MEMOIR 1: MIAMI GEOLOGICAL SOCIETY

A SYMPOSIUM OF RECENT SOUTH FLORIDA FORAMINIFERA

by

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THE ABUNDANCE AND DISTRIBUTION OF FORAMINIFERS IN A BACK-REEF ENVIRONMENT, MOLASSES REEF, FLORIDA

by

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ABSTRACT

Living and dead Foraminifers were examined from 53 samples collected along an 11 station traverse in a back-reef environment in the Florida Keys. Foraminiferal populations occurring in the sediment and on the vegetation were examined at each location.

The larger number of individuals counted and the closeness of the sampling locations yielded a high degree of precision. Samples taken only a few feet apart prove to be from statistically different populations in almost every case. However, the variation between adjacent samples is less than that between widely spaced samples. The variation in abundance between adjacent samples is due to the presence of microenvironments.

The Foraminifers are typical, shallow water, marine, tropical forms. The depth distribution of Uvigerina peregrina and Pyrgo subsphaerica is extended into shallow water. One new species is described.

The distribution of the total population and the distribution of certain species can be correlated with the grain size distribution of the sediments. Current movement is a major factor governing the distribution of the sediments and also the distribution of some of the foraminiferal tests.

In areas lacking a vegetative cover there are few living Foraminifers present in the sediment. In areas with a vegetative cover more living Foraminifers are found on the vegetation than on the bottom. Most of the Foraminifers live attached to the vegetation and settle to the bottom after death. There is a correlation between the distribution of living species and the empty tests.

The specimens are slightly smaller than is typical for these species due to the high temperature of the water. The species are well adapted to the environment as test structures and niche selection provide protection from water movements.

INTRODUCTION

Reefs, their ecology, the distribution of their sediments, and their influence on geologic environments have been widely studied in recent years. Reefs are commonly divided into three sub-environments, fore-reef, reef, and back-reef, each of which has a characteristic structure, sediment distribution, and biologic composition. Usually, only faunal lists of Foraminifers are given for reef environments. Occasionally the abundance and distribution of the more important families is given, but the distribution and abundance of the living and dead species in reef areas has not been studied. Foraminifers are not reef constructing organisms, although they do occur on the reef proper. Certain foraminiferal taxa, however, are indicative of tropical, shallow water, marine environments, where reefs are likely to occur, and certain taxa may even be indicative of reef environments.

The purpose of this study is to determine the abundance and distribution of the Foraminifers occurring in a back-reef environment in the Florida Keys. Both the living and the dead Foraminifers were examined and the relationships between them noted. It has been shown (Shifflett, 1961) that the total population on the bottom does not necessarily represent the living population in that immediate area. Living populations must be examined in order to draw ecological conclusions.

Included within this study is a re-examination of sampling methods and sample spacing. Most collections of recent material have been made by means of grab samples or coring operations from sampling locations spaced a mile or more apart. An individual sample which represents, on the average, no more than 18 cm^2 of bottom is assumed to contain a foraminiferal population which is representative of the population found in an area of several square miles. In this study, several adjacent samples were taken at each station and a comparison made between them in order to test the validity of the assumption that the distribution of specimens in one sample can be extrapolated to represent an area.

PREVIOUS INVESTIGATIONS

The Foraminifers of the Atlantic side of the Florida Keys have not been described and figured, although many of the samples taken by the Challenger expedition (Brady, 1884) and by

Cushman (1922a, 1922b, 1923, 1929, 1930, 1931) were collected in the Florida Keys area. Studies of the Florida Bay fauna (Lynts, 1962; and Bock, 1961), revealed species similar to those found on the outer side of the Keys. Stubbs (1940) gave faunal lists for Biscayne Bay. The fauna has been classified as Indo-Pacific (Cushman, 1922a) and is similar to that found in the shore sands of Cuba (d'Orbigny, 1839) and Jamaica (Cushman, 1921), and in the Phillipine Islands (Graham and Militante, 1959).

Ecologic conditions governing the distribution of Foraminifers in the Florida Keys were discussed by Norton (1930). He noted the depth distribution of various families and gave an annotated faunal list. The relative abundances of species were given. Smith, Williams, and Davis (1950) listed the physical and chemical characteristics of this area.

Moore (1957) examined the death assemblages of Foraminifers in Florida Bay and in the reef tract, but realized the importance of the transportation of tests after the death of the organisms. He also discussed familial differences between the bay, back-reef, reef, and fore-reef environments.

The earliest work on sediment parameters and sedimentary materials in this area was undertaken by Matson (1910). Thorp (1936) examined a suite of samples from the Florida-Bahama region and described the constituent particles. He realized the importance of organic detritus in the sediment and discussed the influence of energy conditions on grain size distributions. Ginsburg (1956) recognized the uniformity of conditions prevailing within each of the reef subenvironments, and presented measurements of grain size across the reef tract, noting the influence of the reef on energy conditions and sediment transportation and the effect of vegetation on sediment distribution.

METHODS OF STUDY

A 4.9 mile traverse was established off Key Largo, Florida from Rodriguez Key to Molasses Reef (Fig. 1). Samples were taken at 11 locations along the traverse on July 10-11, 1963.

The problem of sampling for benthonic microorganisms has been approached in several ways. Large area sampling devices are useful for macroorganisms, but the sample obtained is larger than generally considered necessary, and is usually disturbed. The flow of water around a large sampler as if falls to the bottom may severely disturb the sediment-water interface just before the sample is taken. Sampling devices for microorganisms usually consist of a square or circular tube with a small cross section. The sample may be taken by one or an array of these. Most of these sampling devices depend on cohension of the sediment in order to retain the sample, and do not work well in sands. The more elaborate devices have a one-way valve which permits water to pass through the tube on the way down, but remains closed on the way up, helping to retain the sample. Samples for Foraminifers have for many years been taken primarily with a device known as the Phleger Bottom Sampler. The Phleger sampler consists of a short (6-24 inch) piece of plastic core tube having an inside diameter of 1 7/8 inches and an outside diameter of 2 inches. This fits inside a metal sleeve which has at its upper end a 20-50 pound weight. When the Phleger sampler is dropped, the weight drives the tube and sleeve into the bottom, and if the sediment is cohesive, a sample will be recovered. The top centimeter of the core is cut off and used for study. This technique is very useful for a study of thanatocoenoses, but it fails to recover Foraminifers epizoic on other organisms. Because living Foraminifers have been found to be primarily epizoic on other organisms in shallow waters (Arnold, 1954; Jones, J.I., and Bock, W.D., personal communication), the Phleger sample cannot be expected to recover a representative sample of living shallow water Foraminifers.

In view of the difficulties encountered in remote sampling of living Foraminifers in shallow waters, it was decided to take the samples directly by diving. The SCUBA divers used coring tube of the same dimensions as the standard Phleger sampler. The tube is carefully worked into the bottom by the diver who first caps the top of the tube and then digs into the sediment beside the tube in order to seal the bottom with another plastic cap. In this way, the entire tube can be filled with an undisturbed sample. The advantages of this method are numerous. The collector is able to observe bottom conditions and he is able to place the tube on the bottom between any vegetative cover to insure the collection of organisms from the bottom only. There is no danger of sample contamination because each piece of tubing is used only once. Any sediment type may be sampled because the tube is sealed at both ends and there is no danger of sediment loss during ascent. The core is easily extruded from the tube and the top centimeter removed for equal volume studies on the Foraminifers.

This method is limited to the depth at which SCUBA can be used. Cores could be taken at depths as great as 200-250 feets, but time of descent and ascent, physiological limitations, and diver experience effectively limit sampling to depths less than 130 feet. Remote sampling devices are usually faster than SCUBA methods, but require the use of a large boat. The actual number of cores that can be taken per day using SCUBA depends upon the depth of water, distance between stations, and experience of the diver and boat crew. In this study, operating in water less than 40 feet deep, within 6 miles of harbor, and with experienced divers, it was possible to take 45 samples at 12 stations in less than 2 days.

The usual sampling interval is on the order of a few miles, but for this study it was decided to establish stations less than 1/2 mile apart and to take at least 3 samples at each station. Divers sampled the bottom vegetation at each station for epizoic Foraminifers by carefully sweeping it with a 250 mesh nylon net.

The top centimeter of each core and the material caught in the nylon met were placed in sample jars and preserved with a 95% ethyl alcohol solution. This was diluted by water contained in the sediment. Alcohol was chosen as the preservative rather than neutralized formalin, because formalin decomposes to produce formic acid which will react with calcareous material in the sample.

Rose Bengal solution was added to the samples. This stains protoplasm a bright red, making it possible to distinguish living from dead Foraminifers. This staining process has been described in detail by Walton (1952). In this study, the term "dead Foraminifers" refers to unstained tests, whereas the term "living Foraminifers" refers to tests stained by the Rose Bengal.

The samples were dried and sieved on a .074 mm (3.75ϕ) sieve and then split using an Otto microsplit (Otto, 1933). A sample size of at least 1000 individuals per station was desired. The samples were split until a fraction was obtained which appeared to have an adequate number of individuals. The unused fractions of each split were retained separately so that they might be used should the examined fraction prove inadequate. No more than four splits were made on any sample. Once an adequate split was obtained, the entire population of the split was counted. An attempt was made to separate the foraminiferal tests from the rest of the sediment by means of carbon tetrachloride flotation. However, examination of the residue revealed that the Foraminifers floated off were not representative of the proportions of different species present in the untreated sample. For this reason the flotation process was abandoned and the entire sample examined.

The precision with which a percentage abundance may be stated is a function of the number of observations and the observed abundance (Dixon and Massey, 1957, p. 85). This relationship may be stated as follows:

$$d = \frac{Z_{(1-.5\alpha)} \sqrt{p(1-p)}}{\sqrt{N}}$$

where:
d = possible error
Z = normal deviate from mean
α = level of significance
N = number of observations
p+= observed abundance expressed as a proportion

$\sqrt{p(1-p)}$ = approximation of the population standard deviation (σ)

Few species have an observed abundance greater than 5 percent and the average bottom sample size is 2450. Therefore, if a 5 percent level of significance is chosen:

$\alpha = .05$
N = 2450
p = .05
$Z_{(1-.5\alpha)} = 1.96$

$$d = \frac{1.96 \sqrt{.0475}}{\sqrt{2450}} = .009 = 0.9 \text{ percent}$$

Hence the observed frequency of 5 percent can be expressed with a greater precision than to the nearest percent but with less precision than to the nearest tenth of a percent. The data relating to the total population in Table 2 are given to the nearest tenth of a percent, although the data are not always this precise. The data for the living specimens in the vegetation are given to the nearest precent.

The samples were weighed and the total number of Foraminifers per gram of sediment computed. This value, which Schott (1935) called the Foraminiferal Number may be used to compare the abundance of Foraminifers in different areas. This value, because it is based on the dry weight of sediment, can be utilized in comparisons with fossil populations.

The number of species at each sampling location is a measure of population diversity. Large numbers of species may indicate the presence of a large number of ecologic niches. Because the number of observed species increases with the number of specimens observed until all species present have been detected, a direct rigorous comparison of species numbers can be made only if the same number of observations are made on each sample. As the number of observations is different for each sample in this study, further considerations must be made before any comparisons can be attempted. This problem can not be avoided by counting the same number of individuals in each sample split as this introduces bias into the counting procedure. The entire sample split must be counted in order to insure unbiased results.

The probability of observing a new species per observation decreases as the number of observations per sample increases (Fig. 2). The shape of this curve is a function of the number of species present at a given location and the relative abundance of each species at that location. At some point of the curve (A) the probability of observing additional species is small.

It is possible to determine the sample size necessary to detect a species occurring in a certain abundance at a certain level of significance (Dennison, J.M., personal communication). Because the probability of failure or success (detection of a species) is involved, a form of the binomial distribution is best suited to the problem. The Poisson distribution is chosen because the sample size (N) is very large and the proportion abundance (p) of a species is very small ($N \cdot p$ is large relative to p and N is large relative to $N \cdot p$). The equation of the Poisson distribution,

$$f(x) = \frac{e^{-N \cdot p}(N \cdot p)^x}{x!}$$

where:
x = number of success
N = sample size
p = proportion abundance
e = 2.7183

is solved for N at a given p and level of significance by setting x = 0. A series of curves comparing N and p at various levels of significance has been prepared (Dennison, in manuscript). These curves indicate that a sample size of 3000 is necessary to detect all species occurring in abundances greater than 0.1 percent with 95 percent confidence, and a sample size of 300 for abundances of 1.0 percent.

Errors might be introduced into the counting procedure through inconsistency in species recognition. In order to determine whether this inconsistency was significant, several samples were split and the specimens of both halves identified and counted. A comparison of the two halves was made with a chi-square test. In all cases the differences between the two halves should be due to chance at the 5 percent level of significance. The probability of a type β error is small due to the large sample size (500).

Errors might be introduced through inaccuracy in the sample splitting technique, but the results of the chi-square test mentioned above also indicate that the same proportion of individuals is present in each split. However, there is a possibility that a greater number of individuals might be present in one half of the split than in the other. This would not affect the relative abundances of species but would alter the Foraminiferal Number. In order to test the accuracy of the splitting technique, the number of specimens in each split was compared with the expected value. In all cases the variation from the expected value could be due to chance at the percent level of significance.

The samples were dried, weighed, and sieved in order to determine the mean grain size and the degree of sorting. The graphic mean (M_z) of Folk and Ward (1957), expressed in phi units, is used as the measure of mean grain size, and the graphic standard deviation (σ_g) of Inman (1952) is used as the measure of sorting. The more precise inclusive graphic standard deviation (σ_I) of Folk and Ward (1957) was not used because it requires the use of the coarsest particles present,

$$\sigma_I = \frac{\phi 84 - 16}{4} + \frac{\phi 95 - \phi 5}{6.6}$$

and these particles may have been derived from fragmentation of *in situ* organisms and would not necessarily reflect the energy conditions of the area.

DESCRIPTION OF AREA

The Florida reef tract is a 5-10 mile wide arc-shaped area lying just each and southeast of the Florida Keys. There is a semi-diurnal tidal exchange with the open oceanic water of the Florida Straits. The prevailing winds, which are easterly (Fig. 3), serve to provide the tract with open circulation by means of wind driven water movements. The mean tidal range at Molasses Reef is 2.2 feet. The axis of the Florida Current passes about 7 miles southeast of Molasses Reef; the water has an average velocity of 3-4.5 knots (H.O. Chart 944). Intermittent countercurrents may have some effect on water movement.

In general, material is carried from the reef to the area behind the reef by the tides and wind driven water movements, and southwestward by the counter current. The velocity of the water movement has been measured near Rodriguez Key by Vaughn (1935) as 0.3 knot.

Winds in excess of 15 miles per hour produce a condition known as white water. The fine sediment is stirred up and remains in suspension for some period of time, giving the water a white color. The areas nearest the Keys are most affected by this phenomenon. The water returns to its usual brilliant transparency a few days after the winds subside. As there are no tidal inlets in the vicinity of the traverse, the tidal exchange with Florida Bay has little effect on the turbidity.

The seasonal temperature variation of the water near the Keys appears to be greater than the variation near the reef. Smith, Williams, and Davis (1950) found a variation from 19.2^{o} -32.3^{o}C. near the Keys and a variation from 24.4^{o} -29.8^{o}C. near the reef.

The salinity variation is also less in areas near the reef than in areas closer to the Keys. Smith, Williams, and Davis (1950) found a variation from 34.43-37.40 o/oo near the Keys and a variation from 35.25-36.50 o/oo near the reef. The greater variations in salinity are expected in the shallow water near shore. Dilution by rain and runoff lowers the salinity during part of the year, whereas the salinity increases during the dryer season (November-April).

Phosphate and nitrite concentrations are low and sometimes undetectable (Smith, Williams, and Davis, 1950). The absence of phosphate may be due to utilization by phytoplankton and the absence of replenishment from phosphate-rich deeper ocean water. The nitrite is probably utilized by the phytoplankton as rapidly as it can be produced by the decay of the vegetation. Low concentrations of phosphate and nitrite are common in tropical waters. The water is almost completely saturated with oxygen and sometimes supersatruated (Smith, Williams, and Davis, 1950).

The deepest parts of the back-reef environment range from 30-40 feet and the shallowest areas are awash at low tide. The bottom profile along the sampled traverse is shown in Figure 4.

The bottom is covered with turtle grass, *Thalassia testudinum*, and occasionally *Sargassum* sp. Scattered areas have no vegetative cover. These sand patches lie 1-2 feet lower than the surrounding vegetation covered areas. Green algae such as *Halimeda*, *Penicullus*, and *Udotea* are abundant. The red algae *Goniolithon* and *Amphiroa* are locally abundant. Corals, echinoderms, bryozoa, basket sponges, and a large variety of mollusks comprise the larger invertebrate macrofauna.

The sediments consist almost entirely of clastic carbonate grains, consisting primarily of skeletal fragments. The most abundant organic constituent is calcareous algae detritus. The rest of the sediment consists primarily of mollusk and coral fragments and Foraminifers. Because the sediment is almost wholly calcium carbonate, variations in mineralogy should have no effect on the distributions and abundances of the various species within the environment.

The relationship of the mean grain size and the sorting to distance from the reef is shown in Figures 5 and 6. The samples from the sand patches are also plotted. Regression lines were fitted to the data and tested for a significant slope at the 5 percent level of signficance. The mean grain size exhibits a significant decrease with distance from the reef. This is due to the decrease in energy away from the reef. Wind driven water moves over the shoaling reef and winnows the finer sediment and carries it landward. The sediment in the sand patches has a mean grain size which differs significantly (t-test for difference of two means; 95% confidence) from that of the areas covered by vegetation. This is due to the effect of the vegetative cover which acts as a sediment trap by slowing the currents passing over it. The barren areas are subjected to more intense current movement which can transport coarser particles.

The sediment is better-sorted near the reef. This may be due to greater selective sorting near the high-energy reef environment. Particles smaller than a certain size are carried shoreward, and are deposited in the more protected areas, providing a wider ranger of grain sizes in this area.

Although the graphic standard deviation and the graphic mean are theoretically independent of one another, numerous studies have shown a distinct relationship between them (Krumbein and Aberdeen, 1937; Hough, 1942), probably due to the non-normality of the sediment size distribution. Figure 7 shows the relationship between the mean grain size and the sorting in the samples examined. There is a vague correlation between the two parameters. The finer the mean grain size, the poorer the sorting. This is probably due to the energy conditions described above.

The relationship between depth and the sediment parameters is shown in Figure 8. The slopes of the regression lines are not significant and there appears to be no relationship between the sediment parameters and depth.

A summary of the station locations, water depths, vegetation type, sediment parameters, and foraminiferal abundance is given in Table 1.

OCCURRENCE AND DISTRIBUTION OF FORAMINIFERS

A summary of foraminiferal population data for each station is given in Table 2. The presence of dead individuals in the vegetation may be due to any of three factors: 1) individuals, upon death, may remain attached to the vegetation; 2) the movement of the sampling net through the vegetation may have stirred up bottom sediment, although there was very little non-foraminiferal material in the samples; 3) the staining method may not be adequate for the recognition of all living forms. It is possible that some species are so securely attached to the vegetation that they would not be easily removed by a sweeping motion. The abundance and distribution of the Foraminifers found in the bottom samples and living on the vegetation is given in Table 3.

The relationships between the Foraminiferal Number and distance, mean grain size, sorting, and depth are shown in Figures 9-11. A summation of the relationships between measurable parameters is given in Figure 12. There is a significant increase in the Foraminiferal Number with distance from the reef. This increase is probably not due to water depth (Fig. 11) because the relatively small variations in depth encountered in this area would have little effect on vegetation type and abundance, light penetration, nutrient abundance, or temperature and pressure conditions, all of which could effect the foraminiferal abundance and distribution. The Foraminiferal Number is not a function of the sorting of the sediment (Fig. 10). There is however, a marked relationship between the mean grain size and the abundance of Foraminifers (Fig. 10).

The Foraminiferal Number varies directly with distance from the reef and inversely with the mean grain size. The correlation between Foraminiferal Number and mean grain size does not imply a cause-effect relationship as the abundance of Foraminifers and the mean grain size are both functions of wave and current action. Figure 5 shows that there is a significant decrease in mean grain size with distance. Most of the Foraminifers examined were from 2.50-1.25 phi units in size. The winnowing of fine sediment near the reef also removes small foraminiferal tests. As has been shown, the energy conditions are such that material is moved from the reef shoreward. Transportation after death is an important factor in determining the final distribution of the tests (Illing, 1950) and in some cases may be as important as the ecologic niche occupied by the living species. It was with these considerations in mind that the Foraminifers from the the vegetation were collected and examined spearately from the bottom samples.

Many of the specimens are smaller than is typical of members of their species. If these assemblages were found fossil, they might be described as a dwarfed fauna. The usual correlation of dwarfed faunas with unfavorable environmental conditions made from observations on higher invertebrates would not be justified in this case. As Loeblich and Tappan (1964, p. 125-126) have suggested, "dwarfed" foraminiferal faunas may be a result of favorable conditions for reproduction, and larger tests may result from prolonged periods of vegetative growth and a slower reproductive rate under less favorable conditions.

The abundances of the more common species are shown in Graphs 1-24. The total abundance in the bottom samples is plotted as well as the abundance of the living specimens in the vegetation. Visual comparisons can be made between the distribution of the living organisms and the distribution of tests in the sediment.

A few species are ubiquitous and equally abundant throughout the area. These species are:

Miliolinella circularis
Quinqueloculina akneriana
Quinqueloculina laevigata
Triloculina bassensis
Triloculina linneiana
Peneroplis proteus

Most species exhibit a non-random distribution. Some are more abundant near the reef. These Species are:

Textularia agglutinans
Articulina pacifica
Archaias angulatus
Discorbis rosea
Rosalina floridana
Asterigerina carinata
Cibicides pseudoungeriana
Cybaloporetta squammosa

Amost half of the common species are more abundant near shore. These species are:

Clavulina tricarinata
Valvulina oviedoiana
Scutuloris bocki
Quinqueloculina agglutinans
Quinqueloculina bidentata
Quinqueloculina bosciana
Quinqueloculina bardyana
Quinqueloculina lamarckiana
Triloculina bermudezi
Peneroplis carinatus
Discorbis mira
Ammonia beccarii tepida
Cribroelphidium poeyanum
Elphidium advenum

Several species exhibit one or more peaks of abundance along the traverse. These species are:

Quinqueloculina funafutiensis
Quinqueloculina poeyana
Quinqueloculina tenagos
Triloculina trigonula
Sorites marginalis
Sagrina pulchella
Rosalina candeiana
Ammonia avalonensis

Most of the Foraminifers occurring in this environment appear to live attached to the vegetation. The vegetation reduces the effect of water movement and offers a place of attachment for the individuals. The test structure and mode of life of the species must be adapted to the changing conditions of a shallow water environment. The flattened test of Discrobis, Rosalina, and Spirillina and the discoidal test of Sorites are able to withstand high energy conditions despite their delicate nature. Cibicides and Planorbulina are able to attach themselves to the substrate or to vegetation with the ventral surface assuming the shape of the object on which it rests. The depressed streamlined test of Peneroplis offers little resistance to water movement. The thick, lens-shaped tests of Elphidium and Amphistegina also provide protection from water movement.

The distribution and abundance of the Foraminifers on the bottom is related to their occurrence in the vegetation. In most cases the region of greatest abundance on the bottom lies shoreward from the area of greatest abundance of living forms in the vegetation (Graphs, 7, 14, 15, 20, 21, and 23). As the prevailing current and tidal movement is shoreward, this distribution is to be expected, because the tests will be transported shoreward after death. In a few cases the greatest bottom abundance lies reefward from the greatest vegetation abundance (Graphs 1 and 17). In all of these apparently anomalous cases living specimens were found at only one station and the information may be insufficient for any valid conclusions. Several species have a living distribution which corresponds very well with the distribution of the tests on the bottom (Graphs 10, 11, 12).

Textularia agglutinans (Graph 1) occurs on the exposed margins of the Bahama Banks (Illing, 1952), an environment similar to the area just shoreward from the reef. Clavulina tricarinata (Graph 2) is commonly found in protected areas near shore (Norton, 1930).

Triloculina trigonula was found to have its greatest abundance near shore by Norton (1930) and is found in a similar position in this study (Graph 11). Davis (1964) found Amphistegina lessonii and Archaias angulatus to be common species on Alacran Reef. These species are also most abundant near the reef examined in this study (Graphs 24 and 13). Wilcoxon (1964), Bandy (1954), and Norton (1930) found Ammonia beccarii tepida occurring in very shallow water near shore. It occupies a similar position near Rodriguez Key (Graph 21).

Parker (1954) reported Bulimina spicata, Eggerella bradyi, and Uvigerina peregrina only at depths greater than 390 feet. Uvigerina peregrina was also found only in deep water by Norton (1930). Pyrgo subsphaerica (Parker, 1948; Wilcoxon, 1964) and Reussella altantica (Phleger, 1960) have been recorded only from depths greater than 300 feet.

Bulimina spicata, Eggerella bradyi, and Reussella atlantica occur only rarely in the bottom population and no living specimens are found along the Rodriguez Key-Molasses Reef traverse. These species probably do not ordinarily inhabit this environment. The specimens that were examined are much smaller than is typical for the species. It is possible that these were young individuals which were brought to the surface by upwelling currents and then swept over the reef by surface currents. Uvigerina peregrina, and Pyrgo subsphaerica occur throughout the area (Table 3) and are present as living specimens on the bottom and in the vegetation although never in great abundance. These species appear to have a greater bathymetric range than previously reported.

Figure 13 shows the distribution of the more abundant families. The Miliolidae exhibit a decrease in abundance from the shore to the reef. The Ataxophragmiidae are abundant only near shore whereas the Amphisteginidae are abundant only near the reef. The abundance of the Elphididae decreases toward the reef and the Discorbidae increase in abundance toward the reef. These trends are common in reef environments (Davis, 1964; Henson, 1950).

The presence of vegetation has a pronounced effect on the abundance of Foraminifers. As seen in Table 1 the number of Foraminifers per gram of sediment in the sand patches (Samples 9 and 10) is lower than in the areas covered with vegetation. This is due to the sheltering effect of the vegetation, which provided a place of attachment for the individuals. The vegetation also acts as a sediment trap, decreasing the water velocity and collecting more sediment than adjacent barren areas over which currents can pass undisturbed. As has been shown, the mean grain size of the sand patches is significantly greater than that of the covered areas. There are, therefore, fewer Foraminifers in the sand patches for both mechanical and ecological reasons. The type of vegetation does not appear to have an effect on the abundance of Foraminifers although there is not enough control to firmly establish this supposition.

The relationships between the sediment parameters and total abundance of Foraminifers has been previously discussed. In view of these relationships there ought to be some correlation between the distribution of certain species and the grain size. Tests of larger species such as Archaias angulatus, Valvulina oviedoiana, Quinqueloculina agglutinans, and Discorbis rosea are more abundant in the sand patches than in adjoining areas. Test of smaller species such as Miliolinella circularis, Artciulina pacifica, Schlumbergerina alveoliniformis, Ammonia beccarii sobrina, and Ammonia beccarii tepida are less abundant in the sand patches than in the adjoining vegetated areas.

The three samples from each location were compared with one another by means of a contingency table (Siegel, 1965, p. 175). The results of this test are shown in Table 4. With the exception of Sample 8 and perhaps Sample 10a, the three adjacent bottom samples taken at each station represent statistically different populations. The same species are present in all three samples but the number of individuals of each species is significantly different, although the adjacent samples taken at each station come from an apparently homogenous bottom community. The quantitative variation between sampling locations is greater than that between adjacent samples at the same location.

CONCLUSIONS

Closely spaced multiple samples are necessary for the quantitative description of foraminiferal populations in shallow water, whereas widely spaced single samples suffice for the characterization of the species present in an environment.

Carbon tetrachloride as a means of concentrating Foraminifers for quantitative examinination is questioned. Not only is the proportion of certain species changed by the process, but some species do not float and are not even present in the concentrate.

The inadequacies of the Rose Bengal staining technique are not fully known and rigorous quantitative work based on living populations identified by this method must be utilized with care until these inadequacies are better understood.

Because the samples were dried prior to sieving, fragile forms may have been destroyed. Tests smaller than .074mm were also lost because of the sieving technique used.

There is no "correct" number of Foraminifers which must be counted in order to provide accurate results. The operator must decide on the precision desired and chose the sample size accordingly. Care must be taken that the data are not presented in such a manner as to imply a greater precision than is warrented by the sample size.

The Foraminifers found in the back-reef environment are typical shallow water tropical forms and with the exception of Amphistegina lessonii, are not restricted to reef environments. The bathymetric distribution of Uvigerina peregina and Pyrgo subsphaerica are extended into shallow water.

The following species are common to the back-reef environment examined in this study, but are not confined to the back-reef and should not be considered unique to this environment:

Scutuloris bocki
Schlumbergerina alveoliniformis
Quinqueloculina bosciana
Quinqueloculina bradyana
Peneroplis carinatus

Archaias angulatus
Sorites marginalis
Rosalina candeiana

The Foraminifers appear to live primarily in the vegetation, usually attached to blades of *Thalassia*. The population of foraminiferal tests on the bottom is a death assemblage. The distribution of the bottom population is a function of both the distribution of the living individuals and the factors acting on the tests after death. Transportation by current movement is a significant factor in the final distribution of the tests. Most of the tests have remained in the proximity of their original niche or have been transportated shoreward. Selective solution of tests after deposition on the bottom may also affect the distribution and abundance.

The temperature of the water is somewhat higher than the optimum temperature for reproduction. This may account for the numerous undersized individuals which are present.

Vegetation appears to be necessary to the habitat of the Foraminifers described in this study. The vegetation offers shelter and a place of attachment. Vegetation type and density may affect the distribution and abundance of Foraminifers, but the data are insufficient for any conclusions.

The Foraminifers in the back-reef environment are well adapted to life in shallow water. They are able to attach themselves to substrate or vegetation or to provide themselves with tests which will withstand vigorous water movements.

FAUNAL LIST

The benthonic foraminiferal fauna consists of 117 species belonging to 60 genera. A brief synonmy is given for each species as well as its abundance and distribution. The frequencies given refer to the total population in the sediment. Classification is based on Loeblich and Tappan (1964).

FAMILY HORMOSINIDAE

SUBFAMILY HORMOSININAE

Reophax atlantica (Cushman)

Proteonina atlantica Cushman, 1944, Cush. Lab. Foram. Res., Spec. Publ. 12, p. 5, Pl. 1, Fig. 4.

Hypotypes: T-1611, T-1611-A

This species occurs sporadically along the traverse. It is rare; frequencies are less than 1 percent.

FAMILY RZEHAKINIDAE

Miliammina fusca (Brady)

Quinqueloculina fusca Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. 6, p. 47, Pl. 11, Figs. 2-3.

Miliammina fusca (Brady), Phleger and Walton, 1950, Amer. Jour. Sci., vol. 248, p. 47, Pl. 1, Fig. 19.

Hypotype: T-1612

This species is ubiquitous and occurs with frequencies less than 2 percent. Living specimens are found in the vegetation and on the bottom.

FAMILY LITUOLIDAE

SUBFAMILY HAPLOPHRAGMOIDINAE

Haplophragmoides sp.

Hypotype: T-1613

The specimens are small and poorly preserved. No attempt at specific identification was made. The forms are somewhat more common near the reef although they never occur in frequencies greater than 1 percent.

SUBFAMILY LITUOLINAE

Ammobaculites exilis Cushman and Brönniman

Ammobaculites exilis Cushman and Brönnimann, 1948, Cush. Lab. Foram. Res., Contr., vol. 24, p. 39, Pl. 7, Fig. 9.

Hypotype: T-1614

This species occurs only sporadically and in frequencies less than 1 percent.

FAMILY TEXTULARIIDAE

SUBFAMILY TEXTULARIINAE

Bigenerina irregularis Phleger and Parker

Bigenerina irregularis Phleger and Parker, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 4, Pl. 1, Figs. 16-21.

Hypotype: T-1615

Only one specimen of this species was observed.

Textularia agglutinans d'Orbigny

Textularia agglutinans d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 144, Pl. 1, Figs. 17-18, 32-34.

Hypotypes: T-1616, T-1616-A

This species is ubiquitous and occurs in frequencies up to 3 percent. It is more common near the reef (Graph 1). Living specimens are found in most bottom samples and in one sample from the vegetation.

FAMILY TROCHAMMINIDAE

SUBFAMILY TROCHAMMININAE

Trochammina advena Cushman

Trochammina advena Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 20, Pl. 1, Figs. 2-4.

Hypotype: T-1617

This species is distributed sporadically and is rare with frequencies less than 1 percent.

FAMILY ATAXOPHRAGMIIDAE

SUBFAMILY GLOBOTEXTULARIINAE

Eggerella bradyi (Cushman)

Verneuilina pygmaea Brady, 1884 (not Bulimina pygmaea Egger. 1857), Rept. Voy. Challenger, Zool., vol. 9, p. 385, Pl. 47, Figs. 4-7.

Verneuilina bradyi Cushman, 1911, U.S. Nat. Mus., Bull. 71, pt. 2, p. 54.

Eggerella bradyi (Cushman), Cushman, 1933, Cush. Lab. Foram. Res., Contr., vol. 9, p. 33.

Only one specimen of this species was found.

SUBFAMILY VALVULININAE

Clavulina nodosaria d'Orbigny

Clavulina nodosaria d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 110, Pl. 2, Figs. 19-20.

Hypotype: T-1618

This species occurs only near shore in frequencies less than 1 percent.

Clavulina pacifica Cushman

Clavulina pacifica Cushman, 1924, Carnegie Inst. Wash. Publ. 342, p. 22, Pl. 6, Figs. 7-11.

Hypotype: T-1619

This species occurs only near shore in frequencies less than 1 percent. Living specimens are present at Station 1 both on the bottom and in the vegetation.

Clavulina tricarinata d'Orbigny

Clavulina tricarinata d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 114, Pl. 2, Figs. 16-18.

Hypotype: T-1620

This species is most common near shore, but is present throughout the traverse. It occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation (Graph 2).

Valvulina oviedoiana d'Orbigny

Valvulina oviedoiana d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 103, Pl. 2, Figs. 21-22.

Hypotype: T-1621

This species is most common near shore, but is present throughout the area. It occurs in frequencies less than 2 percent. Living specimens occur both on the bottom and in the vegetation.

FAMILY NUBECULARIIDAE

SUBFAMILY OPHTHALMIDIINAE

Wiesnerella auriculata (Egger)

Planispirina auriculata Egger, 1893, Abhandl, k. bay. Akad. Wiss., München, vol. 18, pt. 2, p. 245, Pl. 3, Figs. 13-15.

Wiesnerella auriculata (Egger), Cushman, 1933, Cush. Lab. Foram. Res., Contr., vol. 9, p. 33.

Hypotypes: T-1622, T-1622-A

This species is not present near shore, but occurs elsewhere in frequencies less than 2 percent. Living specimens are present on the bottom.

SUBFAMILY SPIROLOCULININAE

Spiroloculina antillarum d'Orbigny

Spiroloculina antillarum d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 166, Pl. 9, Figs. 3-4.

Hypotype: T-1623

This species is ubiquitous and occurs in frequencies less than 1 percent.

Spiroloculina caduca Cushman

Spiroloculina caduca Cushman, 1922, Carnegie Inst. Wash. Publ. 311, p. 61, Pl. 11, Figs. 3-4.

Hypotype: T-1624

This species is present only near shore and is very rare.

Spiroloculina communis Cushman and Todd

Spiroloculina excavata Brady, 1884 (not d'Orbigny, 1846), Rept. Voy. Challenger, Zool., vol. 9, p. 151, Pl. 9, Figs. 5-6.

Spiroloculina impressa Brady, 1884 (not Terquem, 1878), ibid., p. 151, Pl. 10, Figs. 3-4.

Spiroloculina communis Cushman and Todd, 1944, Cush. Lab. Foram. Res., Spec. Publ. 11, p. 62, Pl. 8, Figs. 26-28.

Hypotype: T-1625

This species is very rare and is sporadically distributed.

FAMILY MILIOIDAE

SUBFAMILY MILIOLINELLINAE

Miliolinella circularis (Bornemann)

Triloculina circularis Bornemann, 1885, Zeitschr. deutsch. geol. Ges., vol. 7, pt. 2, p. 349, Pl. 19, Fig. 4.

Miliolinella circularis (Bornemann), Asano, 1951, Illus. Cat. Jap. Tert. Small. Foram., pt. 6, p. 9, Figs. 65-67.

Hypotype: T-1626

A costate variety (figured here) and a smooth variety are combined under this specific taxon. This species is ubiquitous and is present in frequencies less than 4 percent. Living species are present on the bottom and in the vegetation (Graph 3).

Miliolinella fichteliana (d'Orbigny)

Triloculina fichteliana d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 171, Pl. 9, Figs. 8-10.

Hypotype: T-1659

This species is more common away from the shore and occurs in frequencies less than 1 percent. Living specimens are present on the bottom.

Miliolinella labiosa (d'Orbigny)

Triloculina labiosa d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 178, Pl. 10, Figs. 12-14.

Miliolinella labiosa (d'Orbigny),Said, 1950, Cush. Lab. Foram. Res., Contr., vol. 1, p. 5, Pl. 1, Fig. 10.

Hypotypes: T-1628, T-1632

This species is present in most samples and occurs in frequencies less than 3 persent. One living specimen was found in the vegetation.

Scutuloris bocki nov. sp.

Triloculina oblonga (Montagu), Cushman, 1921, U.S. Nat. Mus., Bull. 100, pt. 4, p. 459, Pl. 92, Fig. 3.

Milioinella oblonga (Montagu), Asano, 1951, Illus. Cat. Jap. Tert. Small. Foram., pt. 6, p. 10, Figs. 68-69.

Miliolinella? sp. Miller, 1953, Cush. Found. Foram. Res., Contr., vol. 4, pt. 2, p. 53, Pl. 7, Fig. 11.

Miliolinella sp. A. Todd and Brönniman, 1957, Cush. Found. Foram. Res., Sp. Publ. 3, p. 28, Pl. 3, Figs. 23-24.

Holotype: X1233 University of Illinois Type Collection

Paratype: X1234

Type stratus: Recent

Description. Test free, medium size, calcareous, porcelaneous, imperforate: translucent to white; outline elliptical, periphery smooth, quinqueloculine; chambers inflated, increasing in size as added, arcuate' sutures distinct, simple, slightly depressed, narrow; aperture terminal, simple, slightly produced, constricted by broad flap.

Dimensions. Holotype length - 0.30mm
width - 0.19mm
thickness - 0.12mm

Discussion. S. bocki differs from S. tegminis Loeblich and Tappan in having less inflated chambers and a more elliptical outline.

Remarks. S. bocki is ubiquitous in the Molasses Reef area and is present in frequencies up to 8 percent (Graph 4). Living specimens are present in the vegetation and on the bottom. The species has been reported from the Pliocene of Japan and in Recent sediments from Mason Inlet, North Carolina, the eastern Gulf of Paria, Trinidad, and in the Philippine Islands. The species is named for Wayne D. Bock in recognition of his studies of the Foraminifers of the Florida Keys.

SUBFAMILY TUBINELLINAE

Articulina mucronata (d'Orbigny)

Vertebralina mucronata d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 52, Pl. 7, Figs. 16-19.

Articulina mucronata (d'Orbigny), Cushman, 1944, Cush. Lab. Foram. Res., Spec. Publ. 10, Pl. 2, Figs. 11-18.

Hypotype: T-1629

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation.

Articulina pacifica (Cushman)

Articulina sulcata Brady, 1884 (not Reuss, 1850), Rept. Voy. Challenger, Zool., vol. 9, p. 183, Pl. 12, Figs. 12-13.

Articulina sagra Heron-Allen and Earland, 1915 (not d'Orbigny, 1839), Trans. Zool. Soc. London, vol. 20, p. 585, Pl. 45, Figs. 22-25.

Articulina pacifica Cushman, 1944, Cush. Lab. Foram. Res., Spec. Publ. 10, Pl. 4, Figs. 14-18.

Hypotype: T-1630

This species is ubiquitous and occurs in frequencies less than 3 percent. Living specimens are present on the bottom and are very abundant in the Saragassum near the reef (Graph 5).

Articulina sagra d'Orbigny

Articulina sagra d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 183, Pl. 9, Figs. 23-26.

Hypotype: T-1631

This species is ubiquitous and is present in frequencies less than 1 percent.

SUBFAMILY QUINQUELOCULININAE

Pyrgo denticulata (Brady)

Biloculina ringens var. denticulata Brady, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 143, Pl. 3, Figs. 4-5.

Pyrgo denticulata (Brady), Cushman, 1929, U.S. Nat. Mus., Bull. 104, pt. 6, p. 69, Pl. 18, Figs. 3-4.

Hypotype: T-1633

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present in the vegetation and on the bottom.

Pyrgo subsphaerica (d'Orbigny)

Biloculina subsphaerica d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 162, Pl. 8, Figs. 25-27.

Pyrgo subsphaerica (d'Orbigny), Cushman, 1929, U.S. Nat. Mus., Bull. 104, pt. 6, Pl. 18, Figs. 1-2.

Hypotype: T-1634

This species is ubiquitous and occurs in frequencies less than 1 percent. One living specimen was found on the bottom. This species is not usually considered to be a shallow water form.

Quinqueloculina agglutinans d'Orbigny

Quinqueloculina agglutinans d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 195, Pl. 12, Figs. 11-13.

Hypotypes: T-1635, T-1635-A

Included with this species are agglutinated forms with a triloculine outline. It is ubiquitous and occurs in frequencies up to 5 percent and is more common near shore. Living specimens are present in the vegetation and on the bottom.

Quinqueloculina akneriana d'Orbigny

Quinqueloculina akneriana d'Orbigny, 1846, Foram. Fossiles Vienne, p. 290, Pl. 18, Figs. 16-21.

Hypotypes: T-1653, T-1653-A

This species is ubiquitous and occurs in frequencies less than 4 percent. Living specimens are present in the vegetation and on the bottom.

Quinqueloculina antillarum d'Orbigny

Quinqueloculina antillarum d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 194, Pl. 12, Figs. 4-6.

Hypotype: T-1636

This species is present at most stations and occurs in frequencies less than 1 percent. Living specimens are present on the bottom at one station.

Quinqueloculina biocostata d'Orbigny

Quinqueloculina bicostata d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 195, Pl. 12, Figs. 8-10.

Hypotype: T-1638

This species occurs sporadically and is rarely present in any abundance.

Quinqueloculina bidentata d'Orbigny

Quinqueloculina bidentata d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 197, Pl. 12, Figs. 18-20.

Hypotype: T-1639

This species is ubiquitous and occurs in frequencies less than 4 percent. It is more common near shore. Living specimens are present on the bottom and in the vegetation.

Quinqueloculina bosciana d'Orbigny

Quinqueloculina bosciana d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 191, Pl. 11, Figs. 22-24.

Hypotypes: T-1640, T-1640-A, T-1640-B

This spcies is ubiquitous and occurs in frequencies up to 8 percent. It is more common near shore. Living specimens are common on the bottom and in the vegetation, especially near shore (Graph 6).

Quinqueloculina bradyana Cushman

Miliolina undosa Brady, 1884 (not Karrer, 1867) Rept. Voy. Challenger, Zool., vol. 9, p. 176, Pl. 6, Figs. 6-8.

Quinqueloculina bradyana Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 52, Pl. 18, Fig. 2.

Hypotypes: T-1641, T-1641, T-1641-A, T-1641-B

This species exhibits a great deal of variation both in shape and in surface texture. The species is ubiquitous and occurs in frequencies up to 7 percent. It is more common near shore. Living specimens are common on the bottom and in the vegetation, especially near the shore.

Quinqueloculina collumnosa Cushman

Miliolina curvieriana Heron-Allen and Earland, 1915 (not Q. curieriana d'Orbigny, 1839), Trans. Zool. Soc. London, vol. 20, p. 571, Pl. 4, Figs. 33-36.

Quinqueloculina collumnosa Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 65, Pl. 10, Fig. 10.

Hypotype: T-1642

This species occurs sporadically near the reef with frequencies less than 1 percent.

Quinqueloculina crassa d'Orbigny

Quinqueloculina crassa d'Orbigny, 1826, Ann. Sci. Nat., p. 135.

Hypotype: T-1643

This species occurs only rarely.

Quinqueloculina funafutiensis (Chapman)

Miliolina funafutiensis Chapman, 1902, Jour. Linn. Soc. London, Zool., vol. 24, p. 178, Pl. 19, Fig. 6.

Quinqueloculina funafutiensis (Chapman), Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 67, Pl. 13, Fig. 3.

Hypotype: T-1644

This species is ubiquitous and occurs in frequencies less than 4 percent. Living specimens are common on the bottom but are rare in the vegetation.

Quinqueloculina horrida Cushman

Quinqueloculina horrida Cushman, 1947, Cush. Lab. Foram. Res., Contr., vol. 23, p. 88, Pl. 19, Fig. 1.

Hypotype: T-1645

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom.

Quinqueloculina laevigata d'Orbigny

Quinqueloculina laevigata d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 301.

Hypotype: T-1646

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation.

Quinqueloculina lamarckiana d'Orbigny

Quinqueloculina lamarckiana d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 189, Pl. 11, Figs. 14-15.

Hypotype: T-1647

There appears to be a gradational change between this species and Q. funafutiensis. The variation is in the degree of acuteness of the chamber angles and the width of the chambers. This species is ubiquitous and occurs in frequencies less than 4 percent. It is more abundant near shore. Living specimens occur on the bottom and in the vegetation (Graph 7).

Quinqueloculina lata Terquem

Quinqueloculina lata Terquem, 1876, Essai, Class. Anim. Dunkerque, pt. 2, p. 82, Pl. 11, Fig. 8.

Hypotype: T-1648

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present in the vegetation and on the bottom.

Quinqueloculina poeyana d'Orbigny

Quinqueloculina poeyana d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 191, Pl. 11, Figs. 25-27.

Hypotypes: T-1649, T-1656, T-1656-A

This species is ubiquitous and occurs in frequencies less than 6 percent. Living specimens are present in the vegetation and on the bottom.

Quinqueloculina polygana d'Orbigny

Quinqueloculina polygana d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 198, Pl. 2, Figs. 21-23.

Hypotypes: T-1650, T-1650-A

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation.

Quinqueloculina sclerotica Karrer

Quinqueloculina sclerotica Karrer, 1868, Sitzb. Akad. Wiss., Wien, vol. 58, no. 1, p. 152, Pl. 3, Fig. 5.

Hypotype: T-1652

This species occurs only once on the bottom.

Quinqueloculina tenagos Parker

Quinqueloculina costata d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 135 (p. 301, nomen nudum).

Quinqueloculina rhodiensis Parker, Phleger, and Peirson, 1953 (not Q. rhodiensis Wiesner) Cush. Found. Foram. Res., Spec. Publ. 2, p. 12, Pl. 4, Figs. 15-17.

Quinqueloculina tenagos Parker, 1962, Cush. Found. Foram. Res., Contr. vol. 13, p. 110.

Hypotype: T-1651

This species is not present near the reef. It occurs in frequencies less than 3 percent. Living specimens are present on the Thalassia and on the bottom.

Quinqueloculina tricarinata d'Orbigny

Quinqueloculina tricarinata d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 187, Pl. 11, Figs. 7-9, 11.

Hypotypes: T-1654, T-1654-A, T-1661

This species is present only near the reef in frequencies less than 1 percent.

Sigmoilina arenata (Cushman)

Spiroloculina arenata Cushman, 1921, U.S. Nat. Mus., Proc., vol. 59, p. 63, Pl. 14, Fig. 17.

Sigmoilina arenata (Cushman), Cushman, 1946, Cush. Lab. Foram. Res., Contr., vol. 22, p. 42, Pl. 6, Fig. 28.

Hypotype: T-1655

This species is ubiquitous and occurs in frequencies less than 1 percent. One living specimen was found on the bottom.

Triloculina bassensis Parr

Triloculina bassensis Parr, 1945, Roy. Soc. Victoria Proc., vol. 56 (new ser.), pt. 2, p. 198, Pl. 8, Figs. 7a-c.

Hypotypes: T-1664, T-1665, T-1665-A

There is considerable variation in the nature of the aperture in this species. Young specimens have a slightly flattened circular aperture whereas mature forms exhibit a compressed slit. The species is ubiquitous and occurs in frequencies less than 4 percent. Living specimens are present on the bottom and in the vegetation near shore (Graph 8).

Triloculina bermudezi Acosta

Triloculina bermudezi Acosta, 1940, Soc. Cubana Hist. Nat., La Habana, vol. 14, no. 1, p. 37, Pl. 4, Figs. 1-5.

Hypotype: T-1657

This species is ubiquitous and occurs in frequencies up to 6 percent. It is more common near shore. Living specimens are present in the vegetation and on the bottom (Graph 9). The specimens are smaller than typical.

Triloculina carinata d'Orbigny

Triloculina carinata d'Orbigny, 1839, *in* De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 179, Pl. 10, Figs. 15-17.

Hypotypes: T-1658, T-1658-A

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom.

Triloculina fiterrei meningoi Acosta

Triloculina fiterrei var. *meningoi* Acosta, 1940, Torreia, no. 3, p. 26, Pl. 4, Figs. 1-5.

Hypotype: T-1660

This species is more common away from shore and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation.

Triloculina linneiana d'Orbigny

Triloculina linneiana d'Orbigny, 1839, *in* De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 172, Pl. 9, Figs. 11-13.

Hypotype: T-1663

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation (Graph 10).

Triloculina oblonga (Montagu)

Vermiculum oblongum Montagu, 1803, Test. Brit., p. 522, Pl. 14, Fig. 9.

Triloculina oblonga (Montagu), d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 300, no. 16.

Hypotypes: T-1662, T-1662-A

This species is ubiquitous and occurs in frequencies less than 3 percent. Living specimens are present on the bottom and in the vegetation. Living specimens are more common near the shore.

Triloculina rotunda d'Orbigny

Triloculina rotunda d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 299, No. 4.

Hypotype: T-1666

This species may represent a juvenile triloculine stage of *Pyrgo* subsphaerica. This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and are very common near shore in the vegetation.

Triloculina sidebottomi Martinotti

Miliolina subrotunda Sidebottom, 1904 (not *Vermiculum subrotundum* Montagu, 1803), Manchester Lit. Phil. Soc., vol. 68, no. 5, p. 8, Text-Fig. 2, Pl. 3, Figs. 1-7.

Triloculina sidebottomi Martinotti, 1920, Atti. Soc. Ital. Sci. Nat., vol. 59, Pl. 2, Fig. 29, Text-Figs. 59-61.

Hypotype: T-1667

This species is only present at one station on the bottom. Living specimens are present in the vegetation at that station.

Triloculina terquemiana (Brady)

Miliolina terquemiana Brady, 1884, Rept. Voy. *Challenger*, Zool., vol. 9, p. 166, Pl. 114, Fig. 1.

Triloculina terquemiana (Brady), Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 72, Pl. 27, Fig. 2.

Hypotype: T-1668

This species is very similar to *Triloculina tricarinata* d'Orbigny. The only major distinction between the two is the costate test of *T. terquemiana*. This species is present in areas away from the reef in frequencies less than 1 percent. Living specimens are present on the bottom.

Triloculina transversestriata (Brady)

Miliolina transversestriata Brady, 1881, Quart. Jour. Micr. Sci., n.s., vol. 21, p. 45.

Triloculina transversestriata (Brady), Cushman, 1921, U.S. Nat. Mus., Proc., vol. 59, no. 2360, p. 70.

Hypotype: T-1669

This species is rare and occurs sporadically throughout the traverse.

Triloculina trigonula (Lamarck)

Miliolina trigonula Lamarck, 1804, Ann. Mus., vol. 5, p. 351, no. 3; 1807, vol. 9, Pl. 17, Fig. 4.

Triloculina trigonula (Lamarck), d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 299, no. 1, Pl. 16, Figs. 5-9.

Hypotype: T-1670

This species is ubiquitous and occurs in frequencies less than 4 percent. Living specimens are present on the bottom and in the vegetation, especially near shore (Graph 11).

SUBFAMILY MILIOLINAE

Hauerina bradyi Cushman

Hauerina compressa Brady, 1884 (not d'Orbigny, 1846), Rept. Voy. *Challenger*, Zool., vol. 9, p. 190, Pl. 11, Figs. 12-13.

Hauerina bradyi Cushman, 1917, U.S. Nat. Mus., Bull. 71, p. 62, Pl. 23, Fig. 2.

Hypotype: T-1671

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present in the vegetation.

Hauerina ornatissima (Karrer)

Quinqueloculina ornatissima Karrer, 1868, Sitzb. Akad. Wiss. Wien, vol. 58, p. 151, Pl. 3, Fig. 2.

Hauerina ornatissima (Karrer), Brady, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 192, Pl. 7, Figs. 15-22.

Hypotype: T-1672

This species is present at most stations in frequencies less than 1 percent. Living specimens are present in the vegetation.

Schlumbergerina alveoliniformis (Brady)

Miliolina alveoliniformis Brady, 1879, Quart. Jour. Micr. Sci., n.s., vol. 19, p. 268.

Schlumbergerina alveoliniformis (Brady), Cushman, 1929, U.S. Nat. Mus., Bull. 104, pt. 6, p. 36.

Hypotypes: T-1673, T-1637

This species is distributed sporadically along the traverse and occurs in frequencies less than 6 percent. One living specimen was found on the bottom.

FAMILY SORITIDAE

SUBFAMILY PENEROPLINAE

Monalysidium polita (Chapman)

Peneroplis (Monalysidium) polita Chapman, 1902, Jour. Linn. Soc. London, Zool., vol. 28, p. 4, Pl. 1, Fig. 5.

Monalysidium polita (Chapman), Heron-Allen and Earland, 1915, Trans. Zool. Soc. London, vol. 20, p. 603, Fig. 43.

Hypotype: T-1674

This species is present near shore in frequencies less than 1 percent.

Peneroplis bradyi Cushman

Peneroplis bradyi Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 40, Pl. 14, Figs. 8-10.

Hypotype: T-1675

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom and in the vegetation.

Peneroplis carinatus d'Orbigny

Peneroplis carinatus d'Orbigny, 1839, Voy. Amer. Merid., vol. 5, pt. 5, "Foraminiferes", p. 33, Pl. 3, Figs. 7-8.

Hypotype: T-1676

This species is ubiquitous and occurs in frequencies up to 11 percent. It is more common away from the reef. Living specimens are present in the vegetation and on the bottom (Graph 12).

Peneroplis pertusus (Førskal)

Nautilus pertusus Førskal, 1775, Descr. Anim., p. 125, No. 65.

Peneroplis pertusus (Førskal), Jones, Parker and Brady, 1865, Mon. Foram. Crag., p. 19.

Hypotype: T-1677

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present in the vegetation and on the bottom.

Peneroplis proteus d'Orbigny

Peneroplis proteus d'Orbigny, 1839, *in* De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 66, Pl. 8, Figs. 4-7.

Hypotype: T-1678

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present in the vegetation and on the bottom.

Spirolina arietina (Batsch)

Nautilus (Lituus) arietinus Batsch (part), 1791, Conch. Seesamdes, p. 4, Pl. 6, Fig. 15c.

Spirolina arietina (Batsch), Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 43, Pl. 15, Figs. 4-5.

Hypotype: T-1679

This species occurs sporadically with frequencies less than 1 percent.

SUBFAMILY MEANDROPSININAE

Broeckina orbitolitoides (Hofker)

Praesorites orbitolitoides Hofker, 1930, Siboga-Exped., Mon., 4a, p. 149, Pl. 55, Figs. 8, 10-11; Pl. 57, Figs. 4, 6; Pl. 58; Pl. 61, Figs. 3, 14.

Hypotype: T-1680

This species is more common near the reef. It is present in frequencies less than 1 percent.

SUBFAMILY ARCHAIASINAE

Archaias angulatus (Fichtel and Moll)

Nautilus angulatus Fichtel and Moll, 1798, Test. Micr. Aliaque, Min. Gener. Argonauta et Nautilus, Wien, p. 113, Pl. 22, Figs. a-e.

Archaias angulatus (Fichtel and Moll), Cushman, 1928, Cush. Lab. Foram. Res., Spec. Publ. No. 1, p. 218, Pl. 31, Fig. 9.

Hypotype: T-1681

A. angulatus is ubiquitous and is the most abundant species in the bottom samples. It comprises up to 50 percent of the foraminiferal population. It is more common near the reef. Living specimens are present on the bottom and in the vegetation, especially near the reef (Graph 13).

SUBFAMILY SORITINAE

Sorites marginalis (Lamarck)

Orbulites marginalis Lamarck, 1816, Syst. Anim. sans Vert., vol. 2, p. 196.

Sorites marginalis (Lamarck), Cushman, 1930, U.S. Nat. Mus. Bull., 104, pt. 7, p. 49, Pl. 18, Figs. 1-4.

Hypotype: T-1682

This species is ubiquitous and occurs in frequencies less than 4 percent. Living specimens are present on the bottom and in the vegetation, especially near the reef (Graph 14).

FAMILY ALVEOLINELLIDAE

Borelis pulchra (d'Orbigny)

Alveolina pulchra d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Cuba, "Foraminiferes", p. 70, Pl. 8, Figs. 19-20.

Borelis pulchra (d'Orbigny), Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 55, Pl. 15, Figs. 9-10.

Hypotype: T-1683

This species is present in greater abundance near the reef. It occurs in frequencies less than 1 percent. Living specimens are present on the bottom.

FAMILY GLANDULINIDAE

SUBFAMILY OOLININAE

Fissurina quadricostulata (Reuss)

Lagena quadricostulata Reuss, 1870, Sitzb. Akad. Wiss. Wien. vol. 62, p. 469.

Hypotype: T-1684

This species is ubiquitous and occurs in frequencies less than 1 percent. A few living specimens are present in the vegetation.

FAMILY POLYMORPHINIDAE

SUBFAMILY POLYMORPHININAE

Guttulina plancii d'Orbigny

Guttulina plancii d'Orbigny, 1839, Voy. Amer. Merid., vol. 5, pt. 5, p. 60, Pl. 1, Fig. 5.

Hypotype: T-1685

This species is distributed sporadically along the traverse in frequencies less than 1 percent.

Guttulina problema (d'Orbigny)

Polymorphina (Guttulina) problema d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 266, No. 61.

Guttulina problema (d'Orbigny), d'Orbigny, 1839, in De la Sagra, HIst. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 132.

Hypotype: T-1686

This species is distributed sporadically along the traverse in frequencies less than 1 percent.

FAMILY TURRILINIDAE

SUBFAMILY TURRILININAE

Buliminella milletti Cushman

Buliminella milletti Cushman, 1933, Cush. Lab. Foram. Res., Contr., vol. 9, p. 78, Pl. 8, Figs. 5-6.

Hypotypes: T-1687, T-1687-A

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present in the vegetation and on the bottom.

FAMILY BOLIVINITIDAE

Bolivina lowmani Phleger and Parker

Bolivina lowmani Phleger and Parker, 1951, Geol. Soc. American, Mem. 46, pt. 2, p. 13, Pl. 6, Figs. 20-21.

Hypotype: T-1688

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom.

Bolivina rhomboidalis (Millett)

Textularia rhomboidalis Millett, 1899, Journ. Roy. Micr. Soc., p. 599, Pl. 7, Fig. 4.

Bolivina rhomboidalis (Millett), Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 28.

Hypotypes: T-1689, T-1689-A

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present in the vegetation and on the bottom.

Bolivina striatula Cushman

Bolivina striatula Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 27, Pl. 3, Fig. 10.

Hypotypes: T-1690, T-1690-A

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present in the vegetation and on the bottom.

Rectobolivina advena (Cushman)

Siphogenerina advena Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 35, Pl. 5, Fig. 2.

Rectobolivina advena (Cushman), Bandy, 1954, U.S. Geol. Survey, Prof. Paper 254-F, p. 138, Pl. 31, Fig. 8.

Hypotype: T-1691

This species occurs sporadically along the traverse in frequencies less than 1 percent.

FAMILY BULIMINIDAE

SUBFAMILY BULIMININAE

Bulimina spicata Phleger and Parker

Bulimina spicata Phleger and Parker, 1951, Geol. Soc. Americana, Mem. 46, pt. 2, p. 16, Pl. 7, Figs. 25, 30-31.

Hypotype: T-1692

This species is usually found only in deep water. It occurs at most stations in frequencies less than 1 percent. No living specimens were found.

SUBFAMILY PAVONONINAE

Reussella atlantica Cushman

Reussella spinulosa (Reuss) var. atlantica Cushman, 1947, Cush. Lab. Foram. Res., Contr., vol. 23, p. 91, Pl. 20, Figs. 6-7.

Reussella atlantica Cushman, Bandy, 1954, U.S. Geol. Survey, Prof. Paper 254-F, p. 138, Pl. 31, Fig. 7.

Hypotype: T-1693

This species is present near shore in frequencies less than 1 percent.

FAMILY UVIGERINIDAE

Sagrina pulchella d'Orbigny

Sagrina pulchella d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 150, Pl. 1, Figs. 23-24.

Hypotypes: T-1694, T-1694-A, T-1694-B

This species is present in frequencies less than 3 percent. Living specimens are present in the vegetation and are very abundant near shore (Graph 15).

Uvigerina bellula Bandy

Uvigerina auberiana d'Orbigny var. laevis Goes, 1896, Mus. Comp. Zool., Bull. 29, p. 51.

Uvigerina laevis Goes (not Ehrenberg, 1845), Parker, 1954, Mus. Comp. Zool, Bull. 111, p. 520, Pl. 8, Fig. 4).

Uvigerina bellula Bandy, 1956, U.S. Geol. Survey, Prof. Paper 274-G, p. 199, Pl. 31, Fig. 13.

Hypotype: T-1695

This species occurs sporadically along the traverse in frequencies less than 1 percent. A few living specimens are present on the bottom and in the vegetation.

Uvigerina peregrina Cushman

Uvigerina pygmaea Flint (not U. pigmea d'Orbigny, 1826), 1899, U.S. Nat. Mus., Rept. 1897, p. 320, Pl. 68, Fig. 2.

Uvigerina peregrina Cushman, 1923, U.S. Nat. Mus., Bull. 104, Pl. 42, Figs. 7-10.

Hypotype: T-1696

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom and in the vegetation.

FAMILY DISCORBIDAE

SUBFAMILY DISCORBINAE

Buccella hannai (Phleger and Parker)

Eponides hannai Phleger and Parker, 1951, Geol. Soc. Americana, Mem. 46, pt. 2, Pl. 10, Figs. 11-14.

Buccella hannai (Phleger and Parker), Anderson, 1952, Wash. Acad. Sci., Jour., vol. 42, no. 5, p. 144, p. 147, Text-Fig. 3.

Hypotype: T-1697

This species is present only near shore in frequencies less than 1 percent.

Discorbis mira Cushman

Discorbis mira Cushman, 1922, Carnegie Inst. Wash., Publ. 311, Pl. 6, Figs. 10-11.

Hypotype: T-1700

This species is ubiquitous and occurs in frequencies less than 3 percent. It is more common near shore. Living specimens are present on the bottom (Graph 16).

Discorbis rosea (d'Orbigny)

Rotalia rosea d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 272, No. 7, Modeles no. 36.

Hypotype: T-1701

This species is not present near shore and is most abundant near the reef, where it occurs in frequencies up to 5 percent (Graph 17). One living specimen was found on the bottom.

Neoconorbina terquemi (Rzehak)

Rosalina orbicularis Terquem, 1876 (not d'Orbigny, 1850), Essai Class. Anim. Dunkerque, pt. 2, p. 166, Pl. 9, Fig. 4.

Discorbina terquemi Rzehak, 1888, Geol. Reichsanst., Verh., Wien, p. 228.

Neoconorbina terquemi (Rzehak), Hofker, 1951, Arch. Neerlandaises Zool., vol. 8, pt. 4, p. 357.

Hypotypes: T-1702, T-1702-A, T-1702-B

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation.

Rosalina candeiana d'Orbigny

Rosalina candeiana d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 97, Pl. 4, Figs. 2-4.

Hypotype: T-1698

This is one of the most common species in the area. It is ubiquitous and occurs on the bottom in frequencies up to 13 percent. Living specimens are common on the bottom. It is especially abundant on the vegetation (Graph 18).

Rosalina floridana (Cushman)

Discorbis floridana Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 39, Pl. 5, Figs. 11-12.

Hypotype: T-1699

This species is ubiquitous and occurs in frequencies less than 6 percent. It is somewhat more abundant away from shore. Living specimens are present on the bottom. The living specimens occurring in the vegetation are present only near shore (Graph 19).

SUBFAMILY BAGGININAE

Cancris sagra (d'Orbigny)

Rotalina sagra d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 77, Pl. 5, Figs. 13-15.

Cancris sagra (d'Orbigny), Cushman, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 74, Pl. 15, Fig. 2.

Hypotypes: T-1704, T-1704-A

This species is more common near the reef and occurs in frequencies less than 1 percent. Living specimens are present on the bottom.

FAMILY GLABRATELLIDAE

Glabratella pulvinata (Brady)

Discorbina pulvinata Brady, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 650, Pl. 88, Fig. 10.

Glabratella pulvinata (Brady), Dorreen, 1948, Jour. Paleontology, vol. 22, p. 294.

Hypotype: T-1703

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom and are abundant in the vegetation.

FAMILY SIPHONINIDAE

Siphonina pulchra Cushman

Siphonina pulchra Cushman, 1919, Carnegie Inst. Wash., Publ. 291, p. 42, Pl. 14, Fig. 7.

Hypotype: T-1705

This species is ubiquitous and occurs in frequencies less than 1 percent.

FAMILY ASTERIGERINIDAE

Asterigerina carinata d'Orbigny

Asterigerina carinata d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 118, Pl. 5, Fig. 25, Pl. 6, Figs. 1-2.

Hypotypes: T-1706, T-1706-A

This species is only present away from shore and in frequencies up to 6 percent. Living specimens are present on the bottom and in the vegetation (Graph 20).

FAMILY SPIRILLINIDAE

SUBFAMILY SPIRILLININAE

Spirillina vivipara Ehrenberg

Spirillina vivipara Ehrenberg, 1841, Abhandl. k. Akad. Wiss. Berlin., p. 422, Pl. 3, sec. 7, Fig. 41.

Hypotype: T-1707

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation.

FAMILY ROTALIIDAE

SUBFAMILY ROTALINNAE

Ammonia advena (Cushman)

Discorbis advena Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 40; 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 13, Pl. 2, Fig. 8.

Hypotype: T-1708

This species is not present near shore. It occurs in frequencies less than 1 percent. Living specimens are present on the bottom.

Ammonia avalonensis Natland

Rotalia depressa Natland, 1938 (not Munster, 1838), Scripps Inst. Ocean., Bull., Tech. Ser., vol. 4, no. 5, p. 147, Pl. 5, Fig. 15.

Rotalia avalonensis Natland, 1950, Geol. Soc. America, Mem. 43, pt. 4, Pl. 8, Fig. 4.

Hypotype: T-1709

This species is ubiquitous and occurs in frequencies less than 4 percent. Living specimens are present on the bottom and in the vegetation, especially near the reef.

Ammonia beccarii sobrina (Shupack)

Rotalia beccarii (Linnaeus) var. sobrina Shupack, 1934 Am. Mus. Novatites, no. 737, p. 6, Pl. 1, Fig. 4.

This species is ubiquitous and occurs in frequencies less than 3 percent. It is more common away from shore. Living specimens are present on the bottom.

Ammonia beccarii tepida (Cushman)

Rotalia beccarii (Linnaeus) var. tepida Cushman, 1926, Carnegie Inst. Wash., Publ. 344, p. 79, Pl. 1.

Hypotype: T-1710

This species is much smaller than typical. This species is ubiquitous and occurs in frequencies up to 6 percent. It is most common near shore. Living specimens are present in the vegetation and on the bottom (Graph 21).

FAMILY ELPHIDIIDAE

SUBFAMILY ELPHIDIINAE

Cribroelphidium poeyanum (d'Orbigny)

Polystomella poeyanum d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 55, Pl. 6, Figs. 25-26.

Cribroelphidium poeyanum (d'Orbigny), Cushman and Brönnimann, 1948, Cush. Lab. Foram. Res., Contr., vol. 24, p. 18.

Hypotype: T-1711

This species is common in areas away from the reef where it occurs in frequencies up to 6 percent. Living specimens are present on the bottom but not in the vegetation (Graph 22).

Elphidium advenum (Cushman)

Polystomella subnodosa Brady, 1884 (not von Munster), Rept. Voy. Challenger, Zool., vol. 9, p. 734, Pl. 110, Fig. 1.

Polystomella advena Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 56, Pl. 9, Figs. 11-12.

Elphidium advenum (Cushman), Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 25, Pl. 10, Figs. 1-2.

Hypotypes: T-1712, T-1712-A

This species is ubiquitous and occurs in frequencies less than 2 percent. It is more abundant near shore. Living specimens are present in the vegetation (Graph 23).

Elphidium articulatum rugulosum Cushman and Wickenden

Elphidium articulatum (d'Orbigny) var. rugulosum Cushman and Wickenden, 1929, U.S. Nat. Mus., Proc., vol. 75, art. 8, p. 7, Pl. 3, Fig. 8.

Hypotype: T-1713

This species is ubiquitous and occurs in frequencies less than 3 percent. Living specimens are present on the bottom and in the vegetation.

Elphidium crispum (Linnaeus)

Nautilus crispus Linnaeus, 1758, Syst. Nat., ed. 10, p. 709.

Elphidium crispum (Linnaeus), Cushman and Grant, 1927, San Diego Soc. Nat. Hist., Trans., vol. 5, no. 6, p. 73, Pl. 7, Fig. 3.

Hypotype: T-1714

This species is rare.

Elphidium discoidale (d'Orbigny)

Polystomella discoidalis d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 56, Pl. 6, Figs. 23-24.

Elphidium discoidale (d'Orbigny), Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 2, Pl. 8, Figs. 8-9.

Hypotype: T-1715

This species is ubiquitous and occurs in frequencies less than 1 percent.

Elphidium sagrum (d'Orbigny)

Polystomella sagra d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 55, Pl. 6, Figs. 19-20.

Elphidium sagrum (d'Orbigny), Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 24, Pl. 9, Figs. 5-6.

Hypotype: T-1716

This species occurs sporadically and in frequencies less than 1 percent.

FAMILY EPONIDIDAE

Eponides antillarum (d'Orbigny)

Rotalina antillarum d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 75, Pl. 5, Figs. 4-6.

Eponides antillarum (d'Orbigny), Parker, 1954, Mus. Comp. Zool., vol. 111, p. 528, Pl. 9, Figs. 14-15.

Hypotype: T-1717

This species occurs sporadically and in frequencies less than 1 percent.

Eponides repandus (Fichtel and Moll)

Nautilus repandus Fichtel and Moll, 1798, Test. Micr., p. 35, Pl. 3, Figs. a-d.

Eponides repandus (Fichtel and Moll), Cushman, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 49, Pl. 10, Fig. 7.

Hypotype: T-1718

This species is rare.

FAMILY AMPHISTEGINIDAE

Amphistegina lessonii d'Orbigny

Amphistegina lessonii d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 304, No. 3, Pl. 17, Figs. 1-4, Modeles no. 98.

Hypotype: T-1719

This species is most common near the reef where it occurs in frequencies up to 5 percent (Graph 24). Living specimens are present on the bottom.

FAMILY CIBICIDAE

SUBFAMILY CIBICIDINAE

Cibicides pseudoungeriana (Cushman)

Truncatulina ungeriana Brady, 1884 (not Rotalina ungeriana d'Orbigny, 1846), Rept. Voy Challenger, Zool., vol. 9, p. 664, Pl. 94, Fig. 9.

Truncatulina pseudoungeriana Cushman, 1922, U.S. Geol. Survey, Prof. Paper 129-E, p. 97, Pl. 20, Fig. 9.

Cibicides pseudoungeriana (Cushman), Cushman, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, Pl. 22, Figs. 3-7.

Hypotype: T-1720

This species is ubiquitous and occurs in frequencies less than 3 percent. It is more common near the reef. Living specimens are present on the bottom and in the vegetation.

FAMILY PLANORBULINIDAE

Planorbulina acervalis Brady

Planorbulina acervalis Brady, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 657, Pl. 92, Fig. 4.

Hypotype: T-1721

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom and in the vegetation.

Planorbulina mediterranensis d'Orbigny

Planorbulina mediterranensis d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 280, No. 2, Pl. 14, Figs. 4-6.

Hypotype: T-1722

This species is ubiquitous and occurs in frequencies less than 2 percent. Living specimens are present on the bottom and in the vegetation.

FAMILY CYMBALOPORIDAE

Cymbaloporetta squammosa (d'Orbigny)

Rotalia squammosa d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 272.

Cymbaloporetta squammosa (d'Orbigny), Cushman, 1928, Cush. Lab. Foram. Res., Contr., vol. 4, pt. 1, p. 7.

Hypotype: T-1723

This species occurs near the reef in frequencies less than 2 percent. Living specimens are present on the bottom.

FAMILY CAUCASINIDAE

SUBFAMILY FURSENKOININAE

Fursenkoina punctata (d'Orbigny)

Virgulina punctata, d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 139, Pl. 1, Figs. 35-36.

Hypotype: T-1724

This species is present in areas away from the reef in frequencies less than 1 percent. Living specimens are present on the bottom.

Sigmavirgulina tortuosa (Brady)

Bolivina tortuosa Brady, 1881, Quart. Jour. Micr. Sci., vol. 21, p. 57.

Sigmavirgulina tortuosa (Brady), Loeblich and Tappan, 1957, U.S. Nat. Mus., Bull. 215, p. 227, Pl. 73, Figs. 1-2.

Hypotype: T-1725

This species is ubiquitous and occurs in frequencies less than 1 percent. Living specimens are present on the bottom and in the vegetation, especially near the reef.

FAMILY LOXOSTOMIDAE

Loxostomum limbatum (Brady)

Bolivina limbata Brady, 1881, Quart. Jour. Micr. Soc., vol. 21, p. 27.

Loxostoma limbatum (Brady), Cushman, Cush. Lab. Foram. Res., Spec. Publ. 9, p. 186, Pl. 21, Figs. 26-29.

Hypotype: T-1726

This species occurs sporadically and in frequencies less than 1 percent.

Loxostomum mayori (Cushman)

Bolivina mayori Cushman, 1922, Carnegie Inst. Wash., Publ. 311, p. 27, Pl. 3, Figs. 5-6.

Loxostomum mayori (Cushman), Bermudez, 1935, Mem. Soc. Cubana Hist. Nat., vol. 9, p. 197.

Hypotype: T-1727

This species occurs sporadically and in frequencies less than 1 percent.

FAMILY CASSIDULINIDAE

Cassidulina subglobosa Brady

Cassidulina subglobosa Brady, 1881, Quart. Jour. Micr. Sci., vol. 21, p. 60; 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 430, Pl. 54, Fig. 17.

Hypotype: T-1728

This species occurs sporadically and in frequencies less than 1 percent.

FAMILY NONIONIDAE

SUBFAMILY NONIONINAE

Astrononion sidebottomi Cushman and Edwards

Nonionina stelligera Sidebottom, 1909 (not d'Orbigny, 1839) Manchester Lit. Phil. Soc., Mem. and Proc., vol. 53, no. 21, p. 13, Pl. 4, Fig. 9.

Astrononion sidebottomi Cushman and Edwards, 1937, Cush. Lab. Foram. Res., Contr., vol. 13, Pl. 3, Fig. 8; Cushman, 1939, U.S. Geol. Survey, Prof. Paper 191, p. 36, Pl. 10, Fig. 2.

Hypotype: T-1729

This species is rare.

Nonion grateloupi (d'Orbigny)

Nonionina grateloupi d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 294, No. 19.

Nonion grateloupi (d'Orbigny), Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, Pl. 3, Figs. 9-11; Pl. 4, Figs. 1-4.

Hypotype: T-1730

This species is present in frequencies less than 1 percent and is more common in areas away from the reef. Living specimens are present on the bottom.

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