooth (e.g. Neumann, 1971; Redfield, 1967; Scholl et al., 1969) or highly fluctuating (e.g. Colquhoun and Brooks, 1987; Fairbridge, 1976; Stapor et al., 1991; Ters, 1987) curves, by using various sea-level indicators such as peat, archeological remains, shell middens, and beach ridges. The detection of small-scale sea-level oscillations requires highly accurate sea-level markers. Scott and Medioli (1978, 1980a) showed that marsh foraminifera are distributed in well defined vertical zones with respect to higher high water (HHW). Recognition of these foraminiferal zones in subsurface peats permits the accurate determination of past sea levels and the production of representative sea-level curves.

Bermuda appears to represent a stable sea-level gauge in the middle of the Atlantic Ocean, in the deep Sargasso Sea (5,000 m depth). Since the Holocene glacio-isostatic subsidence of the seamount has been insignificant (Redfield, 1967; Ellison, 1993), Bermuda can be presumed to be tectonically and isostatically stable, and therefore sea-level changes are assumed to be attributable only to eustatic mechanisms (water level changes). Several papers deal with Pleistocene sea-level changes in Bermuda but few discuss Holocene sea-level changes. Three published Holocene sea-level curves have been produced for Bermuda (Redfield, 1967; Neumann, 1971; Ellison, 1993). Redfield (1967) and Neumann (1971) used undifferentiated peat samples and assumed that freshwater peat must have been in constant equilibrium with sea level because Bermuda is small and the rocks are permeable hence not able to support a freshwater swamp above sea-level. Ellison (1993) studied pollen to recognize mangrove peat. By using foraminifera, it is possible to distinguish, without any doubt, freshwater peat from marine peat, and it is also possible to distinguish accurate vertical zonations.

Redfield (1967) calculated a rate of rising sea level of 3.3 m/1,000y from 12,000y to 4,000y B.P., followed by a rate of 75 cm/1,000y for the last 4,000 years. Neumann (1971) found a rate of sea-level rise of 3.6 m/1,000y from 9,000 to 4,000y B.P., followed by a rate of 96 cm/1,000y to present. Ellison (1993) determined that before 4,000y B.P. sea-level rose at a rate of 25cm/100y; from 4,000 to 1,000y B.P. the rate of sea-level rise declined to 6cm/100y; and in the last 1,000y there was an increase to 14.3cm/100y. Since 1932, tide gauge records from Bermuda show variable but rising sea-level at a rate of 28cm/100y, following a pattern of 10-12 year cycle of MSL. This sea-level rise is possibly due to meteorological causes, and not to subsidence (Ellison, 1993).

To document the recent distribution of benthic foraminifera in mangrove swamps of carbonate settings, and to determine accurate sea-level markers, a detailed study of the vertical zonation of foraminifera in Bermudan mangrove swamps was necessary. Bermudan mangrove swamps are unusual because they grow in an almost exclusively carbonate sediment, and do not receive freshwater input except for rainwater fall and run-off. Thus, the main factor that may affect the distribution of foraminifera in these

Bermuda environments is the elevation relative to mean sea-level (and its associated set of physical parameters).

1.2. Objectives and significance

The two main objectives of my project are to determine the distribution of benthic foraminifera and to use these in sea level studies.

A- Determination of distribution of benthic foraminifera in recent sediments of the isolated subtropical carbonate islands of Bermuda includes:

-determination of living and total assemblages by studying species/genus diversity and abundance, distribution of wall types and shapes, and presence of ecophenotypes and other intraspecific variability, in a wide variety of environments representing a gradient of physical, chemical, and biological factors

-establishment of foraminifera assemblages that are characteristic of particular environments which can be defined by physical parameters

-comparison with other subtropical/tropical settings to establish differences and similarities of foraminiferal distributions in carbonate environments and to improve understanding of Bermuda biogeography

B- Implications for sea-level studies requires:

-establishment of the zonation of recent benthic foraminifera in mangrove swamps and determination of proxy sea-level markers

-comparison of recent thecamoebian and benthic foraminiferal assemblages with fossil assemblages in cores collected in mangrove swamps for determining former sea levels

-production of a late Holocene sea-level curve for Bermuda that will assist in understanding sea-level changes and possibly climatic changes in the north Atlantic region.

The Bermuda carbonate platform is a particularly interesting area to investigate the distribution of benthic foraminifera in recent sediments. Bermuda lagoons, marine caves, mangrove swamps, landlocked marine ponds, and reefs form a wide variety of subtropical carbonate environments where foraminiferal biofacies can be established. In particular, benthic foraminiferal assemblages have never been quantitatively studied in any karstic caves of the world. The Bermuda islands also include the most northern reefs and mangroves swamps in the Atlantic Ocean, and are located within deep waters, far from the continent (1,000 km east off Cape Hatteras). These Bermuda peculiarities may (or may not) be reflected in foraminiferal distributions. A comparison with previous studies of foraminiferal distributions in subtropical/tropical, continental-margin or insular environments such as the Gulf of Mexico, the Caribbean Sea, and the Florida-Bahamas platform, may show interesting differences and/or similarities.

Establishment of biofacies of recent benthic foraminifera on the Bermuda carbonate platform will add to the suite of tools needed for paleoecological studies in ancient carbonates. One aspect of paleoecology is the production of sea-level curves based on benthic foraminiferal zonation in mangrove marshes. The method of using benthic foraminifera as sea-level markers has never been applied before in mangroves associated with carbonate environments. Because of an increasing concern about global warming and its impact on sea level, detailed studies of pre-historical and historical sea-level changes are critical. Bermuda, as a stable sea-level gauge in the central North Atlantic Ocean, offers a unique opportunity for such studies.

Thecamoebians are also useful as environmental indicators. Determination of recent fauna of Bermudan thecamoebians can facilitate the recognition of ancient freshwater environments. This investigation represents the first study of these organisms in Bermuda.

Table 1: Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
BERMUDA Barnhardt, 1963; MacKenzie et al., 1965; Pestana, 1983; Steinker and Clem, 1984;		*Quinqueloculina lamarckiana* *Q. funafutiensis* *Archaias angulatus* *Praesorites orbitolitoides* *Elphidium discoidale* *Ammonia beccarii* *Clavulina tricarinata* *Textularia agglutinans* *Homotrema rubrum* *Peneroplis proteus* *Planorbulina acervalis* *Triloculina rotunda* *Pyrgo subsphaerica* *Rosalina floridana* *Androsina lucasi*	*Tretomphalus bulloides* *Archaias angulatus* *Valvulina oviedoina* *Heterostegina depressa* *Minicina minicea* *Carpenteria spp.* *Homotrema rubrum*	*Archaias spp.* *Quinqueloculina lamarckiana* *Cibicides pseudoungerina* *Planulina wuellerstorfi* *Minicina miniacea* *Acervulina inhaerens* *Planorbulina mediterranensis* *Archaias compressus* *Amphistegina lessonii* *Homotrema rubrum* *Globigerina bulloides*
FLORIDA-BAHAMAS Bock, 1971; Todd & Low, 1971; Rose & Lidz, 1977; Steinker and Steinker, 1976; Steinker et al., 1977; Levy, 1991; Hallock and Peebles, 1993	*Ammonia beccarii parkinsonia* *A. b. ornata* *Elphidium discoidale* *Miliolinella circularis* *Triloculina rotunda*	*Discorinopsis aguayoi* *Parrina bradyi* *Trochammina inflata* *Articulina spp.* *Bolivina lanceolata* *B. lowmanii* *B. paula* *B. pulchella primativa* *B. striatula* *Clavulina tricarinata*	*Discorbis rosea* *Homotrema rubrum* *Pyrgo murrhina* *Fissurina wiesneri* *Ammodiscus spp.* *Latecarenina holophora* *Pyrgo elongata* *Schlumbergerina alveoliformis occidentalis* *Spiroloculina rotunda*	*Bigenerina irregularis* *B. nodosaris* *B. textularoidea* *Eponides repandus* *Marginulina planata* *Lenticulina calcar* *L. iota* *Quinqueloculina bicostata* *Spiroplectammina floridana* *Textularia agglutinans*

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
FLORIDA-BAHAMAS (cont'd) Bock, 1971; Todd & Low, 1971; Rose & Lidz, 1977; Steinker and Steinker, 1976; Steinker et al., 1977; Levy, 1991; Hallock and Peebles, 1993		*Cyclogyra involvens* *C. planorbis* *Rosalina floridana* *Cymbaloporetta squamosa* *Neoconorbina orbicularis* *Elphidium advenum* *E. discoidale* *E. sagrum* *Cribroelphidium poeyanum* *Discorbis mira* *Eponides antillarum* *Fursenkoina complanata* *F. compressa* *F. pontoni* *Hauerina bradyi* *Miliolinella circularis* *M. fichteliana* *M. labiosa* *M. suborbicularis*	*Textularia agglutinans* *Uvigerina flintii* *Discorbis rosea* *Homotrema rubrum* *Pyrgo murrhina* *Fissurina wiesneri* *Ammodiscus spp.* *Latecarenina holophora* *Pyrgo elongata* *Schlumbergerina alveoliformis occidentalis* *Spiroloculina rotunda* *Textularia agglutinans* *Uvigerina flintii* outerreef: *Archaias angulatus* *Amphistegina lessonii* *Asterigerina carinata* *Discorbis rosea* *Peneroplis proteus* *Homotrema rubrum* *Articulina mexicana* *Eponides repandus* *Planktonics*	*T. candeiana* *Textulariella barrettii* *Bigenerina irregularis* *B. nodosaris* *B. textularoidea* *Eponides repandus* *Marginulina planata* *Lenticulina calcar* *L. iota* *Quinqueloculina bicostata* *Spiroplectammina floridana* *Textularia agglutinans* *T. candeiana* *Textulariella barrettii* *Uvigerina flintii* *U. peregrina* *Textularia mayori*

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
FLORIDA-BAHAMAS (cont'd) Bock, 1971; Todd and Low, 1971; Rose and Lidz, 1977; Steinker and Steinker 1976; Steinker et al.,1977; Levy, 1991; Hallock and Peebles, 1993		*Nonion depressulum matagordanum* *Peneroplis pertusus* *Broeckina orbitolitoides* *Pyrgo denticultata* *P. subsphaerica* *Quinqueloculina agglutinans* *Q. bidentata* *Q. bosciana* *Q. laevigata* *Q. lamarckiana* *Q. poeyana* *Q. polygona* *Q. tenagos* *Q. sabulosa* *Q. seminulum* *Q. subpoeyana*	patchreef: *Clavulina tricarinata* *Discrobis mira* *Peneroplis pertusus* *Peneroplis proteus* *Quinqueloculina bradyana* *Q. lamarckiana* *Q. tricarinata* *Q. poeyana* *Discorbis rosea* *Archaias angulatus* *Miliolinella circularis* *Ammonia beccarii parkinsonia* *Elphidium sagrum* *Valvulina oviedoina* *Miliolinella spp.* *Spiroloculina spp.*	

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
FLORIDA-BAHAMAS (cont'd) Bock, 1971; Todd and Low, 1971; Rose and Lidz, 1977; Steinker and Steinker 1976; Steinker et al.,1977; Levy, 1991; Hallock and Peebles, 1993		*Q. tricarinata* *Q. wiesneri* *Sorites marginalis* *Spirillina vivipara* *Spiroloculina antillarum* *S. arenata* *Spirolina acicularis arietinus* *Triloculina bassensis* *T. bermudezi* *T. bicarinata* *T. carinata* *T. fitterei meningoi* *T. linneiana* *T. oblonga* *T. planciana* *T. quadrilateralis* *T. rotunda* *T. sidebottomi* *T. tricarinata* *T. trigonula* *Valvulina oviedoina*	*Other Miliolids*	

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
TOBAGO Radford, 1974 (South Caribbean)		*Triloculina oblonga* *Bolivina subexcavata* *Elphidium poeyanum* *Quinqueloculina poeyana* *Miliammina fusca* *Nonion gradeloupi*	*Cymbaloporetta squamosa* *Discorbis rosea* *Amphistegina lessonii* *Planorbulina mediterranensis* *Siphonina pulchra* *Neoconorbina terquemi* *Sigmoilina distorta*	*Nonion gradeloupi* *Reophax comprima* *Bigenerina irregularis* *Reussella atlantica* *Textularia candeiana* *Quinqueloculina lamarckiana* *Amphistegina lessonii* *Cibicides antillarum* *Cassidulina subglobosa* *Hanzawaia concentrica*
JAMAICA Martin and Liddell, 1988			*Archaias angulatus* *Amphistegina lessonii* *Discorbis rosea* *Peneroplis proteus* *Asterigerina carinata* *Cyclorbulina compressa* *Cymbaloporetta squamosa* *Quinqueloculina bradyana* *Q. semilunum* *Q. tricarinata* *Siphonina pulchra*	*Bigenerina irregularis* *Textularia conica* *Globigerinoides spp.*

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
ST. LUCIA (West Indies) Sen Gupta and Schafer, 1973		protectedlow-energy bay: *Ammonia tepida* *Amphistegina gibbosa* *Buliminella elegantissima* *Elphidium poeyanum* *Miliolinella circularis* *Melonis pompiloides* *Nonionella atlantica* *Quinqueloculina lamarckiana* *Q. semilunum* *Q. vulgaris* *Bolivina pulchella* *Textularia agglutinans* *Uvigerina canariensis*	open bay with reef patches: *Ammonia tepida* *Amphistegina gibbosa* *Archaias angulatus* *Asterigerina carinata* *Cibicides lobatulus* *Cyclorbiculina compressa* *Discorbis mirus* *D. roseus* *Miliolinella circularis* *M. labiosa* *Peneroplis proteus* *Quinqueloculina bidentata* *Q. candeiana* *Q. lamarckiana* *Rosalina floridana* *R. floridensis* *Sorites marginalis* *Textularia agglutinans* *Textularia conica* *Trifarina bella* *Triloculina oblonga*	

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
TRINIDAD Todd and Brönniman, 1957; Saunders, 1957, 1958; Drooger and Kaasschieter, 1958 (South Caribbean)		*Ammonia tepida* *Elphidium spp.* *Buliminella elegantissima* *Bolivina striatula*	*Amphistegina lessonii*	*Amphistegina lessonii* *Textularia gramen* *Quinqueloculina lamarckiana* *Hanzawaia concentrica* *Uvigerina peregrina* *Cassidulina subglobosa* *Reussella atlantica*
VENEZUELA Hedberg, 1934 (South Caribbean)		*Ammonia spp.* *Elphidium poeyanum* *Quinqueloculina poeyanum* *Ammobaculites dilatatus* *Miliammina fusca* *Haplophragmoides spp.* *Trochammina spp.*	*Amphistegina lessonii* *Textularia agglutinans* *Textularia calva*	*Buliminella spp.* *Nonion gradeloupi* *Hanzawaia concentrica* *Cassidulina subglobosa* *Siphonina pulchra* *Cassidulina spp.* *Eponides repandus* *E. antillarum*
PUERTO RICO (Culver, 1990)		*Ammonia tepida* *Bolivina striatula* *Fissurina goreaui* *Rosalina floridana* *Elphidium poeyanum* *E. excavatum* *E. mexicanum* *Fursenkoina pontoni* *Amphistegina lessonii*		

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
CUBA Bandy, 1964 (North Caribbean)	*Ammonia beccarii tepida*	*Ammonia beccarii tepida* *Elphidium discoidale* *E. poeyanum* *Quinqueloculina akneriana* *Q. bosciana* *Q. lamarckiana* *Miliolinella subrotunda* *Pyrgo cuspidata*	*Amphistegina lessonii* *Archaias angulatus* *Asterigerina carinata* *Discorbis rosea* *Sorites marginalis*	
BARBUDA Brazier, 1975a, 1975b; Radford, 1974 (North Caribbean)	*Triloculina oblonga* *Quinqueloculina subpoeyana*	*Triloculina oblonga* *Quinqueloculina poeyana* *Q. laevigata* *Q. quadrilateralis* *Triloculina planciana* *Parrina bradyi*	*Peneroplis proteus* *Discorbis rosea* *Hauerina ornatissima* *Miliolinella subrotunda* *Archaias angulatus* *Cymbaloporetta squamosa* *Planorbulina mediterranensis*	*Amphistegina lessonii* *Cibicides mollis* *C. pseudoungeriana* *Siphonina pulchra* *Cassidulina spp.* *Eponides repandus* *E. antillarum*

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
BELIZE SHELF Wantland, 1975	*Ammonia beccarii tepida* *Ammobaculites exilis* *Ammotium salsum* *Palmerinella palmerae* *Miliammina fusca* *Arenoparella mexicana* *Discorinopsis aguayoi* *Haplophragmoides sp.* *Gaudryina exilis* *Protoelphidium delicatum* *Cribroelphidium poeyanum* "Low-diversity Miliolid dominant" (brackish lagoon): *Archaias angulatus* *Ammonia beccari* *Heterillina sp.* *Triloculina bermudezi* *Miliolinella spp.* *Q. laevigata* *Q. poeyana* *Elphidium poeyanum*	*Cribroelphidium poeyanum* *Elphidium advenum* *Nonion gradeloupi* *Fursenkoiana spp.* *Nouria sp.* *Reophax sp.* *Bigenerina spp.* *Bulimina tenuis* *Brizalina striatula* *Quinqueloculina candeiana* *Q. laevigata* *Q. bicostata* *Textularia conica* *Globocassidulina subglobosa* *Tretomphalus bulloides* *Neocorbina terquemi* *Rosalina subarauncea* *Hanzawaia concentrica* *Cancris sagra* *Planulina exorna*	*Quinqueloculina poeyana* *Q. laevigata* *Q. candeiana* *Q. bosciana* *Q. bicornis* *Q. lamarckiana* *Q. bradyana* *Q. polygona* *Q. tricarinata* *Q. berthelotiana* *Q. exsculpta* *Triloculina bicarinata* *T. quadrilateralis* *T. linneiana* *T. bermudezi* *Ammomassilina alveoliniformis* *Hauerina occidentalis* *Heterillina cribostoma* *Miliolinella labiosa* *Vertebralina spp.* *Articulina spp.* *Peneroplis spp.* *Archaias angulatus*	forereef: *Asterigerina carinata* *Archaias angulatus* *Gypsina vesicularis* *Homotrema rubrum* *Discorbis rosea* *Remaneica sp.* *Glabratella opercularis* *Neocorbina terquemi* *Trifarina bella* *Triloculina linneiana* *Rosalina candeiana* shelf: *Globocassidulina subglobosa* *Trifarina spp.* *Reussella atlantica* *Bigenerina irregularis* *Textularia spp.* *Reophax spp.* *Articulina spp.* *Bulimina tenuis* *Planktonic species*

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
BELIZE SHELF (cond't) Wantland, 1975	*Discorbis spp*	"High-diversity Miliolid dominant" (lagoon-reef): *Quinqueloculina spp.* *Triloculina spp.* *Planorbulina spp.* *Sorites marginalis* *Discorbis mira* *Cymbaloporetta spp.* *Clavulina spp.* *Textularia agglutinans*	*Textularia agglutinans* *Weisnerella auriculata* *Discorbis mira* *Rosalina spp.* *Cymbaloporetta squamosa* *Hemidiscella palabunda* *Bronnimannia palmerae* *Cibicides mayori* *Bolivina variablis* *Abditodentrix rhomboidalis* *Sorites marginalis* *Planorbulina mediterranensis* *Amphisorus hemprichii* *Clavulina spp.* "*Archaias-Asterigerina* dominant"(high turbulence area): *Archaias* *Asterigerina* *Amphistegina* *Glabratella* *Neoconorbina*	

Table 1 (cont'd): Summary of benthic foraminifera distribution in Bermuda and other subtropical/tropical areas from the literature.

AREA	BRACKISH-WATER (1-2 meters)	NEARSHORE & LAGOONS (1-20 meters)	BACKREEF-REEFS (1-10 meters)	FOREREEF-INNER AND OUTER SHELF (5-60 meters)
BELIZE SHELF (cond't) Wantland, 1975			*Trifarina* *Discorbis* *?Remaneicea cf. R. kelletae* *Bolivina rhomboidalis* *Buliminella elegantissima* *Fursenkoina* *Homotrema*	
PANAMA Bocas del Toro Havach and Collins, 1997		*Ammonia beccari* *Nonionella atlantica* *Elphidium poeyanum* *Fursenkoina pontoni* *Haysenina depressula* *Quinqueloculina spp.*	*Amphistegina lessonii* *Discorbis mira* *Eponides antillarum* *Hauerina fragilissima* *Nodobaculariella cassis* *Planulina exorna* *Pyrgo subsphaerica* *Quinqueloculina bicornis* *Q. collumnosa* *Q. tricarinata* *Rotorbinella umbonata* *Siphonaperta sp.* *Archaias angulatus* *Peneroplis proteus/carinata*	*Amphistegina lessonii* *Biloculinella eburnea* *Cyclogyra planorbis* *Hauerina fragilissima* *Peneroplis proteus/carinata* *Neocorbina terquemi* *Nodophtalmidium cassis* *Textularia schencki* *Cassidulina curvata* *Gyroidina regularis* *G. turgida* *G. umbonata* *Uvigerina laevis* *Cibides. aff. C. floridanus* *C. pachyderma* agglutinated *Miliolidae*

Table 2: Summary of benthic foraminifera distribution in worldwide mangroves from the literature. Species are listed by order of decreasing abundance.
S: Salinity, T: temperature.

AREA	MANGROVE SPECIES	S (‰)	T (°C)	pH
BERMUDA Steinker and Butcher, 1981	*Helenina anderseni* *Spiroloculina hyalina* *Discorinopsis aguayoi* *Trochammina inflata* *Rosalina floridana*	36-37.5 (to hypersa-line)	68-87F	
FLORIDA-BAHAMAS Goldstein, 1976 Phleger, 1965 Rose & Lidz, 1977; Hallock et al., 1993	*Trochammina inflata* *Triloculina oblonga* *Discorinopsis aguayoi* *Ammonia beccarii* *Archaias angulatus* *Quniqueloculina poeyana* *Q. bosciana* open-waterspecies: *Haplophragmoides canariensis* *Q. bidentata polygona* *Q. seminulum* *Massilina protea* *Sigmoilina subpoeyana* *Triloculina bassensis* *T. bermudezi* *T. fitterei meningoi* *T. linneiana* *T. quadrilateralis* *Elphidium discoidale* *Cribroelphidium poeyanum* *Ammobaculites exiguus* *ammotium salsum* *Miliammina fusca* *Discorinopsis aguayoi* *Trochammina inflata* *Quinqueloculina tenagos* *Androsina lucasi*	4.5-58.7	9.5-41	6.4-9.4
TOBAGO Radford, 1974	*Siphotrochammina lobata* *Trochammina laevigata*			

Table 2 (cont'd): Summary of benthic foraminifera distribution in worldwide mangroves from the literature. Species are listed by order of decreasing abundance. S: Salinity, T: temperature.

AREA	MANGROVE SPECIES	S (‰)	T (°C)	pH
TRINIDAD Todd & Bronniman, 1957; Saunders, 1957, 1958; Drooger & Kaasschieter, 1958 (South Caribbean)	*Siphotrochammina lobata* *Trochammina spp.* *Miliammina spp.* *Haplophragmoides spp.* *Ammobaculites spp.* *Trochamminita spp.* *Ammotium salsum* *Tiphotrocha comprimata* *Thecamoebians*	0.04-27		
PUERTO RICO (Culver, 1990)	*Trochammina squamata* *T. cf. T. globigeriformis* *Ammobaculites dilatatus* *Cribrostomoides salsus* *Glomospira gordialis* *Gaudryina exilis* *Ammonia tepida* lagoon behind mangroves: *Helenina anderseni* *Nonionella auricula* *Bolivina striatula* *Elphidium spp.* *Rosalina floridana* *Discorbis murrayi*	34.5-36	27-30	7.6-8.2
BARBUDA Brasier, 1975a (North Caribbean)	swamp: *Ammonia beccarii* *Triloculina oblonga* *Miliolinella labiosa* creek: *Triloculina oblonga* *Quinqueloculina subpoeyana* *Triloculina rotunda* *Amphisorus hemprichii*			

Table 2 (cont'd): Summary of benthic foraminifera distribution in worldwide mangroves from the literature. Species are listed by order of decreasing abundance. S: Salinity, T: temperature.

AREA	MANGROVE SPECIES	S (‰)	T (°C)	pH
BRAZIL Zaninetti et al., 1977; 1979; Hiltermann et al., 1981; Scott et al., 1990.	*Arenoparella mexicana* *Iridia sp.* *Haplophragmoides wilberti* *Siphotrochammina elegans* *S. lobata* *Trochammina inflata* *Crithionina sp.* *Trochamminita salsa* *Polysaccammina ipohalina* *Lituola ? salsa* *Miliammina fusca* *Bahianofuscus pontei* *Ammotium spp.* *Ammoastuta spp.* *Chitinosaccus guaratibaensis* external mangrove/bay: *Ammobaculites spp.* *Ammoscalaria sp.* *Trochammina spp.* *Pseudoclavulina spp.* *Ammonia beccarii* *Discorbis sp.* *Discorinopsis ? vadescens* *Elphidium spp.* *Quinqueloculina sp.*			

Table 2 (cont'd): Summary of benthic foraminifera distribution in worldwide mangroves from the literature. Species are listed by order of decreasing abundance. S: Salinity, T: temperature.

AREA	MANGROVE SPECIES	S (‰)	T (°C)	pH
EQUATOR Boltovskoy and Vidarte, 1977	*Arenoparella mexicana* *Miliammina fusca* *Trochammina inflata* *Ammoastuta inepta* *Ammotium salsum* *Pseudoclavulina gracilis* *Siphotrochammina lobata* *Sulcophax palustris (Pseudothurammina limnetis?)* *Tiphotrocha comprimata* *Ammonia beccarii parkinsonia* *Ammotium directum* *Involutina minutissima* *Quinqueloculina miletti* *Textularia earlandi* rare: *Discorbis peruvianus* *Elphidium excavatum* *E. oceanensis* *Discorinopsis vadescens (=D. aguayoi?)* *Glomospira glomerata* *Haplophragmoides wilberti* *Trochammina macrescens* *Ammotium spp.* *Cribrostomoides salsum (=Trochamminita salsa)* Thecamoebian: *Difflugia pyriformis*	11.6-12.8 ‰	24-29	6.5-7.0

Table 2 (cont'd): Summary of benthic foraminifera distribution in worldwide mangroves from the literature. Species are listed by order of decreasing abundance. S: Salinity, T: temperature.

AREA	MANGROVE SPECIES	S (‰)	T (°C)	pH
COLUMBIA (Boltovskoy and Hincapie de Martinez, 1983)	endemic species: *Ammotium salsum* *Ammobaculites exiguus* *Arenoparella mexicana* near-shorespecies: *Trochammina inflata* *Ammonia parkinsonniana* *Pararotalia magdalenensis* *Palmerinella palmerae* *Elphidium spp.* *Bolivina spp.* *Discorbis spp.* *Miliolinella subrotunda* *Pseudononion japonicum* *Quinqueloculina miletti* *Q. semilunum* *Buliminella elegantissima* *Discorinopsis aguayoi* *Textularia earlandi*	18-50		6-7.5
NEW ZEALAND (Gregory, 1973; Hayward et al., 1996)	*Trochammina inflata* *Tr. macrescens* *Miliammina fusca* *M. pelita* *Haplophragmoides wilberti* *H. canariense* *Trochamminita salsa* *Ammotium fragile* *Pseudothurammina limnetis* *Elphidium excavatum* *Haynesina depressula* *Rheophax moniliforme* *Textularia earlandi* *Ammobaculites exiguus* *Elphidium gunteri* *Ammonia beccarii* Thecamoebians: *Difflugia sp.* *Centropyxis sp.*	brackish		

Table 2 (cont'd): Summary of benthic foraminifera distribution in worldwide mangroves from the literature. Species are listed by order of decreasing abundance. S: Salinity, T: temperature.

AREA	MANGROVE SPECIES	S (‰)	T (°C)	pH
SUNDA SHELF (SOUTH CHINA SEA) (Biswas, 1976)	*Arenoparella mexicana* *Haplophragmodium salsum* *Haplophragmoides wilberti* *Miliammina pariaensis* *Trochammina laevigata*	5-25		8
SENEGAL (Debenay et al., 1989)	*Ammotium salsum* *Arenoparella mexicana* *Asterotrochammina sp.* *Eggerella cf. scabra* *Gaudryina exilis* *Trochammina inflata* *Tr. sp.* *Ammonia tepida* *Ammonia parkinsonia* *Bolivina spp.* *Discorbis sp..* *Elphidium gunteri* *Nonion sp.* *Haplophragmoides wilberti* *Trochamminita salsa* *Miliammina fusca* *Quinqueloculina spp.* *Triloculina spp.*	1-124	21-30	7.3-7.8
SINAI (Halicz et al., 1984)	*Textularia cf. T. agglutinans* *Clavulina sp.* *Peneroplis planatus* *Spirolina arietina* *Sorites spp.* *Triloculina sp.* *Quinqueloculina sp.* *Rosalina sp.* *Cymbaloporetta tabellaeformis* *Amphistegina spp.* *Ammonia beccari* *Chaleengerella bradyi* *Calcarina calcar* *Elphidium spp.*	up to 47		

CHAPTER II. METHODS

2.1. Recent distribution of benthic foraminifera

2.1.1. Sampling

In May 1993 and February 1995, about 200 samples of the top 1 cm of surface sediment were collected in a gradient of environments. Although foraminifera can live at depth down to 30 cm in the sediment (Goldstein and Harben, 1993), Collins (1996) concluded that living populations at depth had no effects on total populations, so sampling the top 1cm of sediment was sufficient to study total populations. Lagoons, marine caves, mangrove swamps, landlocked marine ponds, and reefs of Bermuda provide a large variety of subtropical carbonate environments that offers an opportunity to study the influence of various environmental conditions on the distribution of benthic foraminifera in the sediments (fig. 3). The following conditions permit characterization of the environments: different depth, degree of confinement (opening to the sea through channels, underground fissures or caves), degree of exposure, salinity, temperature, illumination, sediment type, and grain size. Other physical and chemical parameters were not measured since each study site was sampled only once or twice. For marshes,

Figure 3. Sampling locations.

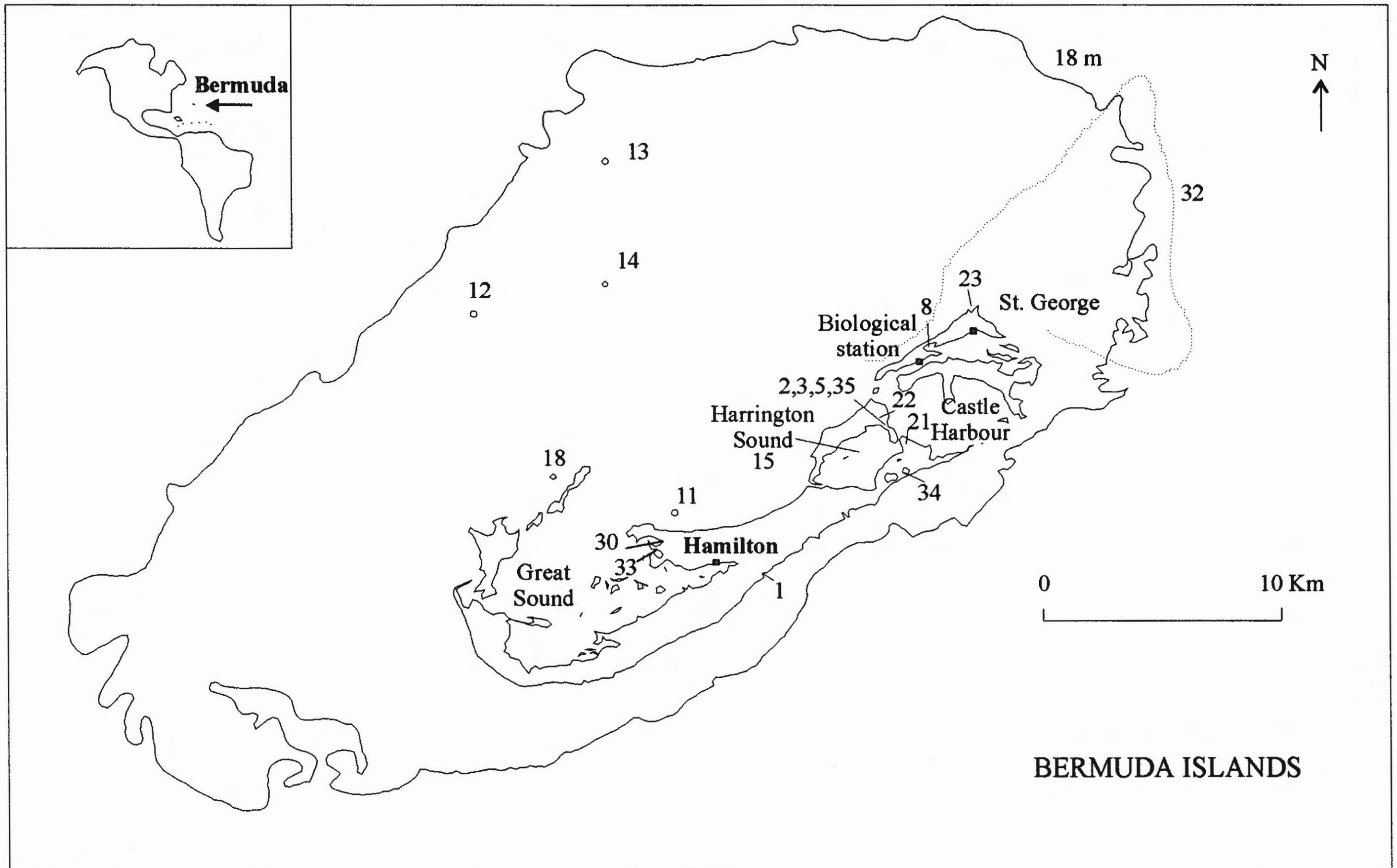


Figure 3: Sampling locations.
Caves: Walsingham cave (2), Leamington cave (21), Crystal cave (22)
Lagoons: Devonshire Dock (11), Harrington Sound (15), along Ireland I. (18), North Lagoon traverse (32)
Reefs: Crescent reefs (12), Hog Breaker reefs (13), Twin reefs (14), North lagoon traverse (32)
Mangrove swamps: Hungry Bay (1), Mangrove Bay (8), Coot Pond (23), Mill Share (33), Walsingham Bay (35)
Landlocked ponds: Grotto Pond (5), Walsingham Pond (3), Spittal Pond (34)
Coring: Hungry Bay (1), Mill Creek (30), Mill Share (33)

Phleger and Bradshaw (1966) have shown that these variables change dramatically throughout each tidal cycle.

Shallow lagoon samples were collected using a grab sampler from a boat. The Ekman Dredge sampler was opened carefully to avoid disturbance of sediment surface and 1cm-deep sediment layer was scooped with a spoon and placed into a container. The surface was covered with a brown organic film, with occasional plants in growth orientations. Deeper lagoon and fore-reef areas were sampled with a Van Veen Grab from a larger vessel. A diver collected reef samples, and a snorkeler collected samples in marine caves. Sediment surface was carefully scooped with a container and the container quickly closed to avoid contamination. The mangrove swamps and landlocked marine ponds were sampled using a small 10 cm-long corer (3.5 cm diameter) pushed by hand in the sediment, and the top 1 cm was put into a container. The sample locations are shown in figure 3. Table 3 summarizes the main characteristics of environments sampled.

Even within the same environment, subject to a particular set of conditions as listed above, benthic foraminiferal distribution shows variations through time (seasonality) and space. Benthic foraminifera have a clumped distribution, so spacing of samples can be critical. Numerous samples were collected to avoid that problem. Schafer (1968) observed a clumped lateral distribution in both living and dead populations in the Gulf of St. Lawrence. These variations may be attributed to feeding habits and locomotive modes of larger marine invertebrates and fish, temporal variation in energy conditions, and mode of reproduction of foraminifera (Schafer, 1968). A study of the variation in living foraminiferal populations (standing crop) over short lateral distances in Florida indicated that "dominant species are quite constant between samples at each station and variation is caused by fluctuations in rarer species" (Lynts, p.1, 1966). The rarer species in recent sediment are probably even more rare in ancient sediment, so the spacing of samples within one environment is judged satisfactory when similarity of diversity and abundance of dominant species is reached. To avoid the problem of seasonal variations, total assemblages (living + dead specimens) were determined instead of only living specimens. Scott and Medioli (1980b) studied living assemblages and total assemblages in a Nova Scotia salt marsh over a three year period. They observed highly variable living assemblages due to seasonal and micro-environmental changes, but very stable total assemblages. The authors concluded that total associations more accurately depict modern environments and are, therefore, more useful to paleoecologists. Seasonal variations, however, should be less important in Bermuda warm waters than in non-tropical waters, because sea water temperatures vary only from 16°C in winter to 28°C in summer, to 38°C in some enclosed ponds (Thomas and Logan, 1992). Some areas (lagoon, mangroves) were sampled twice, in February and in May, to detect possible seasonal variations in living populations.

Differences between living and dead assemblages can be caused by the presence of phytal foraminifera. In Florida Bay, some species are confined to plants, others to sediment, et al. both substrates (Martin and Wright, 1988). The living assemblages studied in this project reflect only species confined to sediment and species living on both plants and sediment. The existence of foraminiferal species confined to plants is not documented in Bermuda. Steinker and Clem (1984) noticed differences in diversity between biocoenosis on plants and thanatocoenosis within the sediment in turbulent environments but not in quiet environments (only 100 specimens counted/sample). If living, exclusively phytal species do occur in turbulent environments, they are assumed not to represent a large percentage of total assemblages in samples representing approximately 10 years of accumulation of empty tests (rate of sedimentation is 1cm/10y).

Another factor that may affect the composition of assemblages is the transport of foraminiferal tests after death. Living specimens detected with Rose Bengal stain (Walton, 1952) give information about diversity of species living in the environment. The abundance of living species reflect only seasonal peaks. Size sorting of dead tests also provide evidence of transport, larger tests being more abundant in high energy environments (Steinker and Clem, 1984).

Reworking of the upper layers of sediment by worms, shrimps, clams, fishes and holothurians can be intense (Morris et al., 1977). This phenomenon probably dilutes the abundance of living organisms by spreading them downward but total assemblages should be unaltered since reworking is random.

Problems posed by differences in rates of sedimentation between environments are avoided by comparing the percentages of foraminiferal species, not absolute numbers.

2.1.2. Sample analysis

After collection, the samples were preserved in a solution of seawater containing 4 g of Borax (buffer) and 40 cc of formaldehyde per liter, until processed. Then, 10cc of the sample was washed through a 63 micron sieve. Rose Bengal was added to determine specimens living at time of collection, and rinsed out after a few days. Samples containing abundant foraminifera were split using a wet splitter (Scott and Hermelin, 1993). Fractions were examined in a Petri dish with water, until a statistically significant number of specimens (at least 300) was reached. The use of water facilitated the recognition of stained specimens and allowed observation of whether the stain colored the foraminiferal protoplasm or only organic matter attached to the test surface.

Identifications of foraminifera species were made using Bermudez and Seiglie (1963), Bock (1971), Bradyi (1884), Buzas and Severin (1982), Cimmermann and Langer (1991), Cushman (1917, 1918-31), Steinker (1980), Todd and Bronnimann (1957), and Wantland (1975). The nomenclature follows Loeblich and Tappan (1964; 1988).

Foraminifera and thecamoebian specimens were photographed using a scanning electron microscope (SEM) in the Biology department of Dalhousie University, and an environmental scanning electron microscope (ESEM) at the Bedford Institute of Oceanography. Pictures of larger species were obtained from a scanning light microscope (SLM) in the Earth Sciences department of Dalhousie University. The pictures were saved on computer as digital images and the plates were made with Adobe® Photoshop program.

The analysis of samples gave information such as: species/genus diversity and abundance, living/total species and specimens ratio, abundances of porcellaneous/agglutinated/hyaline species, species depth ranges, intraspecific variability and ecophenotypes (changes in form, ornamentation, or size of the test resulting from adaptation of a species to different environmental conditions). This information permitted definition of assemblages characteristic of particular environments (biofacies), defined by the physical conditions cited above.

Table 3: Location, description, tidal range, salinity, temperature, sampling depth, sediment type and grain size, and number of sediment samples of Bermuda environments in this study. Numbers in brackets are from Thomas and Logan (1992). R = red mangrove, B = black mangrove, BU = Buttonwood, and HHW = Higher high water.

LOCATION	DESCRIPTION	TIDAL RANGE (m)	SALINITY (‰)	TEMPERATURE (°C)	DEPTH (m)	SEDIMENT TYPE & GRAIN SIZE	NO. SAMPLES
CAVES	in isthmus between Castle Harbor and Harrington Sound						
Walsingham cave	pristine cave, connections through fissures and tunnels with Castle harbor, and possibly with Walsingham Pond, brackish colder 50cm-deepsurfacelayer	tidal	22surface 32 below 0.5m depth	21surface 24.8 below 0.5m depth	0.5-6	f. to m. sand	6
Leamington cave	commercial, connections with Castle Harbor, brackish colder 65cm-deep surfacelayer	tidal	11surface 30 below 0.65m depth	23surface 24.8 below 0.65m depth	1-3	f. sand	4
Crystal cave	commercial, connections with Castle Harbor and Walsingham cave, brackish 65cm-deepsurfacelayer	tidal	16surface 28 below 0.65m depth	20.5-22surface 21 below 0.65m depth	1-10	silty sand to c. sand	7

Table 3: Location, description, tidal range, salinity, temperature, sampling depth, sediment type and grain size, and number of sediment samples of Bermuda environments in this study. Numbers in brackets are from Thomas and Logan (1992). R = red mangrove, B = black mangrove, BU = Buttonwood, and HHW = Higher high water.

LOCATION	DESCRIPTION	TIDAL RANGE (m)	SALINITY (‰)	TEMPERATURE (°C)	DEPTH (m)	SEDIMENT TYPE & GRAIN SIZE	NO. SAMPLES
LANDLOCKED PONDS							
Walsingham pond	landlocked tidal marine pond, connections through fissures, tunnels, and cave to inland lagoon Castle Harbor, R, B, BU, (4,933 m^2)	(0.39)	35 (33-39.5)	24 (19-27.7)	0-0.12	peat	6
Spittal Pond	landlocked saline non-tidal pond, separated from south shore by limestone ridge, marine flooding during storms, B, BU, (229 m^2)	non-tidal	14-17 (6.5-42.5)	18-20 (16.1-37.5)	0-1.5	peat, sandy peat, muddy sand	14
large grotto pond	small pond surrounded by limestone ridge in Tom Moore's jungle, possible connection to inland lagoon Castle Harbor	tidal	35	24	0-0.5	peaty sand, sandy mud	3

Table 3: Location, description, tidal range, salinity, temperature, sampling depth, sediment type and grain size, and number of sediment samples of Bermuda environments in this study. Numbers in brackets are from Thomas and Logan (1992). R = red mangrove, B = black mangrove, BU = Buttonwood, and HHW = Higher high water.

LOCATION	DESCRIPTION	TIDAL RANGE (m)	SALINITY (‰)	TEMPERATURE (°C)	DEPTH (m)	SEDIMENT TYPE & GRAIN SIZE	NO. SAMPLES
MANGROVES							
Hungry Bay	mangrove swamp in bay sheltered from south shore by limestone ridge, R, B, BU (29,717 m^2)	0.6-1.1	29-33	30	HHW-0.3	peat, peaty sand, m. sand	29 (transect) +11 (bay side)
Mill's Share	marsh-mangrove swamp in bay on Great Sound, R, B, BU, (10,907 m^2)	0.6-1.1	33	20	HHW-0	peat, peaty sand, m. sand	23 (transect)
Mangrove Bay	mangrove bay in inland lagoon Ferry Reach, R, B, BU, (2,837 m^2)	0.6-1.1	33	23	0-0.6	peat, sandy peat, m. sand	10
Coot Pond	mangrove bay protected from northeastern shore by limestone ridge, R, B, BU, (1,643 m^2)	0.6-1.1	35	27	0-0.6	peat, m. sand	12
Walsingham Bay	mangrove bay in inland lagoon Castle Harbor, R, B. BU, (3,776 m^2)	0.6-1.1	35	not measured	HHW-0.05	sandy peat	4

Table 3: Location, description, tidal range, salinity, temperature, sampling depth, sediment type and grain size, and number of sediment samples of Bermuda environments in this study. Numbers in brackets are from Thomas and Logan (1992). R = red mangrove, B = black mangrove, BU = Buttonwood, and HHW = Higher high water.

LOCATION	DESCRIPTION	TIDAL RANGE (m)	SALINITY (‰)	TEMPERATURE (°C)	DEPTH (m)	SEDIMENT TYPE & GRAIN SIZE	NO. SAMPLES
REEFS		(0.8)	35-36.5	24 (16-29)			
In lagoon:							
-Crescentreefs	*Thalassia* grass bed surrounded by reefs, centre of North lagoon				4.5	m. to c. sand	5
-North Lagoon traverse	sand trough between reefs, and sand flats on top of reefs, northeastern part of North Lagoon				3.7-4.6	f. to v. c. sand	3
On platform edge:							
-Hogbreakerreefs	sand trough surrounded by reefs, 200m southeast of Hog breaker, northwestern Bermuda platform				9	c. sand	5
-Twinreefs	sand trough surrounded by reefs, 150m south of twin Boiler reefs, northwestern Bermuda platform				9	c. sand	5

Table 3: Location, description, tidal range, salinity, temperature, sampling depth, sediment type and grain size, and number of sediment samples of Bermuda environments in this study. Numbers in brackets are from Thomas and Logan (1992). R = red mangrove, B = black mangrove, BU = Buttonwood, and HHW = Higher high water.

LOCATION	DESCRIPTION	TIDAL RANGE (m)	SALINITY (‰)	TEMPERATURE (°C)	DEPTH (m)	SEDIMENT TYPE & GRAIN SIZE	NO. SAMPLES
LAGOONS							
Devonshire Dock	*Syringodium* grass bed, 100m from North shore, in North Lagoon.	(0.8)	35	24	7	muddy sand	3
Northwest shore, along Ireland island		(0.8)	35	24	15	f. sand	1
Traverse in North Lagoon	sand patches, seagrass beds, and reefs, from northeastern shore to northeastern platform edge	(0.8)	35	24	4.6-25	f. to c. sand	13
Harrington Sound	almost totally enclosed lagoon, narrow opening through Flatt's inlet to North lagoon	0.2	35 (35-37)	20-24 (17-29)	2-24	silt to m. sand	17

2.1.3. Study sites

2.1.3.1. Marine caves

Bermuda Pleistocene limestone hosts between 200 and 300 caves connected to the sea through fissures and channels. During Pleistocene lowstands, the contact basalt/limestone was well above sea level. Percolating ground water concentrated at this contact formed very large solution conduits. Progradational collapse of the conduits produced Bermudan caves (Mylroie, 1989). Some of these caves have tidal pools extending as deep as 24 meters below sea level.

Although Bermuda has always been isolated from continental land masses since its formation 110 million years ago, its littoral fauna shows a low level of endemism. The Gulf Stream has probably been the major source of immigration and is responsible for the large similarity between Caribbean and Bermuda shallow-water faunae (Iliffe et al., 1983). However Bermuda caves are isolated habitats on the islands, and offer a unique opportunity to investigate the origins and evolution of cave faunae. Iliffe et al. (1983) reported a 30% endemism among the cave invertebrate species of Bermuda caves. They believe that the presence of warmer deep cave waters may have permitted survival of some groups of invertebrate during the glaciations, since the early Pleistocene (age of the oldest carbonates in Bermuda). Some cavernicolous species could even have an older origin (separation of the African and American continents, and Tethyan time) and they would have survived in anchialine pools or lava tube caves on post-volcanic Bermuda (about 30 million years ago) until the formation of limestone caves in the early Pleistocene (Iliffe et al., 1983). Other species are probably of deep sea origin, by colonizing the only environment where they could compete with shallow-water fauna (Iliffe, 1979).

To my knowledge, the foraminiferal distribution of karstic cave faunae have never been investigated in detail. The literature deals mainly with reef cave communities, where encrusting foraminifera can be abundant (Logan et al., 1984), but these species are typical reef foraminifera (such as *Homotrema rubrum*) and are absent in the karstic caves that we studied. Sket and Iliffe (1980) cited two foraminiferal species in their preliminary study of Bermuda cave fauna. Steinker (personnal comm.) identified 47 species of foraminifera in samples collected with a fine mesh net in several Bermuda caves. However this is a short unpublished report with no indication of net size, precise sampling locations, foraminiferal abundances, and living assemblages investigation.

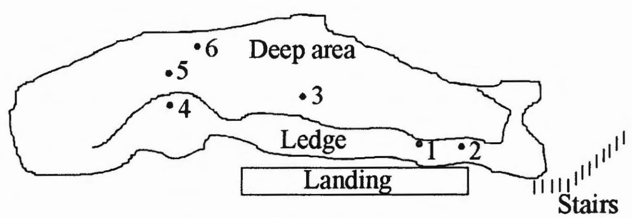
Therefore the Bermuda caves geographic isolation, biogeographic connections, and particular ecological habitat, combined with a poor literature, precipated this study of benthic foraminifera and thecamoebian distribution in three of the numerous Bermuda caves.

Bermuda caves are complex marine environments with tidal fluctuations, reduced illumination, variable connections to surrounding environments (caves, lagoons, and/or mangroves), and temperature and salinity gradients varying with depth. Medium-grained carbonate sand occurs in shallow water (<1m) and silty carbonate sand in deeper water. A 60 cm deep brackish layer occurs at the water surface.

The three tidal marine caves studied, Leamington, Crystal, and Walsingham caves, are located in the isthmus between two inland lagoons called Castle Harbour and Harrington Sound (fig. 3). Leamington and Crystal caves are commercial, and thus are artificially illuminated during the day. Crystal cave hosts a 30 meter deep tidal pool (Bretz, 1960) in a solution chamber 40 metres below the surface. The tidal range (0.3 m) is that of Harrington Sound 3.3 km distant. Stalacmites stand at 10 and 20 meters under water. Walsingham cave is a pristine cave located in Tom Moore's forest, and it is part of a large underwater cave system with close connections to Castle Harbour (D. C. Steinker, pers. comm.).

Seventeen sediment samples were examined for their (living + total) foraminiferal and thecamoebian content. Physical characteristics are summarized in table 3. Sample location is shown on figures 4, 5 and 6.

Figure 4. Samples location in Walsingham cave (site 2).



Walsingham cave

No scale

Figure 5. Samples location in Leamington cave (site 21).

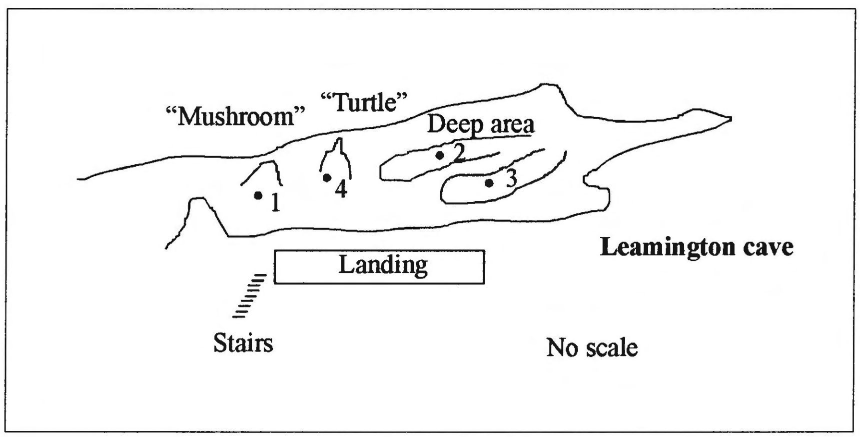
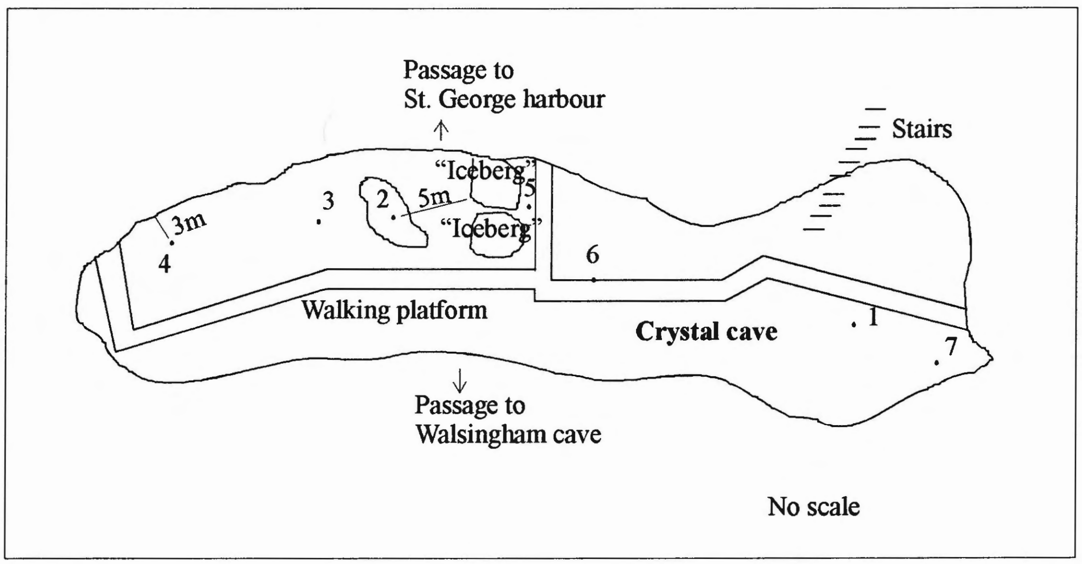

"Mushroom"
"Turtle"
Deep area
1
2
3
4
Landing
Stairs
Leamington cave
No scale

Figure 6. Samples location in Crystal cave (site 22).


Passage to
St. George harbour
Stairs
"Iceberg"
"Iceberg"
3m
5m
1
2
3
4
5
6
7
Walking platform
Crystal cave
Passage to
Walsingham cave
No scale

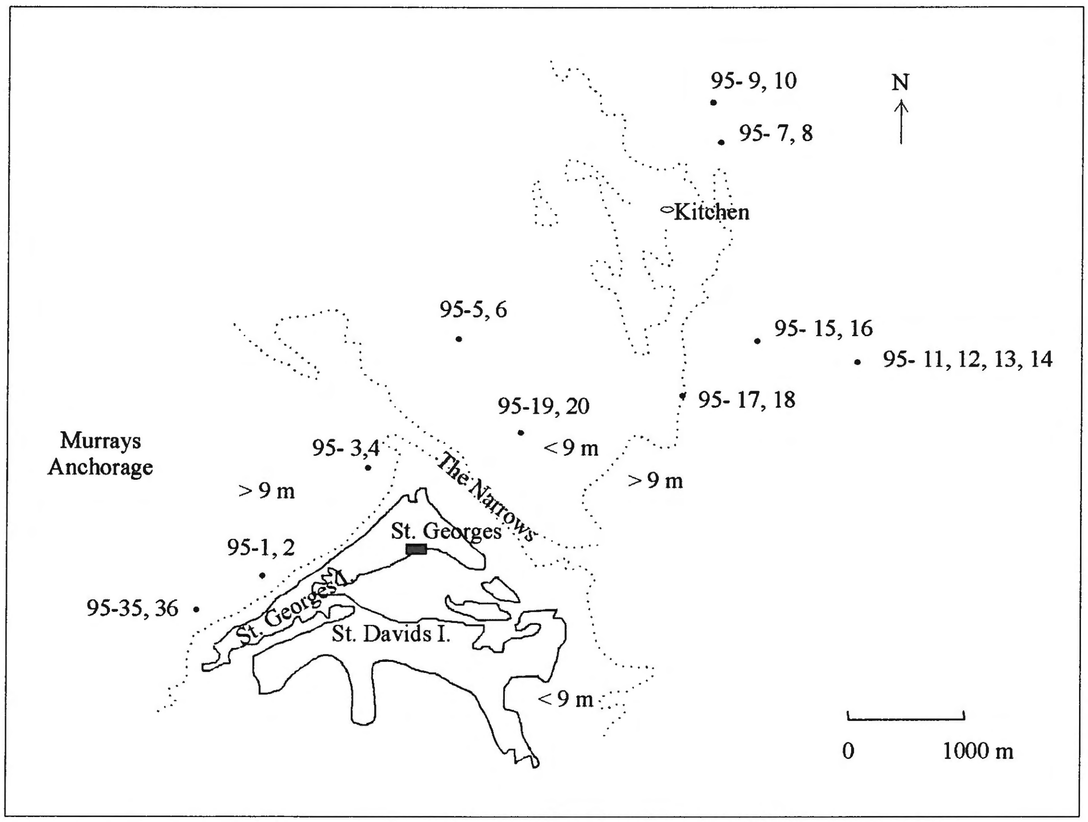
2.1.3.2. Lagoons

Two lagoons were sampled (figs. 7 and 8), a large open lagoon (North Lagoon) and a smaller enclosed lagoon (Harrington Sound). Their physical characteristics are summarized in table 3. These two lagoons were chosen for study because they show very different and opposite environmental conditions. These differences might be reflected in foraminiferal distributions, permitting the determination of foraminiferal biofacies useful to paleoecology.

A. North lagoon

North lagoon is a large open normal-marine environment with stable temperature, salinity, and oxygen content, and with many habitats such as seagrass beds, sand flats, and reefs. It is protected from the open ocean by a reef rim on the north and by the islands on the south. North Lagoon includes a series of depressions separated by irregular banks (Thomas and Logan, 1992). The sediment composition and biotope distribution were described by Upchurch (1970, in Morris et al., 1977) (see introduction). Because of the lagoon's protected condition, the sediment (sand to gravel) is not well sorted or transported, but there is enough water energy to prevent the deposition of silts and clays, except in the deeper holes.

Figure 7. Samples location in North Lagoon traverse (site 32) (modified from Bermuda Admiralty chart 334, 1984).



95- 9, 10
N
95- 7, 8
Kitchen
95-5, 6
95- 15, 16
95- 11, 12, 13, 14
95- 17, 18
95-19, 20
< 9 m
Murrays Anchorage
95- 3,4
> 9 m
> 9 m
The Narrows
St. Georges
95-1, 2
95-35, 36
St. Georges I.
St. Davids I.
< 9 m
0
1000 m

Samples were collected in three different areas of North Lagoon; at Devonshire Dock, 100m from North shore; on the northwest shore, along Ireland island; and along a traverse from the northeastern shore to the northeastern platform edge (fig. 7).

B. Harrington Sound

Harrington Sound was formed in an interdune depression widened by cave collapse and erosion. It is surrounded by cliffs and almost totally enclosed. A narrow inlet (Flatt's Inlet) to its southwestern corner and small subsurface caves and porous rocks connect it to the sea. This protected situation allows very low sediment exchange with the outside but maintains normal oceanic temperature and salinities. However, the lagoon shows a summer stratification, with colder, less oxygenated to anoxic, stagnant, and more saline bottom waters (below 17 meters depth) (Neumann, 1965).

Harrington Sound includes an irregular platform on the west, and two flat-floored basins separated by a median northeastern ridge. Four ecological zones were described on the basis of the sediment content (Neumann, 1965):

-the rocky shore zone on the cliffs;

-the Shallow Sandy zone (below 10 m depth) with medium to coarse sands formed by rock and pelecypod fragments, lesser amounts of calcareous algae, serpulid tubes, and peneroplid foraminifera, the nearshore sands originating mainly from cliff erosion;

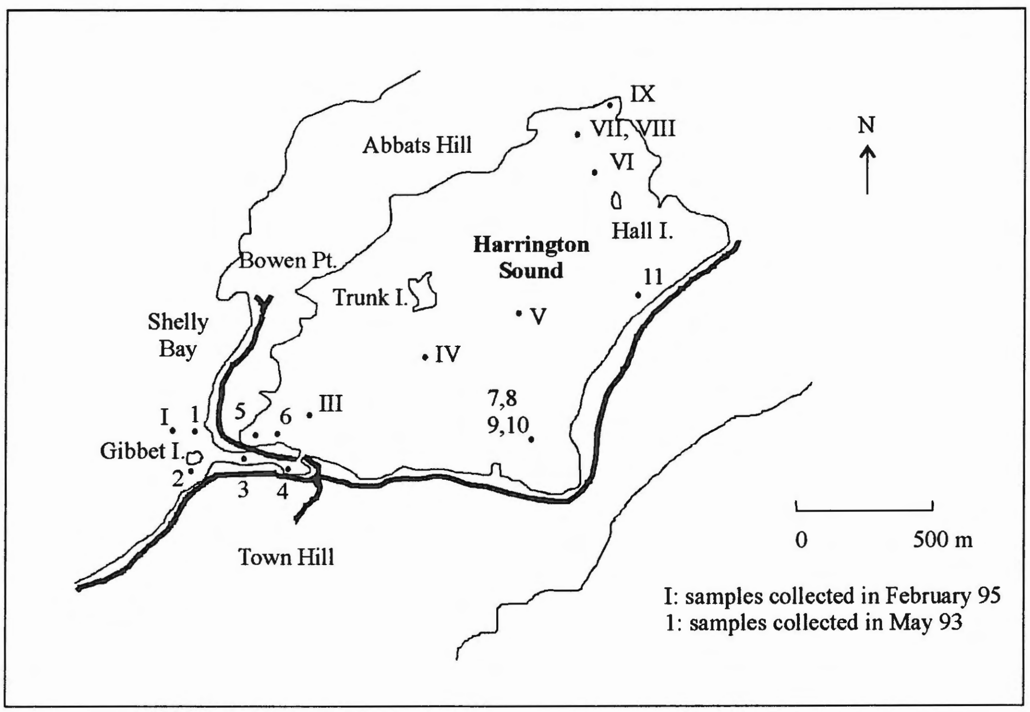
-the *Oculina* zone (between 10 and 17 m depth) with coarse material from fragments of the coral *Oculina* and the mussel *Arca* in a matrix of silt and clay produced mainly by boring organisms and some physical and biochemical attrition of skeletal material and erosion of rock;

-the Subthermocline zone (between 17 and 25 m depth) with silt and clay, and some shells in situ. Harrington Sound includes habitats such as seagrass beds and sand flats.

Erlenkeuser et al. (1981) reconstructed the history of the lagoon by studying one sediment core. Harrington Sound formed around 11,000 y B.P., and became successively, as sea level rose, a freshwater marsh, a brackish lake, and finally a marine lagoon since about 6,200 y B.P. In marine sections of the core, the foraminifera *Elphidium spp.*, *Ammonia beccarii*, *Bolivina spp.*, *Triloculina spp.*, and *Quinqueloculina spp.* were present. The Rotalinids composed 95% of the assemblages. In older sections before 6,200 y B.P. there are no miliolids and only *Elphidium spp.* and *Ammonia beccarii* occur.

Sediment samples were collected twice, in winter (February 95) and in early summer (May 93) to study possible seasonal variations in living populations, and to increase sampling stations (fig. 8).

Figure 8. Samples location in Harrington Sound (site 15) (modified from Bermuda Admiralty chart 334, 1984).


Abbats Hill
IX
VII, VIII
VI
Hall I.
Harrington
Sound
Bowen Pt.
Trunk I.
11
V
Shelly
Bay
IV
III
I
1
5
6
7,8
9,10
Gibbet I.
2
3
4
Town Hill
N
0
500 m
I: samples collected in February 95
1: samples collected in May 93

2.1.3.3. Reefs

The ecology of Bermuda reefs has been extensively studied, and summarised in a guidebook, by Logan (1988). Most rim reefs and nearshore reefs are established on Pleistocene topographic highs, but some lagoonal patch reefs grow on surfaces with no pre-existing relief. Holocene reefs also cover older reefs. The topographic highs were produced by a combination of subaerial solution during Pleistocene glacial periods and carbonate deposition during interglacial periods. Two major communities build the Bermuda reefs. The most common is the coral-algal type, and the second type, found mostly in the south shore, consists of algal-vermetid cup reefs (crustose coralline algae, vermetid gastropods, and the hydrozoan *Millepora*). Both types have a large morphological variety. Reefs are classified according to their morphology, evolutionary stage, size, water depth, and biotic elements (details in Logan, 1988).

Reef foraminifera have not been studied in Bermuda apart from Barnhart's (1963) study of a few samples along a traverse in North Lagoon. The *Archaias-Homotrema-Amphistegina* asssemblage he recognised as typical of reef is detailed in table 1. Pestana (1983) reported two reef species of *Carpenteria* that live on the north edge of the platform and on the south coast, but not in the lagoon or inshore waters. This foraminifer lives mainly on the outer shoals surrounding the platform, attached to dead and live corals.

In other studies about Bermuda reefs, *Homotrema rubrum* is the only cited reef foraminifer. Mackenzie et al. (1965) studied sediment transport using this pink foraminifera as marker, and found that sand-size sediment is transported far down slope but only a short distance into the lagoon. Garrett et al. (1971) examined two patch reefs in North Lagoon and found *Homotrema* and other unidentified encrusting foraminifera in cavities and reef wall. Coarse sediment, such as *Homotrema*, covers the reef top, and occurs only 15 meters down the sediment slope. Fine to medium grained sands extend further, and include, close to the reef, *in situ* skeletal organisms and reef sediment washed off the reef during storms, and away from the reef, calcareous algae, molluscs, and lagoonal foraminifera (peneroplids and miliolids). A halo of silt and very fine sand surrounds the reef top and settle down around it and into reef caves. Scoffin (1972) studied fossilization of Bermuda patch reefs and reported also *Homotrema* as an encrusting organism. He noted that encrustations by foraminifera and other organisms in cavities are common in fossil rocks because primary builders are preferentially removed by boring organisms. Thomas and Stevens (1991) compared northern and southern constructional lips and cup reefs in Bermuda and found more *Homotrema* in the southern reef cavities (11.6-15.2% of volume) than in the northern ones (0.4-0.9%).

Reef samples were collected in two areas of Bermuda platform; along a traverse in North Lagoon on the northeast, and around two outer reefs (Hog breaker and Twin reefs) and one lagoonal reef (Crescent reefs) on the west. The sampling areas (fig. 3) cover rim reefs (outer reefs) and lagoonal reefs on the northwest and northeast. Table 3 summarizes the physical parameters. The results from the reefs sampled along the North Lagoon traverse are discussed in the "lagoons" section (3.1.2.).

2.1.3.4. Mangrove swamps

To document the recent distribution of benthic foraminifera in mangrove swamps of subtropical/tropical settings, and to determine accurate sea-level markers, a quantitative study of foraminiferal distributions in Bermuda mangrove swamps was carried out. Samples were collected along two transects, one transect in Hungry Bay mangrove swamp, and one transect in a marsh-swamp complex in Mill Share, the first detailed transects measured in mangrove swamps for foraminiferal studies (fig. 3). The data were then used to define sea-level marker points that constructed a late Holocene sea-level curve (chapter 3.2.).

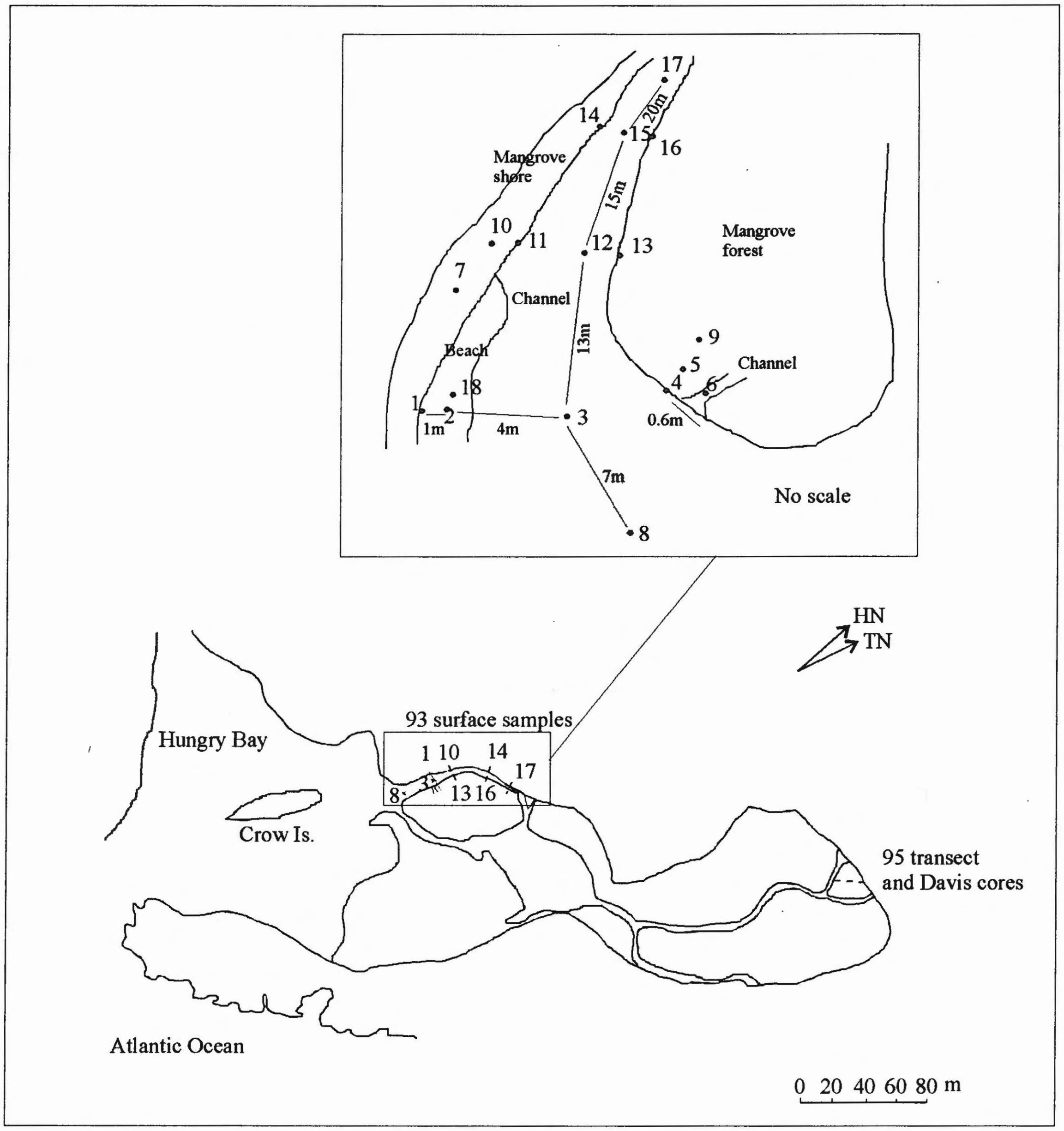
The distribution of mangrove foraminifera was also studied in the fringing mangroves of Mangrove Bay, Coot Pond, and Walsingham Bay, and in the sea side of Hungry Bay (fig. 3).

This set of mangrove study sites forms a variety of mangrove environments differing by physical conditions such as degree of protection (or connections to north shore or south shore or inland lagoons), mangrove swamp or fringing mangrove, and water energy.

A. Hungry Bay

Surface samples were collected by hand in Hungry Bay mangrove swamp. This swamp, located on the Bermuda South shore (fig. 9), is the only non-disturbed mangrove swamp left in Bermuda. It is also the largest mangrove swamp in Bermuda (2.94 ha), and the only swamp with a fully formed drainage channel system. Unfortunately the largest mangrove areas that formerly existed in Hamilton Bay have been almost entirely dredged out. The bay is 1-2 m depth and is protected from the south shore by a limestone ridge. Tides are semi-diurnal and range between 0.6 and 1.1 meters (Ellison, 1993). There are only two mangrove species: *Rhizopora mangle* (red mangrove) and *Avicennia germinans* (black mangrove), associated with the buttonwood. Since there are no rivers in Bermuda, the swamp sediment is mainly autochtonous (peat) with some calcium carbonate from the bay. The samples were collected along a detailed transect starting from a channel to the Higher High Water mark (HHW), in the northeastern deep reach of the mangrove swamp in February 95. Other sediment samples were collected in the bay side of Hungry Bay, in May 93.

Figure 9. Location map of surface sampling (1993), transect and Davis cores (1995) in Hungry Bay (site 1) (modified from Ellison, 1993).


17
14
20m
15
16
Mangrove shore
15m
10
11
12
13
Mangrove forest
7
Channel
13m
9
Beach
5
Channel
4
6
18
1
2
3
1m
4m
0.6m
7m
No scale
8
HN
TN
93 surface samples
Hungry Bay
1 10 14
17
8
3
13 16
Crow Is.
95 transect
and Davis cores
Atlantic Ocean
0 20 40 60 80 m

B. Mill Share

Surface samples were also collected along a transect in the only marsh-mangrove swamp complex of Bermuda, in Mill Share (fig. 10). This area is actually a private backyard and its environmental conditions are partially disturbed. It is growing above a substrate of allochtonous calcareous sand fill (about the top 60 to 90 cm) spread about 30 years ago. The salt marsh is dominated by the succulent herb *Sesuvium portulacastrum* above mean tide level behind the mangrove swamp, and by the salt marsh oxeye, *Borrichia frutescens*, around high tide mark. The mangrove swamp includes the same mangrove species as Hungry Bay swamp. However the surface mangrove environment is assumed to have reached a mature level such that it is representative of a natural mangrove environment that might have existed prior to dredging.

C. Mangrove Bay

Mangrove Bay is a small bay (2,837 m^2) located in the inland narrow Ferry Reach, close to the Bermuda Biological Station for Research. The red and black mangroves grow around the bay, as well as the buttonwoods. Tidal range varies between 0.6 to 1.1 meter (Thomas and Logan, 1992). Samples were collected along two small transects in the fringing mangroves (fig. 11).

Figure 10. Location map of coring activities in Mill Creek (site 30), and coring activities and transect in Mill Share (site 33) (modified from D.D.S. 311, series E8110, Bermuda sheet 3, 1967).

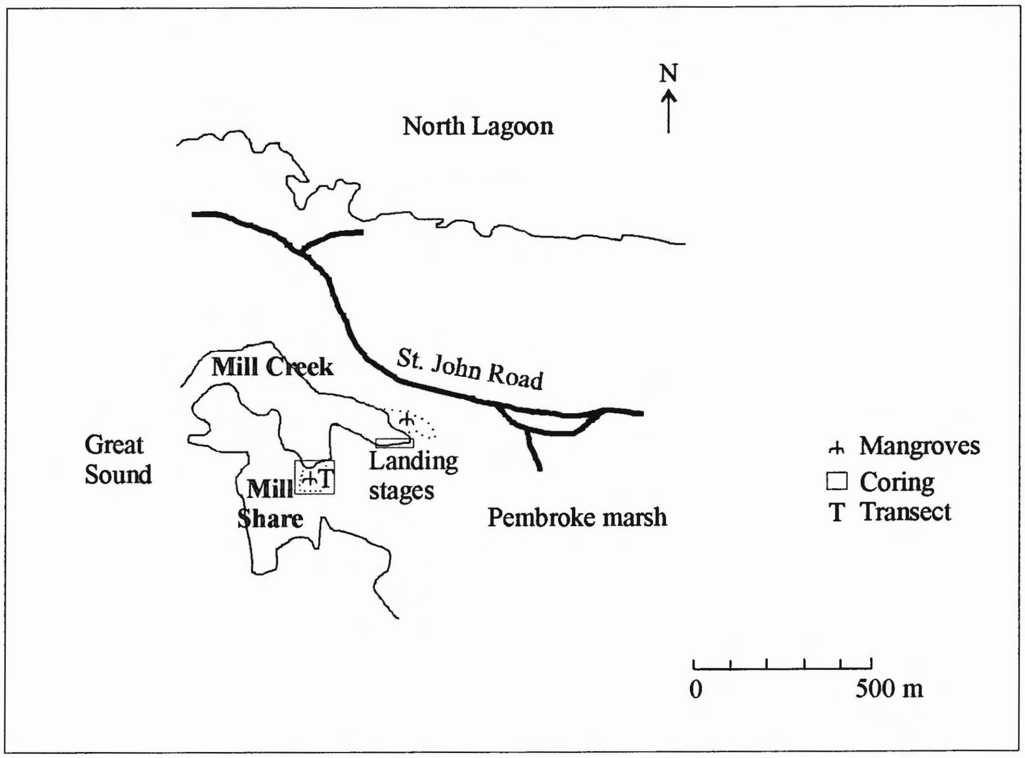
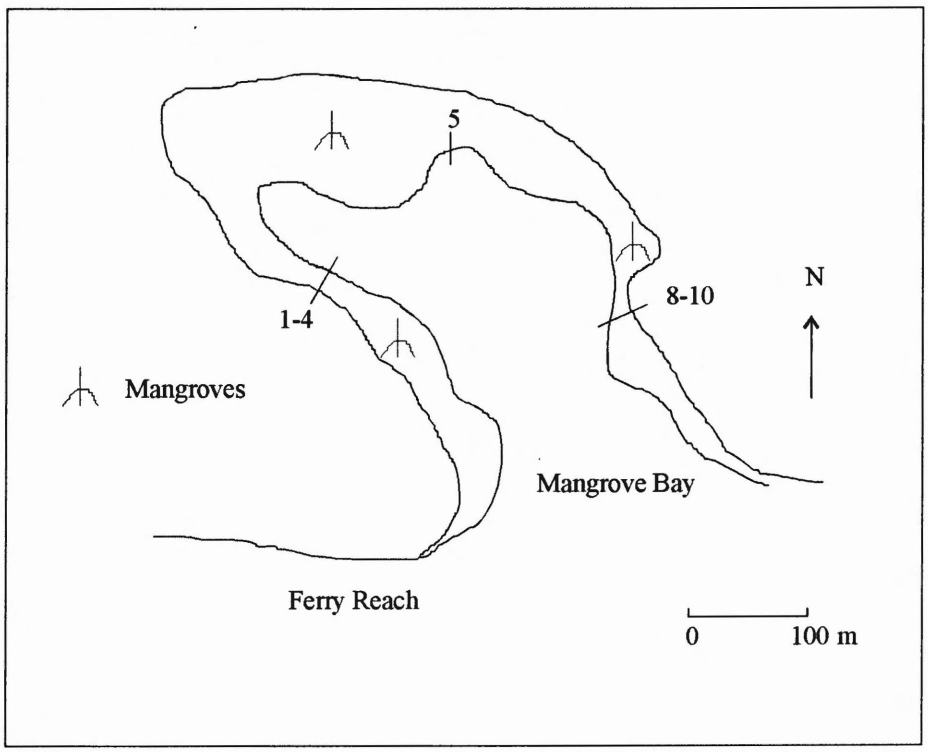

N
North Lagoon
St. John Road
Mill Creek
Great Sound
Mill Share
Landing stages
Pembroke marsh
Mangroves
Coring
Transect
0
500 m

Figure 11. Location map of sampling areas in Mangrove Bay (site 8) (modified from MacKenzie et al., 1970).


5
8-10
N
1-4
Mangroves
Mangrove Bay
Ferry Reach
0
100 m

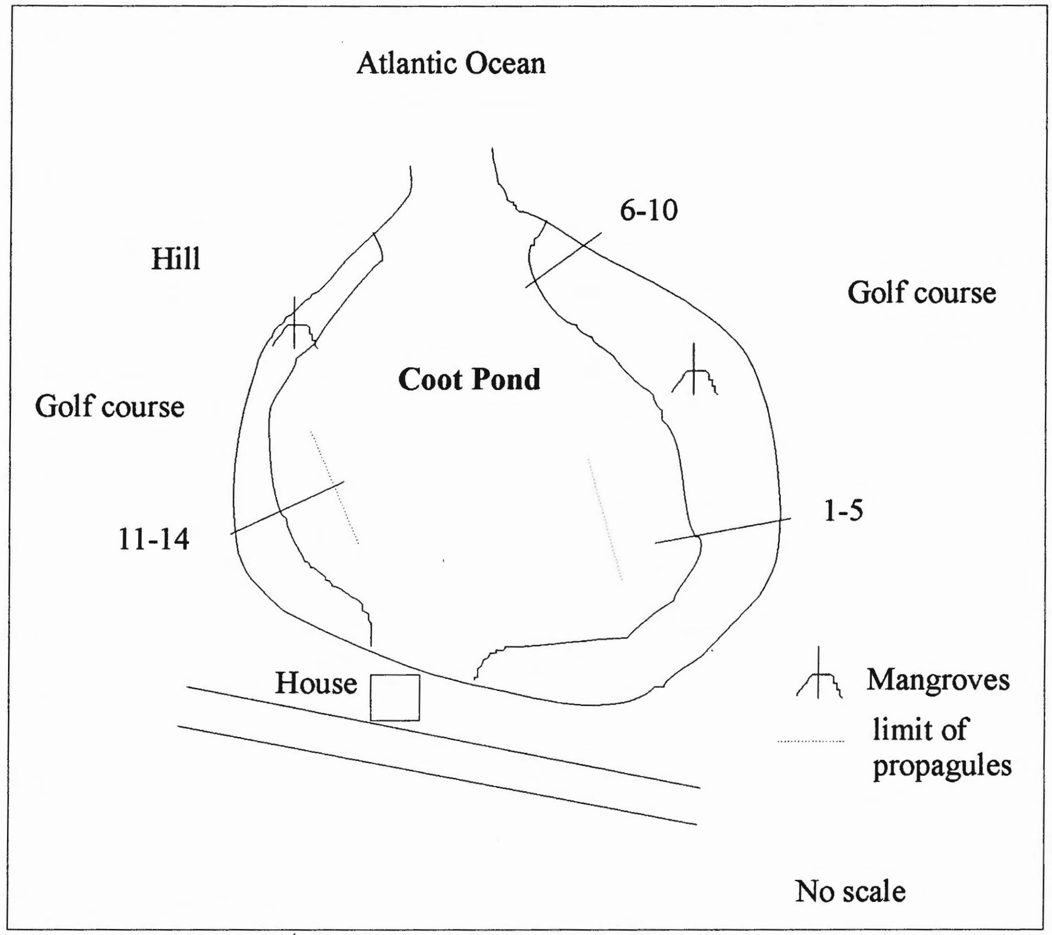
D. Coot Pond

Coot pond is a small bay (1,643 m^2) at the northeastern edge of Bermuda islands, close to St. Catherine Fort and a Gulf course. It is protected from the shore by a limestone ridge. Its shore hosts the red and black mangroves, and the buttonwoods. Tidal range varies between 0.6 and 1.1 meter (Thomas and Logan, 1992). Samples were collected along three short transects in the fringing mangroves (fig. 12).

E. Walsingham Bay

Walsingham Bay is a mangrove bay (3,776 m^2) located in the inland lagoon Castle Harbor. Its shore hosts the red and black mangroves, and the buttonwoods. Tidal range varies between 0.6 and 1.1 meter (Thomas and Logan, 1992). Samples were collected in one area in the fringing mangroves (fig. 13), close to the road to Tom Moore's tavern.

Figure 12. Location map of sampling areas in Coot Pond (site 23) (modified from Bermuda Admiralty chart 1315, 1988).


Atlantic Ocean
6-10
Hill
Golf course
Coot Pond
Golf course
1-5
11-14
House
Mangroves
limit of propagules
No scale

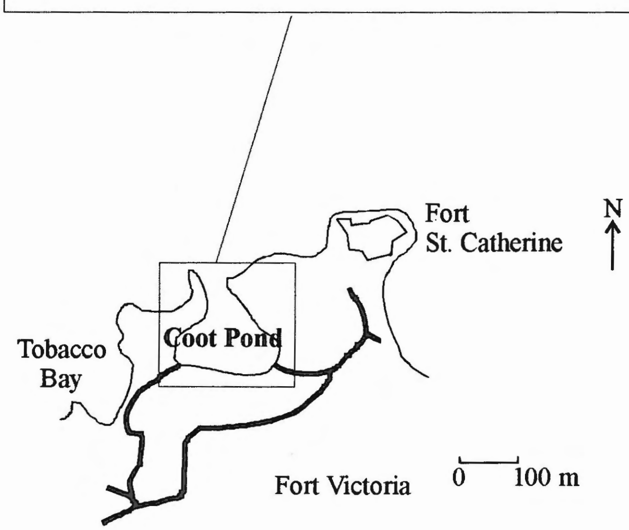
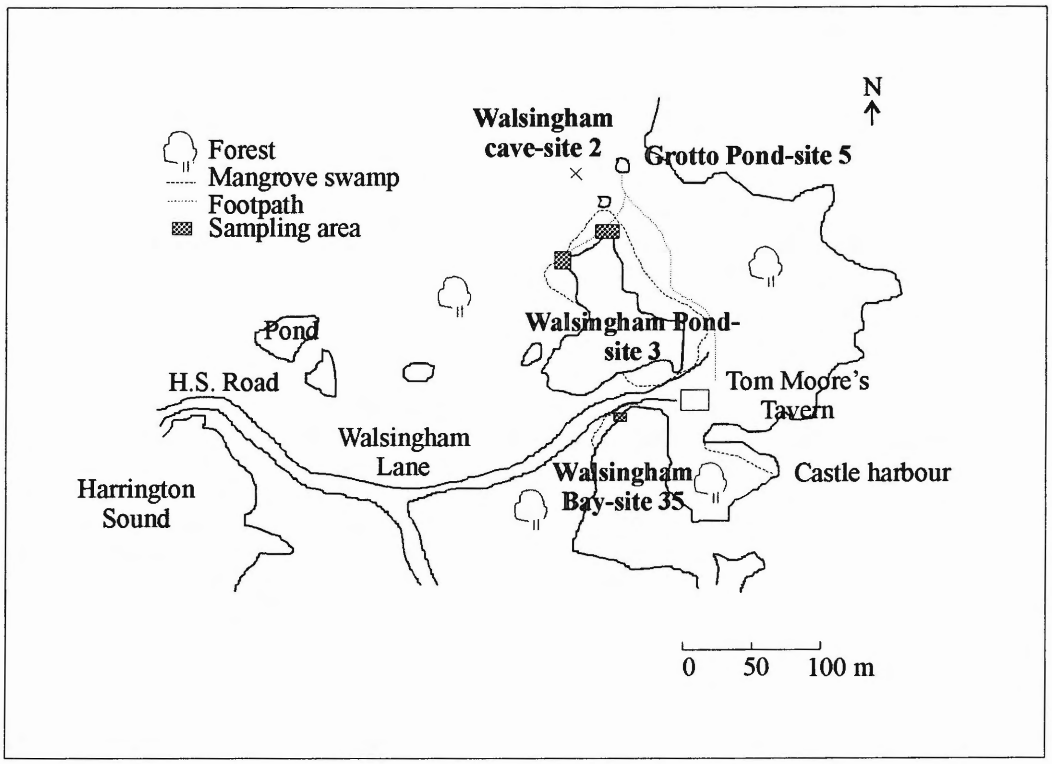

Fort
St. Catherine
N
Tobacco
Bay
Coot Pond
Fort Victoria
0
100 m

Figure 13. Location map of sampling areas in Walsingham Bay (site 35), Walsingham Pond (site 3), and location of Walsingham cave (site 2) and Grotto Pond (site 5) (modified from Thomas and Logan, 1992).


Forest
Mangrove swamp
Footpath
Sampling area
Walsingham
cave-site 2
Grotto Pond-site 5
Pond
Walsingham Pond-
site 3
H.S. Road
Tom Moore's
Tavern
Walsingham
Lane
Castle harbour
Harrington
Sound
Walsingham
Bay-site 35
N
0
50
100 m

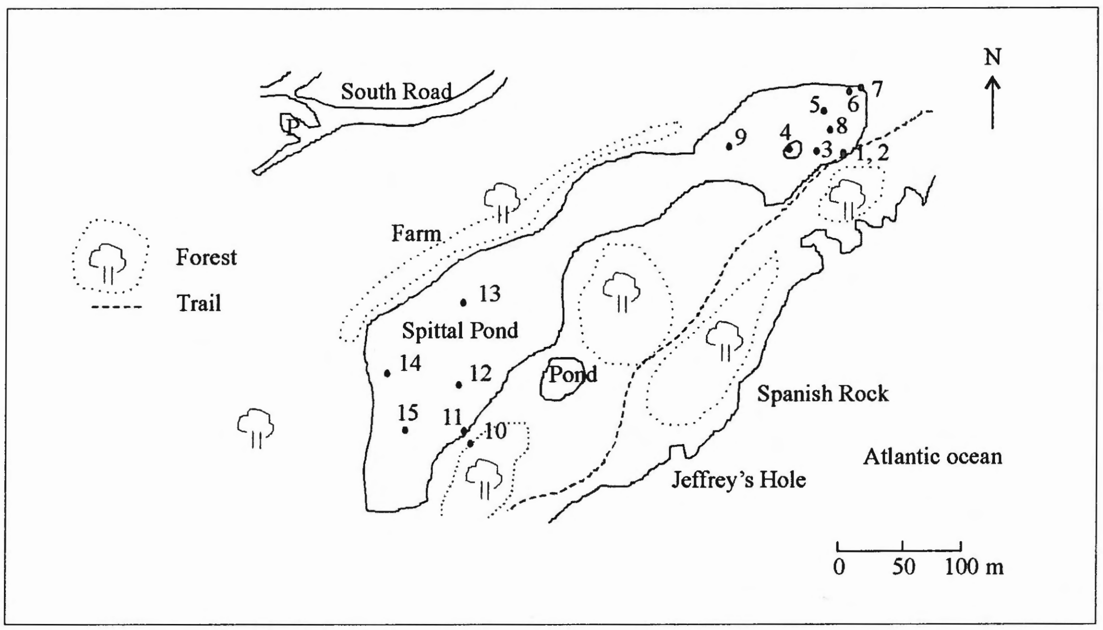
2.1.3.5. Landlocked saline ponds

A. Spittal Pond

Spittal Pond is a shallow landlocked non-tidal saline pond, separated from the south shore by a limestone ridge. The pond comprises two basins (fig. 14) united by a narrow channel. The total pond surface is 229 m^2 (Thomas and Logan, 1992). Among the vegetation surrounding the pond grow a few trees of black mangrove and buttonwood.

Spittal pond is a highly impacted environment. It is polluted by Bermuda's largest dairy farm. The water shows extreme variations in temperature (16.1 to 37.5°C), salinity (6.5 to 42.5 ppm), dissolved oxygen, and aquatic biota (ostracods, gastropods, and algae) (Thomas and Wassmann, 1992). Salinity varies with heavy rains, and occasional marine flooding during storms. Anoxia is common in the fall. Study of a core showed that similar extreme conditions have existed for at least 4,000 years (Jenks, 1970).

Figure 14. Samples location in Spittal Pond (site 34) (modified from Thomas and Logan, 1992).


South Road
P
Farm
Forest
Trail
N
Spittal Pond
Pond
Spanish Rock
Atlantic ocean
Jeffrey's Hole
1, 2
3
4
5
6
7
8
9
10
11
12
13
14
15
0 50 100 m

B. "Grotto Pond"

"Grotto Pond" is a small shallow pond (about $10m^2$) located in "Tom Moore's jungle" in the isthmus between Castle Harbor and Harrington Sound, and is protected from the inland lagoon Castle Harbor by a limestone ridge (fig. 13). Mangrove swamps are present close by, but not directly around the pond which has a rocky shore. Connections might exist between the pond and surrounding caves and lagoon.

C. Walsingham Pond

Walsingham Pond is a landlocked tidal marine pond ($4{,}933m^2$) located in "Tom Moore's jungle" in the isthmus between Castle Harbor and Harrington Sound. The pond is surrounded by mangrove swamps (red and black mangroves, and buttonwoods) and has connections to Castle Harbor through fissures, tunnels and caves (Thomas and Logan, 1992). Salinities vary between 33 and 39.5 ppm and temperature vary between 19 and 27.7°C. Tidal range is 38.5 cm (Thomas and Logan, 1992). Samples were collected on the northern shore of the pond only for logistic reasons (fig. 13).

2.2. Holocene sea-level study

2.2.1. Coring and sampling

Surface samples were collected by hand along two detailed transects starting below or at the Mean Sea Level (MSL) up to Higher High Water (HHW) in Hungry Bay mangrove swamps and Mill Share marsh-mangrove complex which is a remnant of a much larger system (figs. 3, 9, 10). HHW is defined as the level reached by the tides only once or twice a month by spring tides or big storms. In these mangrove swamps, there is no plant zonation related to tidal levels, hence the upper reach of a particular plant could not be used to detect HHW as it is done in temperate marshes (e.g. Scott and Medioli, 1980a). Moreover, there were no benchmark to measure absolute elevation. HHW was considered to be located at the highest line of detritus accumulation. Foraminifera disappear above that level (Scott and Medioli, 1978) and are replaced by thecamoebians (Scott and Medioli, 1980a). Formalin solution was added to the samples for fixing until processing. Elevations were measured using a plumb line and hand level related to HHW. Salinities were measured with a American Optical ® temperature compensated hand held refractometer where there was sufficient water on the swamp surface to obtain a reading. A 10cc fraction of the samples was washed through a 63 micron sieve, and a solution of formalin and Rose Bengal was added to determine specimens living at the time of collection. After washing through a 63 micron sieve to remove the formalin, samples were split using a wet splitter (Scott and Hermelin, 1993) to obtain a workable fraction (at least 300 individuals). All foraminiferal and thecamoebian species were counted and identified in liquid medium to facilitate the detection of stained individuals, and live and total assemblages were determined.

Six vibracores (7.5 cm diameter) were collected in several Bermuda mangrove swamps (Hungry Bay, fig. 9; Mill Share, Mill Creek, fig. 10) using a Wink® vibracorer connected to aluminium irrigation pipes. Fifty-two Davis cores (1.5 cm diameter) were also taken (figs. 9 and 10). The cores were then described (colour, grain size, sediment type, sedimentary structures, type of contacts, presence of shells and corals) and photographed. A 10cc sample of sediment was taken every 20 cm where the cores were homogenous, and above, at, and below all color and lithological changes. The samples for foraminiferal and thecamoebian analysis were washed through a 45 micron sieve and stored in formaldehyde (to prevent bacterial growth) until analyzed.

2.2.2. Dating

Radiocarbon dating is adequate for dating Holocene sediment because the half-life of C^{14} is 5570 years (Libby) and the Holocene commenced 10,000 years ago. Six peat samples, air-dried at 40°C, were sent to Geochron Laboratories in Cambridge, Mass., for radiocarbon dating using an accelerator mass spectrometer (AMS). The samples were treated as follows: "Dry peat was broken into small pieces and hand picked to avoid contamination by rootlets. The entire sample was then dispersed in a large volume of water and the peat and clay matter were eluted away from any sand and silt by sedimentation and decantation The peat fraction was then treated with hot dilute HCL to remove any carbonates, and also with hot dilute NaOH to remove any humic acids or other alkali-soluble organic matter. It was then filtered, washed, dried, and burned in oxygen to recover carbon dioxide from the organic matter for the analysis" (from Geochron Laboratory data sheets). The 12/14C ratio was translated, after correction for isotope fractionation (dC^{13}), into a radiocarbon date by using the Libby half life for C^{14}. Radiocarbon dates were then converted to sidereal years or calendar years before present (present is 1950 AD) using a microcomputer program CALIB 3.0.3 (Stuiver and Reimer, 1986; 1987). Geochron Laboratory also provided the dC^{13}, which varies from zero for seawater to -30 ‰ in humic acids, and whose value helps to determine the amount of marine “reservoir effect”. The values obtained ranged between -24.2 and -28.4 ‰ and indicated a terrestrial origin for the mangrove peat. Thus no correction for “reservoir effect” was needed since mangrove plants, although they grow in a marine environment, draw their C^{14} from the atmosphere.

2.2.3. Production of a late Holocene sea-level curve.

Mangrove swamps form in the upper intertidal zone, thus indicating recent and former sea levels. Former sea levels can be more accurately located if recent benthic foraminifera have a zonational distribution in mangrove swamps and if that zonation can be recognized in subsurface peat from the cores. In that case, the method developed by Scott and Medioli (1978) for temperate marshes can be applied in mangrove swamps to produce an accurate sea-level curve, plotting time (radiocarbon dating) versus depth of peat (relative to present MSL) where marker species are found. This method has never been applied before to mangrove swamps associated with carbonates.

In addition to benthic foraminifera, thecamoebians were also used as environmental indicators. Determination of the recent fauna of Bermudan thecamoebians gives control for freshwater environment delineation. Comparison with fossil assemblages in cores permits an assessment of the original environment of peat formation.

CHAPTER III: RESULTS

3.1. DISTRIBUTION OF BENTHIC FORAMINIFERA IN BERMUDA

3.1.1. MARINE CAVES

3.1.1.1. Walsingham cave

In the 6 samples examined, sediment size ranged from fine to medium sand. Water depth varied between 0.5 and 6 meters. The water surface was covered by a 50 cm-deep, brackish, and colder layer. In that layer, salinity was 22 ppm and temperature was 21°C. Below the layer, salinity was 32 ppm and temperature was 24.8°C (one time measurement in May 93). A total of 183 species were identified. Live and total abundances were high (445 to 1,512 live ind./10cc and 9,182 to 93,960 total ind./10cc). Live diversity was low to moderate (4 to 33 species) and total diversity was high to very high (60 to 122 species) (figs. 13 and 15, appendices table 1).

The most common species were *Helenina anderseni* (0 to 9.5%), *Spirophtalmidium sp.* (0 to 7.6%), *Discorinopsis aguayoi* (0.2 to 6.5%), *Bolivina variabilis* (1.8 to 5.9%), *Cassidulina subglobosa* (0 to 4.8%), *Gyroidina sp.* (0 to 4.7%), *Bolivina subexcavata* (0.7 to 4.6%), *Bolivina paula* (0.2 to 4.3%), *Bolivina lanceolata*

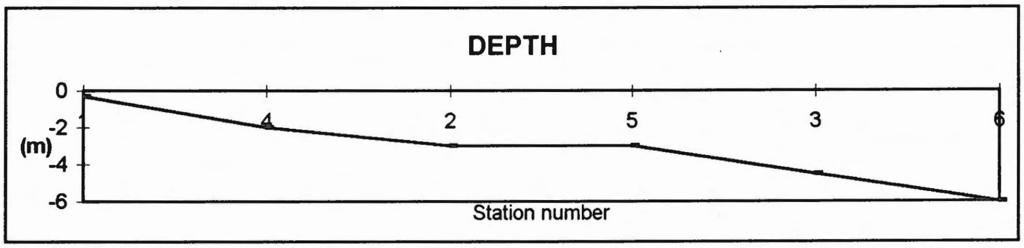
(0.8 to 4.2%), and *Saccamina difflugiformis* (0.2 to 3.1%).

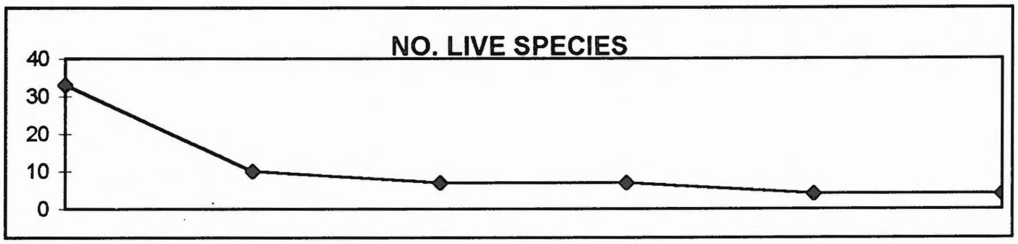
Species with frequencies between 2 and 4% in at least one sample were *Bolivina striatula, Bolivina lowmani, Buliminella elegantissima, Trifarina occidentalis, Technitella legumen, Nonion depressulum, Bolivina tortuosa, Loxostomum mayori, Rosalina concinna, Siphonina pulchra, Spiroloculina arenata, Quinqueloculina laevigata, Rosalina subarauncana, Tubinella funalis, Quinqueloculina seminulum, Quinqueloculina subpoeyana, Quinqueloculina circularis, Fissurina spp.*, and *Reophax spp.*

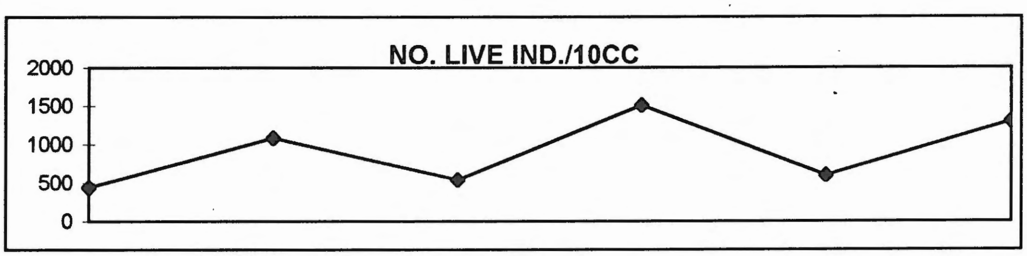
Species with frequencies between 1 and 2% in at least one sample were *Hopskinsina pacifica, Textularia earlandi, Elphidium poeyanum, Lamarckina atlantica, Bigenerina irregularis, Rosalina globularis, Cibicides refulgens, Siphonella soluta, Eponides tuberculata, Archaias angulatus, Cyclogyra planorbis, Triloculina oblonga, Quinqueloculina goesi, Quinqueloculina lamarckiana, Quinqueloculina bicarinata, Quinqueloculina bosciana, Bolivina variabilis var. spathulata,* and *Spiroloculina antillarum.*

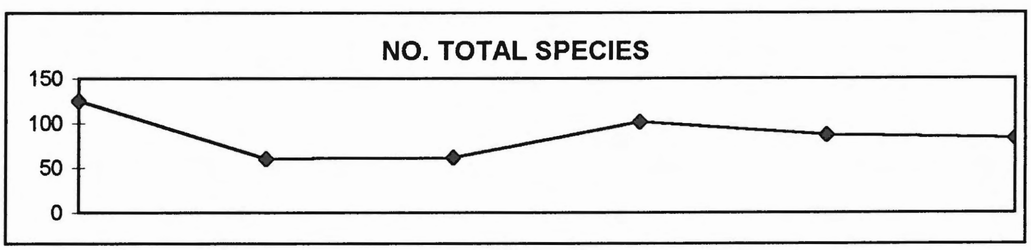
With increasing depth, live diversity decreased and total abundance increased, and live abundance and total diversity were variable. *Saccammina difflugiformis* and *Trifarina occidentalis* increased, and *Helenina anderseni, Discorinopsis aguayoi,* and *Rosalina subarauncana* decreased.

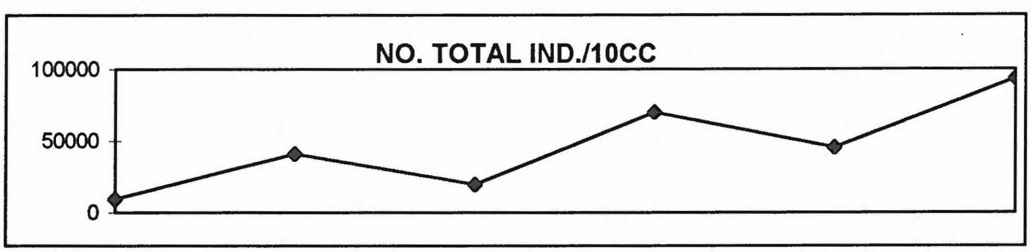
Figure 15. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Walsingham cave.

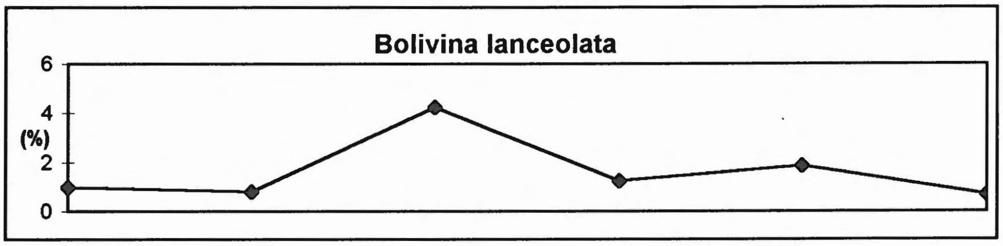

DEPTH
0
-2
(m)
-4
-6
1
4
2
5
3
6
Station number

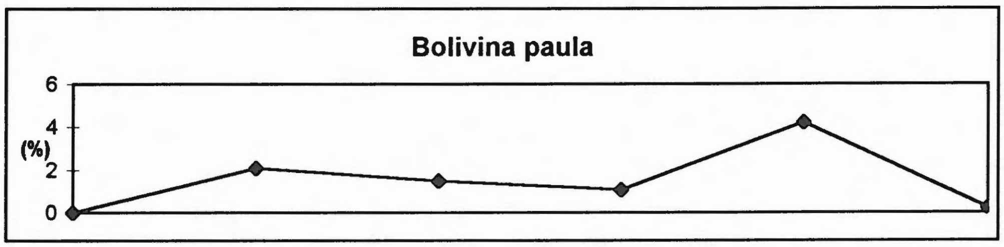

NO. LIVE SPECIES
40
30
20
10
0

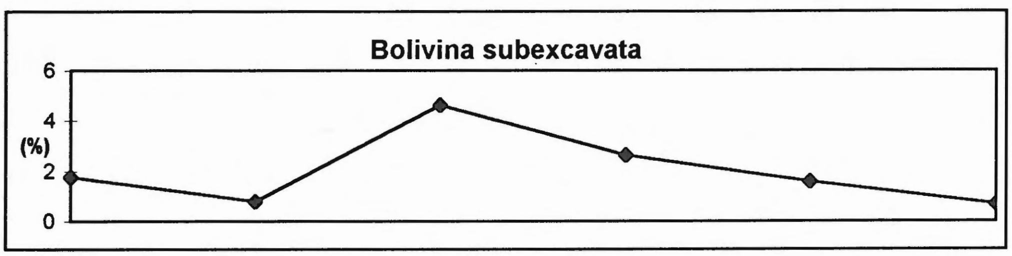

NO. LIVE IND./10CC
2000
1500
1000
500
0

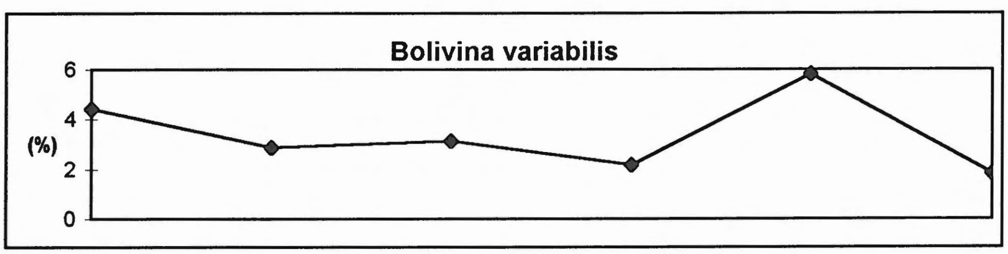

NO. TOTAL SPECIES
150
100
50
0

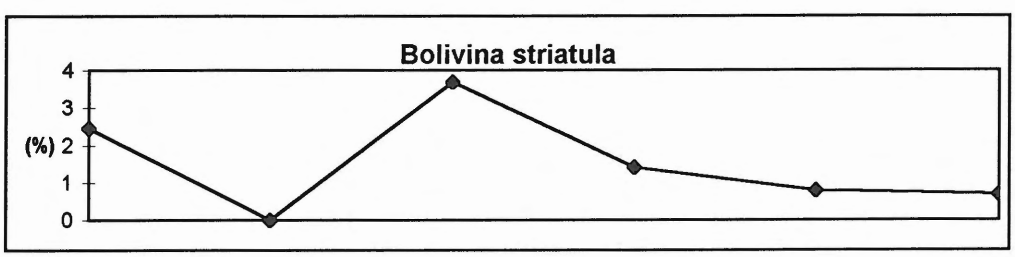

NO. TOTAL IND./10CC
100000
50000
0

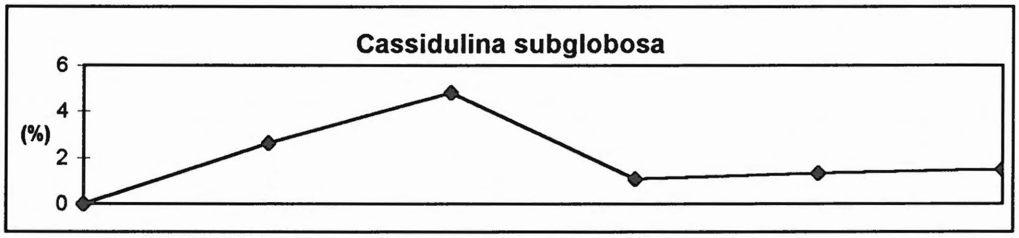

Bolivina lanceolata
6
4
(%)
2
0

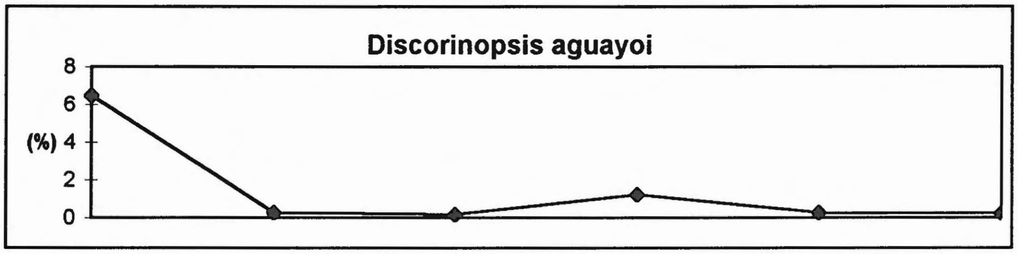

Bolivina paula
6
4
(%)
2
0

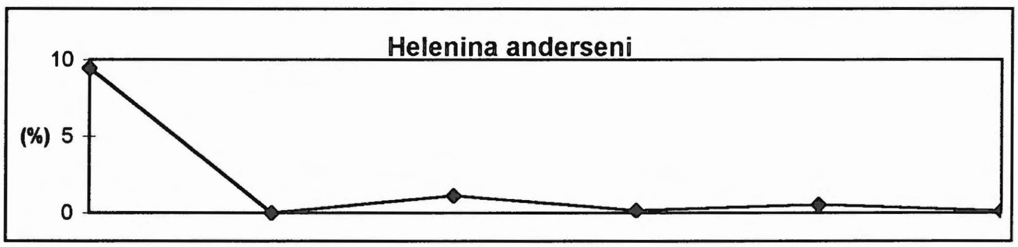

Bolivina subexcavata
6
4
(%)
2
0

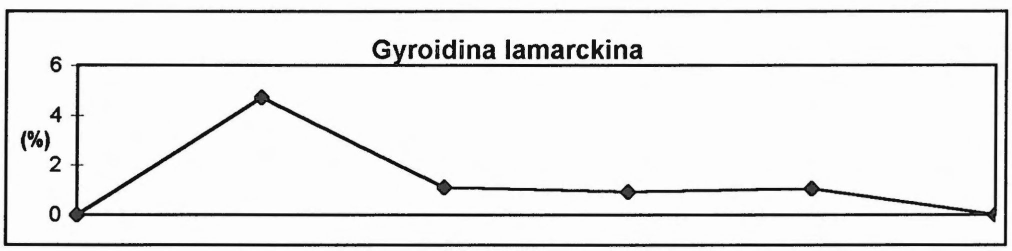

Bolivina variabilis
6
4
(%)
2
0

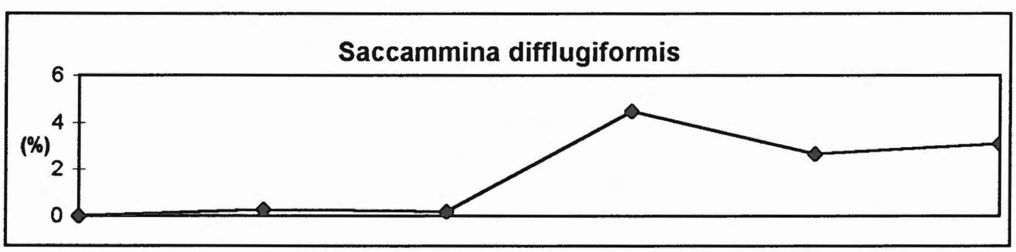

Bolivina striatula
4
3
(%) 2
1
0

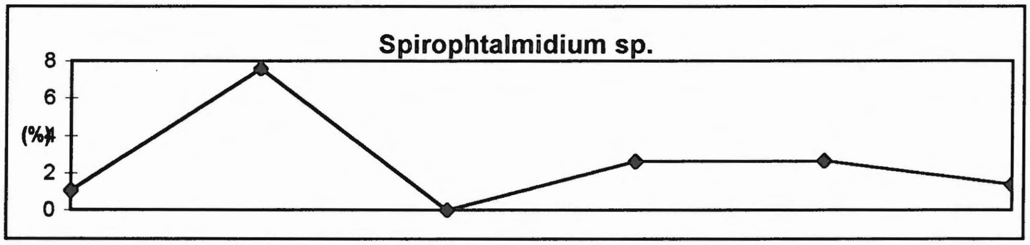

Cassidulina subglobosa
(%)
6
4
2
0


Discorinopsis aguayoi
(%)
8
6
4
2
0


Helenina anderseni
(%)
10
5
0


Gyroidina lamarckina
(%)
6
4
2
0


Saccammina difflugiformis
(%)
6
4
2
0



Spirophtalmidium sp.
8
6
(%)4
2
0

3.1.1.2. Leamington cave

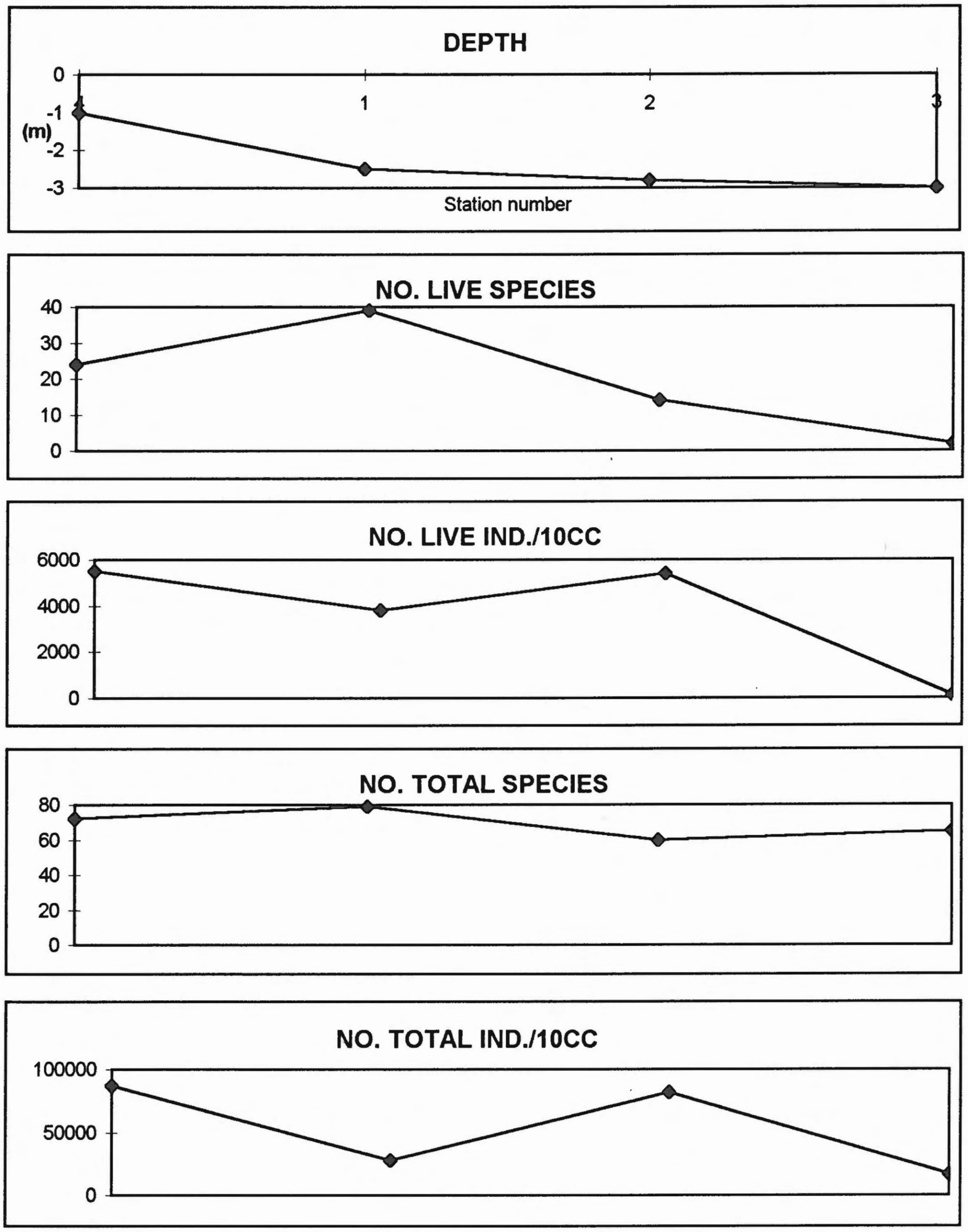
In the 4 samples examined, sediment was fine sand. Water depth varied between 1 and 3 meters. The water surface was covered by a 65 cm-deep, brackish, and colder layer. In that layer, salinity was 11 ppm and temperature was 23°C. Below the layer, salinity was 30 ppm and temperature was 24.8°C (one time measurement in May 93). A total of 128 species were identified. Live and total abundances were high to very high (120 to 5,508 live ind./10cc and 17,160 to 87,048 total ind./10cc). Live diversity was low to moderate (2 to 39 species) and total diversity was high (60 to 75 species) (fig. 16, appendices table 2).

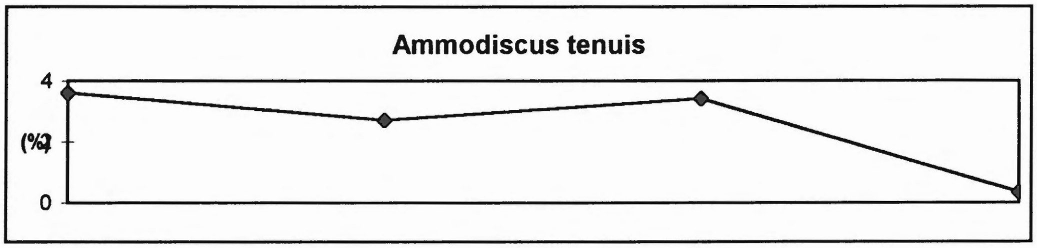
The most common species were *Spirillina vivipara* (0 to 30.7%), *Spirophtalmidium sp.* (11.7 to 23.8%), *Spirillina denticulata* (0 to 15.4%), *Mychostomina revertens* (0 to 8.6%), *Patellina corrugata* (0 to 7.1%), *Siphonina pulchra* (1.4 to 6.6%), *Rosalina micens* (0 to 4.4%), and *Planulina carribea* (0 to 4.2%).

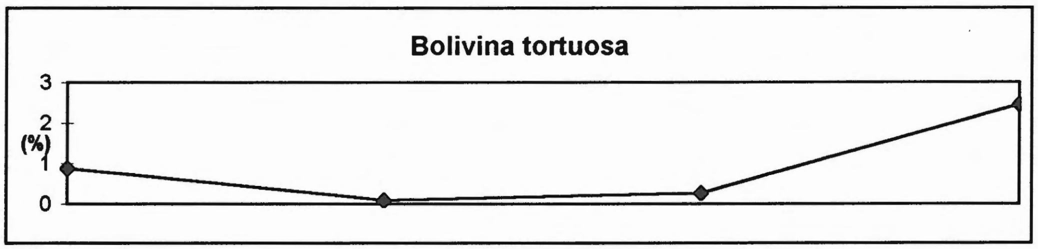
Species with frequencies between 2 and 4% in at least one sample were *Ammodiscus tenuis, Bolivina variabilis, Bolivina tortuosa, Cassidulina subglobosa, Glomospira irregularis, Gyroidina sp., Loxostomum mayori, Patellina sp., Spiroloculina antillarum, Spiroloculina arenata,* and *Triloculina trigonula.*

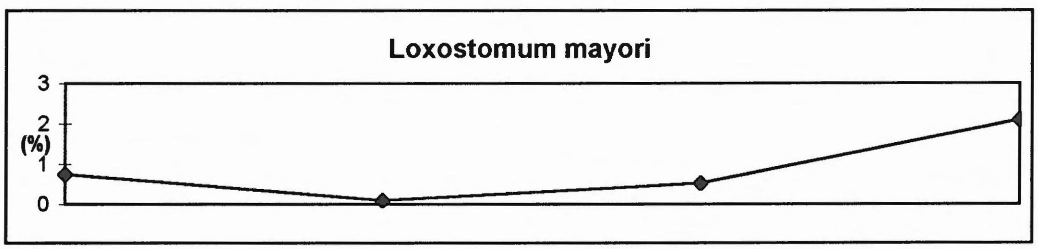
Species with frequencies between 1 and 2% in at least one sample were *Bolivina lanceolata, Bolivina subexcavata, Cassidulina neocarinata, Cibicides refulgens,*

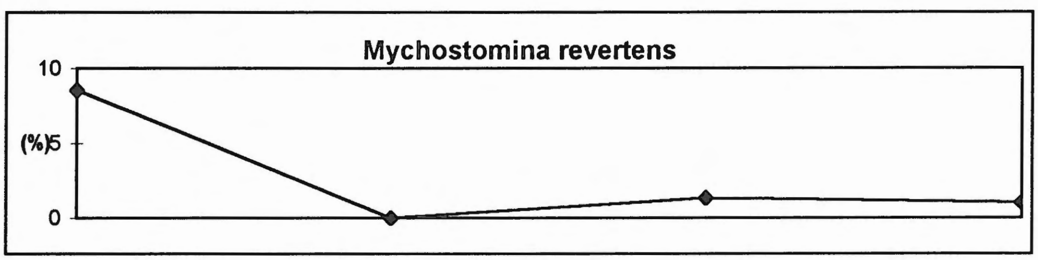
Figure 16. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Leamington cave.

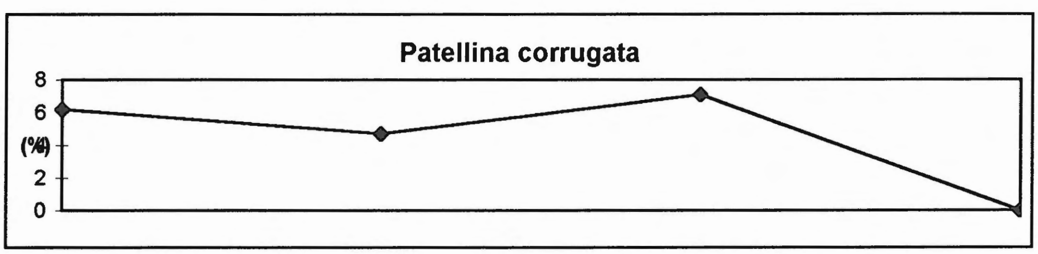

DEPTH
0
-1
(m)
-2
-3
1
2
3
Station number
NO. LIVE SPECIES
40
30
20
10
0
NO. LIVE IND./10CC
6000
4000
2000
0
NO. TOTAL SPECIES
80
60
40
20
0
NO. TOTAL IND./10CC
100000
50000
0

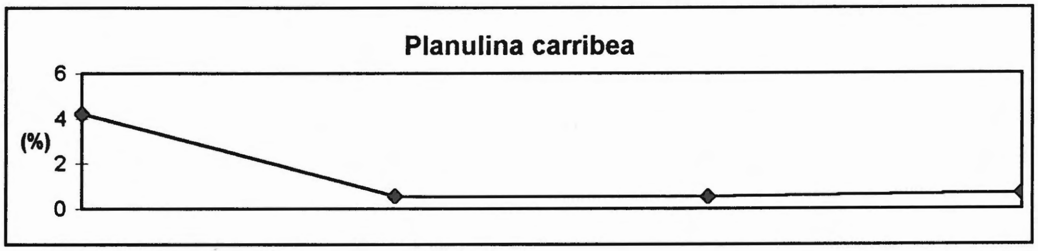

Ammodiscus tenuis
4
(%)2
0

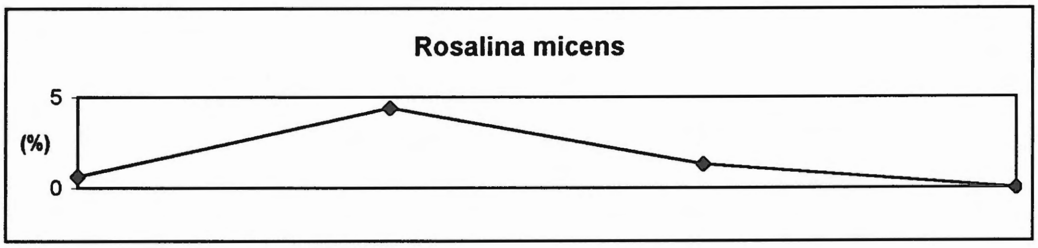

Bolivina tortuosa
3
2
(%)
1
0

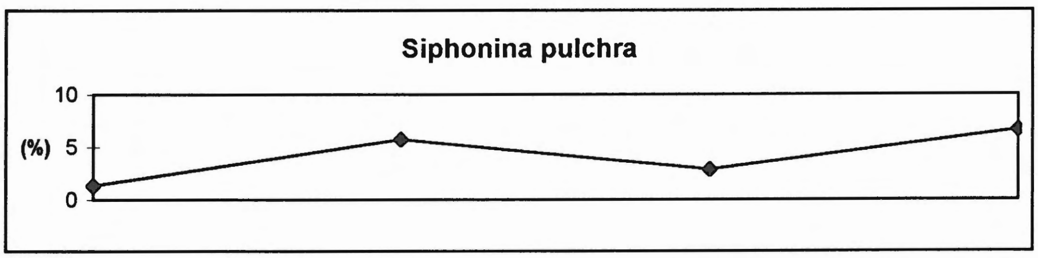

Loxostomum mayori
3
2
(%)
1
0

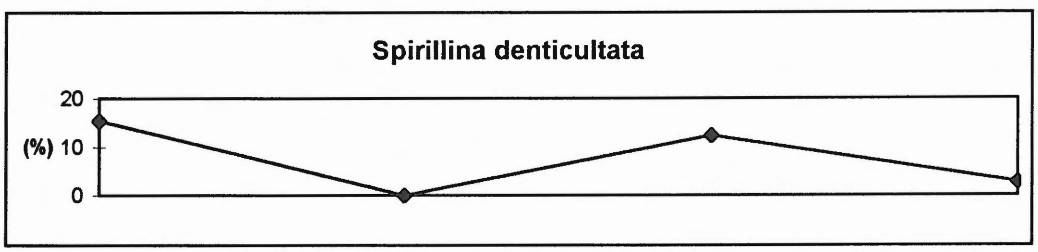

Mychostomina revertens
10
(%)5
0

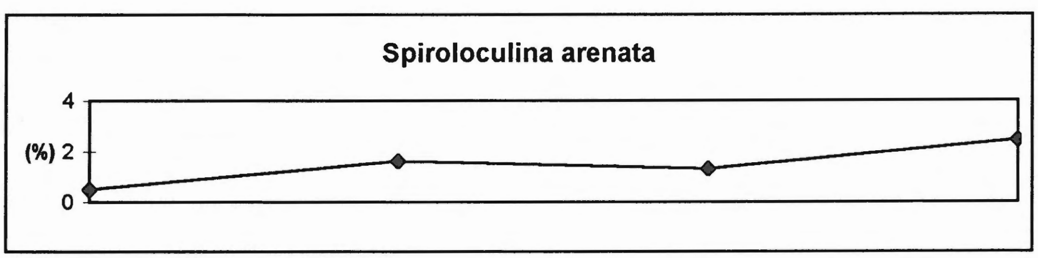

Patellina corrugata
8
6
(%)4
2
0

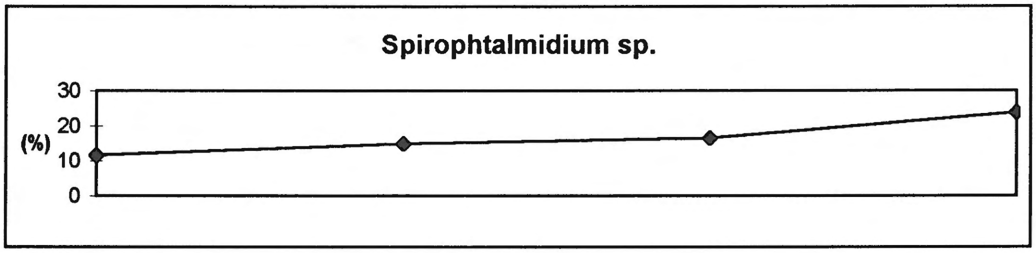

Planulina carribea
6
4
(%)
2
0


Rosalina micens
5
(%)
0


Siphonina pulchra
10
(%) 5
0


Spirillina denticultata
20
(%) 10
0


Spiroloculina arenata
4
(%) 2
0


Spirophtalmidium sp.
30
20
(%)
10
0

Cornuspira planorbis, Epistominella pulchra, Eponides tuberculata, Glabratella sagrai, Neoconorbina terquemi, Quinqueloculina bicarinata, Quinqueloculina circularis, Quinqueloculina tricarinata, Rosalina concinna, Rosalina globularis, Siphoninella soluta, Textularia earlandi, Tiphotrocha comprimata, Tretomphalus atlanticus, and *Triloculina oblonga.*

Thecamoebians are present with frequencies less than 1%.

With increasing depth, live abundance decreased, total abundance and diversity were variable, and total diversity was stable. *Spiroloculina arenata, Loxostomum mayori, Spirophtalmidium sp., Siphonina pulchra,* and *Bolivina tortuosa* increased. *Mychostomina revertens* and *Planulina carribea* decreased after 1 meter depth, and *Patellina corrugata* and *Ammodiscus tenuis* decreased after 2.8 meters depth.

3.1.1.3. Crystal cave

In the 7 samples examined, sediment size ranged from silty to medium sand. Water depth varied between 1 and 10 meters. The water surface was covered by a 65 cm-deep brackish layer. In that layer, salinity was 16 ppm and temperature was 20.5-22°C. Below the layer, salinity was 28 ppm and temperature was 21°C (one time measurement in May 93). A total of 85 species were identified. Live abundance was low (0 to 40 live ind./10cc) except in sample #1 (504 live ind./10cc), and total abundance was low to high

(126 to 14,184 total ind./10cc). Live diversity was low (0 to 5 species) and total diversity was low to moderate (9 to 31 species) (fig. 17, appendices table 3).

The most common species were *Spirophtalmidium sp.* (0 to 67.8%), *Rosalina subarauncana* (0 to 54.3%), *Planispiroides bucculentus* (0 to 40.9%), *Rosalina globularis* (0 to 27.2%), *Cyclogyra planorbis* (0 to 23%), *Spiroloculina antillarum* (0 to 15.5%), *Bolivina lanceolata* (0 to 10.7%), *Bolivina variabilis* (0 to 9.5%), planktonic species (0 to 8.3%), *Spirillina vivipara* (0 to 6.4%), *Spirillina cariacoensis* (0 to 4.8%), *Bolivina lowmanii* (0 to 4.2%), and the thecamoebians *Arcella polypora* (0 to 12%) and *Centropyxis aculeata* (0 to 18.3%). Common reworked species were *Amphistegina lessonii, Archaias angulatus, Cibicides refulgens, Discorbis mira,* and *Peneroplis spp.*

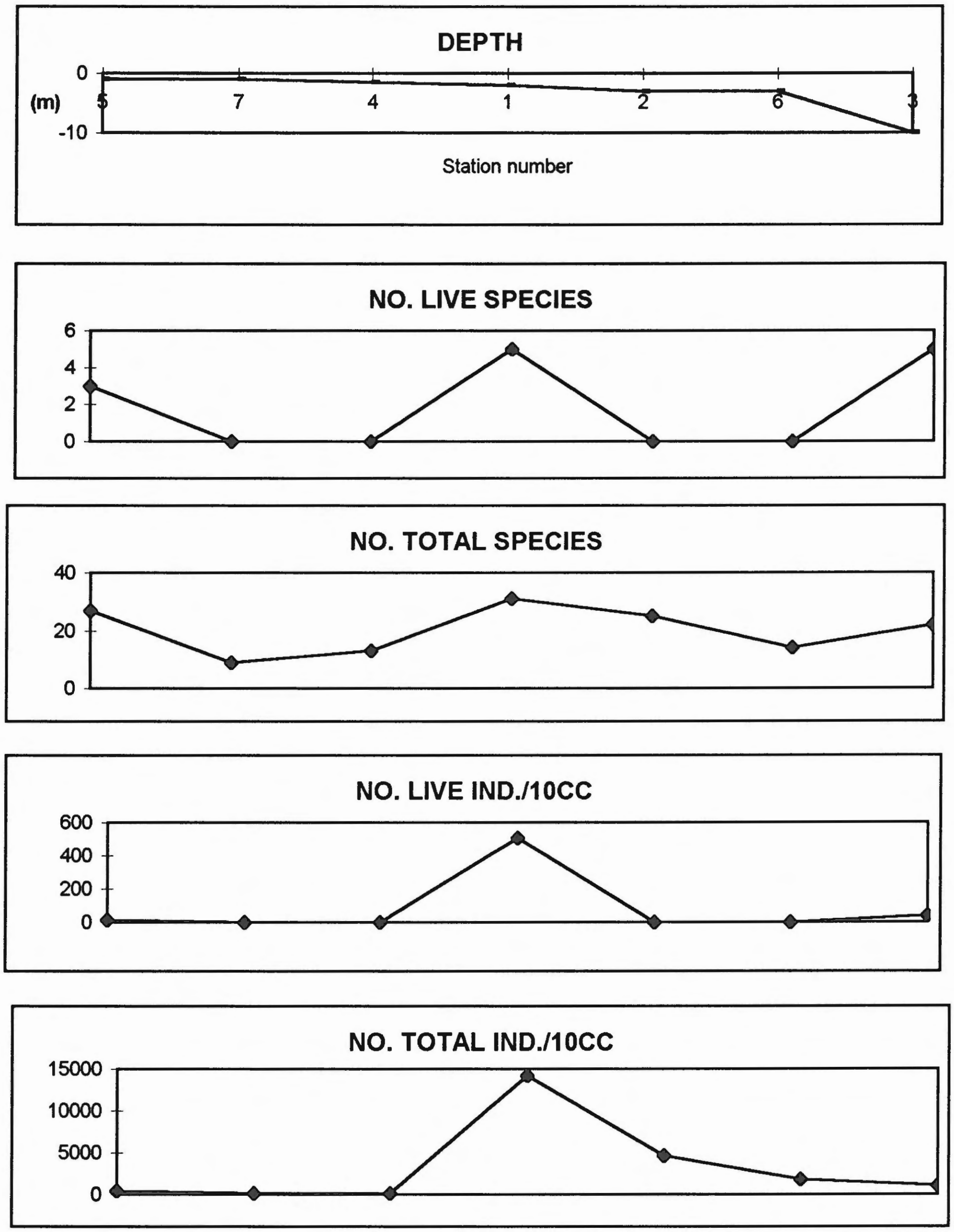
Species with frequencies between 2 and 4% in at least one sample were *Epistominella pulchra, Glabratella sagrai, Patellina sp., Patellina corrugata,* and *Quinqueloculina circularis.*

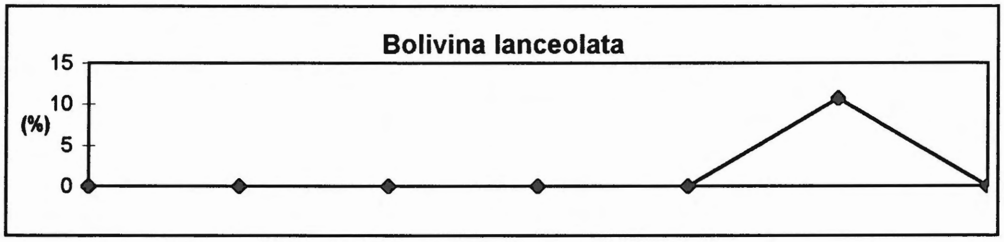
Species with frequencies between 1 and 2% in at least one sample were *Bolivina paula, Miliolinella labiosa, Miliolinella circularis, Mychostomina revertens, Quinqueloculina laevigata, Quinqueloculina tricarinata, Rosalina concinna, Triloculina oblonga,* and *Tubinella inornata.*

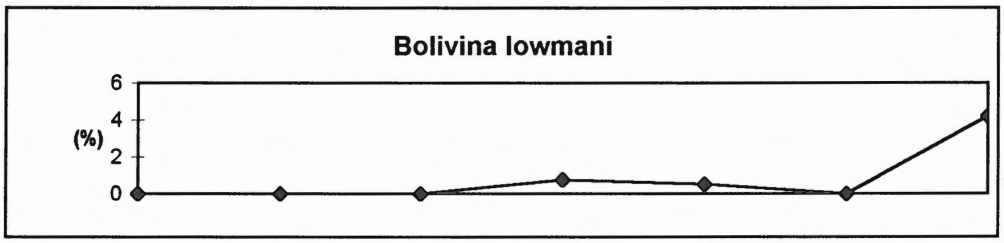
With increasing depth, live and total abundances, and live diversity were variable, and total diversity was stable. *Bolivina lowmani* increased slightly, and *Cyclogyra involvens* decreased, and *Rosalina globularis* was present only in the shallowest sample.

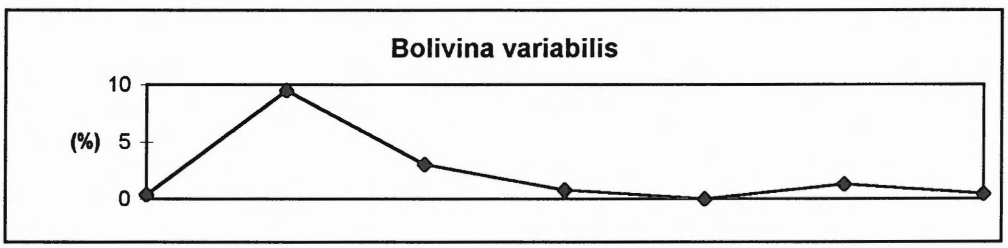
Thecamoebians occurred in samples 4, 5, and 6 only.

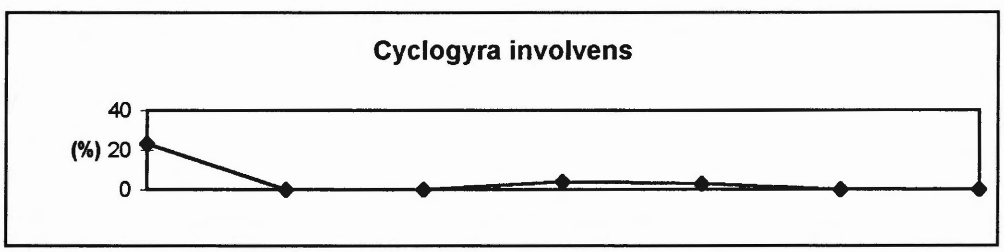
Figure 17. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Crystal cave.

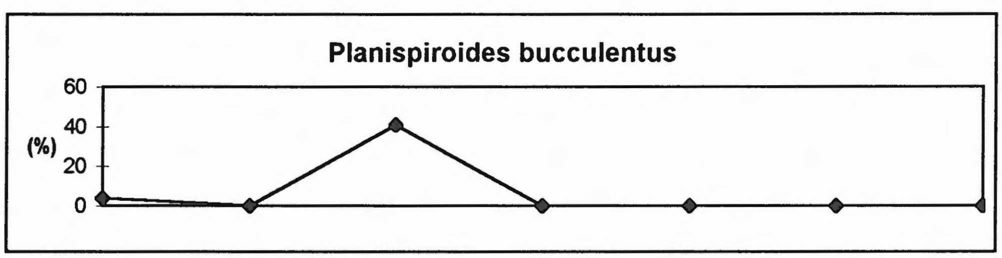

DEPTH
0
(m)
-10
5
7
4
1
2
6
3
Station number
NO. LIVE SPECIES
6
4
2
0
NO. TOTAL SPECIES
40
20
0
NO. LIVE IND./10CC
600
400
200
0
NO. TOTAL IND./10CC
15000
10000
5000
0

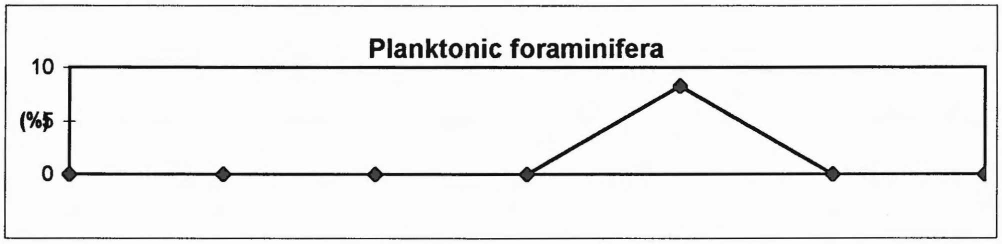

Bolivina lanceolata
15
10
(%)
5
0

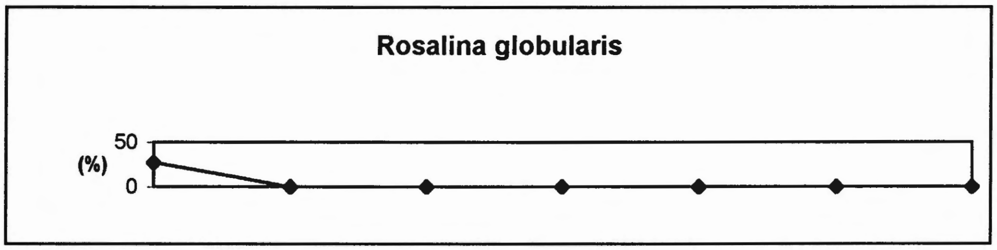

Bolivina lowmani
6
4
(%)
2
0

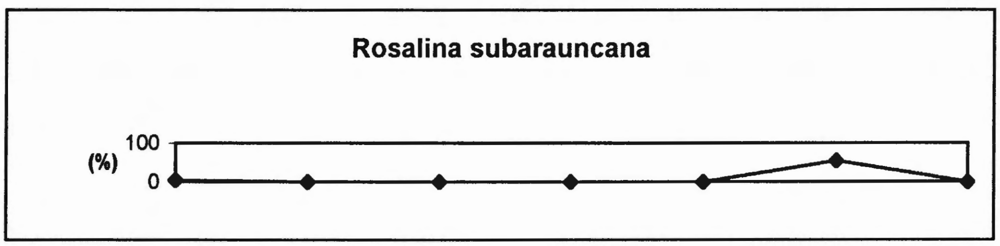

Bolivina variabilis
10
(%) 5
0

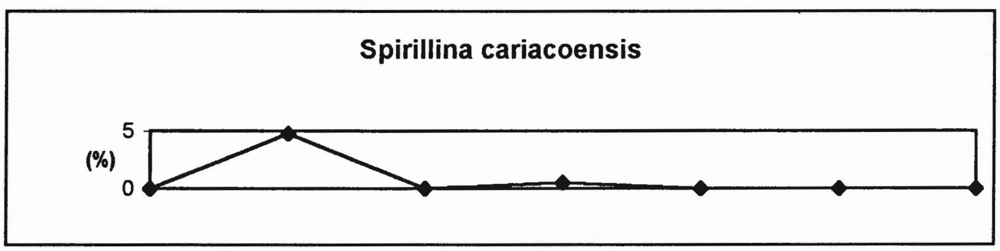

Cyclogyra involvens
40
(%) 20
0

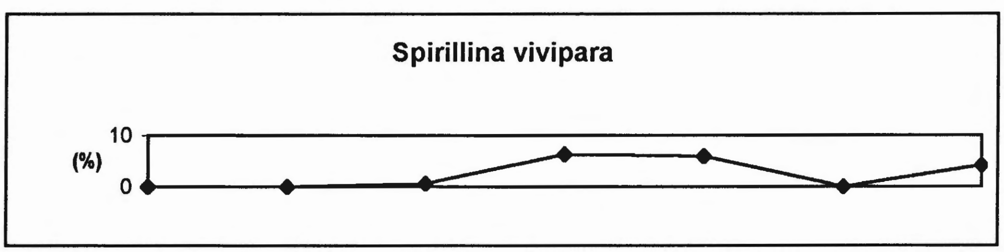

Planispiroides bucculentus
60
40
(%)
20
0

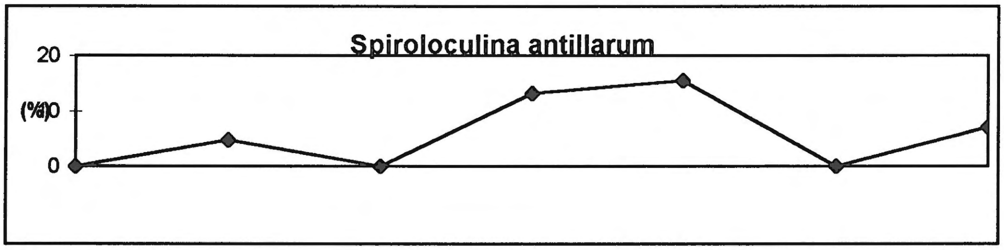

Planktonic foraminifera
10
(%) 5
0

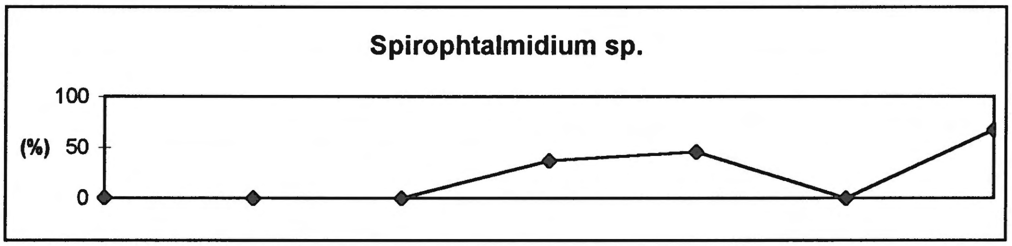

Rosalina globularis
50
(%)
0

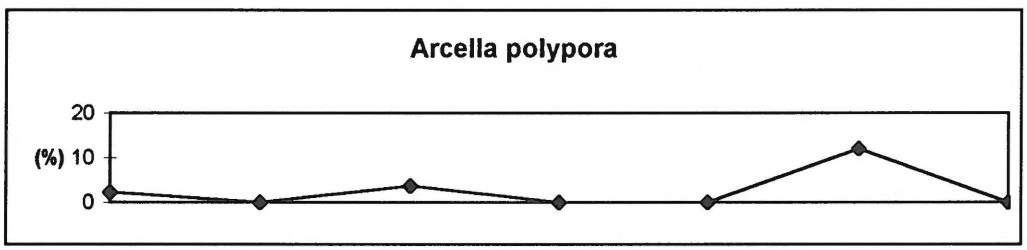

Rosalina subarauncana
100
(%)
0

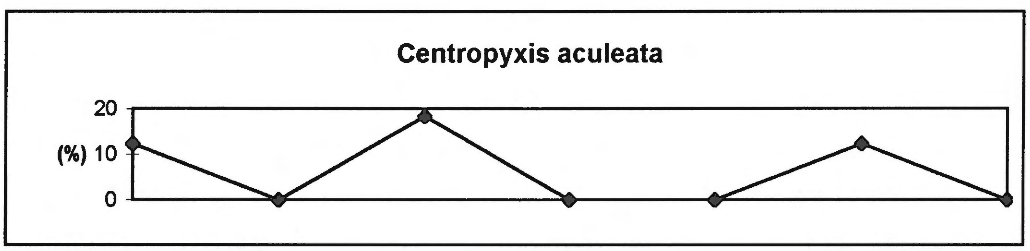

Spirillina cariacoensis
5
(%)
0

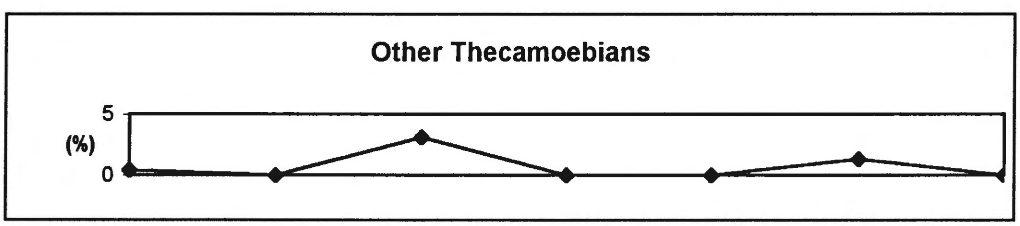

Spirillina vivipara
10
(%)
0


Spiroloculina antillarum
20
(%) 10
0


Spirophtalmidium sp.
100
(%) 50
0


Arcella polypora
20
(%) 10
0


Centropyxis aculeata
20
(%) 10
0


Other Thecamoebians
5
(%)
0

3.1.2. LAGOONS

3.1.2.1. North Lagoon

A total of 167 species were identified for all areas sampled in North Lagoon.

Devonshire Dock

In the three samples examined in this area, sediment size was medium sand. Depth was 7 meters. Temperature was 24°C and salinity was 35 ppm (one time measurement in May 93). Live and total abundances were high (708 to 1,332 live ind/10cc and 3,804 to 5,850 total ind./10cc), and live and total diversities were moderately high (18 to 26 live species, and 46 to 54 total species) (fig. 3, appendices table 4).

The most abundant species were *Peneroplis carinatus/proteus* (20.3 to 23.9%), *Quinqueloculina parkeri var. occidentalis* (0 to 9.8%), *Quinqueloculina bicarinata* (6.3 to 8.9%), *Archaias angulatus* (4.3 to 8.5%), *Quinqueloculina laevigata* (0 to 7.4%), and *Quinqueloculina seminulum* (1.5 to 5.9%), and *Trochammina ochracea* (0 to 5.6%).

Species with total frequencies between 2 and 4% in at least one sample were *Elphidium poeyanum, Elphidium sp., Peneroplis proteus, Quniqueloculina candeiana, Quinqueloculina lamarckiana, Quinqueloculina poeyana, Quinqueloculina subpoeyana, Rosalina subarauncana, Triloculina oblonga*, and *Triloculina trigonula*.

Species with total frequencies between 1 and 2% in at least one sample were *Ammonia beccarii tepida, Ammonia sp., Bolivina lanceolata, Cibicides lobatulus, Elphidium advenum, Peneroplis bradyi, Penroplis pertusus, Miliolinella labiosa, Monalysidium politum, Nonion gradeloupi, Quinqueloculina agglutinans, Quinqueloculina bosciana, Quinqueloculina polygona, Quinqueloculina vulgaris, Rosalina concinna, Textularia agglutinans, Textularia conica*, and *Triloculina bassensis.*

Northwest shore, along Ireland Island

In the sample collected in that area, sediment size was fine sand. Depth was 15 meters. Temperature was 24°C and salinity was 35 ppm (one time measurement in May 93). Live abundance was low (648 in./10cc) and total abundance was high (81,864 ind./10cc). Live and total diversities were high (21 live species and 68 total species) (fig. 3, appendices table 5).

The most common (total) species were *Articulina spp.* (6.9%), *Quinqueloculina laevigata* (6.3%), *Ammonia beccarii tepida* (5%), *Elphidium poeyanum* (4.8%), *Quinqueloculina goesi* (4.5%), and *Elphidium advenum* (4%).

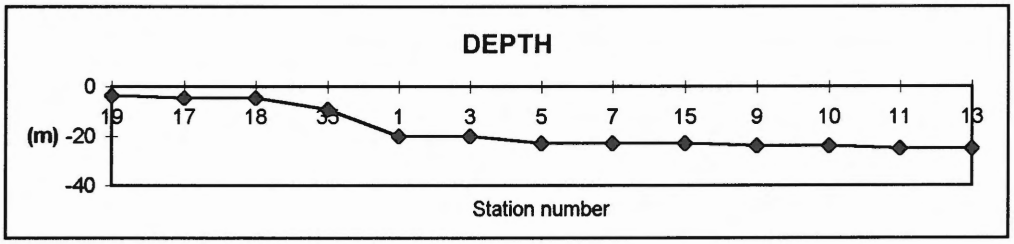
Species with total frequencies between 2 and 4 % in at least one sample were *Bolivina lanceolata, Bolivina variabilis, Peneroplis spp., Quinqueloculina bicostata, Quinqueloculina candeiana, Quinqueloculina subpoeyana,* and *Rosalina subarauncana.*

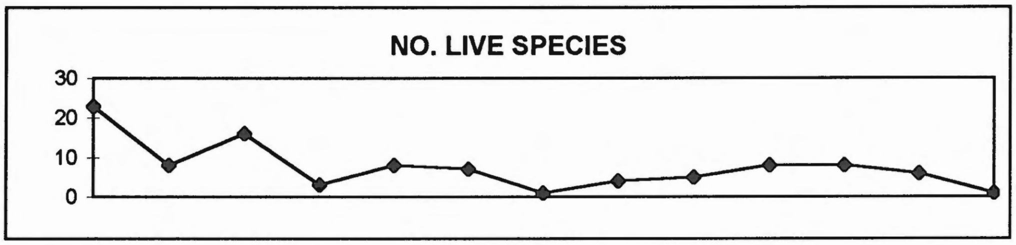
Species with total frequencies between 1 and 2 % in at least one sample were *Bolivina striatula, Buliminella elegantissima, Cyclogyra planorbis, M.onalysidium politum, Nonion gradeloupi, Trochammina ochracea, Quinqueloculina goesi, Quinqueloculina seminulum, Reophax nodulosus, Rosalina globularis,* and *Spiroloculina arenata.*

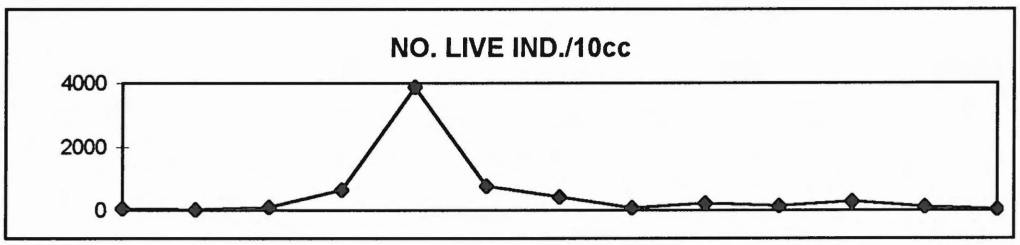
Traverse in northeastern North Lagoon

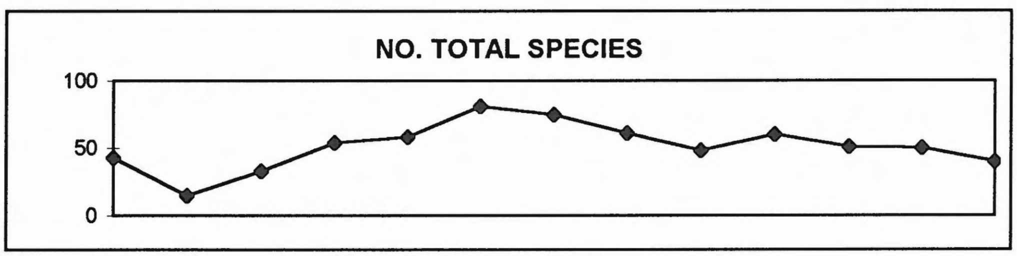
In the 13 samples examined along the traverse, sediment size ranged from fine to very coarse sand. The samples represented 3 subenvironments in North lagoon; samples #17, 18, and 19 were reef samples (samples #17 and 18 were outer reef samples from Mills Breaker Ledge, and sample #19 was a lagoonal reef sample from Three Hill Shoals); samples #1, 3, 35 are protected lagoon samples (on the island side of the reef rim); and samples #7, 9, 11, 13 and 15 are offshore lagoon samples (outside the reef rim). Depth varied between 3.7 to 24 meters. Temperature was 24°C and salinities varied between 35 and 36.5 ppm (one time measurement in Feb. 95). Live and total abundances were low in the three samples shallower than 9 meters (#17 to 19) (11 to 100 live ind/10cc and 309 to 398 total ind./10cc). In the other samples, live abundance was

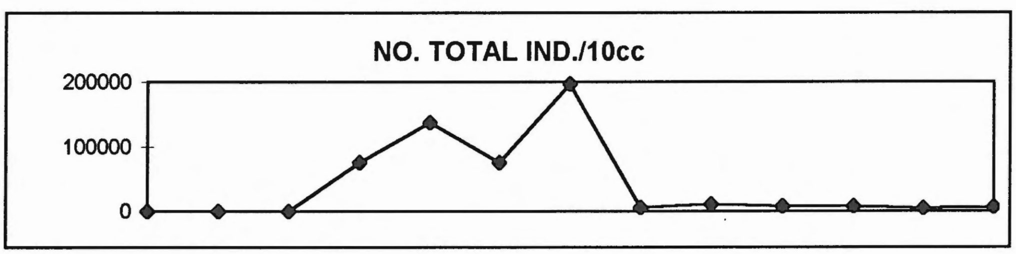
Figure 18. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in North Lagoon traverse.

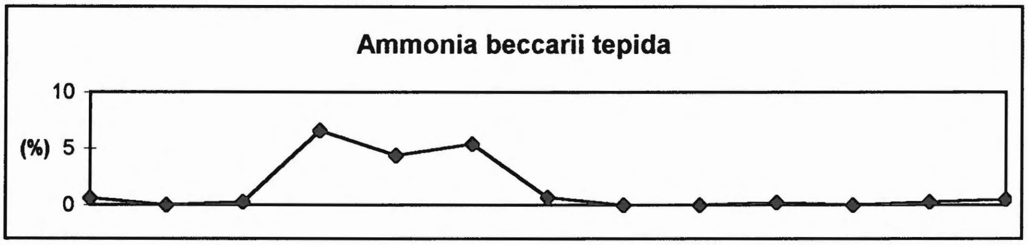

DEPTH
0
(m) -20
-40
19
17
18
1
3
5
7
15
9
10
11
13
Station number

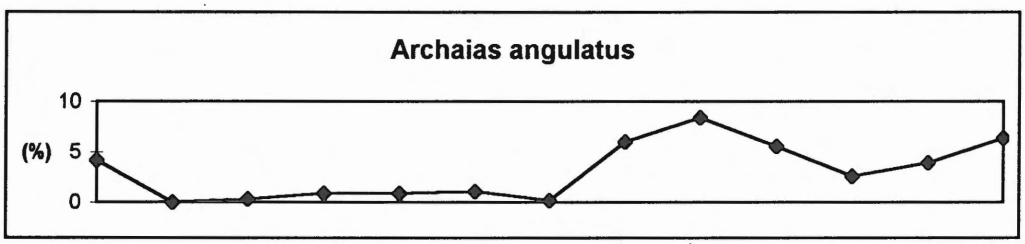

NO. LIVE SPECIES
30
20
10
0

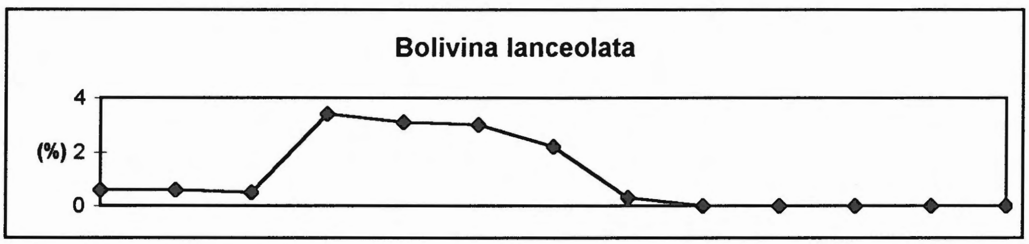

NO. LIVE IND./10cc
4000
2000
0

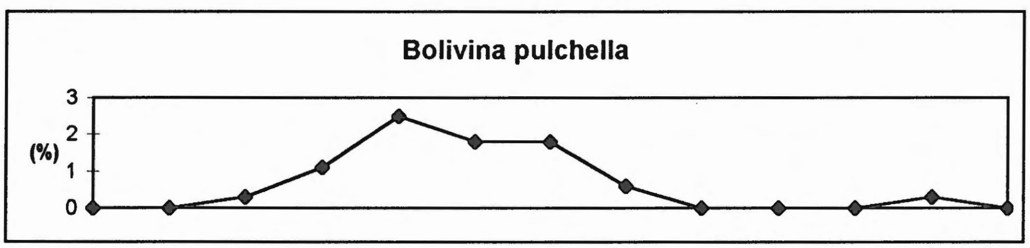

NO. TOTAL SPECIES
100
50
0

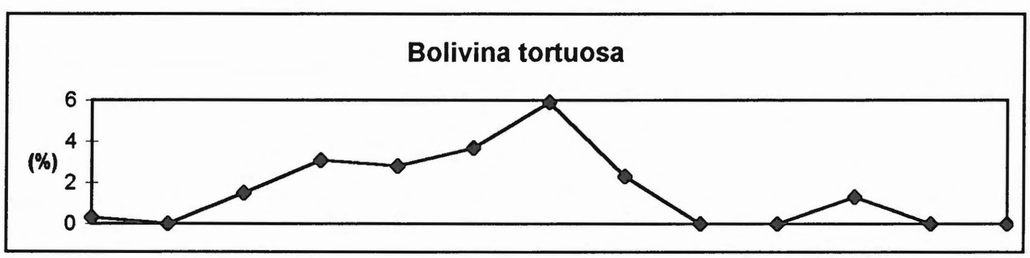

NO. TOTAL IND./10cc
200000
100000
0

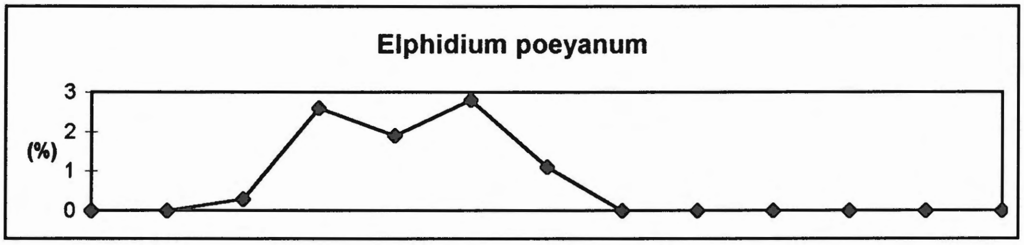

Ammonia beccarii tepida
10
(%) 5
0

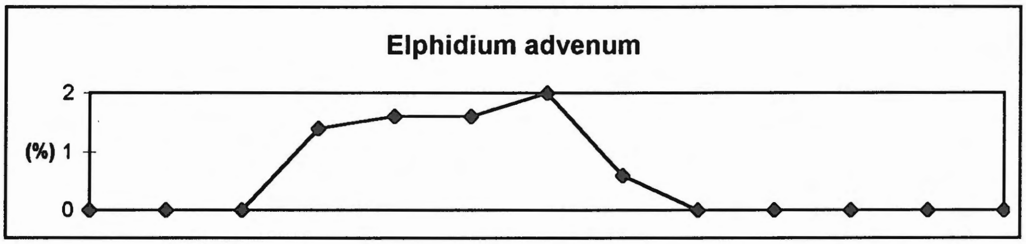

Archaias angulatus
10
(%) 5
0

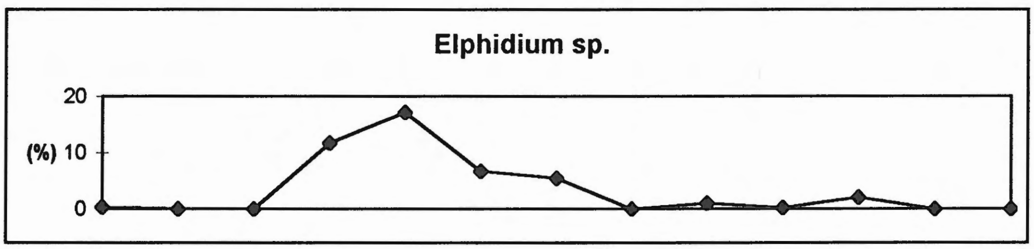

Bolivina lanceolata
4
(%) 2
0

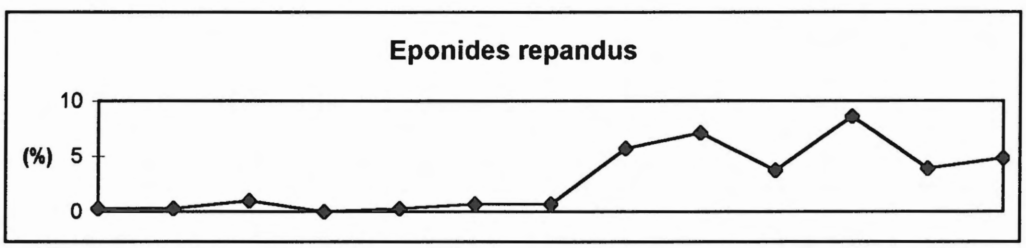

Bolivina pulchella
3
2
(%)
1
0

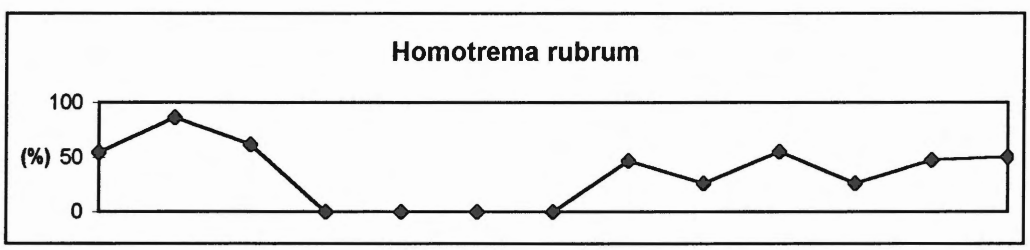

Bolivina tortuosa
6
4
(%)
2
0

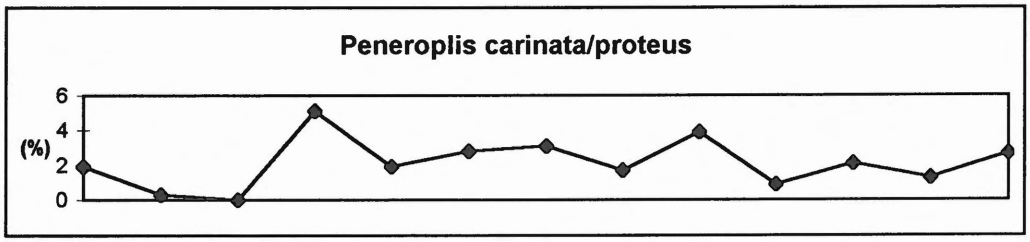

Elphidium poeyanum
(%)
3
2
1
0

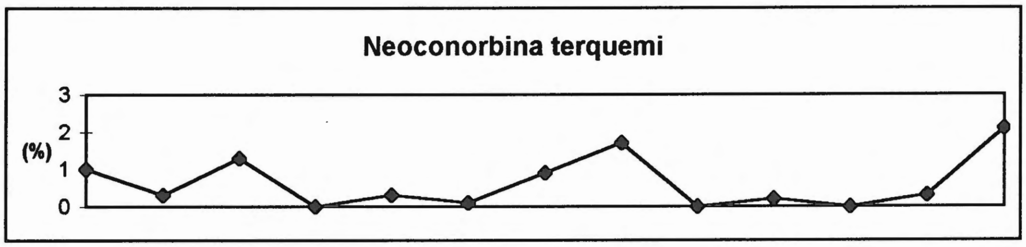

Elphidium advenum
(%)
2
1
0

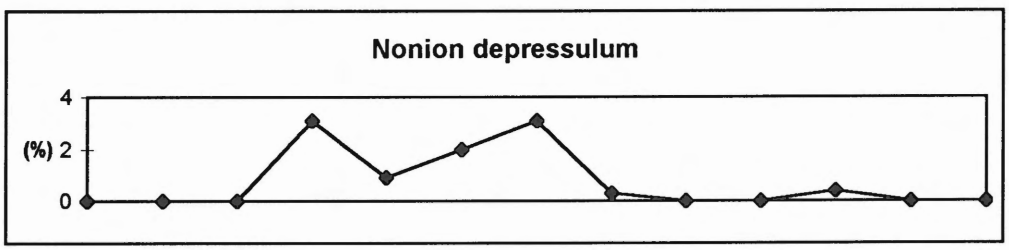

Elphidium sp.
(%)
20
10
0

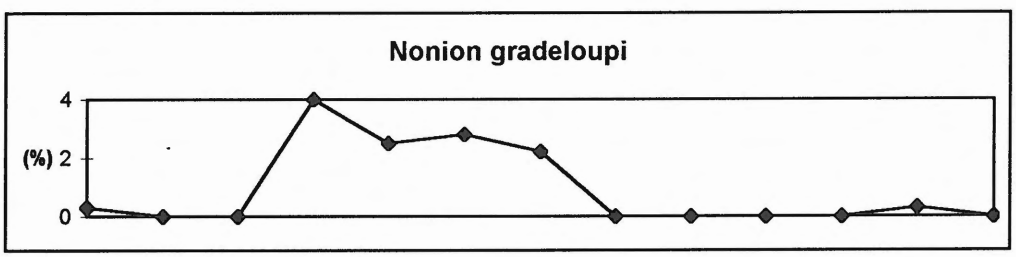

Eponides repandus
(%)
10
5
0

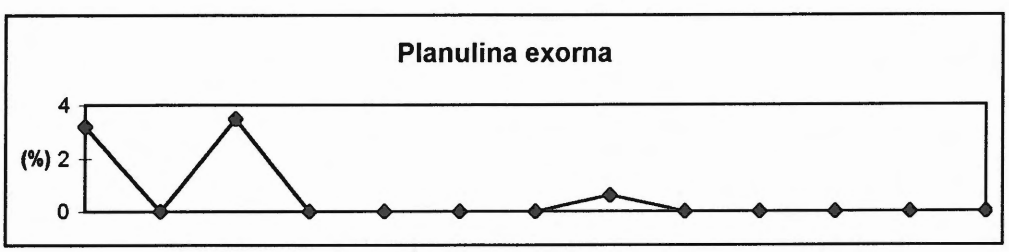

Homotrema rubrum
(%)
100
50
0

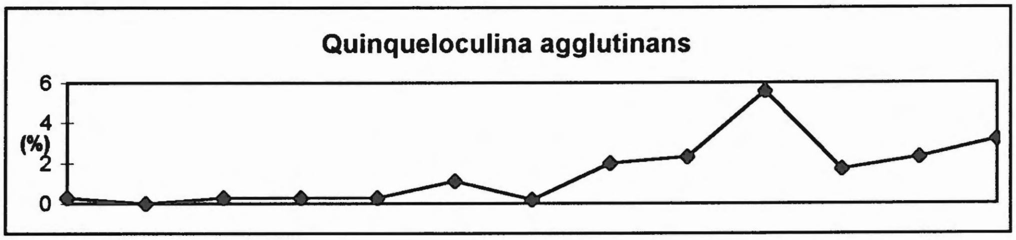

Peneroplis carinata/proteus
(%)
6
4
2
0

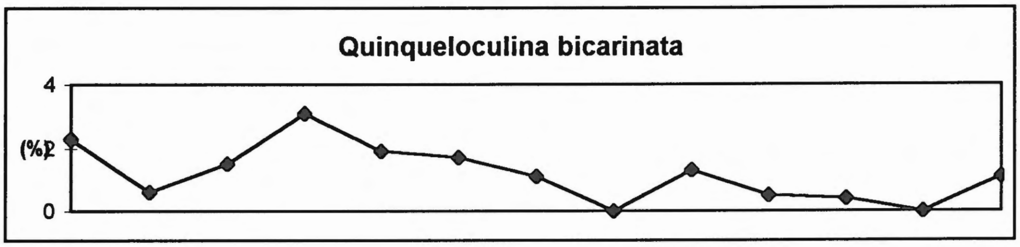

Neoconorbina terquemi
(%)
3
2
1
0

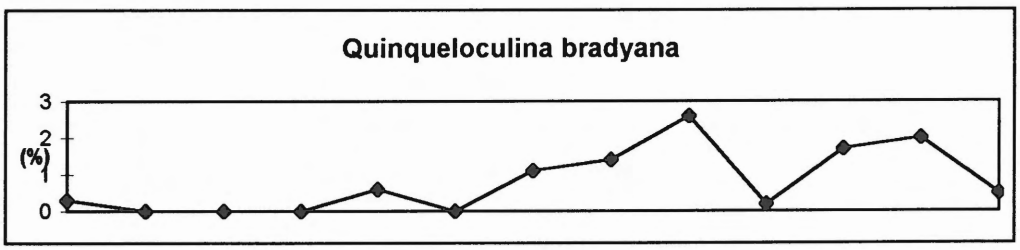

Nonion depressulum
(%)
4
2
0

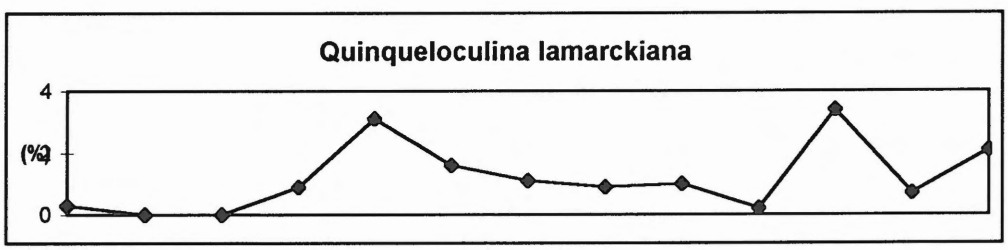

Nonion gradeloupi
(%)
4
2
0

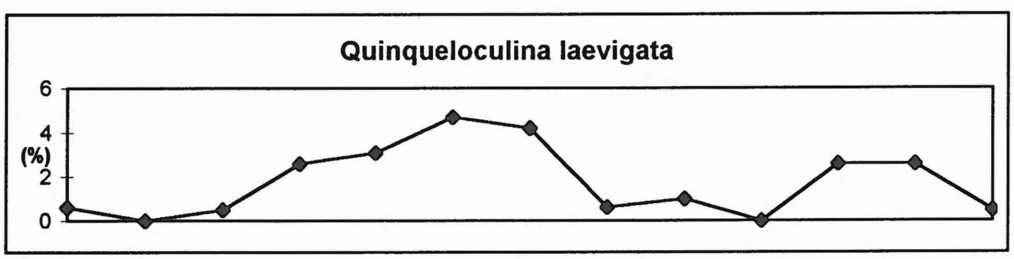

Planulina exorna
(%)
4
2
0

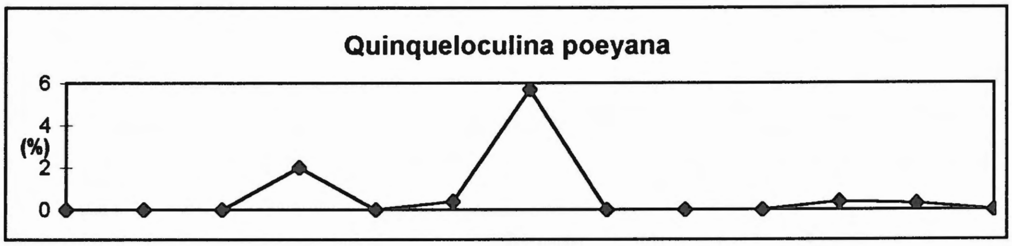

Quinqueloculina agglutinans
6
4
(%)
2
0

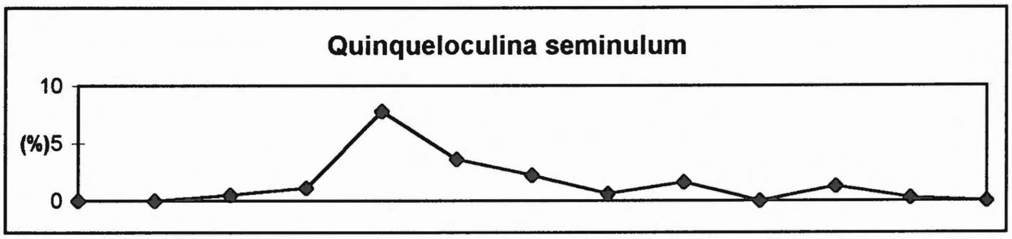

Quinqueloculina bicarinata
4
(%)2
0

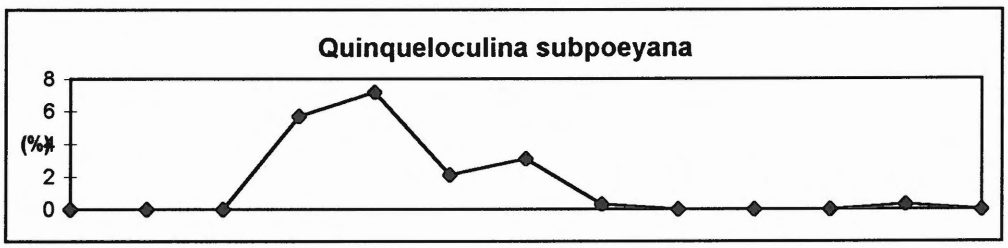

Quinqueloculina bradyana
3
2
(%)
1
0

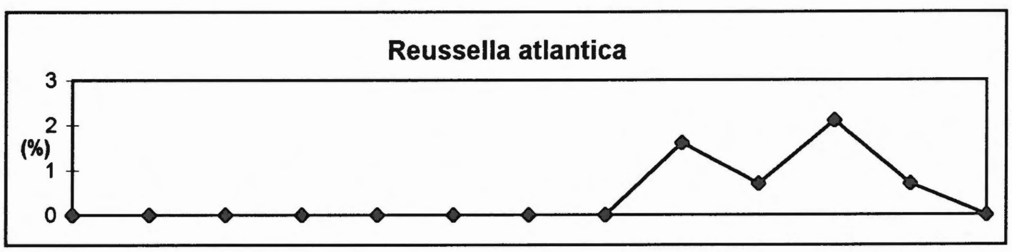

Quinqueloculina lamarckiana
4
(%)2
0

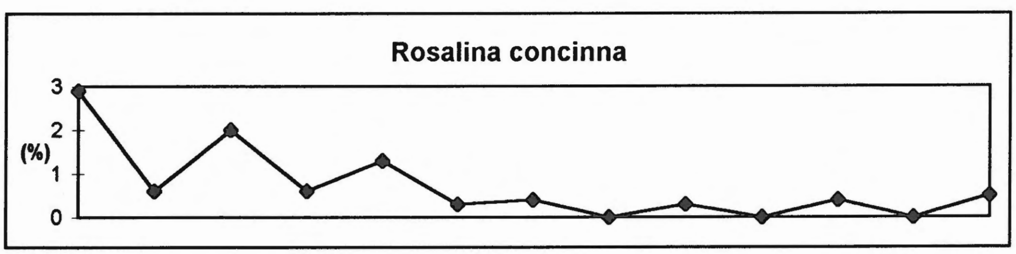

Quinqueloculina laevigata
6
4
(%)
2
0

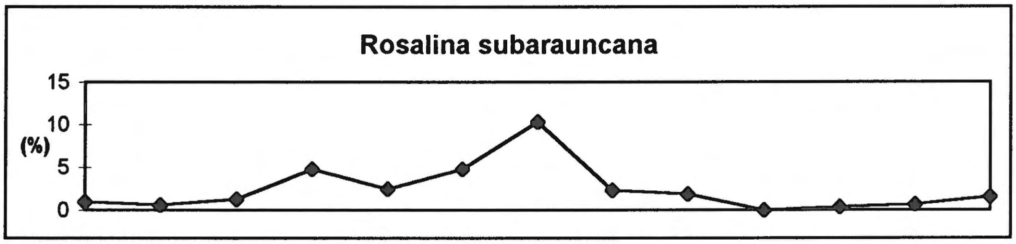

Quinqueloculina poeyana
6
4
(%)
2
0

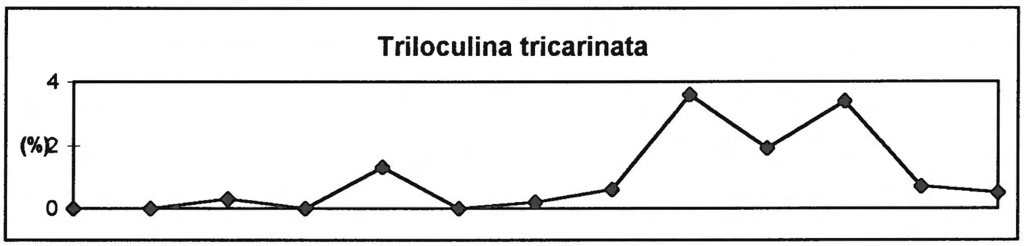

Quinqueloculina seminulum
10
(%)5
0

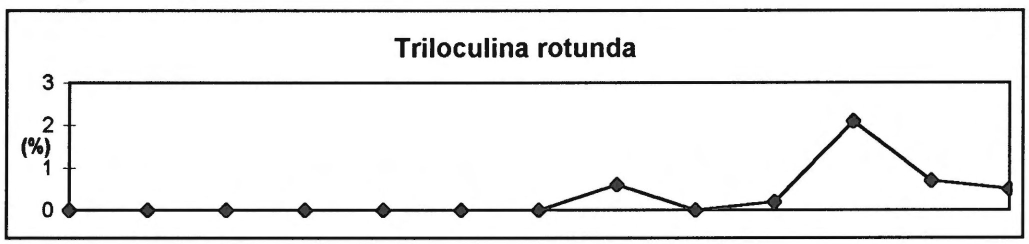

Quinqueloculina subpoeyana
8
6
(%)4
2
0

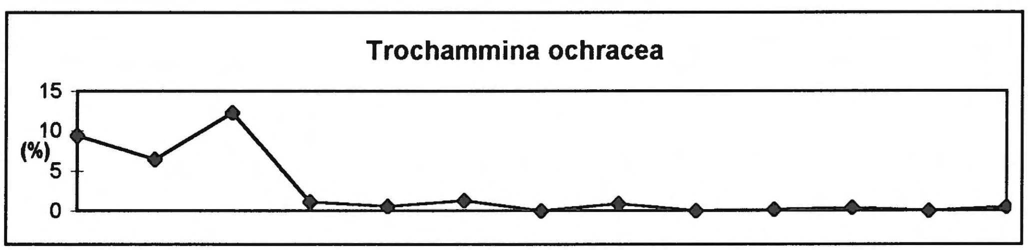

Reussella atlantica
3
2
(%)
1
0

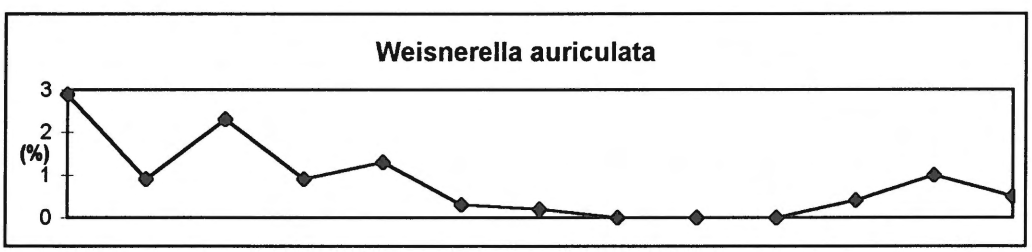

Rosalina concinna
3
2
(%)
1
0


Rosalina subarauncana
15
10
(%)
5
0


Triloculina tricarinata
4
(%)2
0


Triloculina rotunda
3
2
(%)
1
0


Trochammina ochracea
15
10
(%)
5
0


Weisnerella auriculata
3
2
(%)
1
0

variable (90 to 3,888 live ind/10cc) and total abundance was high to very high (5,454 to 197,424 total ind./10cc). Number of live species was low (1 to 8 species) except in the three samples shallower than 9 meters where it is higher (8 to 23 live species). Total diversity was relatively high in the three shallower samples (15 to 43 species) and high (40 to 80 species) in the other samples (fig.18, appendices table 6).

The most abundant species were *Homotrema rubrum* (0 to 86.6%), *Elphidium sp.* (0 to 17.2%), *Trochammina ochracea* (0 to 12.3%), *Rosalina subarauncana* (0 to 10.3%), *Asterigerina carinata* (0 to 10.1%), *Eponides repandus* (0 to 8.6%), *Archaias angulatus* (0 to 8.4%), *Quinqueloculina seminulum* (0 to 7.8%), *Quinqueloculina subpoeyana* (0 to 7.2%), *Ammonia beccarii tepida* (0 to 6.6%), *Bolivina tortuosa* (0 to 5.9%), *Quinqueloculina candeiana* (0 to 5.7%), *Quinqueloculina poeyana* (0 to 5.7%), *Quinqueloculina agglutinans* (0 to 5.6%), *Peneroplis carinatus/proteus* (0 to 5.1%), *Quinqueloculina laevigata* (0 to 4.7%), and *Nonion gradeloupi* (0 to 4%).

Species with total frequencies between 2 and 4% in at least one sample were *Trioloculina carinata, Planulina exorna, Bolivina lanceolata, Quinqueloculina lamarckiana, Nonion depressulum, Quinqueloculina bicarinata, Rosalina concinna, Quinqueloculina bradyana, Weisnerella auriculata, Elphidium poeyanum, Bolivina pulchella, Neoconorbina terquemi, Articulina pacifica,* and *Triloculina rotunda.*

Species with total frequencies between 1 and 2% in at least one sample were *Buliminella elegantissima, Monalysidium politum, Cassidulina subglobosa, Cyclogyra* *planorbis, Reussella atlantica, Astrononion stelligera, Articulina antillarum, Cymbaloporetta squamosa, Quinqueloculina polygona, Rosalina globularis, Spirillina cariacoensis, Siphonina pulchra, Triloculina bassensis, Valvulina oviedoina, and Triloculina quadrilateralis.*

The distribution of most common species with depth corresponds to their distribution in the three subenvironments represented by the samples: reef, protected lagoon, and offshore lagoon.

Planulina exorna, and *Trochammina ochracea* occurred only in the reef samples. *Homotrema rubrum* and *Weisnerella auriculata* occurred in the reef samples and in the offshore lagoon samples, not in the protected lagoon samples. In the protected lagoon samples, live and total abundances were higher than in the reef and offshore lagoon samples, and the following species were most abundant: *Ammonia beccarii tepida, Bolivina lanceolata, Bolivina pulchella, Bolivina tortuosa, Elphidium poeyanum, Elphidium advenum, Elphidium sp., Nonion depressulum, Nonion gradeloupi, Quinqueloculina poeyana, Quinqueloculina subpoeyana,* and *Rosalina subarauncana*. These species were rare or absent in the reef and offshore lagoon samples. Species common to the protected lagoon and offshore lagoon samples, and rare or absent in the shallow reef samples were *Quinqueloculina seminulum, Quinqueloculina laevigata*, and *Quinqueloculina lamarckiana*. *Quinqueloculina laevigata* was common in the deep lagoonal reef sample. Species occurring only or mostly in the offshore lagoon were

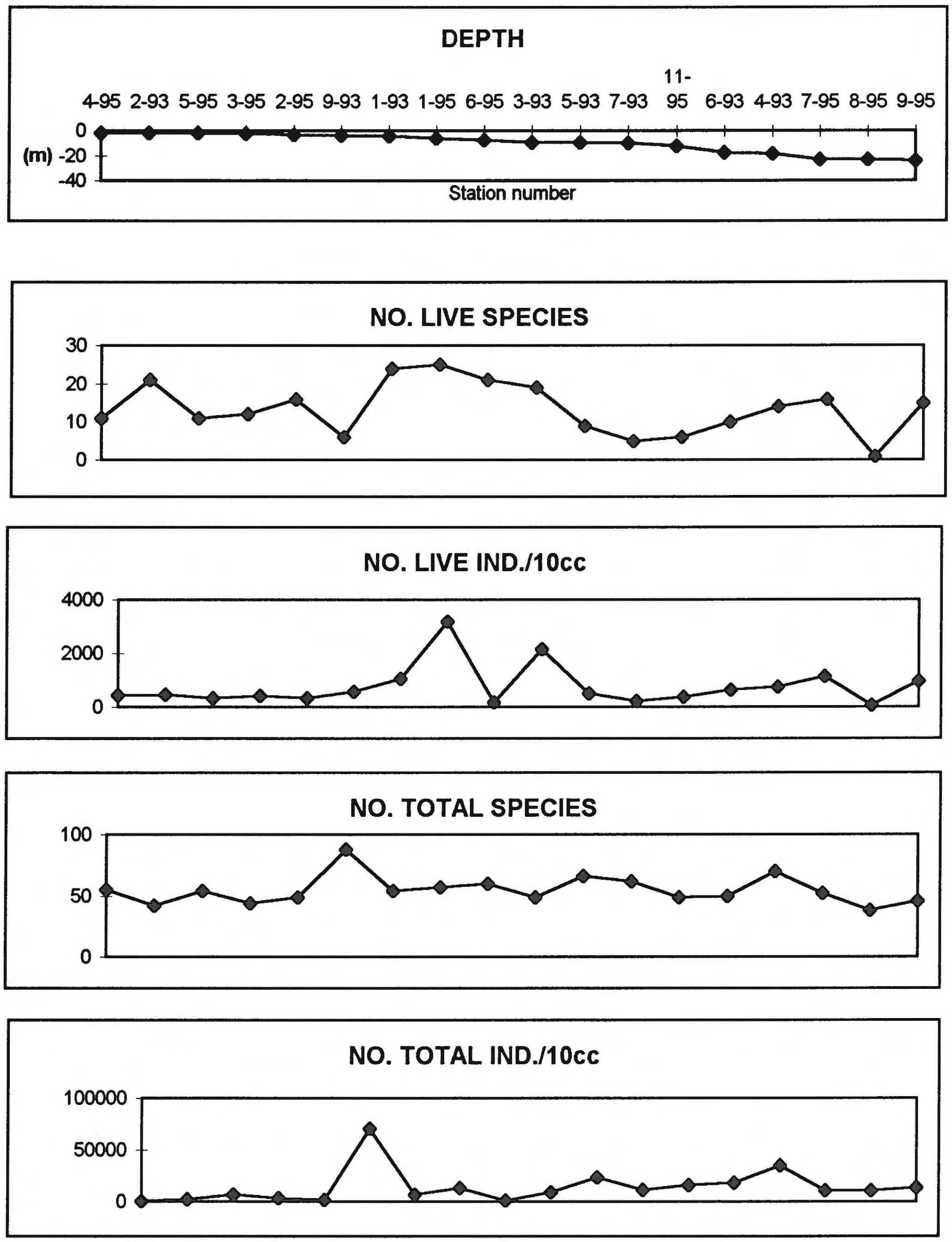
Eponides repandus, Quinqueloculina agglutinans, Quinqueloculina bradyana, Trioloculina tricarinata, Triloculina rotunda, and *Reussella atlantica* (although *Archaias angulatus* was common in the lagoonal reef sample but not in the outer reef samples).

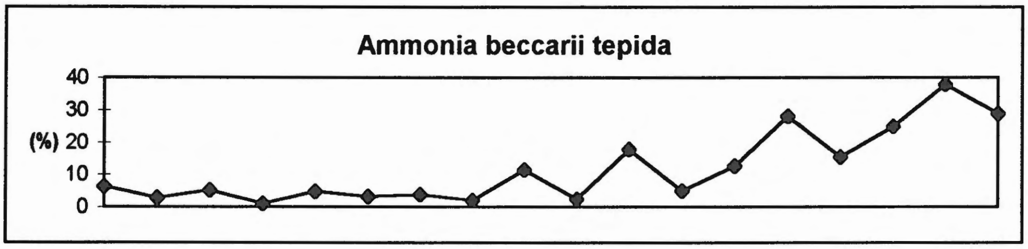
3.1.2.2. Harrington Sound

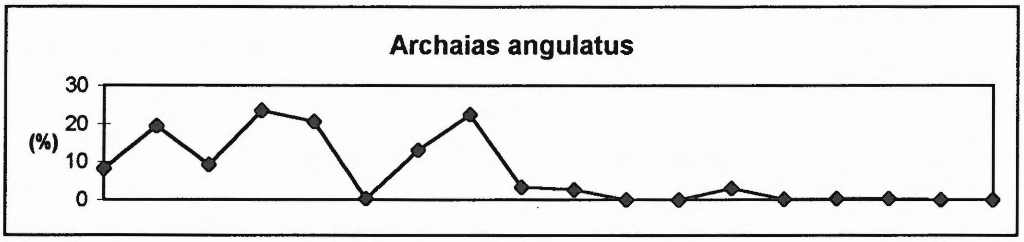
In the 18 samples examined from this lagoon, no major differences in abundance and diversity of living and total species were observed between February 93 and May 95. Sediment size ranged from silty to medium sand. Depth varied between 1.7 and 24 meters (depth range was represented in both sets of samples). Salinity was 35 ppm and temperature was 20°C in February and 24°C in May (one time measurements). A total of 173 species were identified. Live and total abundances varied between moderate to very high (180 to 5,186 live ind/10cc and 1,321 to 70,920 total ind./10cc). Live diversity was low to moderately high, and total diversity was high (1 to 25 live species, and 38 to 88 total species) (fig.19, appendices tables 7 and 8).

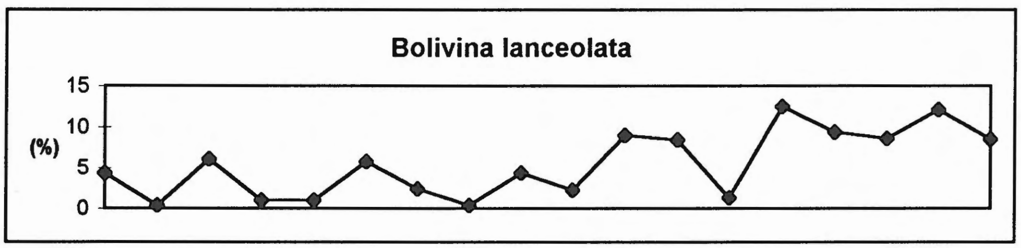
The most abundant species were *Ammonia beccarii tepida* (1 to 37.8%), *Peneroplis carinatus/proteus* (0 to 26%), *Archaias angulatus* (0 to 23.5%), *Textularia agglutinans* (0 to 20.9%), *Quinqueloculina lamarckiana* (0 to 17.7%), *Quinqueloculina bicarinata* (0 to 15.5%), *Bolivina lanceolata* (0 to 12.5%), *Quinqueloculina seminulum* (0 to 12.3%), *Textularia conica* (0 to 12.2%), *Quinqueloculina laevigata* (0.3 to 9.9%),

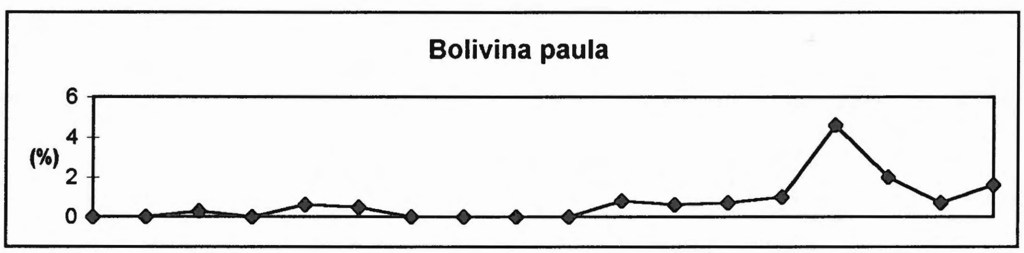
Figure 19. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Harrington Sound.

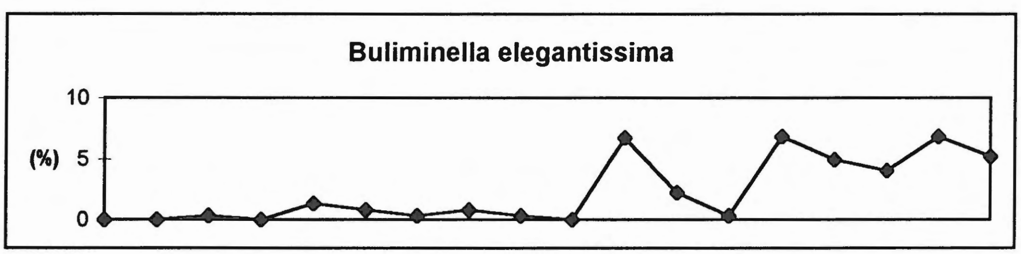

DEPTH
4-95 2-93 5-95 3-95 2-95 9-93 1-93 1-95 6-95 3-93 5-93 7-93 11-95 6-93 4-93 7-95 8-95 9-95
0
(m) -20
-40
Station number
NO. LIVE SPECIES
30
20
10
0
NO. LIVE IND./10cc
4000
2000
0
NO. TOTAL SPECIES
100
50
0
NO. TOTAL IND./10cc
100000
50000
0

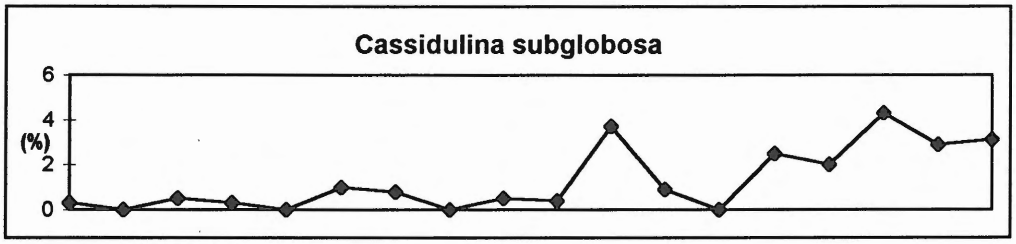

Ammonia beccarii tepida
40
30
(%) 20
10
0

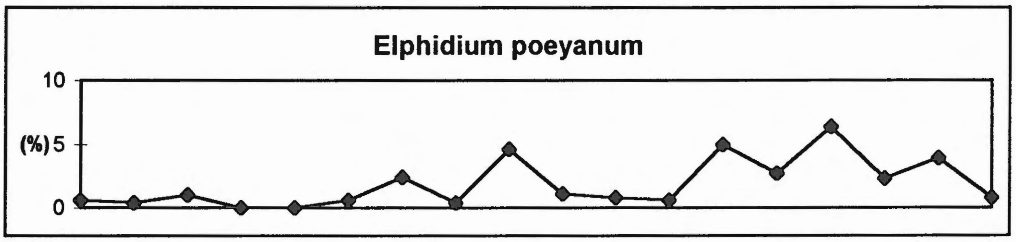

Archaias angulatus
30
20
(%)
10
0

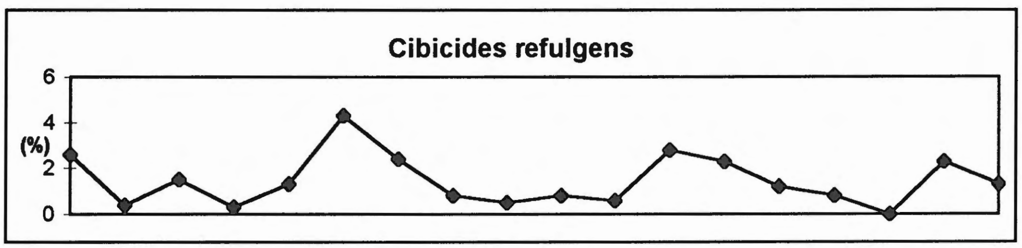

Bolivina lanceolata
15
10
(%)
5
0

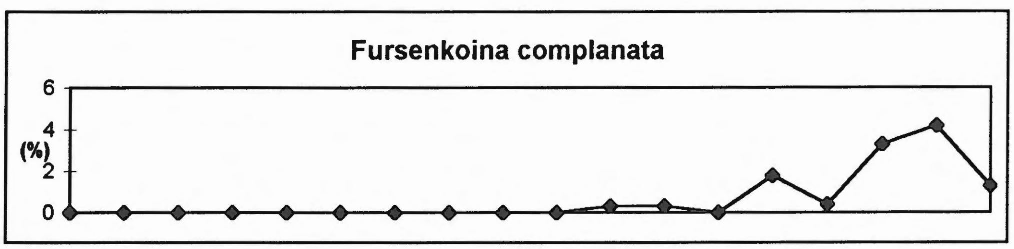

Bolivina paula
6
4
(%)
2
0

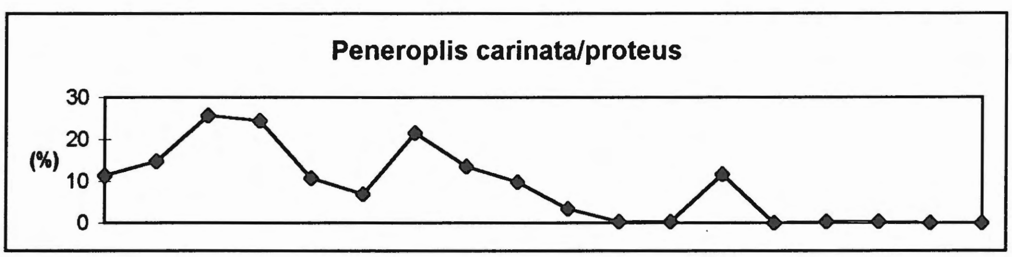

Buliminella elegantissima
10
(%) 5
0

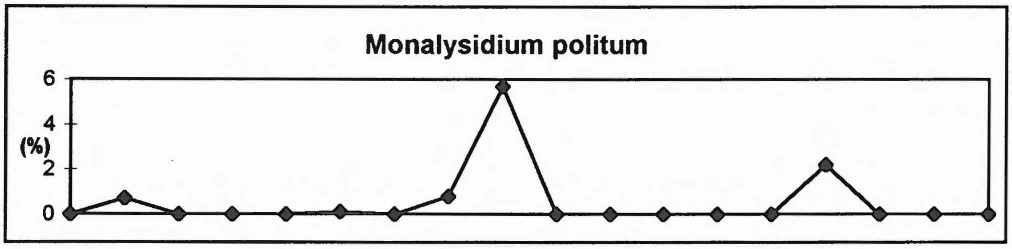

Cassidulina subglobosa
6
4
(%)
2
0

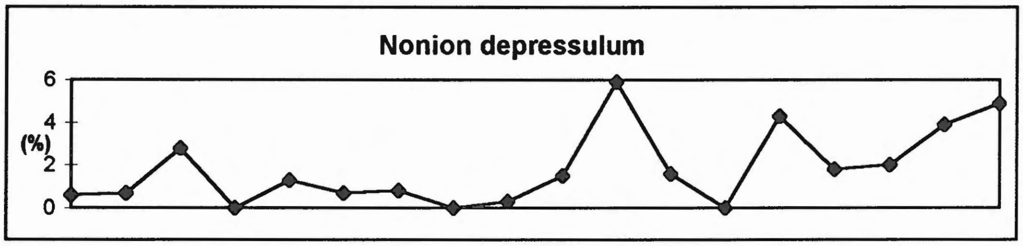

Elphidium poeyanum
10
(%) 5
0

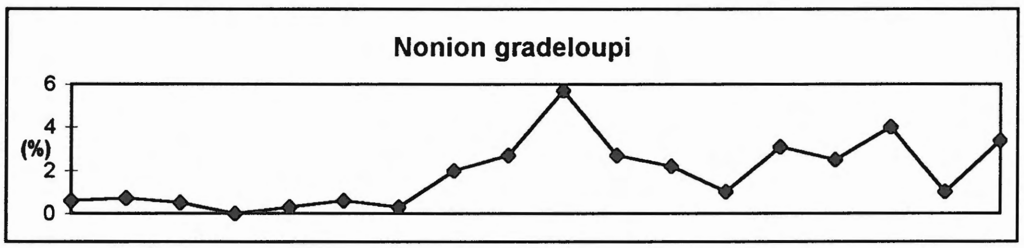

Cibicides refulgens
6
4
(%)
2
0

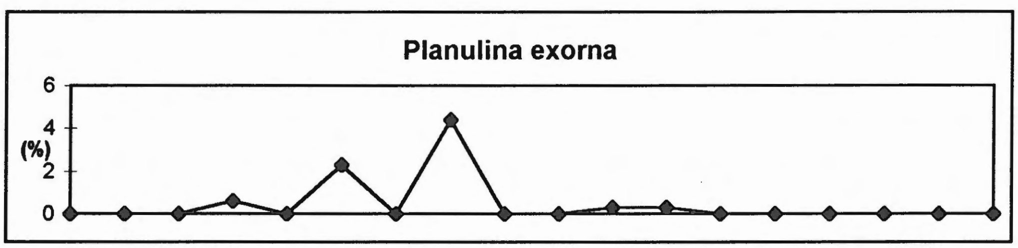

Fursenkoina complanata
6
4
(%)
2
0

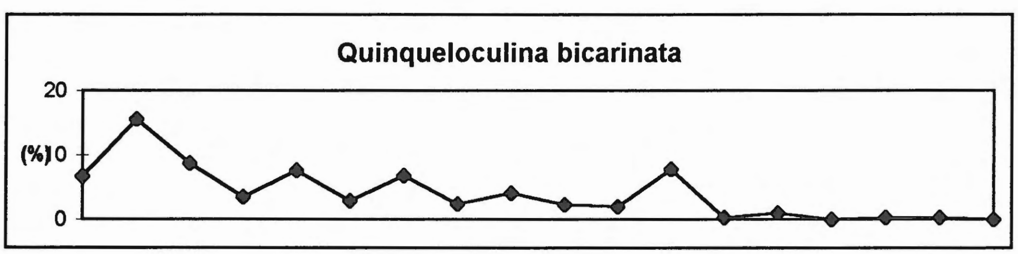

Peneroplis carinata/proteus
30
20
(%)
10
0

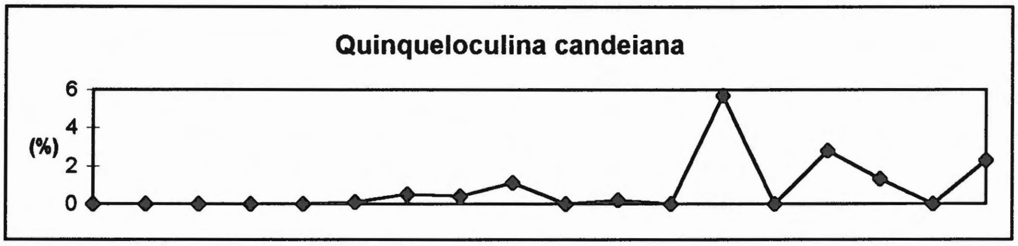

Monalysidium politum
6
4
(%)
2
0

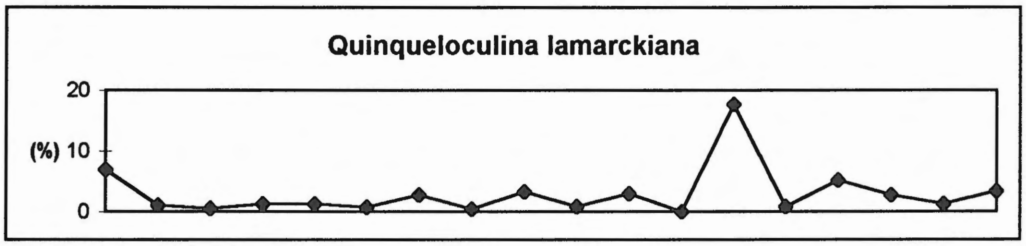

Nonion depressulum
6
4
(%)
2
0

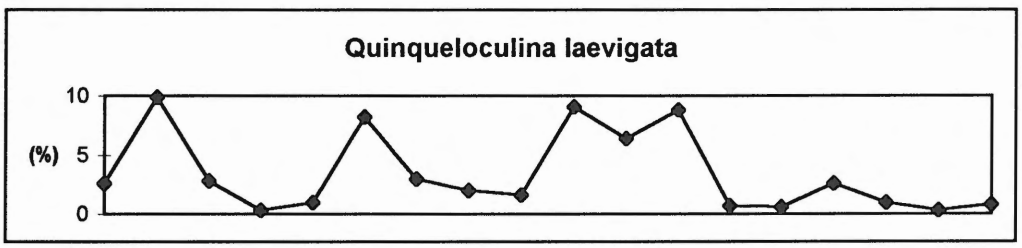

Nonion gradeloupi
6
4
(%)
2
0

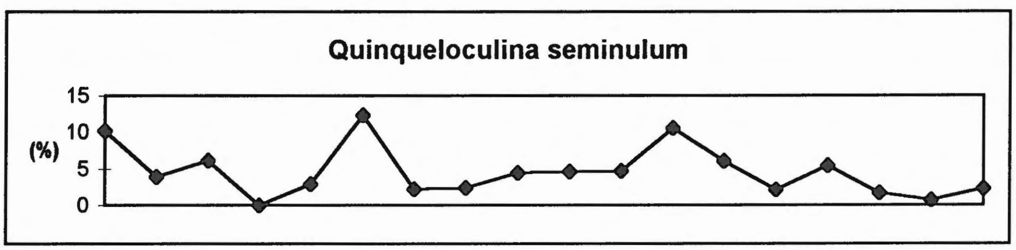

Planulina exorna
6
4
(%)
2
0

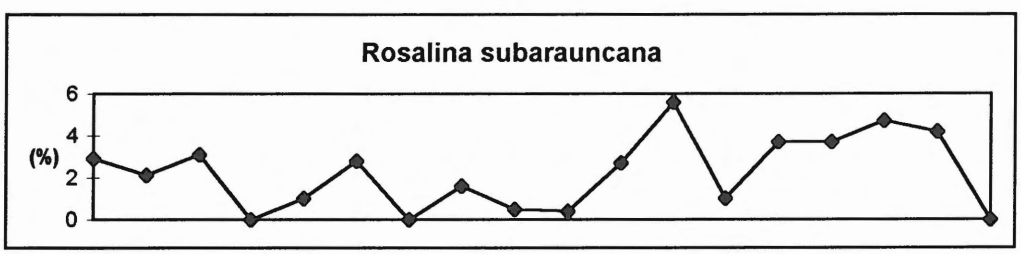

Quinqueloculina bicarinata
20
(%)10
0


Quinqueloculina candeiana
6
4
(%)
2
0

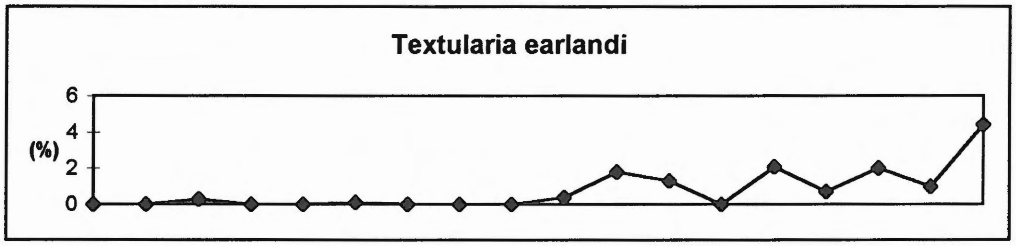

Quinqueloculina lamarckiana
20
(%) 10
0

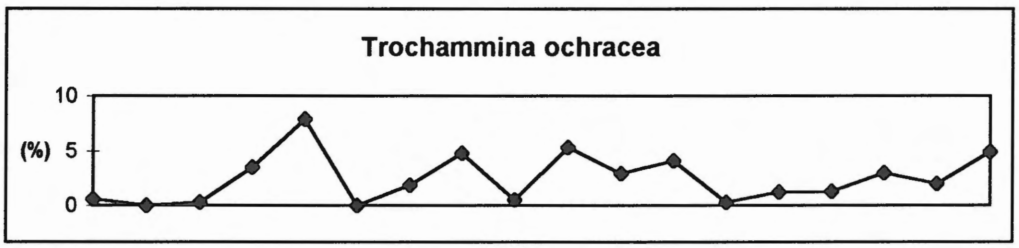

Quinqueloculina laevigata
10
(%) 5
0


Quinqueloculina seminulum
15
10
(%)
5
0


Rosalina subarauncana
6
4
(%)
2
0


Textularia conica
15
10
(%)
5
0


Textularia earlandi
6
4
(%)
2
0


Trochammina ochracea
10
(%) 5
0

Trochammina ochracea (0 to 7.9%), *Cibicides refulgens* (0 to 4.3%), *Buliminella elegantissima* (0 to 6.8%), *Elphidium poeyanum* (0 to 6.4%), *Nonion depressulum* (0 to 5.9%), *Nonion gradeloupi* (0 to 5.7%), *Rosalina subarauncana* (0 to 5.6%), *Cassidulina subglobosa* (0 to 4.3%), *Fursenkoina complanata* (0 to 4.2%), *Monalysidium politum* (0 to 5.7%), *Quinqueloculina candeiana* (0 to 5.7%), and *Textularia earlandi* (0 to 4.4%).

Species with total frequencies between 2 and 4% in at least one sample were *Rosalina globularis, Triloculina oblonga, Triloculina trigonula, Weisnerella auriculata, Glomospira irregularis, Bolivina lowmani, Quinqueloculina bosciana, Quinqueloculina candeiana, Quinqueloculina vulgaris, Reophax nana, Rosalina concinna, Ammobaculites agglutinans, Bolivina paula, Elphidium sp., Elphidium advenum, Quinqueloculina subpoeyana, Quinqueloculina vulgaris, Triloculina bassensis, Reophax scorpiurus,* and *T.riloculina carinata*.

Species with total frequencies between 1 and 2% in at least one sample were *Bolivina tortuosa, Bolivina subexcavata, Bulimina marginata, Bulimina gibba, Elphidium discoidale, Fissurina spp., Neoconorbina terquemi, Q.uinqueloculina polygona, Quinqueloculina sabulosa, Spirillina cariacoensis, Spirillina denticulata, Spiroloculina arenata, Valvulina oviedoina, Elphidium sp., Elphidium sagrum, Articulina pacifica, Asterigerina carinata, Cymbaloporetta squamosa, Miliolinella labiosa, Pyrgo subsphaerica, Quinqueloculina agglutinans, Reophax nana, Triloculina bermudezi*, and *Trochammina inflata*.

At depths equal or deeper than 9 meters, total frequencies of *Ammonia beccarii tepida, Bolivina lanceolata*, and *Buliminella elegantissima* increased; *Fursenkoina complanata, Cassidulina subglobosa, Nonion depressulum,* and *Textularia earlandi* increased slightly; *Archaias angulatus* disappeared; *Peneroplis carinatus/proteus* decreased in frequency then disappeared above 17 meters. *Quinqueloculina bicarinata* decreased, then disappeared above 12 meters depth. *Textularia agglutinans, Quinqueloculina laevigata*, and *Quinqueloculina seminulum* had variable frequencies but disappeared respectively above 9, 12, and 17 meters depth.

3.1.3. REEFS

3.1.3.1. The outer reefs

A. Hog breaker Reefs

In the 5 samples examined from this area, sediment size ranged from coarse to very coarse sand. Depth was 9 meters. A total of 66 species were identified. Live and total abundances were low (124 to 268 live ind./10cc and 648 to 930 total ind./10cc) (Appendices table 9). Live and total numbers of species were moderately high (19 to 30 live species and 24 to 43 total species).

The most abundant species (total frequencies) were *Homotrema rubrum* (61.1 to 71.3%), *Trochammina ochracea* (0 to 11.9%), and *Quinqueloculina bicarinata* (3.1 to 4.7%).

Species with total frequencies between 2 and 4% in at least one sample were *Archaias angulatus, Glabratella opercularis, Peneroplis carinatus/proteus, Planulina exorna, Quinqueloculina seminulum, Rosalina concinna, Ros subarauncana, Spirillina cariacoensis*, and *Weisnerella auriculata*.

Species with total frequencies between 1 and 2% in at least one sample were *Amphistegina lessonii, Asterigerina carinata, Bolivina tortuosa, Peneroplis bradyi, Neoconorbina terquemi, Placopsilina bradyi*, and *Quinqueloculina lamarckiana*.

B. Twin Reefs

In the 5 samples examined in this area, sediment size ranged from medium to very coarse sand. Depth was 9 meters. A total of 72 species were identified. Live and total abundances were low (266 to 516 live ind./10cc and 1,160 to 1,656 total ind./10cc) (Appendices table 10). Live and total numbers of species were moderately high (18 to 27 live species and 33 to 44 total species).

The most abundant species (total frequencies) were *Homotrema rubrum* (45.9 to 71.3 %), *Weisnerella auriculata* (1.6 to 10.9%), *Archaias angulatus* (1.4 to 9.8%), *Quinqueloculina bicarinata* (0.5 to 7.8%), *Trochammina ochracea* (1.8 to 5.9%) and *Peneroplis carinatus/proteus* (0 to 4.4%).

Species with total frequencies between 2 and 4% in at least one sample were *Articulina pacifica, Asterigerina carinata, Peneroplis bradyi, Quinqueloculina seminulum, Rosalina concinna,* and *Rosalina subaraucana.*

Species with total frequencies between 1 and 2% in at least one sample were *Amphistegina lessonii, Carpenteria proteiformis, Placopsilina bradyi, Planulina exorna, Quinqueloculina polygona, Rosalina globularis,* and *Spirillina cariacoensis.*

3.1.3.2. Lagoonal reefs

A. Crescent Reefs

In the 5 samples examined in this area, sediment size ranged from medium to coarse sand. Depth was 4.5 meters. A total of 110 species were identified. Live and total abundances were high (1,926 to 5,184 live ind./10cc and 8,532 to 18,468 total ind./10cc) (Appendices table 11). Live diversity was moderately high (21 to 34 species) and total diversity was high (49 to 93 species).

The most abundant species (total frequencies) were *Peneroplis carinatus/proteus* (20.1 to 30%), *Archaias angulatus* (12 to 17.6%), *Quinqueloculina bicarinata* (1.2 to 5.3%), *Trochammina ochracea* (2.1 to 4.9%), *Miliolinella labiosa* (0.7 to 4.2).

Species with total frequencies between 2 and 4% in at least one sample were *Articulina pacifica, Bolivina pulchella, Cyclogyra planorbis, Homotrema rubrum,* *Peneroplis bradyi, Quinqueloculina candeiana, Quinqueloculina lamarckiana, Quinqueloculina laevigata, Quinqueloculina seminulum, Quinqueloculina subpoeyana, Rosalina globularis*, and *Rosalina subarauncana.*

Species with total frequencies between 1 and 2% in at least one sample were *Acervulina inhaerens, Ammonia beccarii tepida, Bolivina pulchella, Cibicides lobatulus, Cibicides refulgens, Cymbaloporetta squamosa, Elphidium advenum, Glomospira charoides, Hauerina speciosa, Peneroplis pertusus, Nonion gradeloupi, Quinqueloculina agglutinans, Quinqueloculina bosciana, Quinqueloculina polygona, Quinqueloculina vulgaris, Rosalina concinna, Sigmoilina sigmoidea, Textularia sp.*, and *Triloculina trigonula*.

3.1.4. MANGROVE SWAMPS

3.1.4.1. Hungry Bay

A. Hungry Bay transect

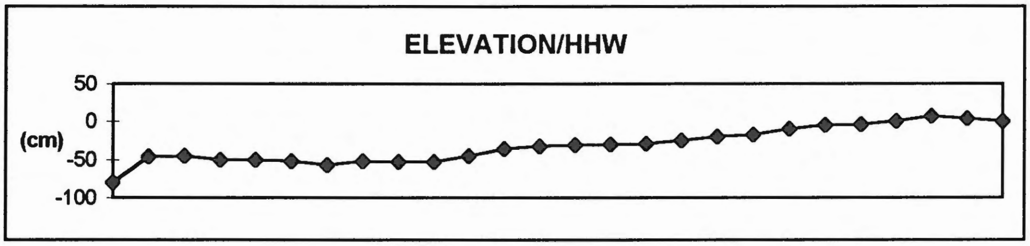
In the 26 samples examined along the transect, sediment was peat. The 44.4 meter-long transect went from HHW to about MSL. Salinities were 24 ppm in the channel and 32-33 ppm on the swamp surface ("one time" measurement, Feb. 95). Temperature was not measured. Total abundance was high (322 to 13,968 ind./10cc), except at the last station (HHW) where total number decreased dramatically (35 ind./10cc). Living abundance was sometimes high, varying from 6 ind./10cc at the last station, to 1,944 ind./10cc. A total of 56 foraminifera species (21 agglutinated species) and 3 thecamoebian species were identified. Live and total diversities were low to moderate (1 to 19 live species and 3 to 40 total species) (fig. 20, appendices table 12).

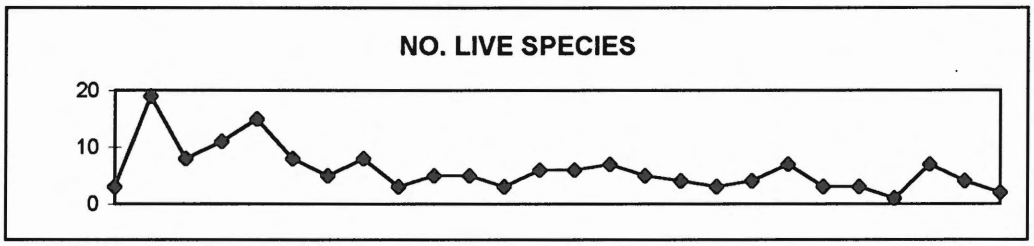
The most abundant species were *Trochammina inflata* (13.2 to 98.8%), *Trioloculina oblonga* (0 to 37.5%), *Arcella polypora* (thecamoebian, 0 to 31.4%), *Trochamminita salsa* (0 to 16.5%), *Helenina anderseni* (0 to 15.6%), *Glomospira irregularis* (0 to 13.8%), *Discorinopsis aguayoi* (0 to 11.5%), *Miliammina fusca* (0 to 8.6%), *Tolypammina vagans* (0 to 6.9%), *Rosalina globularis* (0 to 6.7%), *Textularia earlandi* (0 to 6.5%), *Bolivina lanceolata* (0 to 6.3%), *Trochammina. macrescens* (0 to 5.6%), *"Siphotrochammina" inflata* (0 to 5.3%), *Cyclogyra planorbis* (0 to 4.5%), and *Haplophragmoides wilberti* (0 to 4.2%).

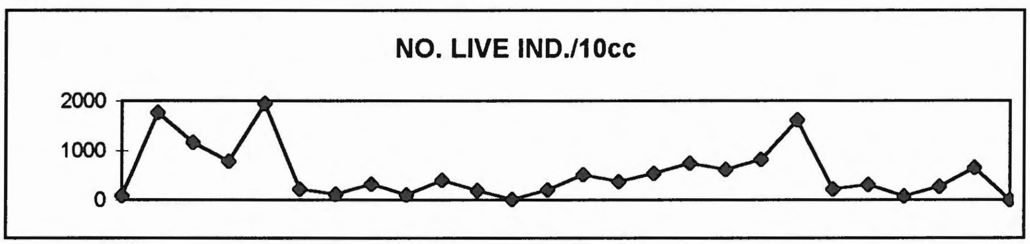
Species with total frequencies between 2 and 4% in at least one sample were *Bolivina variabilis var. spathulata, Elphidium poeyanum, Parrina bradyi, Polysaccammina ipohalina,* and *Quinqueloculina laevigata.*

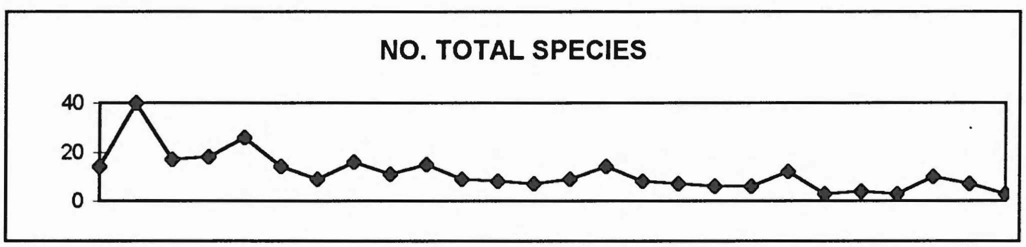
Species with total frequencies between 1 and 2% in at least one sample were *Ammodiscus tenuis, Bolivina tortuosa, Elphidium excavatum, Fissurina spp., Pseudothurammina limnetis, Spiroloculina hyalina,* and the thecamoebian *Centropyxis*

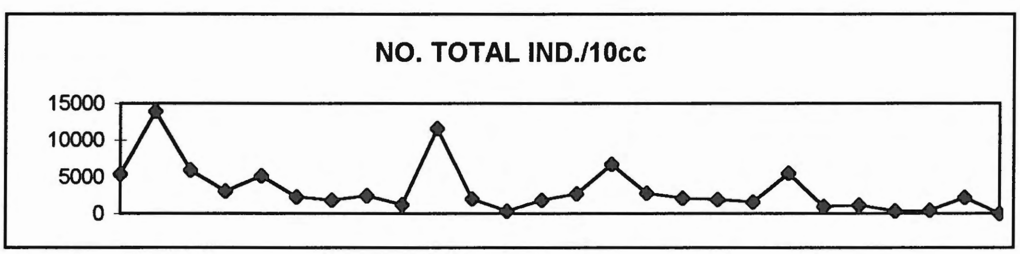
Figure 20. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species along Hungry Bay transect 95.

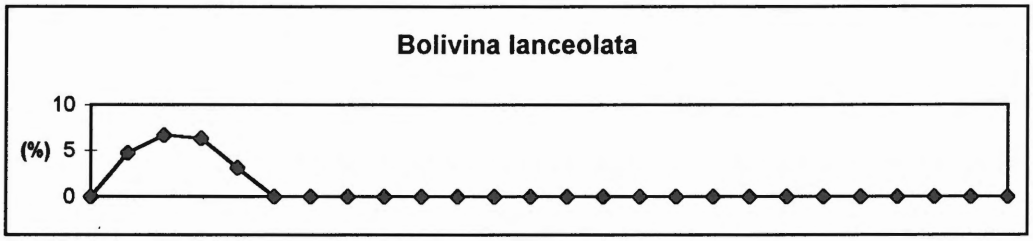

ELEVATION/HHW
50
0
(cm)
-50
-100

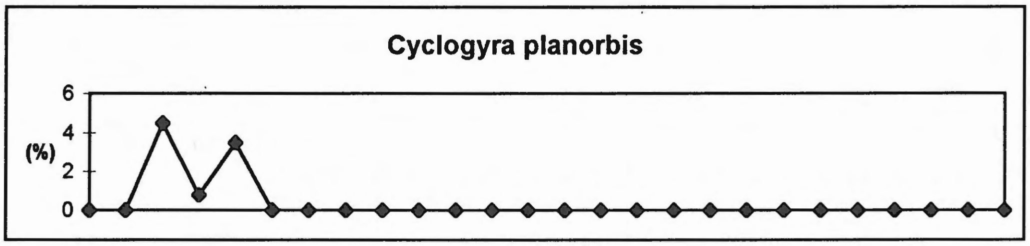

NO. LIVE SPECIES
20
10
0

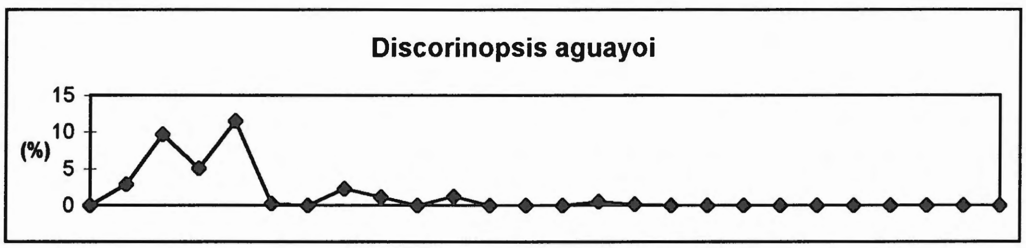

NO. LIVE IND./10cc
2000
1000
0

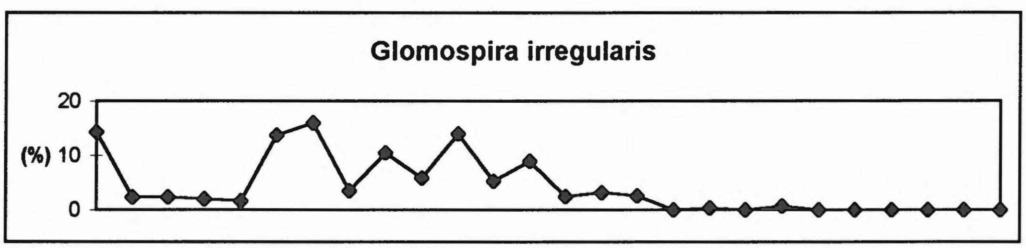

NO. TOTAL SPECIES
40
20
0

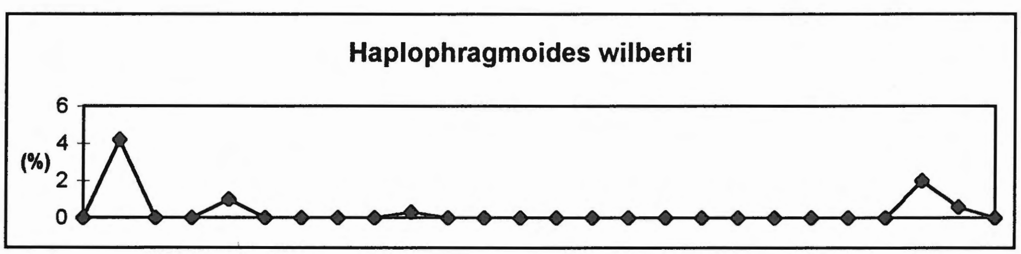

NO. TOTAL IND./10cc
15000
10000
5000
0

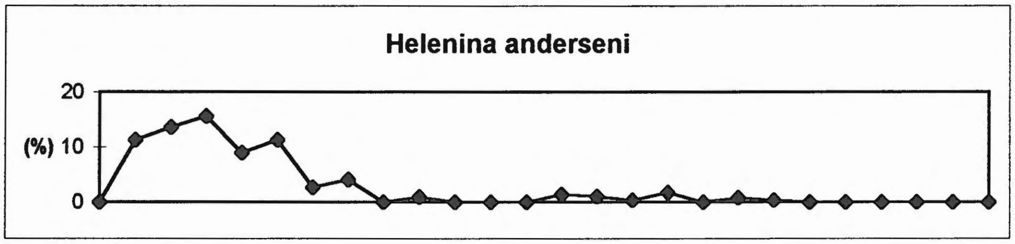

Bolivina lanceolata
10
(%) 5
0

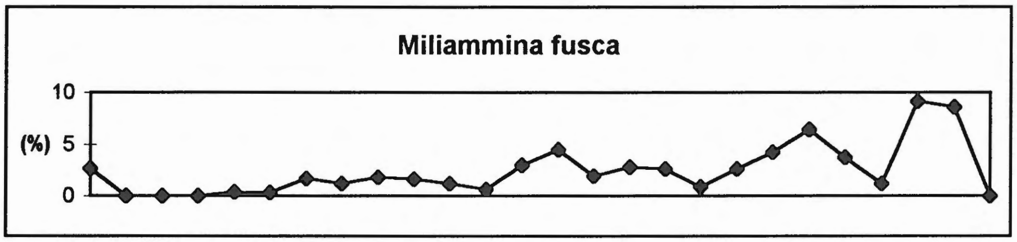

Cyclogyra planorbis
6
4
(%)
2
0

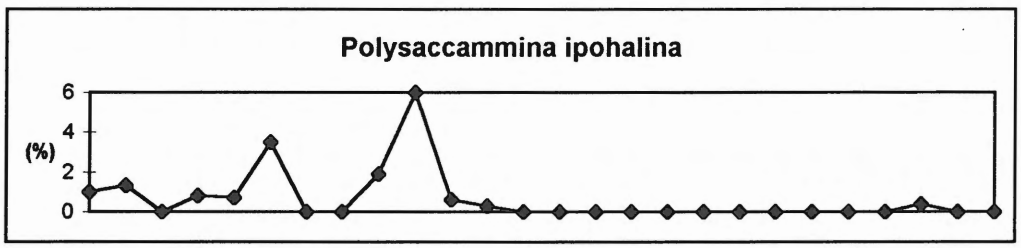

Discorinopsis aguayoi
15
10
(%)
5
0

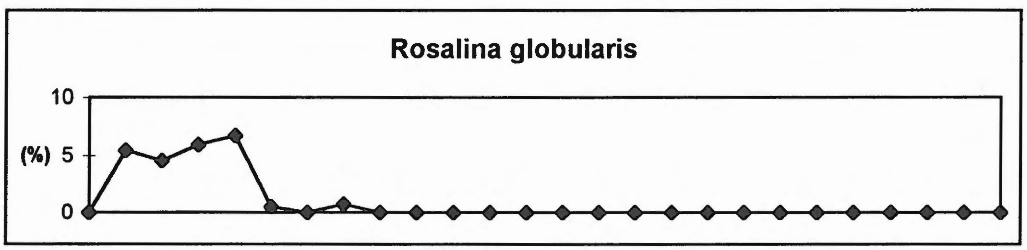

Glomospira irregularis
20
(%) 10
0

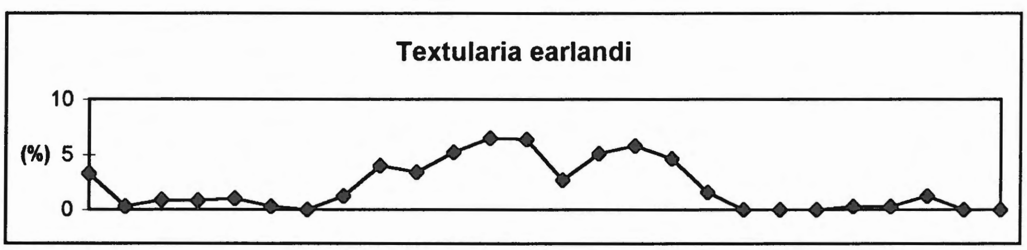

Haplophragmoides wilberti
6
4
(%)
2
0

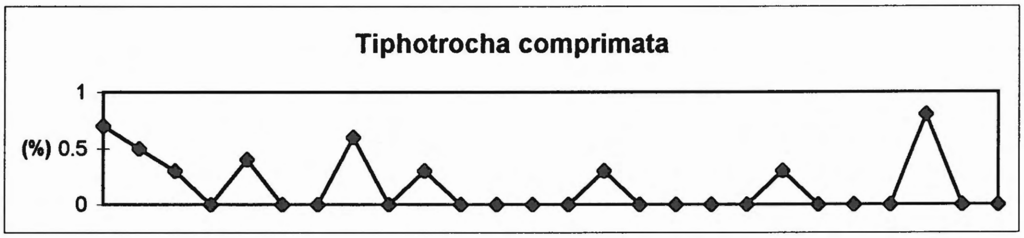

Helenina anderseni
20
(%) 10
0

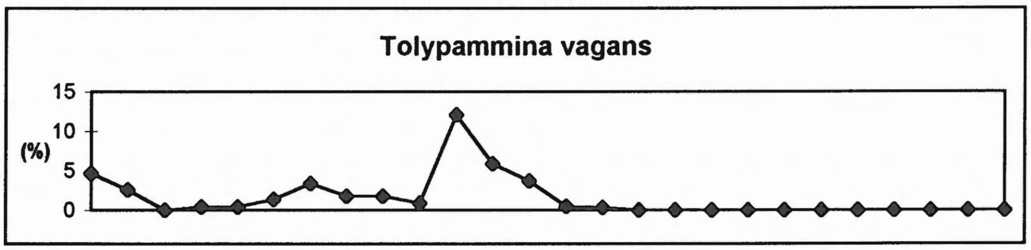

Miliammina fusca
10
(%) 5
0

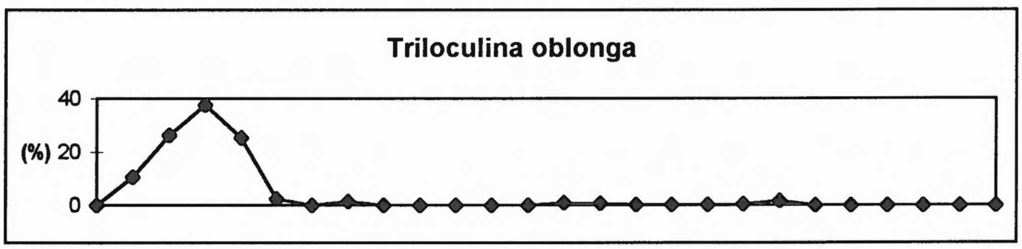

Polysaccammina ipohalina
6
4
(%)
2
0

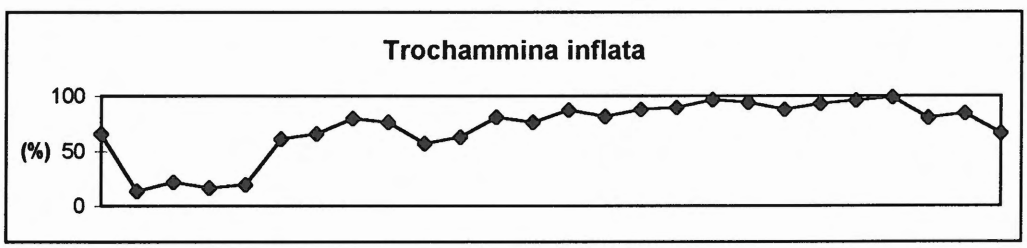

Rosalina globularis
10
(%) 5
0

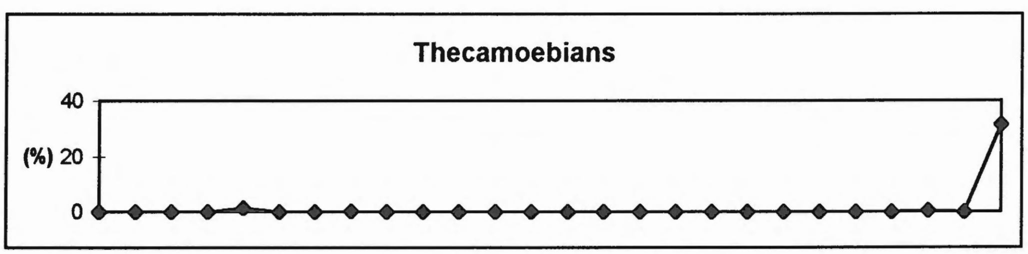

Textularia earlandi
10
(%) 5
0


Tiphotrocha comprimata
1
(%) 0.5
0


Tolypammina vagans
15
10
(%)
5
0


Triloculina oblonga
40
(%) 20
0


Trochammina inflata
100
(%) 50
0


Thecamoebians
40
(%) 20
0

constricta. The thecamoebian *Centropyxis aculeata* was also present but with frequencies lower than 1%.

With decreasing depth (or increasing proximity to HHW) (fig. 20), live and total diversities decreased, and live and total abundances were variable but decreased. This quantitative study of living (stained) and total foraminiferal assemblages along Hungry Bay transect revealed a vertical zonation of benthic foraminifera with respect to HHW. Total populations were used to determine foraminiferal zones since total assemblages are more representative of overall conditions (Scott & Medioli, 1980b), however, living numbers showed the same zonation. Two foraminiferal zones (table 4a) were defined with respect to elevation below HHW:

-Zone 2b (-57 to -25 cm/HHW) was dominated by *Trochammina inflata. Glomospira irregularis*, and *Trochammina macrescens* were common. Variable amounts of *Polysaccammina ipohalina, Textularia earlandi, Trochamminita salsa, Tolypammina vagans, Miliammina fusca,* and *Haplophragmoides wilberti* were also present. The calcareous species *Triloculina oblonga, Rosalina globularis, Discorinopsis aguayoi*, and *Helenina anderseni* were abundant in the first 10 meters of the Hungry Bay transect. They cannot be considered to define zones, since they will be dissolved in subsurface peats, and have no use as paleoindicators of former sea levels.

-Zone 2a (-25 cm to -5 cm/HHW) was dominated by *Trochammina inflata. Miliammina fusca* was common, and *Textularia earlandi* occurred in variable abundance.

-**Zone 1** (-5 to 0 cm/HHW) was dominated by *Trochammina inflata* and the thecamoebians *Arcella polypora, Centropyxis aculeata*, and *Centropyxis constricta. Miliammina fusca* was common.

B. Hungry Bay, bay side

In the 11 samples examined in that area of the swamp, sediment varied from peat, to peaty sand to medium sand. Water depth varied between 0 (exposed samples) and 0.3 meter. Salinity was 32 ppm and temperature was 30°C in the bay (one time measurement in May 93). A total of 171 species were identified. Live and total abundances were high to very high (252 to 14,325 live ind./10cc and 1,800 to 109,184 total ind./10cc). Live and total diversities were moderate to high (5 to 33 live species and 33 to 105 total species) (fig. 21, appendices table 13).

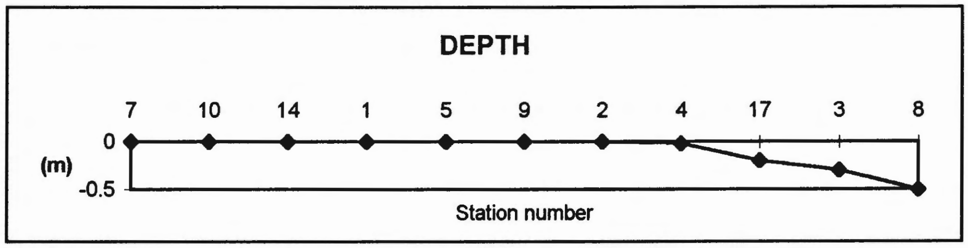
The most abundant species were *Quinqueloculina seminulum* (0.8 to 33.2%), *Triloculina oblonga* (0.7 to 29.7%), *Helenina anderseni* (1 to 21.2%), *Discorinopsis aguayoi* (0.3 to 14.7%), *Bolivina tortuosa* (1.3 to 14.1%), *Rosalina globularis* (0 to 12.2%), *Bolivina lanceolata* (0 to 10.4%), *Cyclogyra planorbis* (0 to 8.5%), *Peneroplis carinatus/proteus* (0 to 8%), *Rosalina subarauncana* (0.3 to 7.8%), *Miliolinella elongata* (0 to 5%), *Spirillina vivipara* (0 to 4.7%), *Cibicides refulgens* (0.5 to 4.3%), and *Trifarina occidentalis* (0 to 4.1%).

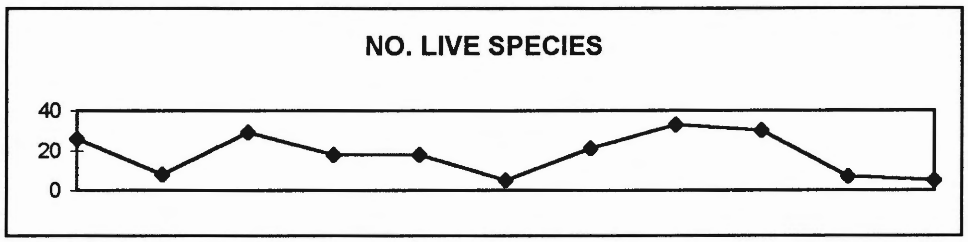
Species with total frequencies between 2 and 4% in at least one sample were *Ammonia beccarii tepida, Archaias angulatus, Bolivina variabilis var. spathulata, Bolivina paula, Bolivina pulchella, Bolivina subexcavata, Elphidium poeyanum, Glomospira irregularis, Nonion depressulum, Nonion gradeloupi, Planispiroides bucculentus, Tiphotrocha comprimata, Quinqueloculina lamarckiana, Rosalina concinna,* and *Trochammina inflata.*

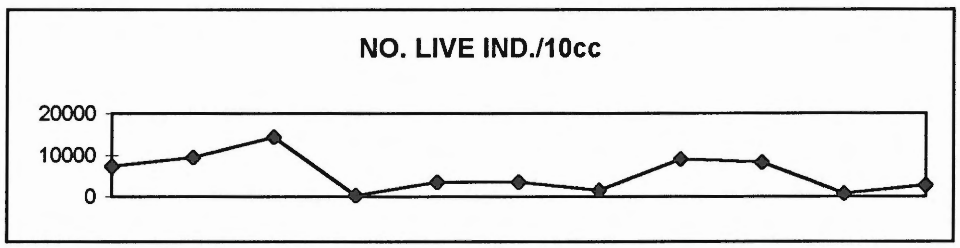
Species with total frequencies between 1 and 2% in at least one sample were *Buliminella elegantissima, Cassidulina subglobosa, Cymbaloporetta squamosa, Discorbis mira, Elphidium advenum, Elphidium discoidale, Elphidium sagrum, Haplophragmoides sp., Loxostomum mayori, Planulina. exorna, Quinqueloculina bicarinata, Quinqueloculina laevigata, Quinqueloculina stelligera, Siphogenerina raphana, Siphonina pulchra, Sorites marginalis, Spiroloculina hyalina,* and *Trochammina macrescens.*

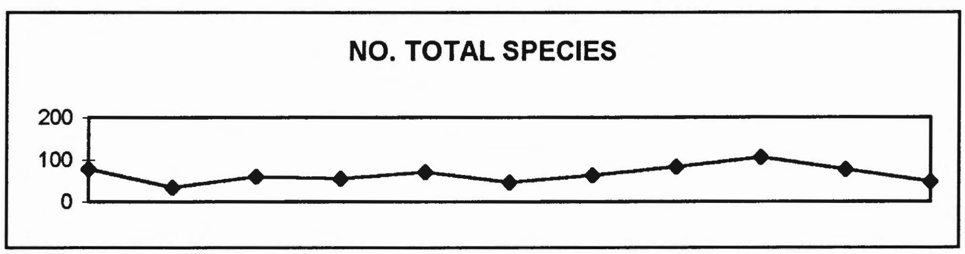
With increasing depth, live and total abundances and diversities were variable; *Bolivina tortuosa, Cibicides refulgens, Quinqueloculina seminulum, Rosalina subarauncana*, and *Trifarina occidentalis* increased; and *Helenina anderseni, Triloculina oblonga*, and *Trochammina inflata* decreased. *Archaias angulatus* and *Ammonia beccarii tepida* occurred in sandy samples and not in peat.

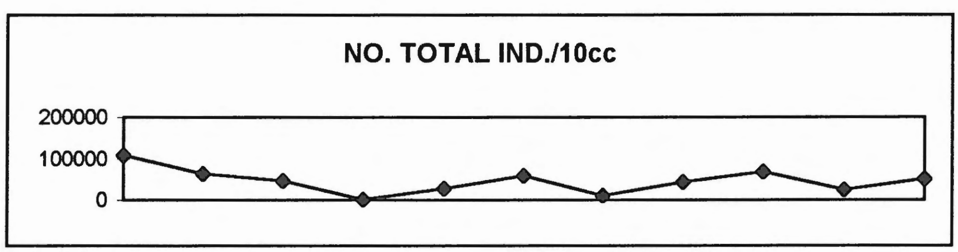
Figure 21. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing elevation in Hungry Bay 93.

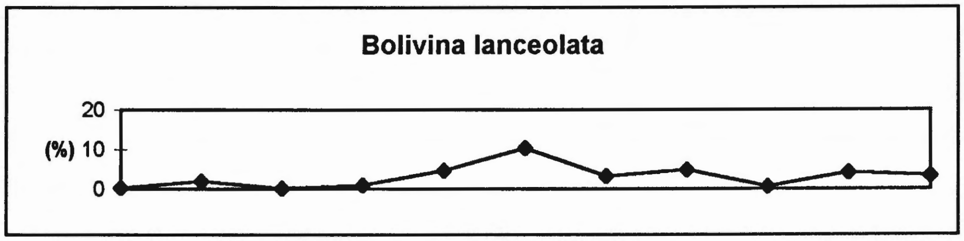

DEPTH
7
10
14
1
5
9
2
4
17
3
8
0
(m)
-0.5
Station number

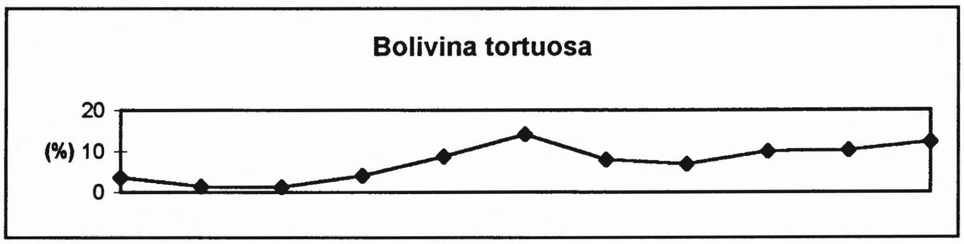

NO. LIVE SPECIES
40
20
0

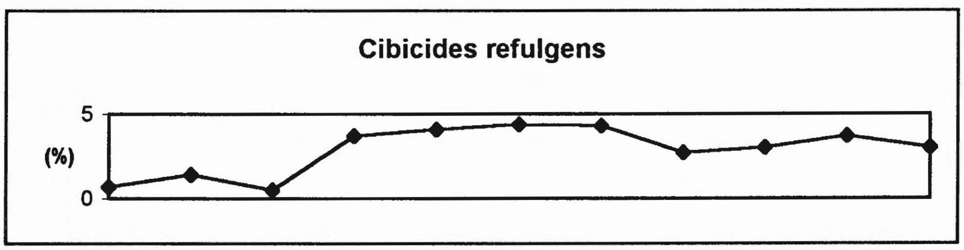

NO. LIVE IND./10cc
20000
10000
0

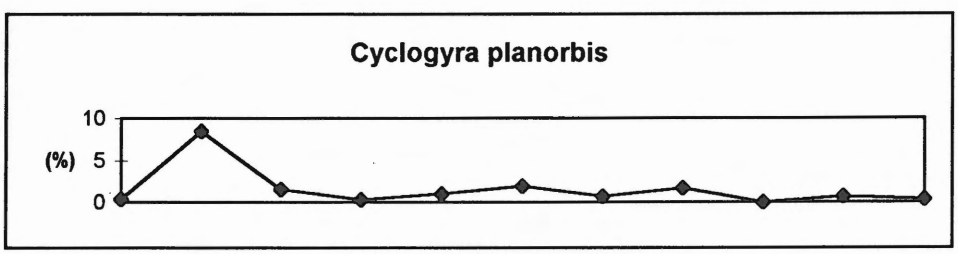

NO. TOTAL SPECIES
200
100
0

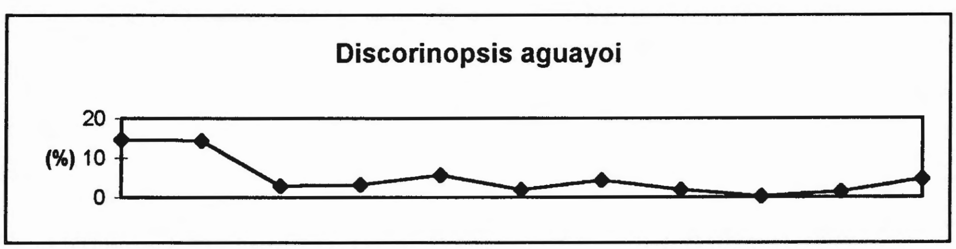

NO. TOTAL IND./10cc
200000
100000
0

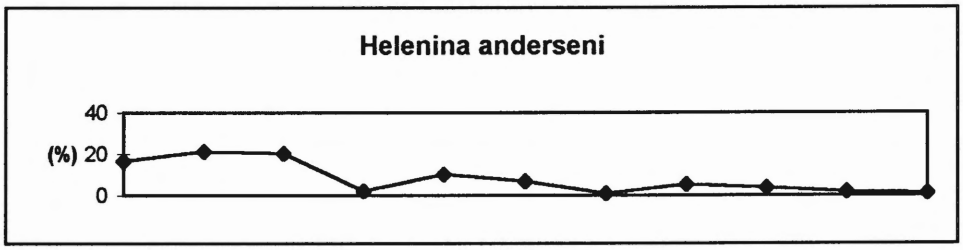

Bolivina lanceolata
20
(%) 10
0

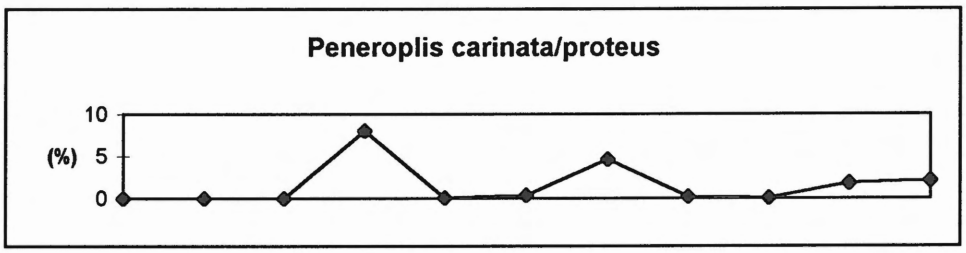

Bolivina tortuosa
20
(%) 10
0

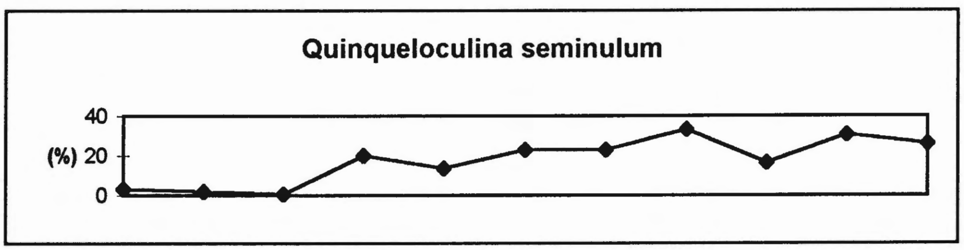

Cibicides refulgens
5
(%)
0

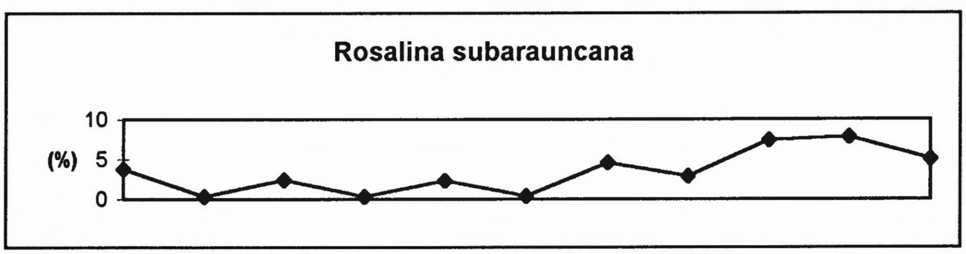

Cyclogyra planorbis
10
(%) 5
0

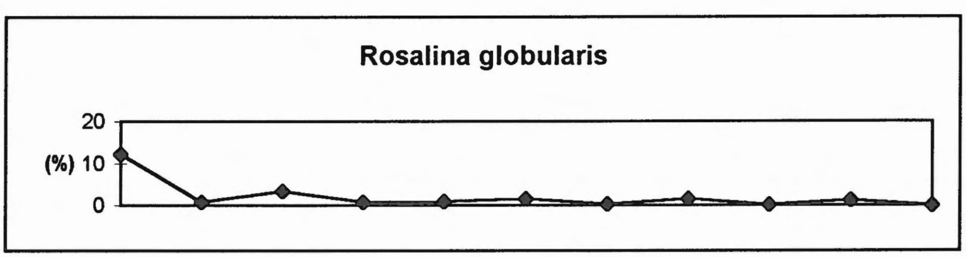

Discorinopsis aguayoi
20
(%) 10
0

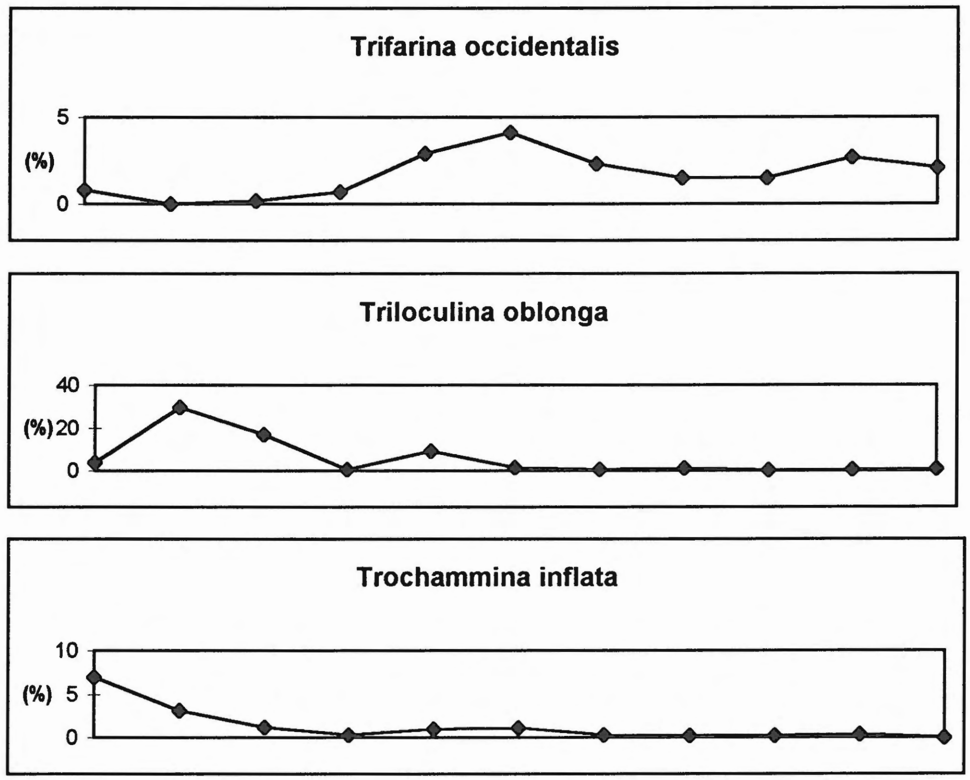

Helenina anderseni
40
(%) 20
0


Peneroplis carinata/proteus
10
(%) 5
0


Quinqueloculina seminulum
40
(%) 20
0


Rosalina subarauncana
10
(%) 5
0


Rosalina globularis
20
(%) 10
0


Trifarina occidentalis
5
(%)
0
Triloculina oblonga
40
(%) 20
0
Trochammina inflata
10
(%) 5
0

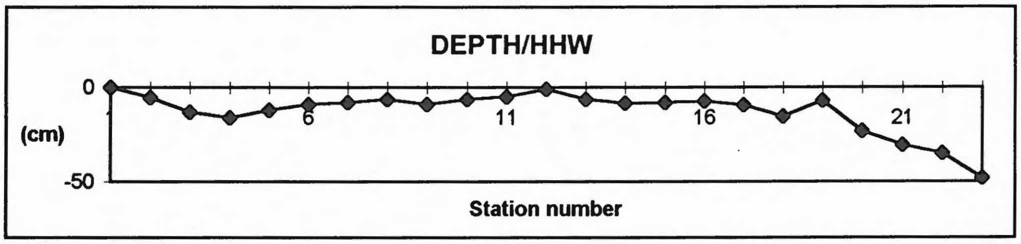
3.1.4.2. Mill Share transect

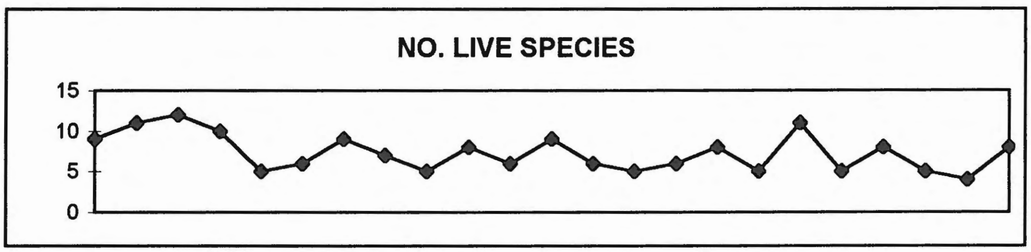
In the 23 samples examined in this marsh-mangrove complex, sediment ranged from peat, to peaty sand, to medium sand. Depth varied from about HHW (0 cm/HHW) to about MSL (-48 cm/HHW) and the total transect length was 33.5 meters. Salinity was 33 ppm and temperature was 20°C (one time measurement in February 95). A total of 33 species were identified. Live and total abundances were moderate to high (94 to 3,918 live ind./10cc and 1,554 to 6,120 total ind./10cc) except in samples 21 and 22 where they were low (21 to 24 live ind./10cc and 49 to 54 total ind./10cc). Live and total diversities were low (5 to 11 live species and 7 to 18 total species) (fig. 22, appendices table 14).

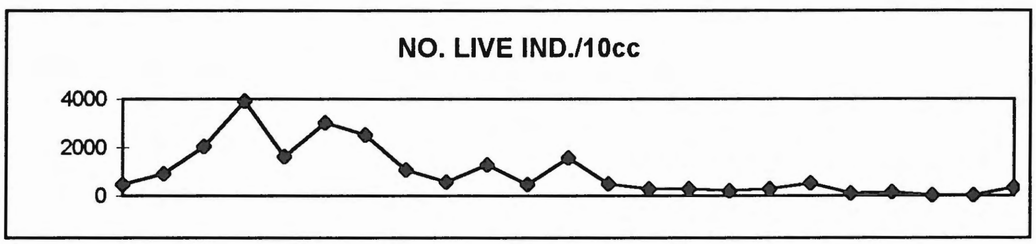
The most abundant (total) species were *Trochammina inflata* (11.8 to 85.6%), *Ammonia beccarii tepida* (0 to 44.8%), *Triloculina oblonga* (0.8 to 35.1%), *Helenina anderseni* (0 to 26.2%), *Glomospira irregularis* (0 to 20.8%), *Trochammina macrescens* (0 to 14.6%), *Discorinopsis aguayoi* (0 to 12.2%), *Polysaccammina ipohalina* (0 to 11.9%), *Miliammina fusca* (0.3 to 11.1%), *Tolypammina vagans* (0 to 7.3%), *Pseudothurammina limnetis* (0.3 to 7.2%), *Bolivina lanceolata* (0 to 6%), *Trochamminita salsa* (0 to 5.7%) and *Haplophragmoides wilberti* (0 to 4.1%).

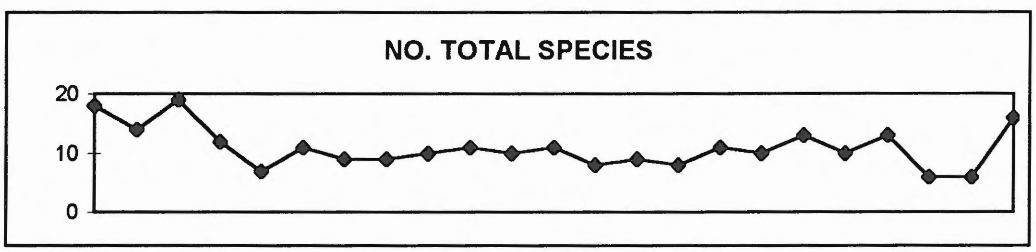
Species with total frequencies between 2 and 4% in at least one sample were *Fissurina spp.*, *Quinqueloculina laevigata*, and *Rosalina globularis*, and thecamoebians *Arcella polypora* and *Centropyxis constricta*.

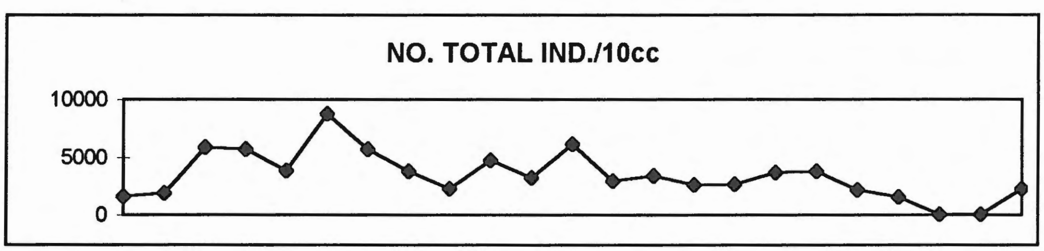
Figure 22. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species along Mill Share transect.

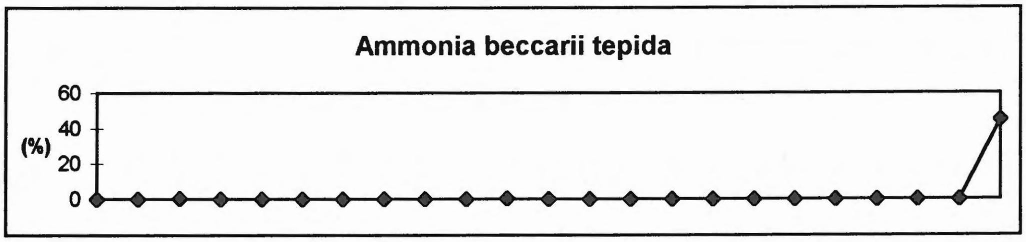

DEPTH/HHW
0
(cm)
-50
6
11
16
21
Station number

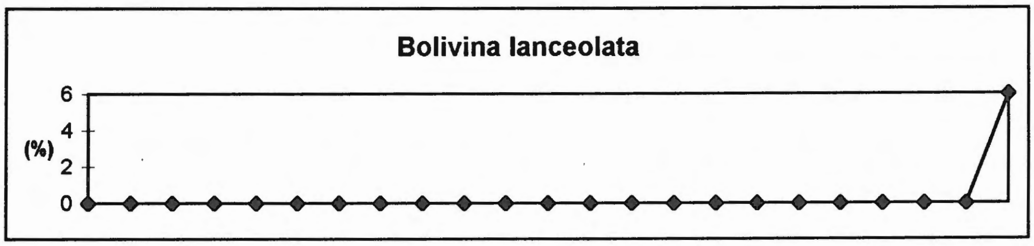

NO. LIVE SPECIES
15
10
5
0

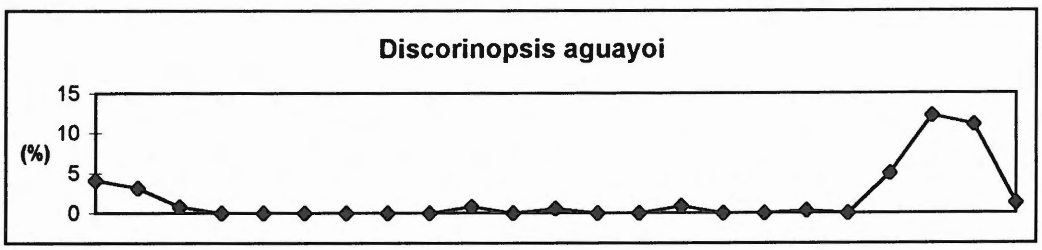

NO. LIVE IND./10cc
4000
2000
0

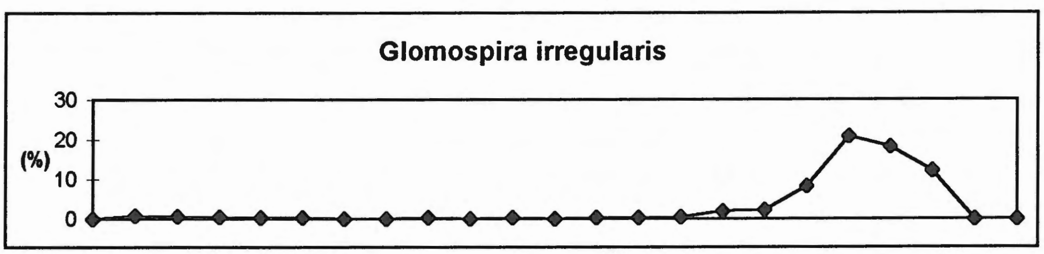

NO. TOTAL SPECIES
20
10
0

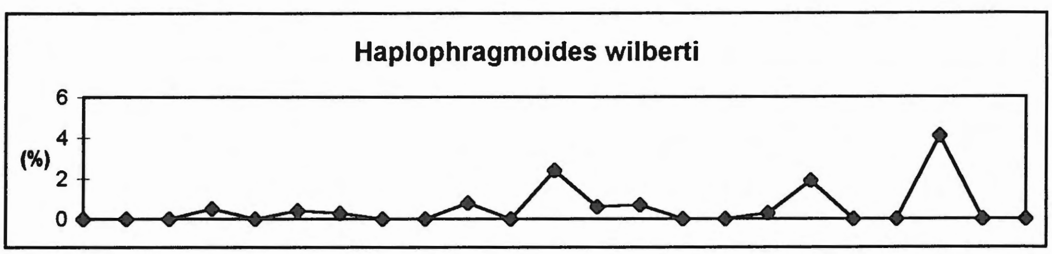

NO. TOTAL IND./10cc
10000
5000
0

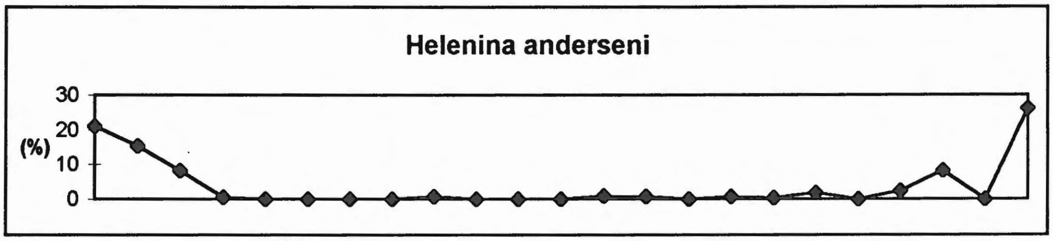

Ammonia beccarii tepida
(%)
60
40
20
0

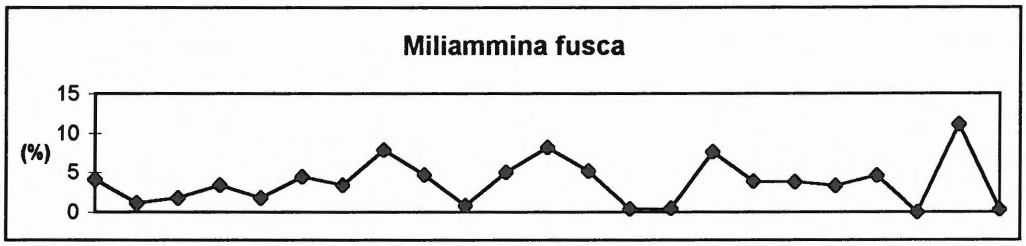

Bolivina lanceolata
(%)
6
4
2
0

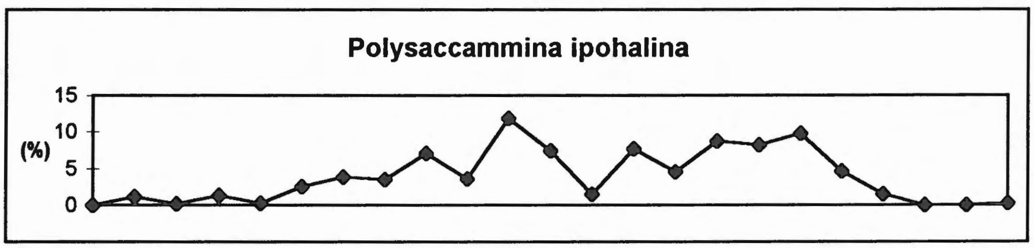

Discorinopsis aguayoi
(%)
15
10
5
0

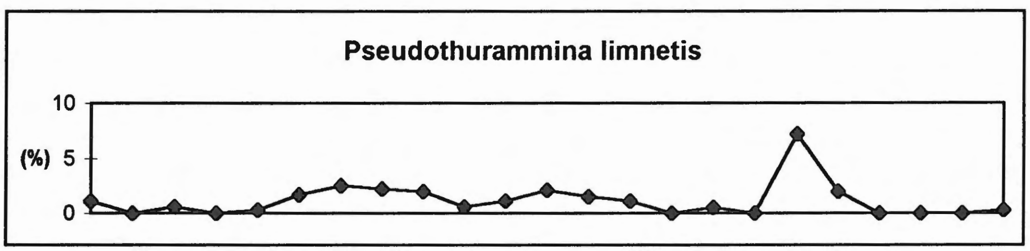

Glomospira irregularis
(%)
30
20
10
0

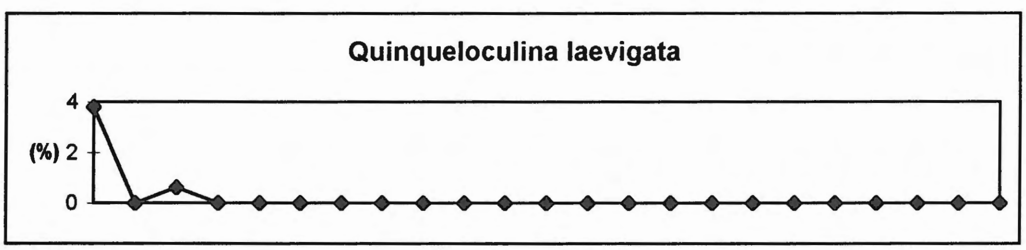

Haplophragmoides wilberti
(%)
6
4
2
0

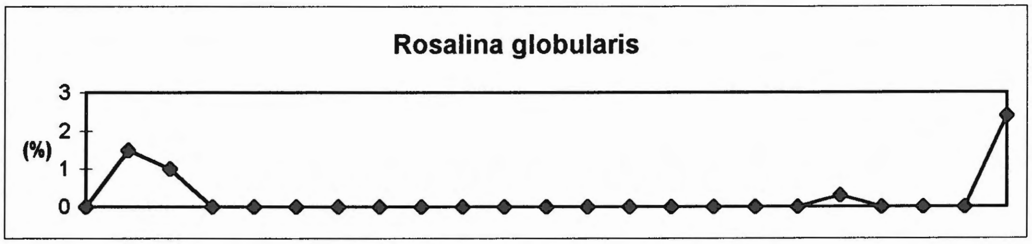

Helenina anderseni
30
20
(%)
10
0

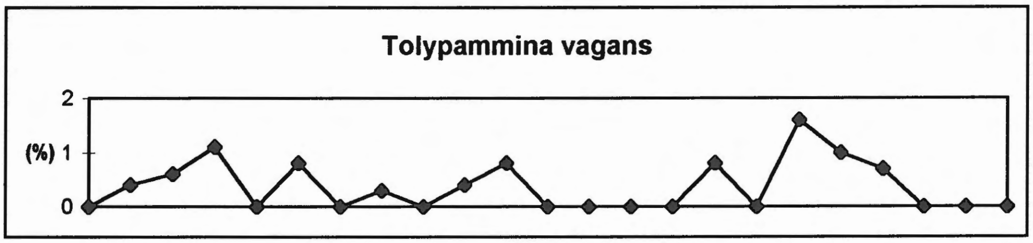

Miliammina fusca
15
10
(%)
5
0

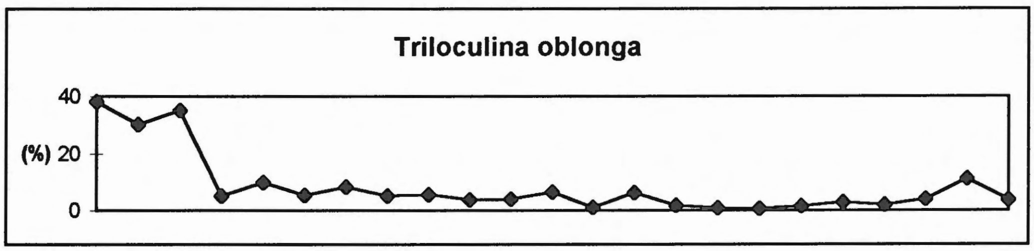

Polysaccammina ipohalina
15
10
(%)
5
0

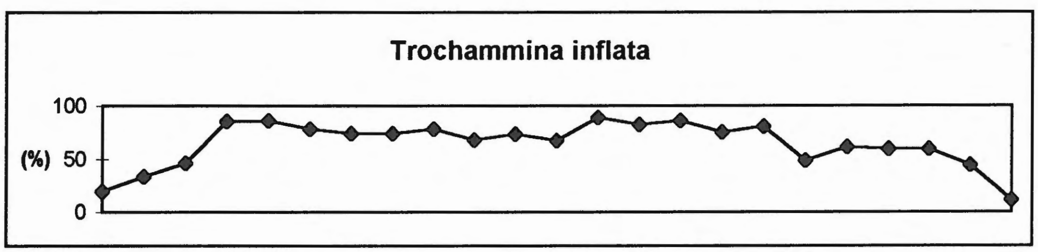

Pseudothurammina limnetis
10
(%) 5
0

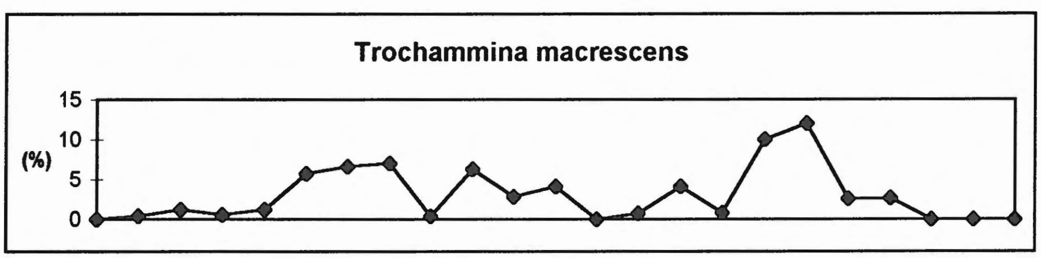

Quinqueloculina laevigata
4
(%) 2
0

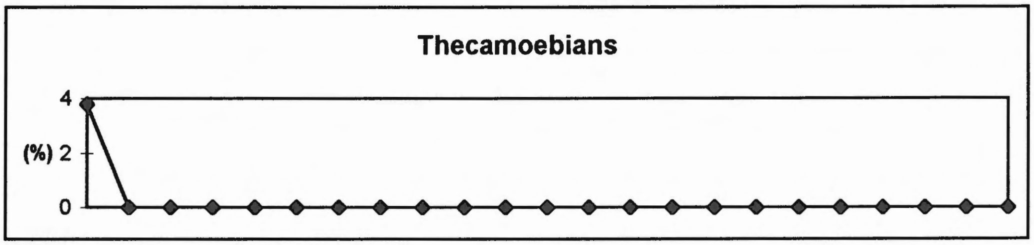

Rosalina globularis
(%)
3
2
1
0


Tolypammina vagans
(%)
2
1
0


Triloculina oblonga
(%)
40
20
0


Trochammina inflata
(%)
100
50
0


Trochammina macrescens
(%)
15
10
5
0


Thecamoebians
4
(%) 2
0

Species with total frequencies between 1 and 2% in at least one sample were *Cyclogyra planorbis, Elphidium poeyanum,* and *Textularia earlandi*.

A vertical zonation of benthic foraminifera with respect to HHW could also be defined. Two foraminiferal zones (table 4b) were defined with respect to elevation below HHW:

-Zone 2b (-48 to -30 cm/HHW) was dominated by *Trochammina inflata* and calcareous species (*Triloculina oblonga, Rosalina globularis, Discorinopsis aguayoi,* and *Helenina anderseni, Bolivina lanceolata*). Variable amounts of *Trochammina macrescens, Miliammina fusca,* and *Haplophragmoides wilberti* were present.

-Zone 2a (-30 to -7 cm/HHW) was dominated by *Trochammina inflata* and calcareous species. *Glomospira irregularis* was common. *Polysaccammina ipohalina, Trochamminita salsa, Pseudothurammina Limnetis, Miliammina fusca, Trochammina macrescens,* and *Haplophragmoides wilberti* occurred in variable abundance.

-Zone 1 (-7 to 0 cm/HHW) was dominated by *Trochammina inflata* and calcareous species. The thecamoebians *Arcella polypora* and *Centropyxis constricta* were common. Variable numbers of *Miliammina fusca, Trochammina macrescens,* and *Trochamminita salsa* occurred.

TABLE 4a. FORAMINIFERAL ZONES RELATIVE TO HHW (HIGHER HIGH WATER) IN HUNGRY BAY TRANSECT

Foram. Zones	Most common species (15-99%)	Common species (1-15%)	Variable occurrence (0-12%)
Zone 2b (-57 to -25 cm/HHW)	*Trochammina inflata* Calcareous species	*Glomospira irregularis* *Trochammina macrescens*	*Trochamminita salsa* *Tolypammina vagans* *Polysaccamina ipohalina* *Textularia earlandi* *Miliammina fusca* *Haplophragmoides wilberti*
Zone 2a (-25 to -5 cm/HHW)	*Trochammina inflata*	*Miliammina fusca*	*Textularia earlandi*
Zone 1 (-5 to 0 cm/HHW)	*Trochammina inflata* Thecamoebians	*Miliammina fusca*	

TABLE 4b. FORAMINIFERAL ZONES RELATIVE TO HHW (HIGHER HIGH WATER) IN MILL SHARE TRANSECT

Foram. Zones	Most common species (15-99%)	Common species (1-15%)	Variable occurrence (0-12%)
Zone 2b (-48 to -30 cm/HHW)	*Trochammina inflata* Calcareous species		*Trochammina macrescen* *Miliammina fusca* *Haplophragmoides wilberti*
Zone 2a (-30 to -7 cm/HHW)	*Trochammina inflata* Calcareous species	*Glomospira irregularis*	*Miliammina fusca* *Trochamminita salsa* *Polysaccamina ipohalina* *Haplophragmoides wilberti* *Trochammina macrescens* *Pseudothurammina limnetis*
Zone 1 (-5 to 0 cm/HHW)	*Trochammina inflata* Calcareous species	Thecamoebians	*Miliammina fusca* *Trochamminita salsa* *Trochammina macrescens*

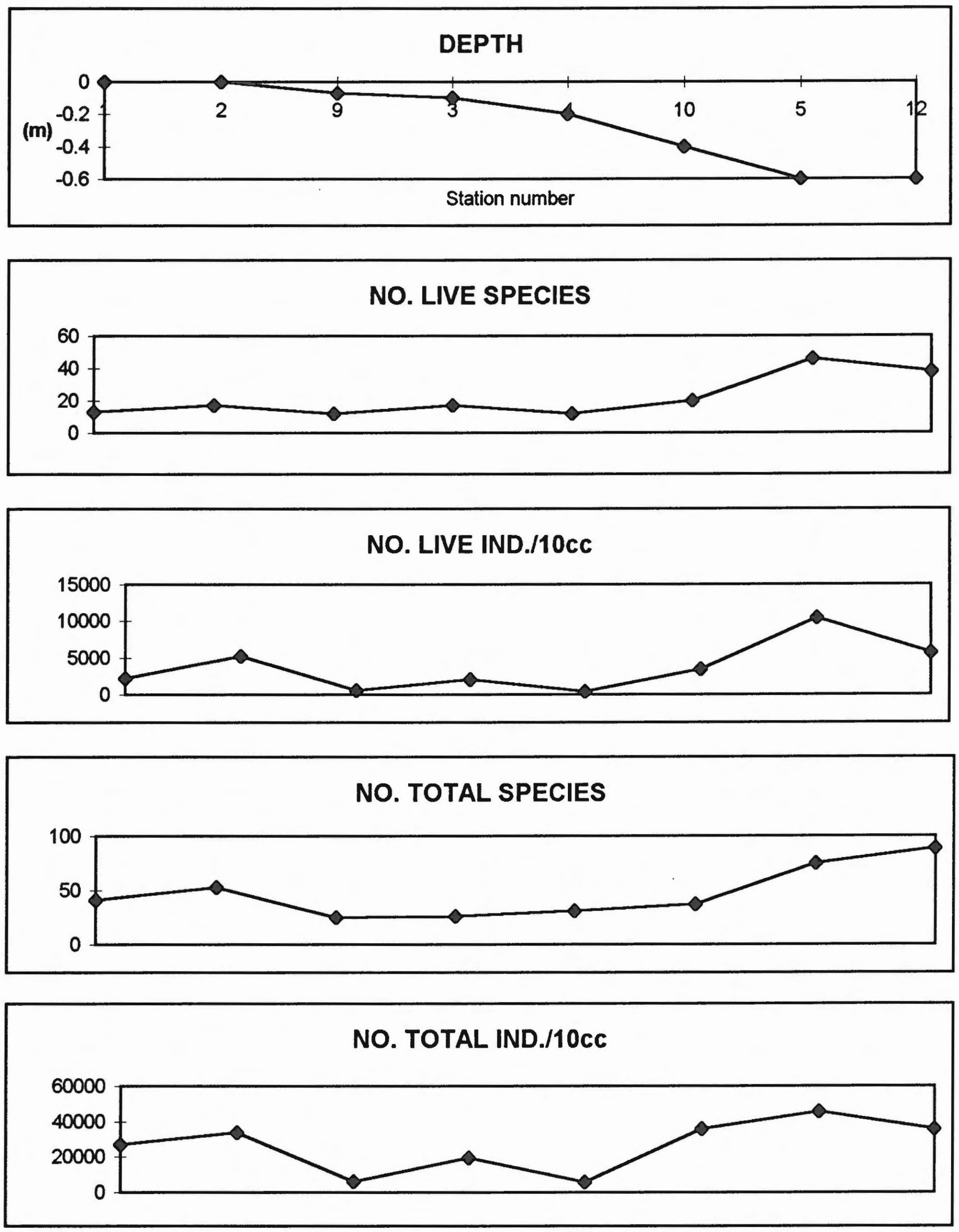
3.1.4.3. Mangrove Bay

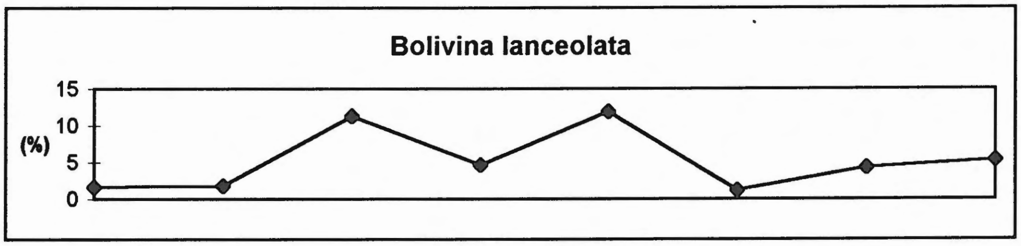
In the 8 samples examined, sediment was peat, peaty sand,or medium sand. Water depth varied between 0 and 0.6 meter. Salinity was 33 ppm and temperature was 23°C (one time measurement in May 93). A total of 130 species were identified. Live and total abundances were high to very high (141 to 10,440 ind./10cc and 5,742 to 45,720 ind./10cc), and live and total diversities were moderate to high (12 to 46 live species and 25 to 89 total species) (fig. 23, appendices table 15).

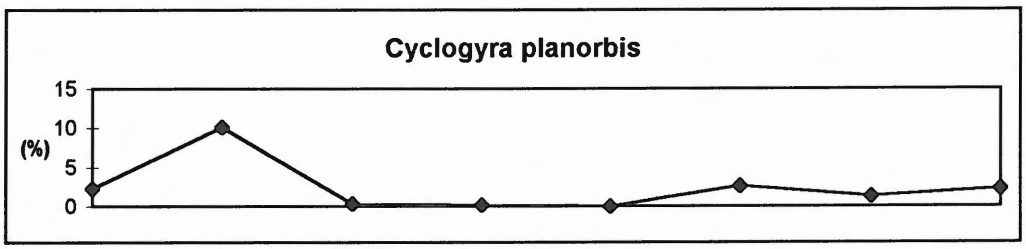
The most abundant species were *Helenina anderseni* (3.1 to 35.7%), *Quinqueloculina seminulum* (0 to 35.4%), *Parrina bradyi* (0 to 23.2%), *Triloculina oblonga* (1.1 to 22.1%), *Discorinopsis aguayoi* (1.1 to 16.8%), *Glomospira irregularis* (0 to 13.8%), *Bolivina lanceolata* (1.2 to 11.9%), *Trochammina inflata* (0.2 to 10.2%), *Cyclogyra planorbis* (0 to 10.1%), *Quinqueloculina laevigata* (0 to 8.4%), *Triloculina bermudezi* (0 to 6.7%), *Spiroloculina hyalina* (0 to 6.1%), *Nonion depressulum* (0 to 5.7%), and *Textularia earlandi* (0 to 5%).

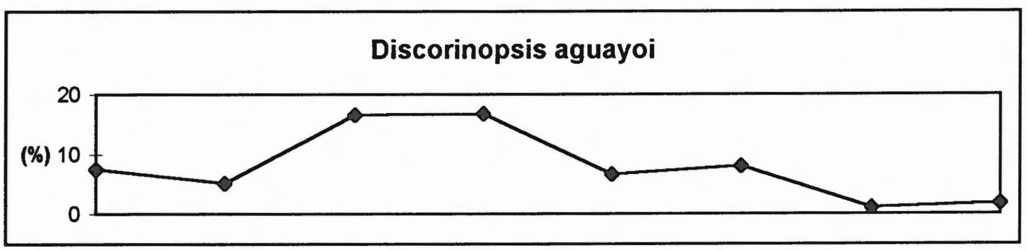
Species with total frequencies between 2 and 4% in at least one sample were *Ammonia beccarii tepida, Bolivina subexcavata, Bolivina variabilis, Pseudothuramina limnetis, Rosalina globularis,* and *Triloculina trigonula.*

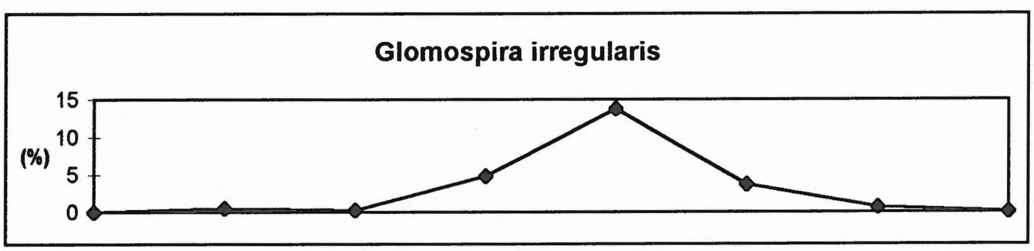
Figure 23. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Mangrove Bay.

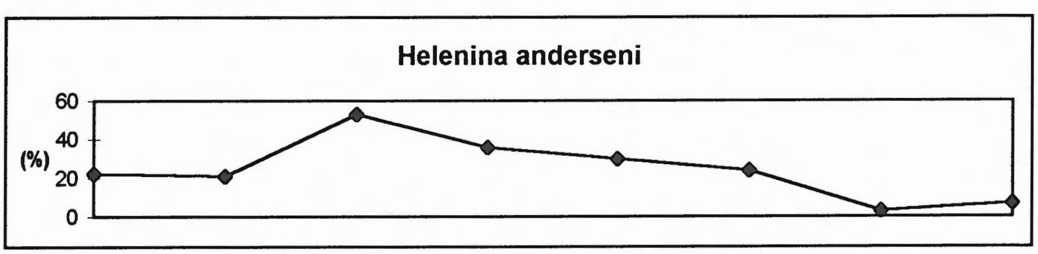

DEPTH
0
-0.2
-0.4
-0.6
(m)
2
9
3
10
5
12
Station number
NO. LIVE SPECIES
60
40
20
0
NO. LIVE IND./10cc
15000
10000
5000
0
NO. TOTAL SPECIES
100
50
0
NO. TOTAL IND./10cc
60000
40000
20000
0

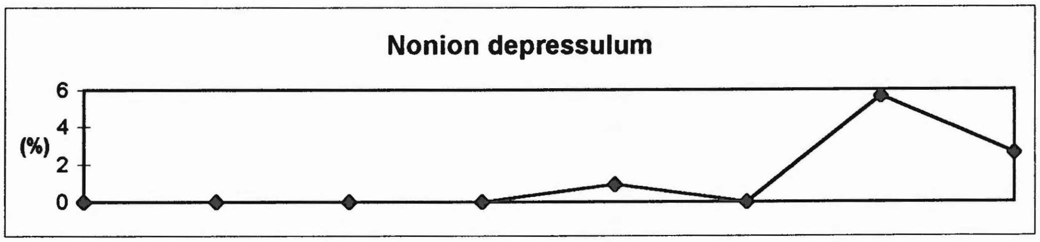

Bolivina lanceolata
15
10
(%)
5
0

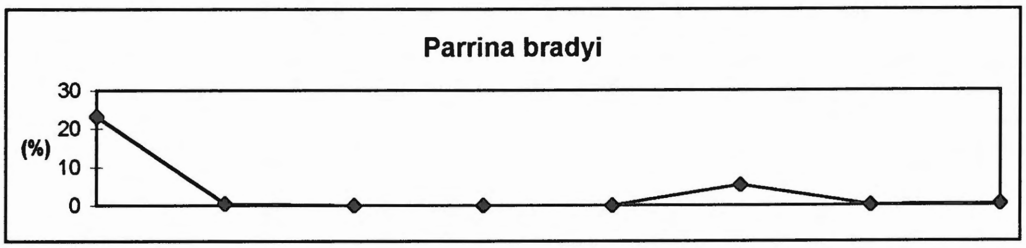

Cyclogyra planorbis
15
10
(%)
5
0

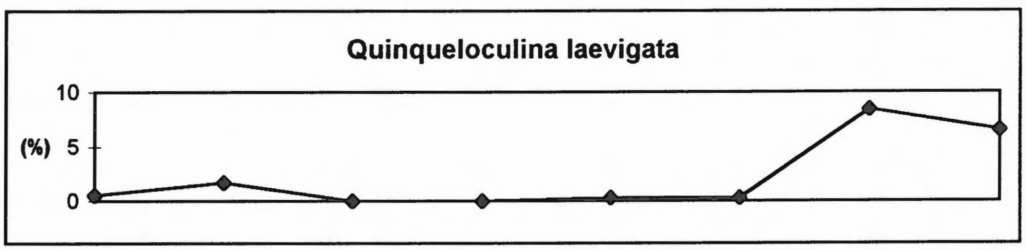

Discorinopsis aguayoi
20
(%) 10
0

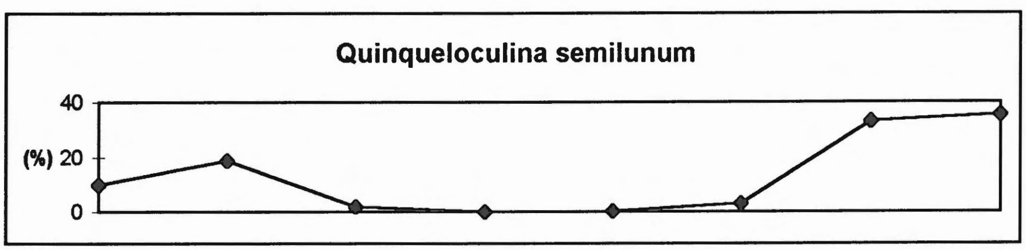

Glomospira irregularis
15
10
(%)
5
0

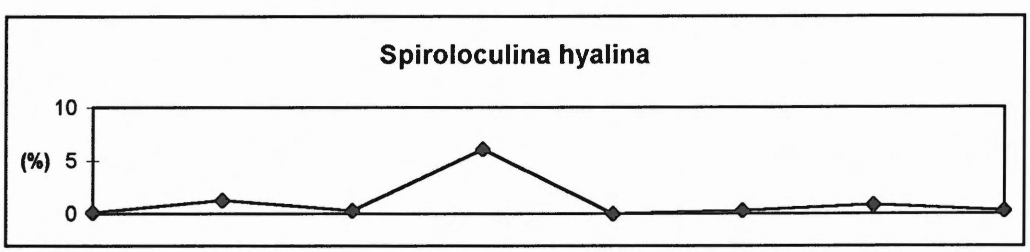

Helenina anderseni
60
40
(%)
20
0

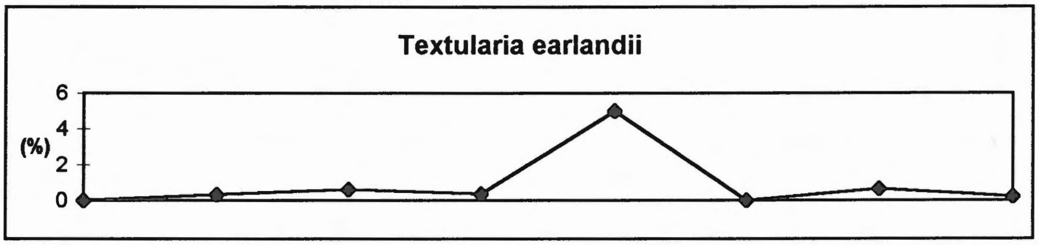

Nonion depressulum
(%)
6
4
2
0

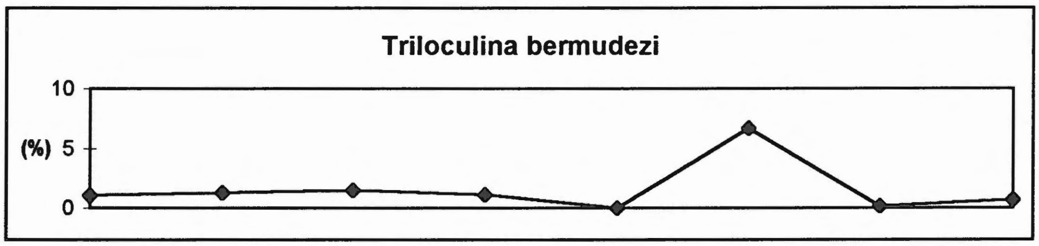

Parrina bradyi
(%)
30
20
10
0

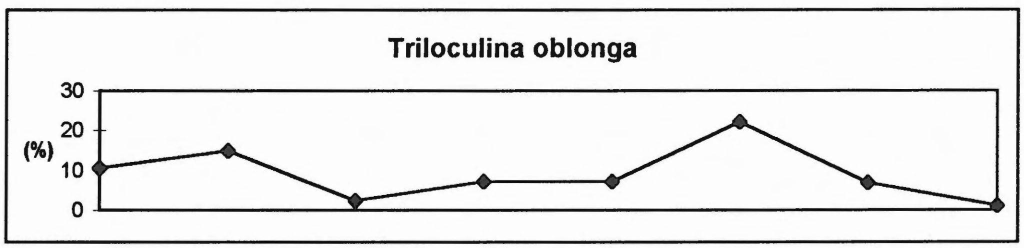

Quinqueloculina laevigata
(%)
10
5
0

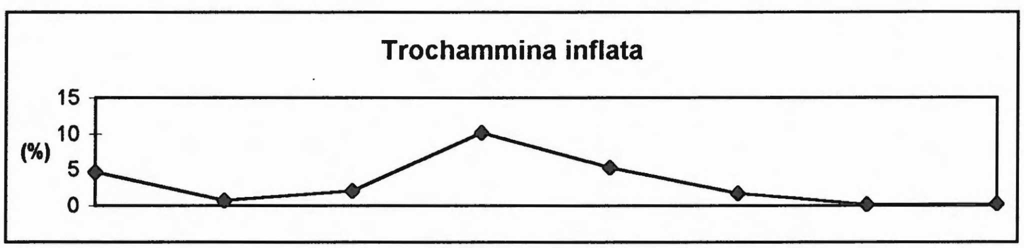

Quinqueloculina semilunum
(%)
40
20
0


Spiroloculina hyalina
(%)
10
5
0


Textularia earlandii
(%)
6
4
2
0


Triloculina bermudezi
(%)
10
5
0


Triloculina oblonga
(%)
30
20
10
0


Trochammina inflata
(%)
15
10
5
0

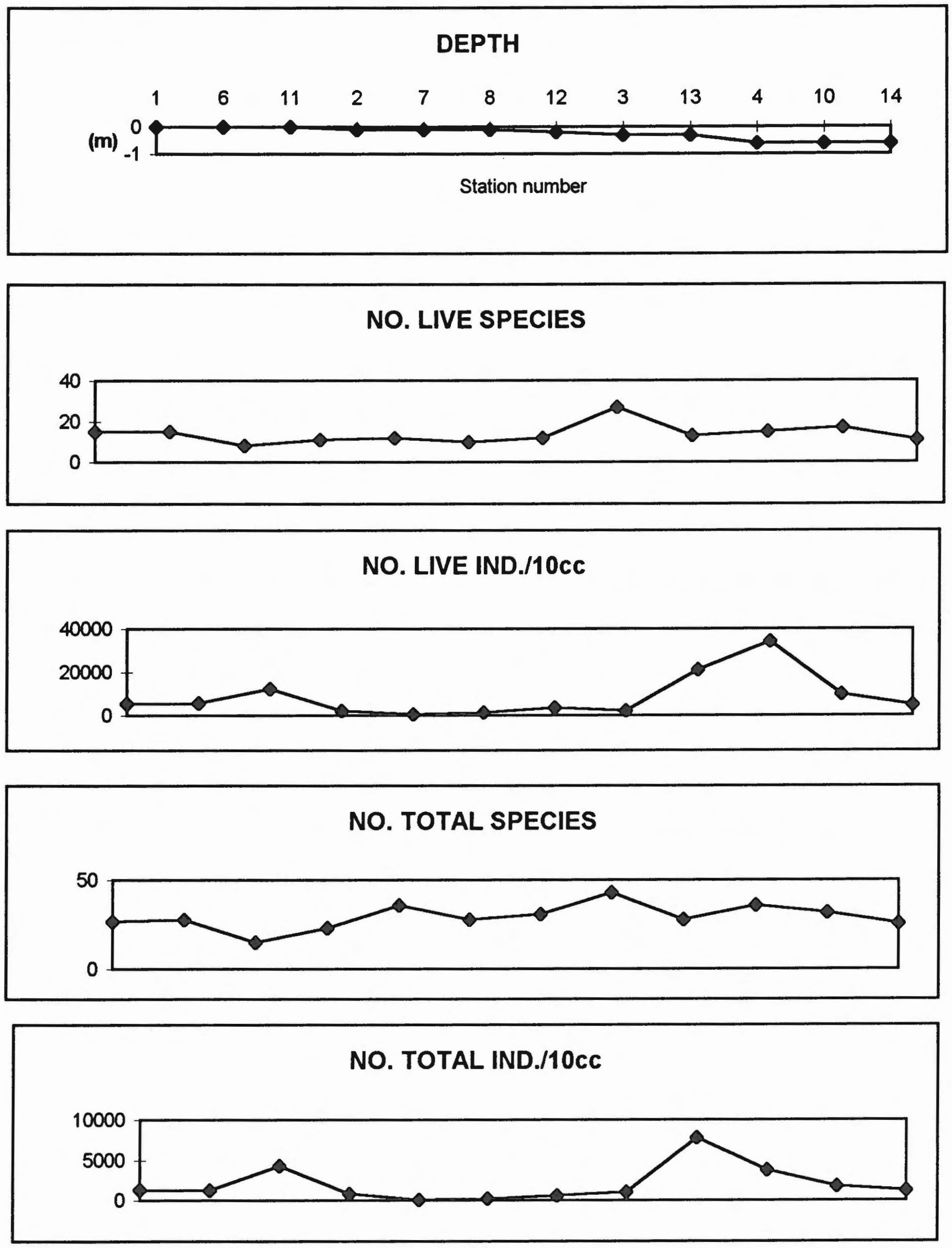
Species with total frequencies between 1 and 2% in at least one sample were *Planispiroides bucculentus, Quinqueloculina lamarckiana,* and *Quinqueloculina subpoeyana*.

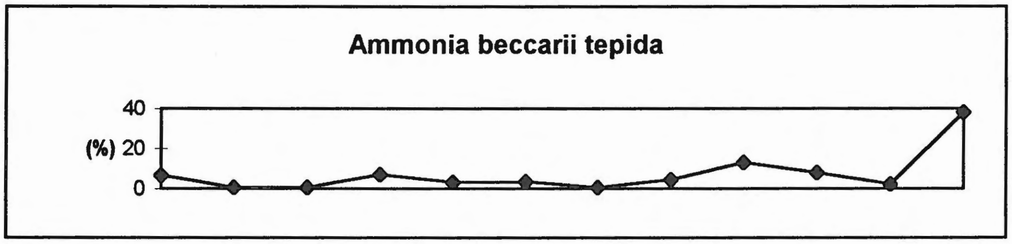
With increasing depth, live and total abundances increased, live diversity increased, and total diversity was variable but increased. *Discorinopsis aguayoi, Helenina anderseni, Triloculina oblonga* decreased, and *Trochammina inflata* decreased slightly. *Glomospira irregularis* increased then decreased in samples out of the mangroves. *Quinqueloculina seminulum* increased and *Quinqueloculina laevigata* increased slightly.

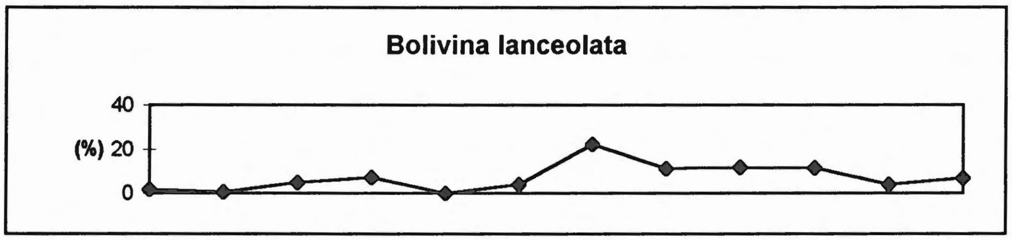
3.1.4.4. Coot Pond

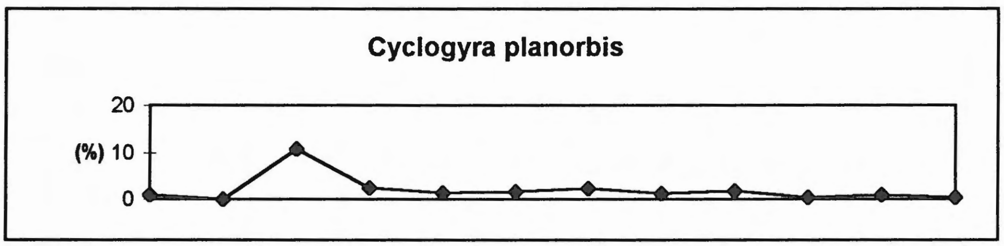
In the 12 samples examined, sediment was peat and medium sand. Water depth varied between 0 and 0.6 meter. Salinity was 35 ppm and temperature was 27°C (one time measurement in May 93). A total of 101 species were identified. Live and total abundances were high (258 to 7,812 ind./10cc and 1,296 to 34,200 ind./10cc) except in sample #6 where they were low (89 live ind./10cc and 442 total ind./10cc) (fig. 24,

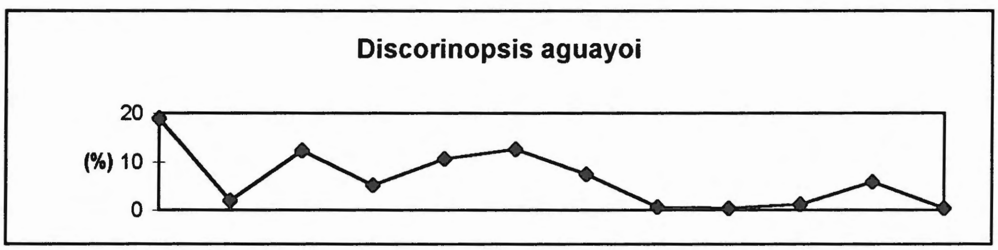
Figure 24. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Coot Pond.

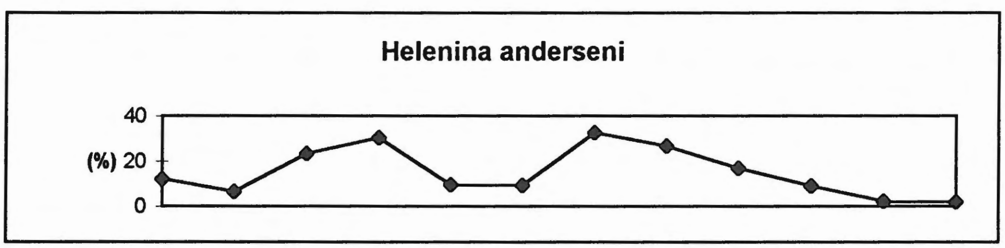

DEPTH
1
6
11
2
7
8
12
3
13
4
10
14
(m)
0
-1
Station number
NO. LIVE SPECIES
40
20
0
NO. LIVE IND./10cc
40000
20000
0
NO. TOTAL SPECIES
50
0
NO. TOTAL IND./10cc
10000
5000
0

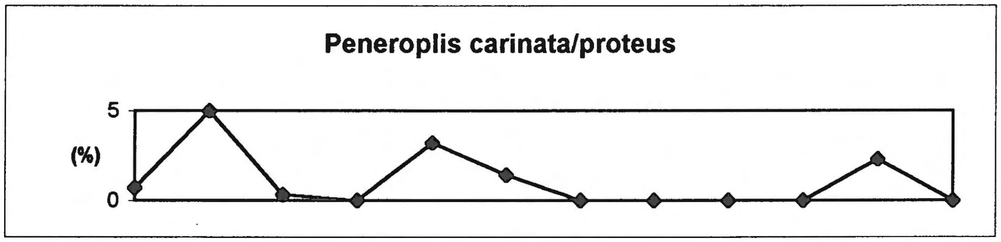

Ammonia beccarii tepida
40
(%) 20
0

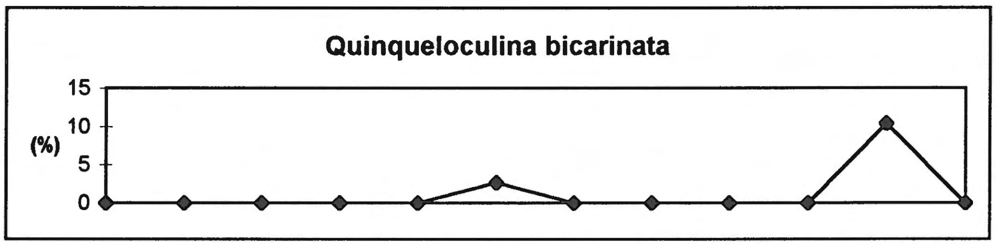

Bolivina lanceolata
40
(%) 20
0

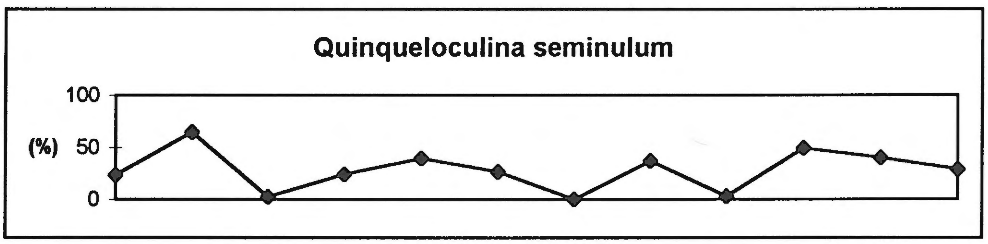

Cyclogyra planorbis
20
(%) 10
0

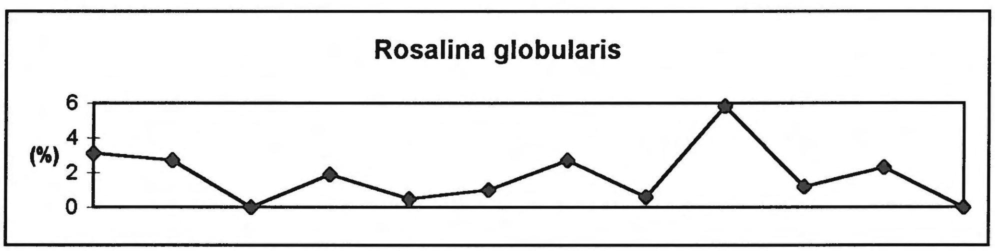

Discorinopsis aguayoi
20
(%) 10
0

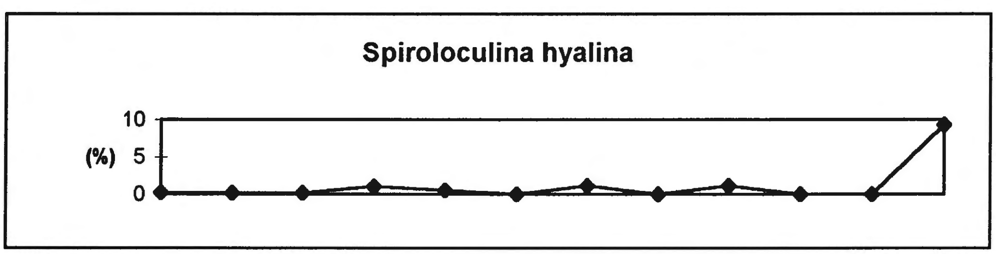

Helenina anderseni
40
(%) 20
0

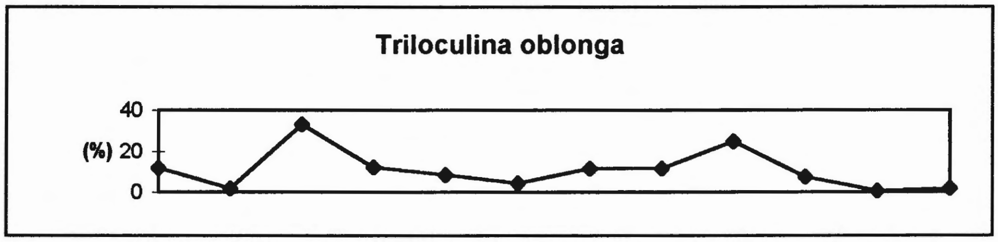

Peneroplis carinata/proteus
5
(%)
0

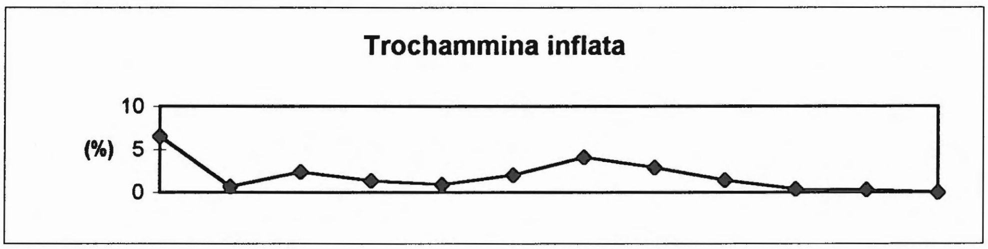

Quinqueloculina bicarinata
15
10
(%)
5
0


Quinqueloculina seminulum
100
(%) 50
0


Rosalina globularis
6
4
(%)
2
0


Spiroloculina hyalina
10
(%) 5
0


Triloculina oblonga
40
(%) 20
0


Trochammina inflata
10
(%) 5
0

appendices table 16). Live and total diversities were low to moderate (8 to 25 live species and 15 to 41 total species).

The most abundant (total) species were *Quinqueloculina seminulum* (0 to 64.7%), *Ammonia beccarii tepida* (0.6 to 38.1%), *Triloculina oblonga* (0.6 to 33.3%), *Helenina anderseni* (1.9 to 32.8%), *Bolivina lanceolata* (0 to 22.1%), *Discorinopsis aguayoi* (0.4 to 19%), *Cyclogyra planorbis* (0 to 10.8%), *Quinqueloculina bicarinata* (0 to 10.4%), *Spiroloculina hyalina* (0 to 9.3%), *Trochammina inflata* (0 to 6.5%), *Rosalina globularis* (0 to 5.8%), *Achaias angulatus* (0 to 5.7%), and *Peneroplis carinatus/proteus* (0 to 5%).

Species with total frequencies between 2 and 4% in at least one sample were *Trochammina ochracea, Rosalina concinna,* and *Triloculina bermudezi.*

Species with total frequencies between 1 and 2% in at least one sample were *Patellina corrugata, Quinqueloculina lamarckiana, Quinqueloculina laevigata*, and *Spiroloculina arenata.*

Along three short unmeasured transects (samples #1 to 4; 6 to 8 and 10; and 11 to 14) with increasing depth, live and total diversities were stable or increased slightly, and live and total abundances were variable but followed the same pattern. *Ammonia beccarii tepida* and *Quinqueloculina seminulum* were stable or increased, *Discorinopsis aguayoi* and *Helenina anderseni* decreased, and *Triloculina oblonga* and *Trochammina inflata* decreased slightly.

3.1.4.5. Walsingham Bay

In the 4 samples examined, sediment was sandy peat. Water depth varied between 0 and 0.05 meter. Salinity was 35 ppm (one time measurement in February 95) and temperature was not measured. A total of 43 species were identified. Live and total abundances were relatively high (120 to 1,260 live ind./10cc and 976 to 25,776 total ind./10cc). Live diversity was low (5 to 9 live species) and total diversity was low to moderate (16 to 29 total species) (fig. 25, appendices table 17).

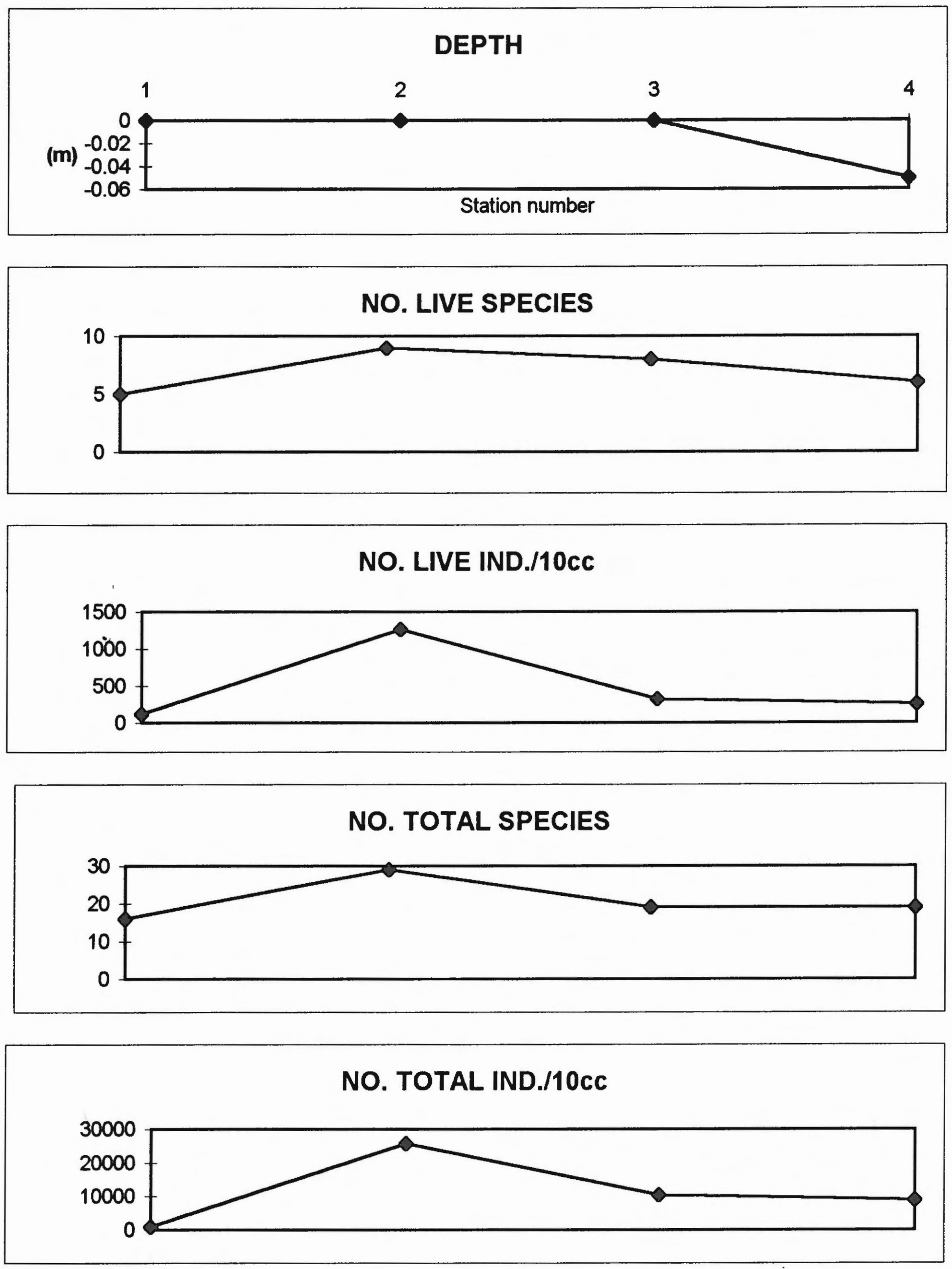
The most abundant species were *Helenina anderseni* (34.2 to 45.2%), *Trochammina inflata* (5 to 35.7%), *Triloculina oblonga* (5.6 to 27%), *Discorinopsis aguayoi* (2.9 to 11.7%), *Parrina bradyi* (0 to 11.2%), and *Bolivina lanceolata* (0 to 8.2%).

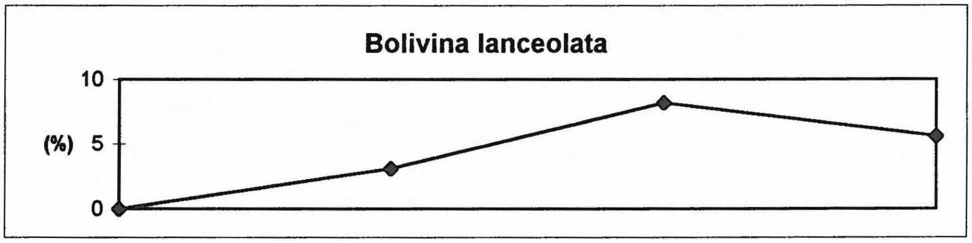
Species with total frequencies between 2 and 4% in at least one sample were *Glomospira irregularis, Haplophragmoides wilberti* and *Textularia earlandi*.

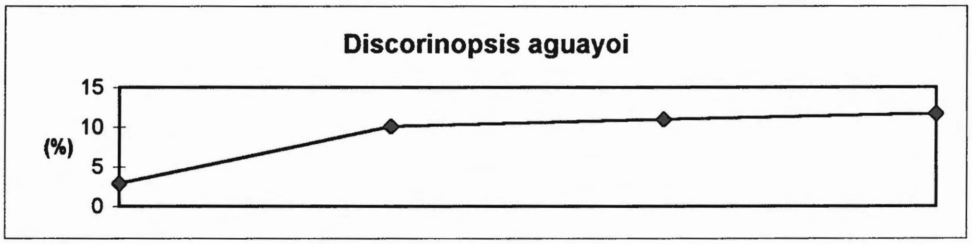
Species with total frequencies between 1 and 2% in at least one sample were *Ammonia beccarii tepida, Bolivina lowmani, Bolivina tortuosa, Pseudothurammina limnetis, Polysaccamina ipohalina, Quinqueloculina seminulum*, and *Trochammina ochracea*.

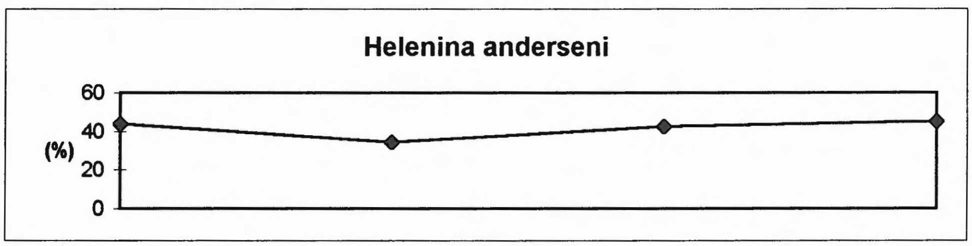
With increasing depth, live and total abundances increased, and live and total diversities were variable; *Bolivina lanceolata* and *Discorinopsis aguayoi* increased, and *Trochammina inflata* and *Haplophragmoides wilberti* decreased.

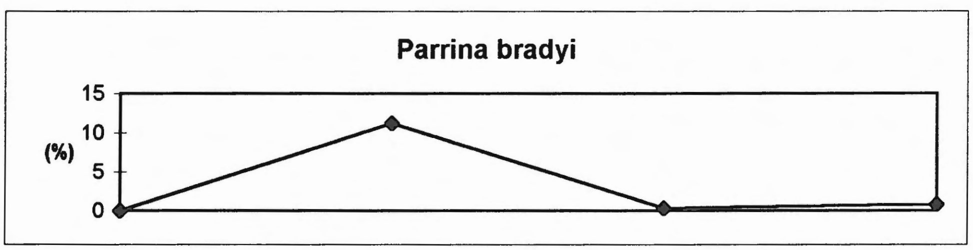
Figure 25. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Walsingham Bay.

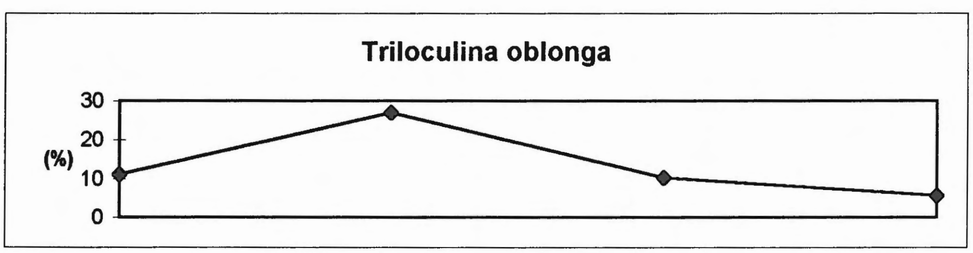

DEPTH
1
2
3
4
0
-0.02
-0.04
-0.06
(m)
Station number
NO. LIVE SPECIES
10
5
0
NO. LIVE IND./10cc
1500
1000
500
0
NO. TOTAL SPECIES
30
20
10
0
NO. TOTAL IND./10cc
30000
20000
10000
0

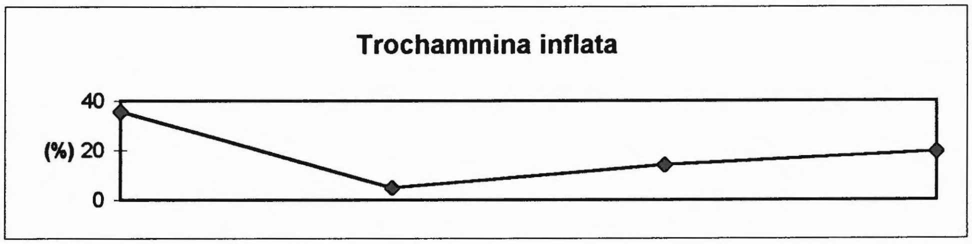

Bolivina lanceolata
10
(%) 5
0


Discorinopsis aguayoi
15
10
(%)
5
0


Helenina anderseni
60
40
(%)
20
0


Parrina bradyi
15
10
(%)
5
0


Triloculina oblonga
30
20
(%)
10
0


Trochammina inflata
40
(%) 20
0

3.1.5. LANDLOCKED SALINE PONDS

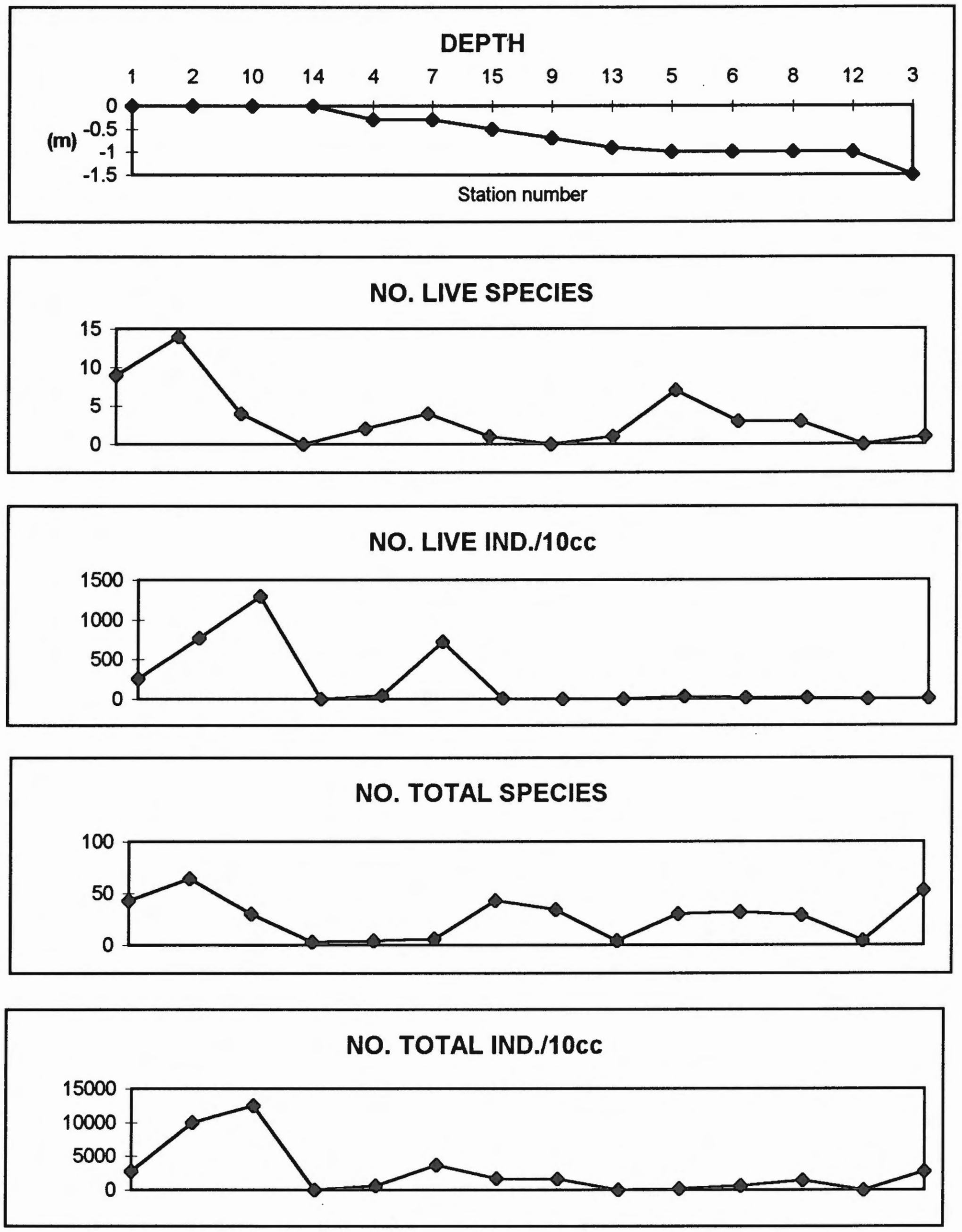
3.1.5.1. Spittal Pond

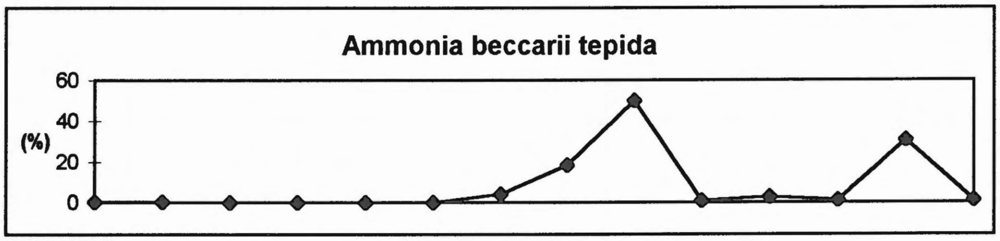
In the 14 samples examined from the pond, sediment size ranged from peat to sandy peat, sandy mud and muddy sand. Samples 1, 2, 10, 14, and 7 were collected in grass around the pond, sample 4 in a grass island, and the other samples in the pond (fig. 14). Water depth varied between 0 and 1.5 meter. Salinity ranged from 14 to 17 ppm (one time measurement in February 95) and temperature varied between 18 to 20°C (one time measurement in February 95).

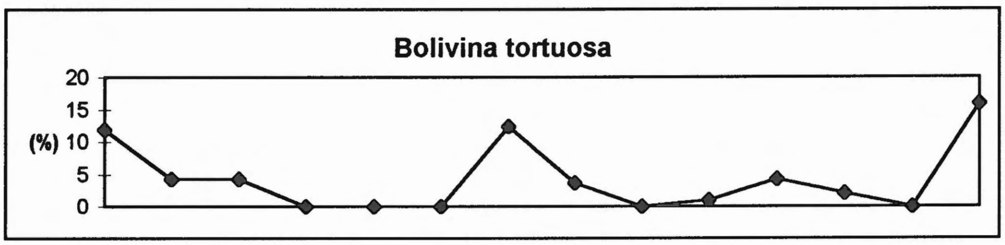
A total of 110 species were identified. Live and total abundances varied from low to high (0 to 1,296 live ind/10cc and 648 to 12,492 total ind./10cc). Number of live species was generally low (0 to 14 species). Total number of species was low to relatively high (3 to 64 species) (fig. 26, appendices table 18).

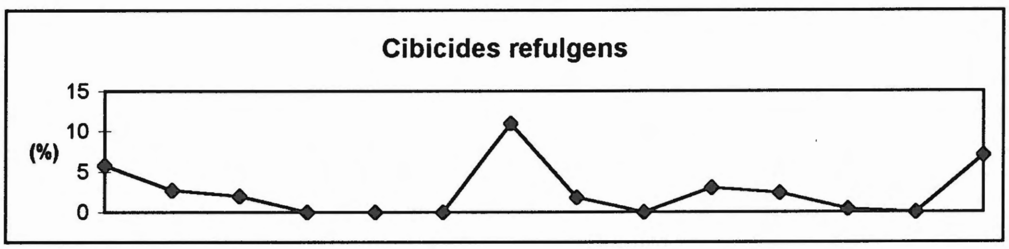
The most abundant (total) species were *Polysaccammina ipohalina* (0 to 15.2%, 80% in one sample), *Trochammina inflata* (0.3 to 76.7%), *Ammonia beccarii tepida* (0 to 50%), *Triloculina oblonga* (0 to 29.4%), *Discorinopsis aguayoi* (0 to 25.8%), *Miliolinella circularis* (0 to 25%), *Miliammina fusca* (0 to 16.7%), *Bolivina tortuosa* (0 to 15.9%), *Quinqueloculina seminulum* (0 to 14.9%), *Ciicides refulgens* (0 to 11%),

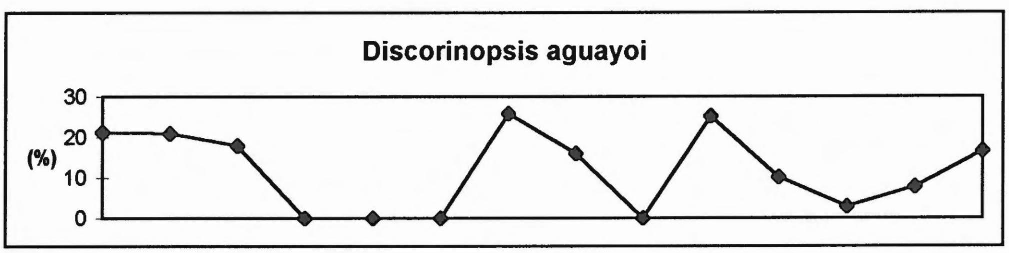
Figure 26. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Spittal Pond.

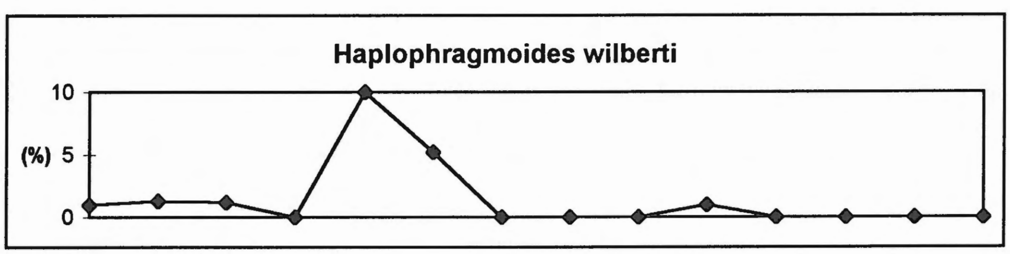

DEPTH
1 2 10 14 4 7 15 9 13 5 6 8 12 3
(m)
0
-0.5
-1
-1.5
Station number
NO. LIVE SPECIES
15
10
5
0
NO. LIVE IND./10cc
1500
1000
500
0
NO. TOTAL SPECIES
100
50
0
NO. TOTAL IND./10cc
15000
10000
5000
0

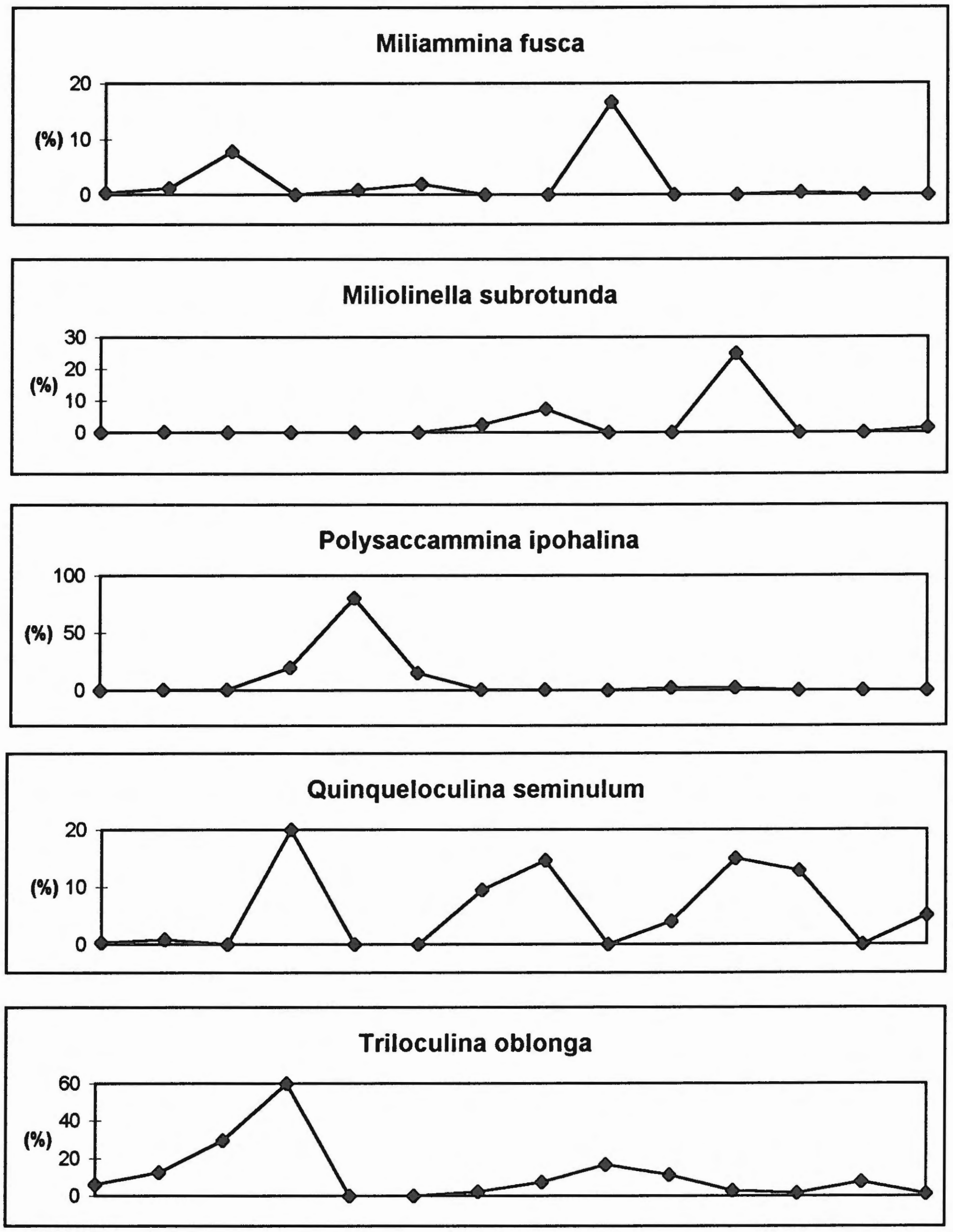

Ammonia beccarii tepida
60
40
(%)
20
0

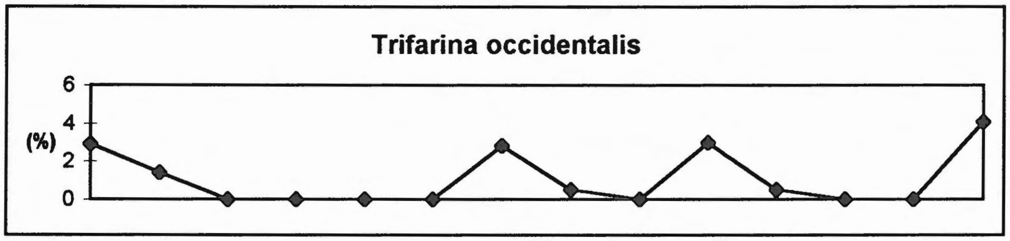

Bolivina tortuosa
20
15
(%) 10
5
0

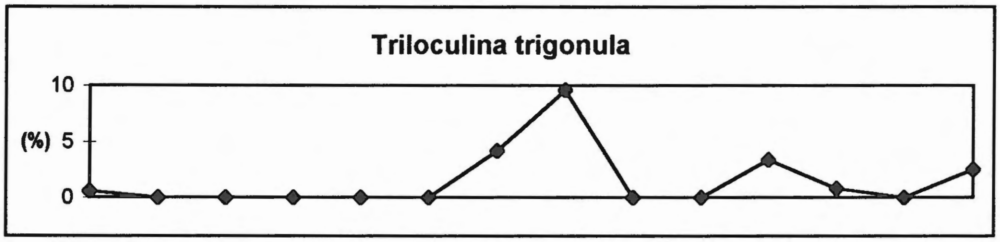

Cibicides refulgens
15
10
(%)
5
0

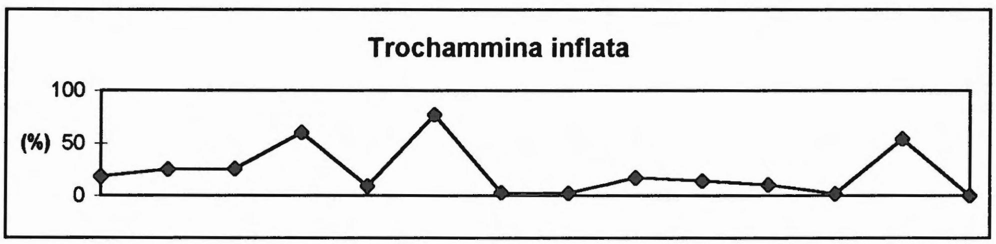

Discorinopsis aguayoi
30
20
(%)
10
0


Haplophragmoides wilberti
10
(%) 5
0


Miliammina fusca
20
(%) 10
0
Miliolinella subrotunda
30
20
(%)
10
0
Polysaccammina ipohalina
100
(%) 50
0
Quinqueloculina seminulum
20
(%) 10
0
Triloculina oblonga
60
40
(%)
20
0


Trifarina occidentalis
6
4
(%)
2
0


Triloculina trigonula
10
(%) 5
0


Trochammina inflata
100
(%) 50
0

Triloculina trigonula (0 to 9.6%), *Haplophragmoides wilberti* (0 to 5.2%), and *Trifarina occidentalis* (0 to 4.1%).

Species with total frequencies between 2 and 4% in at least one sample were *Bolivina lanceolata, Elphidium poeyanum, Cymbaloporetta squamosa, Helenina anderseni, Peneroplis carinatus/proteus, Planispiroides bucculentus, Weisnerella auriculata, Rosalina subarauncana,* and *Spiroloculina hyalina.*

Species with total frequencies between 1 and 2% in at least one sample were planktonic species, *Buliminella elegantissima, Quinqueloculina lamarckiana, Spirophtalmidium sp., Quinqueloculina laevigata, Rosalina concinna, Rosalina globularis, Quinqueloculina subpoeyana, Siphonina pulchra, Spirillina cariacoensis*, and *Spirillina vivipara*.

With increasing depth, live and total abundances decreased and were higher in the grass samples; live number of species was variable but decreased; and total number of species was variable. The frequency of *Ammonia beccarii tepida* increased in samples collected in the pond. *Triloculina oblonga* was more abundant in the grass samples, as well as *Polysaccammina ipohalina*. The other species frequencies were variable.

3.1.5.2. Grotto Pond

In the three samples examined from this small pond, sediment was peaty sand, silty sand, and fine sand. Water depth varied between 0 to 0.5 meter. Salinity was 35 ppm and temperature was 24°C (one time measurement in May 93). A total of 103 species were identified. Live and total abundances were high (1,800 to 7,488 live ind/10cc and 21,996 to 57,312 total ind/10cc). Live and total diversities were also high (14 to 26 live species and 43 to 90 total species) (Appendices table 19).

The most common (total) species were *Discorinopsis aguayoi* (0.9 to 28.8%), *Quinqueloculina seminulum* (5.3 to 28.5%), *Trochammina inflata* (0.3 to 17.5%), *Triloculina oblonga* (0.8 to 11%), *Quinqueloculina laevigata* (0.2 to 10.6%), *Polysacamina ipohalina* (0 to 6.2%), *Bolivina tortuosa* (1.1 to 6.1%), *Cyclogyra planorbis* (2.3 to 5.9%), *Rosalina globularis* (0.4 to 5.2%), *Parrina bradyi* (0.1 to 5%), and *Bolivina lanceolata* (1.1 to 4.3%).

Species with total frequencies between 2 and 4% in at least one sample were *Nonion depressulum, Quinqueloculina subpoeyana, Rosalina globularis, Rosalina subarauncana*, and *Triloculina bermudezi*.

Species with total frequencies between 1 and 2% in at least one sample were *Ammobaculites sp., Ammonia beccarii tepida, Cassidulina subglobosa, Cibicides refulgens, Elphidium poeyanum, Glomospira irregularis, Helenina anderseni,* *Quinqueloculina polygona, Spiroloculina arenata, Spiroloculina gradeloupi, Spirophtalmidium sp.*, and *Textularia earlandi*.

The exposed sample (#1) included more *Cyclogyra planorbis, Discorinopsis aguayoi, Helenina anderseni, Parrina bradyi, Polysacamina ipohalina, Triloculina oblonga,* and *Trochammina inflata.* These species decreased or were absent in deeper samples. With increasing depth, *Ammonia beccarii tepida, Bolivina lanceolata, Bolivina tortuosa, Cassidulina subglobosa, Elphidium poeyanum, Quinqueloculina laevigata, Quinqueloculina seminulum,* and *Quinqueloculina subpoeyana* increased.

3.1.5.3. Walsingham Pond.

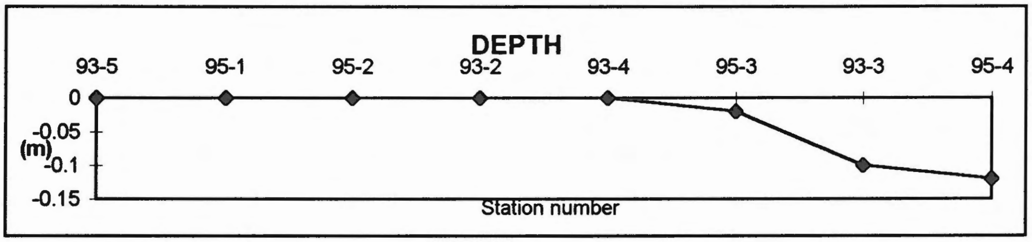
In the 8 samples examined from this site, sediment was peat. Salinity was 35 ppm and temperature was 24°C (one time measurement in May 93). Water depth varied between 0 (exposed samples) and 12 cm. A total of 27 species were identified. Live and total abundances were low to high (60 to 472 live ind./10cc, and 696 to 9,809 total ind./10cc), and live and total diversities were low (3 to 8 live species and 6 to 15 total species) (fig. 27, appendices table 20).

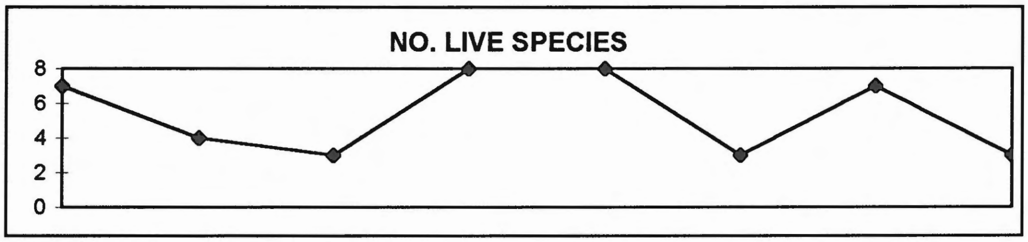
The most common species were *Trochammina inflata* (1.1-70.5%), *Glomospira irregularis* (0-51.1%), *Trochammina macrescens* (0-51.1%), *Tolypammina vagans* (0-21.5%), *"Siphotrochammina inflata"* (0-20.7%), *Polysaccammina ipohalina* (0-19%), *Miliammina fusca* (0-10.7%), *Trochammina ochracea* (0-7.7%), and *Haplophragmoides wilberti* (0-7.1%).

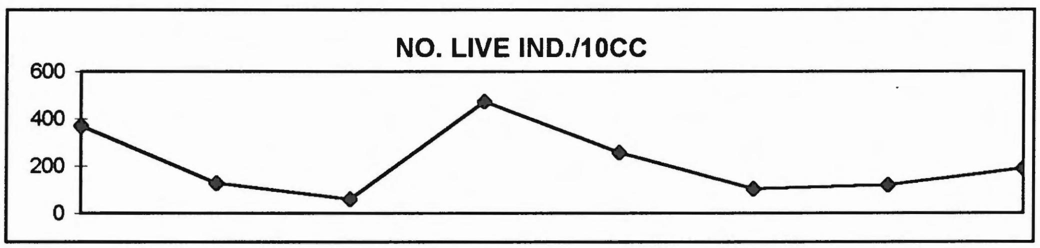
Species with total frequencies between 2 and 4% in at least one sample were *Textularia earlandi, Trochamminita salsa, Helenina anderseni,* and *Triloculina oblonga.* Species with total frequencies between 1 and 2% in at least one sample were *Ammodiscus tenuis, Pseudothurammina limnetis,* and *Ammonia beccarii tepida.*

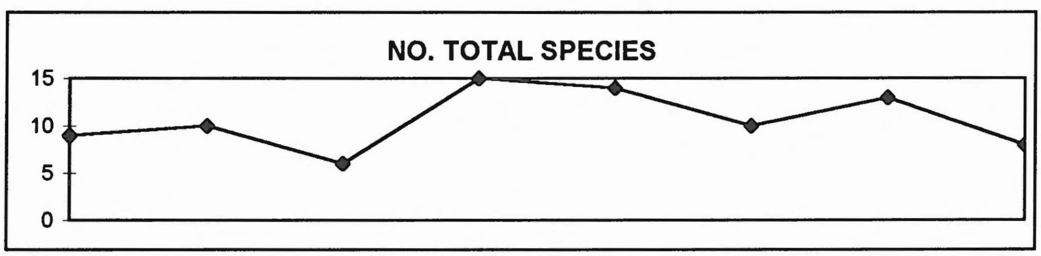
With increasing depth, total abundance decreased, as well as *Haplophrgmoides wilberti, Miliammina fusca*, and *Tolypammina vagans*, while *Glomospira irregularis* increased. The frequency of the other species was variable.

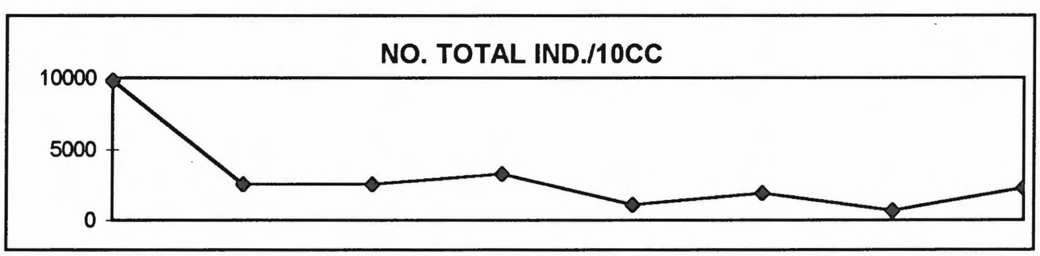
Figure 27. Distribution of live and total number of individuals/10cc, live and total number of species, and main foraminifera species with increasing depth in Walsingham Pond.

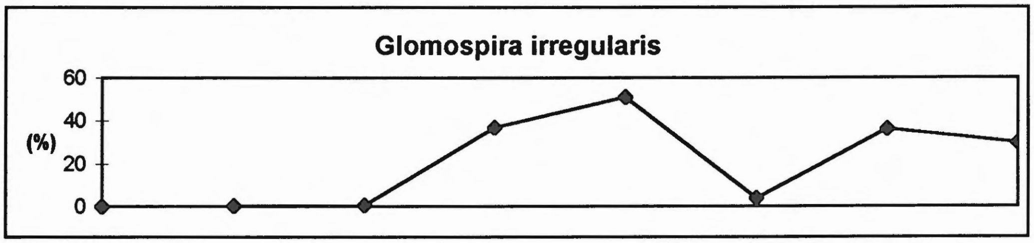

DEPTH
93-5
95-1
95-2
93-2
93-4
95-3
93-3
95-4
0
-0.05
(m)
-0.1
-0.15
Station number

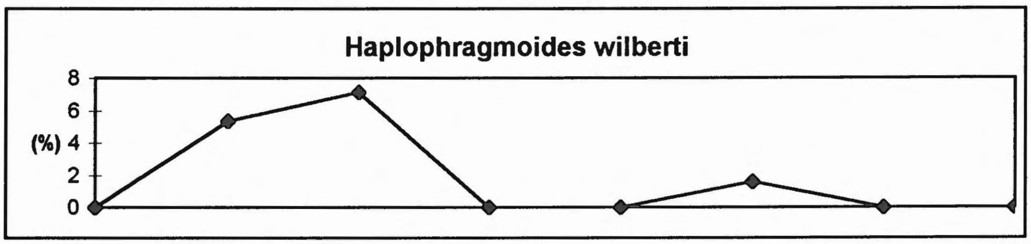

NO. LIVE SPECIES
8
6
4
2
0

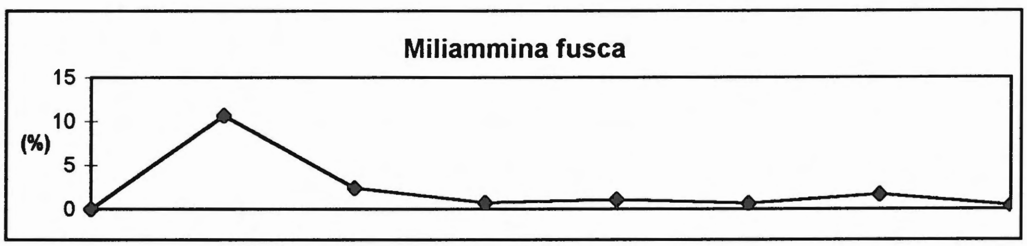

NO. LIVE IND./10CC
600
400
200
0

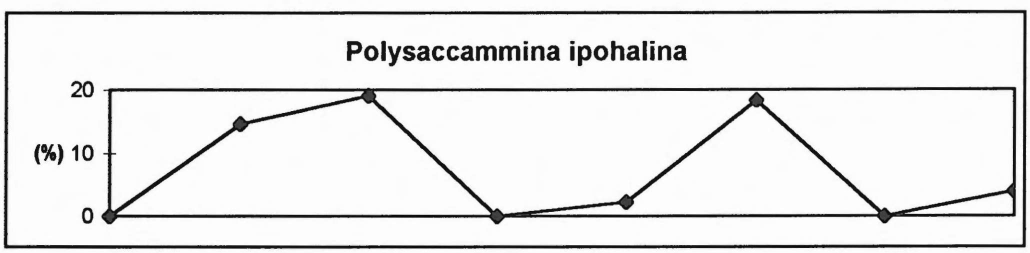

NO. TOTAL SPECIES
15
10
5
0

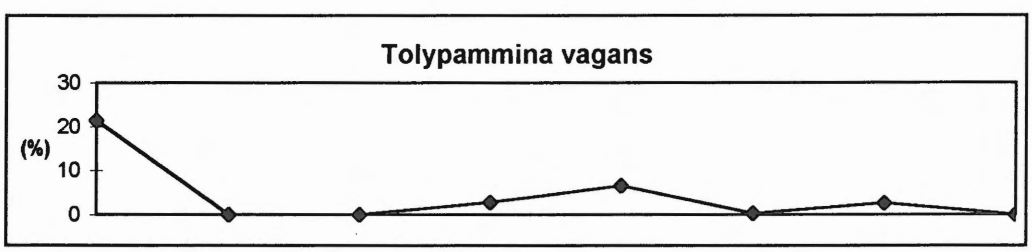

NO. TOTAL IND./10CC
10000
5000
0

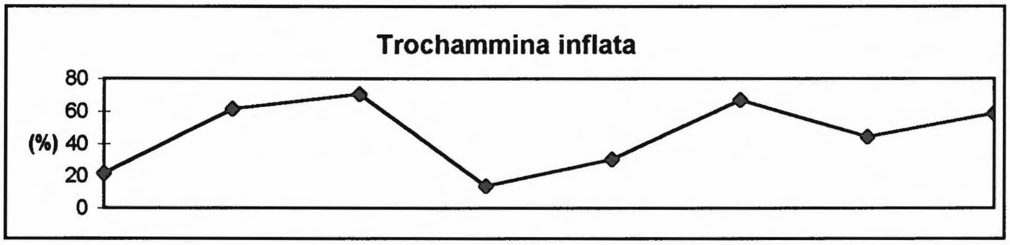

Glomospira irregularis
60
40
(%)
20
0

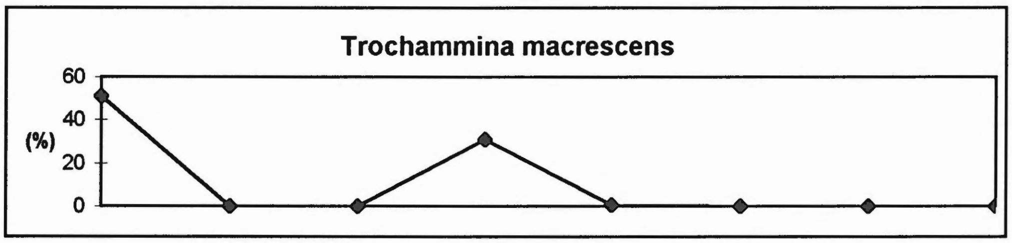

Haplophragmoides wilberti
8
6
(%) 4
2
0

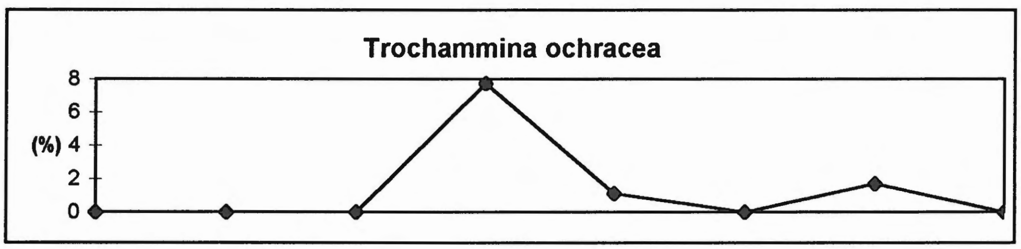

Miliammina fusca
15
10
(%)
5
0


Polysaccammina ipohalina
20
(%) 10
0


Tolypammina vagans
30
20
(%)
10
0


Trochammina inflata
80
60
(%) 40
20
0


Trochammina macrescens
60
40
(%)
20
0

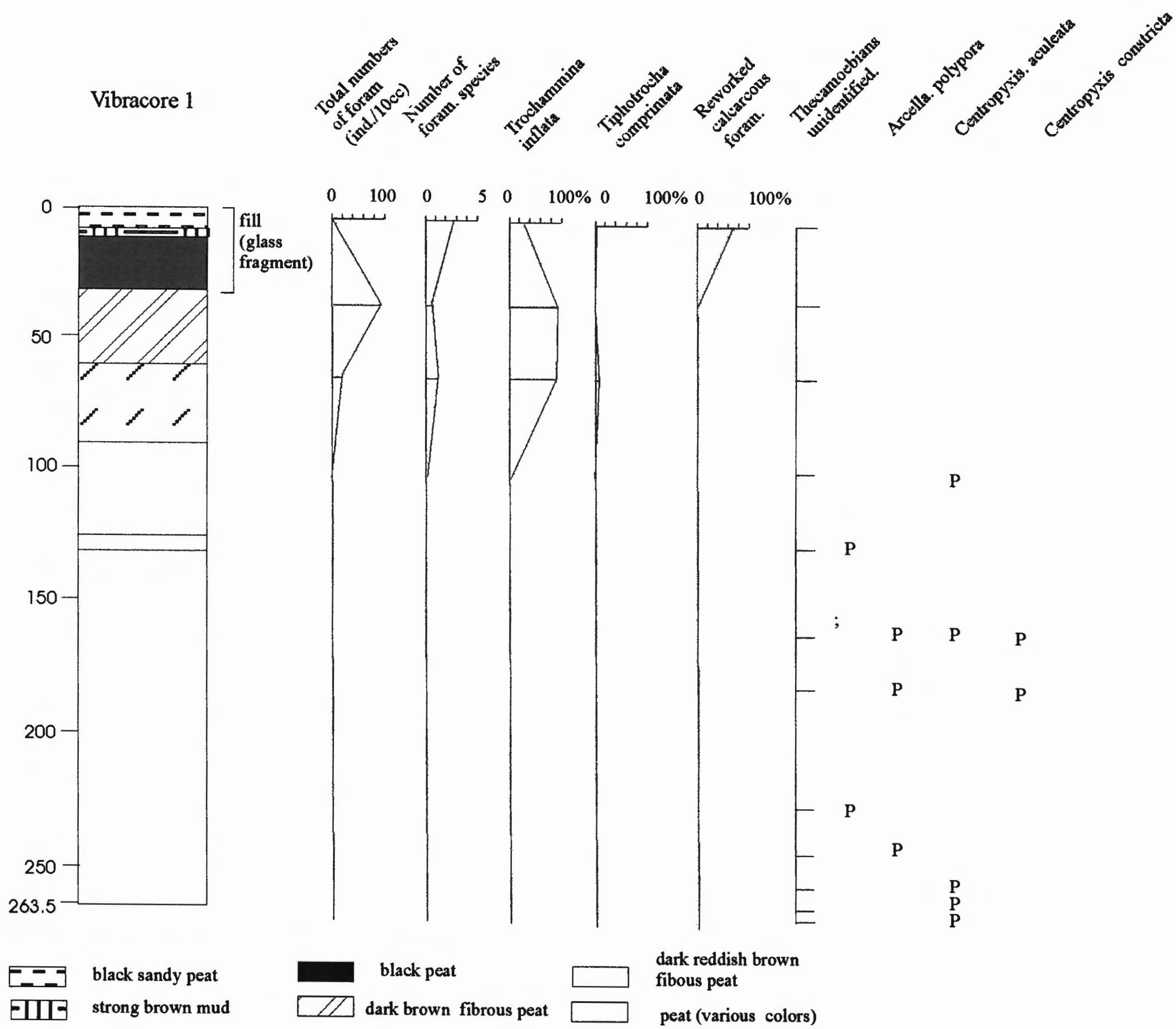

Trochammina ochracea
8
6
(%) 4
2
0

3.2. DISTRIBUTION OF BENTHIC FORAMINIFERA IN CORES

3.2.1. Vibracore 1 (Mill Creek)

Total length of this core was 263.5 cm. Compaction was 74 cm. Sediment was dark brown to dark reddish to black peat with occasional wood and root fragments. The interval 2-33 cm was fill. In the 14 samples examined from this core, abundances were very low. There were no foraminifera from 263 to 100 cm, but only the thecamoebians *Arcella polypora, Centropyxis aculeata,* and *Centropyxis constricta*. In the other samples, abundances varied between 3 and 89 ind./10cc, and the number of species was very low (1 to 3 species). *Trochammina inflata* occurred in these samples, with *Tiphotrocha comprimata* in sample from interval 59-61 cm, and reworked calcareous species in sample from interval 0 to 2 cm (fig. 28, appendices table 21).

Figure 28. Lithostratigraphy, depth, and main foraminifera and thecamoebians through Vibracore 1 (Mill Creek).

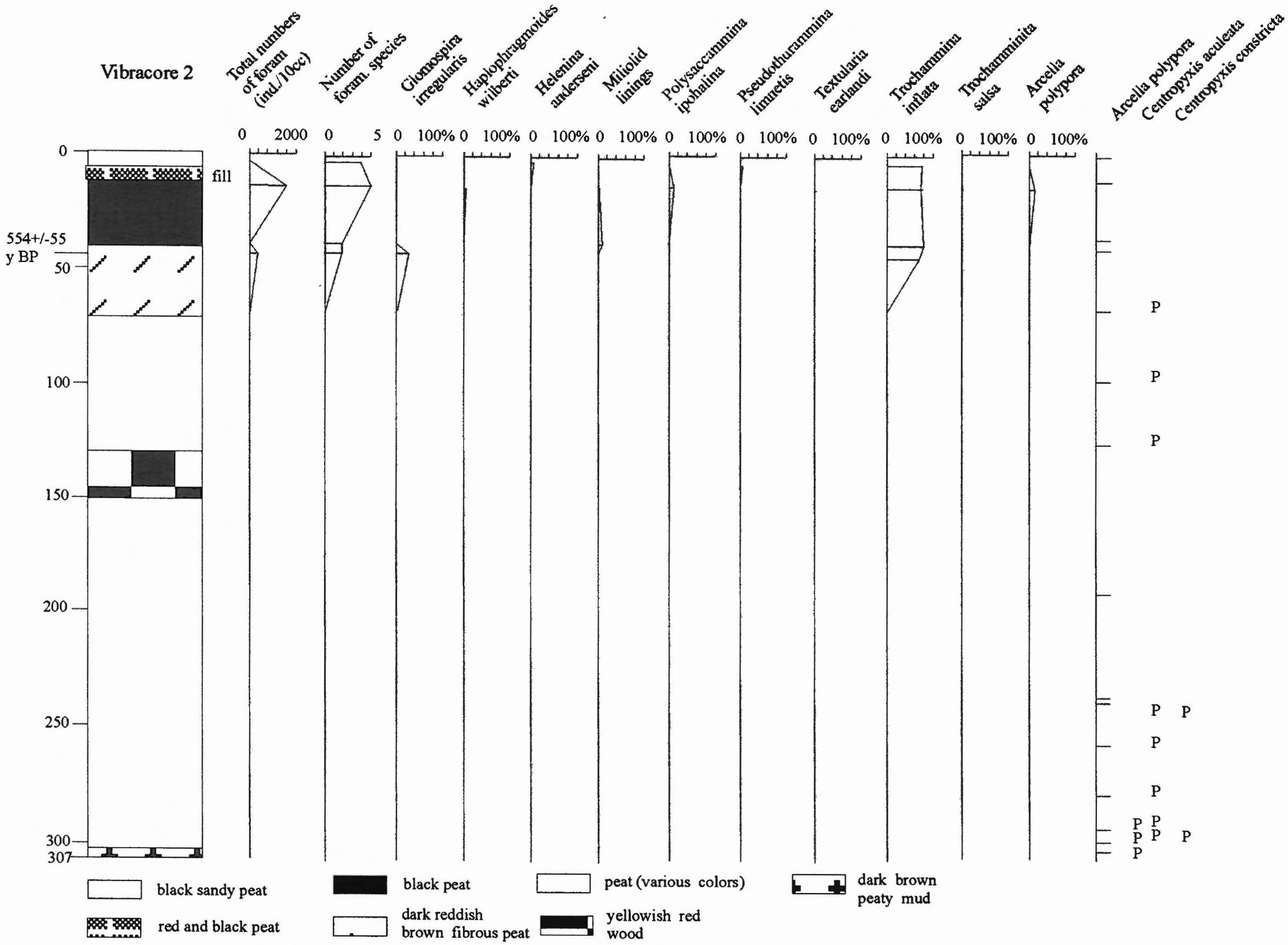


Vibracore 1
Total numbers of foram (ind./10cc)
Number of foram. species
Trochammina inflata
Tiphotrocha comprimata
Reworked calcarous foram.
Thecamoebians unidentified.
Arcella. polypora
Centropyxis. aculeata
Centropyxis constricta
0
50
100
150
200
250
263.5
fill (glass fragment)
0 100
0 5
0 100%
0 100%
0 100%
P
P
P P P
P P
P
P
P
P
P
black sandy peat
strong brown mud
black peat
dark brown fibrous peat
dark reddish brown fibous peat
peat (various colors)

3.2.2. Vibracore 2 (Mill Creek)

Total core length was 307 cm. Compaction was 94 cm. The core bottom (303-307 cm) was dark brown peaty mud. The rest of the core was dark brown, dark reddish, and black, fibrous or not fibrous, peat, with occasional roots and other plant fragments. A large piece of yellowish red wood occurred between 129 and 172 cm. The interval 6-12 cm was fill. A radiocarbon date of 554 ± 55 years before present (y BP) was obtained between 41-45 cm. There were no foraminifera from 306 to 66 cm, but only thecamoebians except in barren samples from intervals 240-242 cm and 185-187 cm. In the other samples, abundance varied between 8 and 1,587 ind./10cc, and diversity was low (2 to 5 species). *Trochammina inflata* dominated all samples, with also *Glomospira irregularis* in sample from interval 41-43 cm; miliolid linings in sample from interval 37-39 cm; *Haplophragmoides wilberti, Polysaccammina ipohalina, Textularia earlandi*, and *Trochamminita salsa* in sample from interval 14-16 cm; and *Helenina anderseni, Pseudothurammina limnetis,* and *Centropyxis aculeata* in sample from interval 2-4 cm (fig. 29, appendices table 22).

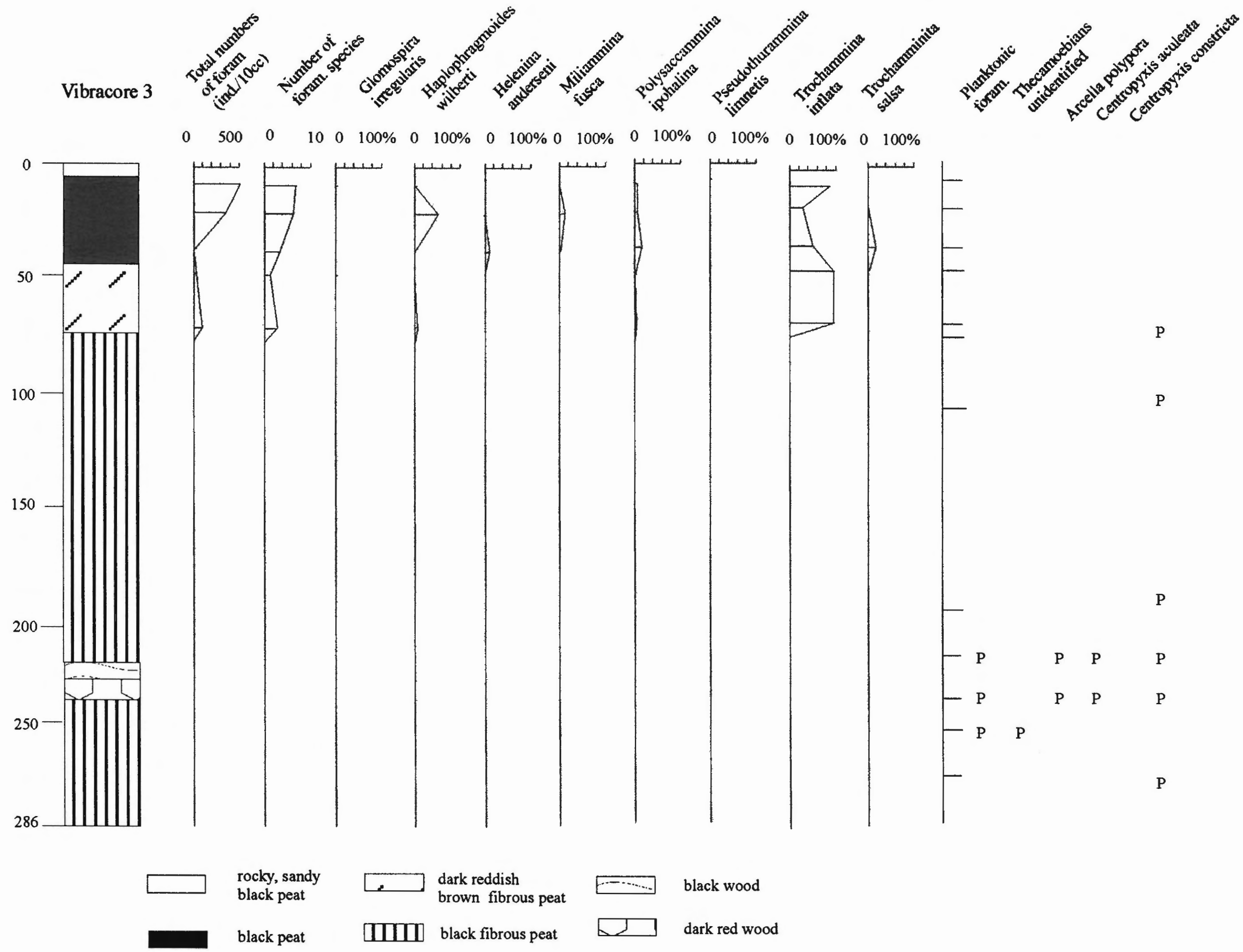
Figure 29. Lithostratigraphy, depth, and main foraminifera and thecamoebians through Vibracore 2 (Mill Creek).


Vibracore 2
Total numbers of foram (ind./10cc)
Number of foram. species
Glomospira irregularis
Haplophragmoides wilberti
Helenina anderseni
Miliolid linings
Polysaccammina ipohalina
Pseudothurammina limnetis
Textularia earlandi
Trochammina inflata
Trochamminita salsa
Arcella polypora
Arcella polypora
Centropyxis aculeata
Centropyxis constricta
0 2000
0 5
0 100%
fill
554+/-55
y BP
0
50
100
150
200
250
300
307
P
black sandy peat
red and black peat
black peat
dark reddish brown fibrous peat
peat (various colors)
yellowish red wood
dark brown peaty mud

3.2.3. Vibracore 3 (Mill Creek)

Total core length was 286 cm. Compaction was 136 cm. Sediment was black fibrous or not fibrous peat, and dark reddish brown peat, with occasional plant fragment, roots, and wood pieces. Dark red wood occurred in interval 231-231 cm. The top 0-6 cm was fill (rocks and sand in peat). There was no foraminifera between 267 and 71 cm, but only thecamoebians. In the other samples, abundance varied between 11 and 498 ind./10cc and diversity between 2 and 7 species. *Trochammina inflata* was the dominant species except in sample from interval 22-24 cm where *Helenina wilberti* was more common. Sample from interval 67-69 cm also included *Helenina wilberti* and *Polysaccammina ipohalina*; sample from interval 45-47 cm included also *Glomospira irregularis*; sample from interval 39-41 cm included also *Helenina anderseni* linings, *Polysaccammina ipohalina*, and *Trochamminita salsa*; sample from interval 22-24 cm included also *Miliammina fusca, Polysaccammina ipohalina*, and *Trochammina inflata*; and sample from interval 8-10 cm included also *Glomospira irregularis, Haplophragmoides wilberti, Miliammina fusca, Polysaccammina ipohalina, Pseudothurammina limnetis*, and *Trochamminita salsa* (fig. 30, appendices table 23).

Figure 30. Lithostratigraphy, depth, and main foraminifera and thecamoebians through Vibracore 3 (Mill Creek).



Vibracore 3
Total numbers of foram (ind./10cc)
Number of foram. species
Glomospira irregularis
Haplophragmoides wilberti
Helenina anderseni
Miliammina fusca
Polysaccammina ipohalina
Pseudothurammina limnetis
Trochammina inflata
Trochamminita salsa
Planktonic foram.
Thecamoebians unidentified
Arcella polypora
Centropyxis aculeata
Centropyxis constricta
0 500
0 10
0 100%
0
50
100
150
200
250
286
P
rocky, sandy black peat
black peat
dark reddish brown fibrous peat
black fibrous peat
black wood
dark red wood

3.2.4. Vibracore 4 (Mill Creek)

Total core length was 89 cm. Compaction was 312 cm. Sediment was reddish black, dark reddish brown fibrous, and black peat. Dark reddish brown wood occurred between 73 and 79 cm. The interval 2-20 cm was fill (sandy peat with sharp contacts). No foraminifera were in this core except a few calcareous reworked species in samples from intervals 4-6 cm and 0-2 cm. Thecamoebians occurred throughout (fig. 31, appendices table 24).

3.2.5. Vibracore 5 (Mill Share)

Total core length was 184 cm. Compaction was 61 cm. The core bottom was light gray sandy mud with pebbles and plant fragments. The rest of the core was black fibrous, and dark reddish brown fibrous peat. Reddish brown organic silty mud with sharp upper contact and grading into black fibrous peat below, occurred between 123 and 154 cm. The interval 25-59 cm was fill (several sandy peat layers with sharp contacts). A radiocarbon date of 1,051 ± 60 y BP was obtained from the interval 169-173 cm. Foraminifera occurred throughout the core, and thecamoebians were present only in samples from interval 143-145 cm (*Arcella polypora*) and 23-25 cm (*Centropyxis aculeata*). Abundance was high (967 to 9,660 ind./10cc) and diversity was low to

Figure 31. Lithostratigraphy, depth, and main foraminifera and thecamoebians through Vibracore 4 (Mill Creek).

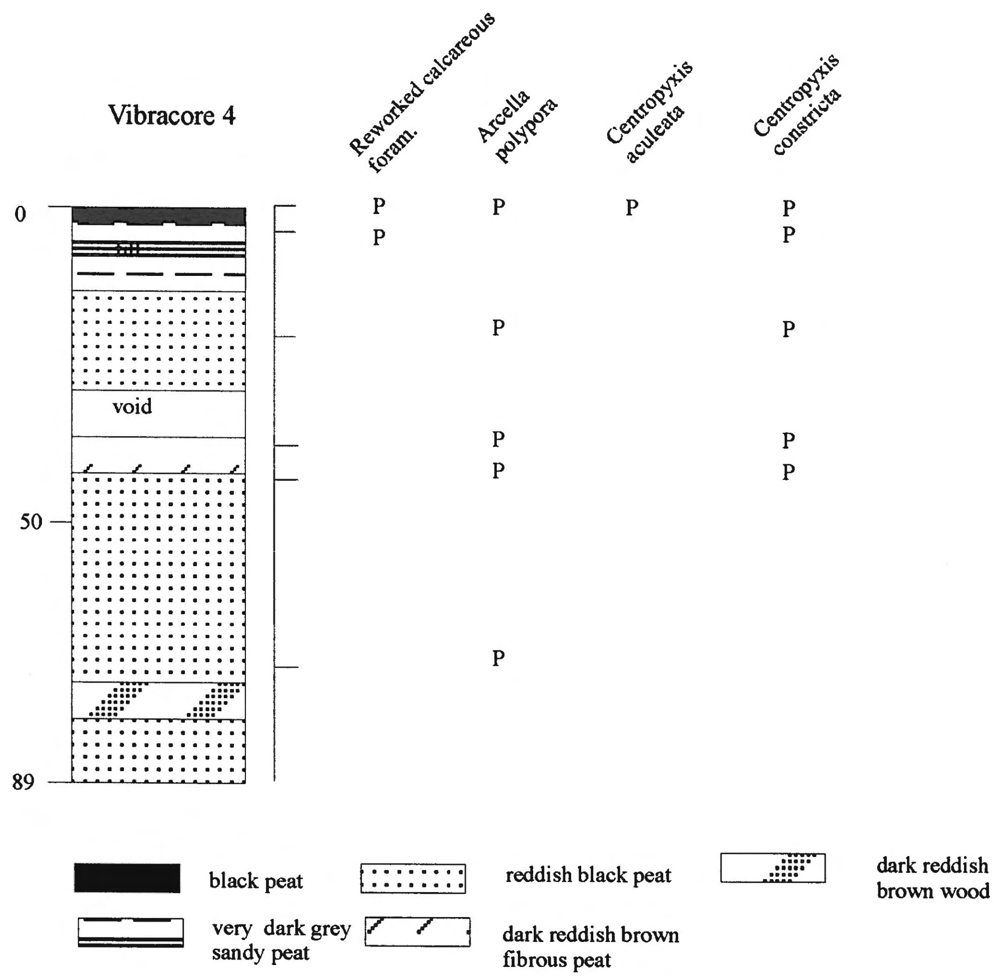
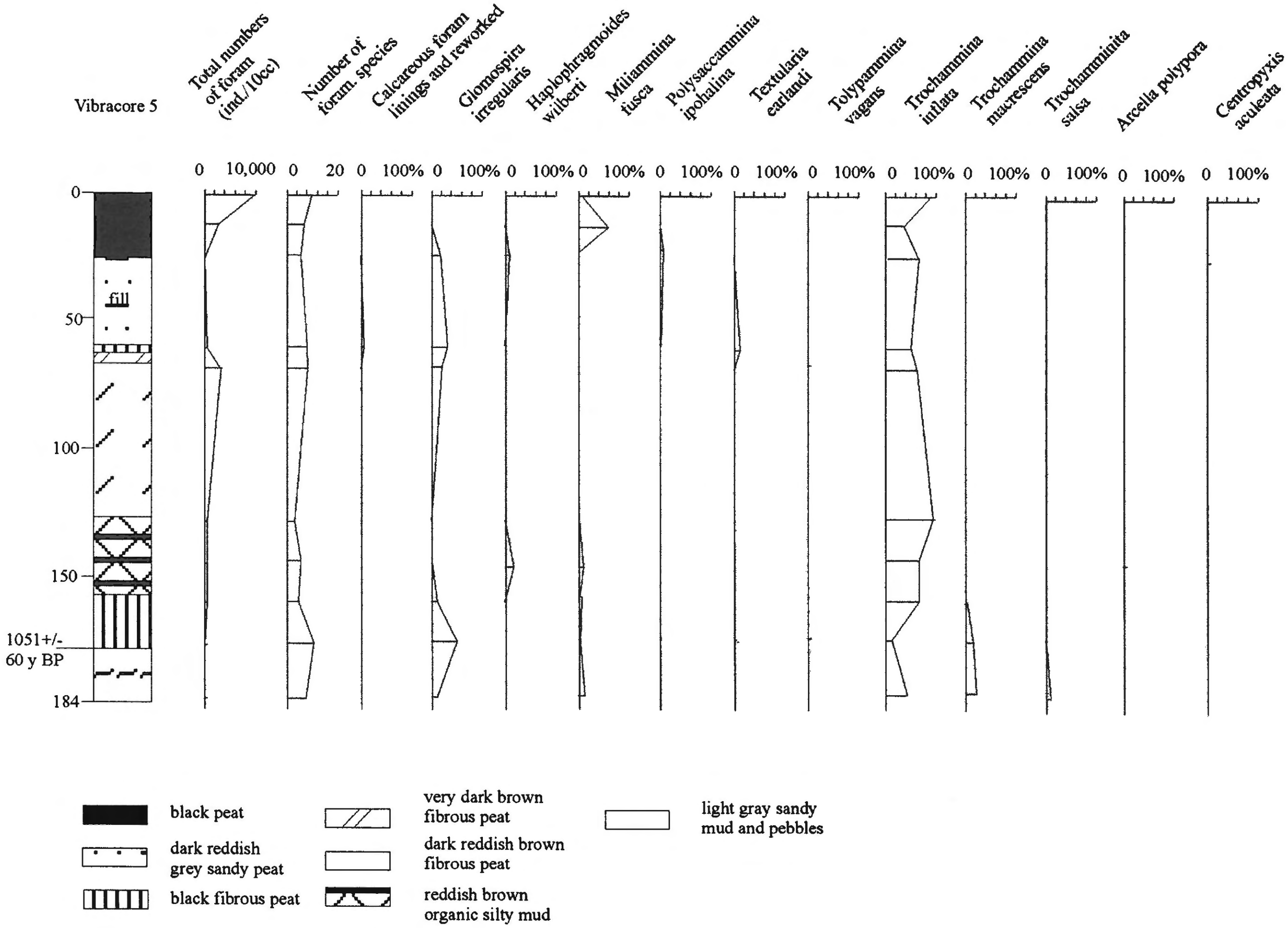

Vibracore 4
Reworked calcareous foram.
Arcella polypora
Centropyxis aculeata
Centropyxis constricta
0
50
89
void
P
black peat
very dark grey sandy peat
reddish black peat
dark reddish brown fibrous peat
dark reddish brown wood

Figure 32. Lithostratigraphy, depth, and main foraminifera and thecamoebians through Vibracore 5 (Mill Share).



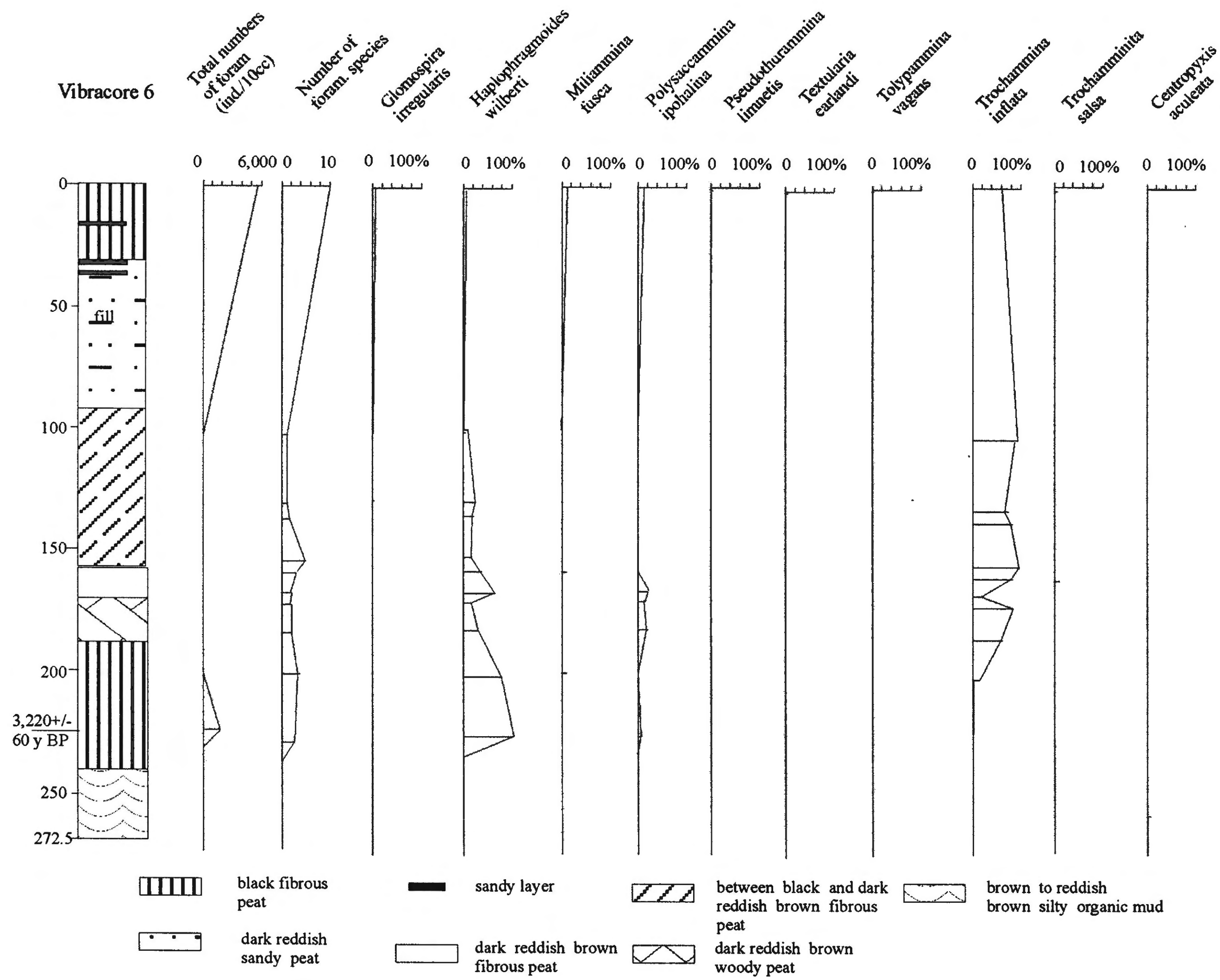
Vibracore 5
Total numbers of foram (ind./10cc)
Number of foram. species
Calcareous foram linings and reworked
Glomospira irregularis
Haplophragmoides wilberti
Miliammina fusca
Polysaccammina ipohalina
Textularia earlandi
Tolypammina vagans
Trochammina inflata
Trochammina macrescens
Trochamminita salsa
Arcella polypora
Centropyxis aculeata
0 10,000
0 20
0 100%
0
50
100
150
184
fill
1051+/- 60 y BP
black peat
dark reddish grey sandy peat
black fibrous peat
very dark brown fibrous peat
dark reddish brown fibrous peat
reddish brown organic silty mud
light gray sandy mud and pebbles

moderate (2 to 12 species). *Trochammina inflata* was the dominant species except in sample from interval 171-173 cm where *Glomospira irregularis* dominated, and in sample from interval 10-12 cm where *Miliammina fusca* dominated. Other abundant species were: in sample from interval 182-184 cm, *Miliammina fusca, Trochammina macrescens*, and *Trochamminita salsa;* in sample from interval 171-173 cm, *Trochammina inflata* and *Trochammina macrescens;* in sample from interval 157-159 cm, *Glomospira irregularis*; in sample from interval 143-145 cm *Haplophragmoides wilberti* and *Miliammina fusca*; in sample from interval 67-69 cm, *Glomospira irregularis*; in sample from interval 60-62 cm, *Glomospira irregularis;* in sample from interval 23-25 cm, *Glomospira irregularis;* and in sample from interval 10-12 cm, *Trochammina inflata* (fig. 32, appendices table 25).

3.2.6. Vibracore 6 (Mill Share)

Total core length was 272.5 cm. Compaction was 49 cm. The core bottom (244-272.5 cm) was brown silty mud grading into reddish brown silty organic mud. In the rest of the core, sediment was black fibrous and dark reddish brown fibrous peat. The interval 30-90 cm was fill (sandy peat with sharp contacts). A radiocarbon date of 3,220 ± 60 y BP was obtained between 220-224 cm. All samples from 272 to 236 cm were barren. Between 224 and 0 cm, foraminifera occurred and thecamoebians were absent, except in

Figure 33. Lithostratigraphy, depth, and main foraminifera and thecamoebians through Vibracore 6 (Mill Share).


Vibracore 6
Total numbers of foram (ind./10cc)
Number of foram. species
Glomospira irregularis
Haplophragmoides wilberti
Miliammina fusca
Polysaccammina ipohalina
Pseudothurammina limnetis
Textularia earlandi
Tolypammina vagans
Trochammina inflata
Trochamminita salsa
Centropyxis aculeata
0 6,000
0 10
0 100%
0
50
100
150
200
250
272.5
fill
3,220+/- 60 y BP
black fibrous peat
sandy layer
between black and dark reddish brown fibrous peat
brown to reddish brown silty organic mud
dark reddish sandy peat
dark reddish brown fibrous peat
dark reddish brown woody peat

sample from interval 204-206 cm. Abundance was low to high (18 to 5670 ind./10cc). Diversity was low (2 to 6 species) except in the top sample where there was 10 species. *Trochammina inflata* was the dominant species except in samples from intervals 167-169 cm, 204-206 cm, and 222-224 cm, where *Haplophragmoides wilberti* dominated. *Haplophragmoides wilberti* was common in the other samples, and *Polysaccammina ipohalina* in samples from intervals 167-169 cm, 172-174 cm, and 184-186 cm (fig. 33, appendices table 26).

3.2.7. Davis cores from Hungry Bay

In the 7 Davis cores examined from this site, sediment was peat or peat and red soil. Depths varied between 110 and 205 cm. A radiocarbon date of 2,042 ± 50 y BP was obtained from core #5 (replicate of core #11) at 165 cm depth. Abundance varied between 3 and 4,193 ind./10cc, and diversity varied between 1 and 14 species. In all the cores, *Trochammina inflata* dominated except in core #2 where planktonic foraminifera dominated and other calcareous species occurred. The other common species were *Haplophragmoides wilberti* in core #7, 10 and 11; and *Trochammina macrescens* in all cores (appendices table 27).

3.2.8. Davis cores from Mill Share

In the 6 Davis cores examined from this site, sediment was peat or red soil and peat. Depth varied between 200 and 400 cm. A radiocarbon date of 3,210 ± 60 y BP was obtained from Davis core (DC) #6 at 290 cm depth. Abundance was low to high (0 to 2,196 ind./10cc) and diversity was low (0 to 7 species). Davis cores #3 and #1 were barren in the fraction >63 microns, but included calcareous foraminifera in the lower fraction (>45<63 microns). *Trochammina inflata* dominated in DC #2 and 4, and *Haplophragmoides wilberti* in DC #5 and 6. *Haplophragmoides wilberti* and *Trochammina macrescens* were common in DC #4. Nothecamoebians were in the cores (appendices table 28).

3.2.9. Davis cores from Mill Creek

In the 6 Davis cores examined for this site, sediment was peat. Depth varied between 390 and 473 cm. A radiocarbon date of 4,422 ± 60 y BP was obtained from DC #5 (replicate of DC # 4) at 445 cm depth. DC # 21 was barren, and DC # 15 and 7 included only thecamoebians. Abundance was low (0 to 76 ind./10cc) and diversity was low to moderate (2 to 10 species). *Trochammina inflata* dominated in DC # 13 and 4, and calcareous species dominated in DC # 1. *Trochammina macrescens* was common in DC # 4 (appendices table 29).

3.2. HOLOCENE SEA-LEVEL CURVE

To document the recent distribution of benthic foraminifera in mangrove swamps of subtropical/tropical settings, and to determine accurate sea-level markers, a quantitative study of foraminiferal distributions in Bermudan mangrove swamps was carried out (chapter 3.1.4.). Six vibracores and 52 Davis cores were collected in the mangrove swamps of Hungry Bay, Mill Creek, and Mill Share, and in the marsh of Mill Share (chapter 3.2., figs. 3, 14, 15).

The vertical zonation of marsh foraminifera can be used to locate former sea-levels, as shown by Scott and Medioli (1978, 1980a) with different foraminiferal zones in temperate North Atlantic marshes. In Bermuda mangrove swamps, the quantitative study of living (stained) and total foraminiferal assemblages along Hungry Bay and Mill Share transects revealed a vertical zonation of benthic foraminifera with respect to HHW. Two foraminiferal zones (table 5, fig. 34) were defined with respect to elevation below HHW and their recognition in subsurface peats permits an accurate (± 4 to 25 cm) determination of past position of HHW levels in Bermuda swamps.

Six peat samples were selected from the cores for radiocarbon dating (table 6, appendix table 32). Their foraminiferal content indicated the marine origin of the peat. Material was sent to Geochron laboratories for dates and sidereal corrections were made (Stuiver and Reimer, 1986, 1987). Samples 1, 3, 4 and 5 were basal peat samples. Sample 2 and 6 were not basal peat samples but sample 2's depth (vibracore) was confirmed by sample 3's depth (Davis core) for a similar age, and sample 6 came from marine peat deposited directly on firm previously compacted freshwater peat. The depth of vibracore samples was also corrected for compaction. As shown by the close ages of sample 2 (vibracore 6) and sample 3 (DC 6) for similar depths, this correction was adequate. Samples 5 and 6 included foraminifera from the foraminiferal zone 2 (*Trochammina inflata* and *Glomospira irregularis*), so the error on depth was ± 25 cm (zone 2 range is 50 cm). Sample 1 contained microfossils from zone 1 (*Trochammina inflata,* thecamoebians) and was given a depth error of ± 4 cm (zone 1 range was 7 cm). The other samples (2, 3, and 4) included also or only *Haplophragmoides wilberti* which is indicative of high marsh in other areas of the world (e.g. South Carolina, Collins et al., 1995). However in Bermuda this species occurred in zone 2, in low percentages (not higher than 4%), and its presence allowed the attribution of a depth error of ± 25 cm to these samples. These sea-level points permitted the construction of a sea-level curve.

The Holocene sea-level curve for Bermuda is shown on figure 35. From 4,422 y BP to 3,220 y BP, the sea-level rose at a rate of 18.5 cm/100y. Then, the sea-level rise slowed to 12.4 cm/100y between 3,220 y BP to 2,042 y BP. From 2,042 y BP to 1,051 y BP, the sea-level dropped at a rate of 7 cm/100y. Then sea-level rose again at 17 cm/100y until 554 y BP when it accelerated at 27 cm/100y for the last 500 years.

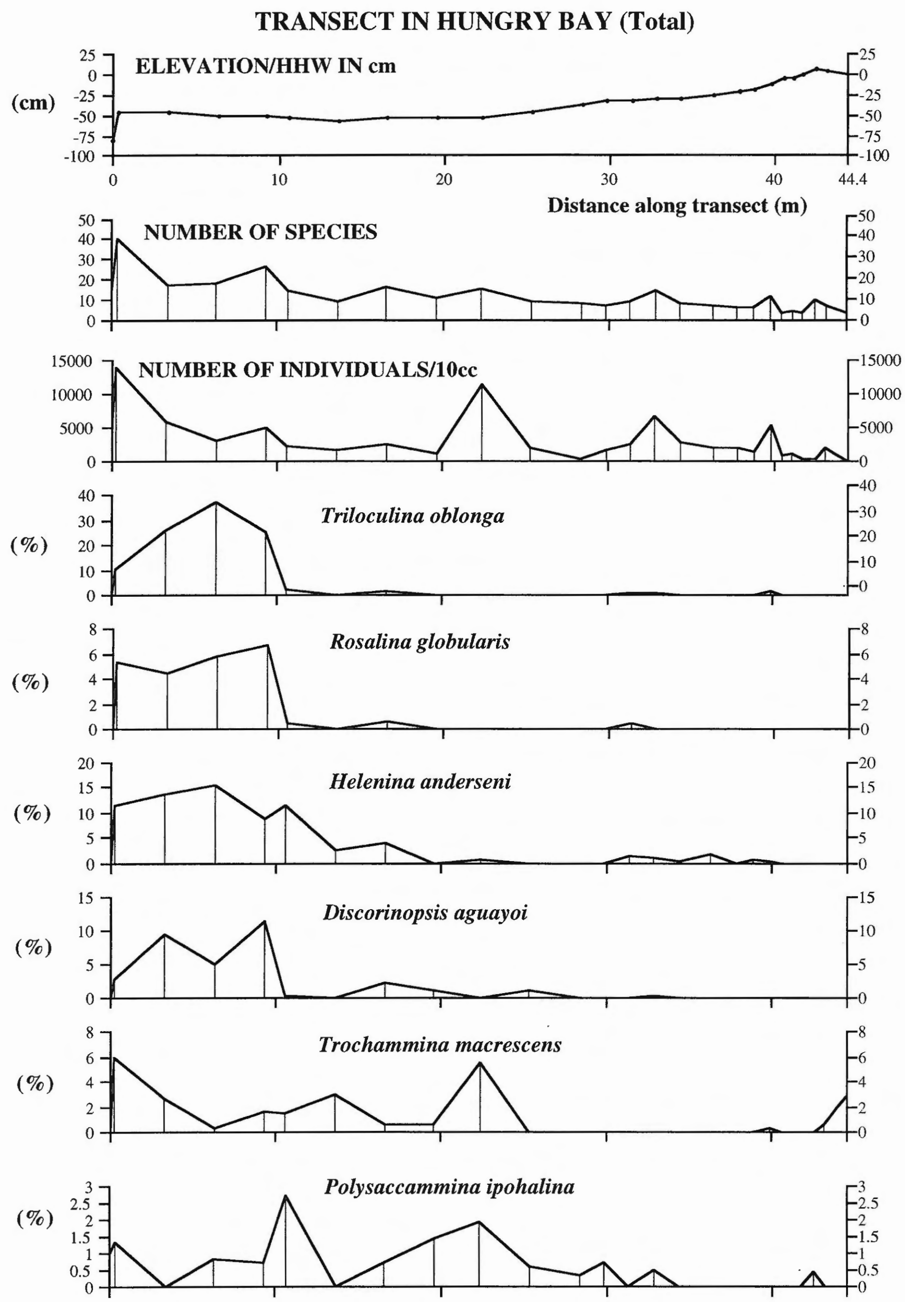
Table 5:Foraminifera zones along Hungry Bay and Mill Share transects, and general zonation for Bermuda mangrove foraminifera.
Calcareous foraminifera are not considered since they are not well preserved in subsurface peat.

	Hungry Bay	Mill Share	Bermuda foraminifera zones
HHW	*Trochammina inflata* *Thecamoebians* *Miliammina fusca*	*Trochammina inflata* *Thecamoebians* *Miliammina fusca* *Trochamminita salsa* *Trochammina macrescens*	*Trochammina inflata* *Thecamoebians* *Miliammina fusca* *Trochamminita salsa* *Trochammina macrescens*
- 5 cm	*Trochammina inflata* *Miliammina fusca* *Textularia earlandi*		
- 7 cm		*Trochammina inflata* *Glomospira irregularis* *Polysaccammina ipohalina* *Haplophragmoides wilberti* *Pseudothurammina limnetis* *Trochammina macrescens* *Miliammina fusca* *Trochamminita salsa*	*Trochammina inflata* *Glomospira irregularis* *Polysaccammina ipohalina* *Textularia earlandi* *Haplophragmoides wilberti* *Trochammina macrescens* *Miliammina fusca* *Pseudothurammina limnetis* *Tolypammina vagans* *Trochamminita salsa*
- 25 cm	*Trochammina inflata* *Glomospira irregularis* *Trochammina macrescens* *Trochamminita salsa* *Tolypammina vagans* *Miliammina fusca* *Polysaccammina ipohalina* *Textularia earlandi* *Haplophragmoides wilberti*		
- 30 cm		*Trochammina inflata* *Haplophragmoides wilberti* *Trochammina macrescens* *Miliammina fusca*	
- 48 cm			
- 57 cm			

TABLE 6. PEAT SAMPLES SELECTED FOR RADIOCARBON DATING AND THEIR MICROFOSSIL CONTENT

#'s in text	Lab number	Material dated and main microfossils	Sample depth below HHW (cm)	C^{14} Age (y BP) (C13 corrected)	Sidereal Age (y BP)
1	GX-21546-AMS	Mill's Creek DC5/ organic mud/zone 1-*Trochammina inflata*-Thecamoebians-*Trochammina macrescens*	445 ± 4	3,880 ± 60	4422 ± 60
2	GX-21542-AMS	Mill's Share core 6/ mangrove peat/ zone 2-*Haplophragmoides*	271 ± 25	2,940 ± 60	3220 ± 60
3	GX-21545-AMS	Mill's Share DC6/ mangrove peat/ zone 2-*Haplophragmoides*	290 ± 25	2,930 ± 60	3210 ± 60
4	GX-21547-AMS	Hungry Bay DC5/ mangrove peat/ zone 2-*Trochammina inflata-Trochammina macrescens-Haplophragmoides*	165 ± 25	2,010 ± 50	2042 ± 50
5	GX-21543-AMS	Mill's Share core 5/ mangrove peat/ zone 2-*Glomospira-Trochammina inflata*	232 ± 25	1,070 ± 60	1051 ± 60
6	GX-21544-AMS	Mill's Creek core 2/ mangrove peat/ zone 2-*Trochammina inflata-Glomospira*	137 ± 25	510 ± 55	554 ± 55

Figure 34. Elevation and distribution of total number of individuals/10cc, total number of species, and main foraminifera species along Hungry Bay transect 95.


TRANSECT IN HUNGRY BAY (Total)
ELEVATION/HHW IN cm
(cm)
Distance along transect (m)
NUMBER OF SPECIES
NUMBER OF INDIVIDUALS/10cc
Triloculina oblonga
Rosalina globularis
Helenina anderseni
Discorinopsis aguayoi
Trochammina macrescens
Polysaccammina ipohalina
(%)

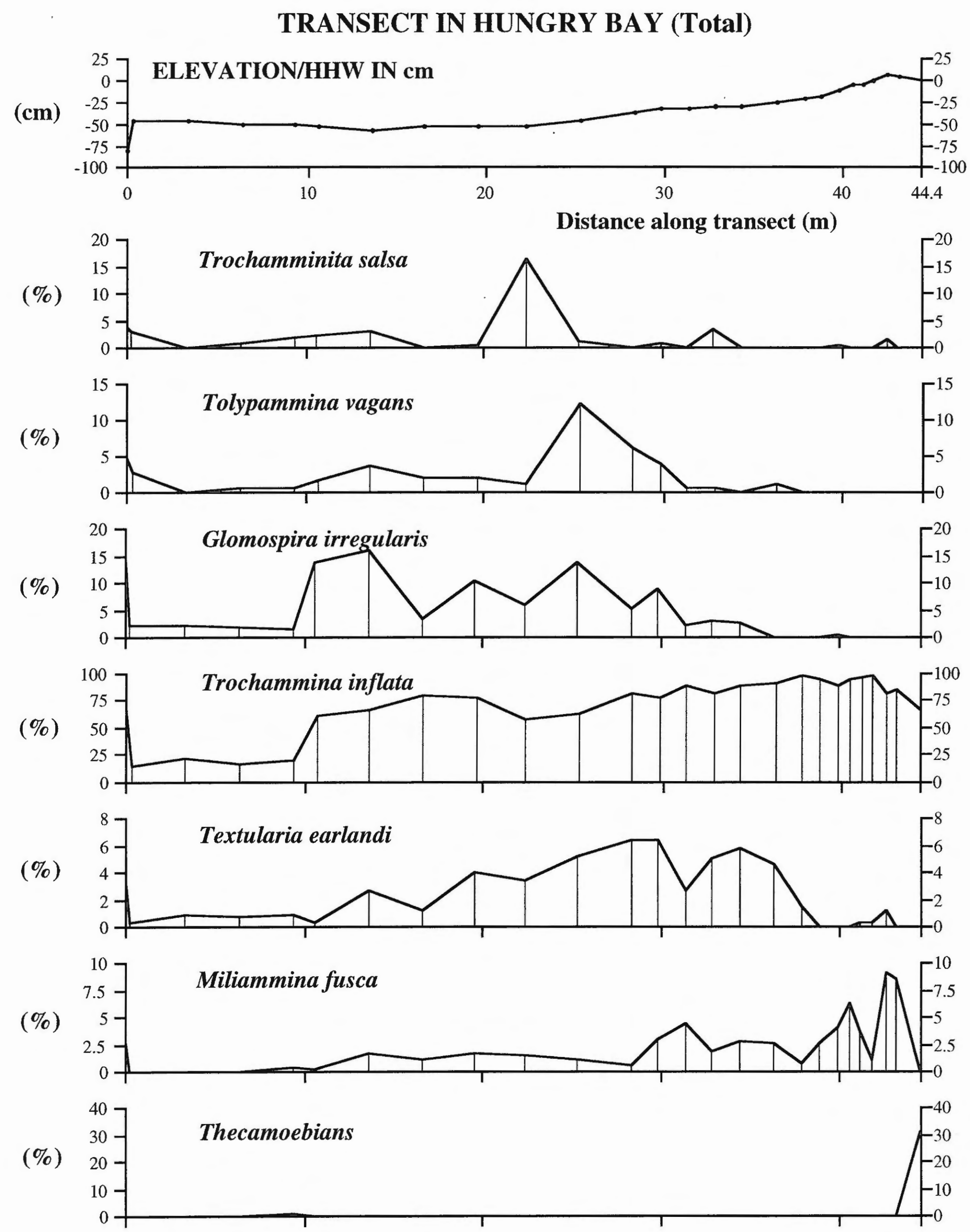
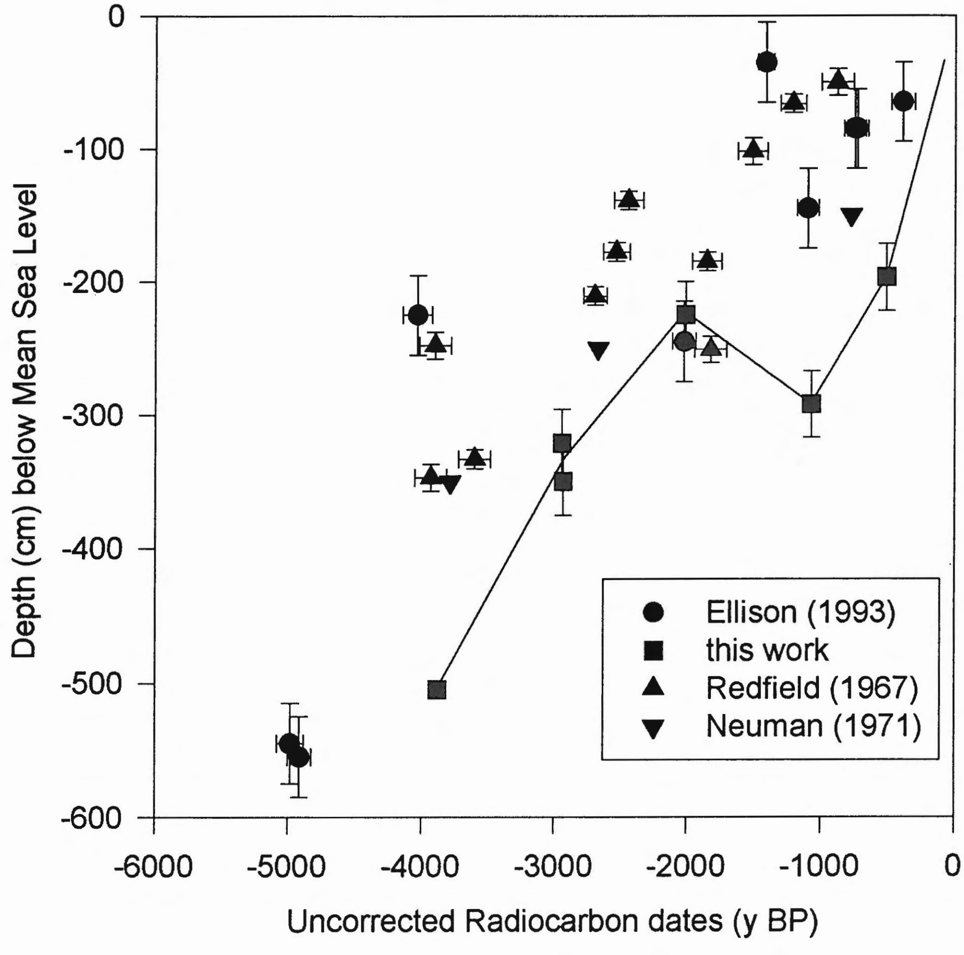

TRANSECT IN HUNGRY BAY (Total)
ELEVATION/HHW IN cm
(cm)
Distance along transect (m)
Trochamminita salsa
Tolypammina vagans
Glomospira irregularis
Trochammina inflata
Textularia earlandi
Miliammina fusca
Thecamoebians
(%)

Figure 35. Late Holocene sea-level curve for Bermuda.

For comparison with previously published Bermuda curves where depths are depths above Mean Sea Level (see discussion), depths below Higher High Water (this study, table 5) were transformed into depths above Mean Sea Level by substracting 60 cm (half the tidal range).


0
-100
-200
-300
-400
-500
-600
Depth (cm) below Mean Sea Level
-6000
-5000
-4000
-3000
-2000
-1000
0
Uncorrected Radiocarbon dates (y BP)
Ellison (1993)
this work
Redfield (1967)
Neuman (1971)

CHAPTER IV: DISCUSSION

4.1. DESIGNATION OF FORAMINIFERAL ASSEMBLAGES IN BERMUDA

The main species of foraminiferal assemblages in each environment (marine caves, lagoons, reefs, mangrove swamps, landlocked ponds) are listed in Table 7.

4.1.1. MARINE CAVES

A total of 231 species were identified, but only 58 species occur in all three caves. Total species diversity and abundance were high in Walsingham and Leamington Caves (60 to 122 species and 9,182 to 93,960 ind./10cc), but generally low in Crystal Cave (9 to 31 species and 126 to 14,184 ind./10cc). Live diversity and abundance were low to moderate in Walsingham and Leamington Caves (2 to 39 species and 120 to 5,508 ind./10cc), and low in Crystal Cave (0 to 5 species and 0 to 504 ind./10cc). The living and total foraminiferal assemblages show similarities in some species occurrence, genera, test shape and chamber arrangement, but also differences reflecting their connections to surrounding environments.

The caves host a particular assemblage of thin, fragile foraminifera where the suborder Spirillinina *(Cyclogyra, Patellina, Spirillina, Mychostomina)* is well represented

(Table 7). Larger and more robust Rotaliids, Miliolids, and Textulariids also occur, and originate from surrounding mangrove, lagoon/reef, and deeper water environments, depending on the connections of the caves to these environments (Tables 7 and 8).

Only *B. variabilis* and *Spirophtalmidium sp.* have a mean percentage above 2 % in the three caves. *Spirophtalmidium sp.*, the most abundant species, is rare or absent in other Bermuda environments.

A variable percentage (0 to 13 mean %) of the total assemblage consists of reworked lagoon/reef foraminifera eroded from surrounding Pleistocene limestone.

The presence of mangrove species in Walsingham and Leamington caves denotes their connection with a mangrove environment (cf. chapter 4.1.4.).

The abundance of the two species of thecamoebians *Arcella polypora* and *Centropyxis aculeata* (>4 % of total assemblage in at least one sample) in Crystal cave indicates more overall brackish conditions (caused by freshwater runoff). Thecamoebians occurred also in Leamington cave but with frequencies less than 1%.

Other foraminiferal species present in the caves live also in the nearby lagoon of Harrington Sound, and reefs and seagrass beds of Castle Harbour.

However, some species such as *Cassidulina subglobosa, Epistominella pulchra, Gyroidina sp., Planulina carribea,* and *Technitella legumen*, and planktonic species are known mostly in deeper water environments (Bock, 1971; Murray, 1991).

Walsingham Cave and Leamington Cave are more similar in foraminifera diversity and abundance, and in the presence of mangrove species. The lower diversity of foraminifera in Crystal Cave could be due to more brackish conditions.

Many attached benthic foraminifera were expected, as on hardground habitats, in Bermuda caves, since there is not much sediment and no plants to live on. In deeper reaches of reef caves, only attached foraminifera are present (Logan et al., 1984). However, only a few attached genera, *Spirillina*, *Patellina*, *Rosalina*, and *Cyclogyra,* were present in Bermuda caves. The other foraminifera present are free-dwelling shallow-water and deeper water species, and they are not restricted to the cave habitat. They are troglophilic species, which means that they live outside the caves but tolerate the cave environment as well (Kobluk, 1988).

Many foraminiferal tests are small and delicate, probably due to lower salinity, reduced illumination, or low nutrient supply. In their review of morphological variations of benthic foraminifera in response to changes in ecological parameters, Boltovskoy et al. (1991) reported that many species become smaller, thin walled, and their ornamentation can decrease in lowered salinities, insufficient light (especially for some symbiotic species), and reduced nutrition.

In reef caves, the light gradient is the main control on the composition of attached biotic communities (Logan et al., 1984; Kobluk, 1988). This factor is important also for most animal and plant organisms in karstic caves, but does not seem to determine the cave foraminiferal distribution. In each cave, a few species showed increased or decreased frequencies with depth, but there were no variations common to the three caves. However the range of depth or the light gradient represented in this study may not have been large enough to show differences in foraminiferal assemblages. The relatively low living population might result from the absence of marine plants caused by poor dim light, since many subtropical benthic foraminifera are epiphytic (Brasier, 1975a; Martin and Wright, 1988). The low light also affects any phototropic food supply. Symbiont-bearing foraminifera are absent in the caves.

One species, *Spirophtalmidium sp.*, appears to be a troglobytic species i.e. it lives only in the caves. I found only rare, dead specimens in lagoonal environments whereas it is the most.abundant species in the caves. This species was reported as rare in only three areas, to my knowledge, in the Mediterranean (Cimmermann and Langer, 1991), in New Guinea (Haig, 1988) and possibly in deep Pacific Ocean, off Fiji, as "*Spiroloculina sp.* abnorm."(Brady, 1884; Barker, 1960, pl. 10, fig. 14).

Thus, the cave foraminifera constitute a particular assemblage characterized by the presence of specific genera, test shape and chamber arrangement, and higher diversity of species of the suborder Spirillinina. Differences in assemblages between the caves reflect connections to surrounding environments. Total cave assemblages are mixed foraminiferal assemblages of species from several sources: a dead assemblage of reworked lagoon/reef foraminifera, lagoon, mangrove, and planktonic species brought by the tides through tunnels or fissures into the caves; a living and dead assemblage of lagoon, mangrove, and deeper water species adapted also to the cave environment (troglophilic species); thecamoebians; and a troglobytic foraminiferal species. To my knowledge, this is the first quantitative study of foraminifera in cave environment.

Cave foraminiferal assemblages are useful in recognizing cave environments in paleoecological studies. Their presence permits an assesment of the salinity of ancient subterranean waters, and of the type of nearby environments connected to the cave. Contrary to Bermuda cave animals and plants, foraminifera show no endemism.

4.1.2. LAGOONS

The lagoon sites include a range of lagoon types : a protected lagoon (Harrington Sound), a semi-protected lagoon (traverse in North Lagoon behind the reef rim, Devonshire Dock, and NW shore along Ireland Island), and an open lagoon (offshore of the rim reef in North Lagoon); as well as reef samples (in North Lagoon traverse). A total of 194 species were identified, but only 103 species occur in all lagoons. Live abundance is low to high (11 to 5,186 ind./10cc), and total abundance is high (1,321 to 197,424 ind./10cc) except in the reef samples where it is low (309 to 328 ind./10cc). Live diversity is low to moderate (1 to 29 species) and total diversity is moderate to high (15 to 88 species).

A general foraminiferal assemblage can be recognized as a lagoon assemblage, and is reported in Tables 7 and 8.

The reef samples show a few differences in foraminiferal distribution. The lagoon species occurred also in the reef samples except *Quinqueloculina lamarckiana, Quinqueloculina oblonga*, and *Quinqueloculina seminulum*. However two species appeared limited to these reefs: *Homotrema rubrum* and *Planulina exorna*. *Homotrema rubrum* occurred also in the offshore lagoon samples but was transported there and not landward into the semi-protected lagoon behind the reef rim, as was observed also by MacKenzie et al. (1965). These observations will be discussed further in the reef discussion (4.1.3.). On Bermuda south shore, the reefs are much less developed and very close to the shore, offering little protection from the rough and quickly deepening ocean. Therefore, beaches pink from *Homotrema* fragments, such as Horseshoe Beach, do occur.

Differences in foraminiferal distribution exist between the different lagoon types (offshore, semi-protected and protected lagoons), that permit a distinction of these subenvironments on the basis of the total foraminiferal assemblages within the sediments.

Within the protected lagoon Harrington Sound, some foraminifera species showed a distribution that corresponded roughly to Neuman (1965)'s ecological zones (see 3.1.2.1.B). In the Shallow Sandy zone (< 9-10 meters depth), Peneroplids (*Archaias angulatus* and *Peneroplis carinatus/proteus*) and *Quinqueloculina bicarinata* were most abundant, and decreased with depth to disappear in the *Oculina* Zone (10-17 meters depth) (*Archaias angulatus* at 9 m and *Quinqueloculina bicarinata* at 12 m) or in the Subthermocline Zone (>17 meters depth) (*Peneroplis carinatus/proteus*). *Quinqueloculina laevigata, Quinqueloculina seminulum*, and *Textularia agglutinans* had variable frequencies but disappeared in the *Oculina* Zone (*Textularia agglutinans* at 9 m, and *Quinqueloculina laevigata* at 12 m) or in the Subthermocline Zone (*Quinqueloculina seminulum*). All these species seemed to prefer shallow well-oxygenated water and sand-sized sediment.

The following species (live and total specimens) increased with depth in the *Oculina* Zone and Subthermocline Zone: *Ammonia beccarii tepida, Bolivina lanceolata, Buliminella elegantissima, Cassidulina subglobosa, Fursenkoina complanata, Nonion depressulum*, and *Textularia earlandi*. These species seemed adapted to the seasonal anoxic conditions occurring in the summer when a salinity and temperature stratification is set. Their distribution corresponded also to areas with finer sediment (silt, clay).

4.1.3. REEFS

The reef sites included two reef types: outer reefs at 9 meters depth (Hog Breaker Reefs and Twin Reefs) located at the northwestern side of the reef rim and at 4.6 meters depth (Mills Breaker Ledge) in the northeastern side of North Lagoon, and lagoonal reefs at 4.5 meters depth (Crescent Reefs) in the northwestern side of North Lagoon and at 3.7

meters depth in northeastern side of North Lagoon (in Three Hill Shoals, North Lagoon traverse). A total of 135 species were identified, but only 36 species occur in all reefs. One foraminiferal assemblage can be defined to recognize reef sediments. Differences in foraminifera distribution, abundance, and diversity also exist between the two reef types, and are due to differences in grain size, water energy, and water depth. Sediments are generally coarser in the outer reefs (medium to very coarse sand) than in the lagoonal reef (medium to coarse sand). The lagoonal reefs are in quieter and shallower water, in the lagoon protected by the reef rim.

Live and total abundances are low to moderate in the outer reefs (11 to 516 live ind./10cc and 328 to 1,656 total ind./10cc) and in the northeastern lagoonal reefs (70 live ind./10cc and 309 total ind./10cc), and high in the northwestern lagoonal reefs (1,956 to 5,184 live ind./10cc and 8,532 to 18,468 total ind./10cc). Live and total diversities are low to moderate in the outer reefs (8 to 30 live species and 15 to 48 total species) and moderate to high in the lagoonal reefs (21 to 34 live species and 49 to 93 total species).

The reef foraminiferal assemblage is reported in Tables 7 and 8.

The common occurrence of *Trochammina ochracea*, a delicate agglutinated foraminifera usually found in marshes and upper estuarine areas in temperate and subpolar regions with high organic content (Scott and Medioli,1980a; Scott et al.,1990; Shennan et al., 1999), was not expected in a fully carbonate environment, but this species seems to have adapted to this high energy habitat by its attachment to other reef components (including other foraminifera) and is very successful living there (one of the most abundant species).

The northwestern outer reefs also included large biconvex Rotaliids *Amphistegina lessonii* and *Asterigerina carinata*, one attached species *Placopsilina bradyi.*, and a few planktonic foraminifera. *Spirillina cariacoensis* and *Weisnerella auriculata* were more common in the outer reefs sediment, and *Homotrema rubrum* was much more abundant (46 to 71.3% in northwestern outer reef sediment versus 2-4% in northwestern lagoonal reef sediment). *Homotrema rubrum* was also abundant in northeastern outer reef sediment (61.6 to 86.8%), in the northeastern lagoonal reef sample (54.4%), and in the offshore lagoon samples (26 to 55%). MacKenzie et al. (1965) observed that this species was transported mostly offshore and not landward into the semi-protected lagoon behind the reef rim. This observation is confirmed by the present results only for the western part of North Lagoon. The additional species present in the northwestern outer reef were rare or absent in the northeastern outer reef samples except *Weisnerella auriculata*. This difference in foraminifera distribution could be due to water depth, the northwestern outer reefs being deeper (9 meters) than their northeastern counterparts (4.6 meters), or insufficient sampling (only 2 samples were collected for the latter).

The northwestern lagoonal reef sediment included more lagoonal species of Rotaliids and Miliolids. The Rotaliids were *Ammonia beccarii tepida, Cibicides lobatulus, Cibicides refulgens, Elphidium advenum, Nonion gradeloupi*. Among the

Miliolids, *Miliolinella labiosa* was common and species of *Quinqueloculina* were more diverse and abundant. The discoidal species *Cyclogyra planorbis* and the attached species *Acervulina inhaerens* were also common. The northeastern lagoonal reef sample included less lagoonal species, and also differed by its low live and total abundances, as compared to the northwestern lagoonal reef samples, probably an effect of insufficient sampling (only 1 sample) but also of grain size. The northeastern lagoonal reef sample was very coarse sand-sized while the northwestern lagoonal reef samples were fine to coarse sand-sized. This northeastern lagoonal reef sample is unusual in foraminifera abundances, distribution, and grain size, and has more outer reef characteristics than expected.

Because of the discrepancies observed above, probably due to insufficient sampling of the northeastern reefs, the differences in foraminifera distribution between outer and lagoonal reefs will be based on the northwestern reefs results (with caution). The general reef assemblage can still be recognized and help to discriminate between reef and non-reef samples.

4.1.4. MANGROVE SWAMPS

The mangrove swamp sites included two types of mangrove subenvironments, the mangrove swamps (Hungry Bay and Mill Share) and the fringing mangroves around bays (Hungry Bay bay side, Mangrove Bay, Coot Pond, and Walsingham Bay). Mill Share also included a marsh landward of the mangrove swamp. Mangrove swamp samples contained mostly peat whereas fringing mangrove samples included little peat and more sand, depending on the sample's elevation relative to sea level. A total of 215 species were identified, but only 16 species occur in all mangroves sites. Live and total abundances were generally high (up to 14,325 live ind./10cc and to 109,184 ind./10cc total ind./10cc) except at high elevation relative to sea level. Live diversity was low to moderate (1 to 46 species) and total diversity was low to high (3 to 89 species). Diversity was higher in fringing mangroves (15 to 105 total species) than in swamps (3 to 40 total species), due to invading bay species.

The mangrove assemblage is reported in Tables 7 and 8. *Planispiroides bucculentus* can be common in mangroves and is rare in other environments (lagoons, reefs, caves). The species *Parrina bradyi* was absent to common in mangroves, but always absent in reef, lagoon, and cave environments. The general mangrove assemblage was often associated with lagoonal species.

Differences in foraminifera distribution existed between mangrove swamps and fringing mangroves. In general, mangrove swamps included less lagoonal species than fringing mangroves except in the lowest elevations close to MSL. Among the agglutinated species, *Tolypammina vagans* and *Trochamminita salsa* occurred only in swamps, and *Miliammina fusca, Trochammina macrescens*, and *Haplophragmoides* *wilberti* were more abundant in swamps (total frequencies > 4% in at least one sample) than in fringing mangroves where they were rare or absent.

Although elevations relative to sea level were not measured for the fringing mangrove sites but only for the swamps sites, a pattern of general foraminifera distribution with depth (or elevation) appeared. Generally, above the limit between the terrestrial vegetation and the mangroves, foraminifera disappeared and thecamoebians appeared. The high part of mangrove environment included agglutinated species *Trochammina inflata,* and sometimes *Miliammina fusca* and *Haplophragmoides wilberti*. The low mangrove included agglutinated species *Glomospira irregularis, Trochammina inflata, Trchammina macrescens, Pseudothurammina ipohalina, Textularia earlandi,* and sometimes *Trochamminita salsa, Tolypammina vagans,* and the calcareous species *Discorinopsis aguayoi, Helenina anderseni,* and *Trioloculina oblonga*. At and below the limit between the mangrove and the bay, calcareous species *Ammonia beccarii tepida, Bolivina tortuosa, Bolivina lanceolata, Quinqueloculina laevigata, Quinqueloculina seminulum, Rosalina globularis* (including *"Rosalina floridana"*), *Rosalina subarauncana, Trifarina occidentalis,* sometimes *Archaias angulatus,* and other lagoonal species of the genera *Elphidium, Quinqueloculina, Triloculina, Bolivina,* and *Nonion* occurred.

4.1.5. LANDLOCKED SALINE PONDS

The three sites studied differed in their physical conditions, ranging from Spittal Pond (mud and peat as sediment types, large, non tidal, restricted from the sea with only occasional storm flooding, and showing extreme seasonal variability in temperature, salinity, turbidity, oxygen content) to Walsingham Pond (peat as sediment type, large, tidal with a few connections to the sea through caves and fissures, daily variability in physical parameters), to Grotto Pond (peat and sand as sediment types, small, tidal with connections to the sea, probably normal marine physical conditions) (see table 3). The three ponds were enclosed totally (Walsingham Pond) or partially (Spittal Pond) by mangrove trees, or in close proximity to mangrove trees (Grotto Pond). Samples were collected in a range of depths in Spittal Pond and Grotto Pond, but only in the shore of the Walsingham Pond (no boat available).

A total of 145 species were identified, but only 16 species occurred in all ponds. Live and total abundances were high in Grotto Pond (1,800 to 7,488 live ind./10cc and 21,996 to 57,312 total ind./10cc), and low to high in the other ponds (0 to 1,296 live ind./10cc and 648 to 12,492 total ind./10cc). Live and total diversities were high in Grotto Pond (14 to 26 live species and 43 to 90 total species), and low to moderate in the other ponds (0 to 14 live species and 3 to 64 total species). The higher abundances and diversities in Grotto Pond resulted from its larger connections to sea and more normal marine conditions.

The general assemblage (Tables 7 and 8) consisted of the agglutinated species *Polysaccammina ipohalina, Trochammina inflata, Miliammina fusca, Haplophragmoides wilberti,* and *Glomospira irregularis*; Rotaliids *Helenina anderseni, Discorinopsis aguayoi*, and *Ammonia beccari tepida*; and a Miliolid *Triloculina oblonga. Parrina bradyi* and *Planispiroides bucculentus* were rare to common in Grotto Pond and Spittal pond, and absent in Walsingham pond. This assemblage was similar to the mangrove assemblage, with mangrove species and one lagoonal species (*Ammonia beccarii tepida*) but less diverse. There were differences in foraminifera distribution between the three ponds. Walsingham Pond hosted similar diversity but higher abundance of agglutinated species (13 species with frequencies higher than 1% in at least one sample, over 15 total species), as compared to the other ponds (4 or 5 species with frequencies higher than 1% in at least one sample, over 13 or 14 total species). This difference was not due to seasonal variations (no difference observed between February and late May samples in Walsingham Pond). In Walsingham Pond, many specimens of *Trochammina inflata* developed a secondary agglutinated tube attached to the umbilical area (photoplate 8). The development of a tube has been shown for *Miliolinella subrotunda* before, and serves as support for this species to reach shallower, nutrient-richer waters (Altenbach et al., 1993). The tube of *Trochammina inflata* does not end by a cone attached to the substrate as in *Miliolinella subrotunda*, and therefore is probably not an anchor as for this species, but could be used for the pseudopodia to reach further for feeding in a dense microhabitat such as mangrove peat.

On the other hand, calcareous species were less diverse and abundant in Walsingham Pond (no *Quinqueloculina spp*., no *Rosalina spp*., only 4 species >1% in at least one sample), than in the other ponds (20 species >1% in at least one sample for Grotto Pond, and 28 for Spittal Pond). However only the shore was sampled and there could be more calcareous species in the pond centre.

The foraminifera distribution in Spittal pond (high diversity of calcareous species and low abundance of agglutinated species) seemed surprisingly "normal" at first sight, considering extreme variation in salinity and temperature, and was more similar to foraminifera distribution in Grotto pond (i.e. a pond with more normal marine conditions) than in Walsingham Pond. However, only the mangrove species and a few calcareous species were found alive (stained) in the pond, and the other calcareous species (including planktonic species) were probably transported during occasional marine flooding. Spittal Pond sediment also included many ostracod shells.

Grotto pond included more lagoonal species than the other ponds as a result of its larger connections to the sea and more normal marine conditions.

Table 7: Main species of foraminiferal assemblages in Bermuda marine caves, lagoons, reefs, mangrove swamps, and landlocked ponds.

Caves	All caves: *Ammodiscus tenuis, Bolivina lanceolata, Bolivina variabilis, Buliminella spp., Cibicides refulgens, Cyclogyra planorbis, Loxostomum spp., Mychostomina revertens, Quinqueloculina subrotunda, Reophax spp., Rosalina concinna, Rosalina globularis, Spirillina spp., Spiroloculina antillarum, Spirophtalmidium sp., Trifarina occidentalis, Triloculina oblonga, Tubinella spp.* Reworked lagoon/reef foraminifera: *Amphistegina lessonii, Archaias angulatus, Asterigerina carinata, Cibicides refulgens, Homotrema rubrum, Peneroplis spp.* Mangroves foraminifera: *Discorinopsis aguayoi, Helenina anderseni, Glomospira irregularis, Textularia earlandi,* and *Tiphotrocha comprimata* Freshwater: thecamoebians Lagoons and reefs foraminifera: *Bolivina spp., Elphidium poeyanum, Nonion depressulum, Patellina corrugata, Planispiroides bucculentus, Quinqueloculina spp., Rosalina globularis, Rosalina subarauncana, Siphonina pulchra, Spirillina vivipara, Spirillina denticulata,* and *Spiroloculina antillarum* Deeper water foraminifera: *Cassidulina subglobosa, Epistominella pulchra, Gyroidina lamarckina, Planulina carribea,* and *Technitella legumen*, and Planktonics
Lagoons	All lagoons: *Ammonia beccarii tepida, Archaias angulatus, Articulina spp., Bolivina lanceolata, Elphidium poeyanum, Elphidium sp., Peneroplis carinatus/proteus, Monalysidium politum, Nonion gradeloupi, Quinqueloculina agglutinans, Quinqueloculina bicarinata, Quinqueloculina candeiana, Quinqueloculina lamarckiana, Quinqueloculina laevigata, Quinqueloculina polygona, Quinqueloculina seminulum, Rosalina concinna, Rosalina subarauncea, Triloculina bassensis,* and *Trochammina ochracea.* Semi-protected and offshore lagoons: *Eponides repandus, Quinqueloculina bradyana, Reussella atlantica, Triloculina rotunda, Triloculina tricarinata.* Protected and semi-protected lagoons: *Ammonia beccarii tepida, Bolivina lanceolata, Elphidim sp., Nonion gradeloupi, Quinqueloculina subpoeyana, Rosalina subarauncea.* Protected lagoon: *Bolivina spp., Fursenkoina spp., Textularia spp., Reophax spp., Buliminella elegantissima*

Table 7 (cont'd): Main species of foraminiferal assemblages in Bermuda marine caves, lagoons, reefs, mangrove swamps, and landlocked ponds.

Reefs	*Archaias angulatus, Homotrema rubrum, Peneroplis bradyi, Planulina exorna, Quinqueloculina bicarinata, Quinqueloculina semilunum, Rosalina concinna Rosalina subarauncea, Trochammina ochracea,* Outer reefs: *Amphistegina lessonii, Asterigerina carinata, Placopsilina bradyi,* planktonics, *Spirillina cariacoensis, Weisnerella auriculata,* more *Homotrema rubrum* Lagoonal reefs: *Ammonia beccarii tepida, Cibicides lobatulus, Cibicides refulgens, Elphidium advenum, Nonion gradeloupi, Miliolinella labiosa, Quinqueloculina spp., Cyclogyra planorbis, Acervulina inhaerens*
Mangroves	All mangroves: *Bolivina lanceolata, Cyclogyra planorbis, Discorinopsis aguayoi, Glomospira irregularis, Helenina anderseni, Rosalina globularis, Textularia earlandi, Triloculina oblonga, Trochammina inflata,* Most mangroves: *Haplophragmoides wilberti, Miliammina fusca, Parrina bradyi, Planispiroides bucculentus,, Polysaccammina ipohalina, Pseudothurammina limnetis, Quinqueloculina laevigata, Tiphotrocha comprimata,* Lagoon foraminifera: *Ammonia beccarii tepida, Archaias angulatus, Bolivina spp., Elphidium spp., Nonion spp., Peneroplis carinatus/proteus, Patellina corrugata, Quinqueloculina spp., Triloculina spp.* Freshwater: thecamoebians
Ponds	*Ammonia beccari tepida, Discorinopsis aguayoi, Glomospira irregularis, Haplophragmoides wilberti, Helenina anderseni, Miliammina fusca, Parrina bradyi, Planispiroides bucculentus, Polysaccammina ipohalina, Triloculina oblonga, Trochammina inflata* More normal marine/less restricted: lagoon foraminifera Restricted: ostracods

4.2. COMPARISON OF ASSEMBLAGES BETWEEN BERMUDA ENVIRONMENTS

4.2.1. SPECIES DISTRIBUTION

Figure 36 reports the environments sampled and their physical conditions. The foraminifera assemblages of each environment are summarized in figure 37. These (total) foraminifera assemblages are sufficiently different to serve in paleoenvironmental reconstructions, and are based on species diversity, suborder percentages, characteristic species and associations, and sediment type. Table 8 summarizes the sediment types, physical and biological parameters, and the general foraminiferal assemblages for Bermuda caves, lagoons, reefs, mangroves, and landlocked ponds. Ubiquitous species are good stratigraphic indicators whereas species restricted to a particular environment are good environmental indicators. Several physical parameters (sediment types and pH, water energy, salinity, light penetration) are discussed below to explain foraminifera distribution in sediments, but other factors such as the presence of phytal substrates are important too, however many phytal foraminifera live also in the sediment or fall into the sediment after death. To discriminate ancient marine carbonate environments in the geological record, comparison with total assemblages found in the sediment is more useful. Study of living populations on plants is a very interesting ecological approach that was not the purpose of this more geological study.

Figure 36. Summary of environment types and physical characteristics.

c.s.: coarse sand, m.s.: medium sand, f.s.: fine sand, ‰: parts per thousand.

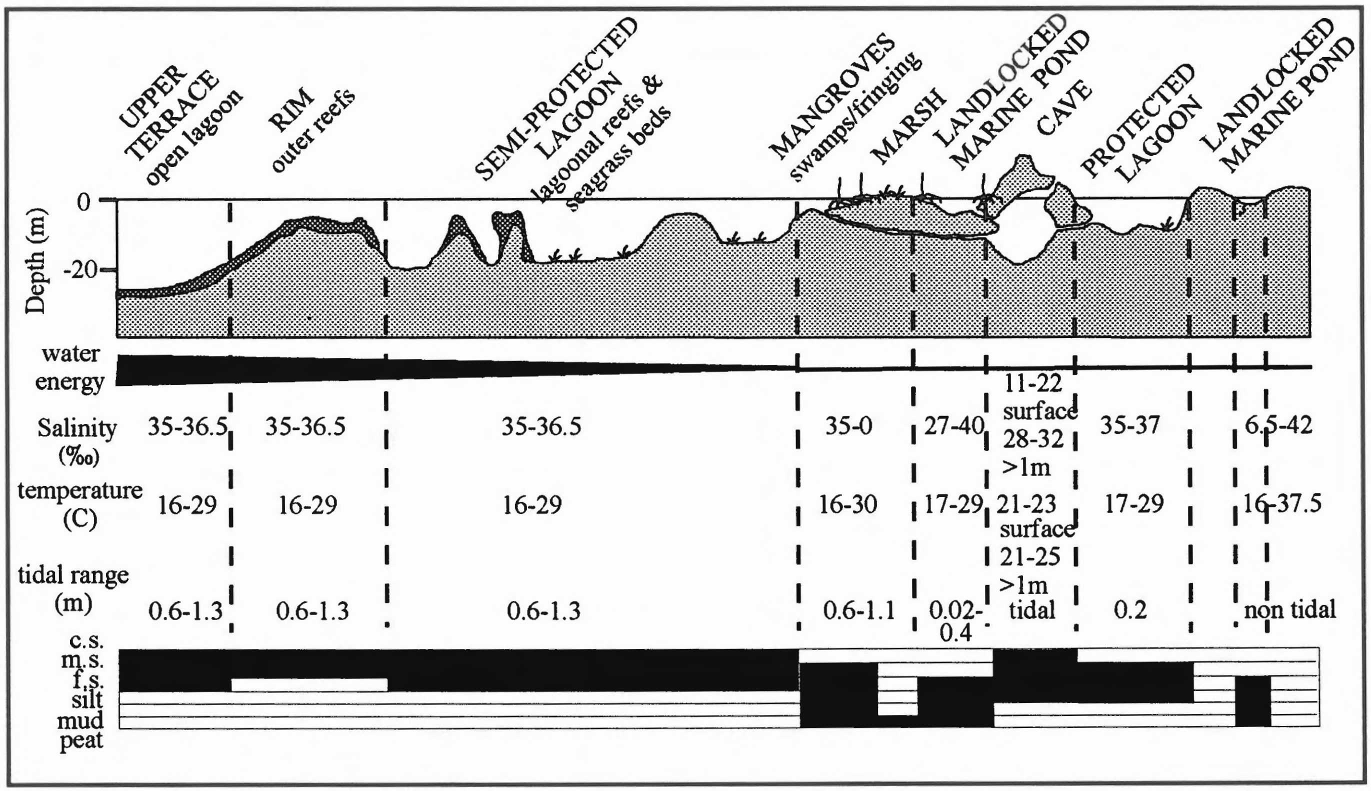
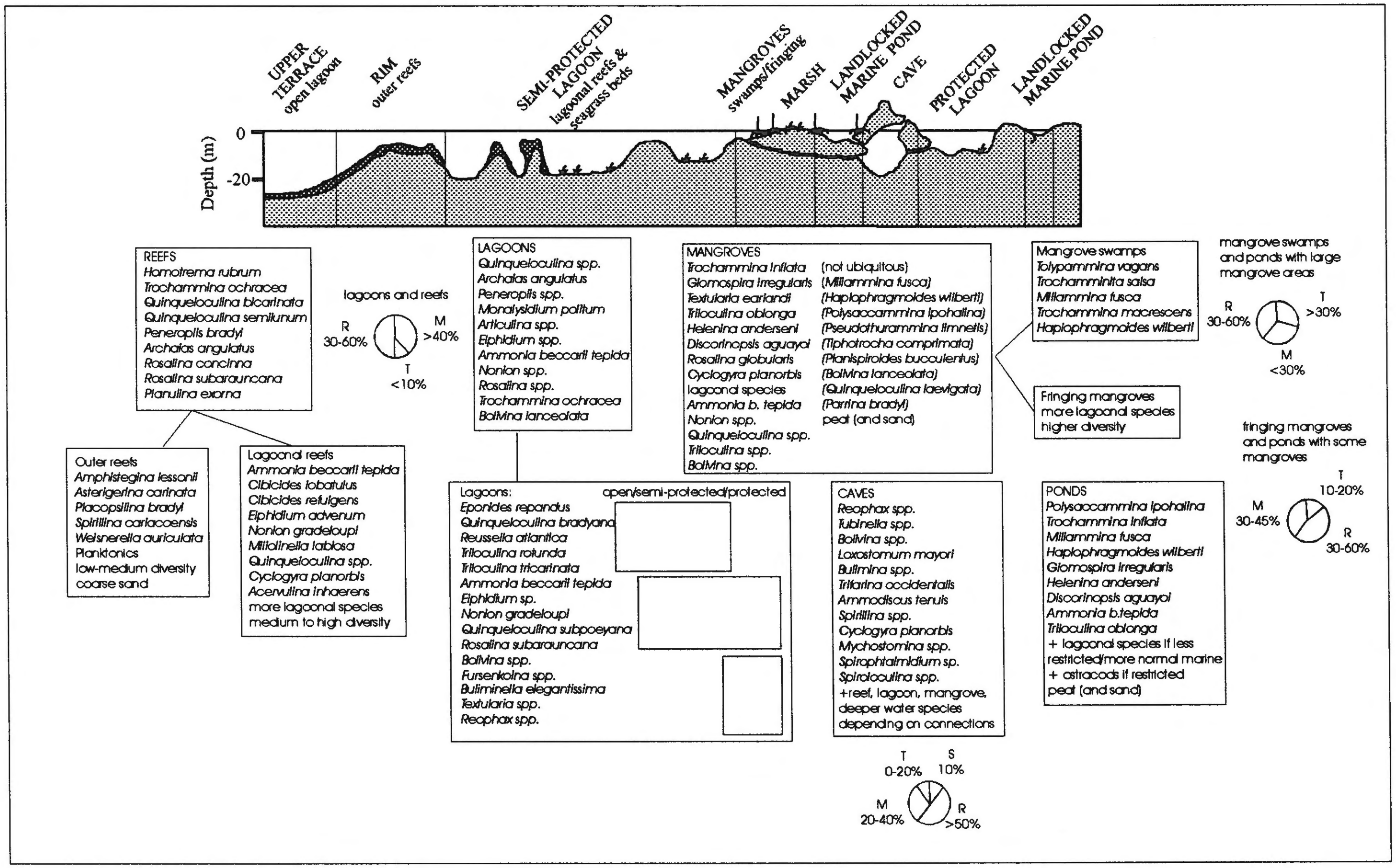

UPPER TERRACE
open lagoon
RIM
outer reefs
SEMI-PROTECTED LAGOON
lagoonal reefs &
seagrass beds
MANGROVES
swamps/fringing
MARSH
LANDLOCKED MARINE POND
CAVE
PROTECTED LAGOON
LANDLOCKED MARINE POND
Depth (m)
0
-20
water energy
Salinity (‰)
35-36.5
35-36.5
35-36.5
35-0
27-40
11-22 surface
28-32 >1m
35-37
6.5-42
temperature (C)
16-29
16-29
16-29
16-30
17-29
21-23 surface
21-25 >1m
17-29
16-37.5
tidal range (m)
0.6-1.3
0.6-1.3
0.6-1.3
0.6-1.1
0.02-0.4
tidal
0.2
non tidal
c.s.
m.s.
f.s.
silt
mud
peat

Figure 37. Distribution of foraminifera assemblages in Bermuda environments.

R: Rotaliina, M: Miolina, T: Textulariina, S: Spirillinina.



UPPER TERRACE open lagoon
RIM outer reefs
SEMI-PROTECTED LAGOON lagoonal reefs & seagrass beds
MANGROVES swamps/fringing
MARSH
LANDLOCKED MARINE POND
CAVE
PROTECTED LAGOON
LANDLOCKED MARINE POND
Depth (m)
0
-20
REEFS
Homotrema rubrum
Trochammina ochracea
Quinqueloculina bicarinata
Quinqueloculina semilunum
Peneroplis bradyi
Archaias angulatus
Rosalina concinna
Rosalina subarauncana
Planulina exorna
lagoons and reefs
R 30-60%
M >40%
T <10%
Outer reefs
Amphistegina lessonii
Asterigerina carinata
Placopsilina bradyi
Spirillina cariacoensis
Weisnerella auriculata
Planktonics
low-medium diversity
coarse sand
Lagoonal reefs
Ammonia beccarii tepida
Cibicides lobatulus
Cibicides refulgens
Elphidium advenum
Nonion gradeloupi
Miliolinella labiosa
Quinqueloculina spp.
Cyclogyra planorbis
Acervulina inhaerens
more lagoonal species
medium to high diversity
LAGOONS
Quinqueloculina spp.
Archaias angulatus
Peneroplis spp.
Monalysidium politum
Articulina spp.
Elphidium spp.
Ammonia beccarii tepida
Nonion spp.
Rosalina spp.
Trochammina ochracea
Bolivina lanceolata
Lagoons: open/semi-protected/protected
Eponides repandus
Quinqueloculina bradyana
Reussella atlantica
Triloculina rotunda
Triloculina tricarinata
Ammonia beccarii tepida
Elphidium sp.
Nonion gradeloupi
Quinqueloculina subpoeyana
Rosalina subarauncana
Bolivina spp.
Fursenkoina spp.
Buliminella elegantissima
Textularia spp.
Reophax spp.
MANGROVES
Trochammina inflata
Glomospira irregularis
Textularia earlandi
Triloculina oblonga
Helenina anderseni
Discorinopsis aguayoi
Rosalina globularis
Cyclogyra planorbis
lagoonal species
Ammonia b. tepida
Nonion spp.
Quinqueloculina spp.
Triloculina spp.
Bolivina spp.
(not ubiquitous)
(Miliammina fusca)
(Haplophragmoides wilberti)
(Polysaccammina ipohalina)
(Pseudothurammina limnetis)
(Tiphotrocha comprimata)
(Planispiroides bucculentus)
(Bolivina lanceolata)
(Quinqueloculina laevigata)
(Parrina bradyi)
peat (and sand)
Mangrove swamps
Tolypammina vagans
Trochamminita salsa
Miliammina fusca
Trochammina macrescens
Haplophragmoides wilberti
Fringing mangroves
more lagoonal species
higher diversity
mangrove swamps and ponds with large mangrove areas
R 30-60%
T >30%
M <30%
fringing mangroves and ponds with some mangroves
T 10-20%
M 30-45%
R 30-60%
CAVES
Reophax spp.
Tubinella spp.
Bolivina spp.
Laxostomum mayori
Bulimina spp.
Trifarina occidentalis
Ammodiscus tenuis
Spirillina spp.
Cyclogyra planorbis
Mychostomina spp.
Spirophthalmidium sp.
Spiroloculina spp.
+reef, lagoon, mangrove, deeper water species depending on connections
T 0-20%
S 10%
M 20-40%
R >50%
PONDS
Polysaccammina ipohalina
Trochammina inflata
Miliammina fusca
Haplophragmoides wilberti
Glomospira irregularis
Helenina anderseni
Discorinopsis aguayoi
Ammonia b.tepida
Triloculina oblonga
+ lagoonal species if less restricted/more normal marine
+ ostracods if restricted
peat (and sand)

Table 8: Summary of sediment types, physical and biological parameters, and general foraminiferal assemblages for Bermuda environments.

ENVIRONMENTS	**cave**	**lagoon**	**reef**	**marsh/mangrove**	**pond**
SEDIMENT	silt to medium sand	silt to coarse sand	medium to very coarse sand	peat	peat, muddy sand, fine to medium sand
PHYSICAL PARAMETERS					
salinity	brackish upper layer, gradient	normal marine or gradient	normal marine	brackish to hypersaline	normal marine or brackish to hypersaline
temperature (subtropical)	gradient	normal or gradient	normal	variable	normal or highly variable
oxygen content	normal	normal or seasonally anoxic	normal	highly variable	normal or highly variable
pH	basic	basic	basic	acidic	basic or acidic
tidal/non tidal	tidal	tidal	tidal	tidal	tidal or non-tidal
water energy	low	low to high	high	low	low
light exposure	reduced to none	normal	normal	reduced	normal or reduced
depth/elevation	0 to 10 meters	0 to 25 meters	4 to 9 meters	HHW to MSL	HHW to 1,5 meter
degree of protection	protected	open or semi-protected or protected	exposed or semi-protected	protected	connected to sea through fissures, caves, or not connected
BIOLOGICAL PARAMETERS		seagrass beds, algae	corals, algae	mangroves (fringing or swamps), succulent herbs, terrestrial herbs	mangroves, terrestrial herbs, ostracods in non-tidal pond

Table 8 (cont'd): Summary of sediment types, physical and biological parameters, and general foraminiferal assemblages for Bermuda environments.

Caves -thin, fragile foraminifera (tubular *Reophax* and *Tubinella*, biserial lanceolate *Bolivina* and *Loxostomum*, triserial flaring *Buliminella*, and *Trifarina*, discoidal planispiral *Ammodiscus, Spirillina, Cyclogyra,* and *Mychostomina*, and flattened Miliolids *Spirophtalmidium* and *Spiroloculina*) -suborder Spirillinina *(Cyclogyra, Patellina, Spirillina, Mychostomina*) well represented -larger and more robust Rotaliids, Miliolids, and Textulariids from surrounding mangrove, lagoon, reef, and deeper water environments
Lagoons -abundant Miliolids: many *Quinqueloculina* species, large Peneroplids (*Archaias*, *Peneroplis*), the tubular *Monalysidium politum*, and *Articulina spp.* -trochospiral and planispiral Rotaliids (*Elphidium, Ammonia, Nonion, Rosalina*) -one agglutinated attached species *Trochammina ochracea* -biserial lanceolate *Bolivina lanceolata*
Reefs -Four attached species *Homotrema rubrum Trochammina ochracea, Acervulina inhaerens,* and *Placopsilina bradyi* -Miliolids *Quinqueloculina bicarinata* and *Quinqueloculina semilunum,* large Peneroplids *Peneroplis bradyi* and *Archaias angulatus*, -small Rotaliids *Rosalina concinna*, *Rosalina subarauncea*, planispiral robust *Planulina exorna,* and large biconvex *Amphistegina lessonii* and *Asterigerina carinata*, and more robust Spirillinina *Spirillina cariacoensis* -lagoonal foraminifera (Rotaliids *Ammonia beccarii tepida, Cibicides lobatulus, Cibicides refulgens, Elphidium advenum, Elphidium sp., Nonion gradeloupi*; Miliolids *Quinqueloculina spp.*, *Miliolinella labiosa, Weisnerella auriculata*, discoidal *Cyclogyra planorbis* -a few planktonic foraminifera

Table 8 (cont'd): Summary of sediment types, physical and biological parameters, and general foraminiferal assemblages for Bermuda environments.

Marsh/Mangroves -agglutinated species *Trochammina inflata, Glomospira irregularis,* and sometimes *Miliammina fusca, Haplophragmoides wilberti, Polysaccammina. ipohalina, Pseudothurammina limnetis, Tiphotrocha comprimata* and *Textularia earlandi* -Miliolids *Triloculina oblonga,* and planispiral *Cyclogyra planorbis*, and sometimes *Planispiroides bucculentus, Quinqueloculina laevigata, and Parrina bradyi* -Rotaliids *Helenina anderseni, Discorinopsis aguayoi, Rosalina globularis* (*"Rosalina floridana"*) -Bolivinid lanceolate *Bolivina lanceolata* -often associated with lagoonal species of the genera *Elphidium, Quinqueloculina, Triloculina, Bolivina, Nonion*, and *Ammonia beccarii tepida,* and sometimes *Archaias angulatus, Peneroplis carinatus/proteus*, and *Patellina corrugata*
Landlocked saline ponds -less diverse marsh/mangrove assemblage (agglutinated species *Miliammina fusca, Haplophragmoides wilberti, Trochammina macrescens,* and sometimes *Trochammina inflata*, *Polysaccammina ipohalina,* and calcareous species *Ammonia beccarii tepida, Discorinopsis aguayoi, Elphidium sp., Triloculina oblonga*), -other lagoon calcareous species in variable diversity depending on the connections or the proximity of the inland waters from the sea -ostracods in non-tidal pond

Some subenvironments can even be recognized, such as outer/lagoonal reefs, open/semi-protected/protected lagoons, and mangrove swamps/fringing mangroves (fig. 37). However the distinction between mangroves and landlocked ponds will be difficult in the fossil record because their assemblages are similar although mangrove species are less diverse in the ponds. Both environments can host more or less abundant lagoonal species depending on their connections to surrounding lagoons or bays. As Phleger (1970) mentioned, in area of low runoff as in Bermuda, marine water invasion in nearby marsh areas is greater (than in area of high runoff) and consequently the proportion of lagoon species is higher. However, the presence of numerous ostracod shells associated with mangrove foraminifera in the sediment could help differentiate a non-tidal marine landlocked pond from mangrove environments and other ponds. Distribution of foraminifera in a marsh or mangrove is related to elevation relative to sea level (itself related to amounts of tidal flooding and exposure, and associated variable physical parameters such as temperature, oxygen content, salinity, pH) (Phleger, 1970; Scott and Medioli, 1978, 1980b, Boltovskoy, 1984). Spittal pond is non-tidal but shows extreme variations in physical parameters and similar substrate (organic mud, peat), and hosts a foraminifera assemblage similar to that of tidal mangrove areas. Thus mangrove foraminifera are adapted to an environment with daily or seasonally highly variable temperature, oxygen content, salinity, pH, and organic substrate (rich in nutrients), such as mangrove swamps, fringing mangroves, semi-restricted landlocked ponds or restricted marine ponds. They do not require tidal water fluctuations to thrive.

Ecophenotypes, or morphological variations of one species in various environments, were not detected. However they might have been overlooked, and such examination would require detailed morphological and biometrical study of Bermuda foraminifera (such as in Brasier, 1975c, who compared phytal and sediment-dwelling species in Barbuda). Some species showed highly variable morphology, especially in the most variable Bermuda environments. *Trochammina inflata* developed a secondary tube mostly in Walsingham pond, and showed a gradation into *Siphotrochammina lobata* in mangroves. *Rosalina floridana* showed a gradation into *Rosalina globularis* in mangroves. *Triloculina oblonga, Planispiroides bucculentus, Discorinopsis aguayoi* displayed a large variability in mangroves. These morphological variations could correspond to ecophenotypes living in various habitats within the mangrove environment. They will be described in the Systematic chapter.

4.2.2. DIVERSITY AND ABUNDANCE

About 250 species were identified in Bermuda recent sediment, including 4 species of Thecamoebians, 37 species of agglutinated foraminifera and 209 calcareous foraminifera (Chapter VI, Systematic). Only 49 species were ubiquitous i.e. found in every environment -mangrove, reef, lagoon, cave, pond- but not in every sample. In general, diversity was high except in outer reef and mangrove swamps. The highest diversity was encountered in two of the caves (Walsingham and Leamington caves) and the lowest in mangrove swamps and one mangrove pond (Walsingham Pond). In association with species distribution, the pattern of diversity can help differentiate between outer and lagoonal reefs (low versus high diversity) and between mangroves and other environments (lagoon, reef, cave). Abundance is highly variable and is not useful to differentiate assemblages.

4.2.3. PROPORTION OF SUBORDERS, OR SHELL COMPOSITION TYPES.

Appendix Tables 30 and 31 report the number and percentage of total species and species with frequencies higher than 1% in at least one sample of the suborders Spirillinina, Rotaliina, Miliolina, and Textulariina for each site. Figures 38 and 39 are triangular diagrams showing the proportions of the suborders Rotaliina, Miliolina, and Textulariina based on percentages of total number of species or of number of species >1% in at least one sample, for each site. These diagrams also illustrate roughly the proportion of calcareous hyaline (Rotaliina), calcareous porcellaneous (Miliolina), and agglutinated (Textulariina) foraminifera.

Figure 38. Suborder percentages for total species in each study site.

Cluster I: mangroves swamps and ponds with large mangrove areas, cluster II: caves, cluster III: fringing mangroves and ponds with few mangrove trees, cluster IV: reefs and lagoons.

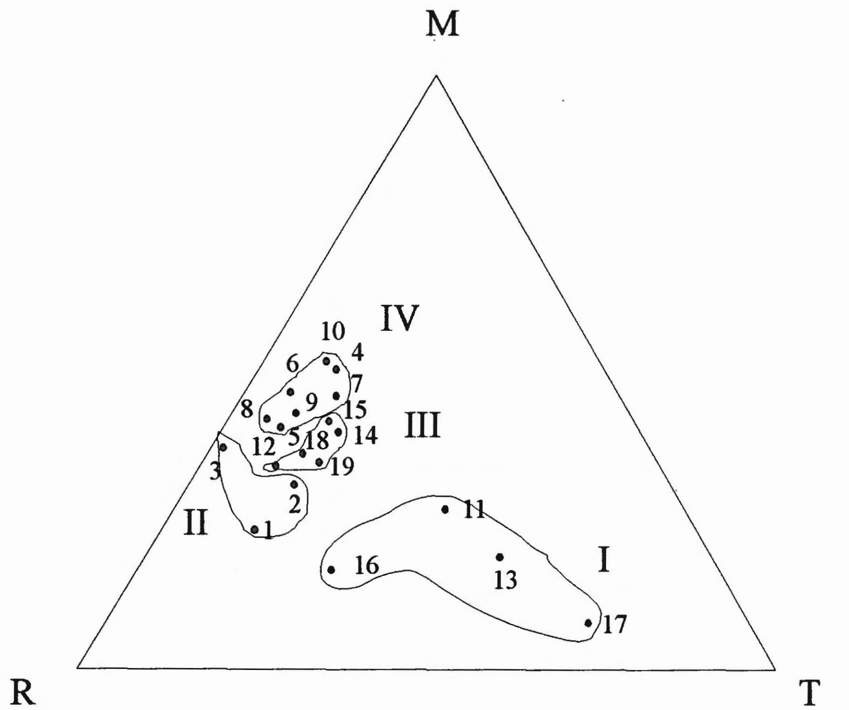


Figure 36: Suborder percentages for total species, in each study site.
M: Miliolina, T: Textulariina, R: Rotaliina
1: Walsingham cave, 2: Leamington cave, 3: Crystal cave, 4: Devonshire Dock, 5: North Lagoon, 6: Along Ireland Isl., 7: Harrington Sound, 8: Hog Breaker, 9: Twin reef, 10: Crescent reef, 11: Hungry Bay swamp, 12: Hungry bay bay, 13: Mill Share, 14: Mangrove Bay, 15: Coot Pond, 16: Walsingham Bay, 17: Walsingham Pond, 18: Spittal Pond, 19: Grotto Pond.

Figure 39. Suborder percentages for species with frequencies higher than 1%, in each study site.

Cluster I: mangroves swamps and ponds with large mangrove areas, cluster II: caves, cluster III: fringing mangroves and ponds with few mangrove trees, cluster IV: reefs and lagoons.

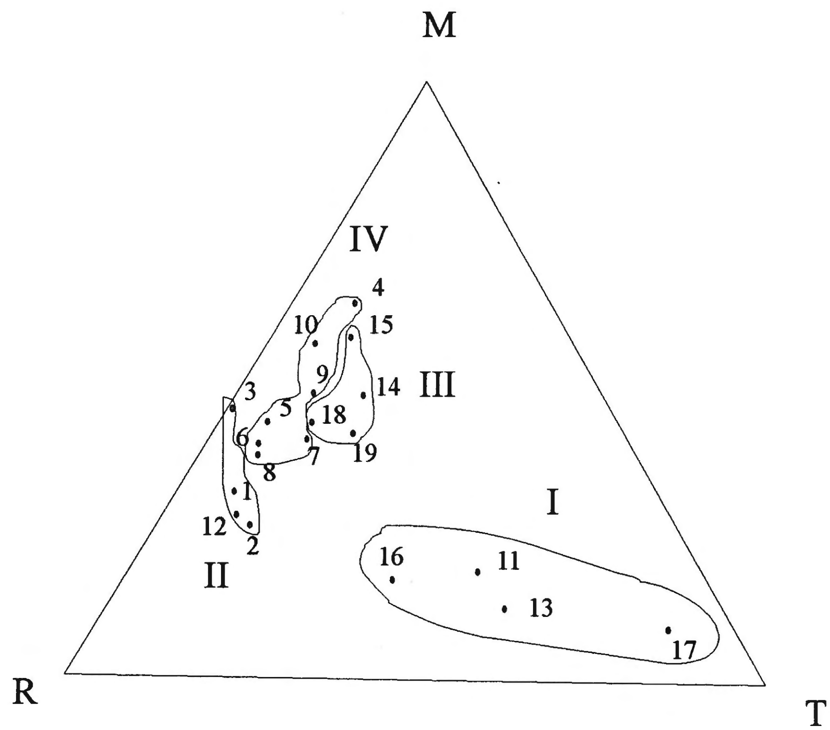


Figure 37: Suborder percentages for species with frequencies higher than 1 %, in each study site. M: Miliolina, T: Textulariina, R: Rotaliina
1: Walsingham cave, 2: Leamington cave, 3: Crystal cave, 4: Devonshire Dock, 5: North Lagoon, 6: Along Ireland Isl., 7: Harrington Sound, 8: Hog Breaker, 9: Twin reef, 10: Crescent reef, 11: Hungry Bay swamp, 12: Hungry Bay bay, 13: Mill Share, 14: Mangrove Bay, 15: Coot Pond, 16: Walsingham Bay, 17: Walsingham Pond, 18: Spittal Pond, 19: Grotto Pond.

The two diagrams show similar results. Grouping of sites into particular areas of the diagrams corresponds to differences in proportions of the various suborders or shell types, and this proportion can help to discriminate some environments.

Four clusters of sites appear on the diagrams.

The best isolated cluster is cluster 1 (Hungry Bay swamp, Mill Share, Walsingham Bay, and Walsingham pond) which corresponds to mangroves with more extensive swamp area, and differs from the other clusters by the larger proportion of agglutinated foraminifera (more than 30% Textulariina). The Miliolina occur in proportion equal or less than 30%, and the Rotaliina in proportion between 30 and 60%.

Clusters 2, 3 and 4 are more similar (closer on the diagrams).

Cluster 2 includes the caves and is characterized by a higher proportion of Rotaliina or calcareous hyaline species (more than 50%). The Miliolina occur in proportion between 20 and 40%, and the Textulariina between 0 and 20%. The caves also host a higher proportion of species of the suborder Spirillinina (9 to 10% versus 1 to 6% of total number of species for the other environments) (Appendix Table 36).

The major difference between figures 38 and 39 is the displacement of Hungry Bay bay side from cluster 3 for total species (fig. 38), to cluster 2 when species with frequencies higher than 1% are considered (fig. 39), due to the increasing proportion of Rotaliina and decreasing proportion of Miliolina.

Cluster 3 includes all other mangrove sites and ponds and contains a slightly higher proportion of Textulariina (agglutinated foraminifera) (between 10% and 20%) than cluster 4 which corresponds to lagoon and reef sites. Cluster 4 has a higher proportion of Miliolina or porcellaneous species (more than 40%) than other clusters. Both clusters have between 30 and 60% hyaline species (Rotaliina). However, if only percentages of more abundant species (>1%) is considered (fig. 38), clusters 3 and 4 have similar proportions of Miliolina and Rotaliina, and the main difference between them is the proportion of agglutinated species (lower for cluster 4). Within Cluster 4, lagoonal reef includes more Miliolina and less Rotaliina than outer reefs (more than 50% versus less than 50%, and less than 40% versus more than 40%, respectively).

4.2.4. SEDIMENT TYPE

The types of sediment (representing different water energy levels, but also different chemical and biological conditions) encountered in the various study sites can explain in part the clusters observed on the diagrams (figs. 38 and 39). Cluster 1 corresponds to areas with peat, cluster 2 to areas with fine to medium sand, cluster 3 to areas with peat and sand, and cluster 4 to areas with fine to very coarse sand. Textulariina or agglutinated foraminifera are more abundant in peaty substrate where pH is too low for calcareous tests (clusters 1 and 3, mangroves and ponds). The caves (cluster 2) have finer sand than lagoons and reefs (cluster 4) and host more species of the suborder Spirillinina, a suborder that includes generally more delicate, fragile species than the other suborders, and more Rotaliina or calcareous hyaline foraminifera. Within cluster 4, the protected lagoon Harrington Sound has finer sediment (fine sand, silt and clay) than other lagoons and host slightly more Textulariina.

4.2.5. SALINITY

Salinity can also partially explain the clustering of sites. Brackish environments are grouped into cluster 1 (areas with more mangrove swamps), slightly brackish to normal marine environments into cluster 2 (caves), brackish to hypersaline environments into cluster 3 (other mangrove areas connected to bays/lagoons), and normal marine environments into cluster 4 (lagoons and reefs). Agglutinated foraminifera are more abundant in brackish environments (clusters 1 and 3). Calcareous hyaline species prefer slightly brackish to normal marine sites (cluster 2), and calcareous porcellaneous species occur preferentially in normal marine to hypersaline environments (clusters 3 and 4). These observations fit well with other authors' studies (such as Brasier, 1975c).

4.2.6. WATER ENERGY

The highest wave energy occurs in reefs and open lagoon where large Peneroplids and robust Rotaliids are more abundant (see chapters 4.1.2 and 4.1.3.). Within the reefs, outer reef sediment includes more robust Rotaliids than lagoonal reef sediment. Sediment of high-energy areas include attached tests and more robust tests because these foraminifera are better adapted to this physical condition, and/or also because there is probably some size-sorting by waves and currents, robust tests being more resistant to abrasion.

The clusters 1 to 3 correspond to quieter areas than cluster 4. These areas host more agglutinated species (clusters 1 and 3) which have more fragile tests, or more fragile and delicate species of the suborder Spirillinina (cluster 2).

4.2.7. LIGHT PENETRATION

Light intensity is reduced in caves (cluster 2) and somewhat probably in mangroves areas where vegetation is dense. These areas lack the large symbiont-bearing species (Miliolids *Peneroplidae*) common in reefs and lagoons (cluster 4).

4.2.8. GENERAL TRENDS OF DISTRIBUTION AND MORPHOLOGY

The following general trends of foraminifera distribution and morphology can be observed across Bermuda environments:

Miliolids are more diverse in quiet normal marine shallow-water lagoons, and have smooth or slightly ornamented tests (such as *Quinqueloculina seminulum, Quinqueloculina bicarinata, Quinqueloculina poeyana, Triloculina linneiana*), but some smooth-tested species (such as *Triloculina oblonga, Quinqueloculina laevigata, Planispiroides bucculentus*) are most abundant in brackish to hypersaline environments (mangroves, ponds). In high-energy areas, Miliolids have thicker ornamented angulose tests (such as *Quinqueloculina lamarckiana, Quinqueloculina candeiana, Quinqueloculina bradyana, Quinqueloculina agglutinans, Triloculina bassensis, Triloculina bicarinata*). Peneroplids and Soritids occur in normal marine, quiet and turbulent areas (lagoons and reefs).

Textulariina (agglutinated) are more abundant in brackish, and/or low pH and less oxygenated areas (mangroves, ponds, and caves).

Spirillinina occur preferentially in caves.

Reophax spp. and *Buliminінacea* (*Bolivina, Buliminella, Trifarina*) are more abundant in quiet protected and even seasonally anoxic areas (caves, protected lagoons).

Rotaliids are more abundant in slightly brackish (caves) to normal marine (lagoons, reefs) environments, although a few are adapted to highly variable conditions (such as *Ammonia beccarii tepida, Rosalina globularis* (including *Rosalina floridana*), *Discorinopsis aguayoi, Helenina anderseni*). In high-energy areas, Rotaliids have robust and/or biconvex tests (*Amphistegina lessonii, Asterigerina carinata, Eponides repandus, Planulinaexorna*) or attach themselves to the substrate (*Rosalina spp., Homotrema rubrum*). Agglutinated attached species also occur in these turbulent areas (*Trochammina ochracea, Placopsilina bradyi*).

4.3. COMPARISON WITH OTHER TROPICAL/SUBTROPICAL AREAS

Despite its isolated position in the North Atlantic ocean and its most northern location for subtropical faunas, Bermuda sediments display a large diversity of benthic foraminifera, larger than previously reported diversities in other subtropical/tropical areas. A total of 283 foraminifera species were identified in Bermuda recent sediment, while Bock (1971) catalogued 235 species in South Florida area, Wantland (1975) identified approximately 200 species in the Belize shelf sediments, and Brasier (1975a) found 205 species in sediments around Barbuda.

Comparison of foraminifera distribution between Bermuda and other subtropical/tropical areas revealed similarities in assemblages but also differences.

Foraminifera have access to all areas compared here by the Gulf Stream, birds, fishes, boats, or floating debris (e.g. blades of marine grasses, Bock, 1969), so differences in foraminifera assemblages are probably the result of differences in physical parameters (such as temperature, salinity, water energy, oxygen content, light intensity, pH, nutrient level, tidal exposure, freshwater runoff, sediment type, carbonate/clastic setting, latitude, insularity), biotic interactions, and some unknown factors. Generally, assemblages in insular settings (Table 1) are less diversified than continental ones (except Bermuda), but they can include species absent on continental settings.

The principal factors affecting foraminifera distribution in the sediments are salinity, temperature, depth (Bock, 1971; Brasier, 1975a); fine organic particles in the sediment, vegetation, and predation (Brasier, 1975a); turbulence, grain size, substrate stability, light penetration, and food supply (Triffelman et al., 1991); amount of detritus (Steinker et al., 1977). For some authors (Illing, 1950, 1952; L. V. Illing, 1954), the principal factors are transportation and sorting by marine currents, so foraminifera distribution is controlled by their size. However for a majority, these are secondary controls. In Florida-Bahamas (Rose and Lidz, 1977) and in Bermuda (this study), the large-scale distribution of foraminifera is not affected by current action, as shown by the absence of test size gradient even though there is an energy gradient across the areas, and by the fact that species of high-energy area such as *Amphistegina lessonii* or *Asterigerina carinata* are not redistributed elsewhere. Havach and Collins (1997) found that foraminifera distribution in Caribbean Panama was uncorrelated with grain size, except for the reef habitat. Many species vary in abundance from station to station because of spatial and temporal changes in food supplies, differences in generation times, and predation (Martin and Wright, 1988).

Miliolids, Peneroplids, and Soritids are more eurytopic than the majority of Rotaliids except for a few species such as *Rosalina globularis* ("*Rosalina floridana*") or *Discorinopsis aguayoi*, so that their diversity increases in more variable environments (Waszczak and Steinker, 1987; Martin and Wright, 1988). Their diversity is high in seagrass beds of hypersaline lagoons (Brasier, 1975a, 1975b) and in many shallow-water carbonate banks of the Caribbean (Todd and Low, 1971, Wantland, 1975), in finer sands and sheltered areas (Triffelman et al., 1991). Brasier (1975b) concluded that Miliolids are characteristic of shallow-water tropical carbonates, with little regard to salinity or vegetation. Within shallow quiet areas, elongate fusiform Miliolidae live in deeper waters with better circulation, and rotund species in very shallow water with poor circulation, and in brackish waters (Rose and Lidz, 1977). In fine-grained sand of vegetated areas, *Miliolidae* dominate and have long, narrow chambers, thin tests, rounded aperture and a simple tooth on a long neck (Brasier, 1975c). In more exposed areas of non-vegetated sand, or less stable substrate, Rotaliids attach to substrate, or develop thick rugose biconvex tests, and miliolids are strongly ornamented and have a large aperture with a bifid tooth on a short neck, or have chamberlets that host symbionts (Brasier, 1975c).

Rotaliids are more stenotypic and diverse in open waters than in lagoons where there are more stable conditions (Brasier, 1975c; Wasczak and Steinker, 1987). They live preferentially in coarse sand, on hardgrounds (Wantland, 1975; Triffelman et al., 1991) and in high energy areas. Heavy-walled, and multichambered Rotaliidae live in exposed areas of platform and platform margin, and frosted or ornamented species in restricted and brackish areas (Rose and Lidz, 1977).

These general trends of foraminifera distribution are observed also in Bermuda (see 4.2.8.).

A few species, mainly mangrove species, are common in Bermuda, and absent or rare in other areas: *Planispiroides bucculentus* in Bermuda mangroves and lagoons only; *Spirophtalmidium sp.*, a cave indicator in Bermuda, reported in the Mediterranean (Cimmermann and Langer, 1991), in New Guinea (Haig, 1988), and possibly in deep Pacific Ocean, off Fiji (Barker, 1960); *Parrina bradyi* in Bermuda mangroves, Barbuda (Brazier, 1975a) nearshore/lagoon, and nearshore areas of Bahama Bank west of Andros Island (Todd and Low, 1971); *Glomospira irregularis* (not reported in other subtropical/tropical areas); and *Tolypammina vagans* (a mangrove species in Bermuda, a deep-sea species elsewhere).

In this comparison between foraminifera assemblages of Bermuda and other subtropical/tropical areas, possible double listing of some species due to taxonomic errors have been taken into account in the best of my knowledge. Some caution should be advised because some authors reported only the most abundant species and not all of them, however, those species are usually the ones considered in defining environmental indicator assemblages.

4.3.1. CAVES

To my knowledge, no previous studies of karstic cave foraminifera have been published before, so a comparison with other areas is not possible at this time. The most similar habitat to caves would be the water wells of Kara-Kum Desert, east of Caspian Sea (Resig, 1974) where small, weakly calcified transparent tests of living species of the probably incorrect genera *Spiroloculina, Pyrgo, Textularia, Lagena, Nodosaria, Globigerina, Discorbis,* and thecamoebians were found. Salinity was 0.5 to 1.1 ppm. No more detailed information about these papers is available because they were published in a journal difficult to find ("Tashkent University Center-Asiatic State Transactions"). Mikhalevich (1976) described doubtful new species of the genera *Haplophragmoides, Elphidium, Elphidiella, Discorbis, Bolivina,* and *Turrilina* from the Middle Asia wells of Kara-Kum and Ust-urt deserts.

4.3.2. NEARSHORE/LAGOONS

Comparison of nearshore/lagoon foraminifera assemblages between Bermuda (this study, chapter 4.1) and other subtropical/tropical areas as reported in the literature (Table 1) revealed similarities between all areas but also some striking differences.

Nearshore/lagoon species were grouped under this heading in most studies. Truly lagoonal species will be discussed below, and species more common in Bermuda shores (including brackish-water species, see Table 1) are discussed in this paragraph and also in more detail in the mangrove discussion (see chapter 4.3.5). *Parrina bradyi*, a mangrove species in Bermuda, is reported only in Barbuda and Bahama Bank. *Ammonia beccari tepida*, a low mangrove and lagoon species in Bermuda, occurs in Trinidad, Tobago, Belize shelf, Puerto Rico, Cuba, St. Lucia, and possibly Venezuela (under *Ammonia spp.*) and Panama (under *Ammonia beccarii*). *Triloculina oblonga*, a mangrove species in Bermuda, is present in Tobago, Barbuda, Florida-Bahamas only, and in St. Lucia reefs. *Rosalina globularis* ("*Rosalina floridana*"), also a mangrove species in Bermuda, occurs only in Florida, Puerto Rico, and St. Lucia reefs, and possibly in Belize shelf reefs (under *Rosalina spp.*) but it has been reported off Nova Scotia as well as in most saline marine marshes worldwide. *Discorinopsis aguayoi* and *Helenina anderseni,* both mangrove species in Bermuda, are reported in Belize and Florida-Bahamas. *Helenina anderseni* occurs also in temperate marshes (Scott and Medioli, 1980b). Agglutinated species are reported in Florida-Bahamas (*Trochammina inflata*), Tobago (*Miliammina fusca*), St. Lucia (*Textularia agglutinans* and *Textularia conica*),Venezuela (*Miliammina fusca, Trochammina spp., Haplophragmoides spp.*, and *Ammobaculites dilatatus,* the latter absent in Bermuda), Belize shelf (*Miliammina fusca, Haplophragmoides spp., Gaudryina exilis* or *Textularia earlandi,* and three other species absent in Bermuda; *Ammobaculites exilis, Ammotium salsum,* and *Arenoparella mexicana*). These species are reported in marshes worldwide outside of tropical areas (Scott and Medioli, 1980a).

The species *Buliminella elegantissima* occurs preferentially in low-energy areas such as the protected bay in St. Lucia, the protected lagoon Harrington Sound and marine caves in Bermuda, and lagoons in Trinidad, as well as in many lagoons on both coasts of north America (e.g. Scott et al., 1976; Collins, 1996).

Most lagoon sediment includes many species of *Quinqueloculina, Triloculina*, and *Elphidium* (except Barbuda for the latter). Surprisingly, Peneroplids (such as *Archaias angulatus, Broeckina orbitolitoides, Peneroplis spp.*, and *Sorites marginalis*) are common only in Bermuda, Florida-Bahamas, Belize shelf, Jamaica lagoons. They are absent from lagoons, reefs and deeper water (or rare and not reported) in Tobago, Trinidad, Venezuela, Puerto Rico. In Cuba, Barbuda, St. Lucia, and the Belize shelf, they occur only (or mostly) in reefs. In Panama, they are present in reefs and deeper open water.

Archaias angulatus is a moderately euryhaline species, tolerating salinities between 29 and 33 ppm but not highly brackish waters (Rose and Lidz, 1977; Hallock and Peebles, 1993), and temperature between 14 and 33 °C. This species lives in protected seagrass beds of shallow lagoons, open-shelf and shelf-margin, but is relatively intolerant to strong waves and currents, and intolerant to reduced oxygen content and to presence of hydrogen sulfide (Hallock and Peebles, 1993). In the northern Florida Keys, Martin (1986) observed that *Archaias angulatus* dominated living populations in quiet nearshore and restricted marine habitats, and was less common in high-energy environments because of its weak powers of attachment (by its reticulopodia), but, when considering dead assemblages, was ubiquitous in sediment of shallow-water carbonate environments because of its resistance to abrasion.

Peneroplis proteus and *Peneroplis bradyi* are stenohaline species living on limestone and algae in reefs and lagoons, and open shelf (5 to 30 meters depth). *Monalysidium politum, Trochammina ochracea,* and *Articulina spp.* are common only in Bermuda lagoons. *Articulina spp.* occur also in reefs of the Belize shelf, and lagoons of Florida-Bahamas (in the "Open Interior fauna" of Rose and Lidz, 1977).

Ammonia beccarii is a good shallow lagoon indicator in Caribbean Panama (Havach and Collins, 1997), and occurs in nearshore/lagoon of Trinidad (*Ammonia beccarii tepida*), Venezuela (*Ammonia spp.*), Puerto Rico (*Ammonia beccarii tepida*), Cuba (*Ammonia beccarii tepida*), St. Lucia (*Ammonia beccarii tepida*), and in brackish waters of Florida-Bahamas (*Ammonia beccarii parkinsonia* and *A. b. ornata*), Cuba (*Ammonia beccarii tepida*), and the Belize shelf. In Bermuda, *Ammonia beccarii tepida* lives in lagoons, mangroves and ponds. Therefore the form *tepida* of this species seems to be euryhaline.

4.3.3. REEFS

Most reefs host *Asterigerina carinata* and *Amphistegina lessonii*. Wantland (1975), Brasier (1975b), and Havach and Collins (1997) showed that *Amphistegina lessonii, Discorbis mira, Quinqueloculina collumnosa, Quinqueloculina lamarckiana,* and *Textularia conica* were associated with coarse sediments, as well as *Eponides antillarum, Pyrgo subsphaerica, Quinqueloculina tricarinata* and *Planulina exorna* (Havach and Collins, 1997). Peneroplids occur in Bermuda, Florida-Bahamas, Jamaica, Cuba, Barbuda, St. Lucia, and the Belize shelf reefs, are rare in Panama, and absent in other areas (Tobago, Trinidad, Venezuela, Puerto Rico). *Homotrema rubrum,* a very abundant species and reef indicator in Bermuda and Florida-Bahamas, occurs only in deeper water in Belize shelf, and is absent (or not reported and rare) in Tobago, Jamaica, Panama, Trinidad, Venezuela, Puerto Rico, St. Lucia, Cuba, and Barbuda. Another striking difference is the occurrence of a reef indicator species *Discorbis rosea* in all areas but Bermuda, Panama, Trinidad, and Venezuela. *Discorbis rosea* is probably a high-energy indicator rather than a reef indicator because it is very abundant in Serranilla Bank where reefs are absent (Triffelman et al., 1991). *Weisnerella auriculata* is present in Bermuda outer reefs and in Belize shelf reefs, not in other areas.

Trochammina ochracea seems to occur only in Bermuda reefs where it is among the most abundant species, with *Planulina exorna,* present in Caribbean Panama reefs only. Brasier (1975b) reported "*Trochammina squamata*" (synonym of *Trochammina ochracea*) in backreef environment of Barbuda. Wantland (1975) found an attached agglutinated foraminifera in high turbulence areas of the Belize shelf that he called "*?Remaneicea sp. cf. R. kelletae*" and which could be in fact *Trochammina ochracea. Trochammina ochracea* is reported in most places as living in cold to temperate waters with high organic content and quiet conditions (e.g. Scott et al., 1980, 1990; Shennan et al., 1999; Collins, 1996) so it is very surprising to see it in an environment (reefs) that is the very opposite of this species previously known habitat.

Florida is the only area, other than Bermuda (this study), where a comparison of foraminifera distribution between outer reefs and lagoonal reefs (or patch reefs in Florida) was conducted (Weis and Steinker, 1977). Florida outer reefs hosted robusts tests. *Archaias angulatus* was the most abundant species, followed by *Discorbis rosea, Peneroplis proteus, Amphistegina lessonii, Homotrema rubrum, Articulina mexicana, Asterigerina carinata, Eponides repandus,* and planktonic species. The patch reefs had less well sorted sediment and tests, fragile tests were more common. The most abundant species was *Discorbis rosea*, followed by *Archaias angulatus, Quinqueloculina* *lamarckiana, Quinqueloculina tricarinata, Discorbis mira, Peneroplis proteus, Miliolinella circularis, Ammonia bccarii parkinsonia, Clavulina tricarinata, Elphidium sagrum, Peneroplis pertusus, Quinqueloculina poeyana, Valvulina oviedoina*, and species of *Miliolinella, Spiroloculina*, and other Miliolids. Bermuda and Florida outer reefs were similar except for Bermuda's other common species such as *Placopsilina bradyi, Spirillina cariacoensis,* and *Weisnerella auriculata*, absent in Florida. *Homotrema rubrum* was also much more abundant in Bermuda outer reef versus lagoonal reefs. Foraminifera distribution differed more between lagoonal reefs in the two areas. The Florida patch reefs included species (*Quinqueloculina bradyana, Discorbis mira, Clavulina tricarinata, Penerolpis pertusus*) common to lagoons in Bermuda, and Bermuda lagoonal reefs hosted lagoonal species common to Florida lagoons, such as *Nonion spp., Quinqueloculina spp., Miliolinella labiosa, Cibicides refulgens, Cibicides lobatulus, Elphidium advenum*, but also *Ammonia beccarii tepida* and *Arcervulina inhaerens*, 2 species absent in Florida.

In South florida, Steinker et al. (1977) observed that fragile species were abundant on vegetation in reef areas, but much less common in sediments because of transport, sorting and breakdown by currents and waves after death. The most abundant species on phytal substrates were "*Rosalina floridana*" (*Rosalina globularis*), *Planorbulina acervalis, Sorites marginalis, Discorbis mira,* and various miliolids. However, these fragile species are more abundant in their high-energy environment sediment than in protected environments where they don't live, so tests may be added more rapidly to sediment of high-energy areas than they can be removed, and test dissolution is less than in inshore sediments because of less acidic pore waters (Martin and Wright., 1988). In quieter areas, living populations on plants and in the sediment are similar (Waszczak and Steinker, 1987). Wetmore and Plotnick (1992) studied the correlations between test morphology, crushing strength, and habitat in "*Amphistegina gibbosa*" (synonym of *Amphistegina lessonii*, Rose and Lidz, 1977), *Archaias angulatus*, and *Peneroplis proteus* from Bermuda. The authors observed that the tests of these species collected in high-energy exposed reef were harder to crush than similar-sized tests of the same species in low-energy sheltered seagrass beds.

4.3.4. DEEPER WATER

For deeper water environments (forereef, inner and outer shelf), the comparison is difficult to make with Bermuda where samples collected outside the reef rim did not exceed 25 meters depth (for logistic reasons). However some similar species occur in deeper water samples from Bermuda and other areas: *Eponides repandus*, *Cassidulina subglobosa* (also in Bermuda caves), *Nonion gradeloupi* (also in Bermuda lagoons), *Textularia spp*. (also in Bermuda lagoons), *Bigenerina irregularis* (also in Bermuda lagoons), *Hanzawaia concentrica*, *Siphonina pulchra* (also in Bermuda caves), *Reussella* *atlantica* (in Trinidad and Belize shelf deeper water environments, and in Bermuda caves) and planktonic species. Other common deep water species occurring in other areas are listed in Table 1.

4.3.5. MANGROVES

Comparison between mangrove foraminifera assemblages in Bermuda and in other worldwide areas (Table 2) revealed that no mangrove foraminifera assemblages are similar, and no one species is recorded in all mangroves, as observed also by Boltovskoy (1984).

The most widely distributed species (Boltovskoy,1984; Scott et al., 1990, 1991), *Ammotium salsum*, *Arenoparella mexicana, Ammobaculites exiguus*, *Ammoastuta sp.*, and *Miliammina fusca* are absent in Bermuda except for the latter. *Ammoastuta* is found only in extremely brackish conditions which do not exist in Bermuda. Other common mangrove genera (*Ammoscalaria, Amphisorus, Bohianofuscus, Chitinosaccus, Crithionina*, and *Pseudoclavulina*), and nearshore/lagoon foraminifera found in mangroves (*Challengenerella, Eggerella, Haynesina, Pararotalia, Spirolina,* and *Calcarina, Palmerinella, Reophax*) are absent in Bermuda mangroves (the three latter occur in Bermuda lagoons).

Three species occur only in Bermuda mangroves: *Glomospira irregularis* (*Glomospira gordialis* is reported in Puerto Rico and *Glomospira glomerata* in Equator), *Tolypammina vagans* (usually found in deep-sea environment), and *Parrina bradyi* (present only in nearshore Barbuda also). The agglutinated genus *Glomospira* is typical of hypersaline marshes (Boltovskoy, 1984) but also occurs in deep estuarine environments in temperate locations (Scott et al., 1980). It is a useful indicator of low mangrove swamp in sea-level studies and its detailed distribution is reported here for the first time (chapter 3.1.4). This species is small and delicate, and might have been easily overlooked by previous authors, however it is well preserved in subsurface peats.

Among other species found in Bermuda mangroves and also reported in other mangrove areas, *Trochammina inflata* is the most widespread (present in 9 sites among the 13 sites compared in Table 2, including Bermuda) but is absent in Barbuda, Sinai, Tobago, and the Sundae Shelf; followed by *Haplophragmoides wilberti* (present in 8 among 13 sites, not in Florida-Bahamas, Tobago, Barbuda, Columbia, Sinai); and *Miliammina fusca* (present in 8 among 13 sites, not in Tobago, Barbuda, Columbia, Sinai). Besides in Bermuda mangroves, *Polysaccammina ipohalina* occurs only in Brazil, *Pseudothurammina limnetis* and *Trochammina macrescens* in Ecuador and New Zealand, and *Trochammina ochracea* in Puerto Rico. These 5 agglutinated species occur in most marshes.

Among calcareous mangrove species, *Triloculina oblonga* occurs only in Florida-Bahamas, Puerto Rico, Barbuda, and possibly in Senegal and Sinai (under *Triloculina spp.*). *Discorinopsis aguayoi* (*Discorinopsis vadescens* of some authors) is reported in Florida-Bahamas, Brazil, Equator, and Columbia. *Helenina anderseni* is reported only in Puerto Rico. "*Rosalina floridana*" (*Rosalina globularis*) occurs in Puerto Rico, possibly Sinai (under *Rosalina spp.*), and in Florida-Bahamas nearshore/lagoon. The later two species however are common in marsh environments.

The other species also present in Bermuda are variably recorded in about 6 sites among the 13 geographic areas compared.

Hallock and Peebles (1993) found abundant *Androsina lucasi* in open, dwarfed-mangrove flats, growing on mangrove roots and propagules, and algae, in the Florida Keys. This species was rare in Bermuda and occurred only in the lagoon.

Mangrove areas with the more numerous common species with Bermuda mangroves are Puerto Rico (10-11 sp. in common), Ecuador (9-10 sp.), Brazil (8-9 sp.), and New Zealand (7-8 sp.). Others have between 5 and 7 species in common with Bermuda (Florida-Bahamas, Trinidad, Senegal) and the rest have only 1 to 3 species in common with Bermuda (Tobago, Columbia, Sundae shelf, Sinai).

Close examination of physical conditions of the geographic areas compared in table 2 did not provide a clue to explain the differences in mangroves assemblages. Trinidad, Brazil, Ecuador, Sundae shelf and New Zealand have brackish mangroves whereas other areas have brackish to hypersaline mangroves. All areas are subtropical or tropical, with Bermuda and New Zealand being the most northern or southern. Bermuda, Bahamas, Barbuda, Tobago, Puerto Rico, and Trinidad are islands and other areas are continental. Bermuda, Puerto Rico, Sinai, Tobago, and Barbuda have carbonate sedimentation and no estuaries (low freshwater runoff), Florida/Bahamas have a mix of terrigenous and carbonate sediments, and New Zealand, Brazil, Ecuador, Sundae shelf, Trinidad and Columbia have mostly terrigenous sediments. Therefore, the differences or similarities in foraminifera assemblages are not related to unique similar or dissimilar factor such as latitude, climate, salinity, substrate, or insularity, but possibly to various mixes of physical factors or unknown factors. However, an important physical factor in marsh and mangrove distribution is the degree of tidal exposure, or elevation above sea level, that corresponds to the amount of dessication of the sediment.

Even within a geographic area, the distribution of some species can vary between marshes, such as *Trochammina inflata*, a very widespread species reported by Phleger (1970) in every marsh area but not in each marsh.

Most marsh species are also found in mangroves except *Trochammina macrescens* forma *polystoma* and *Polysaccammina hyperhalina*, absent in mangroves. Contrary to Boltovskoy's observation (1984), *Trochammina macrescens f. macrescens* and *Helenina anderseni* occur also in mangroves.

Distribution of species common to various mangrove areas can also vary in their zonation within the mangroves.

Miliammina fusca occurs in low marsh areas at higher latitudes (>40-45°) (Scott and Medioli, 1980a; Scott et al., 1990) whereas it is more abundant in the high part of Bermuda Hungry Bay mangrove swamp. This difference with the foraminifera distribution in Bermuda mangroves can be explained by differences in physical parameters (climate, sediment). Indeed, at lower latitudes (Senegal, Brazil), *Miliammina fusca* occurs in the upper part of mangrove swamps (Scott et al., 1990).

Haplophragmoides wilberti is rare in surface sediment of Bermuda mangroves, but very abundant in some of the subsurface samples. This species usually lives in the upper marsh, and is common to hyposaline marshes (Boltovskoy, 1984; Collins et al., 1995; Scott et al., 1990). Its varying abundance in Bermuda sediment could be due salinity (Bermuda mangroves are brackish to hypersaline), to change in environmental conditions at the marsh surface during deposition (such as small-scale climatic changes affecting the precipitation regime), or to its infaunal habitat. In Georgia, *Haplophragmoides wilberti* was more abundant in high marsh, and occurred in surface and subsurface but also in subsurface low marsh (Goldstein and Harben,1993).

The species *Discorinopsis aguayoi* and *Helenina anderseni* are typical of hypersaline marshes (Boltovskoy, 1984; Scott, 1976a). They are restricted to the low mangrove swamp in Hungry Bay. The calcareous species *Discorinopsis aguayoi* occurs in the upper part of warm temperate marshes (>35° lat.) (Scott, 1976a; Scott et al., 1979, 1990). This difference is due to variation in calcium carbonate availability and distribution. In Hungry Bay, calcareous species are abundant in the low mangrove swamp, close to the channel where sea water rich in calcium carbonate enters. At higher elevations, the pH becomes too low for calcareous species, and only agglutinated species thrive. On the other hand, in Mill's Share marsh-mangrove complex, the entire area is richer in carbonates due to the allochtonous fill, and calcareous species are abundant throughout as a result. This distribution mimics the range of benthic foraminifera that could occur in a naturally calcium carbonate richer marsh.

In a short note, Steinker and Butcher (1981) report the presence of only 10% agglutinated species in Bermuda mangrove shores (*Trochammina inflata*), and the calcareous species include mostly *Helenina anderseni*, *Spiroloculina hyalina*, *Discorinopsis aguayoi* and "*Rosalina floridana*". That research was concentrated on the lower part of fringing mangrove shores, where we also found a dominance of calcareous species (with another common species, *Triloculina oblonga*).

One point that might also be a factor in these comparisons is the amount of material studied. For this study, mangroves were focused on but in places like Florida they were peripheral studies where the full range of species was probably not reported.

4.3.6. LANDLOCKED MARINE PONDS.

Few papers have been published about foraminifera assemblages in landlocked ponds. Resig (1974) studied recent foraminifera in a landlocked Hawaiian lake, and reviewed previous studies (9 references since 1884). Foraminifera occurred in non-marine waters in salt pond near Deva, Rumania (*Enitzia sp.*); water wells of Kara-Kum Desert, east of Caspian Sea (small weakly calcified test of the probably incorrect genera *Spiroloculina, Pyrgo, Textularia, Lagena, Nodosaria, Globigerina, Discorbis,* and thecamoebians); Wadi Rhir, Algeria (*Miliammina fusca, Arenoparella mexicana*, and 5 other agglutinated species); pools and springs near Erfurt, Germany (*Haplophragmoides canariensis* or *Haplophragmoides wilberti*, ostracods); Salton Sea, California (22 foraminifera species among which *Bolivina striatula, Ammonia tepida, Elphidium tumidum, Quinqueloculina bellatula*, rare agglutinated species, and 2 thecamoebians); and Caspian Sea, U.S.S.R. (*Ammonia beccarii, Elphidium poeyanum*, and 3 other species). The Hawaiian lake hosted 41 species, and thecamoebians and ostracods, but most species were not living there. *Trochammina inflata* was the most abundant species, followed by *Haplophragmoides wilberti, Haplophragmoides manilaensis, Discorinopsis aguayoi, Ammonia tepida, Cibicides lobatulus, Hauerina pacifica, Quinqueloculina distorqueata, Triloculina oblonga,* and *Miliammina fusca*. The Hawaian lake assemblage, as well as other assemblages from locations reviewed by Resig (1974) hosted the same species as coastal environments, probably transported inland by birds or humans. Since 1974, a few other landlocked waters have been reported to host foraminifera. The most abundant species in North Carolina brackish ponds (Lefurgey and St. Jean, 1976) were *Ammonia beccarii, Miliammina fusca, Ammotium salsum*, and *Elphidium spp*. In Southern California ponds, Scott (1976b) reported a range of species including *Polysaccammina ipohalina, Trochammina macrescens, Trochammina inflata*, and ostracods. Cann and De Dekker (1981) studied the occurrence of 5 living species from southern Australian lakes. They found *Elphidium sp.* and *Trochammina macrescens* in ephemeral lakes, and *Elphidium sp., Ammonia beccarii (f. tepida,* as I could judge from the plates), *Discorinopsis aguayoi* (called *Trichohyalus tropicus* by the author), and a miliolid (called "? *Triloculina rotunda*" by the author but in fact a species of *Quinqueloculina*) in permanent lakes. *Elphidium sp.* was able to survive through the drying phases of ephemeral lakes and reestablished its living population in the following winters. Patterson and McKillop (1991) reported a new agglutinated species (*Annectina viriosa*), associated with *Trochammina macrescens* and *Polysaccammina ipohalina* in a temperate brackish pond from Manitoba. Almogin-Labin et al. (1995) studied the distribution of *Ammonia beccarii tepida* in saline ponds from Israel. Most of these landlocked waters are brackish and have a low diversity assemblage, with the exception of Australia, Israel, Southern California, and the Caspian Sea waters where salinity varies from brackish to hypersaline values.

Bermuda ponds hosted a mangrove assemblage of agglutinated and calcareous species (*Polysaccammina ipohalina, Trochammina inflata, Miliammina fusca, Haplophragmoides wilberti, Glomospira irregularis, Helenina anderseni, Discorinopsis aguayoi, Ammonia beccarii tepida, Triloculina oblonga*) associated with many calcareous lagoonal species, if the pond was less restricted and more normal marine (Grotto Pond), and with ostracods in the non-tidal pond (Spittal Pond). *Glomospira irregularis* was the only Bermuda species absent in all the other pond areas. The type locality of *Polysaccammina ipohalina* in Southern California (Scott, 1976b) was also a brackish coastal pond, cut off from marine influence, and is the only other place in a non-polar situation where *Polysaccammina ipohalina* is common. Some species found in other areas were absent in Bermuda (*Ammotium salsum, Arenoparella mexicana*, and two endemic species *Annectina viriosa, Enitzia sp*). Diversity was variable, depending on the degree of restriction of the pond, in Bermuda, whereas it is generally low in landlocked waters from other areas.

In conclusion, although all these ponds or landlocked water bodies have different foraminifera assemblages, they generally host a marsh/mangrove assemblage less diverse than in marshes or mangroves (agglutinated species *Miliammina fusca, Haplophragmoides spp., Trochammina macrescens,* and sometimes *Trochammina inflata, Polysaccammina ipohalina, Arenoparella mexicana, Ammotium salsum* and calcareous species *Ammonia beccarii tepida, Discorinopsis aguayoi, Elphidium sp., Triloculina* *oblonga*), other calcareous species also living in lagoons/bays in variable diversity depending on the connections or the proximity of the inland waters from the sea, and sometimes ostracods and thecamoebians.

4.3.7. BERMUDA BIOGEOGRAPHY

"Benthic foraminifera are potentially the most useful organisms for defining global (shelf to abyssal plain) marine provincial schemes due to their abundance and their worldwide distribution in all marine environments" (Culver and Buzas, 1981). Culver and Buzas (1981) recognized seven benthic foraminiferal zoogeographic provinces on the Atlantic continental margin of North America, based on two cluster analyses of 791 species at 350 localities and 149 commonly recorded species at 315 localities respectively (fig. 40). The provinces are 1) the Northern Coastal Province subdivided into a) marsh biofacies, and b) bay/estuary/beach biofacies, 2) Northern Shelf Province, 3) Northern Outer Shelf and Slope Province, 4) Northern Slope and Rise Province, 5) Southern Shelf Province, 6) Southern Slope Province, and 7) Bahaman Province. Most of these provinces are related to the following major water masses respectively; 1) marginal waters, 2) northern shelf water, 3) slope water, 4) water of the Gulf Stream and Western Boundary Undercurrent, 5) southern shelf water, and 6) water of the Florida and Antilles currents. The Bahaman Province (7) is probably related to a carbonate sedimentary environment (Culver and Buzas, 1981). Culver and Buzas (1982) also produced catalogs and maps of distribution of Caribbean foraminiferal species. They recorded 1868 taxa (1189 after synonymization) at 338 sample localities in the Caribbean region. Of the 1189 species, only 11% of the species (130 species) occured at 4% or more of the localities (mostly shallow shelf depths), so most species were rare, but cluster analysis of these most commonly recorded species showed no meaningful clusters. Therefore the authors considered the Caribbean data to represent a Caribbean shelf Province, which probably extends to the southern tip of Florida and the Yucatan. Diversity is higher in the Caribbean region (1189 species) than in the Gulf of Mexico (848 species) or on the eastern continental margin of North America (876 species), and the relationship between the Caribbean region and the Gulf of Mexico is not yet defined (Culver and Buzas, 1982). For reef and lagoon environments, Bermuda benthic foraminifera fauna shows an overall similarity (despite differences) with Florida, the Bahamas, and the Caribbean Sea (including the islands Tobago, Jamaica, Trinidad, Puerto Rico, Barbuda, Cuba, and St. Lucia, and the continental shelves of Belize, Venezuela, and Panama) (see Table 1 and chapter 4.3). Sediments in most areas are carbonate, mixed with clastics only in the continental shelves. The benthic foraminifera fauna are not identical in these areas but their general similarity (after examination of foraminifera distribution from this work and references in Table 1) permits to define an enlarged biogeographic Caribbean Province

(Buzas and Sen Gupta, 1982; also called Bahaman Province by Culver and Buzas, 1981), that includes Florida, Bahamas, Bermuda and the Caribbean Sea (Fig. 30).

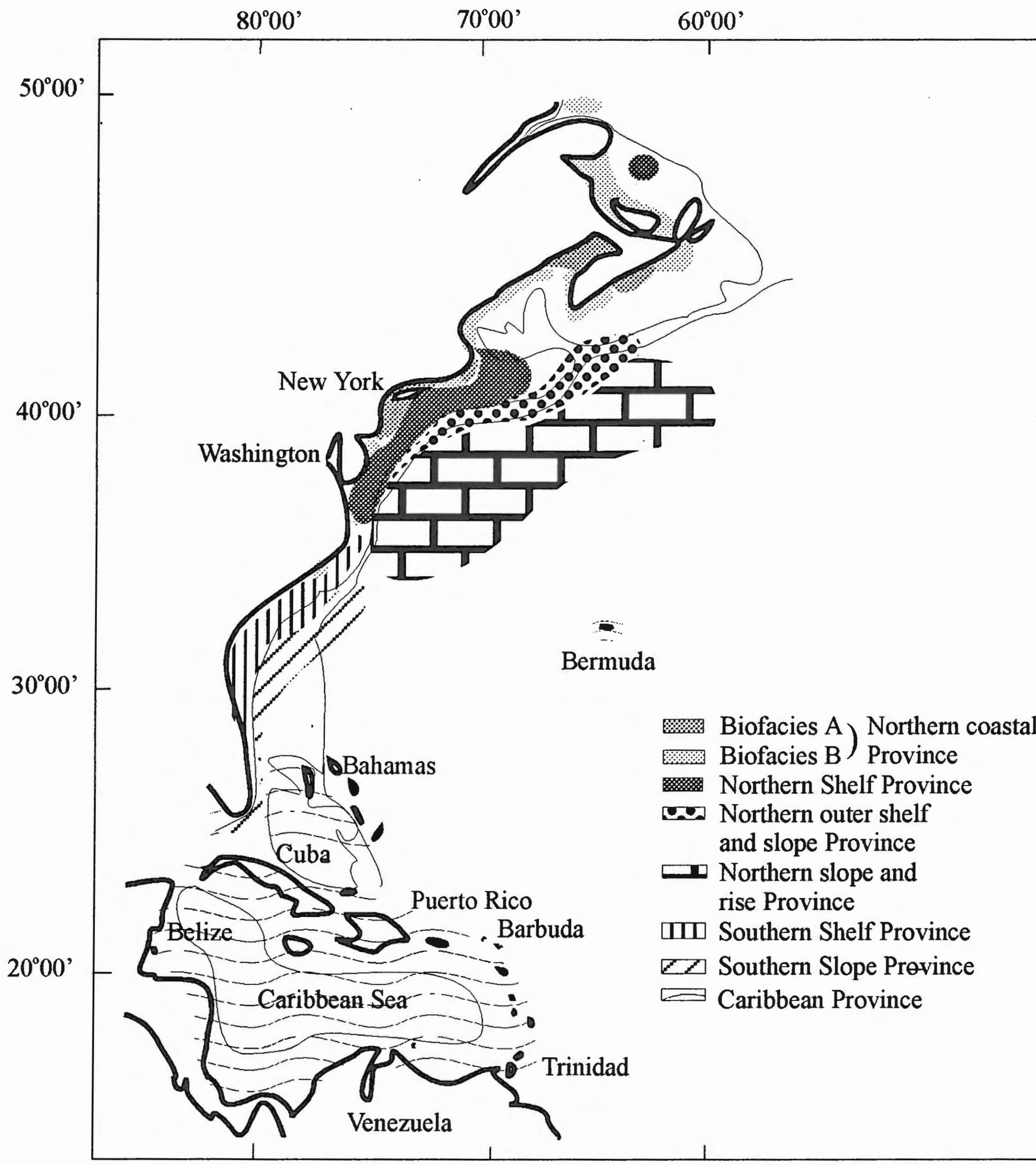
Twenty-seven species of the 29 diagnostic species of the Bahaman Province (Culver and Buzas, 1981, p. 224) are living also in Bermuda. The relationship of this enlarged Caribbean Province with the Gulf of Mexico was not investigated in details in this study but species associations described by Murray (1991) and discussion by Buzas and Sen Gupta (1982) seem to indicate that these areas belong to different zoogeographic Provinces, although the former author groups both areas in terms of benthic foraminifera distribution.

Mangrove trees evolved during the Cretaceaous period in what is now the Indo-West Pacific region, and spread by migration and continental drift to all the oceans (Thomas and Logan, 1992). Mangroves develop in subtropical and tropical climates, between 32°N (Bermuda) and 27°S (New Zealand). Comparison of worldwide mangrove foraminifera fauna (table 2 and chapter 4.3) revealed that all assemblages are different and no one species is recorded in all mangroves. These differences are not related to unique factor such as latitude, climate, salinity, substrate, or insularity, but possibly to various mixes of physical factors, biotic interactions, or unknown factors. An important factor could also be the fact that few mangroves have been the focus of foraminifera distribution studies but most are peripheral studies. The most widespread species (but not ubiquitous) in mangroves, as in marshes, is *Trochammina inflata*. The marsh biofacies A of the

Northern Coastal Province of Culver and Buzas (1981) includes 3 diagnostic species (*Trochammina inflata, Trochammina macrescens, and Ammotium salsum*) that are common but not ubiquitous in all marshes and mangroves. Scott et al. (1990) compared marsh foraminifera from the east coast of South America with fauna from the east and west coasts of North America, and concluded that there was a latitudinal gradient in both hemispheres of the Americas. The authors recognized 4 areas with different benthic foraminifera associations: High latitude (>50°), Mid latitude (40-45°), Warm temperate (35°), and Mangrove (<27°).

Although marshes and mangroves host a particular agglutinated foraminifera fauna, associated or not with calcareous foraminifera depending on the availability of calcium carbonate, more detailed studies of benthic foraminifera fauna in mangroves are needed to understand their distribution and biogeographic affinities.

Figure 40 Distribution of benthic foraminifera Provinces in the North Atlantic Ocean (modified from Culver and Buzas, 1981; Buzas and Sen Gupta, 1982). Bermuda benthic foraminifera fauna is part of the Caribbean Province enlarged to include Bermuda and the Caribbean Sea, in addition to Florida and the Bahamas. The 180 and 1,800 meters submarine contours are shown.


80°00'
70°00'
60°00'
50°00'
40°00'
30°00'
20°00'
New York
Washington
Bermuda
Bahamas
Cuba
Puerto Rico
Barbuda
Belize
Caribbean Sea
Trinidad
Venezuela
Biofacies A
Biofacies B
Northern coastal Province
Northern Shelf Province
Northern outer shelf and slope Province
Northern slope and rise Province
Southern Shelf Province
Southern Slope Province
Caribbean Province

4.4. SEA LEVEL IMPLICATIONS

Because of the great interest in global warming and its possible impact on sea level, and ultimately on human life, it is critical to conduct detailed studies of historical sea-level changes. This chapter discuss a late Holocene sea-level oscillation, eustatic and possibly linked to climatic change, that could illustrate how strongly climate change can affect sea level.

Holocene sea-level studies have produced smooth (e.g. Neumann, 1971; Redfield, 1967; Scholl et al., 1969) or highly fluctuating (e.g. Colquhoun and Brooks, 1987; Fairbridge, 1976; Stapor et al., 1991; Ters, 1987) curves, by using various sea-level indicators such as peat, archeological remains, shell middens, and beach ridges. The detection of small-scale sea-level oscillations requires highly accurate sea-level markers. Scott and Medioli (1978, 1980a) showed that marsh foraminifera are distributed in well defined vertical zones with respect to higher high water (HHW). The recognition of the foraminiferal zones in subsurface peats permits the accurate location of past sea levels and the production of accurate sea-level curves.

Bermuda was chosen as a study area since it acts as a stable sea-level gauge in the middle of the Atlantic Ocean, in the deep Sargasso Sea (5000 m deep). Since Holocene subsidence of the seamount is insignificant (Redfield, 1967; Ellison, 1993), Bermuda is assumed to be tectonically and isostatically stable and sea-level changes are assumed to be only eustatic. Vacher and Hearty (1989) found that substage 5e reached similar level above sea-level as widespread coastal marine deposits along stable shorelines around the world, and concluded that (Pleistocene) sea-level data in Bermuda do not need tectonic corrections. Three published Holocene sea-level curves have been produced for Bermuda (Redfield, 1967; Neumann, 1971; Ellison, 1993). Redfield (1967) and Neumann (1971) used undifferentiated peat samples and assumed that freshwater peat must have been in constant equilibrium with sea level because Bermuda is small and the rocks are permeable hence not able to support a freshwater swamp above sea-level. Ellison (1993) studied pollen to detect mangrove peat. By using foraminifera, it is possible to distinguish, without any doubt, freshwater peat from marine peat, as well as subdivide the peat into accurate vertical ranges relative to sea level.

If a comparison is made with previously published Bermuda curves (Table 9: Ellison, 1993; Neumann, 1971 and pers. comm.; Redfield, 1967) by removing the range between MSL and HHW (approximately 60 cm or half the tidal range), it appears that all other sea-level points are located at or above the Bermuda curve (fig. 35, this study), depending on the marine or freshwater origin of the basal peat samples the authors used.

The rates of relative sea-level rise (RSL) in the Bermuda curve (fig. 35, this study) are higher than those from previously published Bermuda curves. From 4,422 y BP to 3,220 y BP, the sea-level rose at a rate of 18.5 cm/100y. Then, the sea-level rise slowed to 12.4 cm/100y between 3,220 y BP to 2,042 y BP. From 2,042 y BP to 1,051 y BP,

TABLE 9. PUBLISHED HOLOCENE SEA-LEVEL DATA FOR BERMUDA

Lab number	Uncorrected Age (y BP)	Depth below MSL (cm)
Hungry Bay (Ellison, 1993)		
HB1-1	390± 90	60-70±30
HB1-2	1100±80	140-150±30
HB1-3	2020±90	240-250±30
HB1-9	4910±90	550-560±30
HB2-1	4980±100	540-550±30
HB2-2	730±80	80-90±30
HB4-1	750±60	15-30±30
HB5-1	1411±60	30-40±30
HB5-2	4030±110	220-230±30
Devonshire Marsh (Neumann , 1971 and pers. comm.)		
N.A.*	780	150
N.A.	2670	250
N.A.	3780	350
Long Bay, Somerset (Redfield, 1967)		
I-1685	880±120	50±10
I-1969	1210±95	66±7
I-1764	1510±110	102±10
I-1971	2440±110	139±7
I-1973	2530±100	178±7
I-1975	2690±90	211±7
I-1762	3600±120	333±7
I-1686	3900±120	248±10
I-1763	3930±120	347±10
Shelly Bay (Redfield, 1967)		
I-1684	1820±120	251±10
I-1683	1850±110	185±7

*N.A. = not available

the sea-level dropped at a rate of 7 cm/100y. Then sea-level rose again at 17 cm/100y until 554 y BP when it accelerated at 27 cm/100y for the last 500 years. Redfield (1967), Neumann (1971), and Ellison (1993) found a rate of sea-level rise of respectively 7.6 cm/100y, 9.8 cm/100y, and 6 cm/100y from 4,000 y BP to present. However their curves are best fit curves passing between the points, and they calculated the rate of sea-level rise over a longer time period.

In Connecticut, Nydick et al. (1995) reported a RSL rate of 0.9 mm/y between 250 and 1,100 AD, followed by a slowing rate of RSL between 1,100 and 1,600 AD (0.5 mm/y), and an acceleration of RSL for the last 400 years (3 mm/y). In Florida, the reported RSL rates vary also with the authors. Robbin (1984) reported a RSL rate of 1.2 mm/y between 7,000 and 2,000 y BP, slowing down to 0.3 mm/y for the last 2,000 years. Goodbred et al. (1998) reported a RSL rate of 1.5-3 mm/y between 4,000 y BP and 1,800 y BP, followed by a short-lived rapid rise at a rate of 10 to 20 m/y between 1,800 and 1,700 y BP, and a slower rate of 0.5 to 2 mm/y from 1,700 y BP to the present. Scholl et al. (1969) calculated a RSL rate of 0.35 mm/y after 3,500 y BP. The differences in reported RSl rates by various authors for the same location (Florida or Connecticut) are probably partly due to the time period averaged. During a longer time period, such as the last 2,000 or 4,000 years (Scholl et al., 1965; Robbin, 1984; Goodbred et al., 1998), the RSL rates appear lower than when shorter periods of time are studied (Ellison, 1993; Nydick et al., 1995; Wanless, 1982).

The last 1,000 years of the curve show an acceleration of sea-level rise (17 cm/100y between 1,051 and 554 y BP; and 27 cm/100y for the last 500 y) as in Ellison (1993)'s curve (14.3cm/100y) but at a higher rate. This acceleration is also reported in Connecticut (2.9-3.3 mm/y for the last 400 years; Nydick et al., 1995) although van de Plaasche (1998) reported for the same area a RSL rate of 1mm/y from about 1650 AD, interrupted by little or no rise during the cool 19th century. In Florida, studies of late Holocene sea-level changes do not report a RSL rate calculated for the last 500 years only, making difficult a comparison with Bermuda RSL rate. However, since 1932, tide gauge records from Bermuda and South Florida show variable but rising sea-level at a rate of 28 cm/100y and 23 cm/100y respectively (Wanless, 1982). This acceleration did not occur in South Carolina where the RSL rate has been 0.1 mm/y for the last 500 years (Scott et al., 1995).

The data in this study show a 70 cm drop of sea-level at a rate of 7 cm/100y between 2,042 y BP and 1,051 y BP. Interestingly, sea-level data from Ellison (1993) also show a drop at 1,100 y BP, and data from Neumann (1971) show a slowing RSL or a drop around 780 y BP (fig. 35, Table 9). Sea-level data from Redfield (1967) show a sea-level fall starting earlier, between 2,440 and 1,820 y BP, but some of the data could have come from freshwater peat deposited higher than sea level. Although Bermuda is assumed to be stable by most authors, Hartsock et al. (1995) observed fractures in northeastern Bermuda caused by deep caverns collapse and occasional earthquakes. However, these fracture systems are not prevalent in southwestern Bermuda, our study area. The three low points around 1,000 BP are from three different areas in south-western Bermuda, so it is doubtful that fractures would occur simultaneously at these locations. Furthermore, a similar sea-level fluctuation occurred in south Florida and in Connecticut between 2,000 and 1,000 y BP. Stapor et al. (1991) observed a high sea-level between 2,000 and 1,500 BP, then sea-level dropped 3-5 ft to a lowstand at 1,100 y BP, followed by a rise (2-3 ft), as shown by the position of beach-ridges in south Florida. van de Plaasche et al. (1998) produced a mean-high-water curve for a Connecticut marsh, based on foraminiferal analysis of a peat core. They correlated sea-level oscillations with 5 periods of overall warming, each preceded by cooling, in the North Atlantic during the past 1400 years. A lowstand occurred around 1,000 BP and coincided with cooling shown by northern Fennoscandia, Sargasso Sea, and Northern Hemisphere temperature records.

Colquhoun and Brooks (1987) (South Carolina), Ters (1987) (France), and Fairbridge (1976) (global sea-level curve) produced highly fluctuating Holocene sea-level curves with several oscillations between 2,000 and 1,000 y BP that do not correspond in timing with our lowstand. However Ters (1987) and Fairbridge (1976) used data from distant areas with various tectonic history, and their curves are not considered valid by most authors but have only historical value. Fairbanks (1989) Barbados curve does not show the lowstand, but this may result of incomplete data around 1,000 BP. These curves do not coincide between themselves either and they are based on a highly variable range of indicators.

Bermuda sea-level history differs also from South Carolina (Gayes et al., 1992; Scott et al., 1995a) and eastern Canada (Scott et al., 1995b) where a drop in sea level (Scott et al., 1995b) or decrease in RSL (Scott et al., 1995a) was observed at 4,200 y BP.

If an attempt is made to correlate the sea-level curve with climatic fluctuations, the lowstand seems to have occurred during a cool period ("Early Medieval Ice Advances" or EMIA, Crowley and North, 1991) that followed the Roman Warm Optimum, from 500 AD to 1,000 AD. Bond et al. (1997) (study of North Atlantic deep-sea cores) report a millennial-scale cycle in North Atlantic Holocene climate, with a cooling at about 1,400 y BP. Keigwin (1996)'s study of Bermuda Rise cores from the northern Sargasso Sea demonstrates a 1.5 °C oscillation from a minimum SST 1,500 to 1,700 years ago (EMIA) to a maximum 900 to 1,000 years ago (Medieval Warm Period or MWP), to a minimum 300 to 400 years ago (Little Ice Age or LIA). The sea-level rise following the lowstand in the curve coincides with the Medieval Warm Period (1100-1300 AD). Surprisingly during the Little Ice Age (1,350-1,900 AD), the Bermuda curve shows another acceleration of sea-level rise that is also reported in Connecticut (Nydick et al., 1995), even though this cooling is registered in Bermuda Rise sediments 700 km to the northeast of Bermuda (Keigwin, 1996). This acceleration preceded the beginning of modern global warming.

Thus modern sea-level rise is at least partly caused by natural processes-probably climatic changes-, maybe as part of the millennial-scale cycle proposed by Bond et al. (1997).

The Bermuda lowstand documented here between 2,042 y BP and 1,051 y BP also coincides with a possible displacement of the Bermuda High over Bermuda. A displacement at that time period was suggested by Collins et al. (1998) from their study of hurricane records in South Carolina subsurface marsh deposits. Forman et al. (1995) proposed that shifts in the position of the Bermuda High caused continental-scale changes in climate and atmospheric circulation patterns. They observed episodes of dune reactivation at 6,000, 4,500, and 1,000 y BP in the central United States, that reflect northeasterly shifts of the Bermuda High over Bermuda. Liu (1999) used this mechanism to explain millennial-scale variations in Gulf Coast hurricane activity, but it may also explain at least part of the Bermuda sea-level drop between 2,000 and 1,000 y BP since an increase of air pressure causes a sea-level fall. One millibar of pressure equals 1 cm of sea-level drop (K. Thompson, Dept. Oceanography, Dalhousie Univ., pers. comm.) and the Bermuda High would represent up to a 15 millibar increase in air pressure-not enough to cause the entire 50 to 70 cm observed here but other peripheral weather effects may have also contributed since, as Forman et al. (1995) state, the displacement of the Bermuda high causes a complete reorganization of climate patterns.

The Bermuda curve presented in this dissertation illustrates the high variability of late Holocene sea level and climate.

CHAPTER V: CONCLUSIONS

1. Bermuda foraminifera distribution

-Foraminifera assemblages from lagoons, reefs, caves, mangroves, and ponds are sufficiently different to serve in paleoenvironmental reconstructions. They are based on species diversity, suborder percentages, characteristic species and associations, and sediment types. Some subenvironments can even be recognized, such as outer/lagoonal reefs, open/semi-protected/protected lagoons, mangrove swamps/fringing mangroves, non-tidal marine landlocked ponds/mangroves and other ponds.

-The following general trends of foraminifera distribution and morphology can be observed across Bermuda environments:

-Miliolids are more diverse in quiet normal marine shallow-water lagoons, and have smooth or slightly ornamented tests (such as *Quinqueloculina seminulum, Quinqueloculina bicarinata, Quinqueloculina poeyana, Triloculina linneiana*), but some smooth-tested species (such as *Triloculina oblonga, Quinqueloculina laevigata, Planispiroides bucculentus*) are most abundant in brackish to hypersaline environments (mangroves, ponds). In high-energy areas, Miliolids have thicker ornamented angulose tests (such as *Quinqueloculina lamarckiana, Quinqueloculina candeiana, Quinqueloculina bradyana, Quinqueloculina agglutinans, Triloculina bassensis,* *Triloculina bicarinata*). Peneroplids and Soritids occur in normal marine, quiet and turbulent areas (lagoons and reefs).

-Textulariina (agglutinated) occur preferentially in brackish, and/or low pH and less oxygenated areas (mangroves, ponds, and caves).

-Spirillinina are more abundant in caves.

-*Reophax spp*. and Buliminінacea (*Bolivina, Buliminella, Trifarina*) are more abundant in quiet protected and even seasonally anoxic areas (caves, protected lagoons).

-Rotaliids are more abundant in slightly brackish (caves) to normal marine (lagoons, reefs) environments, although a few are adapted to very variable conditions (such as *Ammonia beccarii tepida, Rosalina globularis, Discorinopsis aguayoi, Helenina anderseni*). In high-energy areas, Rotaliids have robust and/or biconvex tests (*Amphistegina lessonii, Asterigerina carinata, Eponides repandus, Planulina exorna*) or attach themselves to the substrate (*Rosalina spp., Homotrema rubrum*). Agglutinated attached species also occur in these turbulent areas (*Trochammina ochracea, Placopsilina bradyi*).

-Main factors controlling foraminifera distribution in Bermuda are salinity, sediment type, pH, water energy, oxygen content, light penetration, and elevation above sea level (degree of tidal exposure, or amount of dessication). Presence of phytal substrate is also very important but was not investigated in this more geological study of sediment assemblages.

-In general, species diversity is high except in outer reefs and mangrove swamps, and abundance is variable.

-Morphological variability of some species can be high, especially in mangrove environments which display the most variable physical conditions (*Triloculina oblonga, Planispiroides bucculentus, Discorinopsis aguayoi, Rosalina floridana/globularis, Trochammina inflata/Siphotrochammina lobata*), but also in stable lagoons (*Archaias angulatus*). Detailed biometrical and morphological examination of living populations in various habitats would be necessary to detect ecophenotypes.

-Karstic cave foraminifera were studied for the first time with this study, and one possible troglobytic species was discovered (*Spirophtalmidium sp.*) that was rare or absent in other world areas.

2. Comparison with other subtropical/tropical areas.

-Bermuda recent sediment host a benthic foraminifera fauna as or more diverse as in other subtropical and tropical areas.

-General trends of foraminifera distribution and morphology are similar in Bermuda and other subtropical and tropical areas. This overall similarity permits to define an enlarged biogeographic Caribbean Province (Buzas and Sen Gupta, 1982; also called Bahaman

Province by Culver and Buzas, 1981), including Florida, Bahamas, Bermuda and the Caribbean Sea.

-Despite similar trends and general associations, there are some differences between Bermuda and other subtropical/tropical areas in lagoon, reef, pond, and mangrove foraminifera assemblages. The most striking differences are:

-in reefs, presence of *Trochammina ochracea* only in Bermuda, Barbuda (backreefs) and possibly in Belize shelf ; of *Planulina exorna* only in Bermuda and Panama; of *Homotrema rubrum* only in Bermuda, Florida-Bahamas, and Belize shelf; and absence of *Discorbis rosea* in Bermuda, Panama, Trinidad, and Venezuela.

-in lagoons and reefs, Peneroplids are not among the most abundant foraminifera in all areas.

-in mangroves, assemblages of all areas are similar but all different, and these differences are not due to one physical factor, but to various sets of physical factors or to unknown factors. Widely distributed species (*Ammotium salsum, Arenoparella mexicana, Ammobaculites exiguus, Ammoastuta sp.*) and other common mangrove genera are absent in Bermuda. Three species (*Glomospira irregularis, Tolypammina vagans, Placopsilina bradyi*) occur only in Bermuda mangroves, and common species in Bermuda mangroves (*Triloculina oblonga, Discorinopsis aguayoi, Helenina anderseni, Polysaccammina ipohalina, Pseudothurammina limnetis*) are not widespread in other areas.

3. Sea-level implications.

-In Bermuda mangrove swamps, foraminifera distribution shows a zonation relative to higher high water level, that can be used in accurate paleo-sea-level reconstructions. The present work includes the first detailed measured transects carried out in mangrove swamps for foraminiferal studies.

-The late Holocene sea-level curve for Bermuda shows a lowstand between 2,000 y BP and 1,000 y BP, and a relative sea level acceleration since about 500 y BP that preceded the onset of modern global warming. The lowstand occurred also in Connecticut and South Florida, but not in other areas, and coincided with a cool period (Early Medieval Ice Advances) also detected elsewhere, and possibly also with a displacement of the Bermuda High over Bermuda. This curve illustrates the high variability of late Holocene sea-level and climate.

CHAPTER VI. SYSTEMATICS

Abbreviated systematic taxonomy of thecamoebians and benthic foraminifera.

Generic classification of the foraminifera follows that of Loeblich and Tappan (1964; 1988). Genera and species within genera are listed in alphabetical order. Each synonymy includes the original reference, references used for identification, and some generic changes for each species.

Order ARCELLINIDA Kent, 1880

Genus **Arcella** Erhenberg 1832

Arcella polypora Penard, 1890

Plate 1, figure 1

Arcella polypora Penard, 1890, p. 156, pl. 6, figs. 2-9. Scott et al., 1991, p. 384, pl. 1, figs. 1-3

Genus ***Centropyxis*** Stein, 1859

Centropyxis aculeata (Ehrenberg), 1832 *ab* (Ehrenberg), 1830

Plate 1, figure 2

Arcella aculeata Ehrenberg, 1832 (*ab* Ehrenberg, 1830, p. 60, *nomen nudem*), p. 91.

Leptodermella salsa Cushman and Brönnimann, 1948a, p. 15, pl. 3, figs. 3, 4.

Leptodermella variablis Parker, 1952a, p. 452, pl. 1, figs, 11, 12.

Centropryxis excentricus (Cushman and Brönnimann). Scott, 1976b, p. 320, pl. 1, figs. 1, 2. Scott et al., 1980, p. 224, pl. 1, figs. 1-3.

Centropyxis aculeata (Ehrenberg). Stein, 1859, p. 43. Scott et al., 1991, p. 384, pl. 1, figs. 7-9.

Centropyxis constricta (Ehrenberg, 1843)

Plate 1, figure 3

Arcella constricta Ehrenberg, 1843, p. 410, pl. 4, fig. 35, pl. 5, fig.1.

Difflugia constricta (Ehrenberg). Leidy, 1879, p. 120, pl. 18, figs. 8-55.

Umulina compressa Cushman, 1930a, p. 15, pl. 1, fig. 2. Parker, 1952a, p. 460, pl. 1, fig. 9. Scott et al., 1980, p. 224, pl. 1, figs. 13-15.

Centropyxis constricta (Ehrenberg). Deflandre, 1929, p. 340, text-figs. 6-67. Scott et al., 1991, p. 384, pl. 1, fig. 4.

Order FORAMINIFERA Eichwald, 1830

Genus ***Abdidodentrix*** Patterson 1985

Abdidodentrix rhomboidalis (Millett), 1899

Plate 1, figure 4

Textularia rhomboidalis Millett, 1899, p. 559, pl. 7, fig.4.

Bolivina rhomboidalis (Millett). Cushman, 1937, p. 138, pl. 18, fig. 7.

Abdidodentrix rhomboidalis (Millett). Cimmerman and Langer, 1991, p. 60. Pl. 63, figs. 10-11.

Genus ***Acervulina*** Schultze, 1854

Acervulina inhaerens Schultze, 1854.

Plate 1, figure 5

Acervulina inhaerens Schultze, 1854, p. 68, pl.6, figs. 13-14 . Cushman, Todd, and Post, 1954, p. 372, pl. 91, figs. 37, 38. Barker, 1960, p. 210, pl. 102, figs. 1-6.

]Genus ***Ammobaculites*** Cushman, 1910

Ammobaculites agglutinans (d'Orbigny), 1846

Plate 1, figure 6

Spirolina agglutinans d'Orbigny, 1846, p. 137, pl. 7, figs. 10-12.

Haplophragmium agglutinans Brady, 1884, p. 301, pl. 32, figs. 19, 20, 24-26.

Ammobaculites agglutinans Cushman, 1910, p. 115, fig. 176. Bock, 1971, p. 7, pl. 1, fig. 15.

Genus ***Ammodiscus*** Reuss, 1862

Ammodiscus tenuis Brady, 1884

Plate 1, figure 7

Ammoniscus tenuis Brady, 1884, p. 78, pl. 38, figs. 5, 6. Bock, 1971, p. 4, pl. 1, fig. 6.

Genus ***Ammonia*** Brünnich, 1772

Ammonia beccarii (Linné), 1758

Plate 1, figures 8 and 9

Nautillus beccarii Linné, 1758, p. 710.

Ammonia beccarii (Linné). Brunnich, 1772, p. 232. Frizzell and Keen, 1949, p. 106. Schnitker, 1974, p. 216-223. Scott and Medioli, 1980a, p. 35, pl. 5, figs. 8, 9.

"Rotalia" beccarii (Linné) var. *parkinsoniana* (d'Orbigny). Phleger and Parker, 1951, p. 23, pl. 12, fig. 6. Bock, 1971, p. 55, pl. 20, figs. 5, 6.

"Rotalia" beccarii (Linné) var. *tepida* Cushman, 1926, P. 79, pl. 1. Phleger and Parker, 1951, p. 23, pl. 12, fig. 7.

"Rotalia" beccarii (Linné) variants. Parker, 1952a, p. 457, pl. 5, figs. 5, 7, 8. Parker et al., 1953, p. 13, pl. 4, figs. 20-22, 25-30. Parker, 1954, p. 531, pl. 10, figs. 1, 2, 5, 6. Phleger, 1954, p. 645, pl. 3, figs. 4-10. Lankford, 1959, p. 2099, pl. 3, figs. 10, 13.

Streblus beccarii (Linné) var. *sobrinus* (Shupack). Bandy, 1954, p. 138, pl. 30, fig. 7. Benda and Puri, 1962, p. 355, pl. 1, figs. 12-14.

Streblus beccarii (Linné) var. *tepida* (Cushman). Benda and Puri, 1962, p. 355, pl. 1, figs. 26, 27.

Streblus tepidus (Cushman). Bandy, 1956, p197, pl. 31, fig.2.

Ammonia parkinsoniana (d'Orbigny) forma *tepida* Cushman. Poag, 1978, p. 397, pl. 1, figs. 1-4, 10-12, 17, 18.

Ammonia parkinsoniana (d'Orbigny) forma *typica* Poag, 1978, p. 397, pl. 1, figs. 5-9, 13-16, 19-21.

In this study, the form *Ammonia beccarii tepida* was the most common, and *A. b. parkinsonia* and *A.b. advena* were rare. However, all these forms are ecophenotypic variants of *Ammonia beccarii*, as Schnitker (1974) demonstrated with culturing techniques.

Genus ***Amphistegina*** d'Orbigny, 1826

Amphistegina lessonii d'Orbigny, 1826

Plate 1, figure 10

Amphistegina lessonii d'Orbigny, 1826, p. 304, no. 3, pl. 17, figs. 1-4. Bock, 1971, p. 58, pl. 21, fig. 10.

This species is probably a synonym of *A. gibbosa* (Rose and Lidz, 1977).

Genus ***Angulogerina***, Cushman, 1927b

Angulogerina sp.

Plate 1, figure 11

]Genus ***Anomalina*** d'Orbigny, 1826

Anomalina glabrata Cushman, 1924

Anomalina glabrata Cushman, 1924, p. 39, pl. 12, figs. 5-7.

Anomalina globulosa Chapman and Parr, 1937

Anomalina globulosa Chapman and Parr, 1937, p. 117. Bock, 1971, p. 66, pl. 24, fig. 6.

Genus ***Archaias*** de Montfort, 1808

Archaias angulatus (Fichtel and Moll), 1803

Plate 1, figure 12

Nautilus angulatus Fichtell and Moll, 1803, p. 112, pl. 21, 2nd. ed.

Nautilus aduncus Fichtell and Moll, 1803, p. 115, pl. 23.

Nautilus orbicularis Fichtell and Moll, 1803, p. 112, pl. 21.

Archaias spirens de Montfort, 1808, p. 190, 48e genre.

Helenis spatosus de Montfort, 1808, p. 195, 49e genre.

Ilotus rotalitatus de Montfort, 1808, p. 199, 50e genre.

Orbiculina adunca Lamarck, 1816, pl. 468, figs. 2a-c.

Orbiculina angulata Lamarck, 1822, p. 609, no. 2.

Orbulina numismalis Lamarck, 1822, p. 609.

Archaias angulatus Cushman, 1928, p. 218, pl. 31, fig. 9. Bock, 1971, p. 35-36, pl. 14, figs. 1-3.

Genus ***Articulina*** d'Orbigny, 1826

Articulina antillarum Cushman, 1922b

Articulina antillarum Cushman, 1922b, p. 71, pl. 12, fig. 5. Bock, 1971, p. 31, pl. 12, fig. 13.

Articulina mayori Cushman, 1922

Articulina mayori Cushman, 1922b, p. 71, pl. 13, fig. 5. Bock, 1971, p. 31, pl. 13, fig. 2.

Articulina cf. mayori

This species was rare.

Articulina mexicana Cushman, 1921

Plate 1, figure 13

Vertebralina sp. Cushman, 1921, p. 64.

Articulina mexicana Cushman, 1922b, p. 70, pl. 11, figs. 7, 8. Bock, 1971, p. 31, pl. 13, fig. 3.

Articulina mucronata (d'Orbigny), 1839a

Plate 1, figure 14

Vertebralina mucronata d'Orbigny, 1839a, p. 52, pl. 7, figs. 16-19.

Articulina mucronata Cushman, 1944, pp. 1-21. Bock, 1971, p. 32, pl. 13, fig. 4.

Articulina pacifica Cushman, 1944

Plate 1, figure 15

Articulina sulcata Brady (not Reuss), 1884, p. 183, pl. 12, figs. 12, 13.

Articulina conico-articulata (Batsch), Cushman, 1917, p. 58, pl. 22, fig. 6.

Articulina pacifica Cushman, 1944, p. 17, pl. 14, figs. 14-18. Bock, 1971, p. 32, pl. 13, fig. 6.

Articulina sagra d'Orbigny, 1839

Articulina sagra d'Orbigny, 1839a, p. 160, pl. 9, figs. 23-26. Bock, 1971, p. 33, pl. 13, fig. 7.

]Genus ***Asterigerina*** d'Orbigny, 1839

Asterigerina carinata d'Orbigny, 1839

Plate 1, figures 16 and 17

Asterigerina carinata d'Orbigny, 1839a, p. 118, pl. 5, fig. 25; pl. 6, figs. 1, 2. Bock, 1971, p. 54, pl. 19, fig. 12; pl. 20, fig. 1.

Genus ***Astrononion*** Cushman and Edwards, 1937

Astrononion stelligerum (d'Orbigny), 1839

Plate 1, figure 18

Nonionina stelligera d'Orbigny, 1839a, p. 128, pl. 3, figs. 1, 2.

Astrononion stelligerum Cushman and Edwards, 1937, p. 31, pl. 3, figs. 7A, B. Bock, 1971, p. 65, pl. 24, figs. 1-3.

Genus ***Bigenerina*** d'Orbigny, 1826

Bigenerina irregularis Phleger and Parker, 1951

Bigenerina irregularis Phleger and Parker, 1951, p. 4, pl. 1, figs. 16-21. Bock, 1971, p. 9, pl. 2, fig. 5.

Genus ***Biloculinella*** Wiesner, 1931

Biloculinella sp.

This species was rare and not identified.

Genus ***Bolivina*** d'Orbigny, 1839a

Bolivina lanceolata Parker, 1954

Plate 1, figure 19

Bolivina lanceolata Parker, 1954, p. 514, pl. 7, figs. 17-20. Bock, 1971, p. 45, pl. 16, fig. 13.

Bolivina lowmani Phleger and Parker, 1951

Plate 1, figure 20

Bolivina lowmani Phleger and Parker, 1951, p. 13, pl. 6, figs. 20, 21. Parker, 1954, p. 515, pl. 7, fig. 21. Lankford, 1959, p. 2097, pl. 3, fig. 4. Bock, 1971, p. 46, pl. 16, fig. 14. *Brizalina lowmani* (Phleger and Parker). Scott et al., 1991, p. 384, pl. 2, fig. 12.

]Bolivina paula Cushman and Cahill, 1932

Bolivina paula Cushman and Cahill *in* Cushman and Ponton, 1932, p. 84, pl. 12, fig. 6. Bock, 1971, p. 46, pl. 16, fig. 15. Buzas and Severin, 1982, p 31., pl. 5, fig. 7.

Bolivina pseudoplicata Heron-Allen and Earland, 1930b

Bolivina pseudoplicata Heron-Allen and Earland, 1930b, p. 181, pl. 3, figs. 36-40. Cushman and Todd, 1947, p. 66, pl. 16, figs. 2, 3. Parker, 1952a, p. 444, pl. 4, fig. 11. Schnitker, 1971, p. 194, pl. 4, fig. 23. Scott et al., 1980, p. 226, pl. 4, fig. 3.

Bolivina pulchella var. ***primitiva*** Cushman, 1930

Plate 1, figure 21

Bolivina pulchella (d'Orbigny) var. *primitiva* Cushman, 1930a, p. 47, pl. 8, fig. 12. Bock, 1971, p. 46, pl. 17, fig. 1.

Bolivina striatula Cushman, 1922b

Plate 1, figure 22

Bolivina striatula Cushman, 1922b, p. 27, pl. 3, fig. 10. Parker et al., 1953, pl. 4, figs. 4, 5. Bandy, 1954, p. 135, pl.31, fig. 9. Lankford, 1959, p. 2097, pl. 3, fig. 6. Bock, 1971, p. 46, pl. 17, fig.1.

]Bolivina subexcavata Cushman and Wickenden, 1929

Plate 2, figure 1

Bolivina subexcavata Cushman and Wickenden, 1929, p. 9, pl. 4, fig. 4; Buzas and Severin, 1982, p. 32, pl. 5, fig. 9.

Bolivina subspinescens Cushman, 1922a

Bolivina subspinescens Cushman 1922a, p. 48, pl. 7, fig.5.

Bolivina tortuosa Cushman, 1936

Plate 2, figure 2

Bolivina tortuosa Cushman, 1936, p. 57. Steinker, 1980, p. 135, pl. 1, fig. 9.

Bolivina variabilis (Williamson), 1858

Plate 2, figure 3

Textularia variabilis Williamson, 1858, p. 76, pl. 6, figs. 162, 183.

Bolivina variabilis (Williamson), Parker, 1952a, p. 445, pl. 4, fig. 12. Wantland, 1975, p. 393, fig. 10, r.

Bolivina variabilis Williamson *v. spathulata* Williamson, 1858, p. 76, pl. 6, figs. 164, 165.

Bolivina variabilis and *Bolivina variabilis v. spathulata* were counted separately.

Genus ***Borelis*** de Montfort, 1808

Borelis pulchra (d'Orbigny), 1839a

Plate 2, figure 4

Alveolina pulchra d'Orbigny, 1839a, p. 70, pl. 8, figs. 19, 20.

Alveolina melo (part) (not Fitchell and Moll), Brady, 1884, p. 223, pl. 17, figs. 14, 15.

Borelis pulchra Cushman, 1930b, p. 55, pl. 15, figs. 9, 10. Bock, 1971, p. 37, pl. 14, fig. 7.

Genus ***Broeckina*** Munier-Chalmas, 1882

Broeckina orbitolitoides (Hofker), 1930

Plate 2, figure 5

Praesorites orbitolitoides Hofker, 1930, p.149, pl. 55, figs. 8, 10, 11, pl. 57, figs. 1-5, pl. 61, figs. 3, 14. Bock, 1971, p. 35, pl. 13, fig. 15. Hallock and Peebles, 1993, p. 284, pl. 2, figs. 5, 6.

]Genus ***Buccella*** Andersen, 1952

Buccella frigida (Cushman), 1922c

Pulvinulina frigida Cushman, 1922c, p. 46, pl. 7, fig. 6.

Buccella frigida (Cushman). Barker, 1960, p. 216, pl. 105, figs. 8,9.

Genus ***Bulimina*** d'Orbigny, 1826

Bulimina aculeata d'Orbigny, 1826

Plate 2, figure 6

Bulimina aculeata d'Orbigny, 1826a, p. 269, no 7. Schnitker, 1971, p. 194. Pl. 5, fig. 4.

Bulimina gibba Fornasini, 1902b

Bulimina gibba Fornasini, 1902b, p. 377, Barker, 1960, p. 102, pl. 50, figs. 1-4.

Bulimina marginata d'Orbigny, 1826.

Bulimina marginata d'Orbigny, 1826, p. 269, pl. 12, figs. 10, 12.

]Genus ***Buliminella*** Cushman, 1911

Buliminella elegantissima (d'Orbigny), 1839b

Plate 2, figure 7

Bulimina elegantissima d'Orbigny, 1839b, p. 51, pl. 7, figs. 13, 14.

Buliminella elegantissima (d'Orbigny). Parker et al., 1953, p. 6, pl. 4, figs. 8, 9. Phleger, 1954, p. 637, pl. 1, figs. 24, 25. Lankford, 1959, p. 2070, pl. 2, fig. 16. Bock, 1971, p. 44, pl. 16, fig. 9.

Buliminella milleti Cushman, 1933

Plate 2, figure 8

Buliminella milleti Cushman, 1933, p. 78. Todd and Low, 1971, p. C12, pl. 2, fig. 13.

Genus ***Calcarina*** d'Orbigny,1826

Calcarina calcar d'Orbigny

Calcarina calcar d'Orbigny, 1826, p. 276, Barker, 1960, p. 222, pl. 108, fig. 3,4.

]Genus ***Cancris*** de Montfort, 1808

Cancris sagra (d'Orbigny), 1839a

Rotalina sagra d'Orbigny, 1839a, p. 77, pl. 5, figs. 13-15.

Pulvinulina sagra Cushman, 1918, p. 70, pl. 24, figs. 6a, b.

Pulvinulina semipunctata Cushman, 1922b, p. 51, pl. 8, figs. 5, 6.

Cancris sagra Cushman, 1931, p. 74, pl. 15, figs. 2a-c. Bock, 1971, p. 53, pl. 19, figs 6, 7.

Genus ***Carpenteria*** Gray, 1858

Carpenteria proteiformis Goës, 1882

Plate 2, figure 9

Carpenteria balaniformis Gray var. *proteiformis* Goës, 1882, p. 94, pl. 6, figs. 208-214; pl. 17, figs. 215-219.

Carpenteria proteiformis Brady, 1884, p. 679, figs. 8-14. Bock, 1971, p. 62, pl. 23, fig. 4.

]Genus ***Cassidulina*** d'Orbigny, 1826

Cassidulina bradyi Norman, 1880

Cassidulina bradyi Norman *in* a manuscript, Wright, 1880, p. 152; Brady, 1881, p. 59; Brady, 1884, p. 431, pl. 54, figs. 6-9.

Cassidulinoides bradyi (Norman). Barker, 1960, p. 112, pl. 54, figs. 6-9.

Cassidulina carinata Cushman, 1922c

Cassidulina laevigata d'Orbigny v. *carinata* Cushman, 1922c, p. 124, pl. 25, figs. 6,7.

Cassidulina carinata Silvestri?. Barker, 1960, p. 110, pl. 54, fig. 2,3.

Cassidulina subglobosa Brady, 1881

Plate 2, figure 10

Cassidulina subglobosa Brady, 1881, p. 60. Bock, 1971, p. 64, pl. 23, fig. 12.

Genus ***Caterina*** Brady, 1884

Caterina spiculotesta (Carter), 1877

Rotalia spiculotesta Carter, 1877, p. 470, pl. 16.

Caterina spiculotesta (Carter). Brady, 1884, p. 346, pl. 41, figs. 7-10; Bermudez and Seiglie, 1963, p. 42, pl. 4, fig. 6 a-c.

Genus ***Cibicides*** de Montfort, 1808

Cibicides cicatricosus Schwager, 1866

Cibicides cicatricosus Schwager, 1866, p. 260, pl. 7, figs. 108. Barker, 1960, p. 194, pl. 94, fig. 8.

Cibicides lobatulus (Walker and Jacob), 1798

Plate 2, figures 11 and 12

Nautilus lobatulus Walker and Jacob, 1798, p. 642, pl. 14, fig. 36.

Truncatulina lobatula (Walker and Jacob). d'Orbigny, 1839a, p. 134, pl. 2, figs. 22-24. Brady, 1884, p. 660, pl. 92, fig. 10; pl. 93, fig. 1. Cushman, 1918, p. 16, pl. 1, fig. 10; p. 60, pl. 17, figs. 1-3.

Cibicides lobatulus (Walker and Jacob). Cushman, 1927a, p. 170, pl. 27, figs. 12, 13. Cushman, 1935, p. 52, pl. 52, figs. 4-6. Parker, 1952a, p. 446, pl. 5, fig. 11. Scott et al., 1980, p. 226, pl. 4, figs. 8, 9.

]Cibicides pseudoungeriana var. io Cushman, 1931

Cibicides pseudoungeriana Cushman v. *io* Cushman, 1931, p. 125, pl. 23, figs. 1, 2.

Cibicides refulgens de Montfort, 1808

Plate 2, figures 13 and 14

Cibicides refulgens de Montfort, 1808, p. 122; Barker, 1960, p. 190, pl. 92, fig. 7-9.

Genus ***Clavulina*** d'Orbigny, 1826

Clavulina difformis Brady, 1884

Clavulina angularis d'Orbigny v. *difformis* Brady, 1884, p. 396, pl. 48, figs. 25-31

Clavulina difformis Brady. Cushman, 1924, p. 23, pl. 6 figs. 5,6; Barker, 1960, p. 98, pl. 98, figs. 25-31.

Clavulina tricarinata d'Orbigny, 1839a

Plate 2, figure 15

Clavulina tricarinata d'Orbigny, 1839a, p. 111, pl. 2, figs. 16-18. Bock, 1971, p. 11, pl. 2, fig. 14. Steinker, 1980, p. 135, pl. 2, fig. 2.

]Genus ***Cyclogyra*** Wood, 1842

Cyclogyra involvens (Reuss), 1850

Operculina involvens Reuss, 1850, p. 370, pl. 46, fig. 30

Cornuspira involvens Reuss, 1863, p. 39, pl.1, fig.2

Cyclogyra involvens (Reuss). Bock, 1971, p. 12.

Cyclogyra planorbis Schultze, 1854

Plate 2, figure 16

Cornuspira planorbis Schultze, 1854, p. 40, pl. 2, fig. 21.

Cyclogyra planorbis Schultze. Bock, 1971, p. 12, pl. 3, fig.3. Steinker, 1980, p. 135, pl. 2, fig. 3.

Genus ***Cyclorbiculina*** Silvestri, 1937

Cyclorbiculina compressa (d'Orbigny), 1839a

Plate 2, figure 17

Orbiculina compressa d'Orbigny 1839a, p. 66, pl. 8, figs. 4-7.

Cyclorbiculina compressa (d'Orbigny), Hallock and Peebles, 1993, p. 282, pl. 2, fig. 5.

This form is called "*Archaias compressus*" by Bock, 1971, p. 36, pl. 14, fig. 4.

Genus ***Cymbaloporetta*** Cushman, 1928

Cymbaloporetta bradyi (Cushman), 1915

Cymbalopora poeyi (d'Orbigny) *var. bradyi*. Cushman, 1915, p. 25, pl. 10, fig.2, pl. 14, fig.2.

Cymbaloporetta bradyi (Cushman). Todd and Bronnimann, 1957, p. 37, pl. 11, fig. 9.

Barker, 1960, p. 210, pl. 102, fig. 14.

Cymbaloporetta squamosa (d'Orbigny), 1826

Plate 2, figures 18 and 19

Rotalia squamosa d'Orbigny, 1826, p. 272, no. 8.

Rosalina squamosa d'Orbigny, 1839a, p. 91, pl. 3, figs. 12-14.

Rosalina poeyi d'Orbigny, 1839a, p. 62, pl. 3, figs. 18-20.

Cymbalopora poeyi Carpenter, Parker and Jones, 1862, p. 215, pl. 13, figs. 10-12.

Cymbalopora poeyi Carpenter, Parker and Jones, var. *squamosa* Chapman, 1902, p. 385, 405.

Cymbalopora squamosa Cushman, 1922b, p. 41, pl. 6, figs. 4-6.

Cymbaloporetta sqaumosa Cushman, 1928, p. 7, Bock, 1971, p. 61, pl. 23, figs. 1, 2.

]Genus ***Dentalina*** Risso, 1826

Dentalina sp.

This species was rare and not identified.

Genus ***Dentritina*** d'Orbigny, 1826

Dentritina antillarum d'Orbigny, 1826

Dentritina antillarum d'Orbigny, 1826, p. 39, no. 3. Steinker, 1980, p. 135, pl. 2, fig.4.

Genus ***Discanomalina*** Asano, 1951

Discanomalina semipunctata (Bailey, 1851)

Rotalina semipunctata Bailey, 1851, p. 11, figs. 17-19.

Anomalina coronata Parker and Jones, 1857, p. 294, pl. 10, figs. 15-18.

Discanomalina japanica Asano, 1951a, p. 13, figs. 3-5.

]Genus ***Discorbis*** Lamarck, 1804

Discorbis sp.

Discorbis mira Cushman, 1922b

Plate 2, figures 20 and 21

Discorbis mira Cushman, 1922b, p. 39, pl. 6, figs. 10, 11.

Discorbis mirus (Cushman). Graham and Militante, 1959, p. 93, pl. 13, fig. 23.

Discrobina turbo d'Orbigny, Brady, 1884, p. 642, pl. 87, fig. 8.

Rotorbinella mira (Cushman). Todd, 1965, p.18, pl. 8, fig. 2. Bock, 1971, p51, pl. 18, figs. 3, 4. Steinker, 1980, p. 135, pl. 2, fig. 5.

Genus ***Discorinopsis*** Cole, 1941

Discorinopsis aguayoi (Bermudez), 1935

Plate 2, figures 22 to 26

Discorbis aguayoi Bermudez, 1935, p. 204, pl. 15, figs. 10-14.

Discorinopsis aguayoi (Bermudez). Phleger, Parker and Peirson, 1953, p. 7, pl. 4, figs. 23, 24.

Trichohyalus aguayoi (Bermudez). Bermudez and Seiglie, 1963, p. 176, pl. 26, fig. 4

Discorinopsis aguayoi (Bermudez). Arnold, 1954, p. 6-12, pl.1, figs. 1-10. Bock, 1971, p. 50, pl. 18, fig. 42. Steinker, 1980, p. 135, pl. 2, fig. 6.

S.E.M. photographs show the variability of this species in test perforation, test shape, and amount of spongy material on the ventral side. This variability has been shown before only in cultured specimens (Arnold, 1954).

Genus ***Elphidium*** de Montfort, 1808

Elphidium advenum (Cushman), 1922b

Plate 3, figure 1

Polystomella subnodosa Brady, (not von Munster), 1884, p. 743, pl. 110, , fig. 1.

Polystomella advena Cushman, 1922b, p. 56, pl. 9, figs. 11, 12.

Elphidium advenum Cushman, 1930b, p. 25, pl. 10, figs. 1, 2. Bock, 1971, p. 56, pl. 20, figs. 7, 8.

Elphidium articulatum (d'Orbigny), 1839a

Polystomella articulata d'Orbigny, 1839a, p. 30, pl. 3, figs. 9, 10.

Elphidium articulatum (d'Orbigny). Steinker, 1980, p. 135, pl. 2, fig. 8.

Elphidium discoidale (d'Orbigny), 1839a

Plate 3, figure 3

Polystomella discoidalis d'Orbigny, 1839a, p. 56, pl. 6, figs. 23, 24.

Elphidium discoidale Cushman, 1930b, p. 22, pl. 8, figs. 8, 9. Bock, 1971, p. 56, pl. 20, figs. 9, 10. Steinker, 1980, p. 135, pl. 2, fig. 9.

Elphidium excavatum (Terquem) forma ***excavatum*** (Terquem), 1876

Plate 3, figure 4

Polystomella excavata Terquem, 1876, p. 429, pl. 2, fig. 2.

Elphidium excavatum (Terquem). Cushman, 1930b, p. 21, pl. 8, figs. 1-7. Cushman, 1944, p. 26, pl. 2, fig. 40.

Elphidium excavatum (Terquem) forma *excavata* (Terquem). Miller et al., 1982, p. 128, pl. 1, figs. 9-12; pl. 2, figs. 1, 2; pl. 4, figs. 13-16; pl. 5, figs. 15, 15; pl. 6, figs. 6-8, 14.

Elphidium poeyanum (d'Orbigny), 1839a

Plate 3, figure 5

Polystomella poeyana d'Orbigny, 1839a, p. 55, pl. 6, figs. 25, 26.

Cribroelphidium kugleri Cushman and Brönnimann, 1948a, p. 18, pl. 4, fig. 4.

Cribroelphidium poeyanum (d'Orbigny). Bock, 1971, p. 57, pl. 21, figs. 1, 2.

Elphidium kugleri (Cushman and Brönnimann). Hansen and Lykke-Andersen, 1976, p. 12, pl. 9, figs. 4-8.

Elphidium poeyanum (d'Orbigny). Cushman, 1930b, p. 25, pl. 10, figs. 4, 5. Parker et al., 1953, p. 9, pl. 3, fig. 26. Bandy, 1954, p. 136, pl. 30, fig. 6. Parker, 1954, p. 509, pl. 6, fig. 17. Phleger, 1954, p. 639, pl. 2, figs. 8, 9. Steinker, 1980, p. 136, pl. 3, fig. 1.

Elphidium sagrum (d'Orbigny), 1839a

Plate 3, figure 6

Polystomella sagra d'Orbigny, 1839a, p. 55, pl. 6, figs. 19, 20.

Polystomella lanieri Cushman, 1920b, p. 72, pl. 11, fig. 22.

Elphidium sagrum Cushman, 1930b, p. 24, pl. 9, figs. 5, 6. Bock, 1971, p. 56-57, pl. 20, figs 11, 12. Steinker, 1980, p. 136, pl. 3, fig. 2.

Elphidium sp.

Plate 3, figure 2

This species was common in lagoons and is easily recognizable by its numerous large pores on the smooth transparent chamber surface

Elphidium spp.

Other rarer forms of *Elphidium* were not identified at the species level.

Genus ***Epistominella*** Husezima and Maruhasi, 1944

Epistominella pulchra (Cushman), 1933

Plate 3, figures 7 and 8

Pulvinulinella pulchra Cushman, 1933, p. 92, pl. 9, figs. 10a-c.

Epistominella pulchra(Cushman). Cushman et al., 1954, p. 365,

Genus ***Eponides*** de Montfort, 1808

Eponides antillarum (d'Orbigny), 1839a

Rosalina antillarun d'Orbigny, 1839a, p. 75, pl. 5, figs. 4-6.

Truncatulina antillarum Fornasini, 1902a, p. 63.

Pulvinilina incerta Cushman, 1922a , p. 51, pl. 9, figs. 1-3.

Eponides antillarum Cushman, 1931, p. 42, pl. 9, fig.2; Bock, 1971, p. 57, pl. 21, figs. 4, 5.

Eponides repandus (Fichtel and Moll), 1798

Plate 3, figures 9 and 10

Nautilus repandus Fichtel and Moll, 1798, p. 35, pl. 3, figs. a-d.

Eponides repandus (Fichtel and Moll). Barker, 1960, p. 214, pl. 104, fig. 18. Bock, 1971, p. 58, pl. 21, figs. 6, 7.

Eponides tuberculata (Balkwell and Wright), 1885

Discorbina tuberculata Balkwell and Wright, 1885, p. 350, pl. 13, figs. 28-30.

Eponides (?) tuberculata (Balkwell and Wright). Cushman, 1931, p. 55, pl. 11, fig. 5a-c.

Genus ***Fissurina*** Reuss, 1850

Fissurina spp.

The species of this genus were rare and were not identified.

Genus ***Floresina*** Marie, 1938

Floresina sp.

Genus ***Fursenkoina*** Loeblich and Tappan, 1961

Fursenkoina complanata (Egger), 1893

Plate 3, figure 11

Virgulina schreibersiana Czjzek var. *complanata* Egger, 1893, p. 292, pl. 8, figs. 91, 92. Bock, 1971, p. 62, pl. 23, fig. 6.

Fursenkoina pauciloculata (Brady), 1884

Virgulina pauciloculata Brady, 1884, p. 414, pl. 52, figs. 4, 5.

Fursenkoina pontoni (Cushman), 1932

Virgulina pontoni Cushman, 1932, p. 17, pl. 3, fig. 7. Bock, 1971, p. 63, pl. 23, fig. 9.

Genus ***Glabratella*** Dorreen, 1948

Glabratella carinata (d'Orbigny), 1839a

Asterigerina carinata d'Orbigny, 1839a, p. 118, pl. 5, fig. 25, pl. 6, figs. 1,2; Cushman, 1931, p. 77, pl. 15, figs. 4,5.

Rotalia carinata (d'Orbigny). Brady, 1884, p. 703.

Glabratella opercularis (d'Orbigny), 1826

Rosalina opercularis d'Orbigny, 1826, p. 271, fig. 7.

Planoglabratella opercularis (d'Orbigny). Jones, 1994, p. 95, pl. 89, figs. 8,9.

Glabratella sagrai (Todd and Brönnimann), 1957

Rosalina sagrai Todd and Brönnimann, 1957, p. 37, pl. 9, figs. 22a-c.

Glabratellina sagrai (Todd and Brönnimann). Buzas and Severin, 1982, p. 35, pl. 7, figs. 5,6.

Genus **_Globobulimina_** Cushman, 1921

Globobulimina pacifica (Cushman), 1927c

Bulimina pyrula (d'Orbigny). Brady, 1884, p. 399, pl. 50, figs. 7-10.

Globobulina pacifica Cushman, 1927c, p. 67, pl. 14, fig.12.

Globobulimina pacifica (Cushman). Barker, 1960, p. 102, pl. 50, figs. 7-10.

Genus ***Globorotalia*** Cushman, 1927c

Globorotalia sp.

This species was rare and not identified.

Genus ***Glomospira*** Rzehak, 1885

Glomospira charoides (Jones and Parker), 1860

Trochammina squamata Jones and Parker v. *charoides* Jones and Parker, 1860, p. 304.

Glomospira charoides (Jones and Parker). Höglund, 1947, p. 129, pl. 3, fig. 11; Barker, 1960, p. 78, pl. 38, figs. 10-16.

Glomospira irregularis (Grzybowski),1898

Plate 3, figure 12

Ammodiscus irregularis Grzybowski, 1898, p. 285, pl. 11, figs. 2-3

Glomospira irregularis (Grzybowski).- Geroch, 1960, pl. 8, figs. 11-12

Glomospira ? (*Tolypammina*) *irregularis* (Grzybowski). Hemleben and Trvster, 1984, p. 519, pl. 1, fig. 22

This species is separated from all other species of the genus *Glomospira* by its coarser agglutination and its irregular coiling.

Genus ***Gyroidina*** d'Orbigny, 1826

Gyroidina sp.

Gyroidina soldanii d'Orbigny, 1826

Gyroidina soldanii d'Orbigny, 1826, p. 278, no. 5; Cushman, 1931, p. 38, pl. 8, figs. 3-8.

Genus ***Gypsina*** Carter, 1877

Gypsina vesicularis (Parker and Jones), 1860

Plate 3, figure 13

Orbitolina vesicularis Parker and Jones, 1860, p. 31.

Gypsina vesicularis (Parker and Jones). Wantland, 1975, p. 397, pl. 12, c.

Genus ***Hanzawaia*** Asano, 1944

Hanzawaia concentrica (Cushman), 1918

Truncatulina concentrica Cushman, 1918, p. 64, pl. 21, fig. 3

Cibicides concentrica (Cushman). Renz, 1948, p. 127, pl. 10, fig. 8.

Hanzawaia concentrica (Cushman). Drooger and Kaasschieter, 1958, p. 49, fig. in map 17. Wantland, 1975, p. 399, fig. 6, n.

Genus ***Haplophragmoides*** Cushman, 1910

Haplophragmoides wilberti Andersen, 1953

Plate 3, figure 14

Haplophragmoides wilberti Andersen, 1953, p. 21, pl. 4, fig.7. Zaninetti et al., 1977, pl. 1, figs. 12, 13. Boltovskoy, 1984, fig. 7. Scott et al., 1991, p. 385, pl. 1, figs 20, 21.

Genus ***Hauerina*** d'Orbigny, 1839

Hauerina speciosa (Karrer), 1868

Spiroloculina speciosa Karrer, 1868, p. 135, pl. 1, fig. 8.

Hauerina speciosa (Karrer), Said, 1949, p. 17, pl. 2, fig. 10. Bock, 1971, p. 30, pl. 12, figs. 10, 11.

Genus ***Helenina*** Saunders, 1961

Helenina anderseni (Warren), 1957

Plate 3, figures 15 and 16

Pseudoeponides anderseni Warren, 1957, p. 39, pl. 4, figs. 12-15.

Helenina anderseni (Warren). Saunders, 1961, p. 148. Scott and Medioli, 1980a, p. 40, pl. 5, figs. 10, 11. Scott et al., 1991, p. 385, pl. 2, figs. 19, 20. Steinker, 1980, p. 136, pl. 3, fig. 3.

Genus ***Hoeglundina*** Brotzen, 1948

Hoeglundina elegans (d'Orbigny), 1826

Plate 3, figures 17 and 18

Rotalina (*Turbinulina*) *elegans* d'Orbigny, 1826, p. 276,no. 54.

Pulvinulina elegans Parker, Jones and Brady, 1871, p. 174, pl. 12, fig. 142.

Epistomina elegans Martinotti, 1926, p. 3.

Hoeglundina elegans Brotzen, 1948, p. 92. Bock, 1971, p. 66, pl. 24, figs. 7-10.

Genus ***Homotrema*** Hickson, 1911

Homotrema rubrum (Lamarck), 1816

Plate 3, figure 19

Milipora rubra Lamarck, 1816, p. 202.

Polytrema rubra Dujardin, 1841, p. 259.

Homotrema rubrum Hickson, 1911, p. 445, 454, pl. 30, fig.2; pl. 31, fig. 9; pl. 32, figs. 19, 22, 28. Bock, 1971, p. 61, pl. 23, fig. 3.

Genus ***Hopskinsina*** Howe and Wallace, 1932

Hopskinsina pacifica Cushman, 1933

Hopskinsina pacifica Cushman, 1933, p. 86, pl. 8, fig. 16. Wantland, 1975, p. 393, pl.5, k.

Genus ***Involutina*** Kristan-Tollman, 1960

Involutina sp.

This species was rare and not identified.

Genus ***Lagena*** Walker and Boys, 1784

Lagena spiralis Brady, 1884

Lagena spiralis Brady, 1884, p. 114, fig. 9. Barker, 1960, pl. 114, fig. 9.

Lagena spp.

The other species of *Lagena* were not identified.

Genus ***Lamarckina*** Berthelin, 1881

Lamarckina atlantica Cushman, 1931

Lamarckina atlantica Cushman, 1931, p. 34-35, pl. 7, figs. 7a-c.

Lamarckina haliotidea Heron-Allen and Earland, 1911

Pulvinulina haliotoidea Heron-Allen and Earland, 1911, p. 338, pl. 11, figs. 6-11.

Lamarckina haliotoidea (Heron-Allen and Earland). Cushman, 1931, p. 36, pl. 7, figs. 8,9.

Genus ***Laticarinina*** Galloway and Wissler, 1927

Laticarinina pauperata Parker and Jones, 1865

Pulvinulina repanda v. *menardii,* subvar. *pauperata* Parker and Jones, 1865, p. 395, pl. 16, figs. 50,51; Cushman, 1931, p. 114, pl. 20, figs. 4a-c, pl. 21, figs. 1a-c.

Laticarinina halophora (Stache). Barker, 1960, p. 214, pl. 104, figs. 3-11.

Laticarinina pauperata (Parker and Jones). Jones, 1994, p. 104, pl. 104, figs. 3-11.

Genus ***Lenticulina*** Lamarck, 1804

Lenticulina calcar (Linne), 1767

Nautilus calcar Linne, 1767, p. 162, no. 272.

Cristellaria calcar Parker, Jones and Brady, 1871, p. 241, pl. 10, figs. 91, 93, 94.

Lenticulina calcar Thalmann, 1932, p. 304. Bock, 1971, p. 40, pl. 15, fig. 7.

Genus ***Loxostomum*** Ehrenberg, 1854

Loxostomum limbatum (Brady)

Bolivina limbata Brady, 1884, pl. 52, figs. 31, 32.

Loxostomum limbatum (Brady). Cushman, 1937, p. 186, pl. 21, figs. 28, 29.

Loxostomum mayori (Cushman), 1922b

Plate 3, figure 20

Bolivina mayori Cushman, 1922, p. 27, pl. 3, figs. 5, 6.

Loxostomum mayori Bermudez, 1935, p. 197. Bock, 1971, p. 63, pl. 23, fig. 10.

Loxostomum porrectum (Brady), 1884

Plate 3, figure 21

Bolivina porrecta Brady, 1884, p. 106, pl. 52, fig. 22.

Bifarina porrecta Millett, 1900, p. 540, pl. 4, fig. 3.

Loxostomum porrectum Cushman, 1937, p. 190. Bock, 1971, p. 63, pl. 23, fig. 11.

Genus ***Massilina*** Schlumberger, 1893

Massilina protea Parker, 1953

Massilina protea Parker, 1953, p. 10, pl. 2, figs. 1-4, text fig. 2. Bock, 1971, p. 22, pl. 8, figs. 8, 9.

Genus ***Melonis*** de Montfort 1808

Melonis pompilioides Fichtel and Moll, 1798

Plate 3, figure 22

Nautilus pompilioides Fichtel and Moll, 1798, p. 31, pl. 2, figs. a-c.

Nonion pompilioides (Fichtel and Moll). Cushman, 1930b, p. 4, pl. 1, figs. 7-11, pl. 2, figs. 1, 2. Barker, 1960, p. 224, pl. 109, figs. 10,11.

Melonis pompilioides (Fichtel and Moll). Jones, 1994, p. 108, pl. 109, figs. 10,11.

Genus ***Miliammina*** Heron-Allen and Earland, 1930a

Miliammina fusca (Brady), 1870

Plate 3, figure 23

Quinqueloculina fusca Brady, 1870, p.286, pl. 11, figs 2, 3.

Miliammina fusca (Brady). Parker et al., 1953, p. 10, pl. 1, figs. 40, 41. Scott and Medioli, 1980a, p. 40, pl.2, figs. 1-3. Scott et al., 1991, p. 386, pl. 1, fig. 14.

Genus ***Miliolinella*** Wiesner, 1931

Miliolinella circularis (Bornemann), 1855

Triloculina circularis Bornemann, 1855, p. 349, pl. 19, figs. 4a-c.

Miliolina circularis Brady, 1884, p. 169, pl. 4, fig. 3, pl. 5, figs. 13, 14.

Miliolinella circularis Asano, 1951b, p. 9, figs. 65-67. Bock, 1971, p. 29, pl. 12, fig. 5. Steinker, 1980, p. 136, pl. 3, fig. 7.

Miliolinella fichteliana (d'Orbigny), 1839a

Plate 3, figure 24

Triloculina fichtelina d'Orbigny, 1839a, p. 171, pl. 9, figs. 8-10. Bock, 1971, p. 29, pl. 12, fig. 6. Steinker, 1980, p. 136, pl. 3, fig. 8.

Miliolinella cf. fichteliana

This species was rare.

Miliolinella labiosa (d'Orbigny), 1839a

Plate 3, figure 25

Triloculina labiosa d'Orbigny, 1839a, p. 178, pl. 10, figs. 12-14.

Miliolina labiosa Brady, 1884, p. 170, pl. 6, figs. 3-5.

Miliolinella labiosa Said, 1950, p. 5, pl. 1, fig. 10. Bock, 1971, p. 29, pl. 12, fig. 7. Steinker, 1980, p. 136, pl. 3, fig. 9.

Genus ***Monalysidium*** Chapman, 1900

Monalysidium politum Chapman, 1900

Plate 3, figure 26

Peneroplis (*Monalysidium*) *polita* Chapman, 1900, p. 179, p.4, pl. 1, fig. 5.

Monalysidium politum (Chapman), Heron-Allen and Earland, 1915, p. 603. Bock, 1971, p. 34, pl. 13, fig. 12.

Genus ***Mychostomina*** Berthelin, 1881

Mychostomina revertens (Rhumbler)

Plate 3, figure 27

Spirillina vivipara Ehrenberg v. *revertens* Rhumbler, 1906, p. 32; Barker, 1960, p. 176, pl. 85, fig. 5.

Mychostomina revertens (Rhumbler). Galloway, 1933, p. 88.

Mychostomina sp.

This species was rare and not indentified.

Genus ***Neoconorbina*** Hofker, 1951

Neoconorbina terquemi (Rzehak), 1888

Plate 4, figures 1 and 2

Discorbina terquemi Rzehak, 1888, p. 228.

Neoconorbina terquemi (Rzehak). Steinker, 1980, p. 136, pl. 4, fig.1.

Genus ***Neouvigerina*** Thalmann, 1952

Neouvigerina porrecta (Brady), 1879

Uvigerina porrecta Brady, 1879, p. 60, pl. 8, figs. 15,16.

Neouvigerina porrecta (Brady). Hofker, 1951, p. 213; Barker, 1960, p. 156, pl. 74, figs. 24-26.

Genus ***Nodosaria*** Lamarck, 1812

Nodosaria sp.

This species was rare and not identified.

Genus ***Nonion*** de Montfort, 1808

Nonion depressulum var. ***matagordanum*** Kornfeld, 1931

Plate 4, figure 3

Nonion depressulum (Walker and Jacob) var. *matagordanum* Kornfeld, 1931, p 87, pl. 13, figs. 2a, b. Bock, 1971, p. 64, pl. 23, fig. 14.

Nonion grateloupi (d'Orbigny), 1826

Plate 4, figure 4

Nonionina grateloupi d'Orbigny, 1826, p. 294, no. 19.

Nonion grateloupi Cushman, 1930b, p. 10, pl. 3, figs. 9-11; pl. 4, figs. 1-4. Bock, 1971, p. 65, pl. 23, fig. 15.

Nonion spp.

Other rarer species of this genus were not identified at the species level.

Genus ***Nonionella*** Cushman, 1926

Nonionella turgida (Williamson)

Rotalina turgida Williamson, 1858, p. 50, pl. 4, figs. 95-97

Nonionella opima (Cushman). Cimerman and Langer, 1991, p. 74, pl. 84, figs. 1-3.

Nonionella turgida (Williamson). Barker, 1960, p. 224, pl. 109, figs. 17-19.

Nuttallides Findlay, 1939

Nuttallides umbonifera (Cushman), 1933

Pulvinulina umbonifera Cushman, 1933, p. 90, pl. 9, figs. 9a-c.

Eponides bradyi Earland. Barker, 1960, p. 196, pl. 95, figs. 9, 10.

Genus ***Ophtalmidium*** KÜbler and Zwingli, 1870

Ophtalmidium sp.

This species was rare and not identified.

Genus ***Orbulina*** d'Orbigny, 1839a

Orbulina sp.

This species was rare and not identified.

Genus ***Oridorsalis*** Andersen, 1961

Oridorsalis umbonatus (Reuss)

Rotalina umbonata Reuss, 1851, p. 75, pl. 5, figs. 86-89.

Eponides umbonatus (Reuss). Cole, 1928, p. 215, pl. 2, fig. 6.

Oridorsalis umbonatus (Reuss). Lohmann, 1978, p. 26, pl. 4, figs. 1-3.

Genus ***Osangularia*** Brotzen, 1940

Osangularia culter (Parker and Jones), 1865

Planorbulina culter Parker and Jones, 1865, p. 4231, pl. 19, fig. 1.

Truncatulina culter (Parker and Jones) Brady, 1884, p. 668, pl. 96, fig. 3.

Pulvinulinella culter (Parker and Jones) Cushman, 1927b, p. 164, pl. 5, figs. 8, 9.

Parella culter (Parker and Jones) Hokfer, 1951, p. 336, Text figs. 229-232.

Osangularia culter (Parker and Jones) Parker, Phleger and Peirson, 1953, p. 42, pl. 9, figs. 11, 16. Bock, 1971, p. 65, pl. 24, figs. 4, 5.

Genus ***Palmerinella*** Bermudez, 1934

Palmerinella palmerae Bermudez, 1934

Palmerinella palmerae Bermudez, 1934, p. 84, figs. 1-3. Wantland, 1975, p. 395, pl. 4, p.

Genus ***Parrina*** Cushman, 1931

Parrina bradyi (Millett)

Plate 4, figure 5

Nubercularia bradyi Millett, 1898, p. 261, pl. 5, figs. 6a,b.

Parrina bradyi (Millett). Barker, 1960, p. 2, pl. 1, figs. 5,6.

Genus ***Patellina*** Williamson, 1858

Patellina sp.

Patellina corrugata Williamson, 1858

Plate 4, figures 6 and 7

Patellina corrugata Williamson, 1858, p. 46, pl. 3, figs. 86-89. Phleger and Parker, 1951, p. 23, pl. 12, fig. 4. Steinker, 1980, p. 136, pl. 4, fig. 4.

Genus ***Peneroplis*** de Montfort, 1808

Peneroplis bradyi Cushman, 1930b

Plate 4, figure 8

Peneroplis bradyi Cushman, 1930b, p. 40, p. 114, figs. 8-10. Bock, 1971, p. 33, pl. 13, fig. 8.

Peneroplis carinatus d'Orbigny, 1839b

Peneroplis carinatus d'Orbigny, 1839b, p. 33, pl. 3, figs. 7, 8. Bock, 1971, p. 33, pl. 13, fig. 8.

This species was compted with *P. proteus,* because of the morphological similarity of the two species, especially in young stages.

Peneroplis pertusus (Forskal), 1775

Plate 4, figure 9

Nautilus pertusus Forskal, 1775, p. 125, no. 65.

Peneroplis pertusus Jones, Parker and Brady, 1866, p. 19. Bock, 1971, p. 34, pl. 13, fig. 10.

Peneroplis proteus d'Orbigny, 1839a,

Plate 4, figure 10

Peneroplis protea d'Orbigny, 1839a, p. 60, pl. 7, figs. 7-11.

Peneroplis proteus Cushman, 1921, p. 75, pl. 18, figs. 13-19. Bock, 1971, p. 34, pl. 13, fig. 11.

Genus ***Pileolina*** Bermudez, 1952

Pileolina patelliformis (Brady)

Discorbina patelliformis Brady, 1884, p. 647, pl. 83, figs.3a-c, pl. 84, fig. 1.

Pileolina(?) *patelliformis* (Brady). Barker, 1960, p. 183, 184, pl. 83, figs. 3a-c, pl. 84, fig. 1.

Genus ***Placopsilina*** d'Orbigny, 1850

Placopsilina bradyi Cushman and McCulloch, 1939

Plate 4, figure 11

Placopsilina bradyi Cushman and McCulloch, 1939, p. 112; Barker, 1960, p. 74, pl. 36, fig.1.

Genus ***Planispirinella*** Weisner, 1931

Planispirinella sp.

This species was rare and not identified.

Genus ***Planispirinoides*** Parr, 1950

Planispirinoides bucculentus (Brady)

Plate 4, figures 12 to 14

Miliolina bucculenta Brady, 1884, p. 170, pl. 114, fig. 3.

Planispirinoides bucculentus (Brady). Parr, 1950, p. 287. Barker, 1960, p. 234, pl. 114, fig.3.

Genus ***Planorbulina*** d'Orbigny, 1826

Planorbulina acervalis Brady, 1884

Plate 4, figure 15

Planorbulina acervalis Brady, 1884, p. 657, pl. 92, fig. 4. Bock, 1971, p. 60, pl. 22, figs. 9, 10. Wantland, 1975, p. 307, pl. 11, d.

Planorbulina mediterranensis d'Orbigny, 1826

Plate 4, figure 16

Planorbulina mediterranensis d'Orbigny, 1826, p. 280, no. 2, pl. 14, figs. 4-6. Bock, 1971, p. 60, pl. 22, figs. 11, 12. Wantland, 1975, p. 397, pl. 11, b.

Planorbulina variabilis (d'Orbigny), 1826

Truncatulina variabilis d'Orbigny, 1826, p. 279.

Cibicidella variabilis (d'Orbigny). Cushman, 1931, p. 127, pl. 24, fig. 3.

Planorbulina variabilis (d'Orbigny). Loeblich and Tappan, 1988, p. 588.

Genus ***Planulina*** d'Orbigny, 1826

Planulina caribaea Cushman, 1931

Planulina caribaea Cushman, 1931, p. 112, pl. 20, figs. 1a-c.

Planulina edwardsiana (d'Orbigny), 1839a

Rosalina edwardsiana d'Orbigny, 1839a, p. 106, pl. 6, figs. 8-10.

Anomalina edwardsiana (d'Orbigny). Cushman, 1922b, p. 50, pl. 8, figs. 1, 2.

Planulina exorna Phleger and Parker, 1951

Plate 4, figures 17 and 18

Planulina exorna Phleger and Parker, 1951, p. 32, pl. 18, figs. 5-8. Bock, 1971, p. 59, pl. 21, figs. 11, 12.

Genus ***Polysaccammina*** Scott, 1976b

Polysaccammina ipohalina Scott, 1976b

Plate 4, figure 19

Polysaccammina ipohalina Scott, 1976b, p. 316, pl. 2, figs. 1-4; text-fig. 4. Scott and Medioli, 1980a, p. 43, pl. 2, figs. 8-11. Scott et al., 1991, p. 386, pl. 2, fig. 3.

Genus ***Pseudothurammina*** Scott, Medioli and Williamson, *In* Scott et al., 1981

Pseudothurammina limnetis (Scott and Medioli), 1980a

Plate 4, figure 20

Astrammina sphaerica (Heron-Allen and Earland). Zaninetti et al., 1977, pl. 1, fig. 9.

Thurammina (?) *limnetis* Scott and Medioli, 1980a, p. 43, pl. 1, figs. 1-3.

Pseudothurammina limnetis (Scott and Medioli) *In* Scott et al., 1981, p. 126. Scott et al., 1991, p. 386, pl. 2, fig. 4.

Genus ***Pyrgo*** Defrance, 1824

Pyrgo denticulata (Brady), 1884

Plate 4, figure 21

Biloculina ringens Lamarck var. *denticulata* Brady, 1884, p. 143, pl. 3, figs. 4, 5.

Biloculina denticulata Cushman, 1917, p. 80, pl. 33, fig. 1.

Pyrgo denticulata Cushman, 1929, p. 80, pl. 33, fig. 1. Bock, 1971, p. 23, pl. 8, fig. 11.

Pyrgo elongata (d'Orbigny), 1826

Plate 4, figure 22

Biloculina elongata d'Orbigny, 1826, p. 298, No. 4.

Pyrgo elongata Cushman, 1929, p. 70, pl. 19, figs. 2, 3. Bock, 1971, p. 23, pl. 8, figs. 1, 2.

Pyrgo subsphaerica (d'Orbigny), 1839a

Plate 4, figure 23

Biloculina subsphaerica d'Orbigny, 1839a, p. 162, pl. 8, figs. 25-27.

Pyrgo subsphaerica Cushman, 1929, p. 68, pl. 18, figs. 1, 2. Bock, 1971, p. 24, pl. 8, fig. 15.

Genus ***Quinqueloculina*** d'Orbigny, 1826

Quinqueloculina agglutinans d'Orbigny, 1839a

Plate 4, figures 24 and 25; plate 5, figure 1

Quinqueloculina agglutinans d'Orbigny, 1839a, p. 195, pl. 2, figs. 11-13. Bock, 1971, p. 16, pl. 4, fig. 3-5.

Quinqueloculina bicarinata d'Orbigny, 1826

Plate 5, figures 2 and 3

Quinqueloculina bicarinata d'Orbigny, 1826, p. 302. Bock, 1971, p. 16, pl. 4, figs. 6-8.

Quinqueloculina bicostata d'Orbigny, 1839a

Quinqueloculina bicostata d'Orbigny, 1839a, p. 195, pl. 12, figs. 8-10. Bock, 1971, p. 17, pl. 4, figs. 9-11.

Quinqueloculina bidentata d'Orbigny, 1839a

Quinqueloculina bidentata d'Orbigny, 1839a, p. 197, pl. 12, figs. 18-20. Bock, 1971, p. 17, pl. 4, fig. 2; pl. 5, figs. 1-2.

This species was counted with *Q. agglutinans*, because the large morphological overlap between the two species, as observed also by Bock, 1971, p. 16.

Quinqueloculina bosciana d'Orbigny, 1839a

Plate 5, figure 4

Quinqueloculina bosciana d'Orbigny, 1839a, p. 191, pl. 11, figs. 22-24. Bock, 1971, p. 17, pl. 5, figs. 3-5.

Quinqueloculina bradyana Cushman, 1917

Plate 5, figure 5

Miliolina undosa Brady (not *Quinqueloculina undosa* Karrer), 1884, p. 176, pl. 6, figs. 6-8.

Quinqueloculina bradyana Cushman, 1917, p. 52, pl. 18, fig. 2.

Quinqueloculina candeiana d'Orbigny, 1839a

Plate 5, figures 6 and 7

Quinqueloculina candeiana d'Orbigny, 1839a, p. 170, pl. 12, figs. 24-26. Bock, 1971, p. 18, ???

Quinqueloculina collumnosa Cushman, 1922b

Miliolina cuvieriana Heron-Allen and Earland (not d'Orbigny), 1915, p. 571, pl. 4, figs. 33-36.

Quinqueloculina collumnosa Cushman, 1922b, p.65, pl. 10, fig. 10. Bock, 1971, p. 18, pl. 5, figs. 9-11.

Quinqueloculina funafutiensis (Chapman), 1901

Plate 5, figures 8 to 10

Miliolina funafutiensis Chapman, 1901, p. 178, pl. 19, fig. 6.

Quinqueloculina funafutiensis (Chapman). Cushman, 1922b, p. 67, pl. 13, fig. 3. Cushman, 1929, p. 30, pl. 4, fig. 4. Steinker, 1980, p. 136, pl. 5, fig. 9.

Quinqueloculina goesi Todd and Bronnimann, 1957

Plate 5, figure 11

Quinqueloculina goesi Todd and Brönnimann, 1957, p. 27, pl. 3, figs. 11a-b. Buzas and Severin, 1982, p. 25, pl. 2, figs. 14-17.

Quinqueloculina horrida Cushman, 1947

Quinqueloculina horrida Cushman, 1947, p. 88, pl. 19, fig. 1. Bock, 1971, p. 19, pl. 6, figs. 1-3.

Quinqueloculina laevigata d'Orbigny, 1826

Plate 5, figures 12 and 13

Quinqueloculina laevigata d'Orbigny, 1826, p. 301, no. 6. Cimmerman and Langer, 1991, p., pl., figs. 8-11.

Quinqueloculina lamarckiana d'Orbigny, 1839a

Plate 5, figures 14 and 15

Quinqueloculina lamarckiana d'Orbigny, 1839a, p. 189, pl. 11, figs. 14, 15. Cushman, 1921, p. 65, pl. 15, figs. 13, 14. Cushman, 1922b, p. 64. Cushman, 1929, p. 26, pl. 2, fig. 6. Bock, 1971, p. 19, pl. 6, figs. 7-9. Todd and Low, 1971, p. 8, pl. 2, fig. 10.

***Quinqueloculina parkeri* var. *occidentalis* Cushman, 1921**

Quinqueloculina parkeri (Brady) var. *occidentalis* Cushman, 1921, p. 69. Bock, 1971, p. 19, pl. 6, figs. 10-12.

***Quinqueloculina poeyana* d'Orbigny, 1839a**

Plate 5, figure 16

Quinqueloculina poeyana d'Orbigny, 1839a, p. 191, pl. 11, figs. 25-27. Bock, 1971, p. 20, pl. 6, figs. 13-15. Steinker, 1980, p. 136, pl.6, fig.1.

***Quinqueloculina polygona* d'Orbigny, 1839a**

Plate 5, figures 17 and 18

Quinqueloculina polygona d'Orbigny, 1839a, p. 198, pl. 12, figs. 21-23. Cushman, 1921, p. 66, pl. 16, figs. 3,4. Cushman, 1929, p. 28, pl. 3, fig. 5. Bock, 1971, p. 20, pl. 7, figs. 1-3. Todd and Low, 1971, p. 8, pl. 2, fig. 5. Steinker, 1980, p. 136, pl. 6, fig. 2.

***Quinqueloculina pseudoreticulata* Parr, 1941**

Plate 5, figure 19

Triloculina reticulata d'Orbigny, 1826, p. 299, no. 9.

Miliolina reticulata (d'Orbigny). Brady, 1884, p. 177, pl. 9, fig. 2-4

Quinqueloculina pseudoreticulata Parr, 1941, p. 305; Barker, 1960, p. 18, pl. 9, figs. 2-4.

Quinqueloculina sabulosa Cushman, 1947

Quinqueloculina sabulosa Cushman, 1947, p. 87, pl. 18, fig. 22. Bock, 1971, p. 20, pl. 7, figs. 4-6.

Quinqueloculina seminulum (Linné), 1758

Plate 5, figure 20

Serpula seminulum Linné, 1758, p. 786.

Quinqueloculina seminulum (Linné). d'Orbigny, 1826, p. 301. Cushman, 1929, p. 24, pl. 2, figs. 1, 2. Parker, 1952a, p. 456, pl. 2, fig. 7. Bock, 1971, p. 21, pl. 7, figs. 7-9. Steinker, 1980, p. 136, pl. 6, fig. 3.

Quinqueloculina seminulum (Linné), 1758 forma ***jugosa*** Cushman, 1944

Quinqueloculina seminulum (Linné, 1758) var. *jugosa* Cushman, 1944, p. 13, pl. 2, fig. 15. Parker, 1952a, p. 456, pl. 2, fig. 8.

Quinqueloculina jugosa Cushman. Cimmerman and Langer, 1991, p. 37, pl. 33, figs. 12-14.

Quinqueloculina stelligera Schlumberger, 1893

Quinqueloculina stelligera Schlumberger, 1893, p. 210, pl. 2, figs. 58,59; Cimmerman and Langer, 1991, p 38., pl.34, figs. 13-15.

Quinqueloculina subpoeyana Cushman, 1922b

Plate 5, figures 21 and 22

Quinqueloculina subpoeyana Cushman, 1922b, p. 66. Bock, 1971, p.21, pl. 7, figs. 10-12.

Quinqueloculina tenagos Parker, 1962

Quinqueloculina costata d'Orbigny, 1826, p. 135.

Quinqueloculina rhodiensis Parker, new name. Parker, Phleger, and Pierson, 1953, p. 12, pl. 2, figs. 15-17.

Quinqueloculina tenagos Parker, 1962, p. 103. Bock, 1971, p. 21, pl. 7, figs. 13-15.

Quinqueloculina tricarinata d'Orbigny, 1839a

Quinqueloculina tricarinata d'Orbigny, 1839a, p. 187, pl. 11, figs. 7-9, 11. Bock, 1971, p. 22, pl. 8, figs. 1-2.

Quinqueloculina vulgaris d'Orbigny, 1826

Plate 6, figures 1 and 2

Quinqueloculina vulgaris d'Orbigny, 1826, p. 302, no. 33. Steinker, 1980, p. 136, pl. 6, fig. 4.

Genus ***Reussella*** Galloway, 1933

Reussella atlantica Cushman, 1947

Plate 6, figure 3

Reussella spinulosa (Reuss) var. *atlantica* Cushman, 1947, p. 91, pl. 20, figs. 6, 7.

Reussella atlantica Cushman. Bock, 1971, p. 48, pl. 17, fig. 10. Steinker, 1980, p. 136, pl. 6, fig. 5.

Genus ***Reophax*** de Montfort, 1808

Reophax arayensis Bermudez and Seiglie, 1963

Reophax arayensis Bermudez and Seiglie, 1963, p. 146, pl.1, fig. 1-3, pl. 2, fig. 1.

Reophax dentaliniformis Brady, 1881

Reophax dentaliniformis Brady, 1881, p. 49. Bock, 1971, p.5, pl. 1, fig. 7.

Reophax nana Rhumbler, 1911

Reophax nana Rhumbler, 1911, p. 182, pl. 8, figs. 6-12. Parker et al., 1953, p. 13, pl. 1, fig. 11. Lankford, 1959, p. 2099, pl. 1, fig. 2. Scott and Medioli, 1980a, p. 43, pl. 2, fig. 6.

Reophax nodulosus Brady, 1879

Reophax nodulosus Brady, 1879, p. 52, pl. 4, figs. 7, 8. Bock, 1971, p. 5, pl. 1, fig. 10.

Reophax scorpiurus de Montfort, 1808

Plate 6, figure 4

Reophax scorpiurus de Montfort, 1808, p. 330. Bock, 1971, p. 6, pl. 1, fig. 11.

Reophax spiculifera Brady, 1884

Plate 6, figure 5

Reophax spiculifera Brady, 1884, p. 295, pl. 31, figs. 16,17.

Genus ***Rosalina*** d'Orbigny, 1826

Rosalina concinna (Brady), 1884

Plate 6, figures 6 and 7

Discorbina concinna Brady, 1884, p. 646, pl. 90, figs. 7,8.

Rosalina concinna (Brady). Buzas et al., 1977, p. 85, 86, pl. 4, figs. 4-6.

Rosalina globularis d'Orbigny, 1826

Plate 6, figures 8 to 13

Rosalina globularis d'Orbigny, 1826, p. 271, pl. 13, figs. 1-4.

Discorbis floridana Cushman, 1922b, p. 39, pl. 5, figs. 11, 12.

Rosalina floridana (Cushman). Schnitker, 1971, p. 210, pl. 5, fig. 19.

Rosalina floridana was counted with this species because of the morphological overlap between the two species, as illustrated here (pl. 6, figs. 8-13). The S.E.M. photographs show the intergradation between the two species, and the variability in ventral side perforation, presence and size of last chamber overlap, and inflation of the test. This intergradation has been shown only in culture before (Chinn, unpublished MSc thesis, 1972) where *Rosalina floridana* variants, produced in clones without environmental change, could be classified in three different genera (*Discorbis, Rosalina, Planorbulina*) and possibly a fourth (*Cibicides*).

Rosalina floridensis (Cushman), 1931

Discorbis bertheloti (d'Orbigny) var. *floridensis* Cushman, 1931, p. 17, pl. 3, figs. 3-5. Bock 1971, p. 52, pl. 18, figs. 11, 12.

Rosalina micens Cushman, 1933

Discorbis micens Cushman, 1933, p. 89, pl. 9, figs. 5a-c; Cushman et al., 1954, p. 358, pl. 89, figs. 8,9.

Rosalina subarauncana (Cushman), 1922

Plate 6, figures 14 and 15

Discorbis subarauncana Cushman, 1922b, p. 41, pl. 7, figs. 1,2.

Rosalina vilardeboana d'Orbigny, 1939b

Rosalina vilardeboana d'Orbigny, 1839b, p. 44, pl. 6, figs. 16-18; Barker, 1960, p. 178, pl. 86, fig. 9.

Discorbina vilardeboana (d'Orbigny). Brady, 1884, p. 645, pl. 86, fig. 9.

Discorbis vilardeboana (d'Orbigny). Cushman 1931, p. 34.

Genus ***Saccammina*** Carpenter, 1869

Saccammina difflugiformis Brady, 1879

Plate 6, figure 16

Reophax difflugiformis Brady, 1879, p. 51, pl. 4, figs. 3a,b.

Saccammina difflugiformis (Brady). Poag et al., 1980, pl. 1, figs. 1-4.

Saccammina sphaerica G.O.Sars, 1872

Saccammina sphaerica Sars, G.O., 1872, p. 250; Barker, 1960, p. 36, pl. 18, figs. 11-15, 17.

Genus ***Schlumbergerina*** Munier-Chalmas, 1882

Schlumbergerina alveoliniformis var. ***occidentalis***, Cushman, 1929

Plate 6, figure 17

Miliolina alveoliniformis Brady, 1879, p. 68.

Quinqueloculina alveoliniformis Cushman, 1917, p. 43.

Sclumbergerina alveoliniformis (Brady), var. *occidentalis* Cushman, 1929, p. 36, pl. 7, fig. 2. Bock, 1971, p. 31, pl. 12, fig. 12.

Genus ***Sigmoilina*** Schlumberger, 1887

Sigmoilina schlumbergeri Silvestri, 1904

Plate 6, figure 18

Sigmoilina schlumbergeri Silvestri, 1904, p. 267. Bock, 1971, p. 25, pl. 9, figs. 1, 2.

Sigmoilina sigmoidea Brady, 1884

Plate 6, figure 19

Planispirina sigmoidea Brady, 1884, p. 197, pl. 2, figs. 1-3.

Sigmoilina sigmoidea (Brady). Schlumberger, 1887, p. 118.

Genus ***Sigmoilinita*** Seiglie, 1965

Sigmoilinita costata (d'Orbigny), 1826

Quinqueloculina costata d'Orbigny, 1826, p. 301, no. 3.

Miliolina costata (d'Orbigny). Heron-Allen and Earland, 1915, p. 579, pl. 44, figs. 9-12.

Genus ***Siphogenerina*** Schlumberger in Milne-Edwards, 1826

Siphogenerina raphana (Parker and Jones), 1865

Plate 6, figure 20

Uvigerina (Sagrina) raphana Parker and Jones, 1865, p. 364, pl. 18, figs. 16, 17.

Siphogenerina raphana (Parker and Jones). Steinker, 1980, p. 136, pl. 6, fig. 9.

Genus ***Siphonaperta*** Vella, 1957

Siphonaperta sp.

Genus ***Siphonina*** Reuss, 1850

Siphonina pulchra Cushman, 1919

Plate 7, figure 1

Siphonina pulchra Cushman, 1919, p. 42, pl. 14, figs. 7a-c.

Siphonina reticulata Cushman (not Czjek), 1919, p. 42. Bock, 1971, p. 54, pl. 19, figs. 10, 11.

Genus ***Siphoninella*** Cushman, 1927c

Siphoninella soluta (Brady)

Truncatulina soluta Brady, 1884, p. 670, pl. 96, figs. 4a-c.

Siphoninella soluta (Brady). Cushman, 1927c, p. 77, pl. 16, fig. 13.

Genus ***Sorites*** Ehrenberg, 1839

Sorites marginalis (Lamarck), 1816

Plate 7, figure 2

Orbutiles marginalis Lamarck, 1816, p. 196.

Orbitolites marginalis Carpenter, 1883, p. 560, fig. 1.

Sorites marginalis Cushman, 1930b, p. 49, pl. 18, figs. 1-4. Bock, 1971, p. 36, pl. 14, figs. 5, 6.

This species is called *Amphisorus hemprichii* by many authors (such as Wantland, 1975).

Genus ***Spirillina*** Ehrenberg, 1843

Spirillina cariacoensis Bermudez and Seiglie, 1963

Plate 7, figure 3

Spirillina cariacoensis Bermudez and Seiglie, 1963, p. 158, pl. 21, fig. 4 a-c.

Spirillina decorata Brady, 1884

Spirillina decorata Brady, 1884, p. 633, pl. 85, figs. 22,25.

Spirillina densepunctata Cushman, 1931

Spirillina vivipara Ehrenberg v. *densepunctata* Cushman, 1931, p. 4,5, pl. 1, figs. 5a,b; Bermudez and Seiglie, 1963, p.158, pl. 21, fig. 3 a-c.

Spirillina denticulata Brady, 1884

Plate 7, figure 4

Spirillina limbata Brady var. *denticulata* Brady, 1884, p. 632, pl. 85, fig. 17.

Bock, 1971, p. 55, pl. 20, fig.2.

Spirillina inaequalis Brady, 1879

Spirillina inaequalis Brady, 1879, p. 278, pl. 8, figs. 25a,b.

Spirillina perforata (Schultze), 1854

Cornuspira perforata Schultze, 1854, p. 41, pl. 2, fig. 22.

Spirillina perforata (Schultze). Williamson, 1858, p. 92, pl. 7, fig. 202.

Spirillina vivipara Ehrenberg, 1841

Plate 7, figure 5

Spirillina vivipara Ehrenberg, 1841, p. 422, pl. 3, sec. 3, fig. 41. Bock, 1971, p. 55, pl. 20, fig. 4.

Genus ***Spiroloculina*** d'Orbigny, 1826

Spiroloculina antillarum d'Orbigny, 1839a

Plate7, figure 6

Spiroloculina antillarum d'Orbigny, 1839a, p. 166, pl. 9, figs. 3, 4. Bock, 1971, p. 13, pl.3, fig.7.

Spiroculina arenata Cushman, 1921

Plate 7, figure 7

Spiroculina arenata Cushman, 1921, p. 63, pl. 14, fig. 17. Bock, 1971, p. 13, pl. 3, fig. 8.

Spiroloculina caduca Cushman, 1922b

Spiroloculina caduca Cushman, 1922b, p. 61, pl. 11, figs. 3, 4.

Spiroloculina communis Cushman and Todd, 1944

Spiroloculina communis Cushman and Todd, 1944, p. 63, pl. 9, figs. 4-8.

Spiroloculina gradeloupi d'Orbigny, 1826

Plate 7, figure 8

Spiroloculina gradeloupi d'Orbigny, 1826, p. 298.

Spiroloculina hyalina Schulze, 1875

Plate 7, figure 9

Spiroloculina hyalina Schulze, 1875. Steinker, 1980, p. 137, pl. 7, fig. 5.

Genus ***Spirophtalmidium*** Cushman, 1927b

Spirophtalmidium sp.

Plate 7, figures 10 to 12

In Bermuda, this species is common in the caves and is a good indicator of this habitat since it is rare or absent in other Bermuda environments. This species was reported as rare specimens in only three areas, at my knowledge, in the Mediterranean (Cimmermann and Langer, 1991), in New Guinea (Haig, 1988), and possibly in deep Pacific Ocean, off Fiji, as "*Spiroloculina sp*. abnorm."(Barker, 1960, pl. 10, fig. 14).

Genus ***Technitella*** Norman, 1878

Technitella legumen Norman, 1878

Plate 7, figure 13

Technitella legumen Norman, 1878, p. 279, pl. 16, figs. 3, 4. Bock, 1971, p.4, pl. 1, fig. 4.

Genus ***Textularia*** Defrance *In* de Blainville, 1824

Textularia agglutinans d'Orbigny, 1839a

Plate 7, figure 14

Textularia agglutinans d'Orbigny, 1839a, p. 136, pl. 1, figs. 17, 18, 32, 34. Bock, 1971, p. 8, pl. 2, fig. 1.

Textularia conica d'Orbigny, 1839a

Plate 7, figure 15

Textularia conica d'Orbigny, 1839a, p. 143, pl. 1, figs. 19, 20. Bock, 1971, p. 8, pl. 2, fig. 3.

Textularia earlandi Parker, 1952a

Plate 7, figure 16

Textularia earlandi Parker, 1952a, p. 458 (footnote). Scott et al., 1991, pl. 2, fig. 9.

Genus ***Tiphotrocha*** Saunders, 1957

Tiphotrocha comprimata (Cushman and Brönnimann), 1948b

Plate 7, figures 17 and 18

Trochammina comprimata Cushman and Brönnimann, 1948b, p. 41, pl. 8, figs. 1-3. Parker et al., 1953, p. 14, pl. 3, figs. 3, 4. Phleger, 1954, p. 646, pl. 3, figs. 20, 21.

Tiphotrocha comprimata (Cushman and Brönnimann). Saunders, 1957, p. 11, pl. 4, figs. 1-4. Scott and Medioli, 1980a, p. 44, pl. 5, figs. 1-3. Scott et al., 1991, p. 388, pl. 2, figs. 5, 6.

Genus ***Tolypammina*** Rhumbler, 1895a

Tolypammina vagans (Brady), 1879

Plate 7, figures 19 and 20

Hyperammina vagans Brady, 1879, p. 33, pl. 3, fig. 5. Brady, 1884, p. 260, pl. 24, figs. 1-5

Tolypammina vagans (Brady).- Rhumbler, 1895b, p. 83

Hyperammina vagans Brady.- Flint, 1899, p. 270, pl. 11, fig. 2

Serpulella vagans (Brady).- Eimer and Fickert, 1899, p. 674

Tolypammina vagans (Brady).- Cushman, 1910, p. 67, figs. 84, 85

Girvanella vagans (Brady).- Rhumbler, 1911, pl. 4, figs. 1, 2. Cushman, 1918, p. 91-93, pl. 35, figs. 4, 5; pl. 36, fig. 1

Tolypammina vagans (Brady).- Barker, 1960, pl. 24, figs. 1-5

Genus ***Tretomphalus*** Möbius, 1880

Tretomphalus atlanticus Cushman, 1934

Plate 7, figures 21 and 22

Tretomphalus atlanticus Cushman , 1934, p. 86, pl. 11, fig. 3, pl. 12, fig. 17. Bock, 1971, p. 53, pl. 19, figs. 1, 3.

The genus *Tretomphalus* is probably just a sexual reproduction stage of *Rosalina* or *Planorbulina* or *Cymbaloporetta.*

Genus ***Trifarina*** Cushman, 1923

Trifarina occidentalis (Cushman), 1923

Plate 7, figure 23

Uvigerina occidentalis Cushman, 1923, p. 169.

Angulogerina occidentalis (Cushman). Cushman, 1930a, p. 50, pl. 9, fig. 8,9.

Trifarina occidentalis (Cushman). Buzas and Severin, 1982, p. 33, pl 5., fig. 16.

Genus ***Triloculina*** d'Orbigny, 1826

Triloculina bassensis Parr, 1945

Plate 7, figures 24 and 25

Triloculina bassensis Parr, 1945, p. 198. Bock, 1971, p. 25, pl. 9, figs. 2-8.

Triloculina bermudezi Acosta, 1940

Plate 7, figures 26 and 27

Triloculina bermudezi Acosta, 1940, p. 37, pl. 4, figs. 1-5. Bock, 1971, p. 25, pl. 9, figs. 9-11.

Triloculina bicarinata d'Orbigny, 1839a

Triloculina bicarinata d'Orbigny, 1839a, p. 158, pl. 10, figs. 18-20. Bock, 1971, p. 25, pl. 9, figs. 12, 13, pl. 10, fig. 1.

Triloculina carinata d'Orbigny, 1839a

Plate 8, figures 1 and 2

Triloculina carinata d'Orbigny, 1839a, p. 179, pl. 10, figs. 15-17. Bock, 1971, p. 26, pl. 10, figs. 2-4. Steinker, 1980, p. 137, pl. 8, fig.1.

Triloculina cuneata Karrer, 1867

Plate 8, figure 3

Triloculina cuneata Karrer, 1867, p. 359, pl. 2, fig. 8.

Pseudotriloculina cuneata (Karrer). Cimmermann and Langer, 1991, p. 43, pl. 39, fig. 4.

Triloculina fitterei var. ***meningoi*** Acosta, 1940

Triloculina fitterei Acosta var. *meningoi* Acosta, 1940, p. 25-26, pl. 4, figs. 1-5. Bock, 1971, p. 26, pl. 1o, figs. 5-7.

Triloculina gracilis d'Orbigny, 1839a

Triloculina gracilis d'Orbigny, 1839a, p. 159, pl. 11, figs. 10-12. Bock, 1971, p. 26.

Triloculina linneiana d'Orbigny, 1839a

Plate 8, figures 4 and 5

Triloculina linneiana d'Orbigny, 1839a, p. 172, pl. 9, figs. 11-13. Bock, 1971, p. 26, pl. 10, figs. 8-10.

Triloculina oblonga (Montagu), 1803

Plate 8, figures 6 to 8

Verniculum oblongum Montagu, 1803, p. 522, pl. 14, fig. 9.

Triloculina oblonga (Montagu). d'Orbigny, 1826, p. 300, no. 16. Bock, 1971, p. 27, pl. 11, figs. 2-4.

This species shows a large variability in size, inflation, and shape of the chambers in mangrove environments.

Triloculina quadrilateralis d'Orbigny, 1839a

Triloculina quadrilateralis d'Orbigny, 1839a, p. 173, pl. 9, figs. 14-16. Wantland, 1975, p. 390, fig. 8, m.

Triloculina rotunda d'Orbigny, 1826

Plate 8, figure 9

Triloculina rotunda d'Orbigny, 1826, p. 299, no. 4. Bock, 1971, p. 27, pl. 11, figs. 8-10.

Triloculina sidebottomi (Martinotti), 1920

Miliolina subrotunda Sidebottom (not *Vermiculum subrotundum* Montagu), 1904, p. 8, pl. 3, figs. 1-7.

Sigmoilina sidebottomi Martinotti, 1920, pl. 2, fig. 29.

Triloculina sidebottomi Parker, Phleger and Pierson, 1953, p. 14, pl. 2, figs. 25-28. Bock, 1971, p. 28, pl. 11, figs. 11-13.

Triloculina tricarinata d'Orbigny, 1826

Triloculina tricarinata d'Orbigny, 1826, p. 299, no. 7. Bock, 1971, p. 28, pl. 12, figs. 1, 2.

Triloculina trigonula (Lamarck), 1804

Miliola trigonula Lamarck, 1804, p. 351, no. 3.

Miliolites trigonula Lamarck, 1807, pl. 17, fig. 4.

Triloculina trigonula (Lamarck). Cushman, 1929, p. 56, pl. 12, figs. 10, 11, pl. 13, figs. 1, 2. Bock, 1971, p. 28, pl. 12, figs. 3, 4.

Genus ***Tritaxis*** Schubert, 1921

Tritaxis sp.

This species was rare and not identified.

Genus ***Trochammina*** Parker and Jones, 1859

Trochammina inflata (Montagu), 1808

Plate 8, figures 10 to 15

Nautilus inflatus Montagu, 1808, p. 81, pl. 18, fig. 3.

Rotalina inflata Williamson, 1858, p. 50, pl. 4, figs. 93, 94.

Trochammina inflata (Montagu). Parker and Jones, 1859, p. 347. Carpenter et al., 1862, p. 141, pl. 11, fig. 5. Parker, 1952a, p. 459, pl. 3, fig. 1. Parker et al., 1953, p. 15, pl.3, figs. 7, 8. Phleger, 1954, p. 646, pl.3, figs.22, 23. Scott and Medioli, 1980a, p. 44, pl. 3, figs. 12-14; pl. 4, figs. 1-3. Boltovskoy, 1984, fig. 13. Scott et al., 1991, p.388, pl. 2, figs. 7,8.

Siphotrochammina lobata Saunders, 1957, p. 9, pl. 3, figs. 1, 2.

Siphotrochammina elegans Zaninetti et al., 1977, pl. 2, figs. 8, 10, 11.

The S.E.M. photographs presented here (pl. 8, figs. 10-13) show an intergradation from *Trochammina inflata* aperture ("an arched slit at the inner margin of the ventral side of the last chamber", Saunders, 1957, p.9) to *Siphotrochammina lobata* aperture ("a forward-directed, circular opening at the inner end of a siphon like lobe that extends from the last chamber into the umbilicus", Saunders, 1957, p.9). This suggests that *Siphotrochammina* morphology is part of the intraspecific variability of *Trochammina*. This intergradation was also observed in Japanese marshes (Scott et al., 1995c) and in South Carolina marshes (Collins, 1996).

Some specimens of *Trochammina inflata* (pl.8, figs.14 and 15) develop a secondary agglutinated tube attached to the aperture, possibly for attachment or to facilitate feeding in a very dense vegetal micro-environment (mangrove peat).

Trochammina macrescens Brady, 1870

Plate 8, figure 16

Trochammina inflata (Montagu) var. *macrescens* Brady, 1870, p. 290, pl. 11, fig. 5. Scott, 1976b, p. 320, pl. 1, figs. 4-7.

Jadammina polystoma Bartenstein and Brand, 1938, p. 381, figs. 1, 2.

Trochammina macrescens Brady. Parker, 1952b, p. 460, pl. 3, fig. 3. Parker et al., 1953, P. 15, pl.3, figs. 7, 8. Phleger, 1954, p. 646, pl. 3, fig. 24. Scott and Medioli, 1980a, p. 44, pl. 3, figs. 1-12. Scott et al., 1991, p. 388, pl. 2, figs. 10, 11.

Trochammina ochracea (Williamson), 1858

Plate 8, figures 17 and 18

Rotalina ochracea Williamson, 1858, p. 55, pl. 4, fig. 112; pl. 5, fig. 113.

Trochammina squamata Parker and Jones, 1865, p. 407, pl. 15, figs. 30, 31. Parker, 1952a, p. 460, pl. 3, fig. 4. Parker, 1952b, p. 408, pl. 4, figs. 11-16. Scott and Medioli, 1980a, p. 45, pl. 4, figs. 6,7.

Trochammina squamata Parker and Jones, and related species. Parker, 1952a, p. 460, pl. 3, fig. 5.

Trochammina ochracea (Williamson). Cushman, 1920a, p. 75, pl. 15, fig. 3, Scott and Medioli, 1980a, p.45, pl. 4, figs. 4,5.

Genus ***Trochamminita*** Cushman and Brönnimann, 1948a

Trochamminita salsa (Cushman and Brönnimann), 1948a

Plate 8, figure 19

Labrospira salsa Cushman and Bronnimann, 1948a, p. 16, pl. 3, figs. 5,6.

Trochamminita irregularis Cushman and Bronnimann, 1948, p. 17, pl. 4, figs. 1-3. Saunders, 1957, emended, p. 4, 5, p. 12, figs. 2-8.

Trochamminita salsa (Cushman and Bronnimann). Saunders, 1957, p. 6, pl.1, figs. 3-8. Jennings et al., 1995, p. 119, fig. 5, 1-17.

Genus ***Tubinella*** Rhumbler, 1906

Tubinella funalis (Brady)

Plate 8, figure 20

Articulina funalis Brady, 1884, p. 185, pl. 13, figs. 6-11.

Tubinella funalis (Brady). Rhumbler, 1906, p. 26, pl. 2, fig. 3.

Tubinella inornata (Brady)

Articulina funalis Brady v. *inornata* Brady, 1884, p. 186, pl. 13, figs. 3-5.

Tubinella inornata (Brady). Rhumbler, 1906, p. 27, pl. 2, fig. 4.

Genus ***Uvigerina*** d'Orbigny, 1826

Uvigerina bradyana Fornasini, 1900

Uvigerina bradyana Fornasini, 1900, p. 390; Barker, 1960, p. 154, pl. 74, figs. 24-26.

Uvigerina canariensis d'Orbigny, 1839a

Uvigerina canariensis d'Orbigny, 1839a, p. 138, pl. 1, figs. 25-27; Brady, 1884, p. 573, pl. 84, figs. 1-3; Barker, 1960, p. 154, pl. 74, figs. 1-3.

Genus ***Valvulina*** d'Orbigny, 1826

Valvulina oviedoiana d'Orbigny, 1839a

Plate 8, figure 21

Valvulina oviedoiana d'Orbigny, 1839a, p. 103, pl. 2, figs. 21, 22. Bock, 1971, p. 10, pl. 2, fig. 11. Steinker, 1980, p. 137, pl. 8, fig. 7.

Genus *Wiesnerella* Cushman, 1933

Wiesnerella auriculata (Egger), 1893

Plate 8, figure 22

Planispirina auriculata Egger, 1893, p. 245, pl. 3, figs. 13-15.

Wiesnerella auriculata (Egger). Schnitker, 1971, p. 214, pl. 2, fig. 9. Wantland, 1975, p. 387, fig. 9, n.

PHOTOPLATES

PLATE 1

Figure 1. *Arcella polypora* Penard. Scale bar = 15 microns.

Figure 2. *Centropyxis aculeata* (Ehrenberg). Scale bar = 20 microns.

Figure 3. *Centropyxis constricta*. Scale bar = 30 microns.

Figure 4. *Abdidodentrix rhomboidalis* (Millett). Scale bar = 40.8 microns.

Figure 5. *Acervulina inhaerens* Schultze. SLM. Scale bar = 136 microns.

Figure 6. *Ammobaculites agglutinans* (d'Orbigny). Scale bar = 100 microns.

Figure 7. *Ammodiscus tenuis* Brady. Scale bar = 35 microns.

Figures 8, 9. *Ammonia beccarii* (Linne) *tepida* Cushman. Fig. 8: dorsal view, scale bar = 97.5 microns; fig. 9: ventral view, scale bar = 40.2 microns.

Figures 10. *Amphistegina lessonii* d'Orbigny. SLM. Scale bar = 152 microns.

Figure 11. *Angulogerina sp*. Scale bar = 40.3 microns.

Figures 12,~~13~~. *Archaias angulatus* (Fichtel and Moll). Scale bar = 201 microns

Figure 13, 14. *Articulina mexicana* Cushman. Scale bar = 68.1 microns

Figure ~~15~~. 14 *Articulina mucronata* (d'Orbigny). Scale bar = 100 microns.

Figure ~~16~~. 15 *Articulina pacifica* Cushman. Scale bar = 49.3 microns.

Figures ~~17,18~~. 16, 17 *Asterigerina carinata* d'Orbigny. Scale bar = microns.

Figure ~~19~~. 18 *Astrononion stelligerum* (d'Orbigny). Scale bar = 40 microns.

Figure ~~20~~. 19 *Bolivina lanceolata* Parker. Scale bar = 44 microns.

Figure ~~21~~. 20 *Bolivina lowmani* Phleger and Parker. Scale bar = 40 microns.

Figure ~~22~~. 21 *Bolivina pulchella var. primitiva* Cushman. Scale bar = 34 microns.

Figure 23. 22 *Bolivina striatula* Cushman. Scale bar = 59.4 microns.

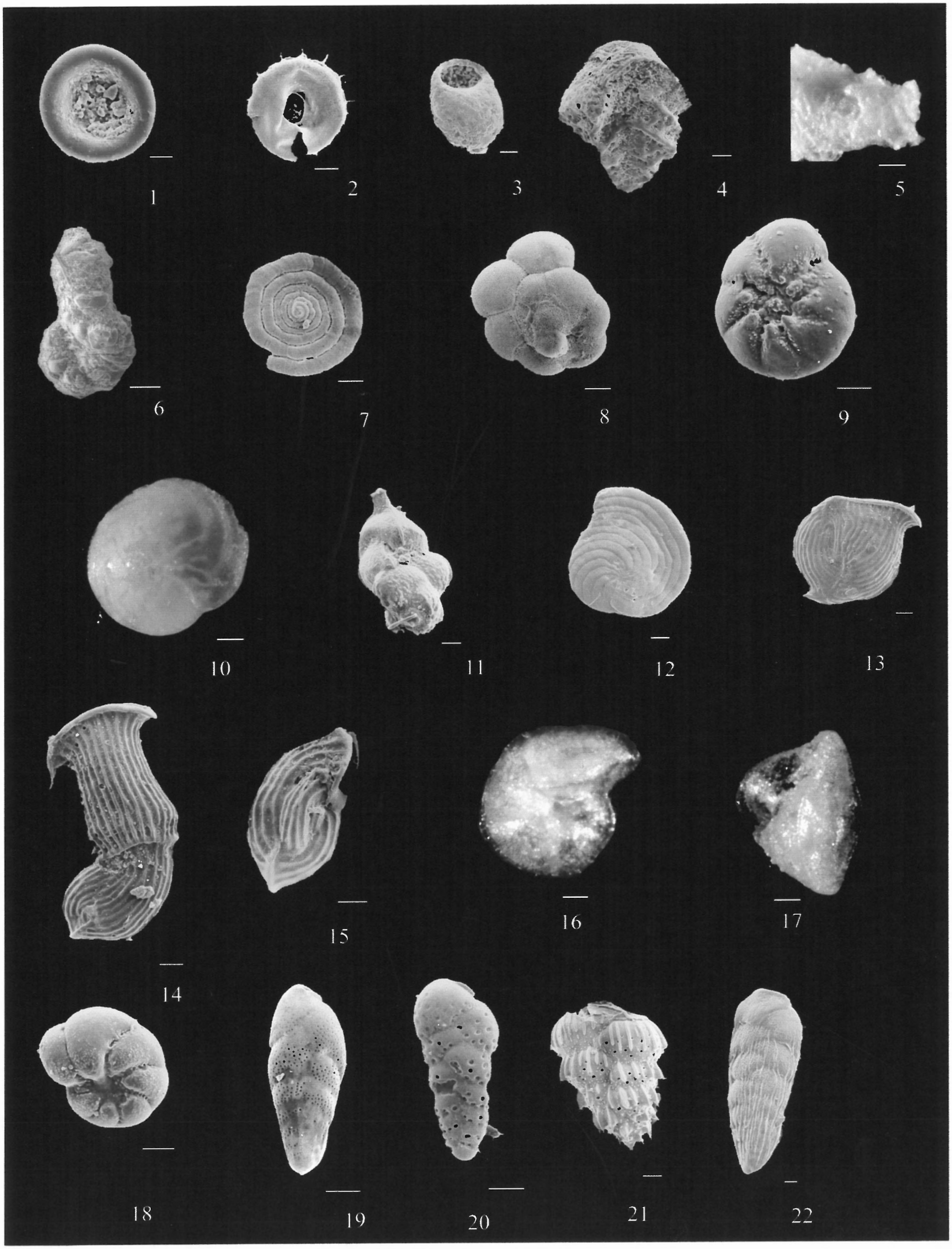

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PLATE 2

Figure 1.	*Bolivina subexcavata* Cushman and Wickenden. Scale bar = 40.2 microns.
Figure 2.	*Bolivina tortuosa* Cushman. Scale bar = 36.4 microns.
Figure 3.	*Bolivina variabilis* (Williamson). Scale bar = 37.7 microns.
Figure 4.	*Borelis pulchra* (d'Orbigny). Scale bar = 58.8 microns.
Figure 5.	*Broeckina orbitolitoides* (Hofker). SLM. Scale bar = 105 microns.
Figure 6.	*Bulimina aculeata* d'Orbigny. Scale bar = 59.4 microns.
Figure 7.	*Buliminella elegantissima* (d'Orbigny). Scale bar = 40.6 microns.
Figure 8.	*Buliminella milleti* Cushman. Scale bar = 40 microns.
Figure 9.	*Carpenteria proteiformis* Goës. SLM. Scale bar = 277 microns.
Figure 10.	*Cassidulina subglobosa* Brady. Scale bar = 28.8 microns.
Figures 11, 12.	*Cibicides lobatulus* (Walker and Jacob). Fig. 11: dorsal view, scale bar = 38.6 microns; fig. 12: ventral view, scale bar = 41.6 microns..
Figures 13, 14.	*Cibicides refulgens* Montfort. Fig. 13: dorsal view, scale bar = 34.7 microns; fig. 14: ventral view, scale bar = 34.6 microns..
Figure 15.	*Clavulina tricarinata* d'Orbigny. Scale bar = 156 microns.
Figure 16.	*Cyclogyra planorbis* Schultze. Scale bar = 39.1 microns.
Figure 17.	*Cyclorbiculina compressa* (d'Orbigny). Scale bar = 198 microns.
Figures 18, 19.	*Cymbaloporetta squamosa* (d'Orbigny). Fig. 18: dorsal view, scale bar = 49.6 microns; fig. 19: ventral view, scale bar = 70.4 microns.
Figures 20, 21.	*Discorbis mira* Cushman. Fig. 20: dorsal view, scale bar = 75 microns; fig. 21: ventral view, scale bar = 68.1 microns.
Figures 22-26.	*Discorinopsis aguayoi* (Bermudez). Fig. 22: dorsal view, scale bar = 130 microns; fig. 23-26: ventral views showing the variability of this species in test perforation, test shape, and amount of spongy material;

fig. 23, scale bar = 170 microns, figs. 24-26, scale bar = 40 microns.

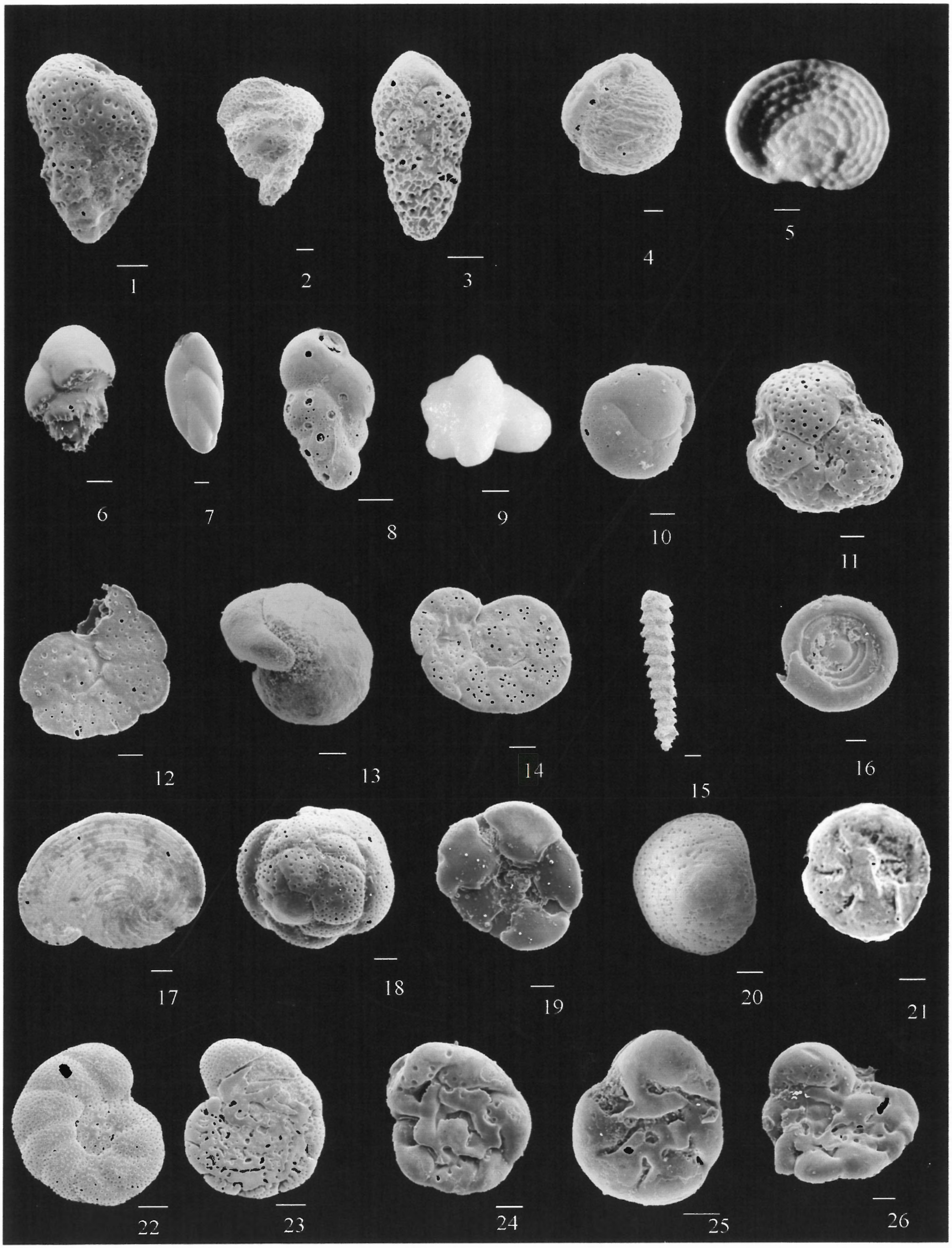
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PLATE 3

Figure 1	*Elphidium advenum* (Cushman). SLM. Scale bar = 65 microns.
Figure 2	*Elphidium sp*. SLM. Scale bar = 88 microns.
Figure 3	*Elphidium discoidale* (d'Orbigny). Scale bar = 45.2 microns.
Figure 4	*Elphidium excavatum* (Terquem) forma *excavatum* (Terquem). Scale bar = 48 microns.
Figure 5	*Elphidium poeyanum* (d'Orbigny). Scale bar = 59 microns.
Figure 6	*Elphidium sagrum* (d'Orbigny). SLM. Scale bar = 105 microns.
Figures 7, 8	*Epistominelle pulchra* (Cushman). Fig. 7: dorsal view, scale bar = 27.3 microns, fig. 8: ventral view, scale bar = 27.3 microns.
Figures 9, 10	*Eponides repandus* (Fichtel and Moll). SLM. Fig. 9: dorsal view, scale bar = 84 microns; fig. 10: ventral view, scale bar = 100 microns.
Figure 11	*Fursenkoina complanata* (Cushman). Scale bar = 40.5 microns.
Figure 12	*Glomospira irregularis* (Grzybowski). Scale bar = 30 microns.
Figure 13	*Gypsina vesicularis* (Parker and Jones). SLM. Scale bar = 179 microns.
Figure 14	*Haplophragmoides wilberti* Andersen. Scale bar = 20 microns.
Figures 15, 16	*Helenina anderseni* (Warren). Fig. 15: dorsal view, scale bar = 100 microns; fig. 16: ventral view, scale bar = 80 microns.
Figures 17, 18	*Hoeglundina elegans* (d'Orbigny). SLM. Fig. 17: dorsal view, scale bar = 238 microns; fig. 18: ventral view, scale bar = 226 microns.
Figure 19	*Homotrema rubrum* (Lamarck). Scale bar = 318 microns.
Figure 20	*Loxostomum mayori* (Cushman). Scale bar = 39.6 microns.
Figure 21	*Loxostomum porrectum*. Scale bar = 99.5 microns.
Figure 22	*Melonis pompiloides* Fichtel and Moll. Scale bar = 40.6 microns.
Figure 23	*Miliammina fusca* (Brady). Scale bar = 40 microns.

Figure 24	*Miliolinella fichteliana* (d'Orbigny). Scale bar = 47.1 microns.
Figure 25	*Miliolinella labiosa* (d'Orbigny). Scale bar = 99 microns.
Figure 26	*Monalysidium politum* Chapman. Scale bar = 36.3 microns.
Figure 27	*Mychostomina revertens* (Rhumbler). Scale bar = 37.8 microns.

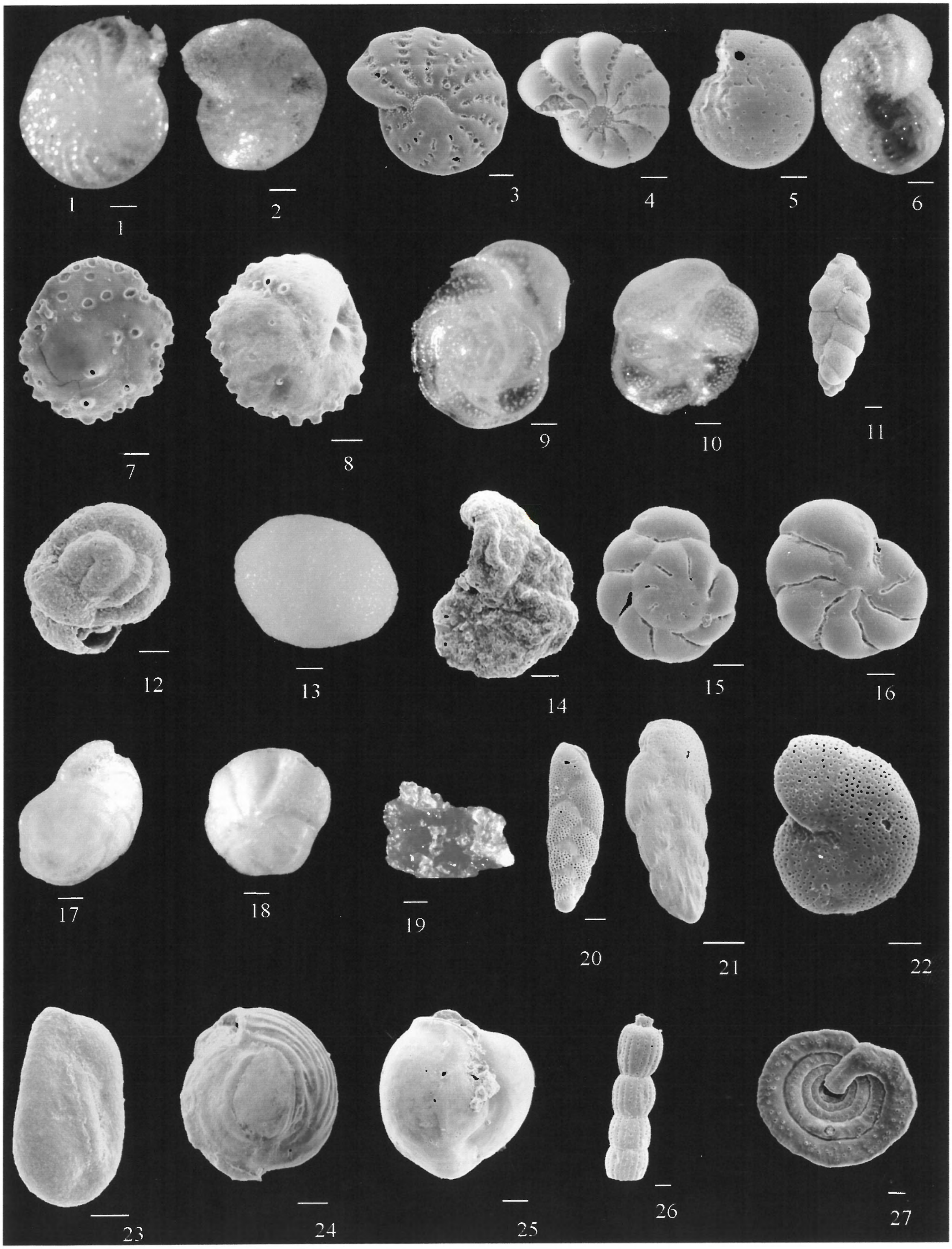
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PLATE 4

Figures 1, 2	*Neoconorbina terquemi* (Rzehak). Fig. 1: dorsal view, scale bar = 33 microns; fig. 2: ventral view, scale bar = 33.2 microns.
Figure 3	*Nonion depressulum* var. *matagordanum* Kornfeld. Scale bar = 34.7 microns.
Figure 4	*Nonion gradeloupi* (d'Orbigny). Scale bar = 56 microns.
Figure 5	*Parrina bradyi* (Millett). Scale bar = 84.5 microns.
Figures 6, 7	*Patellina corrugata* Williamson. Fig. 6: dorsal view, scale bar = 31.1 microns, fig. 7: ventral view, scale bar = 12.8 microns.
Figure 8	*Peneroplis bradyi* Cushman. SLM. Scale bar = 97 microns.
Figure 9	*Peneroplis pertusus* (Forskal). Scale bar = 33.2 microns.
Figure 10	*Peneroplis proteus* d'Orbigny. Scale bar = 200 microns.
Figure 11	*Placopsilina bradyi* Cushman and McCulloch. SLM. Scale bar = 180 microns.
Figures 12-14	*Planispiroides bucculentus* (Brady). Fig. 12: side view, scale bar = 85.6 microns; fig. 13: side view, scale bar = 90.8 microns; fig. 14: apertural view, scale bar = 46.7 microns.
Figure 15	*Planorbulina acervalis* Brady. Scale bar = 98.3 microns.
Figure 16	*Planorbulina mediterranensis* d'Orbigny. Scale bar = 135 microns.
Figures 17, 18	*Planulina exorna* Phleger and Parker. SLM. Fig. 17: dorsal view, scale bar = 100 microns; fig. 18: ventral view, scale bar = 107 microns.
Figure 19	*Polysaccammina ipohalina* Scott. Scale bar = 50 microns.
Figure 20	*Pseudothurammina limnetis* Scott, Medioli and Williamson. Scale bar = 79.7 microns.
Figure 21	*Pyrgo denticulata* (Brady). Scale bar = 86.8 microns.
Figure 22	*Pyrgo elongata* (d'Orbigny). SLM. Scale bar = 80 microns.

Figure 23 *Pyrgo subsphaerica* (d'Orbigny). SLM. Scale bar = 63 microns.

Figures 24, 25 *Quinqueloculina agglutinans* d'Orbigny. Fig. 24: 4 chambers side view, scale bar = 145 microns; fig. 25: 3 chambers side view, scale bar = 140 microns.

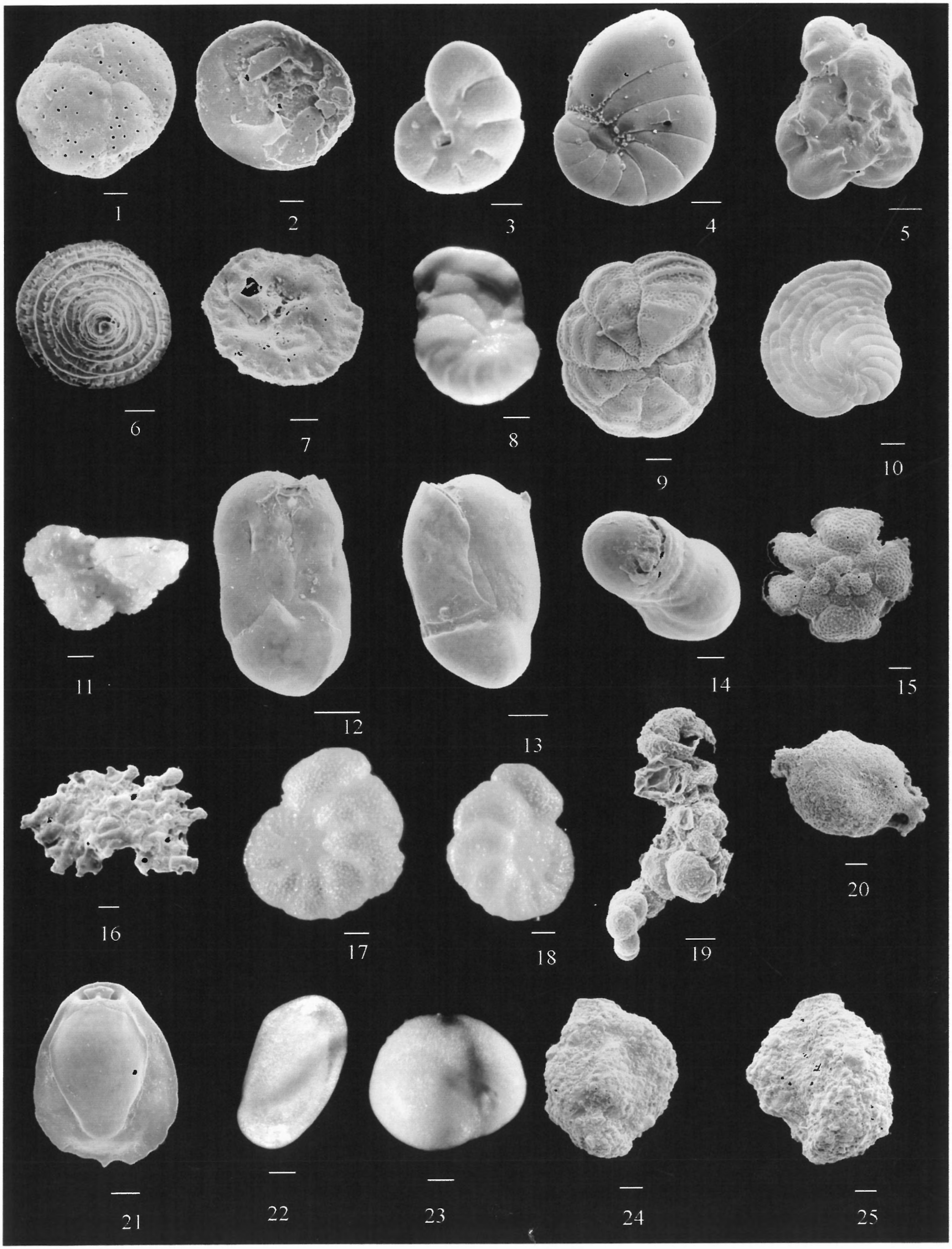
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PLATE 5

Figure 1	*Quinqueloculina agglutinans* d'Orbigny. Apertural view. Scale bar = 81 microns.
Figures 2, 3	*Quinqueloculina bicarinata* d'Orbigny. SLM. Fig. 2: 4 chambers side view, scale bar = 265 microns; fig. 3: 3 chambers side view, scale bar = 113 microns.
Figure 4	*Quinqueloculina bosciana* d'Orbigny. Scale bar = 43.4 microns.
Figure 5	*Quinqueloculina bradyana* Cushman. Scale bar = 39.6 microns.
Figures 6, 7	*Quinqueloculina candeiana* d'Orbigny. SLM. Fig. 6: 4 chambers side view, scale bar = 147 microns; fig. 7: 3 chambers side view, scale bar = 140 microns.
Figures 8-10	*Quinqueloculina funafutiensis* (Chapman). Fig. 8: 4 chambers side view, scale bar = 90.6 microns; fig. 9: 3 chambers side view, scale bar = 84.4 microns; fig. 10: apertural view, scale bar = 69.2 microns.
Figure 11	*Quinqueloculina goesi* Todd and Bronnimann. Fig. 11: 4 chambers side view, scale bar = 107 microns
Figures 12, 13	*Quinqueloculina laevigata* d'Orbigny. Fig. 12: 4 chambers side view, scale bar = 54.7 microns; fig. 13: 3 chambers side view, scale bar = 55.3 microns.
Figures 14, 15	*Quinqueloculina lamarckiana* d'Orbigny. Fig. 14: 4 chambers side view, scale bar = 67.2 microns; fig. 15: 3 chambers side view, SLM, scale bar = 86 microns.
Figures 16	*Quinqueloculina poeyana* d'Orbigny. Fig. 16: 4 chambers side view, scale bar = 87 microns

Figures 17, 18	*Quinqueloculina polygona* d'Orbigny. Fig. 17: 4 chambers side view, scale bar = 99.3 microns; fig. 18: 3 chambers side view, scale bar = 40 microns.
Figure 19	*Quinqueloculina pseudoreticulata* Parr. Scale bar = 39.7 microns.
Figures 20	*Quinqueloculina semilunum* (Linné). Fig. 20: 4 chambers side view, scale bar = 64.4 microns.
Figures 21, 22	*Quinqueloculina subpoeyana* Cushman. SLM. Fig. 21: 4 chambers side view, scale bar = 79 microns; fig. 22: 3 chambers side view, scale bar = 79 microns.

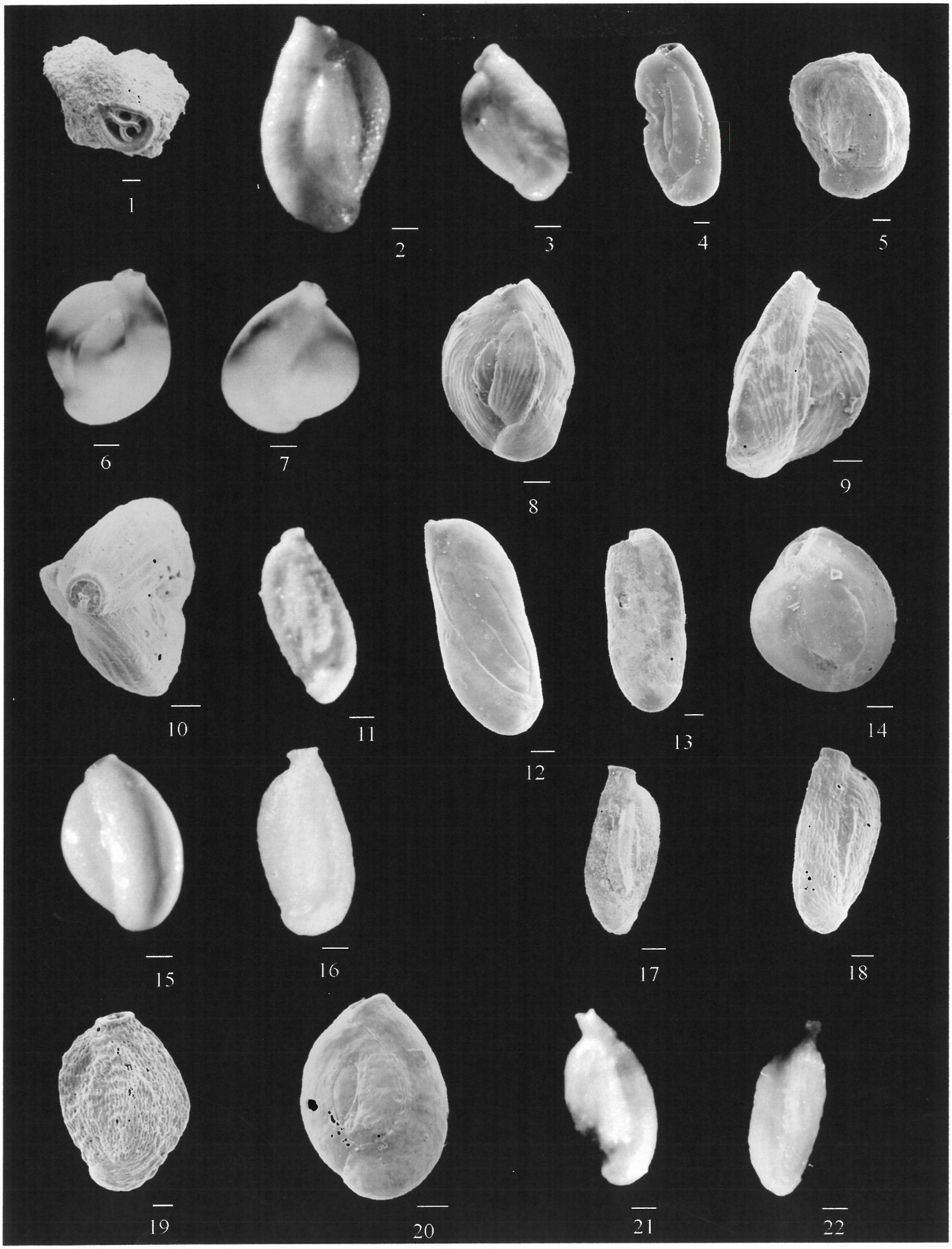
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PLATE 6

Figures 1, 2	*Quinqueloculina vulgaris* d'Orbigny. Fig. 1: 4 chambers side view, scale bar = 55.2 microns; fig. 2: 3 chambers side view, scale bar = 80 microns.
Figure 3	*Reussella atlantica* Cushman. SLM. Scale bar = 73.5 microns.
Figure 4	*Reophax scorpiurus* de Montfort. Scale bar = 76.6 microns.
Figure 5	*Reophax spiculifera* Brady. Scale bar = 64.3 microns.
Figures 6, 7	*Rosalina concinna* (Brady). Fig. 6: dorsal view, scale bar = 42.9 microns; fig. 7: ventral view, scale bar = 42.8 microns.
Figures 8-13	Intergradation series of *Rosalina floridana* (Cushman) to *Rosalina globularis* (d'Orbigny). Scale bars = 40 microns. Figs. 8-9: dorsal views, figs. 10-13: ventral views showing the intergradation between the two species and the variability in ventral side perforation, presence and size of last chamber umbilical overlap, and inflation of the test.
Figures 14, 15	*Rosalina subarauncana* (Cushman). Fig. 14: dorsal view, scale bar = 98.6 microns; fig. 15: ventral view, scale bar = 39.4 microns.
Figure 16	*Saccammina difflugiformis* Brady. Scale bar = 57.4 microns.
Figure 17	*Schlumbergerina alveoliniformis* var. *occidentalis* Cushman. Scale bar = 31.4 microns.
Figure 18	*Sigmoilina schlumbergeri* Silvestri. Scale bar = 41.4 microns.
Figure 19	*Sigmoilina sigmoidea* Brady. Scale bar = 33 microns.
Figure 20	*Siphogenerina raphana* (Parker and Jones). Scale bar = 99 microns.

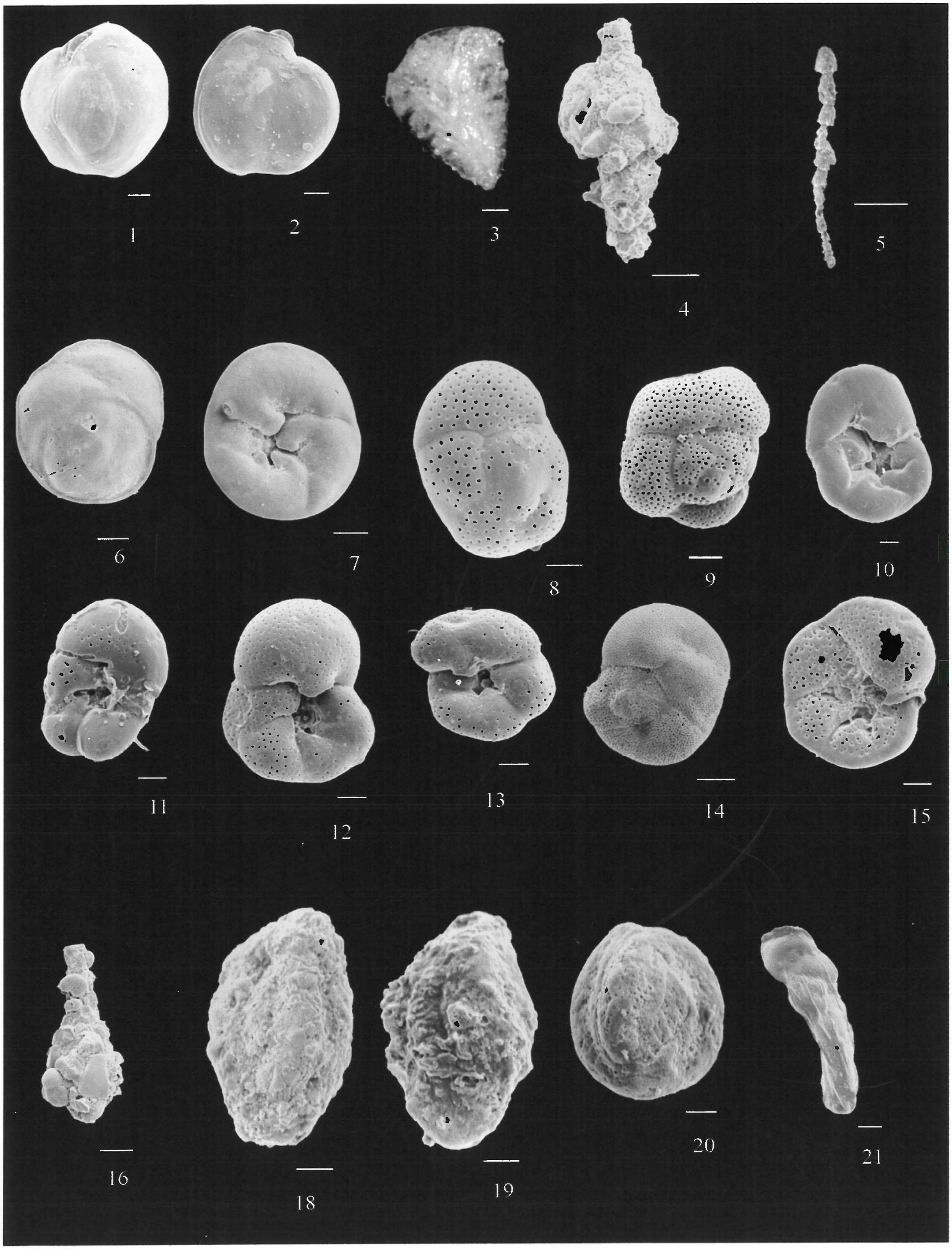
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PLATE 7

Figure 1	*Siphonina pulchra* Cushman. Scale bar = 53.8 microns.
Figure 2	*Sorites marginalis* (Lamarck). SLM. Scale bar = 113 microns.
Figure 3	*Spirillina cariacoensis* Ehrenberg. Scale bar = 42.6 microns.
Figure 4	*Spirillina denticulata* Brady. SLM. Scale bar = 50 microns.
Figure 5	*Spirillina vivipara* Ehrenberg. Scale bar = 60.1 microns.
Figure 6	*Spiroloculina antillarum* d'Orbigny. Scale bar = 66 microns.
Figure 7	*Spiroloculina arenata* Cushman. Scale bar = 92.8 microns.
Figure 8	*Spiroloculina gradeloupi* d'Orbigny. Scale bar = 62.8 microns.
Figure 9	*Spiroloculina hyalina* Schulze. Scale bar = 38.8 microns.
Figures 10-12	*Spirophtalmidium sp.* Side views, scale bars = 68.6, 96.4, and 65.9 microns.
Figure 13	*Technitella legumen* Norman. Scale bar = 88.5 microns.
Figure 14	*Textularia agglutinans* d'Orbigny. Scale bar = 207 microns.
Figure 15	*Textularia conica* d'Orbigny. SLM. Scale bar = 157 microns.
Figure 16	*Textularia earlandi* Parker. Scale bar = 50 microns.
Figures 17, 18	*Tiphotrocha comprimata* (Cushman and Brönnimann). Fig. 17: dorsal view, scale bar = 39.2 microns; fig. 18: ventral view, scale bar = 39.2 microns.
Figures 19, 20	*Tolypammina vagans* (Brady). Fig. 19: free specimen, scale bar = 90.3 microns; fig. 20: attached specimen, scale bar = 120 microns.
Figures 21, 22	*Tretomphalus atlanticus* Cushman. Fig. 21: dorsal view, scale bar = 72.9 microns; fig. 22: ventral view, scale bar = 66.7 microns.
Figure 23	*Trifarina occidentalis* (Cushman). Scale bar = 47.5 microns.
Figures 24, 25	*Triloculina bassensis* Parr. Fig. 24: 3 chambers side view, scale bar = 40 microns; fig. 25: side view, scale bar = 51 microns.

Figures 26, 27 *Triloculina bermudezi* Acosta. Fig. 26: 3 chambers side view, scale bar = 107 microns; fig. 27: 2 chambers side view, scale bar = 84.1 microns.

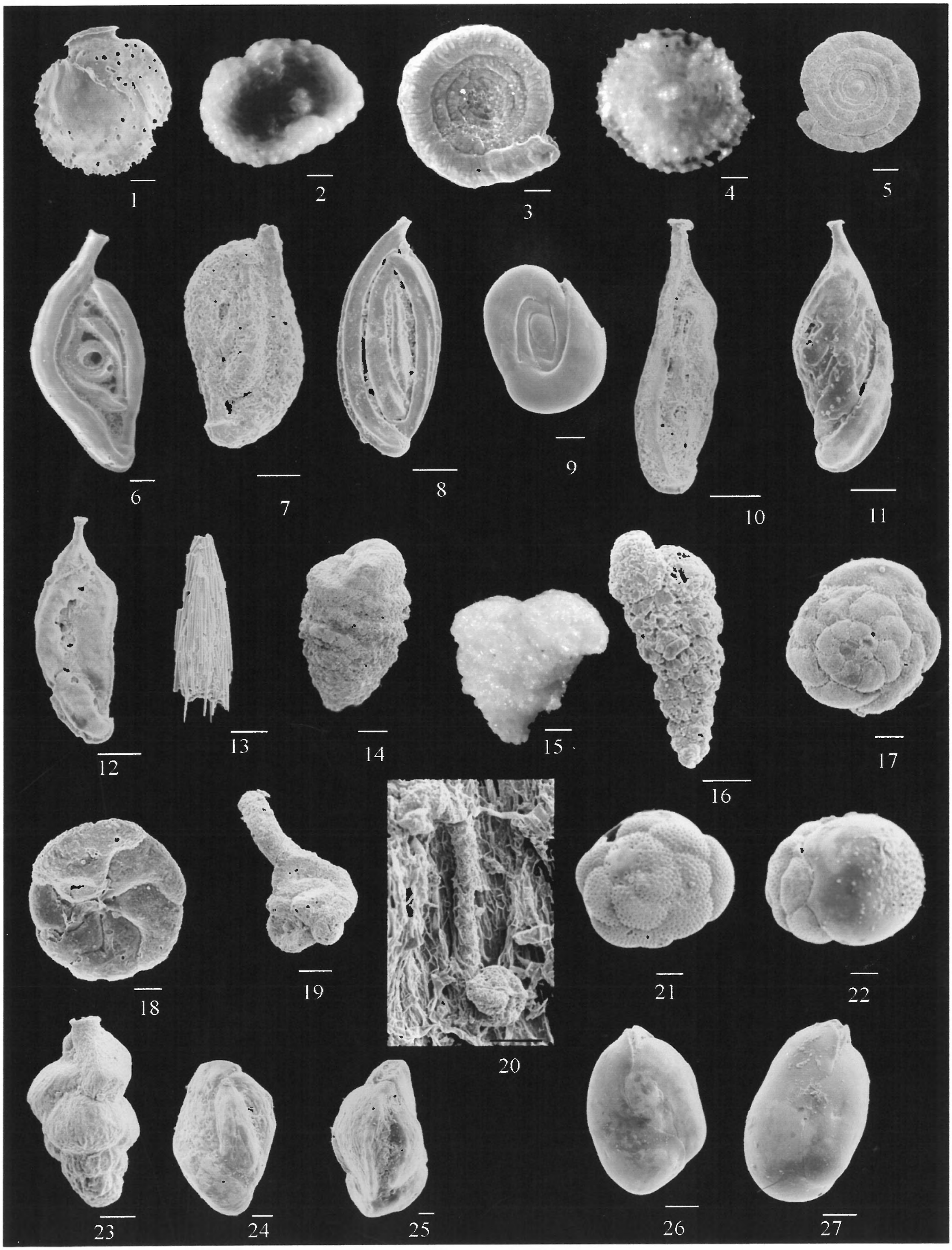
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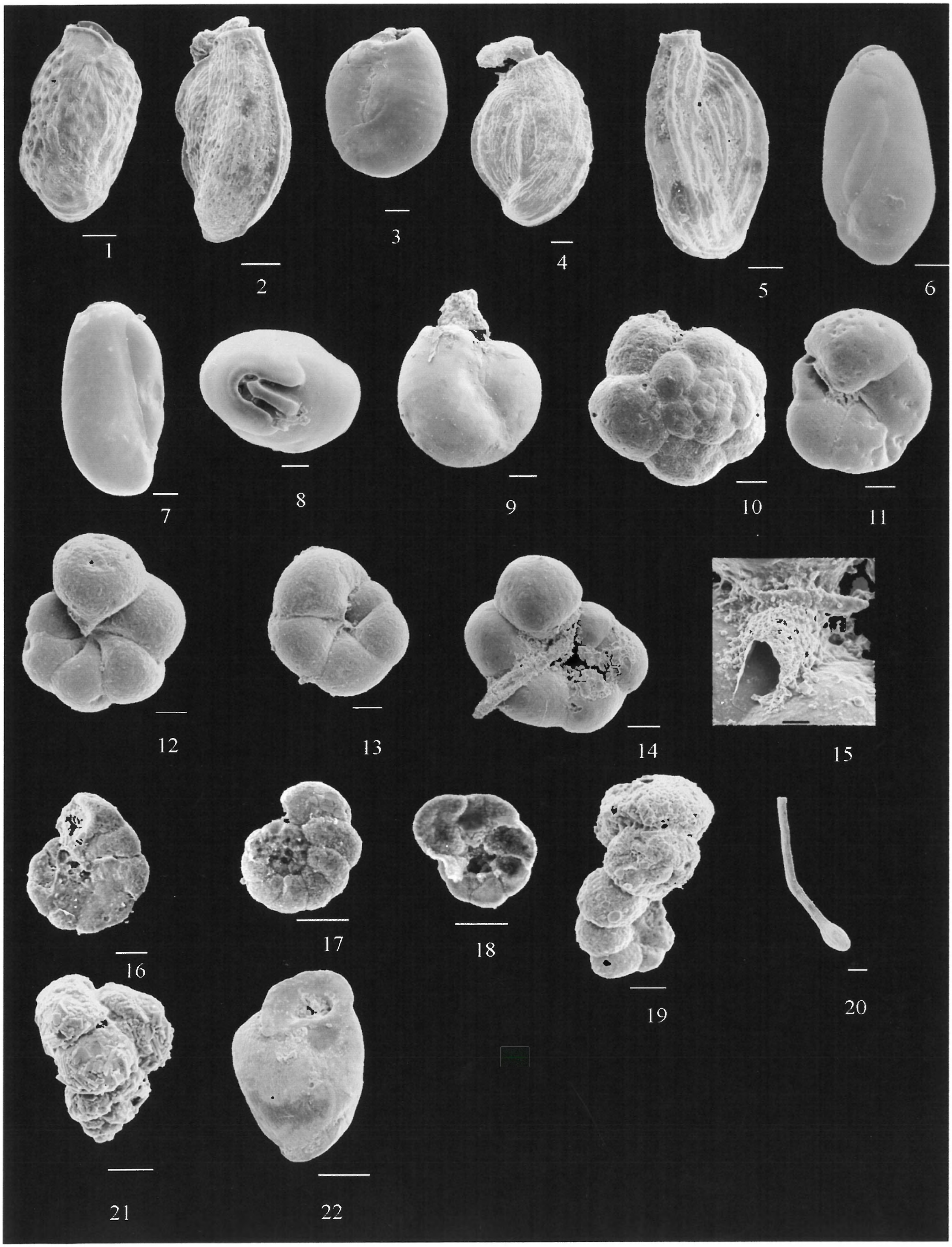
PLATE 8

Figures 1, 2	*Triloculina bicarinata* d'Orbigny. Fig. 1: 3 chambers side view, scale bar = 98.6 microns; fig. 2: 2 chambers side view, scale bar = 98.6 microns.
Figure 3	*Triloculina cuneata* Karrer. Three chambers side view, scale bar = 90.3 microns.
Figures 4, 5	*Triloculina linneiana* d'Orbigny. Fig. 4: 3 chambers side view, scale bar = 140 microns; fig. 5: 2 chambers side view, scale bar = 57.9 microns.
Figures 6-8	*Triloculina oblonga* (Montagu). Fig. 6: 3 chambers side view, scale bar = 70 microns; fig. 7: 2 chambers side view, scale bar = 70 microns; fig. 8: apertural view, scale bar = 40 microns.
Figure 9	*Triloculina rotunda* d'Orbigny. Scale bar = 134 microns.
Figures 10-13	Intergradational series of *Trochammina inflata* (Montagu) to *Siphotrochammina lobata* Saunders. Fig. 10: dorsal view, scale bar = 120 microns; figs. 11-13: ventral views showing the progression from typical aperture to siphon-shaped aperture, scale bars = 50 microns.
Figures 14, 15	*Trochammina inflata* (Montagu). Fig. 14: ventral view showing a secondary agglutinated tube attached to the aperture, scale bar = 120 microns; fig. 15: closeup of the tube, scale bar = 30 microns.
Figure 16	*Trochammina macrescens* Brady. Ventral view, scale bar = 40 microns.
Figures 17, 18	*Trochammina ochracea* (Williamson). Fig. 17: dorsal view, scale bar = 70 microns; fig. 18: ventral view, scale bar = 50 microns.
Figure 19	*Trochamminita salsa* (Cushman and Brönnimann). Scale bar = 40 microns.

Figure 20	*Tubinella funalis* (Brady). Scale bar = 65.3 microns.
Figure 21	*Valvulina oviedoina* d'Orbigny. Scale bar = 39.1 microns.
Figure 22	*Wiesnerella auriculata* (Egger). Scale bar = 99 microns.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APPENDIX DATA TABLES

Table 1: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Walsingham cave.

STATION NUMBER	1		2		3		4		5		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	33	122	7	62	4	84	10	60	7	101	4	83
NO. OF INDIVIDUALS/10cc	445	9182	540	19512	600	45360	1080	41256	1512	70092	1296	93960
REWORKED INDIVIDUALS (%)		2.73	0		0		0		0		8.5	
DEPTH (m)	0.3		3		4.5		2		3		6	
SEDIMENT TYPE	m.s.		f.s.		f.s.		f.s.		f.s.		f.s.	
Abditodentrix rhomboidalis		0.5		0.7		0.5		0.5			0.1	0.1
Ammodiscus tenuis						0.3						
Ammonia beccarii tepida		0.5										0.1
Amphistegina lessonii		0.1										
Angulogerina sp.								0.8		0.2		
Archaias angulatus		1.4										
Articulina antillarum								0.3		0.2		
Articulina mayori										0.3		
Articulina mexicana						0.3		0.3				
Articulina sp.		0.7				0.5		1.1		1.4		
Asterigerina carinata		0.1										
Astrononion stelligerum		0.5										
Bigenerina irregularis			0.2	0.4		1.3				0.5		0.1
Bolivina lanceolata	0.1	1.0		4.2		1.9		0.8		1.2		0.8
Bolivina lowmani		0.6		2.2								1.0
Bolivina paula				1.5		4.2		2.1		1.1		0.2
Bolivina pulchella		0.1										
Bolivina striatula		2.5		3.7		0.8				1.4		0.7
Bolivina subexcavata		1.8	0.2	4.6		1.6		0.8		2.6		0.7
Bolivina subspinescens				0.4								
Bolivina tortuosa		1.4		1.7		3.7		1.6		0.5		1.7
Bolivina variabilis	0.3	4.4		3.1		5.8		2.9		2.2		1.8
Bolivina variabilis var. spathulata	0.1	1.0		0.9								
Bucella frigida		0.1										

STATION NUMBER	1		2		3		4		5		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Bulimina aculeata												0.1
Bulimina gibba		0.3		0.4				0.2				0.7
Bulimina marginata		0.1		0.7			0.3	1.1		0.3		0.6
Bulimina sp.				0.6		0.3			0.3	0.5		
Buliminella elegantissima	0.2	2.5	0.7	2.6	0.3	2.1		3.4		0.6	0.1	0.6
Buliminella milletti		0.1										
Calcarina calcar		1.1										
Cancris sagra						0.3		0.3				0.2
Cassidulina bradyi	0.1	0.3										
Cassidulina subglobosa	0.1	1.5		4.8		1.3		2.6		1.1		1.5
Cibicides cicatrosus				0.7		0.5						
Cibicides lobatulus				0.4		0.5				0.2		0.2
Cibicides pseudoungeriana var. io												0.7
Cibicides refulgens		0.9		1.7		1.1		0.8		0.8		0.5
Cibicides spp.		0.1				0.3						
Clavulina difformis												0.1
Clavulina tricarinata		0.5						0.2				
Cyclogyra involvens				0.4								
Cyclogyra planorbis	0.1	0.9					0.3	1.6		1.1		0.3
Cymbaloporetta squamosa						0.3						
Dentalina sp.												0.1
Discanomalina semipunctata		0.1		0.4								0.1
Discorbis mira	0.1	0.2										
Discorbis sp.								0.3				0.2
Discorinopsis aguayoi	0.4	6.5		0.2		0.3		0.3		1.2		0.2
Elphidium discoidale												0.3
Elphidium excavatum		0.1						0.2				
Elphidium poeyanum		0.7		0.4		0.3		0.3		0.5		1.4
Elphidium sagrum		0.0										

STATION NUMBER	1		2		3		4		5		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Elphidium spp.		0.0				0.3						0.2
Epistominella pulchra						0.5						0.1
Eponides antillarum												0.9
Eponides sp.				0.4		0.5		0.5		1.4		
Fissurina spp.		0.3	0.4	1.1		2.0		3.3		1.1		0.6
Floresina sp.		0.1				0.8		0.5		0.5		
Fursenkoina complanata	0.2	0.8		0.7		0.3						0.5
Fursenkoina pontoni				0.4								
Glabratella carinata								0.5		0.6		
Glabratella sagrai				0.6		0.5		0.3		0.3		
Glabratella sp.								0.5				
Glomospira irregularis				0.4						0.2		0.1
Gyroidina soldanii		0.0										
Gyroidina sp.				1.1		1.1		4.7		0.9		
Hanzawaia concentrica				0.4				0.8		1.1		
Haplophragmoides sp.						0.5		0.2				0.3
Haplophragmoides wilberti		0.1										
Hauerina speciosa		0.1										
Helenina anderseni	0.4	9.5		1.1		0.5				0.2		0.1
Homotrema rubrum		0.1										
Hopskinsina pacifica		0.2		1.1		0.3		0.3				
Lagena spp.		0.2		0.7				0.3		0.2		
Lamarckina atlantica	0.1	1.3		1.1								
Loxostomum limbatum		0.1										
Loxostomum mayori	0.1	0.7		1.3		2.7	0.3	1.3		1.2		0.9
Loxostomum porrectum		0.2										0.1
Loxostomum sp.		0.2						0.2				0.1
Massilina protea		0.1										
Melonis pompiloides	0.3	1.4		0.7								0.6

STATION NUMBER	1		2		3		4		5		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Miliammina fusca				0.4								
Miliolinella labiosa		0.4										
Miliolinella sp.												0.1
Mychostomina revertens								0.3		0.5		
Mychostomina sp.		0.1										
Neoconorbina terquemi		0.1						0.2		0.2		
Neouvigerina porrecta		0.3										
Nonion depressulum	0.3	2.0		1.5								
Nonion gradeloupi		0.6		0.7		0.8		0.5				
Nonion spp.		2.0		3.0		1.1		0.3		1.5		0.1
Other Bolivinids		1.2		4.1		2.1		4.2		2.0		1.7
Other Miliolids	0.1	6.7		1.1		1.6		0.8		2.5		2.5
Other Miliolids reworked		0.3										
Other Planktonic Foram.				0.4		0.5		1.1		0.2		0.2
Other Rotaliids	0.2	5.7		23.3		16.4		12.3		14.6		6.7
Other Rotaliids reworked		0.7										
Palmerinella palmerae						0.3						
Patellina corrugata		0.5				0.5				0.6		0.3
Patellina sp.		0.1										
Peneroplis bradyi						0.3		0.2				
Peneroplis carinatus/proteus	0.1	0.5				0.3		0.5		0.5		
Pileolina patelliformis						0.3						
Planispiroides bucculentus	0.2	0.8										
Planulina exorna		0.4				0.3						
Planulina sp.										0.2		
Polysaccamina ipohalina												0.1
Pyrgo subsphaerica		0.1										
Quinqueloculina bicarinata		0.1						1.1		0.6		
Quinqueloculina bicostata						0.3		0.5				

STATION NUMBER	1		2		3		4		5		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Quinqueloculina bosciana						0.5	0.3	1.8		1.1		0.6
Quinqueloculina bradyana		0.6				0.3						
Quinqueloculina candeiana	P	0.3				0.3						0.1
Quinqueloculina circularis	P	0.3				0.8		1.8		2.5		1.2
Quinqueloculina goesi		1.0		0.4		1.9		1.6		1.7		0.2
Quinqueloculina laevigata	0.1	2.0				2.1	0.3	1.8	0.2	2.9		
Quinqueloculina lamarckiana	0.1	0.1				1.6		1.6		0.8		0.5
Quinqueloculina parkeri var. occid.		0.1										
Quinqueloculina poeyana		0.1						0.2				
Quinqueloculina polygona	0.1	0.5				0.3		0.5		0.3		
Quinqueloculina semilunum	P	1.2				1.6	0.3	3.7		2.9		0.6
Quinqueloculina spp.		0.8				0.5		10.0		6.2		0.8
Quinqueloculina stelligera		0.0				0.3		0.2				
Quinqueloculina subpoeyana		0.5				0.8		1.3		2.3		0.5
Quinqueloculina tricarinata										0.2		
Reophax arayensis				0.4		1.9		2.2				
Reophax dentaliniformis				0.4								
Reophax nana								0.3				0.3
Reophax nodulosus		0.4		0.7				0.2				
Reophax scorpiurus						2.1						
Reophax sp.				0.4				0.2				
Reussella atlantica				0.4								
Rosalina concinna		0.8		2.2		1.3		1.3		0.5		0.5
Rosalina globularis	0.2	2.4		0.7		0.8				1.4		1.1
Rosalina micens		0.4				0.3						
Rosalina sp.		0.3										8.2
Rosalina subarauncana	0.2	2.6										0.1
Rosalina vilardeboana		0.3		0.4								0.1
Saccamina difflugiformis			0.2	0.2		2.7		0.3	0.2	4.5		3.1

STATION NUMBER	1		2		3		4		5		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Sigmoilina sigmoidea		0.1										
Siphogenerina raphana	0.1	0.7		1.5		0.3				0.3		
Siphonina pulchra	0.1	2.1	0.4	2.6		3.2		1.3	0.3	1.2		1.7
Siphoninella soluta		0.2		0.4						0.3		0.1
Spirillina densepunctata												0.3
Spirillina denticulata	0.1	0.6				0.3				0.2		
Spirillina perforata		0.0										
Spirillina sp.		0.1								0.3		
Spirillina vivipara		0.9		0.4		0.3		0.8		0.6		0.3
Spiroloculina antillarum		0.8				0.3		0.5		1.2		0.1
Spiroloculina arenata	0.1	2.7				2.4	0.3	1.6		1.9		0.3
Spiroloculina hyalina		0.5				0.3		0.2				
Spiroloculina spp.		0.4				0.3	0.3	0.8		0.6		
Spirophtalmidium sp.		1.1				2.7		7.6		2.6		1.4
Technitella legumen			0.6	3.1		1.9	0.3	1.4				
Textularia agglutinans		0.1										
Textularia earlandi						1.1		0.2				0.1
Textularia sp.		0.7										
Tiphotrocha comprimata										0.2		
Trifarina occidentalis		1.7	0.2	3.0		2.1	0.3	2.1	0.3	2.0		1.5
Triloculina bassensis		0.1										
Triloculina bermudezi		0.0				0.3				0.6		
Triloculina cuneata												0.1
Triloculina gracilis								0.3		0.3		
Triloculina linneiana		P										
Triloculina oblonga								0.3		1.2		
Triloculina spp.		0.2								0.5		
Triloculina tricarinata		0.0										0.1
Triloculina trigonula	0.2	0.7				0.5		0.5		0.6		

STATION NUMBER	1		2		3		4		5		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Tritaxis sp.						0.3				0.2		0.3
Trochammina inflata		0.1		0.4		0.3				0.2		
Trochammina macrescens		P										
Trochammina ochracea		0.2		0.7								0.3
Trochammina sp.		0.2		0.4								
Tubinella funalis		0.9				0.5	0.3	3.4		1.2		
Tubinella inornata		0.1								0.3		
Uvigerina bradyana		0.1										
Valvulina oviedoiana						0.3						0.3
Virgulina pauciloculata	0.1	0.2										

Table 2: Percent abundance of living (stained, L) and total (T) foraminifera and thecamoebians, and sediment type from Leamington Cave (P = <0.1%).

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	39	75	14	60	2	65	24	72
NO. OF INDIVIDUALS/10cc	3800	27936	5400	82080	120	17160	5508	87048
DEPTH (m)	2.5		2.8		3		1	
SEDIMENT TYPE	f.s.		f.s.		f.s.		f.s.	
Ammobaculites agglutinans						0.4		
Ammodiscus tenuis	1.2	2.7	0.3	3.7		0.4	0.1	3.6
Ammonia beccarii tepida						0.7		
Angulogerina carinata				0.3				0.1
Articulina cf. mayori		0.1						
Articulina mayori		P						
Articulina sp.		0.2		0.3				0.1
Bigenerina irregularis		0.1						
Bolivina lanceolata	0.1	0.2				1.8		
Bolivina paula	P			0.8		0.7		0.1
Bolivina pseudoplicata								0.1
Bolivina striatula				0.3				0.1
Bolivina subexcavata				0.3		0.4		1.7
Bolivina subspinescens								0.1
Bolivina tortuosa		0.1		0.3		2.5		0.9
Bolivina variabilis			0.3	1.8			0.1	2.1
Bolivina variabilis var. spathulata		1.1				0.5		
Buliminella elegantissima				0.5				0.3
Buliminella sp.				0.3				0.3
Cassidulina neocarinata		0.2				1.4		
Cassidulina subglobosa		P	0.3	4.5		1.8	0.6	3.1
Cibicides cicatrosus	0.1	0.6				0.4		
Cibicides lobatulus		0.1						
Cibicides refulgens	0.1	0.3		1.6				1.4
Clavulina difformis		0.1						
Clavulina sp.		0.1						
Clavulina tricarinata	P	P		0.3				
Cyclogyra involvens				0.3		0.4	0.1	1.6
Cyclogyra planorbis			0.3	0.8		0.7		0.5
Cymbaloporetta squamosa		P						
Discorbis mira								0.1
Discorinopsis aguayoi						0.4		
Epistominella pulchra	0.3	0.8		1.3		0.4		0.3
Eponides antillarum		P	0.3	0.8				
Eponides repandus		0.1						
Eponides sp.						0.4		
Eponides tuberculata		P		0.8		0.4	0.1	1.7
Fissurina sp.				0.5			0.3	0.7
Fursenkoina complanata								0.1
Fursenkoina pontoni						0.4		
Glabratella carinata								0.9

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Glabratella sagrai				0.5		0.4	0.5	1.4
Glomospira irregularis		0.2		1.1		2.5		1.1
Gyroidina sp.	0.8	2.7				3.5	0.1	1.4
Hanzawaia concentrica		0.2				0.4		
Helenina anderseni						0.4		
Lagena sp.				0.3				0.1
Lagena spiralis		P						
Lamarckina haliotidea	0.1	0.5						
Loxostomum mayori		0.1		0.5		2.1	0.1	0.7
Miliolinella circularis		P				0.4	0.1	0.3
Mychostomina revertens				1.3		1.1	0.3	8.6
Neocorbina terquemi	0.5	1.2	0.3	1.3				
Nonion spp.		0.2		0.5		0.4		0.3
Orbulina sp.		P						
Oridorsalis umbonatus	0.2	0.7						
Osangularia culter						0.4		0.3
Other Bolivinids	1.0	2.8		1.6		0.7	0.1	0.5
Other Miliolids	0.3	2.5		1.1			0.3	2.6
Other Rotaliids	0.2	2.7	0.5	11.1		7.7		5.2
Patellina corrugata	0.1	4.7		7.1				6.2
Patellina sp.	0.1	2.7				0.4		0.2
Peneroplis sp.		0.1		0.3				
Planktonic Foram.						0.4		0.1
Planorbulina variabilis		P						
Planulina carribea	0.2	0.6		0.5		0.7	0.5	4.2
Planulina edwardsiana								0.1
Planulina sp.		0.1						
Pyrgo denticulata		P						
Quinqueloculina bicarinata				0.3		1.8		0.1
Quinqueloculina bicostata				0.5				0.1
Quinqueloculina bosciana		0.1		0.5		0.7		0.4
Quinqueloculina bradyana						0.4		
Quinqueloculina candeiana				0.3			0.1	0.4
Quinqueloculina circularis	0.1	0.5		1.6			0.6	1.9
Quinqueloculina collumnosa		P						
Quinqueloculina goesi	0.0	0.2		0.3				0.1
Quinqueloculina laevigata	0.1	0.4						0.5
Quinqueloculina lamarckiana	0.1	0.5					1.4	
Quinqueloculina polygona	0.1	0.4						
Quinqueloculina semilunum								0.1
Quinqueloculina spp.		0.7		1.6				0.3
Quinqueloculina subpoeyana				0.8		0.7	0.1	0.4
Quinqueloculina tricarinata				0.8		1.1		0.9
Quinqueloculina vulgaris	0.0	0.2						
Reophax nana				0.3				0.1

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Rosalina concinna			0.3	0.8				1.1
Rosalina globularis	0.4	1.1				0.4		0.4
Rosalina micens	1.0	4.4	0.5	1.3				0.6
Rosalina sp.						0.4		0.1
Sigmoilina schlumbergeri		P						
Siphogenerina raphana		0.1				0.7		0.3
Siphonina pulchra	1.6	5.8		2.9		6.6	0.1	1.4
Siphoninella soluta						1.8	0.1	0.1
Spirillina cariacoensis				0.5		0.4		
Spirillina denticulata			0.3	12.4		2.8		15.4
Spirillina sp.				0.3		0.7		
Spirillina vivipara	0.7	30.7		5.5			0.4	5.2
Spiroloculina antillarum	0.3	0.9	0.5	1.1		2.1		1.1
Spiroloculina arenata	0.3	1.6		1.3		2.5		0.5
Spiroloculina spp.		0.1		1.6		1.8	0.5	1.7
Spirophtalmidium sp.	2.2	14.8	2.4	16.6	0.4	23.8	0.9	11.7
Technitella legumen			0.3	0.3		0.7		
Textularia earlandi		0.2		0.3		1.1		
Textularia sp.						1.1		
Tiphotrocha comprimata				1.1		0.4		0.5
Tretomphalus atlanticus	0.0	0.1				1.1		
Trifarina occidentalis		0.1				0.4		0.6
Triloculina bassensis	0.0	0.1						
Triloculina bermudezi		0.1			0.4			0.1
Triloculina gracilis		0.1						
Triloculina oblonga	0.1	1.1		0.3				0.3
Triloculina rotunda								0.1
Triloculina spp.		0.1						
Triloculina trigonula	0.5	2.5					0.1	0.4
Tritaxis sp.						0.7		
Trochammina inflata	0.2	0.8				0.4		
Trochammina ochracea						0.4		
Trochammina sp.						1.4		
Tubinella funalis		0.1				0.4		0.1
Tubinella inornata		0.2		0.5				
Uvigerina canariensis		0.1						
Valvulina oviedoiana		P				0.4		
Centropyxis sp.								0.1

Table 3: Percent abundance of living (stained, L) and total (T) foraminifera and thecamoebians, and sediment type from Crystal cave.

SAMPLE NUMBER	1		2		3		4		5		6		7	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	5	31	0	25	5	21	0	13	3	27	0	14	0	9
NO. OF INDIVIDUALS/10cc	504	14184	0	4649	40	1070	0	164	13	427	0	1800	0	126
DEPTH (m)	2		3		10		1.5		1		3		1	
SEDIMENT TYPE	f.s.		silty s.		f.s.		f. to m.s.		f.s.		m.s.		f.s.	
REWORKED INDIVIDUALS (%)	80.95		0		0		0		1.6		8.5		80.95	
Ammodiscus tenuis										0.4				
Amphistegina lessonii														33.3
Archaias angulatus												1.0		9.5
Bolivina lanceolata												10.7		
Bolivina lowmani		0.8		0.5	0.5	4.2								
Bolivina paula										1.2		1.0		
Bolivina striatula				0.3										
Bolivina subspinescens				1.0										
Bolivina tortuosa		0.3		0.3						0.4				
Bolivina variabilis		0.8				0.5		3.0		0.4		1.3		9.5
Bolivina variabilis var.spathulata						1.0				0.4				
Cassidulina subglobosa		0.5		0.5										
Cibicides cicatrosus										0.4				
Cibicides lobatulus										0.4				
Cibicides refulgens										0.4				23.8
Cibicides spp.				1.8										
Cyclogyra involvens	0.3	3.8		2.8					2.3	23.0				
Cyclogyra planorbis		0.3		0.5		0.5								
Discorbis mira														4.8
Elphidium spp.												0.3		
Epistominella pulchra		2.5		3.9	0.9	1.4								
Eponides repandus					0.5	0.9								
Eponides tuberculata		0.8												
Fissurina sp.										0.3				

SAMPLE NUMBER	1		2		3		4		5		6		7	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Glabratella carinata		0.3												
Glabratella sagrai		2.8												
Gyroidina sp.										0.8				
Lagena sp.		0.3												
Loxostomum mayori										0.4				
Miliolinella circularis										1.2				
Miliolinella labiosa										1.2				
Mychostomina revertens		1.5								0.4				
Nonion depressulum				0.3										
Nonion gradeloupi				0.3										
Other Bolivinids		1.8						2.4						
Other Miliolids		1.3		2.3		5.6		17.7		2.3				
Other Miliolids reworked												1.0		4.8
Other Rotaliids		1.0		1.8		1.4		5.5		0.4				
Other Rotaliids reworked										0.8				
Patellina corrugata		2.3		2.6		0.5								
Patellina sp.		2.0												
Peneroplis carinatus/proteus														
Planispiroides bucculentus								40.9		3.9				4.8
Planktonic foraminifera		6.6		8.3						0.4				
Quinqueloculina bosciana		0.5												
Quinqueloculina circularis		0.3		2.3		0.5								
Quinqueloculina laevigata		1.0		0.3						0.4				
Quinqueloculina polygona						0.8								
Quinqueloculina semilunum								0.6						
Quinqueloculina spp.	0.3	1.3						0.6		1.2		0.3		
Quinqueloculina spp. reworked												0.3		
Quinqueloculina subpoeyana		0.8		0.3										
Quinqueloculina tricarinata		1.8												

SAMPLE NUMBER	1		2		3		4		5		6		7	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Reophax nana				0.3										
Rosalina concinna		1.8												
Rosalina globularis								0.6		27.2		0.6		
Rosalina micens		0.3												
Rosalina subarauncana										5.5		54.3		
Siphogenerina raphana		0.5												
Siphonina pulchra						0.5				0.4				
Siphoninella soluta		0.8												
Spirillina cariacoensis		0.5												4.8
Spirillina inaequalis				0.3		0.5								
Spirillina sp.		2.8												
Spirillina vivipara	0.3	6.4		5.9		4.2		0.6						
Spiroloculina antillarum	0.8	13.2		15.5		7.0								4.8
Spiroloculina arenata				0.3										
Spiroloculina hyalina					0.5	0.5								
Spiroloculina spp.				1.8		0.9								
Spirophtalmidium sp.	2.0	36.8		45.8	0.5	67.8				0.8				
Trifarina occidentalis										0.4				
Triloculina bermudezi								0.6						
Triloculina oblonga						0.5		1.8		1.6		0.3		
Triloculina spp.				0.3										
Triloculina trigonula								0.6						
Tubinella funalis		0.3				0.5								
Tubinella inornata		1.8				0.5								
Arcella polypora								3.7		2.3		12.0		
Centropyxis aculeata								18.3	0.4	12.3		12.3		
Other Thecamoebians								3.1		0.4		1.3		

Table 4: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Devonshire Dock.

STATION NUMBER	1		2		3	
LIVE/TOTAL	L	T	L	T	L	T
NO. OF SPECIES	25	54	18	46	21	46
NO. OF INDIVIDUALS/10cc	1332	5850	918	5508	708	3804
DEPTH (m)	7		7		7	
SEDIMENT TYPE	m.s.		m.s.		m.s.	
Ammobaculites agglutinans			0.7	0.7	0.3	0.3
Ammobaculites sp.		0.3				
Ammonia beccarii tepida	0.3	1.2	0.3	1.3		1.3
Ammonia sp.		0.3		1.0		
Archaias angulatus	0.9	4.3	0.7	7.8	1.6	8.5
Articulina pacifica		0.6	0.3	0.3		
Bolivina lanceolata		1.2	0.3	1.3		0.6
Bolivina lowmani		0.3				
Bolivina pulchella						0.3
Bolivina tortuosa		0.3				
Broeckina orbitoilitoides	0.3	0.6				0.6
Buliminella elegantissima				0.3		
Cassidulina subglobosa		0.3				
Cibicides lobatulus		0.6		1.0		
Cibicides refulgens						0.9
Cyclogyra planorbis		0.3			0.6	1.3
Cyclorbulina compressa						0.6
Cymbaloporetta squamosa		0.9		0.3	0.3	0.9
Elphidium advenum		1.2				1.9
Elphidium discoidale		0.3		0.3		0.3
Elphidium poeyanum		1.5	0.3	2.6	0.3	0.6
Elphidium sagrum		0.3				
Elphidium sp.		0.3		2.9		
Floresina sp.				0.3		
Glomospira irregularis	0.3	0.3				
Miliammina fusca			0.3	0.3		
Miliolinella circularis		0.6		0.3		
Miliolinella labiosa		0.3		1.6		0.6
Monalysidium politum	0.3	1.8		1.6		0.3
Nonion gradeloupi	0.9	1.2	0.7	1.3	0.9	1.3
Other Miliolids	0.9	5.5		2.6	1.3	8.8
Other Rotaliids	0.3	0.9		2.6	0.3	0.9
Other Textulariids						0.3
Peneroplis bradyi	0.0	1.2		0.7		1.3
Peneroplis carinatus/proteus	2.8	23.3	1.3	20.3	0.9	23.9
Peneroplis pertusus		0.6		1.3		0.3
Planorbulina acervalis				0.7		
Planorbulina mediterranensis						0.6
Pyrgo subsphaerica		0.3				
Quinqueloculina agglutinans				1.0		0.6
Quinqueloculina bicarinata	1.2	8.9	1.0	6.5	0.6	6.3

STATION NUMBER	1		2		3	
LIVE/TOTAL	L	T	L	T	L	T
Quinqueloculina bicostata						0.3
Quinqueloculina bosciana	1.2	1.2				
Quinqueloculina candeiana		0.3	0.3	2.6		
Quinqueloculina funafutiensis		0.3				
Quinqueloculina lamarckiana	0.6	2.2		0.7	0.3	2.2
Quinqueloculina laevugata	3.1	7.4			2.8	7.3
Quinqueloculina parkeri var. occidentalis			5.9	9.8		
Quinqueloculina poeyana		1.5		2.9		0.3
Quinqueloculina polygona		0.9		1.0		0.9
Quinqueloculina semilunum	0.9	1.5	2.0	5.9	2.2	5.7
Quinqueloculina spp.		0.9		2.9		0.3
Quinqueloculina subpoeyana	0.6	2.8		3.3	0.6	3.2
Quinqueloculina vulgaris	0.3	1.8			0.3	1.9
Rosalina concinna	0.3	1.2				
Rosalina globularis		0.9			0.3	0.6
Rosalina subarauncana	0.9	2.5				1.6
Siphonina pulchra						0.3
Sorites marginalis				0.7		
Spiroloculina arenata				0.3		0.3
Textularia agglutinans	1.2	1.8	0.3	1.0	1.3	1.9
Textularia conica	0.3	0.6	0.0	0.7	0.9	1.9
Textularia earlandi		0.3		0.3		
Triloculina bassensis	0.3	0.9		1.3		
Triloculina bermudezi				0.3		
Triloculina carinata			0.7	0.7		
Triloculina cuneata			0.3	0.7		
Triloculina linneiana						0.3
Triloculina oblonga	0.3	0.9		1.0	1.3	2.2
Triloculina rotunda	0.0	0.3			0.0	0.6
Triloculina trigonula	1.2	3.4	0.3	1.0	0.3	1.6
Trochammina ochracea	3.1	5.6	1.0	2.0	0.9	2.9

Table 5: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Nwshore along Ireland Island.

STATION NUMBER	1	1
LIVE/TOTAL	L	T
NO. SPECIES	21	68
NO. INDIVIDUALS/10cc	648	81864
DEPTH (m)		15
SEDIMENT TYPE		f.s.
Ammonia beccarii var. tepida	0.8	5.0
Archaias angulatus		0.8
Articulina antillarum	0.3	2.6
Articulina spp.	0.3	4.2
Bolivina lanceolata	0.5	3.2
Bolivina lowmani		0.3
Bolivina pulchella		0.5
Bolivina striatula		1.3
Bolivina tortuosa		0.5
Bolivina variabilis		2.1
Bolivina variabilis var. spathulata		0.3
Bulimina aculeata		0.5
Buliminella elegantissima	0.3	1.3
Cassidulina spp.		1.1
Cibicides refulgens		0.8
Cyclogyra planorbis	0.3	1.6
Cyclorbiculina compressa		0.5
Cymbaloporetta bradyi		0.3
Elphidium advenum	0.3	4.0
Elphidium discoidale		0.8
Elphidium poeyanum	0.3	4.7
Elphidium sagrum		0.3
Fissurina sp.		0.5
Floresina sp.		0.3
Fursenkoina complanata	0.8	2.4
Fursenkoina pontoni	0.3	0.5
Miliolina spp.		0.3
Miliolinella labiosa		0.3
Monalysidium politum	0.5	1.1
Nonion depressulum		0.8
Nonion gradeloupi		1.3
Other Miliolids		8.2
Other Rotaliids		2.1
Peneroplis carinatus/proteus	0.3	2.6
Quinqueloculina bicarinata		0.5
Quinqueloculina bicostata	0.3	2.4
Quinqueloculina bosciana		0.5
Quinqueloculina bradyana		0.5
Quinqueloculina candeiana		3.2
Quinqueloculina cf. goesi		1.1
Quinqueloculina circularis		0.8

STATION NUMBER	1	1
LIVE/TOTAL	L	T
Quinqueloculina goesi	0.5	4.5
Quinqueloculina laevigata	0.8	6.3
Quinqueloculina lamarckiana	0.3	0.8
Quinqueloculina parkeri var. occidentalis		0.5
Quinqueloculina polygona		0.8
Quinqueloculina semilunum		1.8
Quinqueloculina semilunum var. jugosa		0.3
Quinqueloculina spp.		5.0
Quinqueloculina subpoeyana		2.9
Reophax nodulosus		1.1
Reophax sp.		0.3
Rosalina globularis		1.4
Rosalina subaraucana		2.1
Schlumbergerina alveolif. var. occid.		0.3
Sigmoilina sigmoidea		0.3
Spirillina vivipara		0.5
Spiroloculina antillarum		0.3
Spiroloculina arenata	0.3	1.1
Textularia agglutinans	0.3	0.3
Textularia conica	0.3	0.3
Textularia sp.		0.3
Trifarina occidentalis		0.3
Triloculina carinata	0.3	0.3
Triloculina linneiana		0.3
Triloculina spp.		0.3
Triloculina trigonula	0.3	0.5
Trochammina ochracea		1.1
Uvigerina sp.		0.3
Valvulina oviedoina		0.3

Table 6: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from North lagoon traverse.

STATION NUMBER	1		3		5		7		9		10		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	8	58	7	80	1	74	4	61	8	59	8	51	6	50
NO. OF INDIVIDUALS/10cc	3888	137808	756	75924	432	197424	90	6282	144	7758	288	8388	126	5454
DEPTH (m)	20		20		23		23		24		10cm<surface # 9		25	
SEDIMENT TYPE	f.s.		m.s		f. to m. sand		c.s		c. s.		c. s.		m. s.	
Abditodentrix rhomboidalis						0.2								
Ammobaculites agglutinans						0.4								
Ammobaculites sp.										0.2				
Ammonia beccarii tepida	0.3	4.4	0.1	5.4		0.7				0.2				0.3
Ammonia sp.				0.9		0.4								
Amphistegina lessonii								0.3						0.7
Angulogerina carinata														
Archaias angulatus		0.9		1.1		0.2		6.0	0.2	5.6		2.6		3.9
Articulina antillarum				0.3		1.3								
Articulina mayori														
Articulina mexicana				0.1						0.2		1.3		
Articulina mucronata									0.2	0.2				0.3
Articulina pacifica				0.9		2.2		0.6		0.4				
Articulina sagra														
Asterigerina carinata	0.3	0.3				0.4		1.4		2.6		5.2		10.1
Astrononion stelligerum		0.6		1.1		1.1		0.3						
Bolivina lanceolata	0.3	3.1	0.1	3.0		2.2		0.3						
Bolivina paula		0.6		0.4		0.7		0.3						
Bolivina pulchella		2.5		1.8		1.8		0.6						0.3
Bolivina sp.		0.3										0.4		
Bolivina striatula				0.1										
Bolivina subexcavata				0.4		0.4								
Bolivina tortuosa		2.8		3.7		5.9		2.3				1.3		
Bolivina variabilis		0.3				0.4								
Borelis pulchra								0.3						

STATION NUMBER	1		3		5		7		9		10		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Broeckina orbitolitoides														
Bulimina marginata		0.3		0.9										
Bulimminella elegantissima		1.3	0.1	1.6		1.1								
Cancris sagra														0.3
Carpenteria proteiformis								0.3						
Cassidulina neocarinata				0.7		0.2								
Cassidulina subglobosa		0.3		1.7		0.2								
Cibicides lobatulus				0.6		0.2		0.9		0.2		1.3		0.7
Cibicides refulgens		0.3		1.3		3.3		1.1		0.5		1.7		1.0
Clavulina tricarinata						0.2				0.7		0.4		
Cyclogyra planorbis		0.3		1.7		1.5								
Cymbaloporetta squamosa	0.3	0.6		0.6		0.7		1.1		0.7		0.9		
Discorbis sp.				0.4		0.4		0.3						
Discorbis mira				0.1										
Elphidium advenum		1.6		1.6		2.0		0.6						
Elphidium poeyanum		1.9		2.8		1.1								
Elphidium sagrum								0.3		0.2		0.9		
Elphidium sp.		17.2		6.7		5.5				0.2		2.1		
Elphidium spp.				0.1						0.2				0.3
Eponides repandus		0.3		0.7		0.7		5.7	0.2	3.7		8.6	0.3	3.9
Fissurina sp.				0.4										
Floresina sp.				0.3										
Fursenkoina complanata				0.1										
Glabratella sp.						0.4								
Globobulimina pacifica						0.2								
Hanzawaia concentrica		0.3				0.2				0.2				
Hoeglundina elegans								0.6		0.2				
Homotrema rubrum				0.1		0.2		46.7		55.0		26.2		47.4
Lagena sp.				0.3										

STATION NUMBER	1		3		5		7		9		10		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Loxostomum mayori						0.2								0.3
Melonis pompiloides								0.3						
Miliolinella cf. fichteliana				0.3					0.2	0.5		0.9		
Miliolinella circularis				0.6		0.7		0.9						1.0
Miliolinella fichteliana														1.0
Miliolinella labiosa		0.3		0.7		0.4		1.1		0.5		0.4		0.3
Monalysidium politum		1.3		0.6		0.2								
Neoconorbina terquemi		0.3		0.1		0.9		1.7		0.2				0.3
Nonion depressulum		0.9		2.0		3.1		0.3				0.4		
Nonion gradeloupi		2.5		2.8		2.2							0.3	0.3
Osangularia culter				0.1				0.3		0.2				
Other Miliolids		3.4		4.3		3.9		1.1		0.9	0.4	2.6		2.0
Other Rotaliids		1.9		7.4		7.4		1.1		0.9		3.4		1.6
Patellina corrugata				0.1				0.0						
Peneroplis bradyi										0.2				
Peneroplis carinatus/proteus		1.9		2.8		3.1	0.6	1.7		1.1	0.4	2.1		1.3
Peneroplis pertusus		0.3		0.1										
Peneroplis sp.									0.2	0.2	0.4	0.4		
Pileolina patelliformis								0.3						0.3
Placopsilina bradyi														
Planispiroides bucculentus						0.4								
Planktonic foram.				0.4		0.4								0.3
Planorbulina acervalis												0.4		
Planorbulina mediterranensis										0.5		0.4		
Planulina carribbea										0.2		0.4		0.7
Planulina exorna								0.6						
Pyrgo elongata										0.2				0.3
Pyrgo subsphaerica														1.6
Quinqueloculina agglutinans		0.3		1.1		0.2		2.0		5.6		1.7		2.3

STATION NUMBER	1		3		5		7		9		10		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Quinqueloculina bicarinata		1.9	0.1	1.7		1.1				0.5		0.4		
Quinqueloculina bosciana				0.9		0.4								
Quinqueloculina bradyana		0.6				1.1		1.4		0.2		1.7	0.3	2.0
Quinqueloculina candeiana		3.4		4.8		1.3		1.1		4.4		4.7		0.3
Quinqueloculina circularis		0.3												
Quinqueloculina goesi		0.6		0.3		0.4				0.5		1.3		
Quinqueloculina laevigata	0.6	3.1		4.7		4.2		0.6			0.4	2.6	0.7	2.6
Quinqueloculina lamarckiana		3.1		1.6		1.1		0.9		0.2		3.4		0.7
Quinqueloculina poeyana				0.4		5.7						0.4	0.3	0.3
Quinqueloculina polygona		0.3		0.4		0.4		0.6				0.4	0.3	1.0
Quinqueloculina semilunum	0.3	7.8	0.1	3.6		2.2		0.6			0.4	1.3		0.3
Quinqueloculina spp.		4.4		2.1		1.8		0.9		1.2		0.4		
Quinqueloculina subpoeyana	0.3	7.2		2.1		3.1		0.3						0.3
Quinqueloculina vulgaris			0.1	0.6		0.2		0.6		0.7				0.7
Reophax scorpiurus				0.3										
Reussella atlantica										0.7		2.1		0.7
Rosalina concinna		1.3		0.3		0.4						0.4		
Rosalina globularis	0.3	1.3	0.1	1.2	0.2	1.3		0.9			0.4	0.4		
Rosalina floridensis		0.9												
Rosalina subarauncana		2.5		4.8		10.3		2.3				0.4		0.7
Schlumbergerina alveoliformis								0.6						
Sigmoilina schlumbergeri									0.2	0.2				
Sigmoilina sigmoidea														
Siphogenerina raphana														0.3
Siphonina pulchra				0.1				1.1		0.2		1.7		0.3
Spirillina cariacoensis		0.9				0.9		0.3		0.2				
Spirillina denticulata				0.1						0.2				
Spirillina sp.												0.4		
Spirillina vivipara		0.3												

STATION NUMBER	1		3		5		7		9		10		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Spiroloculina antillarum				0.1		0.2		0.3		0.5		0.9		
Spiroloculina arenata				0.3				0.3		0.2		0.9		0.3
Spiroloculina gradeloupi		0.3		0.1		0.2		0.3						0.3
Spiroloculina sp.										0.2		0.4		
Spirophtalmidium sp.				0.1		0.4		0.3						0.3
Textularia agglutinans		0.3		0.1		0.2								0.3
Textularia conica		0.3		0.3		0.2				0.5				
Trifarina occidentalis		0.3				0.9								
Triloculina bassensis		0.3		0.3		0.2				0.7		0.4		0.3
Triloculina carinata		1.3				0.2		0.6		1.9		3.4		0.7
Triloculina cuneata								0.3		0.7				
Triloculina linneiana		0.6		0.1		0.2		0.3		0.5	0.4	1.7		2.0
Triloculina oblonga				0.1						0.2				
Triloculina quadrilateralis							0.3	1.1		0.2		0.4		
Triloculina rotunda								0.6		0.2		2.1		0.7
Triloculina spp.		0.3		0.3		0.2				0.5				
Triloculina trigonula				0.7		1.1		1.4		0.9		0.4		0.7
Trochammina cf. inflata									0.2	0.2				
Trochammina ochracea		0.6		1.3			0.3	0.9	0.2	0.2	0.4	0.4		
Tubinella funalis														
Valvulina oviedoina								0.9		0.2				
Weisnerella auriculata		1.3		0.3		0.2						0.4		1.0

STATION NUMBER	13		15		17		18		19		35	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	1	40	5	48	8	15	16	33	23	43	3	54
NO. OF INDIVIDUALS/10cc	36	6732	216	11124	11	328	100	398	70	309	648	75816
DEPTH (m)	25		23		4.6		10cm<surface #17		3.7		9.2	
SEDIMENT TYPE	m. s.		m . s.		v. c. s.		v. c. s.		v.c.s.		f. to m. s.	
Abditodentrix rhomboidalis												
Ammobaculites agglutinans												
Ammobaculites sp.												
Ammonia beccarii tepida		0.5						0.3	0.3	0.6		6.6
Ammonia sp.												
Amphistegina lessonii		1.1		0.3								
Angulogerina carinata				0.3					0.3	0.3		
Archaias angulatus		6.4		8.4				0.3		4.2		0.9
Articulina antillarum												1.1
Articulina mayori												0.6
Articulina mexicana				0.3								
Articulina mucronata		0.5		1.0								
Articulina pacifica		0.5		1.6					0.6	1.0		
Articulina sagra		0.5										
Asterigerina carinata		4.8		4.9					0.3	0.6		
Astrononion stelligerum												0.6
Bolivina lanceolata						0.6	0.3	0.5		0.6	0.3	3.4
Bolivina paula												0.3
Bolivina pulchella								0.3				1.1
Bolivina sp.												
Bolivina striatula												
Bolivina subexcavata							0.3	0.5				0.6
Bolivina tortuosa								1.5	0.3	0.3		3.1
Bolivina variabilis								0.3				
Borelis pulchra									0.3	0.3		

STATION NUMBER	13		15		17		18		19		35	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Broeckina orbitolitoides		0.5										
Bulimina marginata												0.3
Bulimminella elegantissima										0.3		0.6
Cancris sagra									0.3	0.3		
Carpenteria proteiformis						0.3						
Cassidulina neocarinata												1.1
Cassidulina subglobosa								0.3				0.6
Cibicides lobatulus				1.9								0.6
Cibicides refulgens		1.1		2.3			0.8	1.5		0.3		2.3
Clavulina tricarinata		0.5		0.6								
Cyclogyra planorbis		0.5							0.6	0.6		0.3
Cymbaloporetta squamosa										0.3		0.3
Discorbis sp.												0.3
Discorbis mira												
Elphidium advenum												1.4
Elphidium poeyanum								0.3				2.6
Elphidium sagrum		1.1		1.3								0.3
Elphidium sp.				1.0						0.3		11.7
Elphidium spp.												
Eponides repandus		4.8	0.3	7.1	0.3	0.3	1.0	1.0		0.3		
Fissurina sp.												
Floresina sp.												
Fursenkoina complanata												
Glabratella sp.												
Globobulimina pacifica												
Hanzawaia concentrica				0.3								
Hoeglundina elegans		0.5		1.0								
Homotrema rubrum		50.3		25.9		86.6		61.6		54.4		
Lagena sp.												

STATION NUMBER	13		15		17		18		19		35	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Loxostomum mayori												
Melonis pompiloides												
Miliolinella cf. fichteliana												
Miliolinella circularis								0.3		0.3		
Miliolinella fichteliana		0.5		0.3								
Miliolinella labiosa		2.7		1.0						0.3		
Monalysidium politum			0.3	0.3					0.3	0.3		0.3
Neoconorbina terquemi		2.1			0.3	0.3	1.3	1.3	0.6	1.0		0.0
Nonion depressulum												3.1
Nonion gradeloupi									0.3	0.3	0.3	4.0
Osangularia culter												
Other Miliolids			0.3	2.3				0.5				5.4
Other Rotaliids		0.5		1.3		0.6	0.3	1.0	0.3	0.3		2.6
Patellina corrugata												
Peneroplis bradyi							0.5	0.5	0.3	1.0		
Peneroplis carinatus/proteus		2.7		3.9		0.3			0.6	1.9		5.1
Peneroplis pertusus												
Peneroplis sp.												
Pileolina patelliformis												
Placopsilina bradyi				0.3								
Planispiroides bucculentus												
Planktonic foram.		0.5		0.6								
Planorbulina acervalis												
Planorbulina mediterranensis		0.5							0.3	0.3		
Planulina carribbea		0.5					0.3	0.3				
Planulina exorna							3.3	3.5	3.2	3.2		
Pyrgo elongata										0.3		
Pyrgo subsphaerica				1.0						0.3		0.6
Quinqueloculina agglutinans		3.2		2.3				0.3		0.3		0.3

STATION NUMBER	13		15		17		18		19		35	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Quinqueloculina bicarinata		1.1	0.6	1.3	0.6	0.6	1.3	1.5	1.6	2.3		3.1
Quinqueloculina bosciana												0.3
Quinqueloculina bradyana		0.5		2.6						0.3		
Quinqueloculina candeiana		0.5		3.6						1.9		5.7
Quinqueloculina circularis												
Quinqueloculina goesi				0.3				0.3				1.4
Quinqueloculina laevigata		0.5		1.0				0.5		0.6		2.6
Quinqueloculina lamarckiana		2.1		1.0						0.3		0.9
Quinqueloculina poeyana												2.0
Quinqueloculina polygona		0.5	0.3	0.3					0.3	0.3		1.7
Quinqueloculina semilunum				1.6				0.5				1.1
Quinqueloculina spp.		0.5		1.9								2.6
Quinqueloculina subpoeyana												5.7
Quinqueloculina vulgaris		1.1		0.3				0.3				0.3
Reophax scorpiurus												
Reussella atlantica				1.6								
Rosalina concinna		0.5		0.3	0.3	0.6	1.8	2.0	1.9	2.9		0.6
Rosalina globularis									0.3	1.0		0.9
Rosalina floridensis												
Rosalina subarauncana	0.5	1.6		1.9	0.3	0.6	0.8	1.3		1.0		4.8
Schlumbergerina alveoliformis												
Sigmoilina schlumbergeri												
Sigmoilina sigmoidea										0.3		
Siphogenerina raphana		0.5		0.3								
Siphonina pulchra				1.3								
Spirillina cariacoensis						0.0	1.3	1.5				0.3
Spirillina denticulata					0.6	0.6	0.8	0.8				
Spirillina sp.												
Spirillina vivipara												

STATION NUMBER	13		15		17		18		19		35	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T
Spiroloculina antillarum											0.3	0.3
Spiroloculina arenata												
Spiroloculina gradeloupi												
Spiroloculina sp.												
Spirophtalmidium sp.												
Textularia agglutinans												
Textularia conica									0.3	0.3		
Trifarina occidentalis												
Triloculina bassensis				1.0								0.6
Triloculina carinata		0.5		3.6				0.3				
Triloculina cuneata												
Triloculina linneiana		1.1		2.6								
Triloculina oblonga				0.3								
Triloculina quadrilateralis				1.0								0.6
Triloculina rotunda		0.5										
Triloculina spp.												
Triloculina trigonula				0.3		0.3						0.6
Trochammina cf. inflata												0.3
Trochammina ochracea		0.5			0.3	6.4	10.3	12.3	7.4	9.4		1.1
Tubinella funalis				0.3								
Valvulina oviedoina						0.9		1.0		1.3		
Weisnerella auriculata		0.5			0.9	0.9	1.3	2.3	1.3	2.9		0.9

Table 7: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Harrington Sound (1993 samples).

STATION NUMBER	1		2		3		4		5		6		7		9	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	24	53	21	41	19	49	14	70	9	66	10	50	5	61	6	88
NO. OF INDIVIDUALS/10cc	1062	6660	459	2547	2160	9468	756	34812	504	23616	648	18468	216	11520	576	70920
DEPTH (m)	4		2		9.2		18.3		9.2		17.2		9.7		3.7	
SEDIMENT TYPE	f.s.		f.s.		m. to c.s.		f.s.		silty s.		silty s.		f. to m.s.		m.s.	
Abditodentrix rhomboidalis																
Ammobaculites agglutinans								1.6				1.0				
Ammobaculites sp.								0.0						1.3		
Ammodiscus tenuis														0.6		
Ammonia beccarii advena						1.5										
Ammonia beccarii tepida	0.3	3.8	0.4	2.8	1.5	2.3	0.4	15.3	0.6	17.7	1.0	27.9		5.0		3.2
Angulogerina carinata										0.2						0.3
Archaias angulatus	0.5	13.0	0.7	19.4	0.0	2.7		0.4				0.2				0.4
Articulina antillarum																
Articulina mayori						0.4				0.5				0.3		
Articulina mexicana										0.2						0.8
Articulina mucronata						0.4										
Articulina pacifica																0.1
Articulina spp.		0.8	0.7	1.1	0.0	0.4		0.5		0.2		0.4				0.8
Astrononion stelligerum								0.2		0.8	0.2	1.6		0.3		
Bigenerina irregularis								0.2		0.2						
Bolivina lanceolata	0.5	2.4	0.4	0.4	0.4	2.3	0.1	9.4	0.3	9.0	0.6	12.5	0.6	8.4	0.2	5.8
Bolivina lowmani								0.6		0.2		0.4		2.5		0.6
Bolivina paula							0.1	4.6		0.8		1.0		0.6		0.5
Bolivina pulchella								0.1								
Bolivina sp.								0.1								
Bolivina striatula												0.2				
Bolivina subexcavata								0.2				0.2		1.6		0.5
Bolivina tortuosa	0.3	1.1				0.4		0.7		0.6		1.4		0.9		0.7
Bolivina variabilis														0.6		

STATION NUMBER	1		2		3		4		5		6		7		9	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Bolivina variabilis var. spathulata						0.4										
Borelis pulchra																
Broeckina orbitoilitoides		0.5														
Bulimina gibba										1.4						
Buliminella elegantissima	0.3	0.3					0.4	4.9	0.2	6.7	0.4	6.8	0.3	2.2	0.1	0.8
Cancris sagra								0.1								
Carpenteria proteiformis																
Cassidulina neocarinata												0.4				
Cassidulina subglobosa	0.8	0.8				0.4		2.0		3.7		2.5		0.9		1.0
Caterina spiculotesta		0.5														
Cibicides lobatulus										0.2			0.3	0.3		1.7
Cibicides refulgens	1.1	2.4		0.4		0.8		0.8		0.6		1.2		2.8		4.3
Clavulina tricarinata														0.3		
Cyclogyra planorbis		0.3	0.4	0.7	0.4	0.4		0.5		0.9				0.3		0.8
Cymbaloporetta squamosa		0.8	0.4	0.7		0.8		0.9		0.2		0.4				1.0
Discorbis granulosa										0.2		0.2				0.5
Discorbis mira																
Elphidium advenum		0.3		0.7		0.8		1.2		1.4				0.3		1.7
Elphidium discoidale		0.3				0.4				0.2		1.4				0.1
Elphidium poeyanum	0.3	2.4	0.4	0.4		1.1		6.4	0.2	0.8		2.7		0.6		0.6
Elphidium sagrum		0.3						0.8		0.2		0.2				
Elphidium sp.				1.1												
Elphidium spp.																
Eponides repandus				0.4												0.1
Fissurina sp.								0.2		1.1		1.4				0.1
Floresina sp.		0.3						0.3		0.3		0.6				0.5
Fursenkoina complanata								0.4		0.3	0.2	1.8		0.3		
Glabratella sp.																
Globobulimina pacifica																

STATION NUMBER	1		2		3		4		5		6		7		9	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Glomospira irregularis	0.3	0.3				0.4				0.3		0.8		2.5		
Hanzawaia concentrica																0.4
Hauerina speciosa								0.2								
Hoeglundina elegans		0.3														
Homotrema rubrum																
Lagena sp.								0.1				0.2				0.1
Loxostomum mayori		0.3						0.2	0.2	0.5		0.6		0.0		0.1
Melonis pompiloides																0.3
Miliolinella cf. fichteliana																
Miliolinella circularis																
Miliolinella fichteliana																
Miliolinella labiosa		0.5				0.4								0.6		4.6
Monalysidium politum				0.7				2.2								0.1
Neoconorbina terquemi		0.3	0.4	0.4	0.4	1.1								0.3		0.1
Nonion depressulum	0.5	0.8		0.7		1.5		1.8	0.3	5.9	0.2	4.3		1.6		0.7
Nonion gradeloupi		0.3	0.4	0.7	1.5	5.7		2.5		2.7		3.1		2.2		0.6
Osangularia culter																0.2
Other Miliolids	0.8	5.7	0.7	2.8		0.8		0.9		2.0	0.0	1.0		0.3		2.5
Other Rotaliids	0.5	1.9		1.1	0.4	1.1		3.8		2.4		5.7		0.9		4.1
Other Textulariids			0.7	0.7				0.2				0.4				
Patellina corrugata								0.1		0.3				0.6		1.0
Peneroplis bradyi		0.3				0.4								0.3		0.1
Peneroplis carinatus/proteus	1.1	24.0	1.1	15.5		3.4		0.3		0.3				0.3		7.0
Peneroplis pertusus		0.3		0.4		0.8										0.9
Peneroplis sp.																
Pileolina patelliformis																
Placopsilina bradyi																
Planispiroides bucculentus														0.3		
Planktonic foram.																

STATION NUMBER	1		2		3		4		5		6		7		9	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Planorbulina acervalis						0.4										
Planorbulina mediterranensis														0.3		1.3
Planulina carribbea																
Planulina exorna										0.3				0.3		2.3
Pseudothurammina limnetis							0.1	0.1								
Pyrgo elongata				0.4												
Pyrgo subsphaerica				0.4												0.1
Quinqueloculina agglutinans		0.8		0.7												0.1
Quinqueloculina bicarinata	0.5	6.8	2.5	15.5		2.3				2.0		1.0		7.8		2.9
Quinqueloculina bicostata				0.4												0.2
Quinqueloculina bosciana							0.1	2.7						0.3		0.4
Quinqueloculina bradyana																0.1
Quinqueloculina candeiana		0.5					0.1	2.8		0.2						0.1
Quinqueloculina circularis																0.4
Quinqueloculina funafutiensis						0.4		0.3								0.1
Quinqueloculina goesi								0.6		0.5				0.9	0.1	0.4
Quinqueloculina laevigata	1.4	3.0	4.2	9.9	3.8	9.1		2.6	0.2	6.4		0.6		8.8	0.2	8.2
Quinqueloculina lamarckiana		2.7		1.1		0.8		5.2	0.2	2.9		0.8				0.7
Quinqueloculina poeyana																0.4
Quinqueloculina polygona	0.5	1.4		0.4				1.8		0.3		0.6		0.3		0.8
Quinqueloculina sabulosa										0.2				1.3		0.1
Quinqueloculina semilunum	1.1	2.2	0.4	3.9	0.4	4.6	0.2	5.4		4.7		2.1		10.6	0.1	12.3
Quinqueloculina spp.								0.5				0.2				0.1
Quinqueloculina stelligera										0.2						
Quinqueloculina subpoeyana	0.3	1.4		0.4				1.2		0.9				0.9		1.1
Quinqueloculina tricarinata								0.1								
Quinqueloculina vulgaris		0.8	0.4	1.8						0.9		0.2		0.3		2.1
Reophax nana						0.4		0.7		2.3	0.4	2.5		2.8		0.5
Reophax nodulosus											0.2	0.2				

STATION NUMBER	1		2		3		4		5		6		7		9	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Reophax scorpiurus																
Reophax spiculifera										0.6				0.3		
Reussella atlantica		0.3														
Rosalina concinna				0.7	1.1	1.5	0.1	0.4		0.6		0.2		2.2		1.3
Rosalina floridensis								0.3								
Rosalina globularis	0.5	1.4		0.4	0.4	2.7		0.6		2.4		0.2		3.4		1.4
Rosalina micens						1.5										0.1
Rosalina subarauncana			0.7	2.1	0.4	0.4		3.7		2.7	0.2	3.7		5.6		2.8
Rosalina vilardeboana								0.1		0.2		0.4		0.0		0.4
Saccammina difflugiformis										0.3						
Schlumbergerina alveoliformis						0.4										
Sigmoilina schlumbergeri																
Sigmoilina sigmoidea																
Siphogenerina raphana																
Siphonina pulchra								0.1								0.1
Sorites marginalis		0.3														
Spirillina cariacoensis										0.3				0.3		1.5
Spirillina denticulata						0.4								0.3		1.2
Spirillina sp.																
Spirillina vivipara																0.1
Spiroloculina antillarum																
Spiroloculina arenata		0.3						0.1		0.2				1.9		0.7
Spiroloculina caduca														0.3		
Spiroloculina communis								0.1								
Spiroloculina gradeloupi		0.3						0.1								
Spiroloculina sp.																0.1
Spirophtalmidium sp.																0.1
Textularia agglutinans	0.8	1.4	0.4	2.5	1.5	20.9			0.2	0.2	0.2	0.4		0.3		0.1
Textularia conica	2.2	2.7	2.5	2.8	6.8	12.2	0.1	0.8		0.5					0.1	1.2

STATION NUMBER	1		2		3		4		5		6		7		9	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Textularia earlandi					0.4	0.4		0.7		1.8		2.1	0.3	1.3		0.1
Tolypammina vagans														0.3		
Trifarina occidentalis							0.1	0.5		0.2				0.3		0.1
Triloculina bassensis	0.3	0.5				0.4		0.0								0.7
Triloculina bermudezi		0.3				0.4		0.1								0.1
Triloculina carinata				0.7				0.2								
Triloculina cuneata																0.7
Triloculina linneiana		0.5												0.6		0.1
Triloculina oblonga	0.8	3.5	0.4	1.4	0.4	1.1		0.4								
Triloculina quadrilateralis																
Triloculina rotunda																
Triloculina spp.		0.3														0.2
Triloculina trigonula	0.3	1.9	0.4	2.8				1.1		0.2				0.3		1.3
Trochammina cf. inflata																
Trochammina inflata					0.4	0.4	0.1	0.1		0.3		0.4		1.5		
Trochammina ochracea		1.9			1.5	5.3	0.1	1.3		2.6		1.2		4.1		
Tubinella funalis																0.1
Valvulina oviedoina				0.7			0.1	0.3		1.5		0.4		0.6		
Weisnerella auriculata					1.1	3.4				0.6			0.3	1.3		0.2

Table 8: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Harrington Sound (1995 samples).

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	25	55	16	48	12	43	11	54	11	53
NO. OF INDIVIDUALS/10cc	3186	13500	330	1890	420	3720	432	12348	324	7074
DEPTH (m)	6		3.5		2.5		1.7		2	
SEDIMENT TYPE	f. to m.s.		m.s.		m.s.		f.s.		f.s.	
Ammobaculites agglutinans										
Ammobaculites sp.	0.8	1.2								
Ammonia beccarri tepida		2.0		4.8		1.0		6.4	0.5	5.1
Amphistegina lessonii		0.4				0.6		0.3		
Angulogerina carinata				0.3						
Anomalina globulosa										
Archaias angulatus	2.8	22.4	1.6	20.6	1.0	23.5		8.2	0.3	9.2
Archaias angulatus reworked				17.1						
Articulina mexicana	0.4	0.8	0.3	0.6						0.5
Articulina mucronata		0.8								0.3
Articulina pacifica	0.4	1.6				0.3		0.9		1.0
Articulina spp.										
Asterigerina carinata						1.6		0.3		
Astrononion stelligerum										0.3
Bigenerina irregularis										
Bolivina lanceolata		0.4	0.0	1.0	0.6	1.0	0.6	4.4		6.1
Bolivina lowmani				0.3			0.3	0.3		
Bolivina paula				0.6						0.3
Bolivina pulchella								0.3		
Bolivina striatula										
Bolivina subexcavata										
Bolivina tortuosa				0.3				0.6		0.5
Bolivina variabilis										
Bolivina variabilis var. spathulata										
Borelis pulchra				0.3		0.6				

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Bulimina gibba				0.3						
Bulimina marginata										
Bulimina sp.										
Buliminella elegantissima	0.4	0.8	0.3	1.3						0.3
Cancris sagra										
Cassidulina subglobosa					0.3	0.3		0.3		0.5
Cibicides cicatrosus								0.6		
Cibicides lobatulus								0.9		
Cibicides refulgens		0.8	0.6	1.3		0.3		2.6		1.5
Clavulina tricarinata		1.2	0.3	0.3		0.3				
Cyclogyra planorbis		0.4				0.3				0.5
Cyclorbiculina compressa				0.3						
Cymbaloporetta squamosa		0.4				0.3	0.3	1.7		0.3
Dentritina antillarum						0.3				
Elphidium advenum		0.4						0.6		2.8
Elphidium discoidale										0.5
Elphidium poeyanum		0.4						0.6		1.0
Elphidium sagrum										
Elphidium sp.				0.6		0.6		2.9		
Eponides repandus		0.4						0.9		
Fissurina sp.										
Floresina sp.										
Fursenkoina complanata										
Glomospira irregularis								0.3		0.3
Hanzawaia concentrica										
Hauerina speciosa								0.6		
Lagena sp.										
Lamarckina haliotidea							0.3	0.3		
Loxostomum mayori				0.3						0.3

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Melonis pompiloides										
Miliolinella circularis										0.8
Miliolinella fichteliana		0.4								
Miliolinella labiosa				1.3	0.3	0.6				
Monalysidium politum		0.8								
Neoconorbina terquemi			0.3	?						
Nonion depressulum				1.3				0.6	0.3	2.8
Nonion gradeloupi	0.8	2.0		0.3				0.6		0.5
Osangularia culter				0.3						
Other Miliolids	1.2	3.6		2.2		7.4		0.9		2.5
Other Rotaliids	0.4	1.2		0.6		1.3		4.4	0.3	1.5
Other Textulariids										
Patellina corrugata										0.3
Peneroplis bradyi				0.3		0.3				
Peneroplis carinatus/proteus	4.0	15.6	1.9	11.1	3.9	31.1		11.7	1.0	26.0
Peneroplis pertusus				0.3		1.0				0.0
Planorbulina mediterranensis						0.6				
Planulina exorna	3.6	4.4			0.3	0.6				
Pseudothurammina limnetis										
Pyrgo subsphaerica		0.4		0.3						0.8
Quinqueloculina agglutinans	0.4	0.8		0.3		1.9		0.9		0.5
Quinqueloculina bicarinata		2.4	1.6	7.6	0.3	3.5		6.7	0.3	8.7
Quinqueloculina bicostata										0.3
Quinqueloculina bosciana										
Quinqueloculina bradyana								0.3		
Quinqueloculina candeiana		0.4								
Quinqueloculina circularis										
Quinqueloculina funafutiensis										
Quinqueloculina goesi				0.3						0.5

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Quinqueloculina laevigata		2.0	0.3	1.0		0.3	0.3	2.6	0.5	2.8
Quinqueloculina lamarckiana		0.4		1.3		1.3	0.3	7.0		0.5
Quinqueloculina poeyana		0.8	0.3	0.3						0.3
Quinqueloculina polygona								0.3		0.8
Quinqueloculina semilunum		2.4	1.3	2.9				10.2	0.5	6.1
Quinqueloculina spp.	0.4	0.4				1.6		0.9		
Quinqueloculina stelligera										
Quinqueloculina subpoeyana	0.8	4.0				2.9		1.7		1.0
Quinqueloculina vulgaris				0.3		0.3		0.6	0.3	3.1
Reophax nana	0.4	0.4					0.3	0.3		
Reophax nodulosus										
Reophax scorpiurus										
Reophax spiculifera										
Rosalina concinna	0.8	1.6			0.3	0.3		0.3		0.3
Rosalina floridensis		0.4								
Rosalina globularis	0.8	0.8	1.0	2.2		0.3				0.3
Rosalina subarauncana		1.6		1.0				2.9		3.1
Sigmoilina sigmoidea	0.8	0.8								
Siphogenerina raphana								0.3		
Siphonina pulchra							0.3	0.3		
Sorites marginalis						0.3				
Spirillina sp.		0.4								
Spirillina vivipara										
Spiroloculina arenata		0.4				0.3		0.3		1.3
Spiroloculina gradeloupi				0.3						0.0
Spiroloculina hyalina								0.3	0.5	0.5
Spiroloculina sp.										
Textularia agglutinans		1.2		0.3	1.0	8.1		1.5		
Textularia conica	0.8	3.2		0.3	1.9	2.3		0.3	0.3	0.8

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Textularia earlandi										0.3
Textularia sp.								0.3		
Trifarina occidentalis										0.5
Triloculina bassensis	0.4	0.4				0.3	0.3	2.3		0.8
Triloculina bermudezi	0.4	1.2								
Triloculina carinata		2.0		1.6	0.0	2.9		1.7		0.3
Triloculina linneiana						0.3		0.6		0.3
Triloculina oblonga	0.4	0.4		0.3			0.3	3.2		
Triloculina quadrilateralis	0.4	0.4								
Triloculina rotunda		0.4				0.3				0.3
Triloculina spp.										
Triloculina trigonula		0.4				0.3		0.9		0.5
Trochammina inflata		0.4	0.3	0.3			0.3	0.9		
Trochammina ochracea	1.6	4.8	4.7	7.9	1.0	3.5		0.6		0.3
Valvulina oviedoina		0.4								
Weisnerella auriculata	0.4	2.0	2.5	2.5	0.3	0.3				0.3

STATION NUMBER	6		7		8		9		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	21	60	16	52	1	38	15	46	6	49
NO. OF INDIVIDUALS/10cc	180	1321	1152	10836	72	11052	972	13896	378	16146
DEPTH (m)	7.5		23		3cm < surface		24		12	
SEDIMENT TYPE	f.s		v.f.s.		silty sand		v.f.s.		f.s.	
Ammobaculites agglutinans		0.3	0.7	3.0						
Ammobaculites sp.	0.3	0.3								
Ammonia beccarri tepida		11.4	3.7	24.9	0.7	37.8	1.6	28.8		12.7
Amphistegina lessonii										0.0
Angulogerina carinata	0.3	0.3						0.3		0.0
Anomalina globulosa		0.3								
Archaias angulatus		3.3		0.3						3.0
Archaias angulatus reworked										
Articulina mexicana										0.0
Articulina mucronata										0.0
Articulina pacifica								0.3		0.0
Articulina spp.		0.3								1.0
Asterigerina carinata		0.3								0.3
Astrononion stelligerum						0.3		1.3		0.0
Bigenerina irregularis								0.3		0.0
Bolivina lanceolata	1.1	4.4	0.3	8.6		12.1	0.8	8.5	0.3	1.3
Bolivina lowmani								1.8		0.3
Bolivina paula				2.0		0.7		1.6		0.7
Bolivina pulchella		0.3								
Bolivina striatula										
Bolivina subexcavata				0.7						
Bolivina tortuosa	0.0	0.5		0.7		1.0		0.8		
Bolivina variabilis				0.3						
Bolivina variabilis var. spathulata				0.7		0.3				
Borelis pulchra										

STATION NUMBER	6		7		8		9		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Bulimina gibba		0.3		4.0		6.8	0.8	5.2		0.3
Bulimina marginata										
Bulimina sp.			0.3	0.7		1.3		2.1		
Buliminella elegantissima				0.3						
Cancris sagra		0.3								
Cassidulina subglobosa	0.3	0.5	0.7	4.3		2.9	0.3	3.1		0.0
Cibicides cicatrosus										
Cibicides lobatulus										0.0
Cibicides refulgens		0.5				2.3		1.3		2.3
Clavulina tricarinata										0.0
Cyclogyra planorbis		0.3								0.3
Cyclorbiculina compressa	1.6	4.6		2.3		3.9		0.8		5.0
Cymbaloporetta squamosa										
Dentritina antillarum		1.4				0.7		0.3		0.7
Elphidium advenum										
Elphidium discoidale		0.5								0.3
Elphidium poeyanum		0.3		1.3		0.7	0.3	1.0		1.3
Elphidium sagrum										
Elphidium sp.		1.6								
Eponides repandus		0.3	0.7	1.0		0.3		0.3		
Fissurina sp.										
Floresina sp.				0.7		0.3		0.5		
Fursenkoina complanata				0.7		0.7				0.3
Glomospira irregularis			0.3	3.3		4.2	0.3	1.3		
Hanzawaia concentrica				0.3				0.5	0.3	0.3
Hauerina speciosa				0.7						0.7
Lagena sp.										
Lamarckina haliotidea		0.8								0.3
Loxostomum mayori		9.8		0.3						11.7

STATION NUMBER	6		7		8		9		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Melonis pompiloides		1.4								
Miliolinella circularis						0.3				
Miliolinella fichteliana										
Miliolinella labiosa		0.3		0.3		0.3		0.3		
Monalysidium politum										
Neoconorbina terquemi	0.3	0.3								
Nonion depressulum		0.5								0.3
Nonion gradeloupi										
Osangularia culter	0.5	5.7								
Other Miliolids		0.3							0.3	0.3
Other Rotaliids	0.3	0.3	0.7	2.0		3.9	0.5	4.9		
Other Textulariids	1.6	2.7		4.0		1.0	0.3	3.4		1.0
Patellina corrugata										
Peneroplis bradyi		7.6		0.3		0.3				1.3
Peneroplis carinatus/proteus		1.1		2.7		3.3		7.5		1.3
Peneroplis pertusus		0.3								0.3
Planorbulina mediterranensis										
Planulina exorna										
Pseudothurammina limnetis				0.3				0.3		
Pyrgo subsphaerica		1.1								0.3
Quinqueloculina agglutinans			0.3	0.7						
Quinqueloculina bicarinata	0.3	4.1		0.3		0.3				0.3
Quinqueloculina bicostata										
Quinqueloculina bosciana		0.3								
Quinqueloculina bradyana										
Quinqueloculina candeiana	0.3	1.1		1.3			0.3	2.3		5.7
Quinqueloculina circularis										0.3
Quinqueloculina funafutiensis				0.3						
Quinqueloculina goesi				0.3				0.3		2.0

STATION NUMBER	6		7		8		9		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Quinqueloculina laevigata	0.3	3.3		2.7		1.3		3.4	0.7	17.7
Quinqueloculina lamarckiana	0.5	1.6		1.0		0.3	0.5	0.8		0.7
Quinqueloculina poeyana										
Quinqueloculina polygona		1.1								
Quinqueloculina semilunum	0.8	4.4		1.7		0.7		2.3		6.0
Quinqueloculina spp.		1.4		1.3						
Quinqueloculina stelligera		0.3								0.3
Quinqueloculina subpoeyana	0.3	0.5		0.3						0.3
Quinqueloculina vulgaris		0.5								0.7
Reophax nana	0.3	0.8		0.3		1.3		0.5		
Reophax nodulosus			0.7	0.7						
Reophax scorpiurus				2.0						
Reophax spiculifera							0.5	0.5		
Rosalina concinna		0.3		0.3		0.3		0.8	0.3	0.3
Rosalina floridensis		0.5	0.3	4.7		4.2				1.0
Rosalina globularis			0.3	1.7		1.0		0.8		1.0
Rosalina subarauncana										
Sigmoilina sigmoidea										
Siphogenerina raphana										
Siphonina pulchra										
Sorites marginalis										
Spirillina sp.							0.3	0.3		
Spirillina vivipara		0.3						0.5		
Spiroloculina arenata										
Spiroloculina gradeloupi										
Spiroloculina hyalina							0.3	0.3		
Spiroloculina sp.	0.5	5.7								
Textularia agglutinans	2.2	4.4	0.3	2.3		0.3		0.3	0.3	9.7
Textularia conica			0.3	2.0		1.0	0.3	4.4		

STATION NUMBER	6		7		8		9		11	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Textularia earlandi										
Textularia sp.						1.0				
Trifarina occidentalis				0.3				0.5		
Triloculina bassensis		0.3								1.0
Triloculina bermudezi										
Triloculina carinata		0.3		0.3						0.3
Triloculina linneiana										0.7
Triloculina oblonga	1.1	1.1						0.3		
Triloculina quadrilateralis										
Triloculina rotunda										0.7
Triloculina spp.		0.3								
Triloculina trigonula	0.3	2.2				0.3				1.0
Trochammina inflata			0.3	1.3		0.3				
Trochammina ochracea	0.5	0.5	0.7	3.0		2.0	0.3	4.9		0.3
Valvulina oviedoina				0.3		0.3				
Weisnerella auriculata	0.0	0.5						0.3		0.3

Table 9: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Hog Breaker reefs.

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	30	43	20	25	20	40	22	24	19	32
NO. OF INDIVIDUALS/10cc	268	930	150	648	172	742	228	766	124	704
DEPTH (m)	9		9		9		9		9	
SEDIMENT TYPE	c.s		v.c.s.		c.s.		v.c.s.		c.s.	
Ammonia beccarri tepida	0.2	0.4		0.2		0.5				0.3
Amphistegina lessonii		0.2		0.5		0.5	0.3	0.3		1.1
Archaias angulatus		0.2				0.3				2.3
Articulina mayori	0.2	0.2				0.3				
Articulina mexicana	0.2	0.2			0.5	0.5				
Articulina mucronata	0.2	0.2								
Articulina pacifica	0.2	0.2	0.7	0.7	0.3	0.3	0.3	0.3	0.6	0.9
Articulina spp.					0.3	0.3				
Asterigerina carinata										1.1
Bolivina lanceolata		0.4	0.2	0.2		0.8				0.3
Bolivina subexcavata	0.2	0.2					0.3	0.3		
Bolivina tortuosa	1.1	1.1	0.2	0.2	0.5	0.8				
Buliminella elegantissima						0.3			0.3	0.3
Cibicides lobatulus		0.4				0.3				
Cibicides refulgens						0.3				0.3
Cyclogyra planorbis	0.2	0.6	0.5	0.5	0.3	0.3				
Cymbaloporetta squamosa		0.2					0.8	0.8		0.3
Elphidium sp.						0.3				
Eponides repandus						0.3	0.5	0.5		
Fissurina sp.		0.9								
Floresina sp.	0.2	0.4								
Glabratella opercularis	2.6	2.6	0.5	0.5						
Gypsina vesicularis								0.5		
Hauerina speciosa									0.3	0.3
Hoeglundina elegans										0.3

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Homotrema rubrum		61.1	0.0	71.3		65.2		66.3		66.5
Peneroplis bradyi	1.9	1.9	1.2	1.2	0.3	0.3				
Peneroplis carinatus/proteus		0.4	0.2	0.5		0.3	2.4	2.4	0.9	1.4
Miliammina fusca										0.9
Miliolinella fichteliana		0.2								
Neoconorbina terquemi	0.4	0.4	0.5	0.5	0.5	0.5	0.8	1.3	1.7	1.7
Nonion gradeloupi						0.3	0.3	0.3	0.0	
Other Miliolids					0.3	0.8				
Other Rotaliids	1.1	1.5	0.7	0.7		0.3	0.8	1.0	0.6	0.9
Patellina corrugata	0.2	0.2							0.3	0.3
Patellina sp.				0.0	0.3	0.3	0.3	0.3	0.0	
Placopsilina bradyi				1.2						
Planktonic foraminifera	0.2	0.6				0.3				
Planorbulina acervalis										0.3
Planulina exorna							2.9	2.9	1.7	2.0
Quinqueloculina bicarinata	4.5	4.5	3.2	3.5	3.5	3.8	4.7	4.7	3.1	3.1
Quinqueloculina lamarckiana			0.2	0.2		0.3	0.3	0.3	1.1	1.1
Quinqueloculina laevigata						0.3				
Quinqueloculina semilunum	0.6	0.6	0.2	0.5	0.3	0.5	2.3	2.3	1.1	1.4
Quinqueloculina spp.	0.2	0.2								
Quinqueloculina stelligera	0.2	0.2								
Quinqueloculina subpoeyana									0.6	0.6
Quinqueloculina vulgaris	0.2	0.9	0.2	0.2					0.3	0.3
Reophax nana		0.2				0.3				
Rosalina concinna	0.9	1.1	2.3	2.5		1.1	1.6	1.6	1.4	2.3
Rosalina globularis		0.6	0.5	0.5						
Rosalina micens		0.2			0.3	0.5				
Rosalina subarauncana	1.7	2.2	1.2	1.2	2.7	3.2				
Rosalina vilardeboana		0.2								

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Saccammina sphaerica							0.5	0.5	0.3	0.3
Siphonina pulchra										0.3
Spirillina cariacoensis	2.2	2.6	1.2	1.2	0.5	0.5	2.1	2.1		
Spirillina denticulata	0.4	0.4			0.5	0.5	0.3	0.3		
Spiroloculina gradeloupi	0.2	0.4								
Spirophtalmidium sp.	0.2	0.2								
Trifarina occidentalis					0.3	0.3	0.5	0.5	0.3	0.3
Triloculina bassensis	0.2	0.2			0.3	0.3				
Triloculina cuneata							0.3	0.3		0.3
Triloculina trigonula				0.2						
Trochammina ochracea	7.6	9.9	7.4	10.0	9.7	12.2	4.4	7.0	2.9	7.7
Weisnerella auriculata	1.3	1.3	2.1	2.1	1.9	1.9	3.4	3.4	0.3	1.1

Table 10: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Twin reefs.

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	21	33	27	44	23	33	18	33	27	42
NO. OF INDIVIDUALS/10cc	346	1456	400	1234	516	1160	174	1656	266	1186
DEPTH (m)	9		9		9		9		9	
SEDIMENT TYPE	v.c.s.		v.c.s.		c.s.		m. to c.s.		c.s.	
Ammonia beccarii tepida				0.2						
Amphistegina lessonii		0.8		0.5		0.7		1.7		1.3
Angulogerina carinata				0.2					0.2	0.2
Anomalina globulosa		0.1								
Archaias angulatus		2.3		3.2		1.4	0.5	9.8	0.2	5.1
Articulina mayori									0.5	0.5
Articulina mexicana	0.4	0.4	0.2	0.2	0.3	0.3				
Articulina mucronata			0.5	0.5						
Articulina pacifica	0.1	0.1	0.8	0.8	2.4	2.4		0.2	0.5	0.5
Articulina spp.	0.3	0.3	0.2	0.2	1.0	1.0	0.1	0.1	0.3	0.3
Asterigerina carinata		0.3	0.2	1.1		0.7		3.0		0.2
Bolivina lanceolata					0.3	0.3				0.2
Bolivina subexcavata			0.2	0.2					0.2	0.2
Bolivina tortuosa	0.1	0.1	0.3	0.3	0.3	0.3	0.1	0.1	0.2	0.3
Borelis pulchra		0.1		0.2			0.1	0.1		
Bulimina marginata					0.2	0.2			0.2	0.2
Carpenteria proteiformis								0.4		1.9
Cassidulina neocarinata									0.2	0.2
Cassidulina subglobosa			0.2	0.3	0.2	0.2				
Cibicides lobatulus	0.1	0.1								
Cibicides refulgens				0.3		0.5		0.2		
Clavulina tricarinata				0.2						
Cyclogyra planorbis		0.1	0.2	0.5					0.2	0.2
Cymbaloporetta squamosa				0.2	0.9	0.9				0.5
Elphidium sp.									0.2	0.2

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Eponides repandus		0.1				0.2		0.1		0.2
Gypsina vesicularis								0.2		0.2
Homotrema rubrum		69.6		54.9		45.9		71.3		63.4
Miliolinella labiosa	0.1	0.1								
Miliolinella sp.			0.2	0.5						
Neoconorbina terquemi	0.7	0.8		0.2	0.9	0.9		0.5	0.7	0.7
Nonion depressulum	0.1	0.1	0.2	0.2			0.4	0.4		
Nonion gradeloupi			0.2	0.2	0.2	0.3				0.2
Osangularia culter				0.6						
Other Miliolids	0.1	0.4	0.2	0.3	0.2	0.5			0.2	0.2
Other Rotaliids				0.6		0.7		0.1		
Peneroplis bradyi	1.8	1.8	2.3	2.3	3.3	3.3	0.1	0.2	0.8	0.8
Peneroplis carinatus/proteus	0.3	0.3	0.2	0.2		0.2	1.1	1.5	3.7	4.4
Placopsilina bradyi		0.3		1.0						1.2
Planktonic foraminifera				0.2						
Planorbulina mediterranensis									0.7	0.7
Planulina exorna							1.0	1.0	0.8	0.8
Quinqueloculina agglutinans		0.3						0.4		0.2
Quinqueloculina bicarinata	3.0	3.0	7.0	7.8	5.7	5.9	0.5	0.5	2.2	2.4
Quinqueloculina bicostata										
Quinqueloculina bosciana			0.3	0.3		0.2				
Quinqueloculina bradyana						0.2				
Quinqueloculina candeiana				0.2						0.2
Quinqueloculina funafutiensis								0.1		
Quinqueloculina laevigata		0.1					0.1	0.4		
Quinqueloculina lamarckiana							0.2	0.4		
Quinqueloculina poeyana					0.3	0.3				
Quinqueloculina polygona			0.5	0.5	0.9	1.0	0.6	0.6	0.2	0.3
Quinqueloculina semilunum	1.5	1.5	1.9	2.3	2.6	3.4	1.7	1.7	1.3	1.5

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Quinqueloculina stelligera			0.2	0.2						
Quinqueloculina subpoeyana				0.2						
Quinqueloculina vulgaris	0.1	0.1			0.2	0.3				
Rosalina concinna	1.6	1.9	3.1	3.2	2.1	2.4	0.6	0.6		
Rosalina globularis	0.4	0.4	0.3	0.3	1.0	1.0		0.4	1.2	1.3
Rosalina micens			0.2	0.2						
Rosalina subarauncana	2.5	2.5	1.5	1.5	2.2	2.2		0.1		0.2
Saccammina sphaerica									0.7	0.7
Spirillina cariacoensis	0.7	0.7	1.0	1.1	1.4	1.6	0.1	0.1		
Spirillina denticulata									0.2	0.3
Textularia conica										0.2
Trifarina occidentalis									0.2	0.2
Triloculina bassensis							0.1	0.2		
Triloculina carinata				0.2				0.1		
Triloculina linneiana		0.1							0.2	0.2
Trochammina ochracea	6.1	7.0	5.6	6.7	7.6	9.9	1.6	1.8	2.9	3.4
Valvulina oviedoina										0.2
Weisnerella auriculata	3.6	3.7	5.3	5.5	10.3	10.9	1.6	1.6	3.9	4.4

Table 11: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Crescent reefs.

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	33	93	21	49	30	61	24	53	34	73
NO. OF INDIVIDUALS/10cc	3096	12096	2448	12276	1926	8532	2232	10188	5184	18468
DEPTH (m)	4.5		4.5		4.5		4.5		4.5	
SEDIMENT TYPE	m. to c.s.		m. to c.s.		m. to c.s.		m. to c.s.		m. to c.s.	
Abditodentrix rhomboidalis		0.3								
Acervulina inhaerens		1.2								
Ammobaculites sp.		0.3			0.6	0.8	0.7	0.7	0.2	0.2
Ammonia beccarii tepida		0.0		1.5	0.2	0.4				
Angulogerina carinata		0.3								
Archaias angulatus	1.5	14.9	1.2	17.6	1.5	12.0	0.7	15.9	1.6	16.4
Articulina mexicana		0.9								0.6
Articulina mucronata		0.3			0.4	0.8				0.4
Articulina pacifica		0.9		2.3		0.2		1.1		0.6
Articulina sagra		0.3								
Articulina spp.						0.2		0.4		
Bolivina lanceolata				0.3					0.4	0.8
Bolivina lowmani		0.3								
Bolivina pulchella		1.8		0.6	0.4	0.6	0.4	0.7	0.2	1.6
Bolivina tortuosa			0.3	0.6		0.2				0.4
Borelis pulchra		1.5	0.3	1.5	0.2	1.7		2.1	0.6	2.9
Bulimina marginata	0.3	0.3								
Buliminella elegantissima						0.6				0.2
Cassidulina subglobosa										0.2
Cibicides lobatulus		0.3	0.6	1.2		0.6		1.4		0.2
Cibicides refulgens	0.6	1.2		0.9	0.4	1.5	0.4	0.7		0.4
Clavulina tricarinata				0.3						
Cyclogyra planorbis							1.8	2.5	0.4	0.6
Cyclorbiculina compressa		0.3								
Cymbaloporetta squamosa		0.3			0.2	0.4		1.1	1.2	1.2

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Discanomalina semipunctata		0.6								
Discorbis mira		0.3						0.4		0.4
Elphidium advenum						0.6		1.1		
Elphidium poeyanum		0.9	0.0	0.3	0.2	0.2		0.7		0.4
Elphidium sp.						0.2				
Elphidium spp.		0.3								
Eponides repandus				0.3		0.4		0.4		
Glomospira charoides							0.4	0.7	1.4	1.4
Hauerina speciosa								0.4	0.2	1.0
Homotrema rubrum		2.1		1.2		1.5		3.2		1.0
Involutina sp.	0.3	0.3								
Loxostomum mayori								0.4		0.2
Miliolinella labiosa	2.4	4.2	0.3	1.2	1.1	2.1		0.7	0.2	1.2
Monalysidium politum	0.6	0.9			0.2	0.2	0.4	0.4	0.4	0.4
Neoconorbina terquemi	0.3	0.3	0.0	0.3		0.2	0.0		0.6	0.8
Nonion gradeloupi	0.3	0.6	0.3	1.2	0.2	1.7	0.4	0.4	1.4	1.4
Nonionella opima	0.3	0.3								
Other Miliolids	3.9	8.9	1.8	7.3	0.6	4.0	1.8	5.7	3.3	7.2
Other Rotaliids	0.9	3.0		0.3		1.3		1.1	0.8	1.6
Patellina corrugata										0.2
Peneroplis bradyi				0.3		1.9	0.4	1.1	0.0	0.6
Peneroplis carinatus/proteus	4.8	29.7	6.2	30.0	4.4	26.4	3.9	23.3	3.9	20.1
Peneroplis pertusus				0.9		0.6	0.0	0.4	0.4	1.2
Planorbulina acervalis				0.3		0.2		0.4		0.4
Planorbulina mediterranensis		0.3			0.2	0.6		0.4		
Planulina carribbea		0.3								
Planulina exorna									0.4	0.4
Pyrgo denticulata										0.2
Pyrgo subsphaerica		0.3			0.2	0.8				0.4

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Quinqueloculina agglutinans	0.3	1.2	0.6	1.5	0.0	1.3	0.0	1.1	0.6	1.6
Quinqueloculina bicarinata	0.9	1.2	0.9	5.3	1.1	4.6	1.1	2.1	1.0	2.3
Quinqueloculina bicostata	0.3	0.9								0.2
Quinqueloculina bosciana		0.6	0.6	0.6	0.2	0.2	1.4	1.4	0.2	0.2
Quinqueloculina bradyana		0.3		0.6					0.0	0.2
Quinqueloculina candeiana		1.2		0.9					0.2	2.1
Quinqueloculina funafutiensis		0.3						0.4		
Quinqueloculina goesi		0.3		0.3		0.8				
Quinqueloculina laevigata	0.3	0.6	0.3	3.2	0.6	2.3	0.7	3.2	0.2	1.0
Quinqueloculina lamarckiana	0.3	0.6	0.3	2.1		1.7	0.4	2.1	0.6	2.1
Quinqueloculina parkeri var. occid.		0.3								
Quinqueloculina poeyana										0.6
Quinqueloculina polygona	0.3	0.9		0.9	0.2	1.7		1.1		1.4
Quinqueloculina pseudoreticulata	0.3	0.3								
Quinqueloculina sabulosa	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Quinqueloculina schlumbergeri	0.0	1.8								
Quinqueloculina semilunum	0.9	1.8	1.2	2.6	0.6	2.1	0.4	1.4	0.8	1.9
Quinqueloculina spp.	0.3	2.1		0.3		0.4	0.7	3.5	0.4	1.4
Quinqueloculina subpoeyana		1.5		0.6	1.3	2.3	1.1	2.8		0.4
Quinqueloculina vulgaris		0.3		0.3		1.1		0.4		1.0
Reophax nana						0.2				
Rosalina concinna				0.3	0.6	1.7	0.4	0.4	0.8	1.0
Rosalina globularis		0.3	1.5	2.6	2.3	3.4	0.7	2.1	2.6	3.0
Rosalina micens	0.6	0.9								
Rosalina subarauncana		0.9		0.6		1.5	0.4	2.5		1.2
Schlumbergerina alveoliformis			0.3	0.3					0.2	0.2
Sigmoilina schlumbergeri					0.2	0.4				
Sigmoilina sigmoidea		1.5		0.3		0.4				
Siphonina pulchra						0.2		0.4		0.6

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Sorites marginalis		0.3						0.4		0.2
Spirillina cariacoensis			0.3	0.3		0.2				
Spirillina decorata		0.3								
Spirillina denticulata				0.3						0.2
Spiroloculina antillarum	0.3	0.3								0.2
Spiroloculina arenata		0.3	0.3	0.3		0.2				
Spiroloculina hyalina					0.2	0.2			0.2	0.6
Textularia agglutinans					0.2	0.2	0.4	0.4		0.4
Textularia conica		0.3						0.4	0.2	0.4
Textularia earlandi					0.4	0.4			0.0	
Textularia sp.	0.6	1.5							0.0	
Tretomphalus atlanticus		0.3								
Triloculina bassensis		0.3		0.6		0.6			0.0	1.0
Triloculina bermudezi		0.3							0.0	0.8
Triloculina carinata	0.3	1.2	0.3	0.9		0.8		1.4	0.0	1.2
Triloculina cuneata	0.3	0.3				0.6		0.4	0.0	0.6
Triloculina linneiana				0.6					0.2	0.4
Triloculina oblonga				0.3		0.2				
Triloculina quadrilateralis										0.2
Triloculina sidebottomi	0.3	0.3								0.2
Triloculina spp.	0.3	0.6						0.7		
Triloculina trigonula		0.9	0.3	1.2	0.2	1.1				0.4
Trochammina ochracea	2.7	3.9	2.3	3.2	3.2	4.9	3.2	3.9	2.3	3.9
Valvulina oviedoina							0.4	0.4		
Weisnerella auriculata		0.3				0.4	0.0		0.4	0.6

Table 12: Percent abundance of living (stained, L) and total (T) foraminifera and thecamoebians, and sediment type from Hungry Bay transect (1995 samples).

STATION NUMBER	1		2		3		4		5		6		7	
DISTANCE ALONG TRANSECT (m)	0		0.3		3.3		6.3		9.3		10.6		13.6	
ELEVATION/HHW (cm)	-80		-46		-45		-50		-50		-52		-57	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	3	14	19	40	8	17	11	18	15	26	8	14	5	9
NO. OF INDIVIDUALS/10cc	90	5418	1764	13968	1170	5958	780	3072	1944	5184	222	2226	120	1800
Ammodiscus tenuis			1	2		1.2						0.5		1.3
Ammonia beccarii tepida														
Bigenerina irregularis				0.3										
Bolivina lanceolata			0.8	4.7	1.8	6.7	2	6.3	1.7	3.1				
Bolivina pulchella				0.3										
Bolivina sp.		0.3												
Bolivina subexcavata				0.3										
Bolivina tortuosa	0.3	0.3		1.3	0.3	0.3	0.4	0.8						
Bolivina variabilis var.spathulata			0.3	2.9										
Buliminella sp.				0.5										
Cibicides refulgens				0.5										
Cyclogyra involvens					1.2	4.5	0.4	0.8	1	3.5				
Discorinopsis aguayoi			0.8	2.9	1.2	9.7		5.1	5.6	11.5		0.3		
Elphidium excavatum				1										
Elphidium poeyanum			0.3	2.4										
Fissurina sp.			1	1.8				0.8						
Floresina sp.				0.3										
Glomospira irregularis		14.3	0.3	2.4		2.4		2		1.7	1.1	13.8	0.3	16
Haplophragmoides wilberti			0.3	4.2					0.4	1				
Helenina anderseni			0.5	11.3	3.3	13.6	12.1	15.6	3.1	9	9.7	11.3	2	2.7
Miliammina fusca		2.7								0.4	0.3	0.3		1.7
Miliolids linings				2.3										
Miliolinella labiosa										0.4				
Nonion gradeloupi		0.3		0.3		0.3				0.4				
Nonion sp.						0.6								

STATION NUMBER	1		2		3		4		5		6		7	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Other Miliolids			0.3	2.9										
Other Rotaliids			0.5	3.6										
Parrina bradyi				1.6		3.6	2	3.9	0.4	1.7				
Planispiroides bucculentus				0.3						0.4				
Planktonic foraminifera				0.3										
Polysaccamina ipohalina		1	0.3	1.3				0.8		0.7		3.5		
Pseudothurammina limnetis							0.4	0.8						
Quinqueloculina laevigata			0.3	2.6										
Quinqueloculina sp.				0.5										
Reophax nana				0.5						0.4				
Rosalina globularis			1	5.4	0.3	4.5	2	5.9	2.1	6.7	0.5	0.5		
Siphonaperta minuta														
"Siphotrochammina inflata"		0.3						0.4						
Spirillina vivipara									0.4	0.7				
Spiroloculina hyalina			0.3	0.8		0.3	0.4	0.8	0.4	1	1.1	1.1		
Spiroloculina sp.		0.3												
Textularia earlandi		3.3		0.3		0.9		0.8	0.7	1		0.3		
Tiphotrocha comprimata		0.7		0.5		0.3			0.4	0.4				
Tolypammina vagans	0.3	4.7	1	2.6				0.4		0.4		1.4		3.4
Triloculina linings				0.8										
Triloculina oblonga			1.3	10.6	9.1	26.3	14.5	37.5	16	25.4	1.6	2.4		
Triloculina sp.									1.4	2.4				
Triloculina trigonula						0.3								
Tritaxis sp.				0.3										
Trochammina inflata	1	65.5	1.6	13.2	2.4	21.8	2.7	16.4	3.1	19.1	4.9	60.9	3.3	65.7
Trochammina linings		2.3												
Trochammina macrescens			0.8	6		2.7		0.4		1.7	0.5	1.6	0.3	3
Trochammina ochracea										0.8				
Trochammina spp.				2.3						0.4				

STATION NUMBER	1		2		3		4		5		6		7	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Trochamminita salsa		4		3.1				0.8	0.4	2.1		2.2	0.3	3
Valvulina oviedoina				0.8										
Arcella polypora														
Centropyxis aculeata														
Centropyxis constricta									0.7	1.4				

STATION NUMBER	8		9		10		11		12		13		14	
DISTANCE ALONG TRANSECT (m)	16.6		19.6		22.3		25.3		28.3		29.3		31.3	
ELEVATION/HHW (cm)	-52		-53		-53		-45		-36		-33		-31	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	8	16	3	11	5	15	5	9	3	8	6	7	6	9
NO. OF INDIVIDUALS/10cc	324	2484	104	1247	396	11556	186	1980	16	322	204	1794	516	2676
Ammodiscus tenuis		0.3												
Ammonia beccarii tepida				0.4										
Bigenerina irregularis														
Bolivina lanceolata														
Bolivina pulchella														
Bolivina sp.														
Bolivina subexcavata														
Bolivina tortuosa														
Bolivina variabilis var.spathulata														
Buliminella sp.														
Cibicides refulgens														
Cyclogyra involvens														
Discorinopsis aguayoi	1.5	2.3	0.7	1.1				1.2						
Elphidium excavatum														
Elphidium poeyanum														
Fissurina sp.														
Floresina sp.														
Glomospira irregularis	0.3	3.5		10.5		5.9	0.3	14	0.6	5.3	1	9	0.5	2.5
Haplophragmoides wilberti						0.3								
Helenina anderseni	4.1	4.1			0.3	0.9							1.4	1.4
Miliammina fusca		1.2		1.8		1.6		1.2		0.6	0.7	3	0.5	4.5
Miliolids linings						0.3								
Miliolinella labiosa														
Nonion gradeloupi														
Nonion sp.														

STATION NUMBER	8		9		10		11		12		13		14	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Other Miliolids														
Other Rotaliids														
Parrina bradyi														
Planispiroides bucculentus														
Planktonic foraminifera														
Polysaccamina ipohalina				1.9	0.3	6		0.6		0.3	0.7			
Pseudothurammina limnetis		0.6		1.1			0.3	1.5		0.3				0.5
Quinqueloculina laevigata														
Quinqueloculina sp.														
Reophax nana														
Rosalina globularis		0.7											0.5	
Siphonaperta minuta														
"Siphotrochammina inflata"		0.3				0.6								
Spirillina vivipara														
Spiroloculina hyalina														
Spiroloculina sp.														
Textularia earlandi	0.3	1.2	1.1	4		3.4	0.5	5.2	0.6	6.5	1.3	6.4	0.5	2.7
Tiphotrocha comprimata		0.6				0.3								
Tolypammina vagans	0.6	1.8		1.8		0.9	2.1	12.1		5.9	0.7	3.7		0.5
Triloculina linings														
Triloculina oblonga	0.6	1.5											0.5	0.9
Triloculina sp.														
Triloculina trigonula														
Tritaxis sp.														
Trochammina inflata	5.5	79.4	6.5	76.2	1.2	56.7	5.2	62.7	3.7	80.8	7.4	76.3	16.1	87.4
Trochammina linings														
Trochammina macrescens	0.3	0.6		0.7	0.6	5.6								
Trochammina ochracea						0.3								
Trochammina spp.						0.3								

STATION NUMBER	8		9		10		11		12		13		14	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Trochamminita salsa		0.3		0.4	0.6	16.5		1.2		0.3	0.3	1		
Valvulina oviedoina														
Arcella polypora		0.3												
Centropyxis aculeata														
Centropyxis constricta														

STATION NUMBER	15		16		17		18		19		20		21		22	
DISTANCE ALONG TRANSECT (m)	32.8		34.3		36.3		37.8		38.8		39.8		40.5		41.1	
ELEVATION/HHW (cm)	-30		-29		-25		-20		-17		-10		-5		-4	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	7	14	5	8	4	7	3	6	4	6	7	12	3	3	3	4
NO. OF INDIVIDUALS/10cc	372	6696	540	2790	744	2082	612	1926	816	1596	1620	5526	220	932	306	1131
Ammodiscus tenuis																
Ammonia beccarii tepida																
Bigenerina irregularis																
Bolivina lanceolata																
Bolivina pulchella																
Bolivina sp.																
Bolivina subexcavata																
Bolivina tortuosa																
Bolivina variabilis var.spathulata																
Buliminella sp.																
Cibicides refulgens																
Cyclogyra involvens																
Discorinopsis aguayoi	0.3	0.5		0.2												
Elphidium excavatum																
Elphidium poeyanum																
Fissurina sp.																
Floresina sp.																
Glomospira irregularis	0.5	3.2	0.2	2.6				0.3				0.7				
Haplophragmoides wilberti																
Helenina anderseni	0.3	1	0.2	0.4		1.8			0.8	0.8	0.3	0.3				
Miliammina fusca		1.9	0.7	2.8		2.6		0.9		2.6	0.7	4.2	0.9	6.4	0.5	3.7
Miliolids linings																
Miliolinella labiosa																
Nonion gradeloupi																
Nonion sp.																

STATION NUMBER	15		16		17		18		19		20		21		22	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Other Miliolids																
Other Rotaliids																
Parrina bradyi																
Planispiroides bucculentus																
Planktonic foraminifera																
Polysaccamina ipohalina	0.5															
Pseudothurammina limnetis				0.4		0.6		0.6		1.5	0.3	0.3	0.4	0.4	0.3	0.3
Quinqueloculina laevigata																
Quinqueloculina sp.																
Reophax nana																
Rosalina globularis																
Siphonaperta minuta																
"Siphotrochammina inflata"																
Spirillina vivipara																
Spiroloculina hyalina	0.3															
Spiroloculina sp.																
Textularia earlandi	0.3	5.1	5.6	5.8	1.2	4.6	0.9	1.6								0.3
Tiphotrocha comprimata		0.3										0.3				
Tolypammina vagans		0.3			.6.9											
Triloculina linings																
Triloculina oblonga	0.5	0.8		0.2	0.3	0.3	0.3	0.3	0.4	0.4	1.6	1.6				
Triloculina sp.																
Triloculina trigonula																
Tritaxis sp.																
Trochammina inflata	12.6	81.4	17.6	87.5	32	89.3	30.6	96.3	49.6	94.4	24.7	88	22.3	93.2	26.3	95.8
Trochammina linings																
Trochammina macrescens												0.3				
Trochammina ochracea		0.3														
Trochammina spp.		0.5														

STATION NUMBER	15		16		17		18		19		20		21		22	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T
Trochamminita salsa	1.1	3.5										0.7				
Valvulina oviedoina																
Arcella polypora																
Centropyxis aculeata																
Centropyxis constricta																

STATION NUMBER	23		24		25		26	
DISTANCE ALONG TRANSECT (m)	41.7		42.5		43.1		44.4	
ELEVATION/HHW (cm)	0		7		4		0	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	1	3	7	10	4	7	2	3
NO. OF INDIVIDUALS/10cc	76	341	271	436	660	2160	6	35
Ammodiscus tenuis								
Ammonia beccarii tepida								
Bigenerina irregularis								
Bolivina lanceolata								
Bolivina pulchella								
Bolivina sp.								
Bolivina subexcavata								
Bolivina tortuosa								
Bolivina variabilis var.spathulata								
Buliminella sp.								
Cibicides refulgens								
Cyclogyra involvens								
Discorinopsis aguayoi								
Elphidium excavatum								
Elphidium poeyanum								
Fissurina sp.								
Floresina sp.								
Glomospira irregularis								
Haplophragmoides wilberti			0.4	2		0.6		
Helenina anderseni								
Miliammina fusca		1.2	1.6	9.1	4.4	8.6		
Miliolids linings								
Miliolinella labiosa								
Nonion gradeloupi								
Nonion sp.								

STATION NUMBER	23		24		25		26	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Other Miliolids								
Other Rotaliids								
Parrina bradyi								
Planispiroides bucculentus								
Planktonic foraminifera								
Polysaccamina ipohalina			0.4	0.4				
Pseudothurammina limnetis				0.6				
Quinqueloculina laevigata								
Quinqueloculina sp.								
Reophax nana								
Rosalina globularis								
Siphonaperta minuta								
"Siphotrochammina inflata"			0.4	0.8	1.4	5.3		
Spirillina vivipara								
Spiroloculina hyalina								
Spiroloculina sp.								
Textularia earlandi		0.3		1.2				
Tiphotrocha comprimata			0.4	0.8				
Tolypammina vagans								
Triloculina linings								
Triloculina oblonga								
Triloculina sp.								
Triloculina trigonula								
Tritaxis sp.								
Trochammina inflata	22.3	98.8	29.6	80.3	24.5	84.5	8.6	65.8
Trochammina linings								
Trochammina macrescens					0.3	0.6		2.9
Trochammina ochracea								
Trochammina spp.				1.4				

STATION NUMBER	23		24		25		26	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Trochamminita salsa			1.2	1.6				
Valvulina oviedoina								
Arcella polypora							8.6	31.4
Centropyxis aculeata				0.4				
Centropyxis constricta								

Table 13: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Hungry Bay bay side (1993 samples).

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	18	55	21	62	7	77	33	83	18	70
NO. OF INDIVIDUALS/10cc	252	1800	1584	10980	756	24048	9036	44100	3528	28440
SEDIMENT TYPE	m.s.		m.s.		m. to c.s.		sandy peat		peaty sand	
DEPTH (M)	exposed, rocks edge		beach		0.3, mid channel		0.02, roots edge		exposed	
Abdidodentrix rhomboidalis									0.1	0.8
Ammodiscus tenuis										0.1
Ammonia beccarii tepida		2.3		1.3		1.8		0.1		1.0
Angulogerina carinata		0.3	0.3	0.3		0.1		0.6		0.4
Anomalina globulosa						0.1				
Archaias angulatus	0.3	3.0		0.7		0.1				
Archaias angulatus reworked		3.3								
Articulina mexicana										
Articulina sp.			0.3	0.3		0.1		0.1		0.3
Asterigerina carinata		0.7		0.3		0.1				
Astrononion stelligerum										0.4
Bigenerina irregularis								0.2		
Biloculinella sp.										
Bolivina lanceolata		1.0		3.3	0.6	4.2	0.7	4.8		4.6
Bolivina lowmani		0.3				0.4	0.1	0.7		1.4
Bolivina paula		0.7	0.3	2.0		1.3	0.1	1.9		1.4
Bolivina pulchella				0.7		0.6		0.8		1.0
Bolivina sp.				1.3		0.1				
Bolivina striatula										
Bolivina subexcavata		0.3	0.7	0.7		0.4	0.1	1.4	0.3	1.3
Bolivina tortuosa		4.0		7.9		10.3	0.2	6.8	0.3	8.7
Bolivina variabilis										
Bolivina variabilis var. spathulata				0.3		0.3		0.8		0.3
Borelis pulchra		0.7		0.3		0.1				
Bulimina marginata							0.1	0.2		0.3

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Buliminella elegantissima	0.3	0.7		0.3		0.9	0.1	0.6	0.1	1.0
Buliminella milletti										
Cancris sagra								0.2		
Cassidulina subglobosa	0.3	0.3				0.1		1.0		1.5
Cibicides cicatrosus										
Cibicides lobatulus				0.7		0.3				0.3
Cibicides pseudoungeriana										
Cibicides pseudoungeriana var. io										
Cibicides refulgens		3.7	0.3	4.3		3.7		2.7		4.1
Cibicides sp.										
Clavulina tricarinata										
Cyclogyra planorbis	0.3	0.3		0.7		0.7	0.2	1.7	0.4	1.0
Cyclorbiculina compressa										
Cymbaloporetta bradyi										
Cymbaloporetta sp.										
Cymbaloporetta squamosa		0.3		0.7		1.0		0.5		0.8
Discanomalina semipunctata										
Discorbis mira		1.0				0.1		0.1		
Discorbis sp.						0.1		0.1		0.4
Discorinopsis aguayoi	1.3	3.3	1.3	4.3		1.5		2.0	0.3	5.6
Elphidium advenum								0.3		1.4
Elphidium discoidale							0.1	0.9		1.1
Elphidium excavatum										
Elphidium poeyanum					0.3	3.7	0.2	2.5		2.0
Elphidium sagrum		0.3		0.3		1.0		0.1	0.1	0.3
Elphidium spp.		0.7		1.0				0.2		
Epistominella pulchra						0.1		0.2		
Eponides repandus				0.3		0.1				
Fissurina sp.		0.3	0.3	0.7		0.4	0.2	0.8	0.3	1.6

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Floresina sp.										0.1
Fursenkoina complanata							0.1	0.7		0.9
Glabratella sp.										0.5
Globorotalia sp										
Glomospira irregularis			0.3	0.3			0.3	0.4		0.3
Gyroidina soldanii										
Gyroidina sp.				1.3						
Hanzawaia concentrica						0.1				0.1
Haplophragmoides sp.							0.9	1.1		
Haplophragmoides wilberti								0.1		0.1
Hauerina speciosa						0.1				
Helenina anderseni		2.3		1.0		1.8	0.2	5.2	0.5	10.3
Hoeglundina elegans	0.3	3.3		0.3		0.3		0.1		
Hopkinsina pacifica										0.3
Lagena sp.										0.1
Lamarckina atlantica		0.3				0.1		0.2		
Laticarenina halophora										0.1
Lenticulina calcar										
Loxostomum mayori	0.3	0.3		1.0		0.4		0.3		0.3
Massilina crenata										
Melonis pompiloides								0.1		0.1
Miliammina fusca								0.1		
Miliolids reworked				0.3						
Miliolinella labiosa				0.3		0.6		0.4		
Miliolinella sp.										
Monalysidium politum						0.3				
Neoconorbina terquemi	0.3	0.3	0.3	0.3		0.3				0.3
Nodosaria sp.										
Nonion depressulum			0.7	1.6		0.3	0.4	3.0	0.3	2.3

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Nonion gradeloupi						0.7	0.1	1.1		2.2
Nonion spp.								0.1		
Ophtalmidium sp.										
Osangularia culter										
Other Miliolids			0.3	5.2		1.0		0.2		
Other Rotaliids		3.3	0.3	8.9		4.5		2.7		2.7
Palmerinella palmerae				0.3		0.1				
Patellina corrugata		0.7					0.1	0.2		
Peneroplis bradyi		0.7		0.3		0.3				
Peneroplis carinatus/proteus	0.3	8.0		4.6		1.8		0.2		0.1
Pileolina patelliformis							0.1	0.1		
Planispirella sp.										
Planispiroides bucculentus										
Planktonic foraminifera						0.4		0.2		0.9
Planorbulina variabilis										
Planulina carribea								0.1		
Planulina exorna				1.3		0.7		0.2		0.4
Planulina sp.										
Polysaccamina ipohalina										0.4
Pseudothurammina limnetis									0.1	0.5
Pyrgo elongata										
Pyrgo subsphaerica										
Quinqueloculina agglutinans										
Quinqueloculina bicarinata	1.0	1.0	0.3	0.3	0.3	0.3	0.5	0.5		
Quinqueloculina bosciana						0.1				
Quinqueloculina bradyana				0.3		0.3		0.1		
Quinqueloculina candeiana		0.3				0.1				
Quinqueloculina circularis								0.1		
Quinqueloculina goesi						0.1				

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Quinqueloculina gracilis								0.1		
Quinqueloculina laevigata	0.7	1.7	0.3	0.3	0.4	0.9	0.2	0.7		0.1
Quinqueloculina lamarckiana		2.7		1.0		0.7		0.1		0.3
Quinqueloculina poeyana										
Quinqueloculina polygona		0.7		0.7		0.4				0.1
Quinqueloculina semilunum	4.3	20.0	5.6	23.0	1.2	30.7	12.7	33.2	3.5	13.4
Quinqueloculina spp.	0.7	2.7		0.3		0.1				
Quinqueloculina stelligera								0.1		
Quinqueloculina subpoeyana		0.3	0.3	0.3		0.3		0.2		0.5
Reophax sp.							0.2	0.5	0.1	0.1
Reussella atlantica		0.7				0.4		0.1		0.3
Rosalina concinna	0.3	0.7	1.0	2.0		0.4	0.1	0.8		0.6
Rosalina globularis		0.7		0.3		1.2	0.1	1.6		0.9
Rosalina floridensis								1.6		0.1
Rosalina micens										
Rosalina spp.										
Rosalina subarauncana		0.3		4.6		7.8		2.9		2.3
Rosalina vilardeboana					0.1	0.1				
Rotaliids reworked		9.7		0.7		0.6				
Schlumbergerina alveoliformis										
Sigmoilina schlumbergeri										
Sigmoilina sigmoidea		0.7								
Sigmoilinita costata										
Siphogenerina raphana		0.3		0.3		0.6	0.1	1.9		
Siphonaperta minuta										
Siphonina pulchra		1.7	0.3	1.0						
Sorites marginalis	0.3	1.3		0.3		0.1				
Spirillina denticulata								0.1		
Spirillina sp.										

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Spirillina vivipara										
Spiroloculina antillarum				0.3		0.1		0.2		
Spiroloculina arenata						0.1		0.1		
Spiroloculina hyalina	0.7	1.0	0.3	0.3			0.2	0.4	0.6	0.8
Spiroloculina sp.						0.1				
Spirophtalmidium sp.								0.2		
Textularia agglutinans										
Textularia earlandi							0.6	0.7	0.4	0.6
Tiphotrocha comprimata	1.7	2.3	0.3	0.3		0.1		0.3		
Tretomphalus atlanticus								0.1		
Trifarina occidentalis		0.7		2.3		2.7		1.5	0.1	2.9
Triloculina bassensis		0.7		0.3				0.1		0.1
Triloculina bermudezi			0.3	0.3				0.1		
Triloculina carinata						0.1				
Triloculina cuneata						0.1				
Triloculina oblonga		0.7		0.7		0.7	0.8	1.2	4.6	9.2
Triloculina rotunda						0.1				
Triloculina sp.										
Triloculina trigonula							0.1	0.5		
Tritaxis sp.										
Trochammina inflata	0.3	0.3		0.3	0.1	0.4	0.2	0.4	0.1	1.4
Trochammina macrescens								0.2		0.1
Trochammina ochracea										0.1
Trochammina spp.										
Valvulina oviedoina							0.7	0.7	0.3	0.3
Virgulina pauciloculata										
Weisnerella auriculata		1.0				0.4				
Arcella polypora										0.1

STATION NUMBER	7		8		9		10	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	26	78	5	47	5	46	8	33
NO. OF INDIVIDUALS/10cc	7360	109184	2808	50760	3456	58320	9504	63288
SEDIMENT TYPE	peat		m.s.		peaty sand		sandy peat	
DEPTH (M)	exposed		0.5		exposed, in roots		HHW, mossy	
Abdidodentrix rhomboidalis		0.2						
Ammodiscus tenuis								
Ammonia beccarii tepida				2.1				
Angulogerina carinata		0.1						0.3
Anomalina globulosa								
Archaias angulatus						0.4		
Archaias angulatus reworked								
Articulina mexicana				0.4				
Articulina sp.	0.1	0.1				0.4		
Asterigerina carinata								
Astrononion stelligerum								
Bigenerina irregularis								
Biloculinella sp.								
Bolivina lanceolata		0.4		3.4	0.7	10.4		2.0
Bolivina lowmani		1.4		0.9		1.1		0.3
Bolivina paula		0.0		1.7				0.7
Bolivina pulchella		0.6		2.1		1.5		0.3
Bolivina sp.		0.1				0.4		
Bolivina striatula		0.1						
Bolivina subexcavata		2.1				1.5		
Bolivina tortuosa	0.1	3.5	0.9	12.3		14.1	0.3	1.4
Bolivina variabilis		0.5						
Bolivina variabilis var. spathulata		0.9						
Borelis pulchra								
Bulimina marginata				0.4				0.7

STATION NUMBER	7		8		9		10	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Buliminella elegantissima		0.1				0.7		0.3
Buliminella milletti		0.3						
Cancris sagra								
Cassidulina subglobosa	0.2	0.4		0.9		0.7		1.0
Cibicides cicatrosus								
Cibicides lobatulus		0.2		0.9		0.4		
Cibicides pseudoungeriana								
Cibicides pseudoungeriana var. io								
Cibicides refulgens		0.7		3.0		4.4		1.4
Cibicides sp.								
Clavulina tricarinata								
Cyclogyra planorbis	0.1	0.4		0.4	1.5	1.9	3.1	8.5
Cyclorbiculina compressa		0.1						
Cymbaloporetta bradyi								
Cymbaloporetta sp.		0.2						
Cymbaloporetta squamosa	0.1	0.8		1.3		0.7		0.7
Discanomalina semipunctata								
Discorbis mira	0.1	0.3						
Discorbis sp.				0.4				
Discorinopsis aguayoi	1.9	14.7		4.7		1.9	1.0	14.3
Elphidium advenum				0.9		1.9		
Elphidium discoidale				0.4				
Elphidium excavatum								
Elphidium poeyanum				1.3		1.5		
Elphidium sagrum								
Elphidium spp.		0.9						
Epistominella pulchra								
Eponides repandus						0.7		
Fissurina sp.								0.3

STATION NUMBER	7		8		9		10	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Floresina sp.		0.1						
Fursenkoina complanata				0.4		0.4		
Glabratella sp.								0.3
Globorotalia sp		0.2						
Glomospira irregularis						0.4	0.7	2.0
Gyroidina soldanii								
Gyroidina sp.								
Hanzawaia concentrica								
Haplophragmoides sp.								
Haplophragmoides wilberti								
Hauerina speciosa								
Helenina anderseni	0.8	16.6		1.3	0.4	6.7	3.1	21.2
Hoeglundina elegans								
Hopkinsina pacifica								
Lagena sp.								
Lamarckina atlantica		0.1				0.4		0.3
Laticarenina halophora								
Lenticulina calcar								
Loxostomum mayori		0.2						0.3
Massilina crenata								
Melonis pompiloides		0.3						
Miliammina fusca		0.1						
Miliolids reworked								
Miliolinella labiosa				0.4				
Miliolinella sp.						0.4		
Monalysidium politum				0.4				
Neoconorbina terquemi		0.3						
Nodosaria sp.								
Nonion depressulum		0.1	0.9	1.7		1.5		2.4

STATION NUMBER	7		8		9		10	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Nonion gradeloupi		0.2		0.4		0.4		0.3
Nonion spp.		1.6						
Ophtalmidium sp.								
Osangularia culter								
Other Miliolids	0.1	5.7		0.9				
Other Rotaliids	0.2	5.0		8.1		6.7		1.4
Palmerinella palmerae								
Patellina corrugata		0.1						
Peneroplis bradyi		0.1						
Peneroplis carinatus/proteus				2.1		0.4		
Pileolina patelliformis								
Planispirella sp.		0.1						
Planispiroides bucculentus		0.9						
Planktonic foraminifera	0.1	0.5				1.1		
Planorbulina variabilis								
Planulina carribea								
Planulina exorna				0.9	0.4	1.1		
Planulina sp.	0.2	0.2						
Polysaccamina ipohalina						0.4		
Pseudothurammina limnetis								0.3
Pyrgo elongata		0.1						
Pyrgo subsphaerica						0.4		
Quinqueloculina agglutinans								
Quinqueloculina bicarinata			0.4	1.7				
Quinqueloculina bosciana								
Quinqueloculina bradyana	0.1	0.1						
Quinqueloculina candeiana								
Quinqueloculina circularis		0.4						
Quinqueloculina goesi		0.2		0.4				

STATION NUMBER	7		8		9		10	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Quinqueloculina gracilis								
Quinqueloculina laevigata		0.3	0.4	1.7				
Quinqueloculina lamarckiana		0.2		0.4				
Quinqueloculina poeyana		0.1						
Quinqueloculina polygona		0.1		0.9		0.4		
Quinqueloculina semilunum	0.2	3.2	3.0	26.0	3.0	23.0	0.3	2.0
Quinqueloculina spp.	0.1	0.3				0.4		
Quinqueloculina stelligera				1.3				
Quinqueloculina subpoeyana								
Reophax sp.								
Reussella atlantica		0.2		0.9		0.4		0.3
Rosalina concinna	0.1	0.2		1.7		1.5		1.0
Rosalina globularis	0.6	12.1				1.5		0.7
Rosalina floridensis				0.9				
Rosalina micens		0.1						
Rosalina spp.	0.1	3.2						
Rosalina subarauncana	0.1	3.8		5.1		0.4		0.3
Rosalina vilardeboana	0.1	0.1				0.4		
Rotaliids reworked								
Schlumbergerina alveoliformis								
Sigmoilina schlumbergeri								
Sigmoilina sigmoidea		0.1						
Sigmoilinita costata								
Siphogenerina raphana								
Siphonaperta minuta								
Siphonina pulchra		0.1		0.4		0.4		0.3
Sorites marginalis				0.4				
Spirillina denticulata								
Spirillina sp.		0.0						

STATION NUMBER	7		8		9		10	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Spirillina vivipara	0.2	0.7						
Spiroloculina antillarum		0.1						
Spiroloculina arenata		0.1				0.4		
Spiroloculina hyalina	0.1	0.4		0.4				0.7
Spiroloculina sp.								
Spirophtalmidium sp.								
Textularia agglutinans								
Textularia earlandi								
Tiphotrocha comprimata						0.4		0.7
Tretomphalus atlanticus		0.3						
Trifarina occidentalis		0.8		2.1		4.1		
Triloculina bassensis								
Triloculina bermudezi								
Triloculina carinata								
Triloculina cuneata								
Triloculina oblonga	1.3	3.8		0.9		1.5	5.8	29.7
Triloculina rotunda								
Triloculina sp.								
Triloculina trigonula	0.1	0.2						
Tritaxis sp.								
Trochammina inflata	0.1	7.0		0.4		1.1	0.7	3.1
Trochammina macrescens		0.2						
Trochammina ochracea								
Trochammina spp.		0.4						
Valvulina oviedoina				0.4				
Virgulina pauciloculata								
Weisnerella auriculata		0.2						
Arcella polypora								

STATION NUMBER	14		17	
LIVE/TOTAL	L	T	L	T
NO. OF SPECIES	29	59	30	105
NO. OF INDIVIDUALS/10cc	14328	46836	8192	68136
SEDIMENT TYPE	sandy peat		m.s.	
DEPTH (M)	HHW, in roots		0.2, mid channel	
Abdidodentrix rhomboidalis		0.1		0.8
Ammodiscus tenuis				
Ammonia beccarii tepida				0.1
Angulogerina carinata				0.3
Anomalina globulosa				0.1
Archaias angulatus				0.4
Archaias angulatus reworked				
Articulina mexicana				
Articulina sp.				0.3
Asterigerina carinata				0.2
Astrononion stelligerum				0.2
Bigenerina irregularis				
Biloculinella sp.				0.1
Bolivina lanceolata		0.2	0.2	0.6
Bolivina lowmani	0.1	0.6	0.5	2.9
Bolivina paula				
Bolivina pulchella			0.1	2.0
Bolivina sp.		0.4		1.8
Bolivina striatula		0.1		
Bolivina subexcavata		0.5		0.7
Bolivina tortuosa		1.3	1.8	9.9
Bolivina variabilis	0.1	1.0		0.4
Bolivina variabilis var. spathulata		0.3	0.6	3.7
Borelis pulchra				0.2
Bulimina marginata				0.2

STATION NUMBER	14		17	
LIVE/TOTAL	L	T	L	T
Buliminella elegantissima				0.6
Buliminella milletti				0.1
Cancris sagra				0.2
Cassidulina subglobosa		0.2	0.1	0.3
Cibicides cicatrosus				0.2
Cibicides lobatulus				0.1
Cibicides pseudoungeriana				0.1
Cibicides pseudoungeriana var. io				0.1
Cibicides refulgens		0.5	0.3	3.0
Cibicides sp.		0.2		0.6
Clavulina tricarinata				
Cyclogyra planorbis	1.0	1.5		
Cyclorbiculina compressa				
Cymbaloporetta bradyi	0.2	0.3		
Cymbaloporetta sp.				0.7
Cymbaloporetta squamosa				
Discanomalina semipunctata				0.1
Discorbis mira				
Discorbis sp.				0.1
Discorinopsis aguayoi	0.4	2.9		0.3
Elphidium advenum				
Elphidium discoidale				
Elphidium excavatum				0.4
Elphidium poeyanum			0.1	1.6
Elphidium sagrum				0.1
Elphidium spp.		0.2		0.1
Epistominella pulchra				0.1
Eponides repandus				
Fissurina sp.				

STATION NUMBER	14		17	
LIVE/TOTAL	L	T	L	T
Floresina sp.		0.2		0.1
Fursenkoina complanata				
Glabratella sp.				
Globorotalia sp				
Glomospira irregularis	1.1	3.0		
Gyroidina soldanii				0.1
Gyroidina sp.				
Hanzawaia concentrica				
Haplophragmoides sp.				
Haplophragmoides wilberti				
Hauerina speciosa				
Helenina anderseni	5.0	20.2	0.5	3.8
Hoeglundina elegans				0.4
Hopkinsina pacifica				0.1
Lagena sp.				
Lamarckina atlantica				
Laticarenina halophora				
Lenticulina calcar				0.1
Loxostomum mayori			0.2	0.4
Massilina crenata				0.1
Melonis pompiloides		0.2		0.1
Miliammina fusca				
Miliolids reworked				
Miliolinella labiosa	4.0	5.0		0.1
Miliolinella sp.	0.1	0.3		
Monalysidium politum				
Neoconorbina terquemi			0.1	0.6
Nodosaria sp.				0.1
Nonion depressulum			0.2	1.2

STATION NUMBER	14		17	
LIVE/TOTAL	L	T	L	T
Nonion gradeloupi		0.2		0.8
Nonion spp.		0.5		0.6
Ophtalmidium sp.				0.1
Osangularia culter		0.1		
Other Miliolids	3.2	13.1		10.2
Other Rotaliids	0.2	7.1		7.7
Palmerinella palmerae				
Patellina corrugata				0.2
Peneroplis bradyi			0.1	0.2
Peneroplis carinatus/proteus			0.1	0.1
Pileolina patelliformis				
Planispirella sp.				
Planispiroides bucculentus	0.8	2.1		0.1
Planktonic foraminifera		0.6		1.0
Planorbulina variabilis				0.5
Planulina carribea				
Planulina exorna				
Planulina sp.		0.2		0.1
Polysaccamina ipohalina				
Pseudothurammina limnetis				
Pyrgo elongata	0.2	0.3		
Pyrgo subsphaerica			0.1	0.1
Quinqueloculina agglutinans				0.1
Quinqueloculina bicarinata				
Quinqueloculina bosciana	0.2	0.3		0.2
Quinqueloculina bradyana				0.1
Quinqueloculina candeiana				
Quinqueloculina circularis	0.1	0.4		0.1
Quinqueloculina goesi				0.1

STATION NUMBER	14		17	
LIVE/TOTAL	L	T	L	T
Quinqueloculina gracilis				
Quinqueloculina laevigata		0.6	0.3	0.7
Quinqueloculina lamarckiana			0.3	1.6
Quinqueloculina poeyana				
Quinqueloculina polygona	0.1	0.1		0.2
Quinqueloculina semilunum	0.1	0.8	5.2	16.4
Quinqueloculina spp.	0.1	0.3	0.2	1.0
Quinqueloculina stelligera				0.3
Quinqueloculina subpoeyana		0.1		0.3
Reophax sp.				
Reussella atlantica			0.2	0.5
Rosalina concinna			0.1	1.2
Rosalina globularis	0.3	3.4	0.1	0.1
Rosalina floridensis				
Rosalina micens		0.1		
Rosalina spp.	0.3	0.5	0.5	1.3
Rosalina subarauncana		2.4		7.4
Rosalina vilardeboana	0.1	0.1	0.1	0.1
Rotaliids reworked				
Schlumbergerina alveoliformis				0.1
Sigmoilina schlumbergeri				0.1
Sigmoilina sigmoidea				0.2
Sigmoilinita costata		0.1		0.3
Siphogenerina raphana				0.1
Siphonaperta minuta				0.0
Siphonina pulchra		0.1	0.1	0.3
Sorites marginalis				
Spirillina denticulata				
Spirillina sp.		0.1		0.4

STATION NUMBER	14		17	
LIVE/TOTAL	L	T	L	T
Spirillina vivipara	2.1	4.7	0.1	0.3
Spiroloculina antillarum		0.1		
Spiroloculina arenata				
Spiroloculina hyalina	0.1	0.5		
Spiroloculina sp.				0.1
Spirophtalmidium sp.		0.1		0.1
Textularia agglutinans		0.1		
Textularia earlandi				
Tiphotrocha comprimata				
Tretomphalus atlanticus				0.1
Trifarina occidentalis		0.2	0.2	1.5
Triloculina bassensis				0.1
Triloculina bermudezi		0.1		
Triloculina carinata				
Triloculina cuneata				0.1
Triloculina oblonga	8.8	16.8		0.4
Triloculina rotunda			0.1	0.1
Triloculina sp.	0.8	1.5		0.3
Triloculina trigonula	1.0	1.3	0.2	0.6
Tritaxis sp.				
Trochammina inflata	0.2	1.2		0.2
Trochammina macrescens	0.4	1.1		
Trochammina ochracea				
Trochammina spp.			0.1	0.2
Valvulina oviedoina				
Virgulina pauciloculata				0.1
Weisnerella auriculata				0.2
Arcella polypora				

Table 14: Percent abundance of living (stained, L) and total (T) foraminifera and thecamoebians, and sediment type from Mill Share transect.

STATION NUMBER	1		2		3		4		5	
DISTANCE ALONG TRANSECT (m)	0		0.2		0.5		1.1		2.1	
ELEVATION/HHW (cm)	0		-5.5		-13		-16		-12	
% VEG.: Borrischia-Sesuvium-Mangrove	50-50-0		90-10-0		90-10-0		90-10-0		95-0-5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	9	18	11	14	12	19	10	12	5	7
NO. OF INDIVIDUALS/10cc	480	1602	914	1886	2052	5880	3918	5724	1632	3840
Ammodiscus tenuis										
Ammonia beccarii tepida						0.2				
Bolivina lanceolata										
Bolivina tortuosa		0.4								
Cyclogyra revertens		0.8	1.1	1.5		0.2				
Elphidium poeyanum										
Discorinopsis aguayoi	1.9	4.1	2.3	3.1	0.4	0.8				
Fissurina sp.		0.4	1.9	3.4		0.2				
Glomospira irregularis			0.8	0.8	0.4	0.6	0.2	0.5		0.3
Haplophragmoides wilberti								0.5		
Helenina anderseni	6.4	21	7.3	15.3	2.3	8.2	0.6	0.6		
Miliammina fusca	0.4	4.1	0.4	1.1		1.8	1.1	3.4	0.6	1.8
Other Miliolids		1.1								
Planispiroides bucculentus		0.4				0.2				
Polysaccamina ipohalina				1.1		0.2	0.2	1.3		0.3
Pseudothurammina limnetis	1.1	1.1				0.6			0.3	0.3
Quinqueloculina candeiana		0.4								
Quinqueloculina laevigata	1.9	3.8			0.6	0.6				
Reworked calcareous foraminifera				4.9						
Reophax nana										
Rosalina globularis			1.1	1.5	0.2	1				
Spirillina vivipara										
Spiroloculina hyalina					0.4	0.8				
Textularia earlandi	0.4	0.4				0.4	0.2	0.5		
Tiphotrocha comprimata								0.1		
Tolypammina vagans			0.4	0.4	0.2	0.6	0.7	1.1		
Triloculina oblonga	11.6	38.2	12.2	30.2	11	35.1	4.6	5.1	9.5	9.8
Trochammina inflata	6	19.1	19.5	33.2	18.4	45.9	17.2	85.6	32.2	86.1

STATION NUMBER	1		2		3		4		5	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Trochammina macrescens			1.5	3.1	0.8	1.2	0.2	0.6		0.9
Trochammina spp.										
Trochamminita salsa				0.4	0.2	1.2	0.1	0.6	0.3	1.2
Arcella polypora		0.8								
Centropyxis constricta		3								

STATION NUMBER	6		7		8		9		10	
DISTANCE ALONG TRANSECT (m)	3.1		4.1		5.1		7.1		9.1	
ELEVATION/HHW (cm)	-9		-8		-6.5		-9		-6.5	
% VEG.: Borrischia-Sesuvium-Mangrove	90-0-10		100-0-0		95-0-5		70-0-30		70-0-30	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	6	11	9	9	7	9	5	10	8	11
NO. OF INDIVIDUALS/10cc	3024	8784	2538	5724	1080	3780	585	2277	1296	4761
Ammodiscus tenuis										
Ammonia beccarii tepida										
Bolivina lanceolata										
Bolivina tortuosa										
Cyclogyra revertens										
Elphidium poeyanum										
Discorinopsis aguayoi									0.8	0.8
Fissurina sp.										
Glomospira irregularis		0.4						0.4		
Haplophragmoides wilberti		0.4	0.3	0.3						0.8
Helenina anderseni							0.8	0.8		
Miliammina fusca	0.8	4.5	0.3	3.4	0.3	7.9		4.7		0.8
Other Miliolids										
Planispiroides bucculentus										
Polysaccamina ipohalina	0.8	2.5	0.9	3.8	0.3	3.5		7.1	0.8	3.6
Pseudothurammina limnetis	0.4	1.7	1.3	2.5	0.7	2.2	0.4	2	0.2	0.6
Quinqueloculina candeiana										
Quinqueloculina laevigata										
Reworked calcareous foraminifera										
Reophax nana										
Rosalina globularis										
Spirillina vivipara										
Spiroloculina hyalina										
Textularia earlandi		0.4	0.3	0.3	0.3	0.3	0.4	0.4		0.6
Tiphotrocha comprimata										
Tolypammina vagans		0.8				0.3			0.2	0.4
Triloculina oblonga	3.3	5.3	7.6	8.2	3.5	5.1	5.5	5.5	3.4	3.8
Trochammina inflata	27.1	77.9	31.8	74.2	22.9	73.7	18.6	78.3	16.1	68

STATION NUMBER	6		7		8		9		10	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Trochammina macrescens		0.4	0.7	1		0.3		0.4	3.8	14.6
Trochammina spp.										
Trochamminita salsa	1.6	5.7	1.3	6.6	0.7	7		0.4	2.1	6.3
Arcella polypora										
Centropyxis constricta										

STATION NUMBER	11		12		13		14		15	
DISTANCE ALONG TRANSECT (m)	11.1		11.8		12.8		15.3		17.8	
ELEVATION/HHW (cm)	-5		-1		-6.5		-8.5		-8	
% VEG.: Borrischia-Sesuvium-Mangrove	50-0-50		10-0-90		0-10-90		0-0-100		0-0-100	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	6	10	9	11	6	8	5	9	6	8
NO. OF INDIVIDUALS/10cc	468	3267	1566	6120	513	2961	286	3432	288	2652
Ammodiscus tenuis										
Ammonia beccarii tepida		0.3								
Bolivina lanceolata										
Bolivina tortuosa										
Cyclogyra revertens										
Elphidium poeyanum										
Discorinopsis aguayoi			0.6	0.6					0.5	0.9
Fissurina sp.										
Glomospira irregularis		0.3				0.3		0.4		0.5
Haplophragmoides wilberti				2.4	0.3	0.6		0.7		
Helenina anderseni					0.9	0.9	0.7	0.7		
Miliammina fusca	1.4	5	1.8	8.2		5.2		0.4		0.5
Other Miliolids										
Planispiroides bucculentus										
Polysaccamina ipohalina	0.6	11.9	1.5	7.4	0.3	1.5	0.4	7.7	0.5	4.5
Pseudothurammina limnetis	0.3	1.1	0.6	2.1	1.5	1.5		1.1		
Quinqueloculina candeiana										
Quinqueloculina laevigata										
Reworked calcareous foraminifera										
Reophax nana										
Rosalina globularis										
Spirillina vivipara										
Spiroloculina hyalina			0.3	0.3						
Textularia earlandi		0.3		0.3					0.5	0.9
Tiphotrocha comprimata										
Tolypammina vagans		0.8								
Triloculina oblonga	3.6	4.1	3.5	6.5	1.2	1.2	1.1	6.3	1.4	1.8
Trochammina inflata	8.3	73.6	18.8	67.1	13.1	88.8	12.2	82.5	7.2	86

STATION NUMBER	11		12		13		14		15	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Trochammina macrescens				1.2					0.5	0.9
Trochammina spp.										
Trochamminita salsa	0.3	2.8	0.9	4.1			0.4	0.7	0.5	4.1
Arcella polypora										
Centropyxis constricta										

STATION NUMBER	16		17		18		19		20	
DISTANCE ALONG TRANSECT (m)	20.3		22.8		25.3		27.7		28.7	
ELEVATION/HHW (cm)	-7.5		-9.5		-15.5		-7		-23	
% VEG.: Borrischia-Sesuvium-Mangrove	0-0-100		0-0-100		0-0-100		0-0-100		0-0-100	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	8	11	5	10	11	13	5	10	8	13
NO. OF INDIVIDUALS/10cc	216	2657	300	3672	528	3816	94	2182	150	1554
Ammodiscus tenuis										
Ammonia beccarii tepida										
Bolivina lanceolata										
Bolivina tortuosa										
Cyclogyra revertens										
Elphidium poeyanum										
Discorinopsis aguayoi						0.3			0.7	5
Fissurina sp.										
Glomospira irregularis		1.9		2.3	0.9	8.2	0.3	20.8	0.4	18.2
Haplophragmoides wilberti				0.3		1.9				
Helenina anderseni	0.8	0.8	0.3	0.3	1.3	1.9			2.3	2.3
Miliammina fusca	0.3	7.6	0.3	3.9	0.9	3.8		3.3		4.6
Other Miliolids										
Planispiroides bucculentus										
Polysaccamina ipohalina	0.3	8.7	0.7	8.2	0.6	9.8	0.3	4.6		1.5
Pseudothurammina limnetis	0.3	0.5			1.3	7.2		2		
Quinqueloculina candeiana										
Quinqueloculina laevigata										
Reworked calcareous foraminifera										
Reophax nana										
Rosalina globularis							0.3	0.3		
Spirillina vivipara										
Spiroloculina hyalina										
Textularia earlandi	0.3	0.3		0.3	0.6	0.9		1	0.4	1.1
Tiphotrocha comprimata										
Tolypammina vagans		0.8			0.3	1.6		1	0.4	0.7
Triloculina oblonga	0.8	0.8	0.7	0.7	1.6	1.6	2.6	3	1.1	1.9
Trochammina inflata	5.1	75.3	6.2	80.4	4.4	48.7	0.7	61.4	4.3	59.4

STATION NUMBER	16		17		18		19		20	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Trochammina macrescens	0.3	2.4		0.3	0.3	2.2				1.5
Trochammina spp.										0.4
Trochamminita salsa		0.8		10	1.6	12		2.6		2.7
Arcella polypora										
Centropyxis constricta										

STATION NUMBER	21		22		23	
DISTANCE ALONG TRANSECT (m)	29.7		30.7		33.5	
ELEVATION/HHW (cm)	-30.5		-35		-48	
% VEG.: Borrischia-Sesuvium-Mangrove	0-0-100		0-0-100		0-0-100	
LIVE/TOTAL	L	T	L	T	L	T
NO. OF SPECIES	5	6	4	6	8	16
NO. OF INDIVIDUALS/10cc	21	49	24	54	348	2292
Ammodiscus tenuis						
Ammonia beccarii tepida					3.7	44.8
Bolivina lanceolata					2.4	6
Bolivina tortuosa						0.3
Cyclogyra revertens						
Elphidium poeyanum						1.1
Discorinopsis aguayoi	12.2	12.2	11.1	11.1	0.5	1.3
Fissurina sp.					0.3	0.3
Glomospira irregularis	6.1	12.2				
Haplophragmoides wilberti	0	4.1				
Helenina anderseni	8.2	8.2			6	26.2
Miliammina fusca				11.1		0.3
Other Miliolids						
Planispiroides bucculentus						
Polysaccamina ipohalina						0.3
Pseudothurammina limnetis						0.3
Quinqueloculina candeiana						
Quinqueloculina laevigata						
Reworked calcareous foraminifera						
Reophax nana						0.3
Rosalina globularis					0.5	2.4
Spirillina vivipara						
Spiroloculina hyalina						
Textularia earlandi						0.3
Tiphotrocha comprimata				11.1		
Tolypammina vagans						
Triloculina oblonga	2	4.1	11.1	11.1	1.1	3.7
Trochammina inflata	14.3	59.2	11.1	44.4	0.9	11.8

STATION NUMBER	21		22		23	
LIVE/TOTAL	L	T	L	T	L	T
Trochammina macrescens			11.1	11.1		1.1
Trochammina spp.						
Trochamminita salsa						
Arcella polypora						
Centropyxis constricta						

Table 15: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Mangrove Bay.

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	13	41	17	53	17	26	12	31
NO. OF INDIVIDUALS/10cc	2232	27000	5184	33804	2016	19476	414	5742
SEDIMENT TYPE	peat		peat		sandy peat		peat	
DEPTH (M)	HHW		exposed		0.1, in roots		0.2, in roots	
Abdidodentrix rhomboidalis				0.1				
Ammobaculites agglutinans				0.1				
Ammobaculites sp.								
Ammodiscus tenuis					0.2	0.4		0.6
Ammonia beccarii tepida				0.6		0.2		2.8
Archaias angulatus				0.1				
Articulina sp.		0.4		0.3				
Bigenerina irregularis								
Biloculinella sp.	0.3	1.2		0.4				
Bolivina lanceolata		1.6	0.2	1.8	0.9	4.6	1.3	11.9
Bolivina paula								
Bolivina sp.								
Bolivina subexcavata		0.3		0.9	0.4	1.3		0.9
Bolivina tortuosa		0.1		0.2				
Bolivina variabilis					0.6	2.0		0.9
Bolivina variabilis var. spathulata		0.3	0.1	0.1				
Buliminella elegantissima	0.1	0.1		0.2				
Buliminella miletti								
Cassidulina subglobosa	0.1	0.1		0.5				0.3
Cibicides lobatulus								
Cibicides refulgens				0.1				
Clavulina tricarinata								
Cyclogyra planorbis	0.3	2.3	5.8	10.1		0.2		
Cyclorbiculina compressa		0.1						
Cymbaloporetta bradyi								
Cymbaloporetta squamosa								
Discorbis mira								
Discorbis sp.								
Discorinopsis aguayoi	1.2	7.5	0.4	5.1	1.5	16.8	0.3	6.6
Elphidium excavatum						0.6		
Elphidium poeyanum								0.9
Elphidium sagrum								
Elphidium sp.				0.2				
Eponides bradyi								
Eponides repandus				0.1				
Fissurina sp.	0.1	0.5	0.1	0.4		0.7		0.3
Floresina sp.								
Fursenkoina complanata								
Fursenkoina pontoni								
Glomospira irregularis			0.3	0.5	0.7	4.8	0.9	13.8
Haplophragmoides sp.							0.3	0.9

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Haplophragmoides wilberti				0.1				
Helenina anderseni	1.9	22.3	2.3	20.8	1.3	35.7	0.9	29.8
Hoeglundina elegans								
Lamarckina sp.				0.1				
Lenticulina calcar				0.1				
Loxostomum limbatum								
Loxostomum mayori				0.1				
Miliammina fusca		0.4				0.2		0.3
Miliolinella circularis			0.1	0.1				
Miliolinella fichteliana								
Miliolinella labiosa								
Miliolinella sp.	0.4	3.3					0.6	0.6
Monalysidium politum								
Neoconorbina terquemi				0.1				
Nonion depressulum								0.9
Nonion gradeloupi								0.6
Nonion sp.		1.1	0.1	2.0				
Other Miliolids (juveniles)		2.5	0.5	6.0	0.2	3.3		1.6
Other Rotaliids		0.1						
Other Textulariids								
Parrina bradyi	1.7	23.2		0.4				
Patellina corrugata		0.1						
Peneroplis bradyi								
Peneroplis carinatus/proteus		0.4		0.6				
Pileolina patelliformis								
Planispiroides bucculentus		0.1		0.3				
Planktonic foraminifera								
Planorbulina acervalis				0.1				
Planorbulina mediterranensis								
Planulina carribea								
Planulina sp.								
Polysaccamina ipohalina		0.1						0.6
Pseudothurammina limnetis		0.3	0.3	1.3			0.3	1.6
Pyrgo elongata								
Pyrgo subsphaerica				0.1				
Quinqueloculina agglutinans								
Quinqueloculina bicarinata		0.4		0.1				
Quinqueloculina bicostata								
Quinqueloculina bosciana								
Quinqueloculina bradyana								
Quinqueloculina candeiana								
Quinqueloculina circularis								
Quinqueloculina collumnosa								
Quinqueloculina funafutiensis								
Quinqueloculina goesi		0.3		0.3				

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Quinqueloculina horrida								
Quinqueloculina laevigata		0.5		1.7				0.3
Quinqueloculina lamarckiana		0.3		1.3			0.3	0.9
Quinqueloculina poeyana								
Quinqueloculina polygona								
Quinqueloculina semilunum	0.8	9.9	1.3	18.8			0.3	0.3
Quinqueloculina spp.				0.3				
Quinqueloculina subpoeyana		0.5		1.3				
Quinqueloculina tricarinata		0.1						
Quinqueloculina vulgaris								
Reophax nana								
Reussella atlantica								
Rosalina concinna		0.4		0.3				0.9
Rosalina globularis		1.2		1.0	0.4	0.9		1.6
Rosalina subarauncana								
Schlumbergerina alveoliformis		0.1		0.4				0.6
Sigmoilina sigmoidea								0.6
Siphonina pulchra								
Sorites marginalis								
Spirillina densepunctata								
Spirillina sp.				0.1				
Spirillina vivipara		0.1						
Spiroloculina arenata				0.2	0.2	0.6		
Spiroloculina hyalina		0.1	0.1	1.3	0.9	6.1		
Spirophtalmidium sp.								
Textularia agglutinans					0.2	0.6		
Textularia earlandi				0.3		0.4	0.3	5.0
Textularia sp.					0.2	0.7		
Tiphotrocha comprimata								
Tolypammina vagans		0.1						0.3
Trifarina occidentalis								
Triloculina bassensis								
Triloculina bermudezi		1.1	0.1	1.3	0.4	1.1		
Triloculina carinata								
Triloculina linneiana								
Triloculina oblonga	0.3	10.5	3.2	14.9	1.3	7.2	0.9	7.2
Triloculina rotunda								
Triloculina sp.								
Triloculina trigonula	0.3	1.1	0.1	1.1		0.4		
Trochammina inflata	0.8	4.7	0.2	0.7	0.9	10.2	0.6	5.3
Trochammina macrescens						0.4		
Trochamminita salsa						0.4		
Valvulina oviedoina				0.2	0.2	0.4		0.6

STATION NUMBER	5		9		10		12	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	46	75	12	25	20	37	38	89
NO. OF INDIVIDUALS/10cc	10440	45720	558	6066	3456	35640	5724	35784
SEDIMENT TYPE	peaty m.s.		m.s.		peaty s.		peaty m.s.	
DEPTH (M)	0.6, roots edge		0.07, in roots		0.4		0.6	
Abdidodentrix rhomboidalis		0.6				0.2		0.5
Ammobaculites agglutinans	0.2	0.2						
Ammobaculites sp.				0.6			0.1	0.1
Ammodiscus tenuis	0.2	0.2				0.2		
Ammonia beccarii tepida	1.0	1.7		0.3		0.4		1.0
Archaias angulatus	0.1	0.2					0.4	0.6
Articulina sp.	0.2	0.9			0.1	0.3		0.6
Bigenerina irregularis								0.1
Biloculinella sp.								
Bolivina lanceolata	1.8	4.3	1.2	11.3	0.2	1.2	1.2	5.3
Bolivina paula								0.8
Bolivina sp.						0.1		
Bolivina subexcavata	0.1	0.9	0.3	2.1		0.5	0.1	1.3
Bolivina tortuosa	0.2	0.3						0.3
Bolivina variabilis	0.1	0.1						
Bolivina variabilis var. spathulata	0.4	1.5		1.2			0.1	0.6
Buliminella elegantissima	1.1	2.8					0.3	0.7
Buliminella miletti								0.1
Cassidulina subglobosa	0.2	0.8					0.1	0.4
Cibicides lobatulus							0.1	0.1
Cibicides refulgens		0.2						0.1
Clavulina tricarinata							0.8	0.8
Cyclogyra planorbis		1.3		0.3	0.3	2.6	0.6	2.3
Cyclorbiculina compressa								
Cymbaloporetta bradyi								0.1
Cymbaloporetta squamosa		0.1						0.1
Discorbis mira							0.3	0.4
Discorbis sp.							0.0	0.3
Discorinopsis aguayoi	0.2	1.1	2.4	16.6	0.8	8.0	0.2	1.8
Elphidium excavatum	0.4	1.3						0.1
Elphidium poeyanum							0.1	0.8
Elphidium sagrum		0.2						
Elphidium sp.						0.3		0.1
Eponides bradyi								0.1
Eponides repandus								
Fissurina sp.	0.5	2.2	0.0	0.3	0.2	1.9	0.1	0.8
Floresina sp.		0.4					0.1	0.5
Fursenkoina complanata	0.2	0.2						
Fursenkoina pontoni		0.1						
Glomospira irregularis	0.5	0.7	0.3	0.3	0.5	3.7		0.1
Haplophragmoides sp.	0.3	0.5	0.6	0.9	0.1	0.1		

STATION NUMBER	5		9		10		12	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Haplophragmoides wilberti								
Helenina anderseni	0.9	3.1	2.1	53.1	1.4	23.8	0.3	6.9
Hoeglundina elegans		0.1						
Lamarckina sp.								
Lenticulina calcar								
Loxostomum limbatum								
Loxostomum mayori	0.1	0.2		0.3		0.1		0.1
Miliammina fusca	0.1	0.3				0.1	0.2	0.4
Miliolinella circularis								
Miliolinella fichteliana								0.3
Miliolinella labiosa	0.1	0.5					0.1	0.7
Miliolinella sp.		0.1		1.8				
Monalysidium politum		0.1						0.1
Neoconorbina terquemi	0.1	0.1					0.2	0.4
Nonion depressulum	1.2	5.7						2.6
Nonion gradeloupi	0.3	0.5					0.1	0.6
Nonion sp.		0.0				0.5		
Other Miliolids (juveniles)		4.0				5.8		3.2
Other Rotaliids								
Other Textulariids						0.1		
Parrina bradyi		0.2			1.2	5.4		0.5
Patellina corrugata						0.2		0.5
Peneroplis bradyi		0.1					0.1	0.3
Peneroplis carinatus/proteus		0.2					0.8	3.4
Pileolina patelliformis							0.1	0.2
Planispiroides bucculentus					0.5	1.5	0.1	0.3
Planktonic foraminifera								
Planorbulina acervalis							0.3	0.5
Planorbulina mediterranensis		0.1					0.1	0.3
Planulina carribea		0.1						
Planulina sp.								0.2
Polysaccamina ipohalina		0.1						
Pseudothurammina limnetis		0.2			0.1	2.2		
Pyrgo elongata		0.1						
Pyrgo subsphaerica								0.1
Quinqueloculina agglutinans								0.4
Quinqueloculina bicarinata	0.1	0.1					0.2	0.3
Quinqueloculina bicostata								0.1
Quinqueloculina bosciana	0.6	1.0					0.2	0.8
Quinqueloculina bradyana	0.0	0.1						0.1
Quinqueloculina candeiana	0.1	0.1						
Quinqueloculina circularis								
Quinqueloculina collumnosa								0.1
Quinqueloculina funafutiensis	0.1	0.2						0.1
Quinqueloculina goesi	0.1	0.9		0.3		0.2		0.4

STATION NUMBER	5		9		10		12	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Quinqueloculina horrida								0.3
Quinqueloculina laevigata	2.3	8.4				0.3	1.5	6.5
Quinqueloculina lamarckiana	0.2	1.2		0.3			0.1	1.6
Quinqueloculina poeyana	0.1	0.3						0.3
Quinqueloculina polygona	0.2	0.6					0.2	0.9
Quinqueloculina semilunum	6.1	33.1	0.3	1.8	0.3	3.1	5.9	35.4
Quinqueloculina spp.		0.2				0.1	0.1	0.3
Quinqueloculina subpoeyana	0.1	1.8				0.5	0.1	1.8
Quinqueloculina tricarinata								
Quinqueloculina vulgaris		0.2						0.5
Reophax nana	0.1	0.6						
Reussella atlantica				0.3				
Rosalina concinna						0.2		0.3
Rosalina globularis		0.1			0.2	2.4		0.6
Rosalina subarauncana								0.2
Schlumbergerina alveoliformis	0.6	1.2						
Sigmoilina sigmoidea								0.1
Siphonina pulchra								0.1
Sorites marginalis								0.1
Spirillina densepunctata								0.1
Spirillina sp.								
Spirillina vivipara								
Spiroloculina arenata	0.1	0.7						0.2
Spiroloculina hyalina	0.4	0.9		0.3	0.1	0.3		0.3
Spirophtalmidium sp.								0.1
Textularia agglutinans								
Textularia earlandi	0.2	0.6		0.6				0.2
Textularia sp.								
Tiphotrocha comprimata		0.0	0.3	0.6				
Tolypammina vagans					0.4	0.9		
Trifarina occidentalis	0.2	0.5			0.1	0.1		0.1
Triloculina bassensis	0.2	0.5					0.1	1.1
Triloculina bermudezi		0.2	0.6	1.5	0.5	6.7	0.2	0.7
Triloculina carinata		0.1						0.1
Triloculina linneiana		0.1						
Triloculina oblonga	0.9	6.9	0.6	2.4	1.8	22.1		1.1
Triloculina rotunda		0.2					0.2	0.4
Triloculina sp.								0.1
Triloculina trigonula	0.1	0.6	0.3	0.9	0.1	2.0	0.1	0.8
Trochammina inflata	0.0	0.2	0.3	2.1	0.7	1.7		0.3
Trochammina macrescens								
Trochamminita salsa								
Valvulina oviedoina		0.4						0.2

Table 16: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Coot Pond.

STATION NUMBER	1		2		3		4		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	15	27	15	28	8	15	11	23	12	36
NO. OF INDIVIDUALS/10cc	1314	5382	1296	5652	4284	12204	837	2268	89	442
SEDIMENT TYPE	peaty sand		m.s. with organics		m.s. with organics		m.s. with organics		m.s.	
DEPTH (m)	HHW		0.1 in roots		0.3 in roots		0.6 in roots		HHW	
Ammobaculites sp.										
Ammodiscus tenuis										
Ammonia beccarii tepida	0.3	6.8	0.3	7.0	0.3	4.4	0.4	7.9		0.5
Anomalina globulosa										
Archaias angulatus				0.3					0.5	5.7
Archaias angulatus reworked										
Articulina mexicana										
Articulina sp.										0.2
Asterigerina carinata				0.6						
Bolivina lanceolata	0.7	1.7	1.6	7.3	2.7	11.2	1.2	11.5		0.7
Bolivina pulchella										
Bolivina sp.				0.3						
Bolivina striatula										
Bolivina subexcavata								0.4		
Bolivina tortuosa						0.3				
Bolivina variabilis		0.3								
Bolivina variabilis var. spathulata						0.3	0.4	0.4		0.2
Buliminella elegantissima							0.4	0.4		
Buliminella sp.				0.3				0.4		
Cibicides refulgens								0.8		
Cibicides sp.										
Clavulina tricarinata										
Cyclogyra planorbis		1.0	1.6	2.5		1.2		0.4		
Cymbaloporetta squamosa		0.3		0.6						0.2
Discorbis mira										
STATION NUMBER	1		2		3		4		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Discorinopsis aguayoi	5.8	19.0	0.6	5.1	0.0	0.6	0.8	1.2	0.5	2.0
Elphidium excavatum										

Elphidium sagrum		0.3								
Elphidium sp.				0.3	0.0	1.2	0.0	1.6		
Eponides repandus										
Fissurina sp.								1.2		
Globocassidulina sp.		0.3								
Glomospira irregularis										
Hauerina speciosa										0.2
Helenina anderseni	3.7	12.2	8.3	30.3	6.5	26.8	3.2	9.1	4.5	6.6
Loxostomum limbatum										
Loxostomum mayori										
Melonis pompiloides	0.0	0.3								
Miliammina fusca										
Miliolids reworked										
Miliolinella labiosa	0.0	0.3								
Miliolinella sp.										
Monalysidium politum										
Nonion depressulum										
Nonion gradeloupi					0.3	0.9	0.4	0.8		
Nonion sp.								1.6		
Other Miliolids	0.3	2.7								
Other Rotaliids	0.3	1.7								0.5
Other Textulariids			0.3	0.3						
Parrina bradyi			0.3	0.3				0.0		
Patellina corrugata										
Peneroplis bradyi										1.1
Peneroplis carinatus/proteus	0.7	0.7							0.5	5.0
Peneroplis pertusus										

STATION NUMBER	1		2		3		4		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Peneroplis sp.				0.3				0.4		
Planispiroides bucculentus		0.3								
Planulina carribea										0.2
Pseudothurammina limnetis										
Pyrgo subsphaerica										0.7
Quinqueloculina bicarinata										
Quinqueloculina bicostata										
Quinqueloculina bosciana										
Quinqueloculina candeiana		1.0	0.3	0.3					0.2	0.2
Quinqueloculina circularis										0.2
Quinqueloculina goesi										0.2
Quinqueloculina laevigata		0.7	0.3	0.6				1.2		0.5
Quinqueloculina lamarckiana		0.3		0.3				1.2		1.6
Quinqueloculina polygona								0.8		0.2
Quinqueloculina semilunum	3.7	23.5	5.1	24.2	23.0	36.9	29.0	49.2	11.3	64.7
Quinqueloculina sp.										0.2
Quinqueloculina stelligera										0.5
Reophax nana										
Rosalina concinna										0.7
Rosalina globularis	0.7	3.1	0.0	1.9	0.0	0.6	0.0	1.2	0.9	2.7
Rosalina subarauncana										
Rosalina vilardeboana										
Rotaliids reworked										
Saccammina difflugiformis										
Schlumbergerina alveoliformis										
Sorites marginalis										0.2
Spirillina denticulata										
Spiroloculina arenata				0.3		0.3				0.2
Spiroloculina hyalina	0.3	0.3		1.0						0.2

STATION NUMBER	1		2		3		4		6	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Spiroloculina sp.										
Textularia earlandi					0.9	0.9	0.4	0.4		
Textularia sp.			0.3	0.3						
Trifarina occidentalis										0.2
Triloculina bassensis									0.2	0.2
Triloculina bermudezi	2.0	3.7							0.2	0.2
Triloculina carinata				0.3						
Triloculina linneiana										0.2
Triloculina oblonga	2.7	11.9	2.9	12.1	0.9	11.5	0.4	7.5	0.7	1.8
Triloculina rotunda									0.2	0.2
Triloculina sp.										
Triloculina trigonula				0.3						
Trochammina inflata	2.0	6.5	1.0	1.3	0.6	2.9	0.4	0.4	0.5	0.7
Trochammina macrescens	0.3	0.3								
Trochammina ochracea										
Trochamminita salsa										
Virgulina sp.										
Weisnerella auriculata										0.2

STATION NUMBER	7		8		10		11		12	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
NO. OF SPECIES	10	28	12	31	25	41	13	28	15	36
NO. OF INDIVIDUALS/10cc	258	1296	624	3528	1030	2218	7812	20988	3780	34200
SEDIMENT TYPE	m.s.		m.s.		m.s.		m.s. with organics		m.s.with organics	
DEPTH (M)	0.1 in roots		0.1		0.6 roots edge		HWM		0.2 in roots	
Ammobaculites sp.										0.1
Ammodiscus tenuis										0.1
Ammonia beccarii tepida	0.9	3.2		3.4	0.3	2.3	0.2	0.7		0.6
Anomalina globulosa		0.5								
Archaias angulatus		1.4		2.4	0.3	0.3				
Archaias angulatus reworked		1.9				0.3				
Articulina mexicana		0.5								
Articulina sp.						0.3		0.2		
Asterigerina carinata										
Bolivina lanceolata				4.1	0.6	3.9	0.3	4.8	1.4	22.1
Bolivina pulchella						0.3				
Bolivina sp.		0.5								
Bolivina striatula										
Bolivina subexcavata					0.3	0.3				0.5
Bolivina tortuosa		0.5		0.7		1.0				0.6
Bolivina variabilis									0.3	1.2
Bolivina variabilis var. spathulata		0.5	0.3	0.7	0.6	1.2				0.5
Buliminella elegantissima				0.3		0.3				0.1
Buliminella sp.			0.3	0.3	0.3	0.3				
Cibicides refulgens		0.5				1.3		0.3		0.2
Cibicides sp.										
Clavulina tricarinata					0.3	0.3				
Cyclogyra planorbis	0.5	1.4	0.7	1.7	0.6	1.0	8.4	10.8	1.2	2.3
Cymbaloporetta squamosa				0.3	0.3	0.3		0.5		0.1
Discorbis mira										
STATION NUMBER	7		8		10		11		12	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Discorinopsis aguayoi	5.1	10.6	3.1	12.6	1.0	5.8	4.1	12.3	0.6	7.4
Elphidium excavatum										1.3

Elphidium sagrum										
Elphidium sp.						1.3		0.2		
Eponides repandus		0.9								
Fissurina sp.				0.3				0.5	0.1	2.2
Globocassidulina sp.										
Glomospira irregularis										0.1
Hauerina speciosa										
Helenina anderseni	4.6	9.7	2.7	9.2	1.0	2.3	12.0	23.3	4.2	32.8
Loxostomum limbatum					0.6	0.6				
Loxostomum mayori							0.3	1.2	0.1	2.2
Melonis pompiloides										
Miliammina fusca										
Miliolids reworked		0.5								
Miliolinella labiosa						0.3				
Miliolinella sp.									0.1	0.2
Monalysidium politum		0.5								
Nonion depressulum									0.1	0.8
Nonion gradeloupi								0.3		
Nonion sp.										
Other Miliolids		5.6	2.0	16.3	2.6	5.8		2.4	0.1	0.7
Other Rotaliids		0.5								
Other Textulariids					0.3	0.3		0.2		
Parrina bradyi										
Patellina corrugata						1.0	0.2	0.3	0.1	0.3
Peneroplis bradyi								0.2		
Peneroplis carinatus/proteus		3.2		1.4	0.3	2.3	0.2	0.3		
Peneroplis pertusus				0.3						

STATION NUMBER	7		8		10		11		12	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Peneroplis sp.										
Planispiroides bucculentus			0.3	0.3	0.3	0.3				
Planulina carribea										
Pseudothurammina limnetis							0.5	1.2		0.2
Pyrgo subsphaerica										
Quinqueloculina bicarinata			0.7	2.7	7.8	10.4				
Quinqueloculina bicostata						0.3				
Quinqueloculina bosciana				0.7		1.3				
Quinqueloculina candeiana				0.7	0.3	0.3				
Quinqueloculina circularis										
Quinqueloculina goesi						1.3		0.2		
Quinqueloculina laevigata				0.0	0.3	1.3				
Quinqueloculina lamarckiana		0.9		1.7		0.3				
Quinqueloculina polygona				0.3						
Quinqueloculina semilunum	0.9	39.4	3.4	26.5	20.1	39.6	0.2	2.6		
Quinqueloculina sp.				0.3						
Quinqueloculina stelligera										
Reophax nana					0.3	0.3				0.2
Rosalina concinna					2.6	2.9				
Rosalina globularis	0.5	0.5		1.0	0.6	2.3				2.7
Rosalina subarauncana	0.5	2.3								
Rosalina vilardeboana	0.5	0.5								
Rotaliids reworked		3.7		1.4						
Saccammina difflugiformis										0.1
Schlumbergerina alveoliformis										0.1
Sorites marginalis										
Spirillina denticulata										0.1
Spiroloculina arenata				1.0		0.3				0.1
Spiroloculina hyalina		0.5						0.2	0.4	1.1

STATION NUMBER	7		8		10		11		12	
LIVE/TOTAL	L	T	L	T	L	T	L	T	L	T
Spiroloculina sp.								0.2		
Textularia earlandi								0.2	0.1	1.5
Textularia sp.										0.4
Trifarina occidentalis				0.3						
Triloculina bassensis				0.3						
Triloculina bermudezi										
Triloculina carinata										
Triloculina linneiana										
Triloculina oblonga	1.9	8.3	1.7	4.4		0.6	9.6	33.3	1.9	11.6
Triloculina rotunda										
Triloculina sp.										
Triloculina trigonula	0.5	0.9				0.6		0.9		1.1
Trochammina inflata		0.9	0.3	2.0	0.3	0.3	1.0	2.4	0.3	4.1
Trochammina macrescens										0.1
Trochammina ochracea			2.0	2.0	3.9	3.9				
Trochamminita salsa								0.2		
Virgulina sp.							0.2	0.2		
Weisnerella auriculata										

STATION NUMBER	13		14	
LIVE/TOTAL	L	T	L	T
NO. OF SPECIES	17	32	11	26
NO. OF INDIVIDUALS/10cc	1800	9972	1296	4860
SEDIMENT TYPE	m.s.with few organics		m.s.	
DEPTH (M)	0.3 in roots		0.6 roots edge	
Ammobaculites sp.				
Ammodiscus tenuis				
Ammonia beccarii tepida		13.0	2.6	38.1
Anomalina globulosa				
Archaias angulatus				1.1
Archaias angulatus reworked		0.4		
Articulina mexicana				
Articulina sp.				0.4
Asterigerina carinata				
Bolivina lanceolata	4.0	11.9	2.6	7.0
Bolivina pulchella				
Bolivina sp.				
Bolivina striatula				0.4
Bolivina subexcavata			0.4	0.4
Bolivina tortuosa	0.4	3.2		1.1
Bolivina variabilis	0.4	0.7		
Bolivina variabilis var. spathulata				
Buliminella elegantissima				
Buliminella sp.	0.4	0.4		
Cibicides refulgens	0.4	1.1	0.4	0.4
Cibicides sp.		0.4		
Clavulina tricarinata				
Cyclogyra planorbis	0.4	1.8		0.4
Cymbaloporetta squamosa				
Discorbis mira			0.4	0.4
STATION NUMBER	13		14	
LIVE/TOTAL	L	T	L	T
Discorinopsis aguayoi		0.4		0.4
Elphidium excavatum				

Elphidium sagrum				
Elphidium sp.				0.4
Eponides repandus				
Fissurina sp.	0.4	1.1		0.4
Globocassidulina sp.				
Glomospira irregularis	0.4	0.4		
Hauerina speciosa				
Helenina anderseni	1.4	17.0	1.1	1.9
Loxostomum limbatum				
Loxostomum mayori		1.1		
Melonis pompiloides				
Miliammina fusca				
Miliolids reworked				
Miliolinella labiosa				
Miliolinella sp.				
Monalysidium politum				
Nonion depressulum				
Nonion gradeloupi				
Nonion sp.		0.7		
Other Miliolids		1.4		
Other Rotaliids		0.4		
Other Textulariids				
Parrina bradyi				
Patellina corrugata				
Peneroplis bradyi				
Peneroplis carinatus/proteus		0.4		1.9
Peneroplis pertusus				

STATION NUMBER	13		14	
LIVE/TOTAL	L	T	L	T
Peneroplis sp.				
Planispiroides bucculentus				
Planulina carribea		0.7		
Pseudothurammina limnetis	0.7	1.1		
Pyrgo subsphaerica				
Quinqueloculina bicarinata				
Quinqueloculina bicostata				
Quinqueloculina bosciana				
Quinqueloculina candeiana				0.4
Quinqueloculina circularis				
Quinqueloculina goesi				
Quinqueloculina laevigata		0.4		
Quinqueloculina lamarckiana		0.4		1.9
Quinqueloculina polygona				
Quinqueloculina semilunum	1.1	2.9	9.6	28.9
Quinqueloculina sp.				
Quinqueloculina stelligera				
Reophax nana				
Rosalina concinna				
Rosalina globularis	0.7	5.8		
Rosalina subarauncana				
Rosalina vilardeboana				
Rotaliids reworked				1.1
Saccammina difflugiformis				
Schlumbergerina alveoliformis				
Sorites marginalis				
Spirillina denticulata				
Spiroloculina arenata		0.4		0.4
Spiroloculina hyalina	1.1	1.1	8.1	9.3

STATION NUMBER	13		14	
LIVE/TOTAL	L	T	L	T
Spiroloculina sp.				
Textularia earlandi			0.4	0.4
Textularia sp.				
Trifarina occidentalis				
Triloculina bassensis				0.4
Triloculina bermudezi				0.4
Triloculina carinata				
Triloculina linneiana		0.4		
Triloculina oblonga	4.0	24.9	0.7	1.9
Triloculina rotunda				
Triloculina sp.	0.7	1.1		
Triloculina trigonula	1.1	3.6	0.4	0.7
Trochammina inflata	0.7	1.4		
Trochammina macrescens				
Trochammina ochracea				
Trochamminita salsa				
Virgulina sp.				
Weisnerella auriculata		0.4		

Table 17: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Walsingham Bay.

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	5	16	9	29	8	19	6	19
NO. OF INDIVIDUALS/10cc	120	976	1260	25776	324	10512	252	8928
SEDIMENT TYPE	sandy peat		sandy peat		sandy peat			
DEPTH (m)	edge grass/mangrove		exposed, in mangrove		exposed, in mangrove		0.05, in mangrove	
Ammonia beccarii tepida						1.7		1.2
Articulina sp.			0.1	0.1				
Bolivina lanceolata				3.1	0.7	8.2	0.4	5.6
Bolivina lowmani				0.7			0.4	1.2
Bolivina paula				0.3				
Bolivina pulchella				0.1				
Bolivina tortuosa				1.0				
Buliminella elegantissima				0.4				
Cancris sagra				0.1				
Cassidulina subglobosa				0.6				
Cibicides refulgens		0.4		0.3				
Cyclogyra planorbis			0.4	0.7				
Discorinopsis aguayoi	2.0	2.9	0.7	10.1	0.3	11.0	0.4	11.7
Elphidium poeyanum				0.1				0.4
Fissurina spp.		0.4		0.6	0.3	0.7		
Glomospira irregularis						3.4		2.0
Haplophragmoides wilberti	0.4	2.0		0.6	0.3	0.7		
Helenina anderseni	2.5	43.9	0.8	34.2	0.3	42.5	0.8	45.2
Miliammina fusca						0.7		
Miliolids reworked		0.4				0.3		
Miliolinella labiosa			0.1	0.3			0.4	0.8
Nonion depressulum				0.3		0.3		
Nonion gradeloupi				0.3		0.7		0.4
Other Miliolids		0.4						
Parrina bradyi			0.8	11.2		0.3		0.8
Patellina corrugata				0.1				
Polysaccamina ipohalina		0.4		0.3		1.4		0.4

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Pseudothurammina limnetis						1.0		0.4
Quinqueloculina semilunum				1.0				
Reussella atlantica		0.4						
Rosalina globularis				0.7				
Rotaliids reworked		0.4						
Siphonina pulchra		0.4						
Spiroloculina hyalina			0.1	0.6		0.3	0.4	0.8
Textularia earlandi				0.1	0.3	2.1		1.6
Tiphotrocha comprimata		0.4						
Tretomphalus atlanticus		0.4						
Trifarina occidentalis				0.3				
Triloculina oblonga	3.7	11.1	1.5	27.0	0.3	10.3		5.6
Trochammina inflata	3.7	35.7	0.1	5.0	0.3	14.0		19.4
Trochammina macrescens		0.4						0.4
Trochammina ochracea								1.2
Valvulina oviedoina						0.3		0.8

Table 18: Percent abundance of living (stained, L) and total (T) foraminifera and thecamoebians, and sediment type from Spittal Pond.

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	9	43	14	64	1	53	2	4
NO. OF INDIVIDUALS/10cc	261	2790	768	9948	9	2826	42	660
SEDIMENT TYPE	c.s.with organics		sandy peat		muddy sand, ostracods		peat	
DEPTH (M)	exposed, in grass		in grass		1.5		0.3, grass island	
Ammonia beccarii tepida		0.3		0.2		1.3		
Angulogerina carinata		1.3		0.1		0.6		
Archaias angulatus								
Archaias angulatus reworked		1.6				0.3		
Articulina pacifica				0.2				
Articulina sp.		0.3						
Asterigerina carinata								
Astrononion stelligerum		0.6				0.3		
Bolivina lanceolata		1.9		1.1		2.5		
Bolivina lowmani				0.1		0.3		
Bolivina paula		0.6		0.1		0.3		
Bolivina pulchella				0.5		0.3		
Bolivina sp.		0.3						
Bolivina subexcavata								
Bolivina tortuosa	0.3	11.9	0.1	4.3	0.3	15.9		
Buliminella elegantissima			0.1	0.2		1.0		
Buliminella sp.						0.3		
Cancris sagra				0.1				
Cassidulina neocarinata				0.1				
Cassidulina subglobosa				0.1		0.3		
Cibicides lobatulus				0.2				
Cibicides refulgens	0.3	5.8		2.7		7.0		
Cyclogyra planorbis				0.5		1.6		
Cymbaloporetta squamosa		1.9		0.2		2.2		
Discorbis sp.				0.2				

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Discorbis mira			0.1	0.2				
Discorinopsis aguayoi	1.9	21.3	1.8	21.0		16.6		
Elphidium advenum						0.3		
Elphidium excavatum								
Elphidium poeyanum			0.1	0.7				
Elphidium sp.								
Eponides repandus		0.3						
Fissurina sp.				0.2		0.3		
Floresina sp.				0.2				
Glomospira irregularis								
Hanzawaia concentrica				0.5				
Haplophragmoides wilberti		1.0	0.2	1.3				10.0
Helenina anderseni	0.3	2.9	0.2	1.6		2.2		
Lamarckina atlantica								
Loxostomum mayori						0.3		
Melonis pompiloides								
Miliammina fusca	0.3	0.3		1.2			0.9	0.9
Miliolids juv.								
Miliolids reworked								
Miliolinella circularis			0.1	0.1		1.6		
Miliolinella fichteliana						0.3		
Miliolinella labiosa								
Monalysidium politum						0.3		
Neoconorbina terquemi		0.3		0.1		1.6		
Nonion depressulum				0.1				
Nonion gradeloupi		0.3	0.2	0.6		0.3		
Nonion sp.								
Other Miliolids		1.6		0.5		3.2		
Other Rotaliids		4.8	0.1	7.0		4.8		

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Parrina bradyi								
Peneroplis bradyi								
Peneroplis carinatus/proteus						2.2		
Peneroplis pertusus								
Peneroplis sp.						0.3		
Planispiroides bucculentus			0.8	3.3				
Planktonic foraminifera		1.0		0.4		0.3		
Polysaccamina ipohalina				0.4			4.5	80.0
Pseudothurammina limnetis		0.3						
Quinqueloculina bicarinata		0.3				0.3		
Quinqueloculina bicostata						0.3		
Quinqueloculina bosciana				0.2				
Quinqueloculina bradyana				0.1				
Quinqueloculina goesi						0.6		
Quinqueloculina laevigata		0.6		0.6		1.3		
Quinqueloculina lamarckiana		0.3				1.3		
Quinqueloculina polygona		0.3		0.1		2.9		
Quinqueloculina semilunum		0.3		0.8		5.1		
Quinqueloculina spp.				0.2				
Quinqueloculina stelligera	0.3	0.6				0.6		
Quinqueloculina subpoeyana		0.3		0.5		0.6		
Reophax nana								
Reussella atlantica						0.3		
Rosalina concinna		1.3	0.1	0.8		1.3		
Rosalina globularis	0.3	0.3		0.4				
Rosalina subarauncana		2.3		1.9		2.2		
Rotaliids reworked		0.3						
Siphonina pulchra		0.3				0.3		
Spirillina cariacoensis				0.1				

STATION NUMBER	1		2		3		4	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Spirillina denticulata								
Spirillina sp.				0.1				
Spirillina vivipara		1.6		0.1				
Spiroloculina arenata				0.1				
Spiroloculina communis								
Spiroloculina hyalina		0.3				0.6		
Spiroloculina sp.		0.0						
Spirophtalmidium sp.		0.6		0.4		1.3		
Textularia earlandi		0.3		0.1				
Tiphotrochammina comprimata				0.1				
Trifarina occidentalis		2.9		1.4		4.1		
Triloculina bassensis				0.1		0.6		
Triloculina bermudezi						0.3		
Triloculina oblonga	1.9	6.1	0.5	12.4		1.3		
Triloculina rotunda								
Triloculina sp.						0.6		
Triloculina trigonula		0.6				2.5		
Trochammina inflata	3.5	18.1	3.0	25.1		0.3	0.9	9.1
Trochammina macrescens				0.2				
Trochammina ochracea				0.1				
Trochammina sp.				0.1				
Trochamminita salsa								
Valvulina oviedoina				0.1				
Weisnerella auriculata		1.0		1.3		1.9		
Arcella polypora				0.8				
Centropyxis aculeata				0.5				

STATION NUMBER	5		6		7		8	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	7	30	3	32	4	6	3	29
NO. OF INDIVIDUALS/10cc	27	148.5	18	648	720	3708	18	1452
SEDIMENT TYPE	sandy peat		sandy mud, ostracods		peat		sandy peat	
DEPTH (M)	1		1		0.3 in grass		1	
Ammonia beccarii tepida		1.0		2.9				1.2
Angulogerina carinata								
Archaias angulatus								
Archaias angulatus reworked								
Articulina pacifica								
Articulina sp.								
Asterigerina carinata								
Astrononion stelligerum		1.0						
Bolivina lanceolata		3.0		1.9				0.8
Bolivina lowmani		1.0						
Bolivina paula								
Bolivina pulchella				0.5				
Bolivina sp.								
Bolivina subexcavata								0.4
Bolivina tortuosa		1.0		4.3				2.1
Buliminella elegantissima								
Buliminella sp.								
Cancris sagra				0.5				0.4
Cassidulina neocarinata		1.0						
Cassidulina subglobosa								
Cibicides lobatulus								0.4
Cibicides refulgens		3.0		2.4				0.4
Cyclogyra planorbis		3.0						
Cymbaloporetta squamosa				0.5				
Discorbis sp.								0.4

STATION NUMBER	5		6		7		8	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Discorbis mira								
Discorinopsis aguayoi	7.1	25.3	0.5	10.1			0.4	2.9
Elphidium advenum		2.0						
Elphidium excavatum		1.0						
Elphidium poeyanum	2.0	3.0		0.5				
Elphidium sp.								
Eponides repandus								
Fissurina sp.								0.4
Floresina sp.								
Glomospira irregularis				0.5				
Hanzawaia concentrica								
Haplophragmoides wilberti		1.0			1.3	5.2		
Helenina anderseni		1.0		1.4				
Lamarckina atlantica								
Loxostomum mayori				0.5				
Melonis pompiloides								0.4
Miliammina fusca					0.3	1.9		0.4
Miliolids juv.								42.1
Miliolids reworked								
Miliolinella circularis				25.0				
Miliolinella fichteliana								
Miliolinella labiosa		1.0						24.8
Monalysidium politum								
Neoconorbina terquemi								
Nonion depressulum	1.0	3.0						0.4
Nonion gradeloupi								
Nonion sp.								
Other Miliolids		1.0		3.8				
Other Rotaliids		4.0		1.4				0.4

STATION NUMBER	5		6		7		8	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Parrina bradyi							0.4	0.4
Peneroplis bradyi				1.0				
Peneroplis carinatus/proteus		1.0						
Peneroplis pertusus								
Peneroplis sp.								
Planispiroides bucculentus								
Planktonic foraminifera				0.5				
Polysaccamina ipohalina		2.0		1.9	2.3	15.2		
Pseudothurammina limnetis			0.5	0.5		0.6		
Quinqueloculina bicarinata								
Quinqueloculina bicostata								
Quinqueloculina bosciana								
Quinqueloculina bradyana								
Quinqueloculina goesi								
Quinqueloculina laevigata				0.5				
Quinqueloculina lamarckiana				0.5			0.4	0.4
Quinqueloculina polygona		1.0		1.4				0.4
Quinqueloculina semilunum		4.0		14.9				12.8
Quinqueloculina spp.								
Quinqueloculina stelligera								
Quinqueloculina subpoeyana				1.4				0.4
Reophax nana								
Reussella atlantica								
Rosalina concinna				1.0				0.8
Rosalina globularis		2.0		0.5				
Rosalina subaraucana								
Rotaliids reworked								
Siphonina pulchra								
Spirillina cariacoensis	1.0	1.0						

STATION NUMBER	5		6		7		8	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Spirillina denticulata								
Spirillina sp.								
Spirillina vivipara								
Spiroloculina arenata								0.4
Spiroloculina communis		2.0						
Spiroloculina hyalina	2.0	2.0		1.0				
Spiroloculina sp.								
Spirophtalmidium sp.								0.8
Textularia earlandi								
Tiphotrochammina comprimata								
Trifarina occidentalis		3.0		0.5				
Triloculina bassensis								
Triloculina bermudezi								0.8
Triloculina oblonga	2.0	11.1		2.9				1.7
Triloculina rotunda								
Triloculina sp.								
Triloculina trigonula				3.4				0.8
Trochammina inflata	3.0	14.1	0.5	10.1	15.5	76.7		1.7
Trochammina macrescens								
Trochammina ochracea								
Trochammina sp.								
Trochamminita salsa						0.3		
Valvulina oviedoina								
Weisnerella auriculata				1.9				0.4
Arcella polypora								
Centropyxis aculeata								

STATION NUMBER	9		10		12		13	
LIVE/TOTAL	L	T	L	T	L	T	L	T
NO. OF SPECIES	0	34	4	30	0	4	1	4
NO. OF INDIVIDUALS/10cc	0	1577	1296	12492	0	13	1	6
SEDIMENT TYPE	muddy sand, ostracods		muddy m. sand		mud, ostracods		sandy mud, pellets	
DEPTH (M)	0.7		exposed, in grass		1		0.9	
Ammonia beccarii tepida		18.3				30.8	16.7	50.0
Angulogerina carinata		0.5						
Archaias angulatus								
Archaias angulatus reworked								
Articulina pacifica								
Articulina sp.				0.3				
Asterigerina carinata				0.6				
Astrononion stelligerum								
Bolivina lanceolata				0.3				
Bolivina lowmani		0.5						
Bolivina paula				0.3				
Bolivina pulchella								
Bolivina sp.								
Bolivina subexcavata								
Bolivina tortuosa		3.7		4.3				
Buliminella elegantissima				0.3				
Buliminella sp.								
Cancris sagra								
Cassidulina neocarinata								
Cassidulina subglobosa								
Cibicides lobatulus								
Cibicides refulgens		1.8		2.0				
Cyclogyra planorbis		0.5						
Cymbaloporetta squamosa		0.9		0.6				
Discorbis sp.				0.3				

STATION NUMBER	9		10		12		13	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Discorbis mira								
Discorinopsis aguayoi		16.0	1.7	17.9		7.7		
Elphidium advenum								
Elphidium excavatum								
Elphidium poeyanum								
Elphidium sp.				0.3				
Eponides repandus								
Fissurina sp.								
Floresina sp.								
Glomospira irregularis								
Hanzawaia concentrica								
Haplophragmoides wilberti				1.2				
Helenina anderseni				0.3				
Lamarckina atlantica								
Loxostomum mayori				0.9				
Melonis pompiloides								
Miliammina fusca			1.4	7.8				16.7
Miliolids juv.								
Miliolids reworked				0.3				
Miliolinella circularis		7.3						
Miliolinella fichteliana								
Miliolinella labiosa								
Monalysidium politum		0.5						
Neoconorbina terquemi								
Nonion depressulum								
Nonion gradeloupi		0.5						
Nonion sp.								
Other Miliolids		0.9						
Other Rotaliids				2.0				

STATION NUMBER	9		10		12		13	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Parrina bradyi								
Peneroplis bradyi								
Peneroplis carinatus/proteus		0.5		0.6				
Peneroplis pertusus								
Peneroplis sp.								
Planispiroides bucculentus								
Planktonic foraminifera		0.5		0.3				
Polysaccamina ipohalina		0.5		0.3				
Pseudothurammina limnetis				0.3				
Quinqueloculina bicarinata		0.5						
Quinqueloculina bicostata								
Quinqueloculina bosciana								
Quinqueloculina bradyana								
Quinqueloculina goesi								
Quinqueloculina laevigata		0.5						
Quinqueloculina lamarckiana				0.3				
Quinqueloculina polygona		0.5						
Quinqueloculina semilunum		14.6						
Quinqueloculina spp.		0.5		0.3				
Quinqueloculina stelligera								
Quinqueloculina subpoeyana		0.9		0.9				
Reophax nana								
Reussella atlantica								
Rosalina concinna		0.9		0.3				
Rosalina globularis		0.9		0.6				
Rosalina subarauncana								
Rotaliids reworked				1.4				
Siphonina pulchra		0.5						
Spirillina cariacoensis								

STATION NUMBER	9		10		12		13	
LIVE/TOTAL	L	T	L	T	L	T	L	T
Spirillina denticulata		0.5						
Spirillina sp.								
Spirillina vivipara								
Spiroloculina arenata		0.5		0.6				
Spiroloculina communis								
Spiroloculina hyalina		2.7						
Spiroloculina sp.								
Spirophtalmidium sp.								
Textularia earlandi								
Tiphotrochammina comprimata								
Trifarina occidentalis		0.5						
Triloculina bassensis								
Triloculina bermudezi								
Triloculina oblonga		7.3	2.3	29.4		7.7		16.7
Triloculina rotunda		0.5						
Triloculina sp.								
Triloculina trigonula		9.6						
Trochammina inflata		2.7	4.9	25.4		53.8		16.7
Trochammina macrescens								
Trochammina ochracea		0.5						
Trochammina sp.								
Trochamminita salsa								
Valvulina oviedoina								
Weisnerella auriculata		3.2						
Arcella polypora								
Centropyxis aculeata								

STATION NUMBER	14		15	
LIVE/TOTAL	L	T	L	T
NO. OF SPECIES	0	3	1	43
NO. OF INDIVIDUALS/10cc	0	5	6	1698
SEDIMENT TYPE	peat		muddy m.s.	
DEPTH (M)	0.9		0.5	
Ammonia beccarii tepida				3.9
Angulogerina carinata				
Archaias angulatus				0.4
Archaias angulatus reworked				0.4
Articulina pacifica				
Articulina sp.				0.4
Asterigerina carinata				1.1
Astrononion stelligerum				
Bolivina lanceolata				2.5
Bolivina lowmani				
Bolivina paula				
Bolivina pulchella				
Bolivina sp.				
Bolivina subexcavata				
Bolivina tortuosa				12.4
Buliminella elegantissima				
Buliminella sp.				
Cancris sagra				
Cassidulina neocarinata				
Cassidulina subglobosa				
Cibicides lobatulus				
Cibicides refulgens				11.0
Cyclogyra planorbis				0.4
Cymbaloporetta squamosa				0.7
Discorbis sp.				0.4

STATION NUMBER	14		15	
LIVE/TOTAL	L	T	L	T
Discorbis mira				
Discorinopsis aguayoi				25.8
Elphidium advenum				
Elphidium excavatum				
Elphidium poeyanum				
Elphidium sp.				
Eponides repandus				0.4
Fissurina sp.				
Floresina sp.				
Glomospira irregularis				
Hanzawaia concentrica				
Haplophragmoides wilberti				
Helenina anderseni				
Lamarckina atlantica				0.4
Loxostomum mayori				0.7
Melonis pompiloides				
Miliammina fusca				
Miliolids juv.				
Miliolids reworked				
Miliolinella circularis				2.5
Miliolinella fichteliana				0.4
Miliolinella labiosa				
Monalysidium politum				
Neoconorbina terquemi				
Nonion depressulum				0.4
Nonion gradeloupi				0.7
Nonion sp.				
Other Miliolids				
Other Rotaliids				1.4

STATION NUMBER	14		15	
LIVE/TOTAL	L	T	L	T
Parrina bradyi				
Peneroplis bradyi				
Peneroplis carinatus/proteus				0.7
Peneroplis pertusus				
Peneroplis sp.				
Planispiroides bucculentus				
Planktonic foraminifera				1.1
Polysaccamina ipohalina		20.0		0.4
Pseudothurammina limnetis				
Quinqueloculina bicarinata				1.1
Quinqueloculina bicostata				
Quinqueloculina bosciana				
Quinqueloculina bradyana				
Quinqueloculina goesi				0.4
Quinqueloculina laevigata				1.4
Quinqueloculina lamarckiana				0.7
Quinqueloculina polygona				
Quinqueloculina semilunum		20.0		9.5
Quinqueloculina spp.				
Quinqueloculina stelligera				
Quinqueloculina subpoeyana				
Reophax nana				
Reussella atlantica				0.4
Rosalina concinna				0.4
Rosalina globularis				0.4
Rosalina subarauncana				
Rotaliids reworked				
Siphonina pulchra				1.1
Spirillina cariacoensis				

STATION NUMBER	14		15	
LIVE/TOTAL	L	T	L	T
Spirillina denticulata				
Spirillina sp.				
Spirillina vivipara				
Spiroloculina arenata				1.4
Spiroloculina communis				1.1
Spiroloculina hyalina				0.7
Spiroloculina sp.				
Spirophtalmidium sp.				0.4
Textularia earlandi				
Tiphotrochammina comprimata				
Trifarina occidentalis				2.8
Triloculina bassensis				0.4
Triloculina bermudezi				
Triloculina oblonga				2.1
Triloculina rotunda				0.4
Triloculina sp.				
Triloculina trigonula				4.2
Trochammina inflata		60.0	0.4	3.2
Trochammina macrescens				
Trochammina ochracea				
Trochammina sp.				
Trochamminita salsa				
Valvulina oviedoina				
Weisnerella auriculata				0.4
Arcella polypora				
Centropyxis aculeata				

Table 19: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Grotto Pond.

STATION NUMBER	1		2		3	
LIVE/TOTAL	L	T	L	T	L	T
Miliolinella circularis				0.1		0.8
Miliolinella fichteliana				0.3		
Miliolinella labiosa	0.3	0.3		0.6	0.2	0.8
Monalysidium politum				0.5		
Neoconorbina terquemi						0.2
Nodophtalmidium antillarum						0.2
Nonion depressulum		0.6		2.3		0.7
Nonion gradeloupi		0.3		0.8	0.2	0.8
Osangularia culter				0.1		0.2
Other Miliolids		0.2		1.9		3.8
Other Rotaliids	0.2	0.5	0.3	6.3	0.3	3.4
Other Textulariids				0.0		0.2
Palmerinella palmerae						0.2
Parrina bradyi	4.3	5.0		0.1		0.2
Patellina corrugata		0.2		0.4		
Peneroplis carinata				0.3		1.0
Planispiroides bucculentus	0.3	0.8				
Planulina exorna				0.3		
Polysaccamina ipohalina	5.2	6.2				
Pseudothurammina limnetis	0.2	0.6		0.1		0.7
Quinqueloculina agglutinans				0.1		0.2
Quinqueloculina bicarinata		0.2		0.8		0.2
Quinqueloculina bosciana				0.4		
Quinqueloculina bradyana				0.6		
Quinqueloculina goesi			0.1	0.1		
Quinqueloculina laevigata		0.2		10.6	0.8	10.3
Quinqueloculina lamarckiana		0.5	0.4	1.3		1.3
Quinqueloculina poeyana				0.3		
Quinqueloculina polygona			0.1	1.9		0.3
Quinqueloculina semilunum	0.2	5.3	0.0	17.0	1.8	28.5
Quinqueloculina spp.				0.5		0.3
Quinqueloculina stelligera				0.1		
Quinqueloculina subpoeyana			0.1	3.1	0.2	3.4
Reophax arayensis				0.3		
Reophax scorpiurus				0.1		
Reophax spiculifera				0.1		
Rosalina concinna		0.5		0.1		0.3
Rosalina floridensis				0.4		0.2
Rosalina globularis	1.5	5.2	0.4	3.0	0.5	1.6
Rosalina subarauncana		0.2		3.0		1.5
Siphogenerina raphana		0.2		0.5	0.2	0.5
Siphonina pulchra			0.1	0.3	0.2	0.2
Spirillina cariacoensis				0.9		0.7

STATION NUMBER	1		2		3	
LIVE/TOTAL	L	T	L	T	L	T
Spirillina denticulata		0.3				
Spiroloculina antillarum				0.1		0.2
Spiroloculina arenata		0.5		1.4	0.2	1.1
Spiroloculina communis				0.1		
Spiroloculina gradeloupi				1.0		
Spiroloculina hyalina	0.6	0.8		0.3	0.2	0.7
Spirophtalmidium sp.		0.2		1.3		
Textularia earlandi				1.5		0.2
Textularia sp.				0.1		
Tiphotrocha comprimata		0.2		0.5		0.3
Trifarina occidentalis				0.1		0.8
Triloculina bassensis				0.1	0.2	0.5
Triloculina bermudezi	0.5	2.3		2.5	0.0	2.5
Triloculina linneiana		0.2				
Triloculina oblonga	2.3	11.0		0.8	0.3	2.0
Triloculina trigonula		0.2		0.3		
Trochammina inflata	6.5	17.5		1.3		0.5
Trochammina macrescens		0.2				
Valvulina oviedoina			0.1	0.1		
Weisnerella auriculata				0.3		0.3

STATION NUMBER	1		2		3	
LIVE/TOTAL	L	T	L	T	L	T
NO. OF SPECIES	17	43	14	90	26	72
NO. OF INDIVIDUALS/10cc	7488	23652	1800	57312	1980	21996
DEPTH (m)	exposed		0.25		0.5	
SEDIMENT TYPE	peaty s.		silty s.		f.s.	
Ammobaculites sp.		0.2	0.8	1.0	0.7	1.1
Ammonia beccarii tepida				0.1	0.5	1.5
Articulina mucronata						0.2
Articulina pacifica	0.2	0.6		0.6		0.8
Astrononion stelligerum				0.3	0.2	0.7
Bigenerina irregularis				0.5		0.2
Bolivina lanceolata		1.1	0.1	4.3	0.5	3.8
Bolivina lowmani		0.3		1.0		0.3
Bolivina paula		0.2		0.8		0.3
Bolivina pulchella		0.2				
Bolivina subexcavata				0.4		0.2
Bolivina tortuosa		1.1	0.1	4.4	0.2	6.1
Buliminella elegantissima				0.9	0.2	0.7
Cancris sagra				0.4		0.2
Cassidulina subglobosa				1.3	0.3	1.5
Cibicides cicatrosus				0.3		0.2
Cibicides refulgens		0.3				1.1
Cyclogyra planorbis	1.2	5.6	0.1	2.9		2.3
Cymbaloporetta squamosa				0.1		0.2
Discorbis sp.				0.5		0.5
Discorbis mira			0.1	0.6		
Discorinopsis aguayoi	8.2	28.8		0.9	0.2	1.0
Elphidium advenum				0.6	0.3	0.7
Elphidium discoidale						0.2
Elphidium poeyanum				0.9	0.5	1.8
Eponides repandus				0.1		0.2
Eponides turgidus				0.1		1.0
Fissurina sp.		0.2		1.1		0.3
Floresina sp.				0.5		0.2
Fursenkoina complanata				0.1		0.2
Glomospira charoides				0.6		
Glomospira irregularis			0.3	1.5	0.2	0.5
Haplophragmoides wilberti				0.3		
Hauerina speciosa				0.3		
Helenina anderseni	0.2	1.8		0.6		0.5
Lagena spp.				0.1		
Loxostomum mayori				0.3	0.2	0.2
Melonis pompiloides				0.5		
Miliammina fusca		0.2			0.2	0.5

Table 20: Percent abundance of living (stained, L) and total (T) foraminifera, and sediment type from Walsingham Pond.

STATION NUMBER	93-2		93-3		93-4	
LIVE/TOTAL	L	T	L	T	L	T
NO. OF SPECIES	8	15	7	12	8	14
NO. OF INDIVIDUALS/10cc	472	3258	120	696	258	1092
SEDIMENT TYPE	peat		peat		peat	
DEPTH (m)	exposed, in roots		in channel, 0.1m		exposed, in roots	
Ammodiscus tenuis		1.1				0.5
Ammonia beccarii tepida						
Bolivina lanceolata						
Bolivina spp.	0.4	2.2				
Cibicides refulgens		0.4				
Cyclogyra planorbis					0.5	0.5
Discorinopsis aguayoi		0.4		0.9		
Glomospira irregularis	6.6	36.8	7.8	36.2	7.1	51.1
Haplophragmoides wilberti						
Helenina anderseni	2.6	2.9	2.6	6.0	0.5	1.1
Involutina sp.						
Miliammina fusca		0.7	1.7	1.7	0.5	1.1
Miliolids linings						
Other Miliolids		0.4				
Polysaccamina ipohalina						2.2
Pseudothurammina limnetis				3.4		1.6
Siphotrochammina inflata						
Textularia earlandi	0.4	0.7	0.9	0.9	2.2	2.7
Tolypammina vagans	0.4	2.7	0.9	2.6	3.8	6.6
Triloculina linings					0.5	0.5
Triloculina oblonga		0.4				
Trochammina inflata	1.5	13.7	3.4	44.0	9.3	30.2
Trochammina macrescens	2.2	30.9				0.5
Trochammina ochracea	0.4	7.7		2.3		1.1
Trochammina spp.		1.5				
Trochamminita salsa						
Valvulina oviedoina				1.7		

STATION NUMBER	93-5		95-1		95-2	
LIVE/TOTAL	L	T	L	T	L	T
NO. OF SPECIES	7	9	4	10	3	6
NO. OF INDIVIDUALS/10cc	371	9809	126	2529	60	2520
SEDIMENT TYPE	peat		peat		peat	
DEPTH (m)	exposed, grass/		edge, terrestrial		exposed, mangrove	
	mangrove edge		grass/mangrove			
Ammodiscus tenuis						
Ammonia beccarii tepida			0.4	1.4		
Bolivina lanceolata				0.7		
Bolivina sp.						
Cibicides refulgens						
Cornuspira planorbis						
Discorinopsis aguayoi						
Glomospira irregularis				0.4		0.5
Haplophragmoides wilberti			1.1	5.3	0.5	7.1
Helenina anderseni		0.7		3.9		
Involutina sp.						
Miliammina fusca			1.4	10.7	0.5	2.4
Miliolids linings	0.4	1.9		0.7		
Other Miliolids						
Polysaccamina ipohalina				14.6		19.0
Pseudothurammina limnetis						0.5
Siphotrochammina inflata	1.0	20.7				
Textularia earlandii		1.0				
Tolypammina vagans		21.5				
Triloculina linings						
Triloculina oblonga	0.8	1.9		0.7		
Trochammina inflata		1.1	2.1	61.6	1.4	70.5
Trochammina macrescens	1.5	51.1				
Trochammina ochracea						
Trochammina spp.		0.1				
Trochamminita salsa						
Valvulina oviedoina						

STATION NUMBER	95-3		95-4	
LIVE/TOTAL	L	T	L	T
NO. OF SPECIES	3	10	3	8
NO. OF INDIVIDUALS/10cc	102	1896	189	2250
SEDIMENT TYPE	peat		peat	
DEPTH (m)	0.02 m, mangrove		0.12 m, mangrove	
Ammodiscus tenuis				
Ammonia beccarii tepida				
Bolivina lanceolata				
Bolivina sp.				
Cibicides refulgens				
Cornuspira planorbis				
Discorinopsis aguayoi				
Glomospira irregularis		3.8	1.6	29.6
Haplophragmoides wilberti		1.6		
Helenina anderseni			3.2	4.0
Involutina sp.				1.2
Miliammina fusca		0.6		0.4
Miliolids linings		2.2		
Other Miliolids				
Polysaccamina ipohalina		18.4		4.0
Pseudothurammina limnetis		0.9		0.8
Siphotrochammina inflata				
Textularia earlandii				
Tolypammina vagans		0.3		
Triloculina linings				
Triloculina oblonga	0.9	1.9		1.2
Trochammina inflata	4.1	67.1	3.6	58.8
Trochammina macrescens				
Trochammina ochracea				
Trochammina spp.				
Trochamminita salsa	0.3	3.2		
Valvulina oviedoina				

Table 21: Percent abundance and/or presence (P) of foraminifera and thecamoebians from vibracore 1 (Mill Creek).

DEPTH INTERVAL (cm)	0-2	35-37	59-61	100-102	122-124	157-159	171-173	221-223	240-242	252-254	257-259	261-263
NO. OF SPECIES	3	1	2									
NO. OF INDIVIDUALS/10cc	3	89	19									
Reworked calcareous forams	66.6											
Tiphotrocha comprimata			5.3									
Trochammina inflata	33.3	100	94.7									
Arcella polypora						P	P		P			
Centropyxis aculeata				P		P				P	P	P
Centropyxis constricta						P	P					
Thecamoebians undet.					P			P				

Table 22: Percent abundance and/or presence (P) of foraminifera and thecamoebians from vibracore 2 (Mill Creek).

DEPTH INTERVAL (cm)	2-4	14-16	37-39	41-4	66-68	98-10	124-12	185-18	240-242	243-245	260-262	274-27	285-287	300-30	304-30
NO. OF SPECIES	4	5	2	2											
NO. OF INDIVIDUALS/10cc	52	1587	8	348											
Glomospira irregularis				27.3											
Haplophragmoides wilberti		1.5													
Helenina anderseni	5.8														
Miliolids lining			12.5												
Polysaccammina ipohalina		10.6													
Pseudothurammina limnetis	3.8														
Reworked calcareous forams															
Textularia earlandi		1.1													
Tiphotrocha comprimata															
Trochammina inflata	80.8	84.9	87.5	72.4											
Trochamminita salsa		1.9													
Arcella polypora													P	P	P
Centropyxis aculeata	9.6				P	P	P			P	P	P	P	P	
Centropyxis constricta										P				P	

Table 23: Percent abundance and/or presence (P) of foraminifera and thecamoebians from vibracore 3 (Mill Creek).

DEPTH INTERVAL (cm)	8-10	22-24	39-41	45-47	67-69	71-73	111-113	195-197	213-215	234-236	254-256	265-267
NO. OF SPECIES	7	6	4	2	3							
NO. OF INDIVIDUALS/10cc	498	337	11	31	157							
Glomospira irregularis	1.8	0.6		3.2								
Haplophragmoides wilberti	1.2	48.7			1.3							
Helenina anderseni lining			9.1									
Miliammina fusca	0.6	12.5										
Planktonic forams									P	P	P	
Polysaccammina ipohalina	4.8	3.9	18.2		2.5							
Pseudothurammina limnetis	1.8	0.3										
Trochammina inflata	89.2	34.1	54.5	96.8	96.2							
Trochamminita salsa	0.6		18.2									
Arcella polypora									P	P		
Centropyxis aculeata									P	P		
Centropyxis constricta						P	P	P	P	P		P
Thecamoebians											P	

Table 24: Percent abundance and/or presence (P) of foraminifera and thecamoebians from vibracore 4 (Mill Creek).

DEPTH INTERVAL (cm)	0-2	4-6	20-22	34-36	41-43	67-69
NO. OF SPECIES						
NO. OF INDIVIDUALS/10cc						
Reworked calcareous forams	P	P				
Arcella polypora	P		P	P	P	P
Centropyxis aculeata	P					
Centropyxis constricta	P	P	P	P	P	

Table 25: Percent abundance and/or presence (P) of foraminifera and thecamoebians from vibracore 5 (Mill Share).

DEPTH INTERVAL (cm)	0-2	10-12	23-25	60-62	67-69	124-126	143-145	157-159	171-173	182-184
NO. OF SPECIES	9	7	6	8	8	2	6	6	12	8
NO. OF INDIVIDUALS/10cc	9660	3034	35	661	4110	230	223	252	683	67
SEDIMENT TYPE	peat	peat	peat	peat	peat	peat	peat	peat	peat	c.s.
Calcareous forams linings			5.7		0.1					
Calcareous forams reworked										3.0
Glomospira charoides								0.4		
Glomospira irregularis	0.6	0.0	17.1	36.3	26.6		0.9	11.1	48.5	4.5
Haplophragmoides wilberti	0.6	0.8	2.9				22.9		0.7	
Miliammina fusca	5.3	56.6		0.3	0.3	3.5	10.3	3.6	2.2	13.4
Miliolids linings	0.5			0.3						
Polysaccammina ipohalina	0.7	0.8	5.7	1.5	1.2		1.3	1.6	1.9	1.5
Textularia earlandi	0.5	0.4		7.3	0.9				3.7	
Tiphotrocha comprimata									0.3	
Tolypammina vagans				0.6	5.8				1.9	
Triloculina oblonga	0.3									
Trochammina inflata	90.9	41.0	65.7	52.2	62.5	96.5	62.3	66.7	11.9	37.3
Trochammina macrescens									17.6	26.9
Trochammina sp.									2.9	9.0
Trochammina ochracea									0.6	1.5
Trochamminita salsa	0.5	0.4		1.5	2.6		1.3		1.9	10.4
Arcella polypora							0.9			
Centropyxis aculeata			2.9							

Table 26: Percent abundance and/or presence (P) of foraminifera and thecamoebians from vibracore 6 (Mill Share).

DEPTH INTERVAL (cm)	0-2	112-114	132-134	136-138	155-157	159-160	167-169	172-174	184-186	204-206
NO. OF SPECIES	10	2	3	2	6	4	3	3	3	5
NO. OF INDIVIDUALS/10cc	5670	18	44	18	136	58	18	14	22	382
SEDIMENT TYPE										
Discorinopsis aguayoi lining	0.1									
Glomospira charoides										
Glomospira irregularis	6.2		2.3		0.7					
Haplophragmoides wilberti	5.4	5.6	25.0	16.7	11.8	24.1	66.7	14.3	27.3	83.8
Miliammina fusca	6.1					3.4				3.7
Miliolids reworked					0.7					
Planktonic forams										
Polysaccammina ipohalina	8.6				0.7		16.7	14.3	13.6	
Pseudothurammina limnetis	1.1									0.5
Textularia earlandi	2.8									
Tolypammina vagans	1.4									
Trochammina inflata	62.6	94.4	72.7	83.3	85.3	69.0	16.7	71.4	59.1	11.5
Trochamminita salsa	5.7				0.7	3.4				
Centropyxis aculeata										0.5

DEPTH INTERVAL (cm)	222-224	236-238	240-242	246-248	258-260	270-272
NO. OF SPECIES	4	0	0	0	0	0
NO. OF INDIVIDUALS/10cc	3001					
SEDIMENT TYPE						
Discorinopsis aguayoi lining						
Glomospira charoides						
Glomospira irregularis						
Haplophragmoides wilberti	97.0					
Miliammina fusca						
Miliolids reworked						
Planktonic forams	0.4					
Polysaccammina ipohalina	2.4					
Pseudothurammina limnetis						
Textularia earlandi						
Tolypammina vagans						
Trochammina inflata						
Trochamminita salsa	0.2					
Centropyxis aculeata						

Table 27: Percent abundance of foraminifera and sediment type from Hungry Bay Davis cores.

DAVIS CORE NUMBER	7	19	10	14	11	4	2
NO. OF SPECIES	8	10	8	6	9	1	14
NO. OF INDIVIDUALS/10cc	4193	79	262	10	452	3	42
SEDIMENT TYPE	peat	peat	peat	red soil+peat	red soil+peat	red soil	peat
DEPTH (m)	1.1	1.3	1.4	1.5	1.63	1.75	2.05
Ammonia beccarii tepida							3.6
Bolivina lanceolata							
Cassidulina subglobosa							1.8
Discorinopsis aguayoi		0.3					
Elphidium sp.							1.8
Fissurina sp.							
Glomospira irregularis		1.0	1.2				
Haplophragmoides wilberti	30.4	1.9	7.5		13.0		
Helenina anderseni							1.8
Miliammina fusca	0.9		1.2	10.0	0.7		
Planktonic foraminifera							44.6
Polysaccammina ipohalina	0.4	1.0	4.9	10.0	3.7		1.8
Rosalina globularis							1.8
Rotaliids linings	0.4	1.0		10.0	3.0		
Rotaliids reworked							
Spiroloculina arenata							1.8
Textularia earlandii					0.3		
Tiphotrocha comprimata	0.3	2.9	2.3	10.0			3.6
Triloculina oblonga							3.6
Trochammina inflata	65.6	87.3	63.0	50.0	62.8	100.0	16.1
Trochammina macrescens	11.9	2.9	17.2	10.0	12.6		10.7
Trochammina spp.							5.4
Trochamminita salsa		1.0	2.9		3.7		1.8

Table 28: Percent abundance of foraminifera and sediment type from Mill Share Davis cores.

DAVIS CORE NUMBER	4	5	6	3	2	1
NO. OF SPECIES	5	7	5	0	1	0
NO. OF INDIVIDUALS/10cc	118	2196	1203	0	3	0
SEDIMENT TYPE	peat	peat	peat	red soil+peat	red soil	red soil
DEPTH (m)	2	2.7	2.9	3	3.76	4
Ammonia beccarii tepida						
Bolivina lanceolata						
Fissurina sp.						
Haplophragmoides wilberti	21.2	93.2	93.5			
Helenina anderseni						
Planktonic foraminifera		0.6		>45<63 mic.		
Polysaccammina ipohalina		0.8	2.5			
Rosalina globularis						
Rotaliids linings	3.4	0.6				
Rotaliids reworked						>45<63 mic.
Textularia earlandi						
Tiphotrocha comprimata						
Triloculina oblonga						
Trochammina inflata	62.7	1.1	0.3		100	
Trochammina macrescens	11.9	2.2	0.5			
Trochamminita salsa	0.9	1.6	3.5			

Table 29: Percent abundance of foraminifera and/or presence of thecamoebians, and sediment type from Mill Creek Davis cores.

DAVIS CORE NUMBER	13	15	21	1	4	7
NO. OF SPECIES	1	1	0	8	10	2
NO. OF INDIVIDUALS/10cc	4		0	25	76	36
SEDIMENT TYPE	peat	peat	peat	peat	peat	peat
DEPTH (m)	3.9	4	4.2	4.35	4.45	4.73
Ammonia beccarii tepida				36.0		
Bolivina lanceolata				4.0		
Fissurina sp.				4.0		
Helenina anderseni				4.0	1.1	
Planktonic foraminifera					1.1	
Rosalina globularis				8.0	1.1	
Rotaliids linings					3.3	
Rotaliids reworked					5.5	
Textularia earlandi				4.0		
Tiphotrocha comprimata					3.3	
Triloculina oblonga				20.0		
Trochammina inflata	100.0			20.0	56.6	
Trochammina macrescens					11.7	
Arcella polypora		>45<63mic.			3.3	23.3
Centropyxis aculeata					13.5	77.7

Table 30. Total number of species and number of species with frequencies higher than 1% in at least one sample, for the suborders Spirillinina, Rotaliina, Miliolina, Textulariina, , in each study site.

Sites	Spirillinina		Rotaliina	
	total nbr. species	nbr. species>1%	total nbr. species	nbr. species>1%
Walsingham cave	11	1	98	31
Leamington cave	10	6	59	21
Crystal cave	9	6	37	14
Devonshire Dock	1	0	26	10
North lagoon	6	2	64	21
Along Ireland isl.	1	1	32	13
Harrington Sound	6	2	52	30
Hog Breaker reef	5	1	30	10
Twin Reef	3	1	32	7
Crescent Reef	5	1	38	15
Hungry Bay swamp	2	1	18	8
Hungry Bay bay side	5	2	86	29
Mill Share marsh/swamp	1	1	9	6
Mangrove Bay	5	1	53	8
Coot Pond	3	2	39	6
Walsingham Bay	2	0	20	8
Walsingham Pond	1	0	6	2
Spittal Pond	5	2	46	13
Grotto pond	4	1	46	10
Sites	Miliolina		Textulariina	
	total nbr. species	nbr. species>1%	total nbr. species	nbr. species>1%
Walsingham cave	44	14	20	3
Leamington cave	33	8	16	4
Crystal cave	23	11	1	0
Devonshire Dock	34	21	8	3
North lagoon	51	17	8	2
Along Ireland isl.	32	9	5	1
Harrington Sound	61	25	15	9
Hog Breaker reef	25	7	3	1
Twin Reef	29	8	6	2
Crescent Reef	53	20	11	3
Hungry Bay swamp	12	4	18	12
Hungry Bay bay side	54	11	17	5
Mill Share marsh/swamp	5	2	13	10
Mangrove Bay	47	10	20	4
Coot Pond	39	10	12	2
Walsingham Bay	6	3	11	7
Walsingham Pond	2	1	15	13
Spittal Pond	36	12	13	4
Grotto pond	34	10	14	5

Table 31. Percentages of total number of species and number of species with frequencies higher than 1% in at least one sample, for the suborders Rotaliina, Miliolina, Textulariina, in each study site.

Sites	Rotaliina	Miliolina	Textulariina
	% nbr. sp.>1%	% nbr. sp.>1%	% nbr. sp.>1%
Walsingham cave	64.6	29.2	6.3
Leamington cave	63.6	24.2	12.1
Crystal cave	56.0	44.0	0.0
Devonshire Dock	29.4	61.8	8.8
North lagoon	52.5	42.5	5.0
Along Ireland isl.	56.5	39.1	4.3
Harrington Sound	46.9	39.1	14.1
Hog Breaker reef	55.6	38.9	5.6
Twin Reef	41.2	47.1	11.8
Crescent Reef	39.5	52.6	7.9
Hungry Bay swamp	33.3	16.7	50.0
Hungry Bay bay side	64.4	24.4	11.1
Mill Share marsh/swamp	33.3	11.1	55.6
Mangrove Bay	36.4	45.5	18.2
Coot Pond	33.3	55.6	11.1
Walsingham Bay	44.4	16.7	38.9
Walsingham Pond	12.5	6.3	81.3
Spittal Pond	44.8	41.4	13.8
Grotto pond	40.0	40.0	20.0
Sites	Rotaliina	Miliolina	Textulariina
	% total nbr. sp.	% total nbr. sp.	% total nbr. sp.
Walsingham cave	60.5	27.2	12.4
Leamington cave	54.6	30.6	14.8
Crystal cave	60.7	37.7	1.6
Devonshire Dock	38.2	50.0	11.8
North lagoon	52.0	41.5	6.5
Along Ireland isl.	46.4	46.4	7.2
Harrington Sound	40.6	47.7	11.7
Hog Breaker reef	51.7	43.1	5.2
Twin Reef	44.8	43.3	9.0
Crescent Reef	37.3	52.0	10.8
Hungry Bay swamp	37.5	25.0	37.5
Hungry Bay bay side	54.8	34.4	10.8
Mill Share marsh/swamp	33.3	18.5	48.1
Mangrove Bay	44.2	39.2	16.7
Coot Pond	43.3	43.3	13.3
Walsingham Bay	54.1	16.2	29.7
Walsingham Pond	26.1	8.7	65.2
Spittal Pond	48.4	37.9	13.7
Grotto pond	48.9	36.2	14.9

Table 32: Percent abundance of foraminifera and thecamoebians from peat samples selected for radiocarbon dating.

VIBRACORE (C)/DAVIS CORE (DC) NUMBER	ill Creek DC	Mill Share C6	ill Share DC	ungry Bay DC	Mill Share C5	Mill Creek C2
DEPTH INTERVAL IN CORE (+COMPACTION)		220-224 (+49)			169-173 (+61)	41-45 (+94)
DEPTH BELOW HHW (cm)	445	271	290	165	232	137
NO. OF SPECIES	10	3	5	9	12	2
NO. OF INDIVIDUALS/10cc	76	2989	1203	452	683	347
Glomospira irregularis					48.5	27.3
Haplophragmoides wilberti		97.4	93.5	13	0.7	
Helenina anderseni	1.1					
Linings	3.3			3.3		
Miliammina fusca				0.7	2.2	
Planktonic Foram.	1.1					
Polysaccamina ipohalina		2.4	2.5	3.7	1.9	
Reworked calcareous foram.	5.5					
Quinqueloculina laevigata						
Rosalina globularis	1.1					
Reworked calcareous foram.						
Textularia earlandi				0.3	3.7	
Tiphotrochammina comprimata	3.3				0.9	
Tolypammina vagans					1.9	
Trochammina inflata	56.6		0.3	62.8	12	72.7
Trochammina macrescens	11.7		0.5	12.6	17.6	
Trochammina spp.					2.9	
Trochamminita salsa		0.2	3.5	3.7	1.9	
Arcella polypora	3.3					
Centropyxis constricta	13.5					

REFERENCES

Acosta, J. T., 1940. *Triloculina bermudezi,* un nuevo foraminifero de las Islas Bahamas. Memorias de la Sociedad Cubana de Historia Natural, 14, p. 37.

Almogobin-Labin, A., Siman-Tov, R., Rodenfeld, A., and Debard, E., 1995. Occurrence and distribution of the foraminifer *Ammonia beccarii tepida* (Cushman) in water bodies, recent and Quaternary, of the Dead Sea Rift, Israel. Marine Micropaleontology, 26, 153-159.

Altenbach, A. V., Heeger, T., Linke, P., Spindler, M., and Thies, A., 1993. *Miliolinella subrotunda* (Montagu), a miliolid foraminifer building large detritic tubes for a temporary epibenthic lifestyle. Marine Micropaleontology, 20, 293-301.

Andersen, H. V., 1952. *Buccella,* a new genus ofthe rotaliid foraminifera. Journal of the Washington Academy of Science, 42, 143-151.

Andersen, H. V., 1953. Two new species of *Haplophragmoides* from the Louisiana coast. Contributions from the Cushman Foundation for Foraminiferal Research, 4, 21-22.

Andersen, H.V., 1961. Genesis and paleontology of the Mississippi River mudlumps, Part II. Foraminifera of the mudlumps, Lower Mississippi River delta. Louisiana Department of Conservation, Geological Bulletin, 35,1-208.

Arnold, Z. M., 1954. *Discorinopsis aguayoi* (Bermudez) and *Discorinopsis vadescens* Cushman and Bronnimann: a study of variation in cultures of living foraminifera. Contributions from the Cushman Foundation for Foraminiferal Research, 5 (1), 4-13.

Asano, K., 1944. *Hanzawaia,* a new genus of foraminifera from the Pliocene of Japan. Journal of the Geological Society of Japan, 51, 97-98.

Asano, K., 1951a. Illustrated Catalogue of Japanese Tertiary smaller Foraminifera . Part 13. Anomalinidae: Tokyo, Hosokawa Printing Co.,12-19.

Asano, K., 1951b. Illustrated catalogue of Japonese Tertiary smaller Foraminifera. Petrolology Branch of the National Research Section, General Headquarters, Supreme Commission For Allied Powers (Tokyo), pt. 6, p.9.

Bailey, J. W., 1851. Microscopical examination of soundings made by the United States Coast Survey off the Atlantic Coast of the United States. Smithsonian Contributions to Knowledge, 2 (3), 1-15.

Balkwell, F.P., and Wright, J., 1885. Report on some Recent foraminifera found off the coast of Dublin and in the Irish Sea. Transactions of the Royal Irish Academy,28,part 18, p. 350, pl. 13.

Bandy, O. L., 1954. Distribution of some shallow-water foraminifera in the Gulf of Mexico. U. S. Geological Survey Professional Paper 254-F, 123-141.

Bandy, O. L., 1956. Ecology of foraminifera in northeastern Gulf of Mexico. U. S. Geological Survey Professional Paper 254-G, 179-204.

Bandy, O. L., 1964. Foraminiferal biofacies in sediments of Gulf of Batabano, Cuba, and their geologic significance. Bulletin of the American Association for Petrologists and Geologists, 48 (10), 1666-1679.

Barnhart, J. T., 1963. Distribution of recent sediments and foraminifera across the Bermuda Platform. MSc. thesis, Dept. of Geology, Univ. of Houston, 138 p.

Barker, R. W., 1960. Taxonomic notes on the species figured by H. B. Brady in his report on the foraminifera dredged by H. M. S. Challenger during the years 1873-1876. Society of Economical Petrology and Mineralogy, Special Publication 29, 238 p.

Bartenstein, H., and Brand, E., 1938. Die foraminiferan-fauna des Jade-Gebietes. 1. *Jadammina polystoma* n.g., n.sp. aus dem Jade-Gebietes (for). Senckenbergiana 20, 381-385.

Benda, W. R., and Puri, H. S., 1962. The distribution of foraminifera and ostracoda off the Gulf Coast of the Cape Romano Area, Florida. Transactions, Gulf Coast Association of Geological Societies, 12, 303-341.

Bermuda maps:
DDS 311 Series E8110, Bermuda Sheet 3, 1967
Bermuda Admiralty Chart 334, 1984
Bermuda Admiralty Chart 1315, 1988

Bermudez, P.J., 1934. Un genero y especie nueva de foraminíferos viventes de Cuba. Memorias de la Sociedad Cubana de Historia Natural "Felipe Poet", 8, p. 129-224.

Bermudez, P. J., 1935. Foraminiferos de la costa norte de Cuba. Memorias de la Sociedad Cubana de Historia Natural, 9 (3), 129-224.

Bermudez, P.J., 1952. Estudio sistematico de los foraminiferos rotaliformes: Boletin de Geologia, Venezuela,2(4), 1-230.

Bermudez, P. J. and Seiglie, G. A., 1963. Estudio sistematico de los foraminiferos del golfo de Cariaco. Boletin de Institute de Oceanographica de Universitad de Oriente, 2 (2), 3-253.

Berthelin, G., 1881. Coup d'oeil sur la faune rhizopodique du Calcaire grossier inférieur de la Marne. Compte rendu de l'Association FranÇaise pour l'Avancement des Sciences, 9th session (Reims, 1880), 553-559.

Biswas, B., 1976. Bathymetry of Holocene foraminifera and Quaternary sea-level changes on the Sunda Shelf. Journal of Foraminiferal Research, 6 (2), 107-133.

Bock, W. D., 1969. *Thalassia testudinum*, a habitat and means of dispersal for shallow water benthonic foraminifera. Transactions, Gulf Coast Association of Geological Societies 19, 337-340.

Bock, W. D., 1971. A handbook of the benthonic foraminifera of Florida Bay and adjacent waters. Miami Geological Society, Memoir 1, 1-92.

Boltovskoy, E., and Vidarte, L. M., 1977. Foraminiferos de la zona de manglar de Guayaquil (Ecuador). Hidrobiologia, 5 (3), 31-40.

Boltovskoy, E. and Hincapie de Matinez, S., 1983. Foraminiferos del manglar de Tesca, Cartagena, Colombia. Revista Espanola Micropaleontologica, 15 (2), 205-220.

Boltovskoy, E., 1984. Foraminifera of mangrove swamps. Physis, A, 42 (102), 1-9.

Boltovskoy, E., Scott, D. B., and Medioli, F. S., 1991. Morphological variations of benthic foraminiferal tests in response to changes in ecological parameters: a review. Journal of Paleontology 65 (2), 175-185.

Bond, G., Showers, W., Cheseby, M., Lotti, R., Almasi, P., deMenocal, P., Priore, P., Cullen, H., Hajdas, I., and Bonani, G., 1997. A pervasive millenial-scale cycle in North Atlantic Holocene and Glacial climates. Science, 278, 1257-1266.

Bornemann J. G., 1855. Die mikroskopische fauna des septarienthones von Hermsdorf bei Berlin. Deutsche Geology Ges. Zeitschrift, 7 (2), p. 307-371.

Brady, H. B., 1870. Part II. Analysis and description of foraminifera. Annals and Magazine of Natural History, 4 (6), 273-309.

Brady, H. B., 1879. Notes on some of the reticularian rhizopoda of the Challenger Expedition, part 1, on new or little known arenaceous types. Quarternary Journal of Microscopic Science, 19, 20-63.

Brady, H. B., 1881. Notes on some of the reticularian rhizopoda of the Challenger Expedition, part 3. Quarternary Journal of Microscopic Science, 21, p. 59.

Brady, H. B., 1884. Report on the foraminifera dredged by H. M. S. Challenger during the years 1873-1876. In: Reports of the Scientific Results of the Voyage of the H.M.S. Challenger, Zoology, London, 9, 814 p.

Brasier, M. D., 1975a. Ecology of recent sediment-dwelling and phytal foraminifera from the lagoons of Barbuda, West Indies. Journal of Foraminiferal Research, 5 (1), 42-62.

Brasier, M. D., 1975b. The ecology and distribution of recent foraminifera from the reefs and shoals around Barbuda, West Indies. Journal of Foraminiferal Research, 5 (3), 193-210.

Brasier, M. D., 1975c. Morphology and habitat of living benthonic foraminiferids from the Caribbean carbonate environments. Revista Espanola Micropaleontologica, 7 (3), 567-578.

Bretz, J. H., 1960. Bermuda: a partially drowned, late mature, Pleistocene karst. Geological Society of America, Bulletin 71, 1729-1754.

Brotzen, F., 1940. Flintrännans och trindelrännans Geologi. Ārsbok Sveriges Geologiska Undersökning, 34, 1-60.

Brotzen, F., 1948. The Swedish Paleocene and its foraminiferal fauna. Ārsbok Sveriges Geologiska Undersökning, 42 (2), 1-140.

Brünnich, M. T., 1772. Brünnich Zoologiae Fundamentals. Grunde I, Dyrelorren, Hafniae at Lipsiae, 253 p.

Buzas, M. A., Smith, R. K., and Beem, K. A., 1977. Ecology and sytematics of foraminifera in two Thalassia habitats, Jamaica, West Indies. Smithsonian Contribution to Paleobiology, 31, 139 p.

Buzas, M. A. and Sen Gupta, B. K., 1982. Foraminifera, notes for a short course, Studies in Geology 6, University of Tennessee, 219 p.

Buzas, M. A. and Severin, K. P., 1982. Distribution and systematics of foraminifera in the Indian River, Florida. Smithsonian Contribution to Marine Science, 16, 73 p.

Cann, J. H. and De Deckker, P., 1981. Fossil Quaternary and living foraminifera from athalassic (non-marine) saline lakes, southern Australia. Journal of Paleontology, 55 (3), 660-670.

Carman, K. W., 1933. The shallow-water foraminifera of Bermuda. Ph.D. dissertation, Department of Geology, Massachussets Institute of Technology, 178 p.

Carpenter, W.B., 1869. On the rhizopodal fauna of the deep sea: The Proceedings of the Royal Society of London, 18, 59-62.

Carpenter, W. B, 1883. Researches on the foraminifera, Supplemental memoire. On the abyssal type of the genus *Orbitolites*; a study in the theory of decent. Philosophical Transactions of the Royal Society, 174, 551-573.

Carpenter, W. B., Parker, W. K., and Jones, T. R., 1862. Introduction to the study of foraminifera. Ray Society of London, 319 p.

Carter, H.J., 1877, Description of a new species of foraminifera (*Rotalia spiculotesta*). Annales and Magazine of Natural History, series 4 (20), p. 470.

Chapman, F., 1900. On some new and interesting foraminifera from the Funafuti Atoll, Ellice Islands. Journal of the Linnaean Society of London , Zoology, 28, 1-27.

Chapman, F., 1901. Foraminifera from the lagoon at Funafuti. Journal of the Linnean Society, 28, 161-210.

Chapman, F. 1902. The foraminifera: an Introduction to the Study of the Protozoa. London: Longmans, Green and Company.

Chapman, F. and Parr, W.J., 1937. Foraminifera *in* Johnston, T.H.(ed.), Australasian Antarctic Expedition, 1911-1914, Scientific Reports: series C, 1, 2, 1-190.

Chinn, A. F., 1972. A study of variation in clonal populations of the foraminifer *Rosalina floridana* (Cushman). Unpublished MSc. Thesis, Dalhousie university, 52 p., 10 pl.

Cimmerman, F. and Langer, M. R., 1991. Mediterranean foraminifera. Acad. Scient. Et art. slovenica Cl. IV, Historia Nat. Op. 30, Paleontologica Institute Ivana Rakovca 2, Ljubljana, 118 p.

Cole, W.S., 1928. A foraminiferal fauna from the Chapapote Formation in Mexico. Bulletins of American Paleontology, 14, 201-232.

Cole, W. S., 1941. Stratigraphic and paleontologic studies of wells in Florida. Florida Geological Survey Bulletin 19(6), 91 p.

Collins, E. S., Scott, D. B., Gayes, P. T., and Medioli, F. S., 1995. Foraminifera in Winyah Bay and North Inlet marshes, South Carolina: relationship to local pollution sources. Journal of Foraminiferal Research, 25, 212-223.

Collins, E. S., 1996. Marsh-estuarine benthic foraminiferal distributions and Holocene sea-level reconstructions along the South Carolina coastline. Unpublished PhD Thesis, Dalhousie University.

Collins, E. S., Scott, D. B., and Gayes, P. T., 1998. Hurricane records on the South Carolina coast: can they be detected in the sediment record? Quaternary International, 56, 15-26.

Colquhoun, D. J. and Brooks, M. J., 1987. New evidence for eustatic components in late Holocene sea-levels. In: Rampino, M. R., Sanders J. E., Newmann, W. S., and Konigsson, L. K. (Editors), Climate: history, periodicity and predictability. Van Nostrand Reinhold Company, N. Y., 143-156.

Crowley, T. I. and North, G. R., 1991. Oxford monography on geology and geophysics 16: paleoclimatology. Oxford Univ. Press, N. Y., Clarendon Press, Oxford.

Culver, S. J., 1990. Benthic foraminifera of Puerto Rican mangrove-lagoon systems: potential for paleoenvironmental interpretations. Palaios, 5, 34-51.

Culver, S. J and Buzas, M. A., 1981. Recent benthic foraminiferal provinces on the Atlantic continental margin of North America. Journal of Foraminiferal research, 11 (3), 217-240.

Culver, S. J and Buzas, M. A., 1982. Distribution of recent benthic foraminifera in the Caribbean region. Smithsonian Contribution to the Marine Sciences, 14, 382 p.

Cushman, J. A, 1910. A monograph of the foraminifera of the North Pacific Ocean. Part 1. Astrorhizidae and Lituolidae. United States Natural History Museum Bulletin, 71, 134 p.

Cushman, J. A, 1911. A monograph of the foraminifera of the North Pacific Ocean. Part 2: Textulariidae. United States Natural History Museum Bulletin, 71, 108 p.

Cushman, J. A, 1917. A monograph of the foraminifera of the North Pacific Ocean. United States Natural History Museum Bulletin 71, part 6, p. 58, p.80.

Cushman, J. A, 1918. Some Pliocene and Miocene foraminifera of the coastal plain of the United States. United States Geological Survey, Bulletin 676, 100 p.

Cushman, J. A., 1919. Fossil foraminifera from the West Indies. Carnegie Institution Washington, 291, 23-71.

Cushman, J. A., 1920a. The foraminifera of the Atlantic Ocean. Smiths. Inst. United States Natural History Museum Bulletin 104, pt. 2. Lituolidae, 111 p.

Cushman, J. A., 1920b. Lower Miocene foraminifera of Florida. United States Geological Survey, Professional Paper 128-B, 67-74, pl. 11.

Cushman, J. A, 1921. Foraminifera from the north coast of Jamaica. Proceedings of the United States Natural History Museum 59, 47-82.

Cushman, J. A, 1922a. Results of the Hudson Bay expedition, 1920: I- the foraminifera. Canada, Biological Board, Contributions to Canadian Biology (1921), 9, 135-147.

Cushman, J. A, 1922b. Shallow-water foraminifera of the Tortugas Region. Publications of the Carnegie Institution Washington 311, Department of Marine Biology, 17, p. 1-85.

Cushman, J. A, 1922c. The foraminifera of the Atlantic Ocean. Pt 3: Textulariidae. United States Natural History Museum Bulletin 104 (3), 149 p.

Cushman, J. A., 1923. The foraminifera of the Atlantic Ocean. Smiths. Inst. United States Natural History Museum Bulletin 104, pt. 4, Lagenidae, 228 p.

Cushman, J.A., 1924, Samoan foraminifera. Publications of the Carnegie Institution of Washington, no. 342, Department of Marine Biology papers, 21, 1-75.

Cushman, J. A, 1926. Foraminifera of the typical Monterey of California. Contributions of the Cushman Laboratory for Foraminiferal Research, 2, 53-69.

Cushman, J. A, 1927a. Some characteristic Mexican fossil foraminifera. Journal of Paleontology, 1, 147-172.

Cushman, J. A, 1927b. Recent foraminifera from off the west coast of America: Bulletin of the Scripps Institution of Oceanography, Technical Ser. 1 (10), 119-188.

Cushman, J.A., 1927c. An outline of a re-classification of the foraminifera. Contributions from the Cushman Laboratory for Foraminiferal Research, 3, 1-105.

Cushman, J. A, 1928. Foraminifera, their classification and economic use. Cushman Laboratory for Foraminiferal Research, Special Publication 1, 1-404.

Cushman, J. A., 1929. The foraminifera of the Atlantic Ocean. United States Natural History Museum Bulletin 104, pt. 6, Miliolidae, Ophthalmidiidae and Fischerinidae, 129 p.

Cushman, J. A, 1930a. The foraminifera of the Chaotawhatchee Formation of florida. Florida state Geological Survey Bulletin 4, 1-63.

Cushman, J. A., 1930b. The foraminifera of the Atlantic Ocean. United States Natural History Museum Bulletin 104, pt. 7, Nonionidae, Camerinidae, Peneroplidae and Alveolinellidae, 79 p.

Cushman, J. A., 1931. The foraminifera of the Atlantic Ocean. United States Natural History Museum Bulletin 104, pt. 8: Rotaliidae, Amphisteginidae, Calcarinidae, Cymbaloporettidae, Globorotaliidae, Anomalinidae, Planorbulinidae, Rupertidae and Homotrematidae, 179 p.

Cushman, J. A., 1932. Notes on the genus *Virgulina*. Contributions to the Cushman Laboratory for Foraminiferal Research, 8 (1), p. 17.

Cushman, J.A., 1933. Some new Recent foraminifera from the tropical Pacific. Contributions from the Cushman Laboratory for Foraminiferal Research, 9, 77-95.

Cushman, J. A., 1934. Notes on the genus *Tretomphalus*, with descriptions of some new species and a genus, *Pyropilus*. Contributions to the Cushman Laboratory for Foraminiferal Research, 10(4), 79-101.

Cushman, J. A, 1935. Upper Eocene foraminifera of the southeastern United States. United States Geological Survey Professional Paper 181, 88 p.

Cushman, J. A, 1936. Some new species of *Elphidium* and related genera. Contributions to the Cushman Laboratory for Foraminiferal Research, 12, 78-89.

Cushman, J. A, 1937. A monograph of the foraminiferal Family Valvulinidae. Cushman Laboratory for Foraminiferal Research Special Publication, 8, 210 p.

Cushman, J. A, 1944. Foraminifera from the shallow water of the New England coast. . Cushman Laboratory for Foraminiferal Research Special Publication, 12, 37 p.

Cushman, J. A, 1947. New species and varieties of foraminifera from off the southeastern coast of the united States . Contributions to the Cushman Laboratory for Foraminiferal Research, 23, 86-92.

Cushman, J. A, and Bronnimann, P., 1948a. Some new genera and species of foraminifera from brackish water of Trinidad. Cushman Laboratory for Foraminiferal Research, 24, 15-21.

Cushman, J. A, and Bronnimann, P., 1948b. Additional new species of arenaceous foraminifera from shallow waters of Trinidad. Cushman Laboratory for Foraminiferal Research, 23, 60-72.

Cushman, J. A. and Cahill, *in* Cushman, J.A., and Ponton, G.M.,1932. The foraminifera of the Upper, Middle, and part of the Lower Miocene of Florida. Florida State Geological Survey Bulletin, 9, 1-147.

Cushman, J. A. and Edwards, 1937. *Astrononion,* a new genus of the foraminifera, and its species. Contributions to the Cushman Laboratory for Foraminiferal Research, 13, 29-36.

Cushman, J. A. and McCulloch, I., 1939. A report on some arenaceous foraminifera. Allan Hancock Pacific Expedition, 6(1), 113 p.

Cushman, J. A. and Todd, R., 1944. The genus *Spiroloculina* and its species. Cushman Laboratory for Foraminiferal Research Special Publication, 11, 1-82.

Cushman, J. A. and Todd, R., 1947. A foraminiferal fauna from Amchitka Island, Alaska. Contributions to the Cushman Laboratory for Foraminiferal Research, 23, 60-72.

Cushman, J.A., Todd, R., and Post, R., 1954,.Recent foraminifera of the Marshall Islands: Bikini and nearby Atolls, part 2, Oceanography (biologic). United States Geological Survey professional paper 260-H, 319-379, pls. 82-93.

Cushman, J.A., and Wickenden, R.T., 1929. Recent foraminifera from off Juan Fernandez Islands: Proceedings of the United States Natural History Museum, 75(2780), 1-16.

Debenay, J. P., Pages, J., and Diouf, P. S., 1989. Ecological zonation of the hyperhaline estuary of the Casamance river (Senegal): foraminifera, zooplankton and abiotic variables. Hydrobiologia, 174, 161-176.

de Blainville, H. M. Ducrotay, 1824. Dictionnaire des Sciences Naturelles. F. G. Levrault (Paris). 32, 567 p.

Deflandre, G., 1929. Le genre *Centropyxis* Stein. Archiv für Protistenkunde 67, 322-375.

de Montfort, P. D., 1808. Conchyliologie systématique et classification méthodique des coquilles 1, F. de Schoell, Paris, 409 p.

d'Orbigny, A. D., 1826. Tableau méthodique de la classe des Céphalopodes. Annales des Sciences Naturelles, 7, 245-314.

d'Orbigny, A. D., 1839a. Foraminifères, in Sagra, R., de la, Histoire physique, politique et naturelle de l'ile de Cuba. A. Bertrand, Paris, 224 p.

d'Orbigny, A. D., 1839b. Voyage dans l'Amérique méridionale, Foraminifères. P. Bertrand, Strasbourg, 5, 1-86.

d'Orbigny, A. D., 1846. Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche), Paris (Gide et cie), p.137.

d'Orbigny, A. D., 1850. Prodrome de paléontologie statigraphique universelle des animaux mollusques et rayonnés, 1, Paris, V. Masson.

Dorreen, J.M., 1948. A foraminiferal fauna from the Kaiatan stage (upper Eocene) of New Zealand. Journal of Paleontology, 22, 281-300.

Dujardin, F., 1841. Histoire naturelle des Zoophytes-In-fusiores. Paris, 648 p., Atlas, 22 pls.

Drooger, C. W., and Kaaschieter, J. P. H., 1958. Foraminifera of the Orinoco-Trinidad-Paria shelf, v. 4 of Reports of the Orinoco Shelf Expedition: Koninkl. Nederlandse Akademie Wetenschapen, Afd. Natuurk. Verh., 1st Reeks, Deel 22, 108 p.

Egger, J. G., 1893. Foraminiferen aus Meeresgrundproben, gelothet von 1874 bis 1876 von S. M. Sc. Gazelle. Abhandlungen der Bayerischen Akademie der Wissenschaften, München, Math.-Phys. Cl. 18, 193-458.

Ehrenberg, C. G., 1830. Organisation, systematik und geographisches Verhältnis der infusionsthierchen. Berlin. Druckerei der Königlichen Akademie der Wissenschaften, 1-108.

Ehrenberg, C. G., 1832. Uber die Entwicklung und Lebensdauer der Infusionsthiere, nebst ferneren Beitragen zu einer Vergleichung ihrer organischen Systeme. Königliche Akademie der Wissenschaften zu Berlin, Abhandlungen 1831, Physikalische Abhandlungen, 1-154.

Ehrenberg, C. G., 1839. Uber die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare organismen. Königliche Akademie der Wissenschaften zu Berlin, Abhandlungen 1838, Physikalische Abhandlungen, 59-147.

Ehrenberg, C. G., 1841. Königliche Akademie der Wissenschaften zu Berlin, Abhandlungen, p. 422.

Ehrenberg, C. G., 1843. Verbreitung und einfluss des Mikroskopsichen Lebens in Süd- und Nord Amerika: Physikalische Abhandlungen der Königliche Akademie der Wissenschaften zu Berlin, (1841), Theil 1, 291-446.

Ehrenberg, C.G., 1854. Mikrogeologie: Leipzig, L. Voss.

Eichwald, C. E. von, 1830. Zoological specialis. Vol. 2. Vilnae. D. E. Eichwaldus, 323 p.

Eimer, G.H.T and Fickert, C., 1899. Die Artbildung und Verwandtschaft bei den Foraminiferen. Entwurf einer natürlichen Eintheilung derselben: Zeitschrift für Wissenschaftliche Zoologie, 65, 599-708.

Ellison, J. C., 1993. Mangrove retreat with rising sea-level, Bermuda. Estuarine, Coastal and Shelf Science, 37, 75-87.

Erlenkeuser, H., R., Futterer, D., Heinrich, H., Libbe, Z. G., Meischner, P., Muller, P., and Wefer, G., 1981. Environmental changes during the last 9000 years as reflected in a sediment core from Harrington Sound, Bermuda. In "The Harrington Sound Project", Kiel University. Bermuda Biological Station for Research, Special Publication, 19, 23-60.

Fairbanks, R. W., 1989. A 17,000-year glacio-eustatic sea-level record: influence of glacial melting rates in the Younger Dryas event and deep ocean circulation. Nature, 342, 637-642.

Fairbridge, R. W., 1976. Shellfish-eating Preceramic Indians in coastal Brazil. Science, 191, 353-359.

Fichtel, L., von and Moll, J. P. C., 1798 and 1803 (reprint). Testacea microscopica, aliaque minuta ex generibus *Argonauta* et *Nautilus*, ad naturam picta et descripta

(Microscopische und andere klein Schalthiere aus den geschlechtern Argonaute und Schiffer). Camesina, Vienna, 124 p.

Findlay, H.J., 1939. New Zealand foraminifera: key species in stratigraphy-No. 1. Transactions of the Royal Society of New Zealand, 68, 504-543.

Flint, J. M., 1899. Recent foraminifera. A descriptive catalogue of specimens dredged by the U. S. Fish Commission Steamer Albatross. Annual Reports of the United States National Museum 1897, 249-349.

Forman, S. L., Oglesby, R., Markgraf, V., and Stafford, T., 1995. Paleoclimatic significance of Late Quaternary eolian deposition on the Piedmont and High Plains, Central United States. Global and Planetary Change, 11, 35-55.

Fornasini, C., 1900, Intorno ad alcuni esemplari di foraminiferi Adriatici. Memorie della R. Accademie della Scienze dell' Istituto di Bologna, Scienze Naturali, series 5 (8), 357-402.

Fornasini, C, 1902a. Sinossi metodica dei foraminiferi sin qui rinvenuti nella sabbia de Libo di Rimini. Memorie della R. Accademie della Scienze dell' Istituto di Bologna, Scienze Naturali, series 5 (10), 1-68.

Fornasini, C., 1902b. Contributo a la conoscenza de la Bulimine adriatiche. Memorie della Real Accademia delle Science dell' Instituto di Bologna, Classe de Scienze Fisiche, series 5 (9), (1901-1902), 360-388.

Forskal, P., 1775. Descriptiones animalium. Haunias, Carsten Niebuhr, Copenhagen, 164 p.

Frizzell, D. L. and Keen, A. M., 1949. On the nomenclature and generic position of *Nautilus beccarii* Linné (Foraminifera "Rotaliidae"). Journal of Paleontology, 23, 106-108.

Galloway, J.J.,1933. A Manual of Foraminifera: Bloomington, Princioia Press.

Galloway, J.J. and Wissler, S.G., 1927, Correction of names of foraminifera. Journal of Paleontology, 1, p. 193.

Garrett, P., Smith, D. L., Wilson, A. O., and Patriquin, D., 1971. Physiography, ecology, and sediments of two Bermuda patch reefs. Journal of Geology, 79, 647-668.

Garrett, P. and Scoffin, T. P., 1977. Sedimentation on Bermuda's Atoll rim. Proceedings of the third International Coral Reef Symposium, University of Miami, 87-95.

Gayes, P. T., Scott, D. B., Collins, E. S., and Nelson, D. N., 1992. A late Holocene fluctuation in South Carolina. In Quaternary coasts of the United States: marine and lacustrine systems. Society for Economical Petrologists and Mineralogists Special Publication, 48, 155-160.

Geroch, S., 1960. Microfaunal assemblages from the Cretaceous and Paleogene Silesian unit in the Beskid Slaski Mts. (Silesian Carpathians). Poland Instytut Geologiczny, Biulytin 153, 7-138, pl.1-13.

Ginsburg, R. N., 1956. Environmental relationships of grain size and constituent particles in some South Florida carbonate sediments. American Association of Petroleum Geologists, Bulletin 40 (10), 2384-2427.

Goës, A,1882. On the reticularian Rhizopoda of the Caribbean Sea: Konglischen Svenska Vetenskaps-Akademiens Handlingar, 19 (4), 1-151.

Goldstein, T. S., 1976. The distribution and ecology of benthic foraminifera in a South Florida mangrove environment. Unpublished MSc. Thesis, Univ. Florida, 111 p.

Goldstein T. S. and Harben, E. B., 1993. Taphofacies implications of infaunal foraminiferal assemblages in a Georgia salt marsh, Sapelo Island. Micropaleontology, 39 (1), 53-62.

Goodbred, S. L., Wright, E. E., and Hine, A. C., 1998. Sea-level change and storm-surge deposition in a late Holocene Florida salt marsh. Journal of Sedimentary Research, 68 (2), 240-252.

Graham, J. J., and Militante, P. J., 1959. Recent foraminifera from the puerto Galera area, northern Mindoro, Philippines. Stanford University Publications, Geological Sciences, 6, 171 p.

Gray, J.E., 1858. On *Carpenteria* and *Dujardinia,* two genera of a new form of Protozoa with attached multilocular shells filled with sponge, apparently intermediate between Rhizopoda and Porifera. Proceedings of the Zoological Society of London, 26, 266-271.

Gregory, M. R., 1973. Benthonic foraminifera from a mangrove swamp, Whangaparapara, Great Barrier Island. Tane, 19, 193-204.

Grzybowski, J., 1898. Otwornice pokladow naftonosnych okolicy Krosna. Rocz. Akad. Umiejet., Wydz. matem.-przyrod., 33 (ser. 2,13), 257-305,1 Tab., Taf. 10-12; Krakow.

Haig, D. W., 1988. Miliolid foraminifera from inner neritic sand and mud facies of the Papuan lagoon, New Guinea. Journal for Foraminiferal Research, 18 (3), 203-236.

Halicz, E., Noy, N., and Reiss, Z., 1984. Foraminifera from Shura Arwashie mangrove (Sinai). In Por, F. D. and Dor, I. (eds.): Hydrobiology of the mangal. Dr. W. Junk Publ., The Hague, 145-149.

Hallock, P., Cottey, T. C., Forward, L. B., and Halas, J., 1986. Population biology and sediment production of *Archaias angulatus* (Foraminiferida) in Largo Sound, Florida. Journal for Foraminiferal Research, 16 (1), 1-8.

Hallock, P, and Peebles, M. W., 1993. Foraminifera with chlorophyte endosymbionts: habitats of six species in the Florida Keys. Marine Micropaleontology, 20, 277-292.

Hansen, H. J., and Lykke-Andersen, A.-L., 1976. Wall structure and classification of fossil and recent Elphidiid and Nonionid foraminifera. Fossils and strata, Universitetsforlaget Oslo 10, 37 p.

Hartsock, J. K., Woodrow, D. L. and Mckinney, D. B., 1995. Fracture systems in northeastern Bermuda. Geological Society of America Special Paper, 300, 325-334.

Havach, S. M., and Collins, L. S., 1997. The distribution of recent benthic foraminifera across habitats of Bocas Del Toro, Caribbean Panama. Journal for Foraminiferal Research, 27 (3), 232-249.

Hayward, B. W., Grenfell, H., Cairns, G., and Smith, A., 1996. Environmental controls on benthic foraminiferal and thecamoebian associations in a New Zealand tidal inlet. Journal for Foraminiferal Research, 26 (2), 150-171.

Hedberg, H. D., 1934. Some recent and fossil brackish to freshwater foraminifera. Journal of Paleontology, 8 (4), 469-476.

Hemleben, C., and Trvster, J., 1984. Campanian-Maestrichtian deep-water foraminifers from Hole 543A, Deep Sea Drilling Project. In: Bij-Duval, B., Moore, J.C. et al., Initial Reports of the Deep Sea Drilling Project, 78A, 509-532.

Heron-Allen, E., and Earland, A., 1911. On the recent and fossil foraminifera of the shore-sands of Selsey Bill, Sussex, IV. Journal of the Royal Microscopical Society, p. 338, pl. 11, figs. 6-11

Heron-Allen, E., and Earland, A., 1915. The foraminifera of the Kerimba archipelago (Portugese E. Africa). Transactions of the Zoological Society of London, 20 (1912-15), 2 (17), p. 543-794.

Heron-Allen, E., and Earland, A., 1930a. Miliammina, a new siliceous genus. Journal of the Royal Microscopic Society of London 50, 38-45.

Heron-Allen, E. and Earland, A., 1930b. The foraminifera of the plymouth District II. . Journal of the Royal Microscopic Society of London, 50, 161-199.

Hickson, S.J. 1911. On *Polytrema* and some allied genera. A study of some sedentary foraminifera based mainly on a collection made by Prof. Stanley Gardiner in the Indian Ocean. Transactions of the Linnean Society of London, Zoology, Series 2(14), 443-462.

Hiltermann, H., Bronnimann, P., and Zaninetti, L., 1981. Neue Biozonosen in den sedimenten der mangrove bei Acupe, Bahia, Brasilien. Notes du Laboratoire de Paléontologie, Université de Genève, 8 (1), 2-6.

Hofker, J., 1930. Foraminifera of the Sigboda Expedition, Part 2, Families Astrorhizidae, Rhizamminidae, Reophacidae, Anomalinidae, Peneroplidae in Sigboda-Expeditie, Monographie Iva, Leiden, E.J. Brill, 79-170.

Hofker, J., 1951. The foraminifera of the Siboga expedition. Part III. Siboga-Expeditie, Monographie Iva, E. J. Brill, Laeiden, 513 p.

Hõglund, H., 1947. Foraminifera in the Gullmar Fjord and Skagerak: Zoologiska Bidrag Från Uppsala, 26, 328p.

Howe, H.V., and Wallace, W.E., 1932. Foraminifera of the Jackson Eocene at Danville Landing on the Quachita, Catahoula Parish, Louisiana; Bulletin of the Geological Survey of Louisiana, 14, 1-122.

Husezima, R., and Maruhasi, M., 1944. A new genus and thirteen new species of foraminifera from the core-sample of Kasiwazaki oil-field, Nigata-ken. Journal of Sigenkagaku Kenkyusyo, 1, 391-400.

Iliffe, T. M., 1979. Bermuda's caves: a non-renewable resource. Environment Conservation, 6 (3), 181-186.

Iliffe, T. M., Hart, J. C. W., and Manning, K. B., 1983. Biogeography and the caves of Bermuda. Nature, 302, 141-142.

Illing, L. V., 1954. Bahaman calcareous sands. American Association of Petroleum Geologists, Bulletin, 38, 1-95.

Illing, M. A., 1950. The mechanical distribution of recent foraminifera in Bahama Banks sediments. Annals and Magazine of Natural History, 12 (3), 757-761.

Illing, M. A., 1952. Distribution of certain foraminifera within the littoral zone of the Bahama Banks, Annals and Magazine of Natural History, 12 (5), 275-285.

James, N.P. and Schenk, P.E., 1983. Field guide to Pleistocene and modern carbonates of Bermuda. Bermuda Biological Station for Research, Special Publication 25, 72p.

Jenks, S., 1970. Description of a core from Spittal Pond. In MacKenzie, F, T., Bricker, O. P., and Herman, S. S., Seminar on organism-sediment interrelationships, Bermuda Biological Station for Research, Special Publication 7, 34-46.

Jones, R.W., 1994. The *Challenger* Foraminifera. The Natural History Museum, London, Oxford University Press, 149 p.

Jones, T.R., and Parker, W.K., 1860. On the Rhizopodal fauna of the Mediterranean, compared with that of the Italian and some other Tertiary deposits. Quarterly Journal of the Geological Society, London, 16, 292-307.

Jones, T.R., Parker, W.K., and Brady, H.B., 1866. A monograph of the foraminifera of the Crag, Part 1: Monograph of the Palaeontological Society, London (1865), 19, 1-72.

Jennings, A. E., Nelson, A. R., Scott, D. B., and Aravena, J. C., 1995. Marsh foraminiferal assemblages in the Valdivia estuary, South-Central Chile, relative to vascular plants and sea-level. Journal of Coastal Research, 11 (1), 107-123.

Karrer, F., 1867. zur Foraminiferenfauna in Österreich. Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften Wien, Mathematisch-Naturwissenschaftliche Klasse, 55, 331-368, pls. 1-3.

Karrer, F.,1868. Die Miocene Foraminiferenfauna von Kostej in Banat: Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften Wien, Mathematisch-Naturwissenschaftliche Klasse, 58(1), 121-193.

Keigwin, L. D., 1996. The Little Ice Age and Medieval Warm Period in the Sargasso Sea. Science, 274, 1504-1508.

Kent, W. S., 1880. A manual of the Infusoria including a description of all known flagellate, ciliate, and tentaculiferous Protozoa, British and foreign, and an account of the organization and affinities of the sponges. D. Bogue (london), 6, 472 p.

Kobluk, D.R., 1988. Cryptic faunas in reefs: ecology and geologic importance. Palaios, 3, 370-390.

Kornfeld, M. M., 1931. Recent littoral foraminifera from Texas and Louisiana. Contributions of the Department of Geology, Stanford University, 1, 77-107.

Kristan-Tollman, E., 1960. Rotaliidae (foraminifera) aus der Trias der Ostalpen, Wien: Jahrbuch der Geologischen Bundersanstalt, Sonderband, 5, 47-48.

Kübler, J., and Zwingli, H., 1870. Die Foraminiferen des Schweizerischen Jura: Winterhur, Steiner, 5-49.

Lamarck, J. B., 1804. Suite des memoires sur les fossiles des environs de Paris. Annales du Musée National d'Histoire Naturelle de Paris, 5, p. 351.

Lamarck, J. B., 1807. Suites des mémoires sur les fossiles de Paris (Applications des plances relatives aux coquelles fossiles des environs de Paris). Annales Muséum National d' Histoire Naturelle, Paris, no. 9.

Lamarck, J.B., 1812. Extrait du cours de Zoologie du Muséum d' Histoire Naturelle sur les animaux invertébrés. Paris, d'Hautel, 1-127.

Lamarck, J. B., 1816. Histoire naturelle des animaux sans vertèbres. Verdière, Paris, tome 2, 1-568 p.

Lamarck, J. B., 1822. Histoire naturelle des animaux sans vertèbres. Verdière, Paris, tome 7, p. 609.

Langer, M. R., Silk, M. T., and Lipps, J. H., 1997. Global ocean carbonate and carbon dioxide production: the role of reef foraminifera. Journal for Foraminiferal Research, 27 (4), 271-277.

Lankford, R. L., 1959. Distribution and ecology of foraminifera from east Mississippi Delta margin. American Association of Petroleum Geologists, Bulletin 43, 2068-2099.

Leidy, J., 1879. Fresh-water Rhizopods of North America. United States Geological Survey of the Territories, Report, 12, 324 p.

Lefurgey, A., and St-Jean, J., Jr., 1976. Foraminifera in brackish-water ponds designated for waste control and aquaculture studies in North Carolina. Journal for Foraminiferal Research 6 (4), 274-294.

Lévy, A., 1991. Peuplements actuels et thanatocénoses à Soritidae et Peneroplidae des Keys de Floride (USA). Oceanologica Acta, 14 (5), 515-524.

Linné, C., 1758. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. G. Engelmann (Lipsiae), 10 (1), 1-824.

Linné, C., 1767. Systema Naturae, (ed. 10): Holmia, Suecia, impensis L. Salvii, 1, 824 p.

Lipps, J. H., and Valentine, J. W., 1970. The role of foraminifera in the trophic structure of marine communities. Lethaia, 3, 279-286.

Liu, K-b, 1999. Millenial-scale variability in catastrophic hurricane landfalls along the Gulf of Mexico coast. In: American meteorological Society, 23rd Conference on Hurricanes and Tropical meteorology, 10-15 January 1999, 374-377.

Loeblich, A. R., and Tappan, H., 1961. Suprageneric classification of the Rhizopodea. Journal of Paleontogy 35, 245-330.

Loeblich, A. R., and Tappan, H., 1964. Sarcodina, chiefly "Thecamoebians" and foraminifera (2 vols.), in Moore, R. C. (Ed.), Treatise on Invertebrate Paleontology, Protista 2, part C, Geological Society of America and Kansas University Press, 900 p.

Loeblich, A. R., and Tappan, H., 1988. Foraminiferal genera and their classification. Van Nostrand Reinhold Company, New York, 2 vols., 970 p., 847 pls.

Logan, A., Mathers, S.M., and Thomas, M.L.H., 1984. Sessile Invertebrate coelobite species communities from reefs of Bermuda: species composition and distribution. Coral Reefs, 2, 205-213.

Logan, A., 1988. Holocene reefs of Bermuda. Sedimenta XI, the Comparative Sedimentary Laboratory, Division of the Marine Geology and Geophysics, University of Miami, Rosentiel School of Marine and Atmospheric Science, 61 p.

Lohmann, G.P., 1978. Abyssal benthonic foraminifera as hydrographic indicators in the western South Atlantic Ocean. Journal of Foraminiferal Research, 8(1), 6-34, pl. 1-4.

Lutze, G. F. and Wefer, G., 1980. Habitat and asexual reproduction of *Cyclorbiculina compressa* (Orbigny), Soritidae. Journal for Foraminiferal, 10, 251-260.

Lynts, G. W., 1966. Variation of foraminiferal standing crop over short lateral distances in Buttonwood Sound, Florida Bay. Limnology and Oceanography, 11, 562-566.

MacKenzie, F. T., Kulm, L. D., Cooley, R. L., and Barnhart, J. T., 1965. *Homotrema rubrum* (Lamarck), a sediment transport indicator. Journal of Sedimentary Petrology, 35, 265-272.

MacKenzie, F., T., Bricker, O. P., and Herman, 1970. Seminar on organism-sediment interrelationships, appendix 1 "class research project: Mangrove Bay", S. S. Bermuda Biological Station for Research, Special Publication, 7, 162-170.

Marie, P., 1938. Sur quelques Foraminifres nouveaux ou peu connus du Crétacé du Bassin de Paris. Bulletin de la Sociéte Géologique de France, series 5(8), 91-104.

Martin, R. E., 1986. Habitat and distribution of the foraminifer *Archaias angulatus* (Fichtel and Moll) (Miliolina, Soritidae), northern Florida Keys. Journal for Foraminiferal Research, 16 (3), 201-206.

Martin, R. E., and Liddell, W. D., 1988. Foraminiferal biofacies on a north coast fringing reef (1-75 m), Discovery Bay, Jamaica. Palaios, 3, 298-314.

Martin, R.E. and Wright, R.C., 1988. Information loss in the transition from life to death assemblages of foraminifera in back-reef environments, Key Largo, Florida. Journal of Paleontology, 62, 399-410.

Martinotti, A., 1920. Foraminiferi della spiggia de Tripoli. Soc. Italianna Sci. Nat. Atti, 59, 249-334.

Martinotti A, 1926. Foraminiferi del Sabbione de Orosei (Sardegna). Bollettino del Ufficio Geologico d' Italia, Roma, 51(5), 1-5.

Mikhalevich, V. I., 1976. New data on the foraminifera of the groundwaters of Middle Asia. Journal of Speleology, 8, 167-175.

Miller, A. A. L., Scott, D. B., and Medioli, F. S., 1982. Elphidium excavatum (Terquem): ecophenotypic versus subspecific variation. Journal for Foraminiferal Research 12, 116-144.

Millett, F.W., 1898. Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durand, F.R.M.S. Journal of the Royal Microscopical Society, 1898, 258-269.

Millett, F. W., 1899. Report on the recent foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S. Journal of the Royal Microscopic Society, 249-255.

Millett, F.W., 1900. Report on the Recent foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S. Part IX. Journal of the Royal Microscopical Society, 539-549.

Mõbius, K.A.,1880. Foraminifera von Mauritius. In: K. Mœbius, et al., Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen, Berlin: Gutman. 65-112.

Montagu, G., 1803. Testacea Britannica, or natural history of British shells, marine, land, and fresh-water, including the most minute. J. S. Hollis, Romsey, England, 606 p.

Montagu, G., 1808. Testacea Britannica. Suppl. Exeter, England S. Woolmer, 183 p.

Morris, B., Barnes, J., Brown, F., Markham, J., 1977. The Bermuda marine environment. Bermuda Biological Station Special Publication, 15, 120 p.

Munier-Chalmas, E.,1882. Un genre nouveau de Foraminifères Sénoniens. Bulletin de la Société Géologique de France (1881-1882), 3(10), 470-471.

Murray, J. W., 1965. The foraminiferida of the Persian Gulf 2: the Abu Dhabi region. Paleoecology Paleoclimatology Paleoceanography 1, 307-332.

Murray, J., 1991. Ecology and paleoecology of benthic foraminifera. Longman Scientific & Technical. 397 p.

Mylroie, J. E., 1989. Speleogenetic contrast between the Bermuda and Bahamas Islands. In Tleter, J. W. (ed.): Proceedings of the 2nd Symposium on the Geology of the Bahamas, 113-128.

Neumann, A. C., 1965. Processes of recent carbonate sedimentation in Harrington Sound, Bermuda. Bulletin of Marine Science, 15, 987-1035.

Neumann, A. C., 1971. Quaternary sea-level data from Bermuda. Quaternary, 14, 41-43.

Norman, A.M., 1878. On the genus *Haliphysema* with a description of several forms apparently allied to it. Annals and Magazine of Natural History, 5 (1), 265-284.

Nydick, K. R., Bidwell, A. B., Thomas, E., and Varekamp, J. C., 1995. A sea-level rise curve from Guilford, Connecticut, USA. Marine Geology, 124, 137-159.

Parker, F. L., 1952a. Foraminiferal distribution in the Long Island Sound-Buzzards Bay area. Harvard Museum of Comparative Zoology Bulletin 106, 438-473.

Parker, F. L., 1952b. Foraminifera species off portsmouth, New Hampshire. Harvard Museum of Comparative Zoology Bulletin, 9, 391-423.

Parker, F. L., 1953. Cushman Foundation for Foraminiferal Research Special Publication 2, p. 10.

Parker, F. L., 1954. Distribution of the foraminifera in the northeastern Gulf of Mexico. Harvard Museum of Comparative Zoology Bulletin 111, 453-588.

Parker, F. L., 1962. *Quinqueloculina tenagos*, new name for *Quinqueloculina rhodiensis* Parker, preoccupied. Cushman Foundation for Foraminiferal Research Contributions 13, pt. 3, p. 103.

Parker, F. L., Jones, T. R., and Brady, H. b., 1871. On the nomenclature of the foraminifera in the Annales des Sciences Naturelles, tome VII, 1826 -(4), the species founded upon the figures in Soldani's Testaceographia ae zoophytographia. Annals and magazine of Natural History, 4 (8), 145-179, 283-266.

Parker, F. L., Phleger, F.B, and Pierson, J.F., 1953. Ecology of foraminifera from San Antonio Bay and environs, southwest Texas. Cushman Foundation for Foraminiferal Research, Special Publication 2, 75p.

Parker, W.K., and Jones, T. R., 1857. Description of some foraminifera from the coast of Norway. Annals and Magazine of Natural History, 2(19), 273-303.

Parker, W. K., and Jones, T. R., 1859. One the nomenclature of the foraminifera. II. On the species enumerated by Walker and Montagu. Annals and Magazine of Natural History 3 (4), 333-351.

Parker, W.K., and Jones, T. R., 1860. On the nomenclature of foraminifera. IV, The species enumerated by Lamarck. Annales and Magazine of Natural History, 3(6), 29-40.

Parker, W.K., and Jones, T. R., 1865. On some foraminifera from the North Atlantic and Artic Oceans, including Davis Strait and Baffin's Bay. Philosophic Transactions of the Royal Society of London, 155, 325-441.

Parr, W. J., 1941. A new genus, Planulinoides and some species of foraminifera from South Australia. Journal of Mining Geology, 2, p. 305.

Parr W. J.,1945. Recent foraminifera from Bawon Heads, Victoria. Roy. Soc. Victoria, Proceedings, Melbourn, 56 (2), 189-227.

Parr, W.J., 1950, Foraminifera: Reports B.A.N.Z. Antarctic Research Expedition 1929-1931, series B (Zoology,Botany), 5(6), 232-392.

Patterson, R. T., 1985. *Abdidodentrix*, a new foraminiferal genus in family Bolivitidae. Journal for Foraminifera Research 15 (2), p. 138-140.

Patterson, R. T. and McKillap, W. B., 1991. Distribution and possible paleoecological significance of *Annectina viriosa*, a new species of agglutinated foraminifera from non-marine salt ponds in Manitoba. Journal of Paleontology, 65 (1), 33-37.

Penard, E., 1890. Etudes sur les Rhizopodes d'eau douce. Mémoire de la Societé de Physique et Histoire Naturelle de Genève, 31 (2), 230 p.

Pestana, H., 1983. Discovery of and sediment production by *Carpenteria* (Foraminifera) on the Bermuda platform. Bulletin of Marine Science, 33(2), 509-512.

Phleger, F. B., 1954. Ecology of foraminifera and associated microorganisms from Mississippi Sound and environs. American Association of Petroleum Geologists, Bulletin 38, 584-647.

Phleger, F. B., 1965. Living foraminifera from coastal marsh, southwestern Florida. Bol. Soc. Geology Mexicana, 28 (1), 45-60.

Phleger, F. B., 1970. Foraminiferal populations and marine marsh processes. Limnology and Oceanography, 15 (4), 522-534.

Phleger, F. B., and Bradshaw, J. S., 1966. Sedimentary environments in a marine marsh. Science, 154, 1551-1553.

Phleger, F. B. and Parker, F. L., 1951. Ecology of foraminifera, northwest Gulf of mexico, part 2: foraminifera species. Geological Society of America Memoir, 46, 64 p.

Phleger, F. B., Parker, F. L., and Pierson, J. F., 1953. Ecology of foraminifera from San Antonio Bay and environs, southwest Texas. Cushman Laboratory for Foraminiferal Research Special Publication 2, 75 p.

Poag, C. W., 1978. Paired foraminiferal ecophenotypes in Gulf Coast estuaries: ecological and paleontological implications. Transactions of the Gulf Coast Association of Geological Societies, 28, 395-421.

Poag, C.W., Knebel, H.J., and Todd, R., 1980. Distribution of modern bentic foraminifera on the New Jersey outer continental shelf. Marine Micropaleontology, 5, 63-49.

Radford, S. S., 1974. Recent foraminifera from Tobago Island, West Indies. Revista Espanola Micropaleontologica, 8 (2), 193-218.

Redfield, A. C., 1967. Postglacial change in sea-level in the Western North Atlantic Ocean. Science, 157 (3787), 687-691.

Renz, H.H., 1948. Stratigraphy and fauna of the Agua Salada Group, State of Falcon, Venezuela. Memoirs of the Geological Society of America, 32(I-X), 1-219.

Resig, J. M., 1974. Recent foraminifera from a landlocked Hawaiian lake. Journal for Foraminiferal Research, 4 (2), 69-76.

Reuss, A. E., 1850. Neues foraminiferen aus denSchichten des österreichischen Tertiärbeckens. Denkschriften der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe, 1, 365-390.

Reuss, A.E., 1851. Ueber die fossilen Foraminiferen und Entomostraceen der Septarienthone der Umgegend von Berlin. Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin, 3, 49-91.

Reuss, A. E., 1862. Entwurf einer systematischen Zusammenstellung der foraminiferen. Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Classe (1861), 44, 355-396.

Reuss, A. E., 1863. Beiträge zur kenntniss der tertiären foraminifern-fauna (Zweite Folge). Sitzungsberichte der der Kaiserlichen Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Classe, 48, 36-71.

Rhumbler, L., 1895a. Beiträge zur Kenntnis der Rhizopoden (Beiträg III, IV, und V). Zeitschrift für wissenschaftliche Zoologie, 61, 38-110.

Rhumbler, L., 1895b. Entwurf eines naturlichen Systems der Thalamophoren: Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen. Math.-Physik. Klasse, 1, 51-98.

Rhumbler, L., 1906. Foraminiferen von Laysan und den Chatham-Inseln. Zoologischer Jahresbericht, 24, 21-80.

Rhumbler, L., 1911. Die Foraminiferen (Thalamophoren) der Plankton-Expedition. Ergebnisse der Plankton-Expedition der Humboldt-Stiftung, 3, 331 p.

Risso, A. 1826. Histoire Naturelle des Principales Productions de l'Europe Méridionale et Particulièrment de Celles des Environs de Nice et des Alpes Maritimes, 4, Paris, F.G.Levrault.

Robbin, D. M., 1984. A new Holocene sea level curve for the upper Florida Keys and Florida reef tract. In: Gleason P. J. (editor), Environments of Soputh Florida, Prsent and past. Miami Geological Society, Miami, 437-458.

Rose, P. R. and Lidz, B., 1977. Diagenetic foraminiferal assemblages of shallow-water modern environments: South Florida and the Bahamas. Comparative Sedimentology Laboratory, University of Miami, Sedimenta VI, 47 p.

Rzehak, A., 1885. Bemerkungen über einige foraminiferen der Oligacän Formation. Verhandl. Naturforschenden Vereins in Brünn (1884), 23, 123-129.

Rzehak, A., 1888. Die foraminiferen der Nummulitenschichten des Waschberges und Michelsberges bei Stockerau in NeiderOesterreich. K. K. Geology Reichsanst., Verhandl. 1888, 226-229.

Said, R., 1949. Foraminifera of the northern Red Sea. Special Publications, Cushman Laboratory for Foraminiferal Research, 26, 231-272.

Said, R., 1950. Additional foraminifera from the northern Red Sea. Contributions, Cushman Foundation for Foraminiferal Research, 1(1, 2), 4-9.

Sars, G. O., 1872. Undersogelser over Hardangerfjordens Fauna. Forhandlinge I Vdenskasselskabet I Kristiania, 1871, 246-255.

Saunders, J., B., 1957. Trochamminidae and certain Lituolidae (Foraminifera) from the recent brackish-water sediments of Trinidad, British West Indies. Smithsonian Miscellaneous Collections, 134, 1-16.

Saunders, J., B., 1958. Recent foraminifera of mangrove swamps and river estuaries and their fossil counterparts in Trinidad. B.W.I. Smithsononian Miscellaneous Collections, 134 (5), 1-16.

Saunders, J., B., 1961. Helenina Saunders, new name for the foraminiferal genus Helenia Saunders, 1957, non Helenia Walcott, 1880. Contributions of the Cushman Foundation for Foraminiferal Research 12, p. 148.

Schafer, C.T., 1968. Lateral and temporal variations of foraminiferal populations living in nearshore shallow water areas. Unpublished report of Atlantic Oceanography Laboratory, Bedford Inst., Darmouth, N.S. Canada. 28p.

Schlumberger, C., 1887. Note sur le genre *Adelosina*. Bulletin de la Société Zoologique de france, 12, 105-118.

Schlumberger, C., 1893. Monographie des Miliolidées du Golfe de Marseille. Mémoires de la Société Zoologique de France, 6, 57-80.

Schnitker, D., 1971. Distribution of foraminifera on the North Carolina continental shelf. Tulane Studies in Geology and Paleontology, 8, 169-215.

Schnitker, D., 1974. Ecotypic variation in *Ammonia beccarii* (Linne). Journal for Foraminiferal Research, 4 (4), 217-223.

Schubert, R.J., 1921. Palaeontologische daten zur Stammesgeschichte der Protozoen. Paläontologische Zeitschrift (1920), 3, 129-188.

Schultze, M. S., 1854. Über der organisms der Polythalamien (Foraminiferen), nebst bemerkungen über die Rhizopoden im allgemeinen. Leipzig, 68 p.

Schwager, C., 1866. Fossile foraminiferen von Kar Nikobar, Reise der Osterreichischen Fregatte Novara um Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. Von Wüllerstorf-Urbair, Geologischer Theil, 2(1), Geologische Beobachtungen, 2 Paläontologische Mittheilungen, 187-268.

Scholl, D. W., Craighead, F. C. and Stuiver, M., 1969. Florida submergence curve revised: its relation to coastal sedimentation rates. Science, 163, 562-564.

Schultze, M. S., 1854. Ueber den Organismus der Polythalamien (Foraminiferen), nebst Bemerkungen über die Rhizopoden im Allgemeinen. Leipzig, Wilhelm Engelmann, 68 p.

Schulze, E. E., 1875. Zoologische Ergebnisse der Nord-seefarht vom 21 Juli bis 9 September 1872. Jb. Komm. Untersuch. Deutsch. Meere in Kiel, 1872-1873, 99-114.

Scoffin, T. P., 1972. Fossilization of Bermuda patch reefs. Science, 178, 1280-1282.

Scott, D. B., 1976a. Quantitative studies of marsh foraminiferal patterns in southern California and their application to Holocene stratigraphic problems. First Int. Symp. On Benthonic Foraminifera of continental margins, part A, Ecology and Biology. Maritime Sedimentology Special Publication, 1, 153-169.

Scott, D. B., 1976b. Brackish-water foraminifera from southern California and description of *Polysaccammina ipohalina* n. gen., n. sp. Journal for Foraminiferal Research, 6, 312-321.

Scott, D. B., and Hermelin, J. O. R., 1993. A device for precision splitting of micropaleontological samples in liquid suspension. Journal of Paleontology, 67 (1), 151-154.

Scott, D.B., and Medioli, F.S., 1978. Vertical zonation of marsh foraminifera as accurate indicators of former sea-levels. Nature, 272, 528-531.

Scott, D.B., and Medioli, F.S., 1980a. Quantitative studies of marsh foraminiferal distributions in Nova Scotia and comparison with those in other parts of the world: implications for sea level studies. Cushman Foundation for Foraminiferal Research Special Publication, 17, 58 p.

Scott, D. B., and Medioli, F. S., 1980b. Living VS. total foraminiferal populations: their relative usefulness in paleoecology. Journal of Paleontology, 54 (4), 814-831.

Scott, D. B., Brown, K., and Collins, E. S., 1995b. A new sea-level curve from Nova Scotia: evidence for a rapid acceleration of sea-level rise in the late mid-Holocene. Canadian Journal of Earth Sciences, 32, 2071-2080.

Scott, D. B., Gayes, P. T., and Collins, E. S., 1995a. Mid-Holocene precedent for a future rise in sea-level along the Atlantic coast of North America. Journal of Coastal Research, 11 (3), 615-622.

Scott, D. B., Hasegawa, S., Saito, T., Ito, K., and Collins, E., 1995c. Marsh foraminiferal and vegetation distributions in Nemuro Bay wetland areas, eastern Hokkaido. Transactions and Proceedings of the Palaeontological Society of Japan, N.S., 180, 282-295.

Scott, D.B., Piper, D.J.W., and Panagos, A.G., 1979. Recent salt marsh and intertidal mudflat foraminifera from the western coast of Greece. Rivista Italia Paleontologia, 85(1), 243-266.

Scott, D. B., Reinhardt, E. G., McCarthy, F. M. G., Patterson, R. T., and Asioli, A., 1998. Detecting environmental effects using benthic foraminifera and thecamoebians. Geological Society of America Short Course, 178 p.

Scott, D. B., Schafer, C. T., and Medioli, F. S., 1980. Eastern Canadian estuarine foraminifera: a framework for comparison. Journal of Foraminiferal Research, 10 (3), 205-234.

Scott, D.B., Schnack, E.J., Ferrero, L., Espinosa, M., and Barbosa, C.F., 1990. Recent marsh foraminifera from the east coast of South America: comparison to the Northern Hemisphere. In Hemleben et al. (eds): Paleoecology, Biostratigraphy, Paleooceanography, and Taxonomy of agglutinated foraminifera, Kluwer Acad. Publ., Netherlands, Proceedings of NATO ASI/Series C, v. 327, p. 717-738.

Scott, D. B., Suter, J., and Kosters, E. C., 1991. Marsh foraminifera and arcellaceans of the lower Mississippi Delta: controls on spatial distributions. Micropaleontology, 37 (4), 373-392.

Scott, D. B., Williamson, M. A., and Duffett, T. E., 1981. Marsh foraminifera of prince Edward Island: their recent distribution and application for former sea level studies. Maritime Sedimentology and Atlantic Geology, 17, 98-129.

Shennan, I.A., Scott, D.B., Rutherford, M..and Zong, V., 1999. Evidence of presubsidence just before the Great Alaska 1964 earthquake: Quaternary International (accepted Jan. 1998).

Seiglie, G. A., 1965. Some observations on Recent foraminifers from Venezuela, Part 1: Contributions from the Cushman Foundation for foraminiferal Research, v. 16, p. 70-73.

Sen Gupta, B. K., and Schafer, C. T., 1973. Holocene benthonic foraminifera in leeward bays of St. Lucia, West Indies. Micropaleontology, 19 (3), 341-365.

Sidebottom, H.,1904. Report on the recent foraminifera from the coast of the island of Delos (Grecian Archipelago). Manchester Lit. Phil. Society, 48 (2), 1-26. 68 (5), p. 8.

Silvestri, A., 1904. Ricerche strutturali su alcune forme dei trubi di Bonfornello (Palermo). Mem. Pont. Accad. Nuovi, Lincei, 22, 235-276.

Silvestri, A., 1937. Foraminiferi dell' Oligocene e del Miocene della Somalia. Palaeontographia Italica, 32, (suppl. 2), 45-264.

Sket, B. and Iliffe, T.M., 1980. Cave fauna of Bermuda. International Revue der gesamten Hydrobiologie, 65, 871-882.

Stanley, D. J. and Swift, D. J. P., 1968. Bermuda's reef-front platform: bathymetry and significance. Marine Geology, 6, 479-500.

Stapor, F. W., Mathews, T. D., and Lindfors-Kearns F. E., 1991. Barrier-island progradation and Holocene sea-level history in southwest Florida. Journal of Coastal Research, 7 (3), 815-838.

Stein, S. F. N. von, 1859. Uber die ihm aus eigener Untersuchung bekannt gewordenen Sûswasser-Rhizopoden. Konigliche Böhmishce Gesellschaft der Wissenschaften Abhandlungen Serie 5 (10), Berichte der Sectionen, 41-43.

Steinker, D. C., 1977. Foraminiferal studies in tropical carbonate environments: South Florida and the Bahamas. Florida Sciences, 40, 46-61.

Steinker, D. C., 1980. Nearshore foraminifera from Bermuda. The Compass, 57 (4), 129-148.

Steinker, D.C. and Butcher, W. A., 1981. Foraminifera from mangrove shores, Bermuda. Micron, 12, 223-224.

Steinker, D. C. and Clem, K. V., 1984. Some nearshore foraminiferal assemblages from phytal substrates and bottom sediments, Bermuda. The Compass, 61 (3), 98-115.

Steinker, P. J. and Steinker, D. C., 1976. Shallow-water foraminifera, Jewfish Cay, Bahamas. Marine Sedimentology Special Publication, 1, 171-180.

Steinker, D. C., Weis, B. R., and Waszczak, R. F., 1977. Foraminiferal assemblages associated with South Florida coral reefs. Proceedings of the Third International Coral Reef Symposium, Rosentiel School of Marine and Atmospheric Science, University of Miami, Florida, May 1977, 79-85.

Stuiver, M., and Reimer, P. J., 1987. User's guide to the program CALIB and DISPLAY 2.1. Seattle, Quaternary Isotope Lab, University of Washington.

Stuiver, M. and Reiner, P.J., 1986. A computer program for radiocarbon age calibration. Radiocarbon, 28, 1022-1030.

Terquem, O., 1876. Essai sur le classement des animaux qui vivent sur la plage et dans les environs de denkerque, pt. 1. Memoire de la Société Dunkerquoise pour l'Encouragement des Sciences des Lettres et des Arts (1874-1875), 19, 405-457.

Ters, M., 1987. Variations in Holocene sea-level on the French Atlantic coast and their climatic significance. In: Rampino, M. R., Sanders, J. E., Newmann, W. S., and Konigsson, L. K. (Editors), Climate: history, periodicity and predictability. Van Nostrand Reinhold Company N. Y., 204-237.

Thalmann, H.E.,1932. Die Foraminiferen-Gattung *Hantkenia* Cushman, 1924, und ihre regional-stratigraphische Verbreitung. Eclogae Geologicae Helvetiae, 25(2), p. 304.

Thalmann, H.E., 1952. Bibliography and index to new genera, species and varieties of foraminifera for the year 1951. Journal of Paleontology, 26, 847-876.

Thomas, M. L. H. and Logan, A., 1992. A guide to the ecology of shoreline and shallow-water communities of Bermuda. Bermuda Biological Station for Research Special Publication, 30, 345 p..

Thomas, M., L., H. and Stevens, J.-A., 1991. Communities of constructional lips and cup reef rims in Bermuda. Coral Reefs, 9, 225-230.

Thomas, M.L.H. and Wassmann, P., 1992. Characteristics of Spittal Pond, a unique, polluted, marine pond in Bermuda. Caribbean Journal of Science, 28(1-2), 81-88.

Todd, R., 1965. The foraminifera of the tropical Pacific collections of the "Albatross" 1899-1900. United States National Museum Bulletin, 161 (4), 139 p.

Todd, R., and Bronnimann, P., 1957. Recent foraminifera and thecamoebina from the eastern Gulf of Paria. Cushman Foundation for Foraminiferal Research, Special Publication, 3, 43 p.

Todd, R., and Low, D., 1971. Foraminifera from the Bahama Bank west of Andros Island. United States Geological Survey Professional Paper 683-C, 1-22.

Triffelman, N. J., Hallock, P., Hine, A. C., and Peebles, M. W., 1991. Distribution of foraminiferal tests of Serranilla Bank, Nicaraguan Rise, Southwestern Caribbean. Journal for Foraminiferal Research, 21 (1), 39-47.

Upchurch, S. B., 1970. Sedimentation on the Bermuda platform. United States Army Corps of Engineering, United States Lake Survey Research Report RR 2-2, Detroit, 172 p.

Vacher, H. L., and Hearty, P., 1989. History of stage 5 sea level in Bermuda: review with new evidence of a brief rise to present sea level during substage 5A. Quaternary Science review, 8, 159-168.

van de Plaasche, O., van der Borg, K., and de Jong, A.F.M., 1998. Sea-level climate correlation during the past 1400 yrs. Geology, 26 (4), 319-322.

Vella, P., 1957. Studies in new Zealand foraminifera: Paleontological Bulletin, Wellington, 28, 1-64.

Verrill, A. E., 1900. Notes on the geology of the Bermudas. American Journal of Science, 4 (159), 313-340.

Walker, G., and Boys, W., 1784. Testacea minuta variora, nuperrime detecta in arena littoris Sandvicensis a Gul. Boys arm. S.A.S. Multa addidit, et omnium figuras ope microscopii ampliatus accurate delineavit Geo. Walker, London, March, 1-25.

Walker, G., and Jacob, E., 1798. In Karmacher, F. (ed.): Adam's essays on the microscope, 2nd edition, Dillon and keating, London, 712 p.

Walton, W. R., 1952. Techniques for recognition of living foraminifera. Contributions of the Cushman Foundation for Foraminiferal Research, 3, 56-60.

Wanless, H. R., 1982. Sea-level is rising, so what? Journal of Sedimentary Petrology, 52 (2), 1051-1054.

Wantland, K. F., 1975. Distribution of Holocene benthonic foraminifera on the Belize Shelf. In Wantland, K. F. and Pursey III, W. C. (eds.): Belize Shelf - carbonate sediments, clastic sediments, and ecology. American Association of Petroleum Geologists Studies in Geology, 2, 332-399.

Warren, A. D., 1957. Foraminifera of the Buras-Scofield Bayou region, southeast Louisiana. Contributions of the Cushman Foundation for Foraminiferal Research 8, 29-40.

Waszczak, R. F., and Steinker, D. C., 1987. Paleoenvironmental and paleoecologic implications of recent foraminiferan distributional patterns in the lower Florida Keys. Miami Geology Memoir, 3, 225 p.

Weiss, B. R., and Steinker, D. C., 1977. Foraminifera from patch reef and outer sediments, lower Florida Keys. The Compass, 54 (4), 87-105.

Wetmore, K. L., and Plotnick, R. E., 1992. Correlations between test morphology, crushing strength, and habitat in *Amphistegina gibbosa, Archaias angulatus*, and *Laevipeneroplis proteus* from Bermuda. Journal for Foraminiferal Research, 22 (1), 1-12.

Wiesner, H., 1931. Die foraminiferen der deutschen Sudpolar Expedition. Deutsche Sudpolar Expedition 1901-1903, herausgegeben von Erich von Drygalski 20, zoologisches 12, 53-165.

Williamson, W. C., 1858. On recent foraminifera of Great Britain. Ray Society London, 107 p.

Wood, S.V., 1842. A catalogue of shells from the Crag: Annals and Magazine of Natural History, 1(9), 455-462.