A POPULATION STUDY OF THE BENTHONIC FORAMINIFERIDA IN NORTHERN BISCAYNE BAY, FLORIDA

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I. ABSTRACT

A portion of northern Biscayne Bay, Dade County, Florida, was investigated to determine the distribution of its benthonic foraminiferal assemblage. Percentages were calculated for the standing crop and total population from a count of all specimens present in aliquots of 26 samples taken from 15 stations. One hundred fifty-two species belonging to 75 genera and 35 families have been identified.

Although the primary interest is the description of the fauna and its distribution, additional information on depth, temperature, and bottom condition was obtained to facilitate discussion of ecologic factors as they pertain to the patterns of distribution. The area is a complex positive estuarine bay, with influx of fresh waters from the west (inland) side and open ocean waters mixing on the east. The presence of barriers, natural and man-made, further complicates the water circulation and water quality, in addi-

tion to the effects of tides, weather, and hydrologic factors.

Areal distribution and abundance of certain species can be correlated with the grain-size distribution of the sediments. The distribution of specimens illustrates areas of mixing or foraminiferal assemblages and the association of certain faunal assemblages with particular environmental conditions. The presence of several species not known to South Florida waters are noted herein. The species recognized are recorded in the section on systematics.

II. INTRODUCTION

The waters of northern Biscayne Bay were chosen for study of their benthonic foraminiferal assemblage. It is an area of complex conditions, affected by temperature, salinity, vegetation, tides, and climate, as well as by additional factors such as barriers to currents. Man's effects include sewage pollution and dredging. It is an area sufficiently removed from tracts where benthonic faunal assemblages have already been adequately catalogued.

This area offered an excellent opportunity for study of a warm, shallow water fauna with its distribution partially dependent on the "blend" of quartz sand sediments and calcareous sediments. Many species can be associated with particular environmental conditions and sediment grain sizes. During the study, many species were noted for the first time that were not previously known to be in the South Florida area.

In all, 152 species from 75 genera and 35 families were noted. They were identified from the 26 samples taken from 15 stations. Stations 1 through 11 were visited on March 6, 1973, and these, with stations 12 through 15, were sampled on May 22, 1973. Data pertaining to depth, temperature, and bottom conditions also were obtained. This information was gathered to facilitate the discussion of species distributions with regard to environmental parameters. Coarse fraction and foraminiferal number have been calculated for each sample, and the percentage distribution determined for the standing crop and total population for each sample. The percentages are based on over 18,000 specimens that were counted; more than 12,000 of these were also "picked" and mounted on paleontological slides.

The number of species illustrated in this report was somewhat limited by restrictions in the funds and time available for the project and in access to scanning electron microscope facilities. Those species chosen for illustration include the more abundant and characteristic species encountered and several of the species not known previously to occur in South Florida waters.

Stubbs (1940) sampled seven stations from the vicinity of Biscayne Bay and investigated the Foraminiferida occurring in the area. He found that the families Miliolidae and Peneroplidae were predominant. Of the 63 species described, from 23 genera, *Archaias angulatus* was the most abundant.

Weiss (1948) was mainly concerned with the occurrence and seasonal fluctuations of sedentary marine organisms within Biscayne Bay. However, he also discussed the general circulation patterns within the area, and also noted that salinity and temperature variations correlated directly to the climate and seasonal temperature changes of the atmosphere.

Hela, *et al.* (1957), while investigating the effects of pollution in Biscayne Bay, studied the hydrography of the area. Circulation patterns were analyzed and tidal predominance was noted. Salinity and oxygen content variations within the bay were observed, and lower values for each were found to occur nearer the western margins of the bay.

Moore (1957) made an ecological study of the Foraminiferida in the northern Florida Keys and recognized four faunal provinces: Florida Bay, back-reef, reef, and fore-reef. The Florida Bay environment is characterized by varying abundances of Miliolidae, Peneroplidae, Nonionidae, and Rotaliidae, with an absence of the Amphisteginidae, Textulariidae, Lagenidae, and Buliminidae. The families Amphisteginidae and Buliminidae are present in the back-reef environment. Moore found that live specimens of species only in the family Miliolidae were present in the Florida Bay environment and that the fauna of this area was sorted by current and wave action.

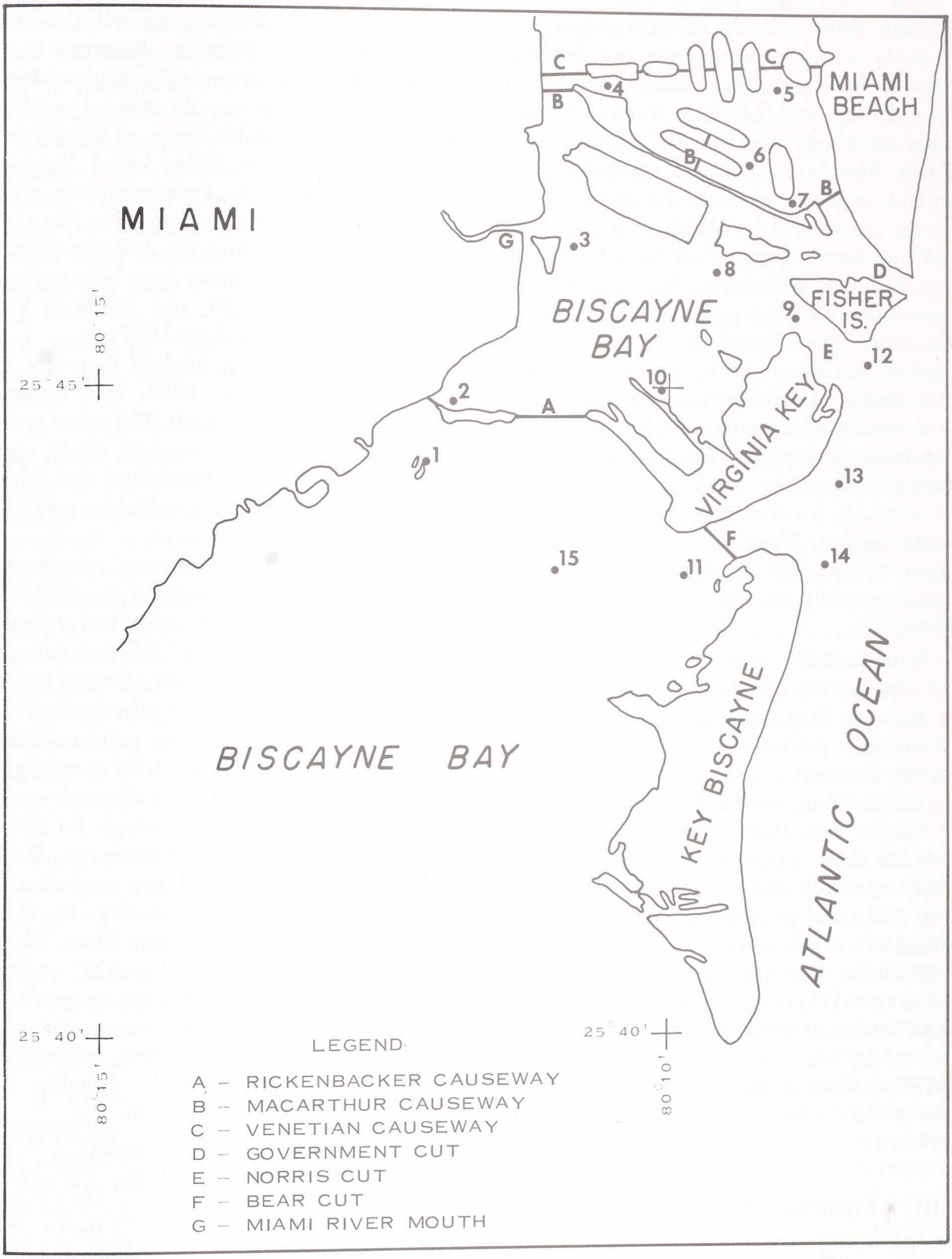

FIGURE 1. COLLECTING STATIONS

Bock (1961, 1967, 1971) has dealt extensively with the taxonomy and distribution of benthonic foraminiferal species in Florida Bay and adjacent waters. He has reported 99 genera and 235 species from South Florida waters and recognizes five general environments: the Straits and Gulf faunas (controlled by depth), the back-reef and bay faunas (controlled by temperature and salinity), and the brackish water fauna (controlled by salinity). In his first study, he discussed the distributional effects of current and wave sorting and the evidence that mixing of offshore and bay waters leads to a mixing of faunal assemblages. *Archaias angulatus, Quinqueloculina bosciana*, and *Q. poeyana* were the most common species recorded. In his second study, a "sediment" fauna and a *Thalassia testudinum* Konig fauna were recognized. Species of the second fauna generally are attached to turtle grass when alive.

Wanless (1967) made a thorough study of the distribution and deposition of sediments in Biscayne Bay. He discussed the existing circulation patterns and the hydrologic factors involved which are presently affecting the distribution of sediments.

Wright and Hay (1971, Bock, *et al.*) sampled along a traverse through a back-reef environment in the Florida Keys. Standing crop and total population of the benthonic foraminiferal community were studied and distribution was determined. The data collected reveal that greater numbers of live and dead foraminifers are associated with areas covered by vegetation, and that many specimens are directly attached to this vegetation (normally *Thalassia testudinum*, turtle grass).

III. GENERAL DESCRIPTION OF AREA

The area of northern Biscayne Bay chosen for study is irregular in shape and bounded by latitudes N25°47.3' on the north and N25°43.5' on the south, and longitudes of W80°12.2' on the west and W80°08.3' on the east. It is the central portion of the larger northern bay complex, and includes approximately ten square miles of water surface and six square miles of exposed land surface. Northern Biscayne Bay includes all basin waters contained within the Dade County metropolitan areas on the western mainland and a series of islands to the east. Miami Beach, Fisher Island, Virginia Key, and Key Biscayne represent the southern-most extension of the barrier sedimentary islands along the Atlantic coast, and these clastic sediments have been transported from the north and offshore by longshore currents (Wanless, 1967).

Government Cut was dredged to create a Main Ship Channel in 1905, and Fisher Island was a secondary result. The other two main channels into the area of study are Norris Cut between Fisher Island and Virginia Key, and Bear Cut, which separates Virginia Key and Key Biscayne.

At the turn of the century, northern Biscayne Bay was considered a shallow lagoon, and the unspoiled region had a great diversity of plant and animal life associating within the clear, warm waters. Man has been the greatest factor in changing the quality of the water and the circulation patterns controlling distribution factors of the remaining fauna. Dredging created boat channels and the spoil banks were used as a base for constructing residences and causeways. For many years the bay served as a depository for untreated sewage originating in the municipalities along the Miami River. This sewage influx has been brought under control but still some pollutants are getting into the bay waters from the businesses and residences in the area. No new sediments reach the area since all of the shoreline is lined with bulkheads or walled in.

The northern part of Biscayne Bay is now classified as a positive, shallow, tidal bar-built estuary (Hela, *et al.,* 1957). The circulation of the waters within and adjacent to the northern bay area has been studied along with its effect on various parameter distributions (salinity, oxygen content, sediment size and type) by several authors (Weiss, 1948, Hela, *et al.,* 1957, Wanless, 1967). The hydrography of the region will be discussed under the following topics:

1) *Tides*—Tides are semidiurnal but do not arrive at all bay stations at the same

time. At the Miami harbor entrance the mean tidal range is 0.8 meters, or about 2.6 feet. The range is less in the bay (Wanless, 1967). Winds affect the time and height of predicted tides.

2) *Tidal currents*—Southern Biscayne Bay receives warm oceanic waters of the Gulf Stream through numerous tidal channels along the eastern side of the bay. Tidal waters reach the area under study primarily through the Main Ship Channel, Norris Cut, and Bear Cut. Flow through these channels and under the bridges of the man-made islands has been measured (Hela, *et al.*, 1957).

3) *Tidal exchange*—Northern Biscayne Bay is too shallow for density stratification (Hela, *et al.,* 1957), so mixing of the incoming tidal flow with water in the bay is "confined to an interface along the perimeter of the incoming water" (Wanless, 1967, p. 9). Weiss (1948) had concluded earlier that little mixing occurred between the water of the north bay and the ocean during each tidal cycle. He noted that in some areas, however, strong currents developed between the closely spaced islands. This brought to certain sites an alternation of bay water and ocean water.

4) *Longshore currents*—Ocean swells resulting from the northeast trade winds arrive from the north, northeast, and east and set up southerly longshore currents (the agent that created the barrier island complex). The summer months also have smaller swells and waves from the south and southeast that cause northerly inshore currents (Morrill and Olson, 1955, *in* Wanless, 1967).

5) *Waves*—The entire bay is protected from offshore swells. Waves in the study area are predominantly wind-generated. Boat wakes will not be considered, although boat operation could be a factor in the distribution of foraminiferal tests in localized areas. In the summer, winds are gentle to moderate, and generally prevail from the southeast and east. Winter winds are stronger and arrive from the northeast and east. Wanless (1967) found that when the wind was less than 20 knots, waves within the bay were less than 0.7 meters high, with winter storm waves reaching one meter. Within the land-locked portion of the north bay, winds would cause slightly smaller waves due to the decreased fetch distance.

6) *Fresh water influx*—Weiss (1948) observed that the waters of the north bay were considerably affected by land and sewage drainage. Much of the fresh water introduced to the western boundary of the study area is from the Miami River, which originates in the Everglades swampland. Burlingame Island, at the river mouth, helps divert the fresh water to the north and south. Other small rivers and creeks are located farther north and south in the bay region. Miami is in the subtropical belt and normal yearly rainfall is over 125 centimeters. It is known that ground water percolating along western Biscayne Bay also mixes with the bay waters.

7) *Salinity*—Although the figures available are not recent, they are believed to be valid since the processes that affected salinity then are the same as the processes occurring now. The seasonal variation (lower salinity in summer, higher in winter) can be directly related to the amount of rainfall. More precipitation results in greater fresh water runoff and higher artesian flow of ground water. Weiss (1948) commented that salinity, which fluctuates much more in the northern bay waters than in the open ocean due to the seasonal variation in rainfall, helps indicate the isolation of this region from the open sea. Salinity fluctuations due to evaporation are related to the climate (temperature and rainfall), and daily fluctuations occur as salinity increases with the incoming tide. Bock (1967) also noted a direct relationship of salinity to depth. There is more water with increasing depth so less dilution can occur by fresh water runoff. The greater fresh water influx is on the western margin of Biscayne Bay. Mixing of bay and ocean waters is restricted to the eastern margin, although the greatest tidal salinity ranges exist near the middle of the study area. Data and figures (Hela, *et al.,* 1957) correspond with expectations. Average salinity values near the Miami River and western shores range from 20 to 25 parts per thousand, and the range on the eastern side of the bay is 30 to 35 parts per thousand. The western

waters are more brackish and near the main channels more oceanic water conditions exist.

8) *Temperature*—Seasonal variations correlate directly with seasonal air temperatures, as "the waters in the north bay respond quickly and directly to seasonal temperature changes of the air" (Weiss, 1948, p. 155). Temperature changes little with depth since Biscayne Bay is shallow throughout and vertical stratification is absent. Bottom water temperatures averaged 23 degrees centigrade on March 6, 1973, and 25 degrees on May 22, 1973. The air temperature range for the first half of 1973 was 32.8 degrees centigrade to 5.6 degrees centigrade.

9) *Circulation*—The mechanisms for circulation of the northern bay waters are not very complicated. Circulation is primarily tide driven, and the complete cycle occurs twice a day with the semidiurnal tide. There is also some wind driven drift of the surface waters. Because of the shallowness of the bay and lack of thermal and density stratification, the circulation system is one-layered (Hela, *et al.,* 1957). The path this system follows is more complex than the mechanisms driving it, however, due to the various channels and barriers present. Weiss (1948) noted that the MacArthur Causeway was a very effective barrier to water circulation since it was a continuous land-fill except for bridges at the eastern and western ends. The same observation applies to the Rickenbacker Causeway, built later to the south. Although not as continuous a land-fill as the other causeway, this one also restricts northward water flow from the southern to central portion of the study area. The two causeways have effectively divided the study area into three bodies supplied by ocean waters through the three main channels (Government Cut, Norris Cut, and Bear Cut). The other causeways have open bridges between the man-made islands and thus offer less resistance to circulation. The incoming tide waters move generally westward and, once inside the bay, are channeled northward (Hela, *et al.,* 1957). The river waters, being less saline and less dense, flow out over the top of the bay waters and proceed to mix because of the "stirring action" of the wind and waves within the bay area.

10) *Man's influence*—As already mentioned, dredging and land-fill influence sediment distribution and affect the circulation pattern. Bulkhead and seawall construction restricts deposition of new sediments since supplies are cut off. Man taps the rivers and ground water for various uses and affects the fresh water influx. Water quality varies in terms of oxygen, organic, and mineral content due to pollution outfall (including operation of water vehicles). This will be evident by inspecting lists of animals and plants that were once recorded within the bay and noting how many of these have disappeared (*The Miami Herald,* October 8, 1972).

11) *Hurricanes*—These are interesting storm phenomena of intense winds with high quantities of precipitation. The large amount of energy released is capable of causing storm tides greater than three meters above mean low water, and large driving waves are built up by the winds. These forces can have a significant effect on the sediment bottom of the shallow bay, transporting large quantities of sediment and ripping up the bottom vegetation. The greater precipitation would lower salinity in the bay, but this is partially offset by the greater tidal flow into the area. The South Florida area occasionally experiences a hurricane, but the last time the eye of a major hurricane passed close to the study area was 1966.

12) *Oxygen content*—The oxygen content of the bay waters will not be discussed at length except to state that levels are probably sufficient for bottom habitation by Foraminiferida in all areas with any water circulation. Pollution was at greater levels during previous studies (Hela, *et al.,* 1957), yet oxygen contents well above 40% had been found throughout the bay. The shallowness of the area and mixing by winds and tides allows all the bay waters to be sufficiently aerated.

The sediments within the study area are varied. Wanless (1967) studied these in great detail and much of this discussion is based on his findings. He made several coring traverses of Biscayne Bay and three of these cut through the area presently under study. The island complex is composed of longshore clastic sand that is predominantly medium to coarse, subrounded quartz and carbonate grains. Below the bay waters to the west these sands interfinger with the more angular quartz sands of the mainland. The mainland quartz sands, and much of the intrabay quartz sediment, have as their source the Pamlico Formation, a Pleistocene submarine bar now exposed along the mainland just north of Miami. On the eastern side of the bay are marine carbonate muds. Overlying much of the mud and sand is organic flock. Bedrock has been reached at depths between four and seven meters within Bear Cut and Norris Cut due to strong tidal currents, but seaward and bayward the channels digitate and shoals are present. Shoals continue below Cape Florida on Key Biscayne as a tidal bar belt and the amount of carbonate material present increases toward Soldier Key farther south. The shoals west of Norris Cut are principally muddy lagoon sands, and these become sandier towards the tidal channel. Due to the tidal currents, sediments within the channels are coarser. There is a greater abundance of shell material near the channels, also. The sediments within the bay area are mainly angular quartz grains that have been reexposed for distribution due to the extensive dredging in the area. The absence of material for deposition allows the organic flock to accumulate into considerable layers. The finer sediments are in areas of lower energy, which indicates wave and current sorting. Areas for these finer sediments include the bay side of Virginia Key and the residential island complex north of MacArthur Causeway and south of Venetian Causeway (which is taken as the effective northern limit of the study area).

The entire bay is considered as a shallow environment. However, there is appreciable variation in depth within the northern bay. The shallower areas are exposed at low tide, and some locations south of Rickenbacker Causeway are covered by about five meters of water at high tide. The Intracoastal Waterway was dredged to 2.4 meters below the mean low tide mark, and the Main Ship Channel is approximately nine meters deep. The shoal and channel system results in rapid depth change with little lateral movement. Depths observed during sampling are mentioned in the discussion on each station (see Table 1).

The amount of vegetation and larger animal activity on the bottom varied within the study area. Some areas, such as those emergent at low tide or swept by faster currents, were devoid of vegetation. The broad, flat-bladed sea grass known as "Turtle Grass" (*Thalassia testudinum* Konig) was the most common. In places, "Manatee Grass" is present, associated with turtle grass in the sparser areas. "Manatee Grass" (*Syringodium filiforme*) is a marine grass with narrow, cylindrical blades. Various species of green algae were also noted at isolated spots, usually nearer the shoal areas to the south. Small mounds in the sediments of the grassy areas and sandy patches testified to the presence of burrowing worms and crustaceans. Browsing mollusks are known to be present in some sections of the area, and echinoderms are rare.

Observations on bottom conditions and information obtained during sampling at each station have been arranged in table form and follow as Table 1, patterned after Stubbs (1940).

IV. PROCEDURES

All areas in the northern Biscayne Bay region chosen for study could be reached easily by the small outboard motor boat used to collect samples. Eleven stations were established for collection on March 6, 1973. Four stations were added during the sampling on May 22, 1973. The choice of stations was made in order that each would be significantly distant from the others and such that waters within and waters entering the bay would be well-sampled. Bearings were taken on landmarks to determine the latitude and longitude and to allow future reoccupation of each station for additional collecting.

In all, 26 samples were taken from the 15 stations selected. Each sample was hand-collected by skin-diving with mask and fins. The person taking the sample would drift a short distance from the boat and then dive

TABLE 1

Description of Stations

"A series" – March 6, 1973 collection "B series" – May 22, 1973 collection

Sample	Location	Depth	Temperature	Character
1A	N25°44.4' W80°12.2'	4 feet	24.0°C	Bottom hard, medium-coarse quartz sand, some mud, turtle grass vegetation, very near two small sand bar islands
1B	Above	5 feet	25.5°C	Medium amount of *Syringodium* ("pin" grass), thick turtle grass (*Thalassia*) vegetation, also much decaying vegetation over fine quartz sand, burrowers present, near two islands
2A	N25°44.8' W80°11.9'	7 feet	23.5°C	Medium quartz sand, some organic flock, light amount of *Syringodium* and *Thalassia,* station near western margin of bay
2B	Above	6.5 feet	25.0°C	Soft bottom, sediment with light amount of *Syringodium* cover, burrowers present, near Rickenbacker Causeway landfill on western bay margin
3A	N25°46.0' W80°10.9'	8 feet	22.0°C	Hard bottom, coarse quartz sand, some organic flock, small shell fragments, near Intracoastal Waterway dredge area, outside of mouth of Miami River
3B	Above	9 feet	25.0°C	"Pot-holed" algal mat with fine sand in slightly depressed areas, no vegetation, near dredge area, outside of mouth of Miami River
4A	N25°47.3' W80°10.6'	9 feet	22.0°C	Light amount of grasses, silty surface, some carbonate fragments, near northern limit of study area
4B	Above	8.5 feet	25.5°C	Soft sediment covering, vegetable matter decaying but no live grass, near northern limit of study area
5A	N25°47.3' W80°09.1'	12 feet	22.0°C	Light amount of grasses, silty surface, some carbonate fragments and organic flock, near northern limit of study
5B	Above	12 feet	24.5°C	Fine sand, no grass, small carbonate fragments, some organic flock, near northern limit of study area
6A	N25°46.7' W80°09.4'	11 feet	21.5°C	Soft bottom, very soft "mud-ooze", dark (high organic content), in area with restricted current movement
6B	Above	12 feet	24.5°C	Fine muddy sand, no grass, very soft bottom, decayed vegetable matter present, low amount of current movement
7A	N25°46.4' W80°09.0'	12 feet	23.0°C	Fine sand, much carbonate fragments, no live grasses visible, near Main Ship Channel currents
7B	Above	12 feet	24.0°C	Fine sand, no grass, decaying grass material with sediments, near Main Ship Channel currents
8A	N25°45.9' W80°09.6'	5 feet	22.0°C	Fine sand, some larger shell fragments, some decaying grasses present and turtle grass near, near a small shoal
8B	Above	4.5 feet	25.5°C	Coarse shelly quartz sand, small mollusks (to ½"), some turtle grass, very near a spoil bank and a small shoal
9A	N25°45.5' W80°08.9'	7 feet	23.5°C	Medium to coarse sand, mostly carbonates (shell and rock fragments), within Norris Cut, grasses on nearby shoals

9B	Above	5 feet	25.5°C	Sampled at edge of small shoal, turtle grass near, some bottom current, coarse, shelly, ½" mollusks present, within Norris Cut
10A	N25°44.9' W80°10.1'	4 feet	23.0°C	Three to six inches of fine sediments held by grasses, turtle grass predominating, much decaying matter, in protected area on bay side of Virginia Key
10B	Above	3 feet	25.5°C	Silt and algae covering on thick growth of *Thalassia* and *Syringodium,* three to six inch mat of silt and decaying grasses on bottom, in protected area on bay side of Virginia Key
11A	N25°43.5' W80°09.9'	4 feet	21.5°C	Very fine sand, some decaying turtle grass blades present, some carbonate material, on bay side of Bear Cut near shallow water shoals
11B	Above	5.5 feet	25.5°C	Medium growth of turtle grass and manatee grass, algae covering grass and bottom, fine sand, on bay side of Bear Cut near shallow water shoals
12B	N25°45.2' W80°08.3'	9 feet	24.5°C	Hard bottom, medium-coarse sand, predominately clastic shell, no grass, 2-3" bivalve shells present, ocean side of Norris Cut
13B	N25°44.2' W80°08.5'	9.5 feet	25.5°C	Hard bottom, no grass, coarse sand composed of clastic shell, slight bottom algae film, exposed to northern side sweep of currents through Bear Cut
14B	N25°43.6' W80°08.7'	8 feet	25.0°C	Medium sand of quartz and shell, some larger shell fragments, abundant turtle grass, some sand patches, exposed to southern side sweep of currents through Bear Cut
15B	N25°43.6' W80°11.0'	13 feet	24.5°C	Fine sand and silt, well burrowed, algal tufts, no grass, soft bottom, in open area of Biscayne Bay

to the bottom of an undisturbed area. At most stations the bottom was not visible from the surface and sampling proceeded randomly at whatever type of bottom was reached during the dive. Small jars were employed to skim off slowly the top one-half centimeter of bottom sediment over a small area. As observed during the sampling, this method does not disturb the sediments significantly. The cap was placed on the jar immediately after skimming the sediment surface to prevent loss of the sample. While positioned at each station, the temperature and depth readings were recorded, and bottom conditions were noted. Because of the small size of the boat, collecting was necessarily carried out on relatively calm days.

To prevent any deterioration of the cytoplasm of the organisms before staining could be accomplished, 90% denatured ethyl alcohol was added to each jar within four hours of the taking of each sample. Alcohol was used since formalin must be buffered to prevent the dissolution of calcareous tests due to the accidental formation of formic acid. The samples then could be safely stored to be processed later when more convenient.

In the laboratory, each sample was further prepared. This included staining of the cytoplasm to facilitate determination of the standing crop distribution and the splitting of each sample to smaller portions or aliquots.

Rose Bengal solution was the stain selected. Walton (1952) has discussed the feasibility of using Rose Bengal as a stain for cytoplasm and compared its effectiveness to other staining procedures. Rose Bengal stains cytoplasm bright red, and Foraminiferida living when collected can be readily distinguished from dead ones. As suggested by Wright and Hay (1971), "living Foraminifers" will refer to those specimens that have taken the stain, and "dead Foraminifers" are all the unstained specimens. The stained samples were washed free of excess stain and then dried in an oven at temperatures below 80 degrees centigrade. The dried samples were then weighed (the stain has no appreciable weight), sieved on a #230 (63 microns or 4 phi) U.S. Standard Sieve and the greater than 63 microns portion weighed again. The weights obtained allowed calculation of the coarse fraction for each sample. For two reasons the cutoff point for sediment size was chosen at 63 microns rather than at 74 microns. Sedimentologists consider 63 microns as the minimum size of sand-sized particles. Also, it was noted while observing samples from areas nearby but outside the study area that juveniles and small tests are caught on the smaller mesh openings, and certainly these tests must be considered as part of the population. The sieved samples were then subdivided with a microsplitter. A sample size of 300 to 400 tests per sample was desired and aliquots were created until it was believed this level had been reached. No maximum number of splits was decided upon, as long as no bias was introduced in the makeup of each aliquot. Each chosen aliquot for the first 11 samples ("A series") was picked of every foraminifer. The individuals were identified and mounted, counts were made, and for each sample the percentage distribution for species was determined for the standing crop and total population. It soon was apparent that each of the first 11 samples had not been split far enough, and this was corrected for in splitting the 15 "B series" samples. The "B series" samples were split farther than the "A series" samples. In these more manageable aliquots (in terms of the number of individuals present), all benthonic foraminifers were identified and counted, and the distributions of standing crop and total population were determined.

Further work was carried out on the material. Each of the aliquots worked was weighed. The total number of Foraminiferida per gram, termed the foraminiferal number, was then computed. The values obtained can be used to compare the abundance of foraminifers in the different sampling areas, as well as comparison of these sample faunas with fossil faunal assemblages. Finally, the percentages derived from the counts of standing crop and total population in each sample have been grouped in Table 3 for easy comparison.

Preparation of specimens for viewing with the University of Miami's AMR Model 900 Scanning Electron Microscope was relatively simple. The specimens were attached to stubs by "double-stick" Scotch tape, and a gold-palladium alloy coating was applied. The film used for the original prints was Polaroid PN/55, black and white.

V. DISTRIBUTION

Much of the recent work on benthonic Foraminiferida has gone beyond the simple listing of species occurring in an area to discussion of possible effects of ecologic parameters on the distribution and frequency of these forms. The distribution and frequency in the Biscayne Bay area will be discussed in relation to the factors affecting the species identified from the samples collected.

A number of factors are known to have definite effects on the distribution and frequency of Foraminiferida. Some of these are: depth, temperature, salinity, oxygen content, wave and current sorting, sediment size and type, bottom vegetation, and pollution. Typically, the interrelationship of these factors prevents complete determination of the contribution of each factor, if any, to the distribution observed. Due to the various environmental factors, species are not uniformly distributed over the bottom, and Shifflett (1961) mentions two assumptions of which one should be wary. The first is the assumption that a total population recovered from a sample is representative of the living population at that sample locality. The second assumption frequently made is that a sample of a small cross-sectional area is representative of a large area on the sea floor. These assumptions are invalid because of relict faunas, wave and current sorting, and the frequent faunal variation over short lateral distances. Wright and Hay (1971) concluded that closely spaced multiple samples are necessary for quantitative description of foraminiferal populations, but that widely spaced single samples are sufficient for characterizing what species are present in an environment. An additional consideration is that different conditions exist at a station at different periods of time, especially in shallow waters. All of this indicates that a very large number of samples is necessary to make an accurate study of effects on population and distribution due to the environmental factors.

In the present study, 11 stations were visited on March 6, 1973, and these with four additional stations were sampled on May 22, 1973. These 26 samples cannot be considered closely spaced, and there was little change in water conditions during the period between the sampling dates. The sampling is considered sufficient for determining the species present in the general environment. However, discussion of the distribution in terms of the previously mentioned factors will be restricted to that of the distributional variation among the stations. Any discussion of the changes through time in population distribution at a particular station has to be omitted because no station was repeatedly sampled during appreciably changing water conditions.

Depth and bottom water temperature were measured at each sampling site. The differences in depth among the stations is not appreciable, and depth was found to have little importance within this shallow bay in terms of distributional effects, other than the secondary aspect of the shallower areas being more susceptible to current and wave sorting. The temperature variation was not more than four degrees centigrade between any two stations, and cannot be considered a significant factor affecting distribution among the stations within the study area.

Salinity variation within the bay has been discussed elsewhere. The presence or absence of three particular species reflects especially well the salinity increase away from the western bay margin. *Ammonia beccarii parkinsoniana*, *Ammonia beccarii tepida*, and *Elphidium gunteri galvestonense* are reliable indicators of a stress environment. More accurately, the presence of only the two *Ammonia beccarii* subspecies would indicate stress conditions, with the additional presence of *Elphidium gunteri galvestonense* in large numbers indicating that the water is brackish and not hypersaline (Bock, 1973, personal communication). These species are found in high concentrations at stations 1, 2, 3, and 4, the ones nearer the western bay margin and affected by the greatest amounts of fresh water influx. Stations 5, 6, 7, 8, 10, and 15 have appreciable numbers of these species and reflect general bay salinity (Hela, *et al.*, 1957). The remaining stations have lower concentrations of these brackish water species and the water salinities are more nearly those recorded for open oceanic waters. This relationship between the mentioned species and salinity is perhaps the easiest to recognize, due to the large numbers of specimens present.

It will be difficult to discuss accurately the effects of oxygen content and pollution on the populations. Even during times of heavy pollution, it appears that the waters have been amply oxygenated (Hela, *et al.*, 1957). So, it will be assumed that oxygen content has had no recent effect on distribution within the bay area. The present benthonic fauna is not as varied as the one that existed at the turn of the century, and there is reason to believe that losses have also occurred in the foraminiferal assemblage. Limited data prevent one from stating specifically in what ways losses have occurred.

One of man's greatest effects on the distribution of benthonic Foraminiferida is dredging. This process stirs up silt that can cover and smother the bottom fauna. Dredging uncovers older sediments and the relict fauna may be reworked into the present fauna. Additionally, creation of islands and various channels leads to new water current routes which cause older sediments with their fauna to be redistributed. The location and extent of the marine grasses change, and it will be discussed later how distribution of benthonic Foraminiferida closely ties in with distribution of bottom vegetation.

There are several observable correlations that can be made concerning the foraminiferal distribution and sediment size. Wave and current sorting is a very active process within the bay. The tests are sorted by size just as the sediments are, and observation of the samples show this indeed to be true. There are two other associations between the finer sediment sizes and species distribution, but coarse fraction values must be discussed first. Grain size distribution information from a coarse fraction determination is not as accurate as that which would be gained from a proper sieve analysis. The small amounts of obtained sample prevented sieve analysis; however, the coarse fraction determination actually is a sieve analysis, with only one sieve. The coarse fractions measured indicate the percentage of sample in grain sizes larger than 63 microns, but indicates nothing about grain size distribution within the coarse or fine fraction. Observation of the sample under the microscope, however, shows a marked tendency of the samples of higher coarse fraction to be coarser-grained also. Station 6 has the lowest coarse fraction and easily is the finest-grained; many of the greater than 63 micron sized sediments were really reworked faecal aggregates of smaller particles. This discussion will now proceed under the premise that in this area there is a direct relationship between coarse fraction and grain size, where coarser-grained samples generally are those with higher coarse fraction values. The other two relationships between sediment size and distribution, using calculated coarse fraction values, can be observed in Table 2. The trend is for the foraminiferal number, the number of Foraminiferida per gram of sample, to be larger for the samples with lower coarse fraction values (greater amounts of fine material). The other relationship is that there is generally an increasing number of species in the samples of increasing mud content (decreasing coarse fraction values). A notable exception to both relationships above is sample "7A", but additional factors here are the specimens associated with inshore transport and the more thorough selective sorting; both are strong factors because of station 7's favorable position with respect to these tidal current effects. These relationships seem to be generally correct, however, and evidence supporting them is their relationship to grassy flats. Many Foraminiferida live on the marine grass blades but are displaced when they die or the test is vacated. The grass traps finer sediments or tests, and the larger tests and sediments will be found in the coarser sand patches devoid of grass. The grass flat with the fine sediments will have the greater variety and greater number of specimens (Bock, 1967, Wright and Hay, 1971). A fourth relationship between grain size and foraminiferal distribution is the restriction of several agglutinated species to areas of finer sediments. Apparently, *Ammotium salsum, Pseudobolivina walshi,* and *Reophax nana* are dependent on these finer grains as building material.

An association is also observed between sediment type and distribution. Soritidae appear in greater abundance at stations more abundant in calcareous sediments. The channels have coarser calcareous sediments than occur elsewhere, transported inshore by tidal currents, and the association of large Soritidae tests with them indicates they are also associated offshore. Additional evidence for this relationship is the higher percentages of Soritidae in samples from southern Biscayne Bay, where the sediments are also more calcareous. As is the case in every distribution discussed here, the interrelationship of effects due to other factors, as well as the limited number of samples, prevents any definite analysis of to exactly what degree distribution and frequency of Foraminiferida is a reflection of the sediment properties.

Bock (1967) observed two other factors that affect foraminiferal distribution and abundance, but they will be only mentioned here since the data are not sufficient for evaluating their effects in Biscayne Bay. Bock noted several abundance relationships between species, and interpreted this as interspecific competition for survival under the conditions present at the time. In addition, he observed that this competition among the foraminifers was apparently limited to species falling within the same general size range. The other factor is the number of other organisms in the area. Some animal forms may purposely feed on foraminifers, but other foraminifers are destroyed by the indiscriminate grazing of gastropods and other organisms. Abundance or absence of microscopic forms (and other nutrients) that serve as food for the Foraminiferida would also affect distribution and abundance.

Comments on the effects of vegetation on distribution will be included within the discussion on standing crop distribution. Bock (1967) investigated the relation between the two and observed that many species prefer living attached to marine grasses, especially *Thalassia testudinum* Konig. In addition to this control on the standing crop, he concluded that the distribution of turtle grass also controls the type of substrate present at a given locality, the substrate in turn controlling the distribution of the foraminiferal fauna. Other than noting this apparent relationship between vegetation and distribution, there is little information available on the effects of vegetation. Several of the stations were devoid of grass; no grass samples were taken; and, because of the condition of the water, over much of the bay it could not even be ascertained from the surface where the grasses were. Discussion on the standing crop will continue, however. Lynts (Bock, *et al.*, 1971) makes two points on variations between the standing crop of two samplings at a station; first, it is not possible to reoccupy the station position exactly, and second, there is variation of the environmental factors between the two times of the year. These points are valid, and changing conditions and variation over short lateral distances should be kept in mind. Wright and Hay (1971) feel that living populations must be examined in order to draw ecological conclusions. The problem is that:

> . . . live specimens could not be found of many genera and species that are abundant in the sediment samples from Florida Bay. Either the sampling and staining techniques are not correct or the tests in the sediment do not reflect the live Foraminifera in the area. Many more samples must be studied before the distribution of live Foraminifera in the area can be discussed with certainty. (Moore, 1957, p. 732)

Already handicapped by a lack of abundant samples, this discussion of the standing crop in relation to the various ecologic parameters is also handicapped by Moore's problem—the lack of live specimens. Less than 6% of the total number of specimens observed were alive (*i.e.*, took the stain). This is an indicator in itself, however. Phleger (1960) said that a low live to dead ratio indicates a low rate of sedimentation, and this the northern bay has. For example, though, there are only four live specimens occurring among the more than 1200 *Elphidium gunteri galvestonense* counted. Finding no live Soritidae in the bay does allow an ecologic conclusion to be made, contrary to Wright and Hay. By taking also into account their distribution and frequency, it can be assumed the Soritidae normally occur in more oceanic saline areas of predominantly carbonate sediments (as now exist to the east and south of the study area). In total, 50 species belonging to 32 genera and 21 families are observed living in the study area. Live specimens are most abundant in the brackish water and bay environments, and are most numerous at station one. This points toward the observation (Bock, 1967, Wright and Hay, 1971) that grasses are very important to many Foraminiferida, since this station has the best vegetative growth as evaluated on abundance and plant color. *Ammonia beccarii tepida* is the most abundant species in the standing crop, followed in total numbers by *Triloculina trigonula, Quinqueloculina bosciana, Ammonia beccarii parkinsoniana, Miliammina fusca,* and *Cribroelphidium poeyanum.*

The remaining discussion on distribution concerns the total population. Table 3 should be consulted.

Several families predominated within the study area. It should be kept in mind, however, that species and family abundances are dependent on the selected sampling sites and the amount of sample examined. If more samples had been examined from near the open ocean, more peneroplids would have been counted and the percentages would

TABLE 2

Sample number	Coarse fraction	Number of species found	Foraminiferal number
1A	92.5%	44	131
1B	96.3%	39	310
2A	96.7%	35	286
2B	92.8%	35	698
3A	96.8%	42	91
3B	94.1%	32	545
4A	29.9%	52	5,232
4B	45.3%	52	12,605
5A	89.0%	71	6,324
5B	90.8%	44	1,486
6A	6.9%	94	20,800
6B	22.7%	76	15,286
7A	99.3%	100	851
7B	78.6%	67	4,667
8A	91.7%	87	3,719
8B	97.9%	61	509
9A	88.1%	75	565
9B	95.6%	58	787
10A	49.3%	58	4,428
10B	58.1%	52	4,387
11A	67.4%	88	3,441
11B	78.6%	71	5,037
12B	98.2%	54	741
13B	98.7%	45	76
14B	93.8%	59	524
15B	50.0%	67	10,545

indicate a greater abundance of the family Soritidae; more brackish water stations would have increased the Rotaliidae counted. Additionally, the particular specimens of a large enough sample count from brackish waters, for example, could outnumber other specimens added together from two or even three smaller-sized samples collected in a more saline area. Statements made about the bay distribution in general, then, would be less valid than statements made for distribution among stations of comparable conditions, and even less valid than statements of distribution at a particular station or within a particular sample. Statements concerning distribution and abundance at several levels will be made, with confidence in the statements increasing with each level.

The first level is the general bay area under study. The total fauna is comprised of 152 species belonging to 35 families and 75 genera. Of the specimens examined, the families Rotaliidae, Miliolidae, Elphidiidae, and Soritidae are the most prevalent, in decreasing order of abundance. The *Ammonia beccarii* subspecies are by far the most abundant foraminifers and account for all but one specimen of the Rotaliidae reported. *Elphidium* and *Cribroelphidium* account for all of the Elphidiidae, and the Soritidae are mostly *Peneroplis* and *Archaias* specimens. Several Miliolidae genera are present in the bay but the most common ones are *Quinqueloculina, Triloculina,* or *Miliolinella.*

The next level of disucssion is on the three faunal zones that can be conveniently distinguished. They are the brackish water fauna, the bay fauna, and the eastern margin inshore transport fauna. Each will be discussed separately.

1) *Brackish water fauna*—This encompasses stations 1, 2, 3, and 4, and is easily discerned by the high percentages present of *Elphidium gunteri galvestonense* and the subspecies of *Ammonia beccarii.* All four stations are near the bay's western margin, an area of high fresh water influx; and salinity appears to be the prime factor controlling distribution with lesser effects of wave and current sorting. Families represented in decreasing order of abundance are

Rotaliidae, Elphidiidae, Miliolidae, and Bolivinitidae.

2) *Bay fauna*—Stations 5, 6, 7, 8, 10, and 15 are considered to contain considerable elements of the bay fauna. Salinity, dredging, bay and ocean water mixing, and wave and current sorting are all deemed important as distribution factors. Grasses and areas of finer sediments are associated with this fauna. In general, the greatest diversity of specimens occurs at these stations. Over two-thirds of the observed species occur at stations 6 and 7. The Miliolidae have become the most numerous, followed by the families Elphidiidae and Rotaliidae. Becoming more noticeable are the Discorbidae, Bolivinitidae, Caucasinidae, and Soritidae. Some of the more abundant specimens include: subspecies of *Ammonia beccarii, Asterigerina carinata, Bolivina lanceolata, Bolivina paula, Cibicides floridana, Cribroelphidium poeyanum, Discorbis mira, Elphidium advenum, Elphidium gunteri galvestonense, Fissurina* cf. *F. lucida, Fursenkoina compressa, Hanzawaia strattoni, Hauerina bradyi, Miliammina fusca, Miliolinella circularis, Peneroplis carinatus, Quinqueloculina bosciana, Q. lamarckiana, Q. poeyana, Q. polygona, Rosalina candeiana, Rosalina floridana,* and *Triloculina trigonula.*

3) *Eastern margin inshore transport fauna*—Stations 9, 11, 12, 13, and 14 are considered to contain the inshore transport fauna. Each of the stations is near the eastern edge of the study area. They are near or within a major tidal channel and so receive the greatest effects of the tidal current (Hela, *et al.*, 1957). Salinity conditions are more nearly like that of the open ocean environment. Considered as distributive factors would be the increased salinity and the wave and current sorting. Inshore transport, though, greatly affects the distribution and abundance of species in this area. The families, in order of decreasing abundance of specimens, are Miliolidae, Soritidae, Discorbidae, Elphidiidae, and Asterigerinidae. Also well evident are members of the Cibicididae, Amphisteginidae, and Bolivinitidae. Several species expected to be found in deeper ocean waters are present in or bayward of the channel areas. Some of these include: *Articulina antillarum, Asterigerina carinata, Astrononion stelligerum, Bigenerina irregularis, Bolivina goesii, Guttulina australis, Hauerina speciosa, Heterostegina depressa, Lagena striata, Loxostomum* spp., *Pseudonodosaria torrida, Pyrgo comata, Rectobolivina advena,* and *Trifarina bella.* There are also several species, notably *Peneroplis carinatus, Archaias angulatus,* and *Textularia agglutinans,* that appear to have been transported inshore from the outlying grassy areas. Evidence for the wave and current sorting includes many smaller specimens of the above occurring in the finer sediments of the bay area, but very few being carried completely to the western bay margin since tidal currents become decreasingly evident in that direction. The sediments found within the channel areas are coarser shell and carbonate fragments, and are further evidence of inshore transport since the barrier island complex is dominantly quartz sand.

Finally, the distribution observed at each station will be considered. The percentages computed in Table 3 are accurate for the distribution within that sample. More samples would be necessary, though, before analysis of the change of distribution through time while different conditions are occurring at each station site could be accomplished. Very probably the changes would be more significant in the standing crop, since this is more quickly affected by many of the environmental factors. The general trend was to find fewer species in the "B series" of samples than in the "A series". This seems due in part to less material being examined and less specimens counted. In addition, the exact sampling site could not be reoccupied. It will not be possible to correlate any changes in the observed fauna at each station to particular environmental factors.

The distribution and abundance of specimens for each station will be discussed individually. All samples from March 6, 1973, will be referred to by an "A", and those from May 22, 1973, will be designated by a "B". The "B" samples were gathered to allow a check on the "A" samples, and also to facilitate a more accurate discussion of the fauna present at the perimeter of the study area. Information for each station can be found in Tables 1, 2, and 3.

Station 1—This station has a brackish water fauna. The Rotaliidae are the most important, and the Miliolidae and Elphidiidae follow. Minor families present include Rzehakinidae, represented only by *Miliammina fusca,* and Bolivinitidae. The most abundant species are two subspecies of *Ammonia beccarii,* followed by *Triloculina trigonula, Cribroelphidium poeyanum, Quinqueloculina poeyana, Miliammina fusca, Elphidium gunteri galvestonense,* and *Quinqueloculina bosciana.* The only specimen of *Massilina secans* observed was found here. In total, 53 species occur at station 1, 44 in the "A" sample and 39 in the "B" sample. This greater abundance of species in the "A" sample generally occurs at every station, and is discussed earlier.

Station 2—This station is also considered to be in brackish water. The *Ammonia beccarii* subspp. account for over half the specimens in the "A" and "B" samples, so again Rotaliidae is the predominant family. The Elphidiidae, Miliolidae, and Bolivinitidae are the other families of importance, and *Elphidium gunteri galvestonense* and *Cribroelphidium poeyanum* are the next most common species. There are 48 species at station 2, 35 species in each sample.

Station 3—Station 3 is definitely brackish water; just on the other side of a small island from the mouth of the Miami River. Fifty-one species occur at this station, 42 "A" species and 32 "B" species being identified. The Rotaliidae family again accounts for over 50% of the total population, and all are *Ammonia beccarii.* The Elphidiidae are second-most common followed by the Miliolidae. *Cribroelphidium poeyanum, Elphidium gunteri galvestonense,* and *Triloculina trigonula* are other very common species.

Station 4—This station has finer sediments than the other three brackish water stations. This may be due to current sorting, since the specimens are smaller; but, the percentages of species closely align with the other brackish water samples. The Rotaliidae are the most numerous, and following in abundance are the Elphidiidae, Miliolidae, and Bolivinitidae. *Ammonia beccarii* is the most common, followed by *Cribroelphidium poeyanum, Elphidium gunteri galvestonense, Triloculina trigonula, Quinqueloculina bosciana,* and *Quinqueloculina poeyana.* Sixty-seven species occur at station 4, 52 in each sample.

Station 5—The rotalids are less numerous at station 5, and the Discorbidae represent about 7% of the fauna. The miliolids are most numerous, and the Elphidiidae are about as common as the Rotaliidae. A general increase in Miliolidae and decrease in the Rotaliidae carries through to the other bay fauna stations. There are 76 species at this station, with 71 species in the "A" sample and 44 species in the "B" sample. The brackish water *Ammonia beccarii* and *Elphidium gunteri galvestonense* are still the most common, but the Miliolidae is the most common family with *Quinqueloculina bosciana, Q. lamarckiana,* and *Q. poeyana* present. The only specimen of *Bolivina hastata* observed occurs here.

Station 6—The foraminiferal number is highest at station 6 and the sediments are the finest. Several species occur only at this station, and include *Pseudonodosaria torrida, Lagena striata, Edentostomina?* sp., *Loxostomum porrectum, Pseudobolivina walshi,* and *Fissurina quadricostulata.* Other very rare specimens present here are *Ammotium salsum, Triloculina gracilis, Stetsonia minuta, Spirillina denticulata, Cibicides refulgens, Buliminoides williamsoniana,* and *Quinqueloculina parkeri occidentalis.* The agglutinated species, *Ammotium salsum, Pseudobolivina walshi,* and *Reophax nana,* are present here, in part, due to the fine sediments available as test-building material. The Miliolidae are the most common followed by the Rotaliidae, Elphidiidae, Bolivinitidae, and Caucasinidae. *Ammonia beccarii* is still most abundant, but *Elphidium gunteri galvestonense* is much less common. Next in abundance to *Ammonia* are *Cribroelphidium poeyanum, Quinqueloculina bosciana, Triloculina trigonula,* and *Quinqueloculina poeyana.* There are 105 species at station 6, 94 species in the "A" sample and 76 species common to the "B" sample.

Station 7—Station 7 is interesting because the number of species present is higher than would be predicted from looking at the coarse fraction and foraminiferal numbers. Possibly this is due to station 7's highly favorable position. It contains a bay fauna but offshore species are carried in by the tidal currents. There are 108 species at station 7, 100 species from the "A" sample and 67 species from the "B" sample. *Quinqueloculina poeyana* is the most common, followed by *Elphidium gunteri galvestonense,* the *Ammonia beccarii* subspecies, *Cribroelphidium poeyanum, Triloculina trigonula,* and *Quinqueloculina bosciana. Peneroplis carinatus* and *Asterigerina carinata* are common. The only occurrences observed of *Loxostomum* sp., *Cibicides deprimus, Bulimina* cf. *B. spicata,* and *Articulina mayori* are at station 7. Very rare specimens of *Articulina multilocularis* and *Articulina lineata* are also here. The family abundance, in decreasing order, is Miliolidae, Elphidiidae, Rotaliidae, Discorbidae, and Soritidae.

Station 8—The distribution of families is the same as for station 7, and this station is also near tidal currents. The Miliolidae are most abundant, followed by the Elphidiidae, Rotaliidae, Discorbidae, and Soritidae. Common in this bay fauna are *Ammonia beccarii* subspp., *Cribroelphidium poeyanum, Discorbis mira, Elphidium gunteri galvestonense, Quinqueloculina lamarckiana, Q. poeyana,* and *Triloculina trigonula.* There are 89 species at this station, 87 species in the "A" sample and 61 species in the "B" sample.

Station 9—This station is within the Norris Cut channel and distribution is strongly affected by tidal currents. The coarser sediments are a result of current sorting. Many of the specimens are very worn and appear older, and possibly have been exposed by the currents cutting into older shoal material. Several very rare specimens, expected to occur only in deeper offshore waters, are present in the samples at this station, and serve as evidence for inshore transport and mixing of offshore and inshore faunas. Miliolids are most prevalent, but the Soritidae are now second-most common, followed by Discorbidae, Asterigerinidae, and Elphidiidae. Very common are *Archaias angulatus, Asterigerina carinata, Discorbis mira, Peneroplis carinatus, Quinqueloculina lamarckiana,* and *Textularia agglutinans.* Very rare forms present are *Astrononion stelligerum, Guttulina australis, Nonion barleeanum, Pyrgo comata,* and an unidentified yellow-colored attached form. Eighty-nine species are present at station 9, and the "A" sample contains 75 species; the "B" sample, 58 species.

Station 10—The Elphidiidae dominate at this station but most are *Cribroelphidium poeyanum,* an accepted bay fauna indicator. Following in abundance are the Miliolidae, Rotaliidae, and Bolivinitidae. Seventy species occur at this station, 58 in the "A" sample and 52 in the "B" sample. Common species include the *Ammonia beccarii* subspp., *Elphidium gunteri galvestonense, Quinqueloculina poeyana,* and *Triloculina trigonula.* The only observed occurrence of *Fissurina* sp. "B" is here.

Station 11—The miliolids dominate at this station, but there are also appreciable numbers of the following families: Discorbidae, Elphidiidae, Rotaliidae, Soritidae, Cibicididae, and Bolivinitidae. Common species are the subspecies of *Ammonia beccarii, Articulina sagra, Cibicides floridana, Cribroelphidium poeyanum, Discorbis mira, Hanzawaia strattoni, Miliolinella circularis, Peneroplis carinatus, Quinqueloculina bosciana, Q. lamarckiana, Q. poeyana,* and *Triloculina trigonula.* Rare species in the sample include *Guttulina australis* and *Rectobolivina advena,* both of them offshore species transported into the bay. There are 96 species at this station, 88 species associated together in the "A" sample and 71 species present in the "B" sample.

Station 12—Stations 12 through 15 were sampled only on May 22, 1973, so no "A" samples exist for these stations. Soritidae are in greater abundance than the Miliolidae at station 12. The large number of Discorbidae are mostly *Discorbis mira* and *Discorbis rosea. Asterigerina carinata,* family Asterigerinidae, is also very common. The major species present, though, are *Peneroplis carinatus* and *Archaias angulatus,* either transported in from offshore or present as a relict fauna (no live Soritidae have been found within the study area). There are fifty-four species present at this station.

Station 13—This station is strongly swept by the tidal currents in Bear Cut. No vegetation is observed anywhere nearby and the sediments are very coarse in size. The Soritidae are the most common, followed by the Miliolidae, Discorbidae, and Asterigerinidae. *Archaias angulatus* accounts for one-quarter of the specimens, and other species present include *Asterigerina carinata, Discorbis mira, Peneroplis carinatus, Quinqueloculina lamarckiana,* and *Discorbis rosea.* Again, the specimens are probably a relict fauna or else are transported in by waves and currents. Forty-five species occur at this station.

Station 14—This station is south of station 13 and is also affected by the tidal currents moving through Bear Cut. The Miliolidae predominate, followed in abundance by the Discorbidae, Elphidiidae, Soritidae, Asterigerinidae, Amphisteginidae, and Cibicididae. Common species are *Amphistegina lessonii, Articulina mucronata, Asterigerina carinata, Cibicides floridana, Discorbis mira, Elphidium gunteri galvestonense, Quinqueloculina lamarckiana, Q. poeyana, Triloculina linneiana,* and *T. trigonula.* There are 59 species present in the sample from station 14.

Station 15—Percentages of abundance are more evenly spread out for station 15. The Miliolidae are the most numerous, followed in decreasing abundance by the Elphidiidae, Rotaliidae, Nonionidae, Soritidae, Anomalinidae, Discorbidae, and Cibicididae. *Ammonia beccarii tepida* is the most common species, and *Cribroelphidium poeyanum* is very abundant. Other numerous species include *Cibicides floridana, Elphidium gunteri galvestonense, Hanzawaia strattoni, Quinqueloculina bosciana, Q. poeyana,* and *Triloculina trigonula.* Considered a bay fauna station, 67 species are identified from the sample.

VI. CONCLUSIONS

There are 35 families, 75 genera, and 152 species represented in the sediments from the northern Biscayne Bay waters of the study area. The following species have not been reported previously in the area, but are now shown to occur in South Florida waters: *Ammotium salsum, Bulimina marginata, Buliminoides williamsoniana, Cibicides deprimus, Cribroelphidium kugleri, Edentostomina?* sp., *Elphidium gunteri galvestonense, Fissurina radiata, Fissurina* sp. "A", *Guttulina laevis, Hanzawaia strattoni, Lagena laevis, Nonion barleeanum, Nonionella opima, Pseudobolivina walshi, Quinqueloculina auberiana, Reophax nana, Rosalina candeiana, Rotalia dubia, Rotaliammina mayori, Siphogenerina costata, Spiroloculina antillarum angulata, Stetsonia minuta, Textularia parvula,* and an unidentified, yellow-colored, attached form.

Salinity is an important population factor within the northern Biscayne Bay, and variations within the bay are evident from the three faunal assemblages that have been established. The subspecies of *Ammonia beccarii* and *Elphidium gunteri galvestonense* dominate the western bay margin brackish waters, but the Miliolidae are most numerous at the bay fauna stations and the Peneroplidae become increasingly numerous at the eastern bay margin stations, where more oceanic saline conditions prevail.

Current and wave sorting distribute foraminifer tests in the same manner as the sediments are distributed. Inspection of the coarse fraction and foraminiferal number data also shows that, as average sediment grain size increases, fewer tests and fewer species occur in the sample. Inclusion of foraminiferal tests of normally deep water species within the shallow bay waters indicates the presence of the active process of inshore transport at the bay's eastern margin.

Discussing the distribution of a foraminiferal assemblage in detail is not an easy task, as the ecological factors are often interrelated. Moore (1957, p. 740) recognized the necessity of examining those factors controlling the distribution of living foraminifers and those factors controlling the accumulation of the empty tests of dead foraminifers, since "the relationship between these two is critical to distribution". Detailed sampling is the best procedure for determining these factors and evaluating the distribution and frequency in terms of them.

VII. ACKNOWLEDGMENTS

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VIII. SYSTEMATICS

The classification that follows is patterned after that adopted by Loeblich and Tappan (1964) in the *Treatise on Invertebrate Paleontology.*

Order FORAMINIFERIDA Eichwald, 1830
Suborder TEXTULARIINA Delage and Hérouard, 1896
Superfamily LITUOLACEA de Blainville, 1825
Family HORMOSINIDAE Haeckel, 1894
Subfamily HORMOSININAE Haeckel, 1894

Genus REOPHAX Montfort, 1808

REOPHAX NANA Rhumbler
Plate 1, fig. 1

Reophax nana RHUMBLER, 1911, Plankton-Exped. Humboldt-Stiftung, vol. 3, p. 182, pl. 8, figs. 6-12.

Discussion: This species occurred at ten stations, generally in very low frequencies.

Family RZEHAKINIDAE Cushman, 1933
Genus MILIAMMINA Heron-Allen and Earland, 1930

MILIAMMINA FUSCA (Brady)
Plate 1, figs. 2, 3

Quinqueloculina fusca BRADY, 1870, Ann. Mag. Nat. Hist., ser. 4, vol. 6, p. 286, pl. 11, figs. 2, 3.

Miliammina fusca (Brady). PHLEGER and WALTON, 1950, Amer. Jour. Sci., vol. 248, p. 47, pl. 1, fig. 19.

Discussion: This species occurred at 13 stations, generally in low frequencies.

Family LITUOLIDAE de Blainville, 1825
Subfamily HAPLOPHRAGMOIDINAE Maync, 1952

Genus HAPLOPHRAGMOIDES Cushman, 1910

HAPLOPHRAGMOIDES CANARIENSIS (d'Orbigny)

Nonionina canariensis D'ORBIGNY, 1839, *in* BARKER-WEBB and BERTHELOT, Hist. Nat. Îles Canaries, vol. 2, pt. 2, p. 128, pl. 2, figs. 33, 34.

Haplophragmoides canariensis (d'Orbigny). CUSHMAN, 1910, U.S. Natl. Mus., Bull. 71, pt. 1, p. 101, fig. 149.

Discussion: Single specimens were found at stations 1 and 7.

Subfamily LITUOLINAE de Blainville, 1825
Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES AGGLUTINANS (d'Orbigny)

Spirolina agglutinans D'ORBIGNY, 1846, Foram. Foss. Bass. Tert. Vienne, p. 137, pl. 7, figs. 10-12.

Ammobaculites agglutinans (d'Orbigny). CUSHMAN, 1910, U.S. Natl. Mus., Bull. 71, pt. 1, p. 115, fig. 176.

Discussion: This species occurred at seven stations in very low frequencies. Grain size of the test-wall varies among specimens and appears dependent on the material available at each station.

Genus AMMOTIUM Loeblich and Tappan, 1953

AMMOTIUM SALSUM (Cushman and Bronnimann)
Plate 1, fig. 4

Ammobaculites salsus CUSHMAN and BRONNIMANN, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, p. 16, pl. 3, figs. 7-9.

Discussion: This species occurred at only three stations and was very rare.

Family TEXTULARIIDAE Ehrenberg, 1838
Subfamily TEXTULARIINAE Ehrenberg, 1838
Genus TEXTULARIA Defrance, 1824

TEXTULARIA AGGLUTINANS d'Orbigny
Plate 1, fig. 5

Textularia agglutinans D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 144, pl. 1, figs. 17, 18, 32-34.

Discussion: This species occurred at 11 stations, normally in low frequencies. It accounted for over 5% of the "9A" sample, however.

TEXTULARIA PARVULA Cushman
Plate 1, fig. 6

Textularia parvula CUSHMAN, 1922, U.S. Natl. Mus., Bull. 104, pt. 3, p. 11, pl. 6, figs. 1, 2.

Discussion: This species occurred at ten stations in very low frequencies.

Genus BIGENERINA d'Orbigny, 1826

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.

Discussion: This species occurred in low frequencies at stations 9 and 12. It normally occurs deeper offshore and its presence in the study area indicates inshore transport.

Subfamily PSEUDOBOLIVININAE Wiesner, 1931
Genus PSEUDOBOLIVINA Wiesner, 1931

PSEUDOBOLIVINA WALSHI (Seiglie)
Plate 1, fig. 7

Parvigenerina walshi SEIGLIE, 1971, Rev. Española Micr., vol. 3, no. 3, p. 268, pl. 3, figs. 9-15.

Discussion: This species occurred only at station 6, and was very rare.

Family TROCHAMMINIDAE Schwager, 1877
Subfamily TROCHAMMININAE Schwager, 1877
Genus TROCHAMMINA Parker and Jones, 1859

TROCHAMMINA SP.

Discussion: Single specimens were found at stations 1 and 6.

Genus ROTALIAMMINA Cushman, emend. Loeblich and Tappan, 1955

ROTALIAMMINA MAYORI Cushman
Plate 1, figs. 8, 9

Rotaliammina mayori CUSHMAN, 1924, Carnegie Inst. Washington, Publ. 342, p. 11, pl. 1, figs. 4, 5.

Rotaliammina mayori Cushman, emend. LOEBLICH and TAPPAN, 1955, Smithsonian Inst., Misc. Coll., vol. 128, no. 5, p. 20, pl. 3, fig. 4.

Discussion: This species occurred at ten stations in low to very low frequencies.

Family ATAXOPHRAGMIIDAE Schwager, 1877
Subfamily VALVULININAE Berthelin, 1880
Genus VALVULINA d'Orbigny, 1826

VALVULINA OVIEDOIANA d'Orbigny

Valvulina oviedoiana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 103, pl. 2, figs. 21, 22.

Discussion: This species occurred at eight stations, but was very rare; in all but one sample only a single specimen was counted.

Genus CLAVULINA d'Orbigny, 1826

CLAVULINA DIFFORMIS (Brady)

Clavulina angularis d'Orbigny var. *difformis* BRADY, 1884, Rept. Voy. *Challenger,* Zool., vol. 9, p. 396, pl. 48, figs. 25-31.

Clavulina difformis (Brady). CUSHMAN, 1921, U.S. Natl. Mus., Bull. 100, vol. 4, p. 156, pl. 31, figs. 2a, b.

Discussion: Single specimens were found at stations 9 and 11.

CLAVULINA TRICARINATA d'Orbigny

Clavulina tricarinata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 111, pl. 2, figs. 16-18.

Discussion: This species occurred at five stations in very low frequencies.

Suborder MILIOLINA Delage and Hérouard, 1896
Superfamily MILIOLACEA Ehrenberg, 1839
Family FISCHERINIDAE Millett, 1898
Subfamily CYCLOGYRINAE Loeblich and Tappan, 1961

Genus CYCLOGYRA Wood, 1842

CYCLOGYRA INVOLVENS (Reuss)
Plate 1, fig. 10

Operculina involvens REUSS, 1850, Denkschr. Akad. Wiss. Wien., vol. 1, p. 370, pl. 46, fig. 20.
Cyclogyra involvens (Reuss). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 12, pl. 3, fig. 2.

Discussion: This species occurred at ten stations in very low frequencies.

CYCLOGYRA PLANORBIS (Schultze)
Plate 1, fig. 11

Cornuspira planorbis SCHULTZE, 1854, Organismus Polythal., p. 40, pl. 2, fig. 21.
Cyclogyra planorbis (Schultze). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 12, pl. 3, fig. 3.

Discussion: This species occurred at 11 stations, and was a little more plentiful than *Cyclogyra involvens.*

Family NUBECULARIIDAE Jones, 1875

Subfamily NUBECULARIINAE Jones, 1875

Genus NUBECULARIA Defrance, 1825

NUBECULARIA cf. N. LUCIFUGA Defrance

Nubecularia lucifuga DEFRANCE, 1825, Dict. Sci. Nat., vol. 35, p. 210.

Discussion: This species occurred at 11 stations, always in frequencies less than 1%. There is considerable variation in size and shape of the test.

Subfamily OPHTHALMIDIINAE Wiesner, 1920

Genus EDENTOSTOMINA Collins, 1958

EDENTOSTOMINA? SP.
Plate 2, figs. 1, 2

Discussion: A single live specimen of this species was found at station 6 in the "A" sample.

Genus WIESNERELLA Cushman, 1933

WIESNERELLA AURICULATA (Egger)
Plate 2, fig. 3

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, Contr. Cushman Lab. Foram. Res., vol. 9, p. 33, pl. 3, figs. 7-9.

Discussion: This species occurred at 11 stations and was present in very low frequencies.

Subfamily SPIROLOCULININAE Wiesner, 1920

Genus SPIROLOCULINA d'Orbigny, 1826

SPIROLOCULINA ANTILLARUM d'Orbigny
Plate 2, fig. 4

Spiroloculina antillarum D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 166, pl. 9, figs. 3, 4.

Discussion: This species occurred at six stations but was very rare.

SPIROLOCULINA ANTILLARUM ANGULATA Cushman
Plate 2, fig. 5

Spiroloculina grata BRADY (part) (*not* Terquem), 1884, Rept. Voy. *Challenger,* Zool., vol. 9, pl. 10, figs. 22, 23.
Spiroloculina grata Terquem var. *angulata* CUSHMAN, 1917, U.S. Natl. Mus., Bull. 71, pt. 6, p. 36, pl. 7, fig. 5.
Spiroloculina antillarum d'Orbigny var. *angulata* CUSHMAN, 1921, U.S. Natl. Mus., Bull. 100, vol. 4, p. 408, pl. 81, figs. 5a, b.

Discussion: This species was rare and appeared at seven stations.

SPIROLOCULINA ARENATA Cushman
Plate 2, fig. 6

Spiroloculina arenata CUSHMAN, 1921, Proc. U.S. Natl. Mus., vol. 59, p. 63, pl. 14, fig. 17.

Discussion: This species has an agglutinated wall. It appeared at 11 stations and approached a frequency of 2% at station 11.

Subfamily NODOBACULARIINAE Cushman, 1927

Genus NODOBACULARIELLA Cushman and Hanzawa, 1937

NODOBACULARIELLA CASSIS (d'Orbigny)

Vertebralina cassis D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 51, pl. 7, figs. 14, 15.
Nodobaculariella cassis (d'Orbigny). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 15, pl. 4, fig. 2.

Discussion: This species occurred at three stations in very low frequencies.

Family MILIOLIDAE Ehrenberg, 1839

Subfamily QUINQUELOCULININAE Cushman, 1917

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA AGGLUTINANS d'Orbigny

Quinqueloculina agglutinans D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 195, pl. 12, figs. 11-13.

Discussion: This species occurred at 14 stations, always with frequencies less than 2%.

QUINQUELOCULINA AUBERIANA d'Orbigny

Quinqueloculina auberiana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 193, pl. 12, figs. 1-3.

Discussion: This species occurred at seven stations, generally in very low frequencies.

QUINQUELOCULINA BICOSTATA d'Orbigny

Quinqueloculina bicostata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 195, pl. 12, figs. 8-10.

Discussion: This species occurred at five stations in very low frequencies.

QUINQUELOCULINA BIDENTATA d'Orbigny

Quinqueloculina bidentata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 197, pl. 12, figs. 18-20.

Discussion: Quinqueloculina bidentata differs from *Quinqueloculina agglutinans* by having a more squarely truncate periphery. This species occurred at only two stations in very low frequencies.

QUINQUELOCULINA BOSCIANA d'Orbigny

Plate 2, figs. 7, 8

Quinqueloculina bosciana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 191, pl. 11, figs. 22-24.

Discussion: This species was ubiquitous and very common. It was the third-most abundant species in the standing crop.

QUINQUELOCULINA COLLUMNOSA Cushman

Miliolina cuvieriana HERON-ALLEN and EARLAND (*not* d'Orbigny), 1915, Trans. Zool. Soc. London, vol. 20, p. 571, pl. 4, figs. 33-36.

Quinqueloculina collumnosa CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 65, pl. 10, fig. 10.

Discussion: This species occurred at six stations in very low frequencies.

QUINQUELOCULINA FUNAFUTIENSIS (Chapman)

Plate 2, figs. 9, 10

Miliolina funafutiensis CHAPMAN, 1901, Jour. Linn. Soc. London, Zool., vol. 28, p. 178, pl. 19, fig. 6.

Quinqueloculina funafutiensis (Chapman). CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 67, pl. 13, fig. 3.

Discussion: Single specimens of this species were found at five stations.

QUINQUELOCULINA LAMARCKIANA d'Orbigny

Plate 3, figs. 1, 2

Quinqueloculina lamarckiana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 189, pl. 11, figs. 14, 15.

Discussion: This ubiquitous species was fairly common, and there is considerable variation in the size and shape of the tests.

QUINQUELOCULINA PARKERI OCCIDENTALIS Cushman

Quinqueloculina parkeri (Brady) var. *occidentalis* CUSHMAN, 1921, Proc. U.S. Natl. Mus., vol. 59, p. 69.

Discussion: Single specimens were found at stations 6, 11, and 15.

QUINQUELOCULINA POEYANA d'Orbigny

Plate 3, figs. 3, 4

Quinqueloculina poeyana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 191, pl. 11, figs. 25-27.

Discussion: This species was common or abundant at every station. It was also fairly common in the standing crop. There is a large range in the size of the tests, and the width to length ratio varies considerably.

QUINQUELOCULINA POLYGONA d'Orbigny

Plate 3, figs. 5, 6

Quinqueloculina polygona D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 198, pl. 12, figs. 21-23.

Discussion: This species occurred at 11 stations in low frequencies, never exceeding 3%.

QUINQUELOCULINA SEMINULUM (Linnaeus)

Serpula seminulum LINNAEUS, 1767, Syst. Nat., ed. 12, p. 1264.

Quinqueloculina seminulum (Linnaeus). D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 303.

Discussion: This species occurred in low frequencies at every station except 13, where it was absent.

QUINQUELOCULINA SUBPOEYANA Cushman
Plate 3, fig. 7

Quinqueloculina subpoeyana CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 66.

Discussion: This species occurred at ten stations, always in frequencies less than 1%.

QUINQUELOCULINA TRICARINATA d'Orbigny

Quinqueloculina tricarinata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 187, pl. 11, figs. 7-9, 11.

Discussion: Single specimens were found at stations 9, 12, and 13. Very possibly they are present as a result of either inshore transport or current scouring into older sediments.

Genus MASSILINA Schlumberger, 1893

MASSILINA SECANS (d'Orbigny)

Quinqueloculina secans D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 303, no. 43.

Massilina secans (d'Orbigny). SCHLUMBERGER, 1893, Mém. Soc. Zool. France, vol. 6, p. 218, pl. 4, figs. 82, 83.

Discussion: A single specimen was found in the "1B" sample.

Genus PYRGO Defrance, 1824

PYRGO CARINATA (d'Orbigny)
Plate 3, fig. 8

Biloculina carinata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 164, pl. 8, fig. 24; pl. 9, figs. 1, 2.

Discussion: This species occurred at six stations in very low frequencies.

PYRGO COMATA (Brady)

Biloculina comata BRADY, 1884, Rept. Voy. *Challenger,* Zool., vol. 9, p. 144, pl. 3, figs. 9a, b.

Pyrgo comata (Brady). CUSHMAN, 1929, U.S. Natl. Mus., Bull. 104, pt. 6, p. 73.

Discussion: A single specimen was found at station 9. The species normally occurs at much greater depths, and its presence in Norris Cut is probably a result of storms and currents.

PYRGO SUBSPHAERICA (d'Orbigny)
Plate 3, fig. 9

Biloculina subsphaerica D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 162, pl. 8, figs. 25-27.

Pyrgo subsphaerica (d'Orbigny). CUSHMAN, 1929, U.S. Natl. Mus., Bull. 104, pt. 6, p. 68, pl. 18, figs. 1, 2.

Discussion: This ubiquitous species occurred in low frequencies.

Genus TRILOCULINA d'Orbigny, 1826

TRILOCULINA BASSENSIS Parr
Plate 4, figs. 1, 2

Triloculina bassensis PARR, 1945, Proc. Roy. Soc. Victoria, vol. 56, pt. 2, p. 198, pl. 8, fig. 7a-c.

Discussion: This species occurred at 13 stations in low frequencies.

TRILOCULINA BERMUDEZI Acosta
Plate 4, figs. 3, 4

Triloculina bermudezi ACOSTA, 1940, Soc. Cubana Hist. Nat., Mem., vol. 14, p. 37, pl. 4, figs. 1-5.

Discussion: This species occurred at nine stations in frequencies near 1%.

TRILOCULINA BICARINATA d'Orbigny

Triloculina bicarinata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 158, pl. 10, figs. 18-20.

Discussion: Single specimens were found at stations 9 and 12. A truncate periphery with double keels differentiates this species from *Triloculina carinata,* which has a more carinate periphery.

TRILOCULINA CARINATA d'Orbigny

Triloculina carinata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 179, pl. 10, figs. 15-17.

Discussion: This species occurred at five stations in very low frequencies.

TRILOCULINA FITERREI MENINGOI Acosta
Plate 4, figs. 5, 6

Triloculina fiterrei Acosta var. *meningoi* ACOSTA, 1940, Torreia, La Habana, Cuba, no. 3, p. 25-26, pl. 4, figs. 1-5.

Discussion: This species occurred at eight stations in low frequencies.

TRILOCULINA GRACILIS d'Orbigny

Triloculina gracilis D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 159, pl. 11, figs. 10-12.

Discussion: Single specimens of this species were found at stations 4, 6, and 14.

TRILOCULINA LINNEIANA d'Orbigny

Triloculina linneiana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 172, pl. 9, figs. 11-13.

Discussion: This species occurred at ten stations, normally in low frequencies. Frequency was near 4%, however, at stations 9 and 14.

TRILOCULINA LINNEIANA COMIS Bandy

Triloculina linneiana d'Orbigny var. *comis* BANDY, 1956, U.S. Geol. Surv. Prof. Paper 274-G, p. 198 , pl. 29, fig. 12.

Discussion: This species occurred at five stations in very low frequencies. This species is smaller than *Triloculina linneiana;* possesses finer, more numerous longitudinal costae; and has its aperture at the end of an extended cylindrical neck.

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.

Discussion: This species occurred at eight stations in very low frequencies.

TRILOCULINA PLANCIANA d'Orbigny

Triloculina planciana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 173, pl. 9, figs. 17-19.

Discussion: This species was very rare and occurred at only two stations. It resembles *Triloculina linneiana,* but the ornamentation consists of fine lines and not prominent ridges.

TRILOCULINA ROTUNDA d'Orbigny

Triloculina rotunda D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 299, no. 4.

Discussion: This species occurred at 11 stations but in very low frequencies.

TRILOCULINA SIDEBOTTOMI (Martinotti)

Miliolina subrotunda SIDEBOTTOM (not *Vermiculum subrotundum* Montagu), 1904, Manchester Lit. Phil. Soc., vol. 68, no. 5, p. 8, pl. 3, figs. 1-7.

Sigmoilina sidebottomi MARTINOTTI, 1920, Atti. Soc. Ital. Sci. Nat., vol. 59, p. 280, pl. 2, fig. 29, text-figs. 59-61.

Triloculina sidebottomi (Martinotti). PARKER, PHLEGER and PIERSON, 1953, Cushman Lab. Foram. Res., Spec. Publ. 2, p. 14, pl. 2, figs. 25-28.

Discussion: This species was very rare and occurred only at stations 4, 8, and 9.

TRILOCULINA TRIGONULA (Lamarck)
Plate 4, fig. 7

Miliola trigonula LAMARCK, 1804, Ann. Mus. [Paris], vol. 5, p. 351, no. 3.

Triloculina trigonula (Lamarck). D'ORBIGNY, 1858, Ann. Sci. Nat., vol. 7, p. 299, no. 1, pl. 16, figs. 5-9.

Discussion: This was a common to abundant species and was ubiquitous. It was the second-most common species in the standing crop. There is considerable variation in chamber-form among specimens, ranging from chambers with subacute angles to broadly rounded chambers.

Subfamily MILIOLINELLINAE Vella, 1957

Genus MILIOLINELLA Wiesner, 1931

MILIOLINELLA CIRCULARIS (Bornemann)
Plate 4, fig. 8

Triloculina circularis BORNEMANN, 1855, Geol. Ges. Zeitschr., vol. 7, pt. 2, p. 349, pl. 19, figs. 4a-c.

Miliolinella circularis (Bornemann). ASANO, 1951, Ill. Cat. Jap. Tert. Smaller Foram., pt. 6, p. 9, figs. 65-67.

Discussion: This species was present everywhere except at station 13. Frequency was fairly low but reached 4% at station 5.

MILIOLINELLA FICHTELIANA (d'Orbigny)
Plate 4, fig. 9

Triloculina fichteliana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 171, pl. 9, figs. 8-10.

Miliolinella fichteliana (d'Orbigny). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 29, pl. 12, fig. 6.

Discussion: This species occurred at nine stations, but in very low frequencies.

MILIOLINELLA LABIOSA (d'Orbigny)
Plate 5, fig. 1

Triloculina labiosa D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 178, pl. 10, figs. 12-14.

Miliolinella labiosa (d'Orbigny). WIESNER, 1931, Deutsche Sud-Polar Exped., vol. 20, p. 108, pl. 15, figs. 181, 182.

Discussion: This species occurred at ten stations, always in frequencies less than 1%.

MILIOLINELLA SUBORBICULARIS (d'Orbigny)

Triloculina suborbicularis D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 300, no. 12.
Miliolinella suborbicularis (d'Orbigny). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 30, pl. 12, fig. 8.

Discussion: This species occurred at six stations in very low frequencies.

Subfamily MILIOLINAE Ehrenberg, 1839

Genus HAUERINA d'Orbigny, 1839

HAUERINA BRADYI Cushman
Plate 5, fig. 2

Hauerina bradyi CUSHMAN, 1917, U.S. Natl. Mus., Bull. 71, pt. 6, p. 62, pl. 23, fig. 2.

Discussion: This species was present at 13 stations in low frequencies.

HAUERINA OCCIDENTALIS Cushman
Plate 5, fig. 3

Hauerina ornatissima CUSHMAN (not Karrer), 1929, U.S. Natl. Mus., Bull. 104, pt. 6, p. 47, pl. 10, figs. 10-12.
Hauerina occidentalis CUSHMAN, 1946, Contr. Cushman Lab. Foram. Res., vol. 22, p. 9, pl. 1, figs. 22-24.

Discussion: This species was very rare and occurred only at stations 5, 7, and 9.

HAUERINA SPECIOSA (Karrer)

Spiroloculina speciosa KARRER, 1868, Akad. Wiss. Wien, vol. 58, p. 135, pl. 1, fig. 8.
Hauerina speciosa (Karrer). SAID, 1949, Cushman Lab. Foram. Res., Spec. Publ. 26, p. 17, pl. 2, fig. 10.

Discussion: This rare species occurred only at stations 5 and 11.

Subfamily TUBINELLINAE Rhumbler, 1906

Genus ARTICULINA d'Orbigny, 1826

ARTICULINA ANTILLARUM Cushman

Articulina antillarum CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 71, pl. 12, fig. 5.

Discussion: This species was rare and occurred only at four stations.

ARTICULINA LINEATA Brady

Articulina lineata BRADY, 1884, Rept. Voy. *Challenger,* Zool., vol. 9, p. 183, pl. 12, figs. 19-21.

Discussion: Single specimens occurred at stations 7, 11, and 15.

ARTICULINA MAYORI Cushman

Articulina mayori CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 71, pl. 13, fig. 5.

Discussion: This species was represented by a single specimen from the "7B" sample.

ARTICULINA MUCRONATA (d'Orbigny)
Plate 5, fig. 4

Vertebralina mucronata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 52, pl. 7, figs. 16-19.
Articulina mucronata (d'Orbigny). CUSHMAN, 1944, Cushman Lab. Foram. Res., Spec. Publ. 10, p. 12, pl. 2, figs. 11-18.

Discussion: This species occurred at 13 stations in low frequencies.

ARTICULINA MULTILOCULARIS Brady, Parker and Jones
Plate 5, fig. 5

Articulina multilocularis BRADY, PARKER and JONES, 1888, Trans. Zool. Soc. London, vol. 12, p. 215, pl. 40, fig. 10.

Discussion: This species was very rare, with single specimens occurring at stations 2, 7, and 8.

ARTICULINA SAGRA d'Orbigny
Plate 5, fig. 6

Articulina sagra D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 183, pl. 9, figs. 23-26.

Discussion: This species occurred at 12 stations in low frequencies.

Family SORITIDAE Ehrenberg, 1839

Subfamily PENEROPLINAE Schultze, 1854

Genus PENEROPLIS Montfort, 1808

PENEROPLIS BRADYI Cushman
Plate 5, fig. 7

Peneroplis bradyi CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 40, pl. 14, figs. 8-10.

Discussion: This species occurred in low frequencies at eight stations.

PENEROPLIS CARINATUS d'Orbigny
Plate 5, fig. 8

Peneroplis carinatus D'ORBIGNY, 1839, Voy. Amer. Merid., vol. 5, pt. 5, p. 33, pl. 3, figs. 7, 8.

Discussion: Frequencies ranged from low to abundant for this species. Absent only from station 3, abundance increased toward the channel stations.

PENEROPLIS PERTUSUS (Forskal)
Plate 5, fig. 9

Nautilus pertusus FORSKAL, 1775, Descr. Anim., p. 125, no. 65.

Peneroplis pertusus (Forskal). JONES, PARKER and BRADY, 1865, Foram. Crag, p. 19.

Discussion: This species was present at 12 stations in low to very low frequencies.

PENEROPLIS PROTEUS d'Orbigny
Plate 6, fig. 1

Peneroplis protea D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 60, pl. 7, figs. 7-11.

Peneroplis proteus d'Orbigny . CUSHMAN, 1921, Proc. U.S. Natl. Mus., vol. 59, p. 75, pl. 18, figs. 13-19.

Discussion: This species occurred at eight stations in low to very low frequencies.

Genus MONALYSIDIUM Chapman, 1900

MONALYSIDIUM POLITUM (Chapman)

Peneroplis (Monalysidium) polita CHAPMAN, 1900, Jour. Linn. Soc. London, Zool., vol. 28, no. 179, p. 4, pl. 1, fig. 5.

Monalysidium politum (Chapman). HERON-ALLEN and EARLAND, 1915, Trans. Zool. Soc. London, vol. 20, p. 603.

Discussion: This species occurred at six stations, generally a single specimen at each.

Genus SPIROLINA Lamarck, 1804

SPIROLINA ACICULARIS (Batsch)
Plate 6, fig. 2

Nautilus (Lituus) acicularis BATSCH, 1791, Conch. Seesandes, p. 34, pl. 6, fig. 16.

Spirolina acicularis (Batsch). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 42, pl. 15, figs. 1-3.

Discussion: This species occurred at four stations and was rare.

SPIROLINA ARIETINUS (Batsch)

Nautilus (Lituus) arietinus BATSCH, 1791, Conch. Seesandes, p. 34, pl. 6, fig. 15.

Spirolina arietinus (Batsch). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 43, pl. 15, figs. 4, 5.

Discussion: Single specimens of this species were found at stations 7 and 9.

Subfamily MEANDROPSININAE Henson, 1948

Genus BROECKINA Munier-Chalmas, 1882

BROECKINA ORBITOLITOIDES (Hofker)

Praesorites orbitolitoides HOFKER, 1930, *Siboga-Expédite*, pt. 2, p. 149, pl. 55, figs. 8, 10, 11; pl. 57, figs. 4, 6; pl. 58, figs. 1-5; pl. 61, figs. 3, 14.

Broeckina orbitolitoides (Hofker). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 35, pl. 13, fig. 15.

Discussion: This species occurred at six stations in very low frequencies.

Subfamily ARCHAIASINAE Cushman, 1927

Genus ARCHAIAS Montfort, 1808

ARCHAIAS ANGULATUS
(Fichtel and Moll)

Plate 6, fig. 3

Nautilus angulatus FICHTEL and MOLL, 1803, Test. Micr., 2nd ed., p. 112, pl. 21.

Archaias angulatus (Fichtel and Moll). CUSHMAN, 1928, Cushman Lab. Foram. Res., Spec. Publ. 1, p. 218, pl. 31, fig. 9.

Discussion: This species occurred at ten stations, and frequency was variable. *Archaias angulatus* was rare within the northern bay but was common within the channels. The increased numbers are probably due to scouring and exposure of older material or inshore transport from the offshore shoal areas.

Genus CYCLORBICULINA Silvestri, 1937

CYCLORBICULINA COMPRESSA
(d'Orbigny)

Orbiculina compressa D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 66, pl. 8, figs. 4-7.

Archaias compressus (d'Orbigny). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 48, pl. 17, figs. 1, 2.

Cyclorbiculina compressa (d'Orbigny). LOEBLICH and TAPPAN, 1964, Treat. Invert. Paleont., p. C495, fig. 383, 1-3.

Discussion: This species occurred at four stations in very low frequencies.

Subfamily SORITINAE Ehrenberg, 1839

Genus SORITES Ehrenberg, 1839

SORITES MARGINALIS (Lamarck)
Plate 6, fig. 4

Orbulites marginalis LAMARCK, 1816, Syst. Anim. sans Vert., vol. 2, p. 196, no. 1.
Orbitolites marginalis (Lamarck). CARPENTER, 1883, Philos. Trans., vol. 174, p. 560, fig. 1.
Sorites marginalis (Lamarck). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 49, pl. 18, figs. 1-4.

Discussion: This species occurred at nine stations in low to very low frequencies.

Family ALVEOLINIDAE Ehrenberg, 1839
Genus BORELIS Montfort, 1808
BORELIS PULCHRA (d'Orbigny)

Alveolina pulchra D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 70, pl. 8, figs. 19, 20.
Borelis pulchra (d'Orbigny). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 55, pl. 15, figs. 9, 10.

Discussion: This species occurred at six stations in low to very low frequencies.

Suborder ROTALIINA Delage and Herouard, 1896
Superfamily NODOSARIACEA Ehrenberg, 1838
Family NODOSARIIDAE Ehrenberg, 1838
Subfamily NODOSARIINAE Ehrenberg, 1838
Genus LAGENA Walker and Jacob, 1798
LAGENA LAEVIS (Montagu)
Plate 6, fig. 5

Vermiculum laeve MONTAGU, 1803, Test. Brit., p. 524.
Lagena laevis (Montagu). CUSHMAN, 1923, U.S. Natl. Mus., Bull. 104, pt. 4, p. 29, pl. 5, fig. 3.

Discussion: This species was present at three stations in very low frequencies.

LAGENA STRIATA (d'Orbigny)

Oolina striata D'ORBIGNY, 1839, Voy. Amer. Merid., vol. 5, pt. 5, p. 21, pl. 5, fig. 12.
Lagena striata (d'Orbigny). REUSS, 1862, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, p. 327, pl. 3, figs. 44, 45; pl. 4, figs. 46, 47.

Discussion: A single live specimen of this species was found in the "6A" sample.

Genus PSEUDONODOSARIA Boomgaart, 1949
PSEUDONODOSARIA TORRIDA (Cushman)

Nodosaria (Glandulina) laevigata d'Orbigny var. *torrida* CUSHMAN, 1923, U.S. Natl. Mus., Bull. 104, pt. 4, p. 65, fig. 10.
Rectoglandulina torrida (Cushman). BARKER, 1960, S.E.P.M., Spec. Publ. 9, pl. 61, figs. 20-22.
Pseudonodosaria torrida (Cushman). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 42, pl. 15, fig. 13.

Discussion: A single specimen was found in the "6A" sample.

Family POLYMORPHINIDAE d'Orbigny, 1839
Subfamily POLYMORPHININAE d'Orbigny, 1839
Genus GUTTULINA d'Orbigny, 1839

GUTTULINA AUSTRALIS (d'Orbigny)

Globulina australis D'ORBIGNY, 1839, Voy. Amer. Merid., vol. 5, pt. 5, p. 60, pl. 1, figs. 1-4.
Guttulina australis (d'Orbigny). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 43, pl. 16, fig. 2.

Discussion: Single specimens of *Guttulina australis* were found at stations 9 and 11.

GUTTULINA LAEVIS de Pourtales
Plate 6, fig. 6

Guttulina laevis DE POURTALES, 1850, Amer. Assoc. Adv. Sci., Proc., vol. 3, p. 88.

Discussion: This species occurred at seven stations in very low frequencies.

Family GLANDULINIDAE Reuss, 1860
Subfamily OOLININAE Loeblich and Tappan, 1961
Genus FISSURINA Reuss, 1850
FISSURINA cf. F. LUCIDA (Williamson)
Plate 6, fig. 7

Entosolenia marginata (Montagu) var. *lucida* WILLIAMSON, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 17, pl. 2, fig. 17.
Fissurina marginata Montagu var. *lucida* (Williamson). LYNTS, 1971, Miami Geol. Soc., Mem. 1, p. 89.

Discussion: This species occurred at 11 stations in low frequencies.

FISSURINA PELLUCIDA Bock

Fissurina pellucida BOCK, 1968, Contr. Cushman Found. Foram. Res., vol. 19, p. 28, pl. 4, figs. 1, 2.

Discussion: This species occurred at five stations and was rare.

FISSURINA QUADRICOSTULATA (Reuss)

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

Fissurina quadricostulata (Reuss). WRIGHT and HAY, 1971, Miami Geol. Soc., Mem. 1, p. 145.

Discussion: Two specimens of this species were found at station 6.

FISSURINA RADIATA Seguenza

Fissurina (Produttine) radiata SEGUENZA, 1862, Terz. dist. Messina, p. 70, pl. 2, figs. 42-43.

Discussion: A single specimen of this species appeared at station 15.

FISSURINA sp. "A"
Plate 6, fig. 8

Discussion: Single specimens of this species were found at stations 5, 6, 7, 10, and 15.

FISSURINA sp. "B"

Discussion: Two specimens of this very rare species were found at station 10 in the "A" sample.

Superfamily BULIMINACEA Jones, 1875
Family TURRILINIDAE Cushman, 1927
Subfamily TURRILININAE Cushman, 1927
Genus BULIMINELLA Cushman, 1911

BULIMINELLA ELEGANTISSIMA (d'Orbigny)
Plate 6, fig. 9

Bulimina elegantissima D'ORBIGNY, 1839, Voy. Amer. Merid., vol. 5, pt. 5, p. 51, pl. 7, figs. 13, 14.

Buliminella elegantissima (d'Orbigny). PHLEGER and PARKER, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 17, pl. 8, figs. 3, 4.

Discussion: This species occurred at nine stations in very low frequencies.

BULIMINELLA MILLETTI Cushman
Plate 7, fig. 1

Buliminella milletti CUSHMAN, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 78, pl. 8, figs. 5, 6.

Discussion: This species was present at nine stations in low frequencies.

Genus BULIMINOIDES Cushman, 1911

BULIMINOIDES WILLIAMSONIANA (Brady)
Plate 7, fig. 2

Bulimina williamsoniana BRADY, 1881, Quart. Jour. Micr. Soc., vol. 21, p. 56.

Buliminoides williamsoniana (Brady). CUSHMAN, 1911, U.S. Natl. Mus., Bull. 71, pt. 2, p. 90, fig. 144.

Discussion: Single specimens of this species were present at stations 6, 7, and 14.

PLATE 1

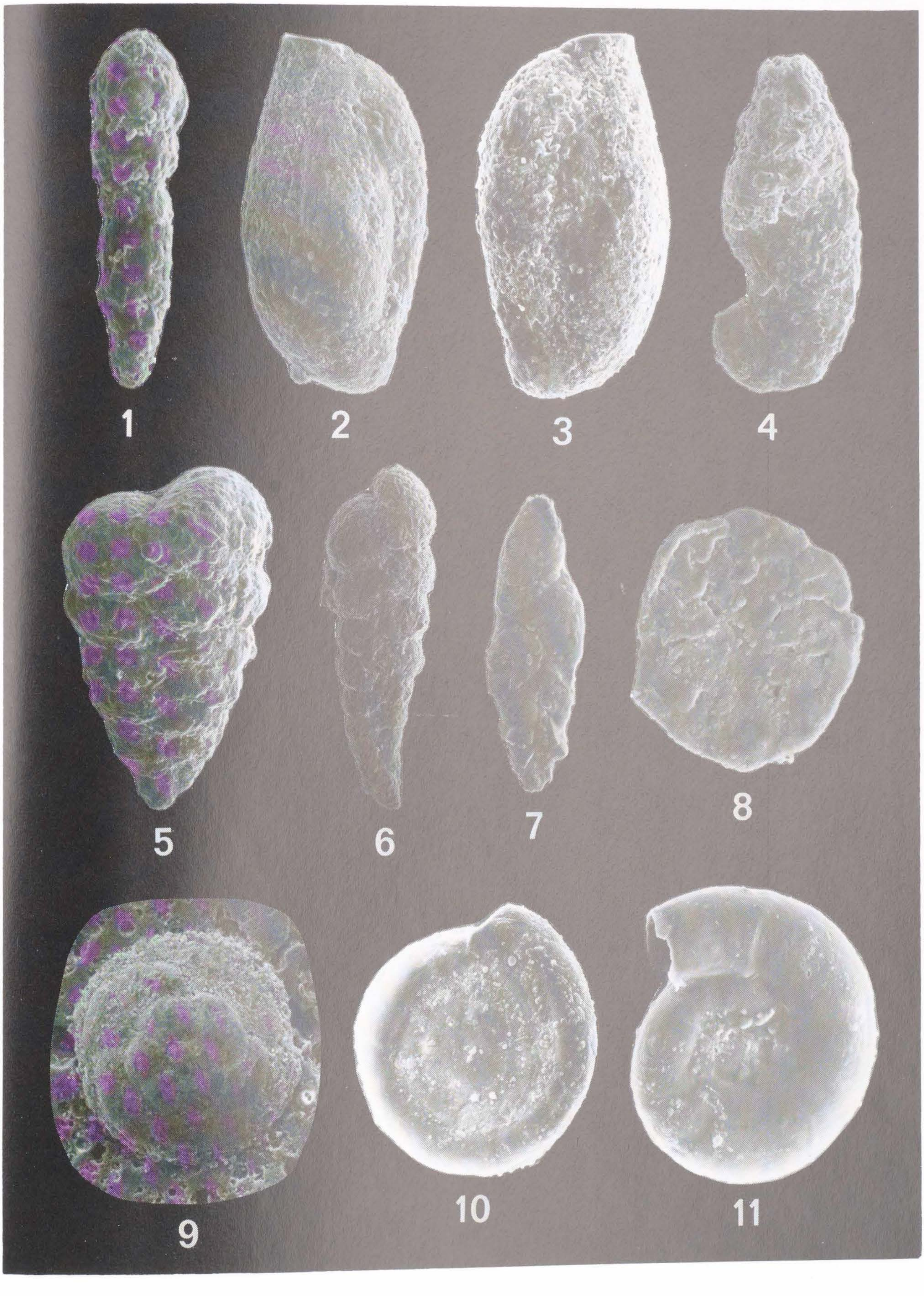

PLATE 1

Family BOLIVINITIDAE Cushman, 1927
Genus BOLIVINITA Cushman, 1927

BOLIVINITA RHOMBOIDALIS (Millett)
Plate 7, fig. 3

Textularia rhomboidalis MILLETT, 1899, Jour. Roy. Micr. Soc., p. 559, pl. 7, fig. 4a, b.
Bolivina rhomboidalis (Millett). CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 28.

Discussion: This species occurred at 12 stations in low to very low frequencies.

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA GOESII Cushman, 1922

Bolivina goesii CUSHMAN, 1922, U.S. Natl. Mus., Bull. 104, pt. 3, p. 34, pl. 6, fig. 5.

Discussion: Four specimens of this species were found at station 4, and only one specimen each at stations 5 and 6.

BOLIVINA HASTATA Phleger and Parker

Bolivina hastata PHLEGER and PARKER, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 13, pl. 6, figs. 18, 19.

Discussion: A single specimen of this species was found at station 5.

BOLIVINA LANCEOLATA Parker
Plate 7, fig. 4

Bolivina lanceolata PARKER, 1954, Bull. Harvard Mus. Comp. Zool., vol. 111, no. 10, p. 514, pl. 7, figs. 17-20.

Discussion: This species occurred at 11 stations in low to very low frequencies.

BOLIVINA LOWMANI Phleger and Parker

Bolivina lowmani PHLEGER and PARKER, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 13, pl. 6, figs. 20, 21.

Discussion: This species occurred at 13 stations in low frequencies.

BOLIVINA PAULA Cushman and Cahill

Bolivina paula CUSHMAN and CAHILL, 1932, Bull. Florida Geol. Surv., vol. 9, p. 84, pl. 12, fig. 6.

Discussion: This species was present at 12 stations in low to very low frequencies.

BOLIVINA STRIATULA Cushman
Plate 7, fig. 5

Bolivina striatula CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 27, pl. 3, fig. 10.

Discussion: Bolivina striatula was present at 11 stations in low to very low frequencies.

Genus RECTOBOLIVINA Cushman, 1927

RECTOBOLIVINA ADVENA (Cushman)

Siphogenerina advena CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 35, pl. 5, fig. 2.
Rectobolivina advena (Cushman). HOFKER, 1951, Vitkom. Zool., Bot. Oceanogr., Geol. Geb., Nederlandsch., Mon. 4a, p. 116, 232.

Discussion: A single specimen of this species was found in the "11b" sample.

Family BULIMINIDAE Jones, 1875
Subfamily BULIMININAE Jones, 1875
Genus BULIMINA d'Orbigny, 1826

BULIMINA MARGINATA d'Orbigny
Plate 7, fig. 6

PLATE 2

Figure		Page
1,2.	*Edentostomina?* sp. Sample 6A, fig. 1, Side view, X135, fig. 2, Apertural view, X110	273
3.	*Wiesnerella auriculata* (Egger). Sample 6A, Side view, X295	273
4.	*Spiroloculina antillarum* d'Orbigny. Sample 8B, Side view, X90	273
5.	*Spiroloculina antillarum angulata* Cushman. Sample 7B, Side view, X90	273
6.	*Spiroloculina arenata* Cushman. Sample 8A, Side view, X135	273
7,8.	*Quinqueloculina bosciana* d'Orbigny. Sample 5B, Side views, X115	274
9,10.	*Quinqueloculina funafutiensis* (Chapman). Sample 12B, fig. 9, Side view, X90, fig. 10, Apertural view, X135	274

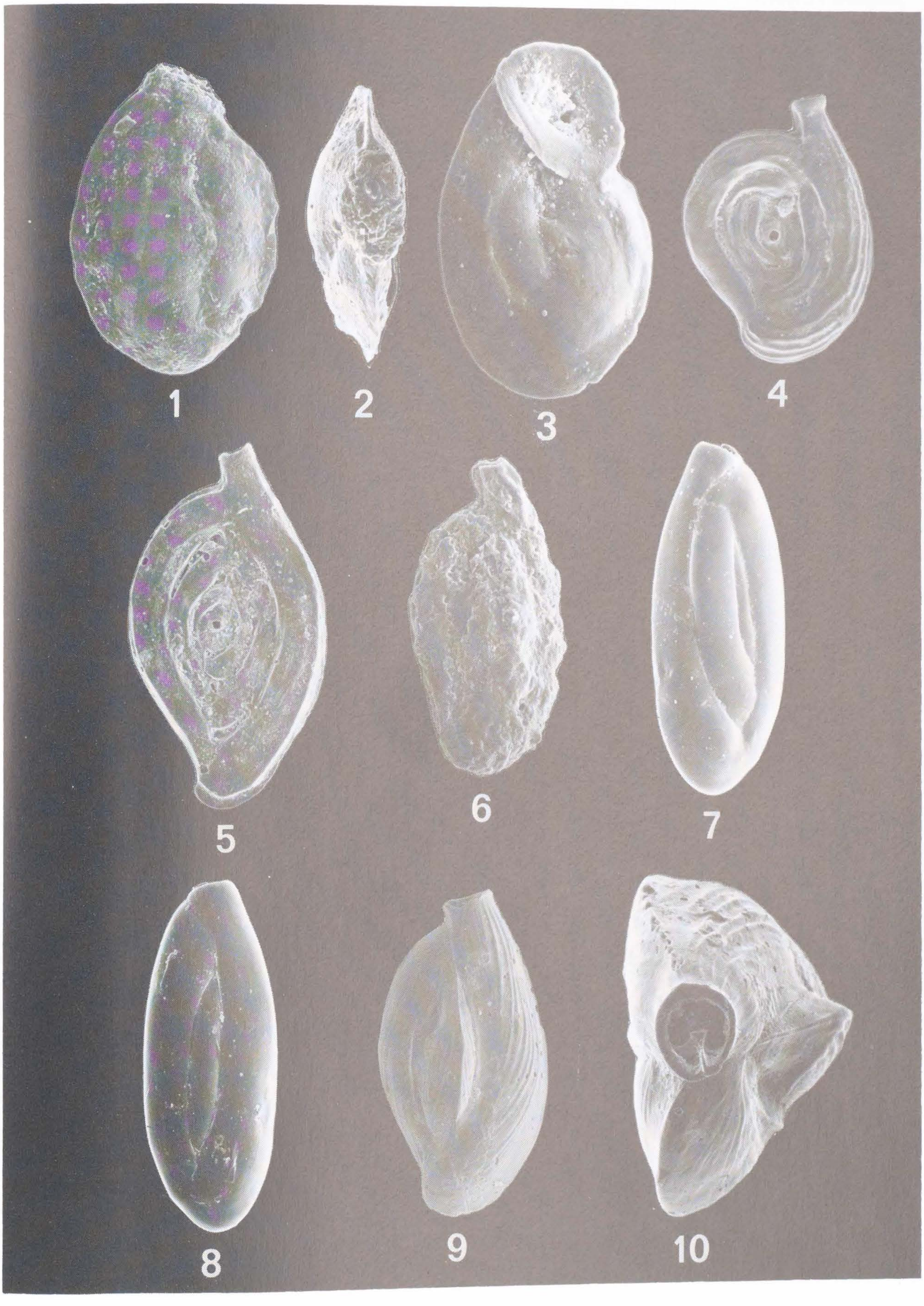

PLATE 2

Bulimina marginata D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 269, no. 4, pl. 12, figs. 10-12.

Discussion: This species occurred at four stations in very low frequencies.

BULIMINA cf. B. SPICATA Phleger and Parker

Bulimina spicata PHLEGER and PARKER, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 16, pl. 7, figs. 25, 30, 31.

Discussion: A single specimen of this species was present at station 7.

Subfamily PAVONININAE Eimer and Fickert, 1899

Genus REUSSELLA Galloway, 1933

REUSSELLA ATLANTICA Cushman

Reussella spinulosa (Reuss) var. *atlantica* CUSHMAN, 1947, Contr. Cushman Lab. Foram. Res., 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.

Discussion: This species occurred at nine stations in very low frequencies.

Family UVIGERINIDAE Haeckel, 1894

Genus UVIGERINA d'Orbigny, 1826

UVIGERINA BELLULA Bandy

Plate 7, fig. 7

Uvigerina auberiana d'Orbigny var. *laevis* GOËS, 1896, Bull. Harvard Mus. Comp. Zool., vol. 29, p. 51, pl. 4, figs. 71-74.

Uvigerina bellula BANDY, 1956, U.S. Geol. Survey Prof. Paper 274-G, p. 199, pl. 31, fig. 13.

Discussion: This species occurred at five stations in very low frequencies.

Genus SAGRINA d'Orbigny, 1839

SAGRINA PULCHELLA PRIMITIVA (Cushman)

Plate 7, fig. 8

Bolivina pulchella (d'Orbigny) var. *primitiva* CUSHMAN, 1930, Florida Geol. Surv., Bull. 4, p. 47, pl. 8, fig. 12.

Discussion: This species occurred at eight stations in low frequencies.

Genus SIPHOGENERINA Schlumberger, 1882

SIPHOGENERINA COSTATA Schlumberger

Plate 7, fig. 9

Siphogenerina costata SCHLUMBERGER, 1883, Feuille Jeunes Nat., no. 154, p. 118, text-fig. B.

Discussion: Single specimens were found at stations 8, 10, and 11.

Genus TRIFARINA Cushman, 1923

TRIFARINA BELLA (Phleger and Parker)

Plate 7, fig. 10

Angulogerina bella PHLEGER and PARKER, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 12, pl. 6, figs. 7, 8.

Trifarina bella (Phleger and Parker). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 49, pl. 17, fig. 13.

Discussion: Trifarina bella occurred in low frequencies at ten stations.

Superfamily DISCORBACEA Ehrenberg, 1838

Family DISCORBIDAE Ehrenberg, 1838

Subfamily DISCORBINAE Ehrenberg, 1838

Genus DISCORBIS Lamarck, 1804

PLATE 3

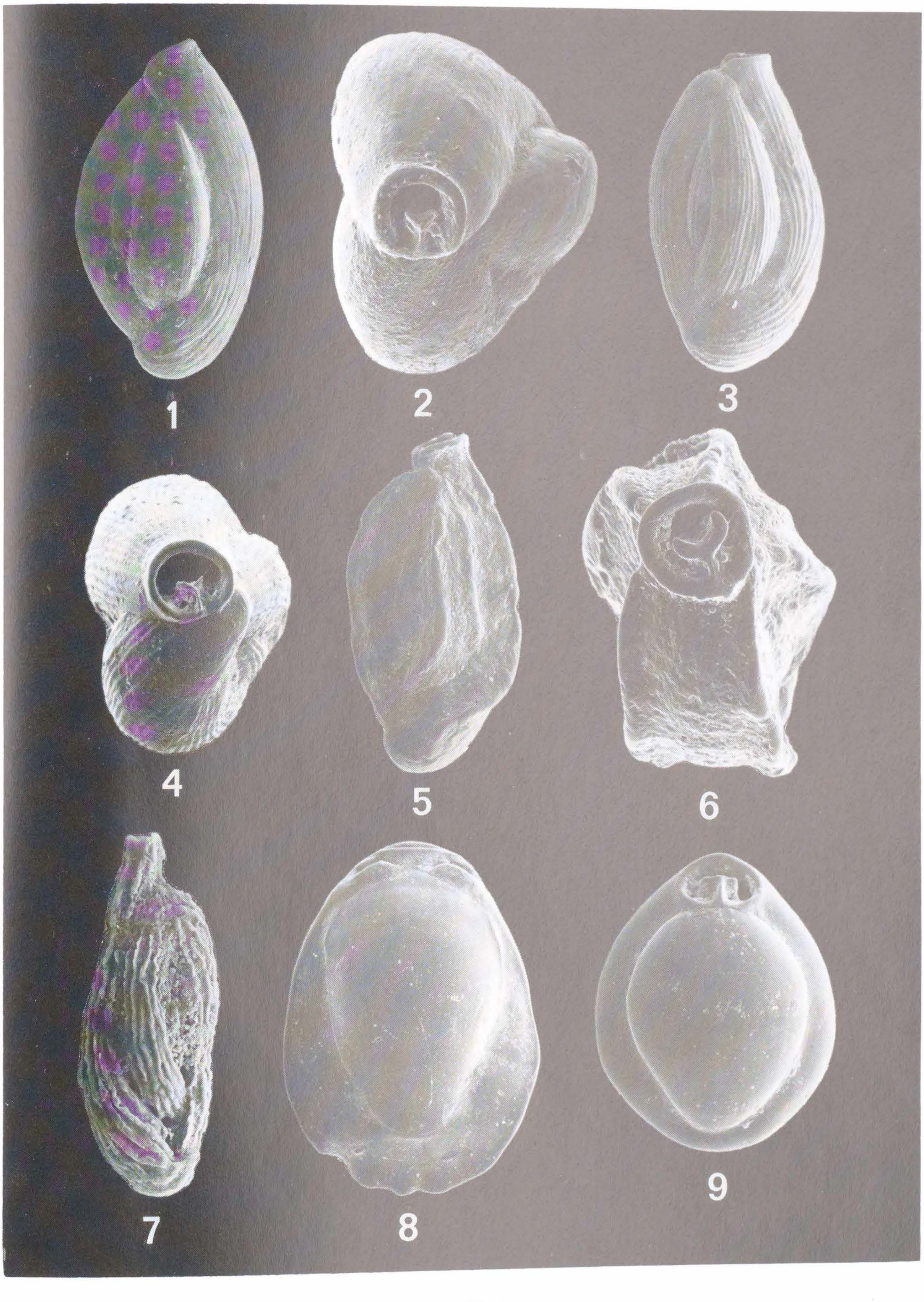

PLATE 3

DISCORBIS MIRA Cushman
Plate 7, figs. 11, 12

Discorbis mira CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 39, pl. 6, figs. 10, 11.

Discussion: This species occurred at 14 stations, and was present in frequencies ranging from rare to abundant.

DISCORBIS ROSEA (d'Orbigny)
Plate 8, figs. 1, 2

Rotalia rosea D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 272, no. 7.

Discorbis rosea (d'Orbigny). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 50, pl. 17, figs. 15, 16.

Discussion: This species occurred at eight stations in varying frequencies.

Genus NEOCONORBINA Hofker, 1951

NEOCONORBINA ORBICULARIS (Terquem)

Rosalina orbicularis TERQUEM, 1876, Ess. Anim. Plage Dunkerque, pt. 2, p. 75, pl. 9, figs. 4a, b.

Neoconorbina orbicularis (Terquem). HOFKER, 1951, Arch. Neerlandaises Zool., vol. 8, pt. 4, p. 357.

Discussion: This species occurred at 11 stations in low to very low frequencies.

Genus ROSALINA d'Orbigny, 1826

ROSALINA CANDEIANA d'Orbigny
Plate 8, figs. 3, 4

Rosalina candeiana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 97, pl. 4, figs. 2-4.

Discussion: This species was present at 14 stations in low to very low frequencies.

ROSALINA FLORIDANA (Cushman)
Plate 8, figs. 5, 6

Discorbis floridanus CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 39, pl. 5, figs. 11, 12.

Rosalina floridana (Cushman). PARKER, 1954, Bull. Harvard Mus. Comp. Zool., vol. 111, no. 10, p. 524, pl. 8, figs. 19, 20.

Discussion: This species occurred at 13 stations in low to very low frequencies.

Genus STETSONIA Parker, 1954

STETSONIA MINUTA Parker
Plate 8, figs. 7, 8

Stetsonia minuta PARKER, 1954, Bull. Harvard Mus. Comp. Zool., vol 111, no. 10, p. 534, pl. 10, figs. 27-29.

Discussion: Single specimens were found at stations 6 and 14.

Genus TRETOMPHALUS Mobius, 1880

TRETOMPHALUS ATLANTICUS Cushman

Tretomphalus atlanticus CUSHMAN, 1934, Contr. Cushman Lab. Foram. Res., vol. 10, pt. 4, p. 86, pl. 11, fig. 3; pl. 12, fig. 7.

Discussion: This species occurred at nine stations but in very low frequencies.

Family SIPHONINIDAE Cushman, 1927
Genus SIPHONINA Reuss, 1850

SIPHONINA PULCHRA Cushman

Siphonina pulchra CUSHMAN, 1919, Carnegie Inst. Washington, Publ. 291, p. 42, pl. 14, figs. 7a-c.

Discussion: This species occurred at eight stations in low to very low frequencies.

Family ASTERIGERINIDAE d'Orbigny, 1839
Genus ASTERIGERINA d'Orbigny, 1839

PLATE 4

Figure		Page
1,2.	*Triloculina bassensis* Parr. Sample 8A, fig. 1, Side view, X115, fig. 2, Apertural view, X125	275
3,4.	*Triloculina bermudezi* Acosta. Sample 10B, fig. 3, Side view, X225, fig. 4, Apertural view, X430	275
5,6.	*Triloculina fiterrei meningoi* Acosta. Sample 1A, fig. 5, Side view, X180, fig. 6, Side view, X160	275
7.	*Triloculina trigonula* (Lamarck). Sample 8A, Front view, X160	276
8.	*Miliolinella circularis* (Bornemann). Sample 11A, Side view, X270	276
9.	*Miliolinella fichteliana* (d'Orbigny). Sample 9A, Side view, X135	276

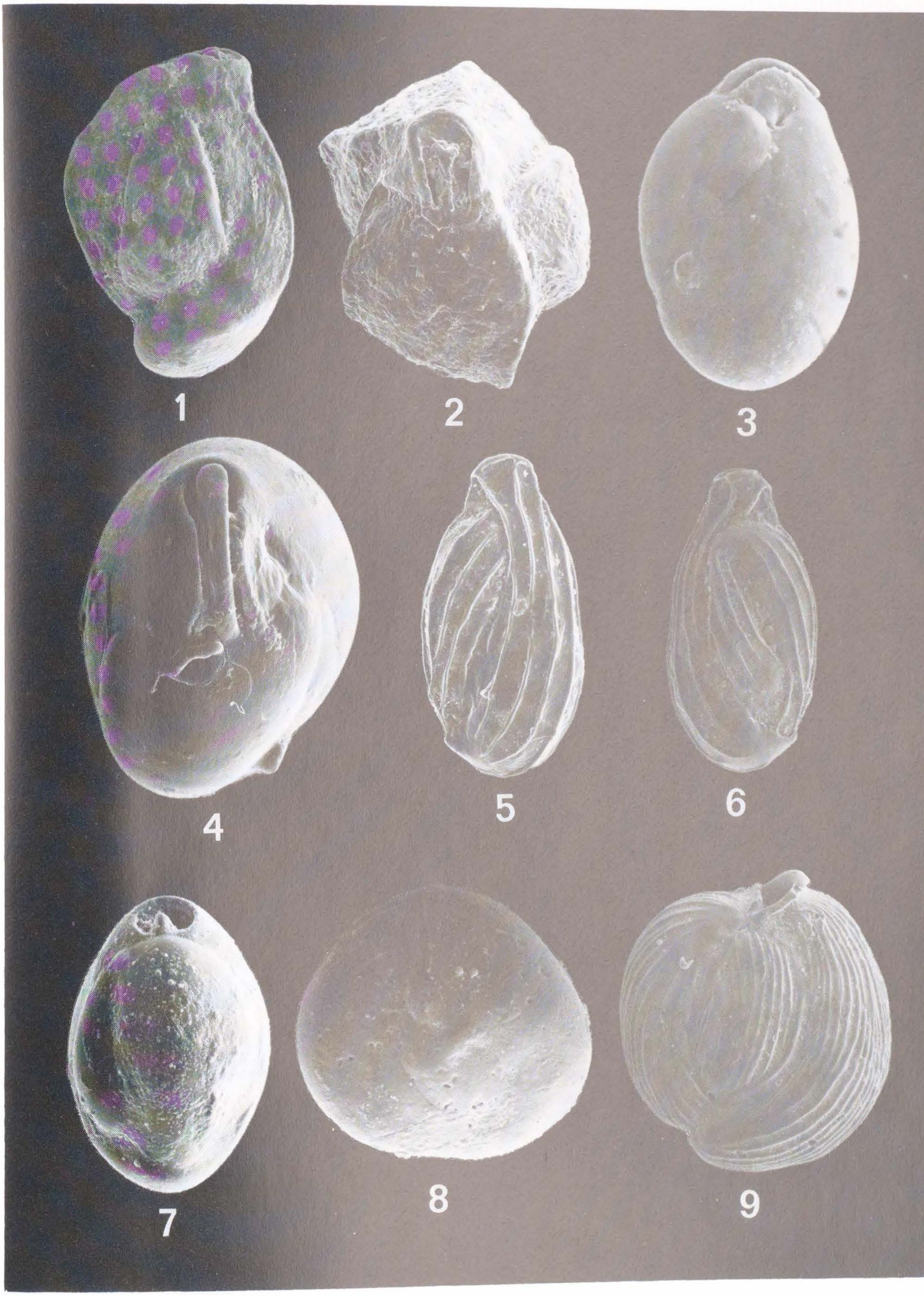

PLATE 4

ASTERIGERINA CARINATA d'Orbigny
Plate 8, fig. 9; Plate 9, fig. 1

Asterigerina carinata D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 118, pl. 5, fig. 25; pl. 6, figs. 1, 2.

Discussion: This species occurred at 14 stations in varying frequencies. It was common near the eastern margin of the bay and rare near the western margin; this probably is due to inshore transport.

Superfamily SPIRILLINACEA Reuss, 1862
Family SPIRILLINIDAE Reuss, 1862
Subfamily SPIRILLININAE Reuss, 1862
Genus SPIRILLINA Ehrenberg, 1843

SPIRILLINA DENTICULATA Brady

Spirillina limbata Brady var. *denticulata* BRADY, 1884, Rept. Voy. *Challenger,* Zool., vol. 9, p. 632, pl. 85, fig. 17.

Spirillina denticulata (Brady). PARR, 1929, B.A.N.Z. Ant. Res. Exped., ser. B, vol. 5, no. 6, p. 351.

Discussion: This species was very rare, with single specimens found only at stations 6 and 11.

SPIRILLINA VIVIPARA Ehrenberg
Plate 9, fig. 2

Spirillina vivipara EHRENBERG, 1843, Abhandl. k. Akad. Wiss. Berlin, Jahr. 1841, p. 422, pl. 3, sec. 7, fig. 41.

Discussion: This species occurred at eight stations in very low frequencies.

Superfamily ROTALIACEA Ehrenberg, 1839
Family ROTALIIDAE Ehrenberg, 1839
Subfamily ROTALIINAE Ehrenberg, 1839
Genus ROTALIA Lamarck, 1804

ROTALIA DUBIA (d'Orbigny)

Rotalina dubia D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 78, pl. 2, figs. 29, 30; pl. 3, fig. 1.

Discussion: A single specimen of this species was found in the "8A" sample.

Genus AMMONIA Brunnich, 1772

AMMONIA BECCARII PARKINSONIANA (d'Orbigny)
Plate 9, figs. 3, 4

Rosalina parkinsoniana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 99, pl. 4, figs. 25-27.

Rotalia beccarii (Linné) var. *parkinsoniana* (d'Orbigny). PHLEGER and PARKER, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 23, pl. 12, figs. 6a, b.

PLATE 5

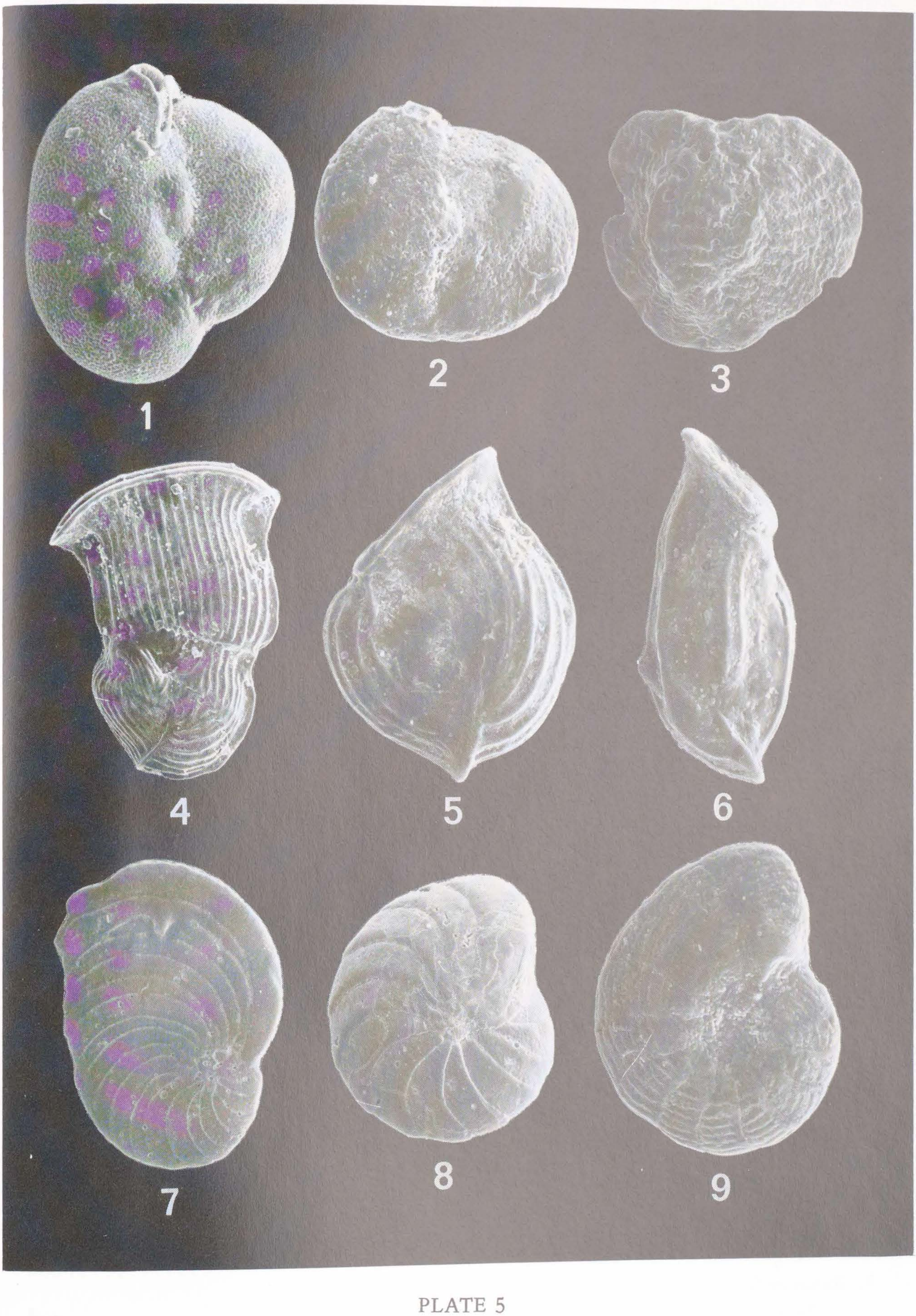

PLATE 5

Ammonia beccarii var. *parkinsoniana* (d'Orbigny). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 55, pl. 20, figs. 5, 6.

Discussion: This ubiquitous species was generally common or abundant. It accounted for nearly 50% of the "3A" sample, and occurred in only low frequencies near the eastern margin of the bay. It was the second-most common species observed in the total population, and was the fourth-most common species in the standing crop. It is an indicator of a stress environment (here brackish water).

AMMONIA BECCARII TEPIDA (Cushman)
Plate 9, figs. 5, 6

Rotalia beccarii (Linné) var. *tepida* CUSHMAN, 1926, Carnegie Inst. Washington, Publ. 344, p. 79, pl. 1.

Ammonia beccarii tepida (Cushman). WRIGHT and HAY, 1971, Miami Geol. Soc., Mem. 1, p. 150.

Discussion: This was by a very large margin, the most common species in the standing crop and the total population. It did not occur at station 12; but, it is a known indicator of a stress environment (here brackish water), and probably few were transported across the bay toward the more saline eastern bay margin. There was a great range in test size and many specimens were very worn, indicating the low amount of deposition and the effects of dredging and exposing older sediments. Several specimens probably were *Ammonia beccarii parkinsoniana,* but were not properly named due to accidental loss of the umbilical plug or to a very small plug not being observed.

Family ELPHIDIIDAE Galloway, 1933
Subfamily ELPHIDIINAE Galloway, 1933
Genus ELPHIDIUM Montfort, 1808

ELPHIDIUM ADVENUM (Cushman)
Plate 9, fig. 7

Polystomella subnodosa BRADY (*not* von Munster), 1884, Rept. Voy. *Challenger,* Zool., vol. 9, p. 734, pl. 110, fig. 1.

Polystomella advena CUSHMAN, 1922, Carnegie Inst. Washington, Publ. 311, p. 56, pl. 9, figs. 11, 12.

Elphidium advenum (Cushman). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 25, pl. 10, figs. 1, 2.

Discussion: This species was ubiquitous and occurred in low frequencies.

ELPHIDIUM GUNTERI GALVESTONENSE Kornfeld
Plate 9, figs. 8, 9

Elphidium gunteri Cole var. *galvestonensis* KORNFELD, 1931, Contr. Dept. Geol. Stanford Univ., vol. 1, no. 3, p. 87, pl. 15, figs. 1-3.

Discussion: This species was the fourth-most common in the total population, and

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PLATE 6

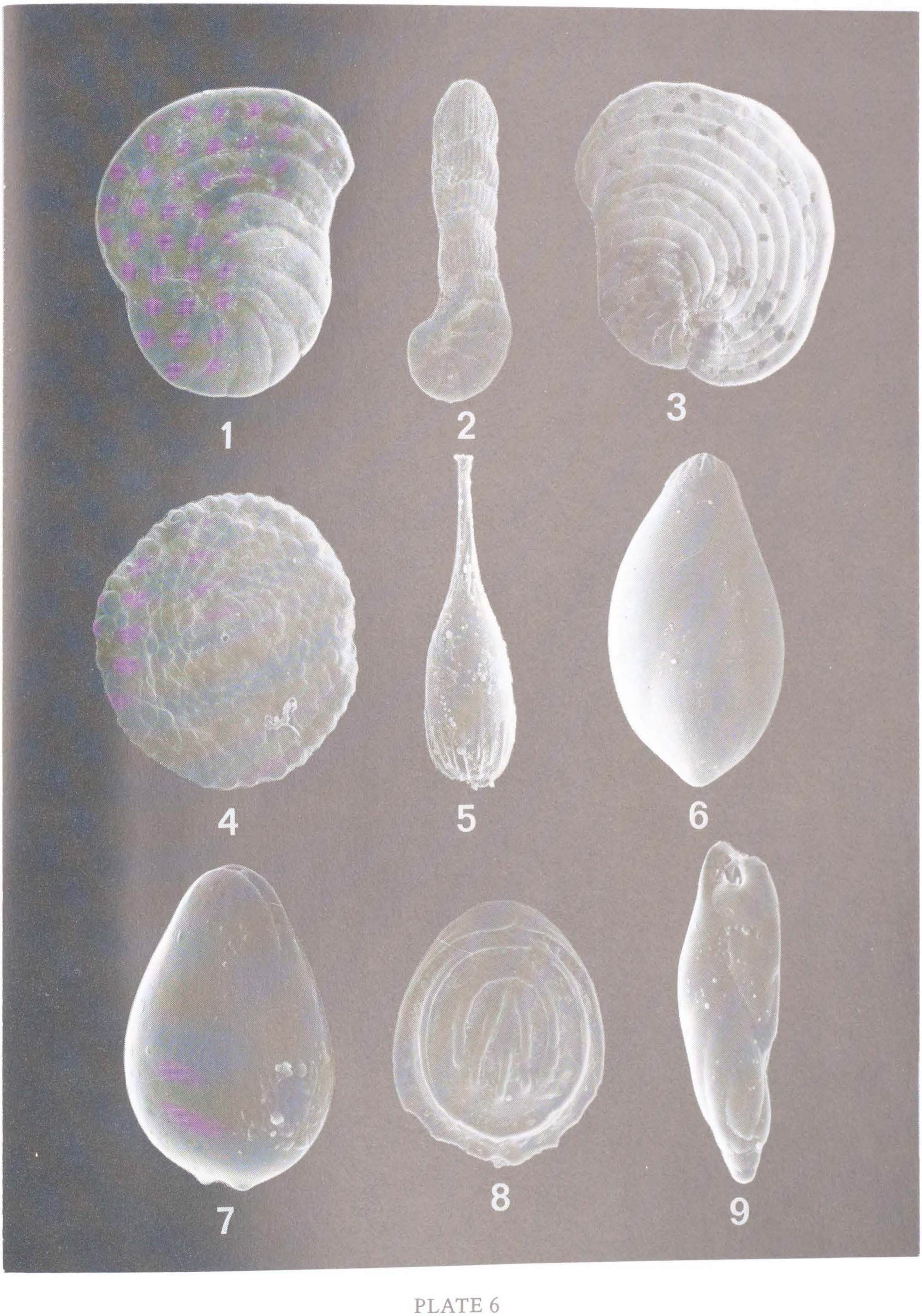

PLATE 6

was present at all stations. There is considerable variation in test size and shape.

ELPHIDIUM INCERTUM MEXICANUM Kornfeld

Elphidium incertum (Williamson) var. *mexicanum* KORNFELD, 1931, Contr. Dept. Geol. Stanford Univ., vol. 1, no. 3, p. 89, pl. 16, figs. 1, 2.

Discussion: This species occurred at six stations in low frequencies.

ELPHIDIUM SAGRUM (d'Orbigny)
Plate 9, fig. 10

Polystomella sagra D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 55, pl. 6, figs. 19, 20.

Elphidium sagrum (d'Orbigny). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 24, pl. 9, figs. 5, 6.

Discussion: This species occurred at nine stations, always in frequencies less than 1%.

Genus CRIBROELPHIDIUM Cushman and Bronnimann, 1948

CRIBROELPHIDIUM KUGLERI Cushman and Bronnimann
Plate 10, fig. 1

Cribroelphidium kugleri CUSHMAN and BRONNIMANN, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, p. 18, pl. 4, fig. 4.

Discussion: This species was present at ten stations in low to very low frequencies.

CRIBROELPHIDIUM POEYANUM (d'Orbigny)
Plate 10, figs. 2, 3

Polystomella poeyana D'ORBIGNY, 1839, *in* DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, "Foraminifères," p. 55, pl. 6, figs. 25, 26.

Elphidium poeyanum (d'Orbigny). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 25, pl. 10, figs. 4, 5.

Cribroelphidium poeyanum (d'Orbigny). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 57, pl. 21, figs. 1, 2.

Discussion: This common to abundant species was absent only from station 12. In some samples frequency was near 1%, but frequency was most often near 10%; and it was third-most common in the total population.

Family NUMMULITIDAE de Blainville, 1825

Subfamily CYCLOCLYPEINAE Butschli, 1880

Genus HETEROSTEGINA d'Orbigny, 1826

PLATE 7

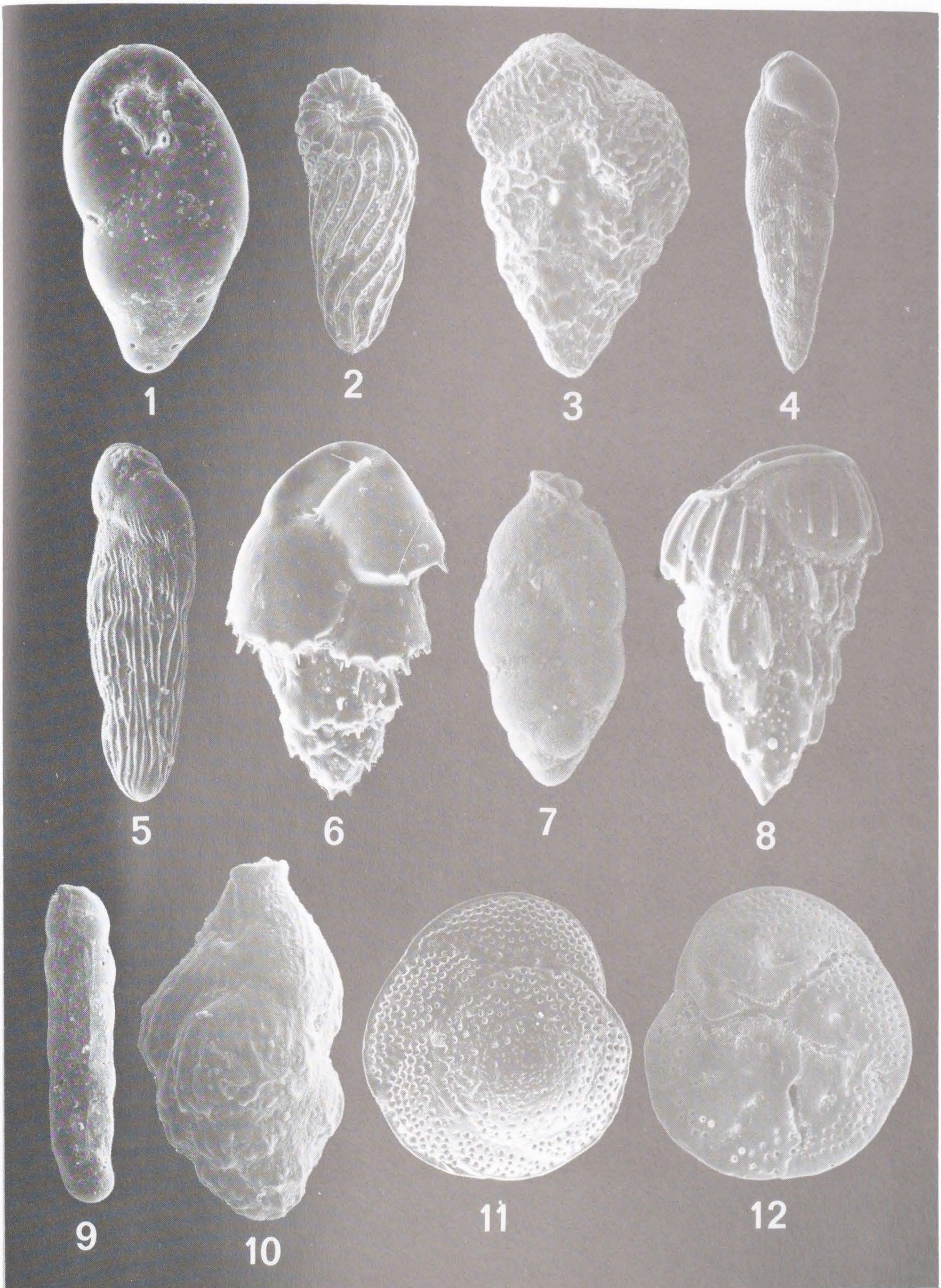

PLATE 7

HETEROSTEGINA DEPRESSA d'Orbigny

Heterostegina depressa D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 305, pl. 17, figs. 5-7.

Discussion: This species occurred at four stations and was rare.

Superfamily ORBITOIDACEA Schwager, 1876

Family AMPHISTEGINIDAE Cushman, 1927

Genus AMPHISTEGINA d'Orbigny, 1826

AMPHISTEGINA LESSONII d'Orbigny

Amphistegina lessonii D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 304, no. 3, pl. 17, figs. 1-4.

Discussion: This species was present at ten stations in low to medium frequencies.

Family CIBICIDIDAE Cushman, 1927

Subfamily CIBICIDINAE Cushman, 1927

Genus CIBICIDES Montfort, 1808

CIBICIDES DEPRIMUS Phleger and Parker

Cibicides deprimus PHLEGER and PARKER, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 29, pl. 15, figs. 16, 17.

Discussion: Two specimens of this species were found at station 7.

CIBICIDES FLORIDANA (Cushman)
Plate 10, figs. 4, 5

Truncatulina floridana CUSHMAN, 1918, U.S. Geol. Surv., Bull. 676, p. 62, pl. 19, figs. 2a-c.

Cibicides floridana (Cushman). CUSHMAN, 1930, Florida Geol. Surv., Bull. 4, p. 61, pl. 12, figs. 3a-c.

Discussion: This species occurred at 13 stations, in low to medium frequencies.

CIBICIDES REFULGENS Montfort

Cibicides refulgens MONTFORT, 1808, Conch. Syst., vol. 1, p. 122.

Discussion: This rare species occurred at three stations. The tests compare favorably with the Cushman figures in Bulletin 104 from the United States National Museum.

CIBICIDES SP.

Discussion: This species occurred at four stations in low frequencies. The specimens may be juveniles of another species.

Family PLANORBULINIDAE Schwager, 1877

Genus PLANORBULINA d'Orbigny, 1826

PLANORBULINA ACERVALIS Brady

Planorbulina acervalis BRADY, 1884, Rept. Voy. *Challenger,* Zool., vol. 9, p. 657, pl. 92, fig. 4.

Discussion: This species occurred at five stations in very low frequencies.

PLANORBULINA MEDITERRANENSIS d'Orbigny

Planorbulina mediterranensis D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 280, pl. 14, figs. 4-6.

Discussion: This species occurred at stations 1, 8, and 11, in very low frequencies.

Family CYMBALOPORIDAE Cushman, 1927

Genus CYMBALOPORETTA Cushman, 1928

CYMBALOPORETTA SQUAMMOSA (d'Orbigny)

Rotalia squammosa D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 272, no. 8.

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

PLATE 8

Figure		Page
1,2.	*Discorbis rosea* (d'Orbigny). Sample 9A, fig. 1, Dorsal view, X115, fig. 2, Ventral view, X115	286
3,4.	*Rosalina candeiana* d'Orbigny. Sample 7A, fig. 3, Dorsal view, X180, fig. 4, Ventral view, X190	286
5,6.	*Rosalina floridana* (Cushman). Sample 8A, fig. 5, Dorsal view, X160, fig. 6, Ventral view, X135	286
7,8.	*Stetsonia minuta* Parker. Sample 6A, fig. 7, Side view, X565, fig. 8, Apertural view, X585	286
9.	*Asterigerina carinata* d'Orbigny. Sample 9A, Dorsal view, X90	288

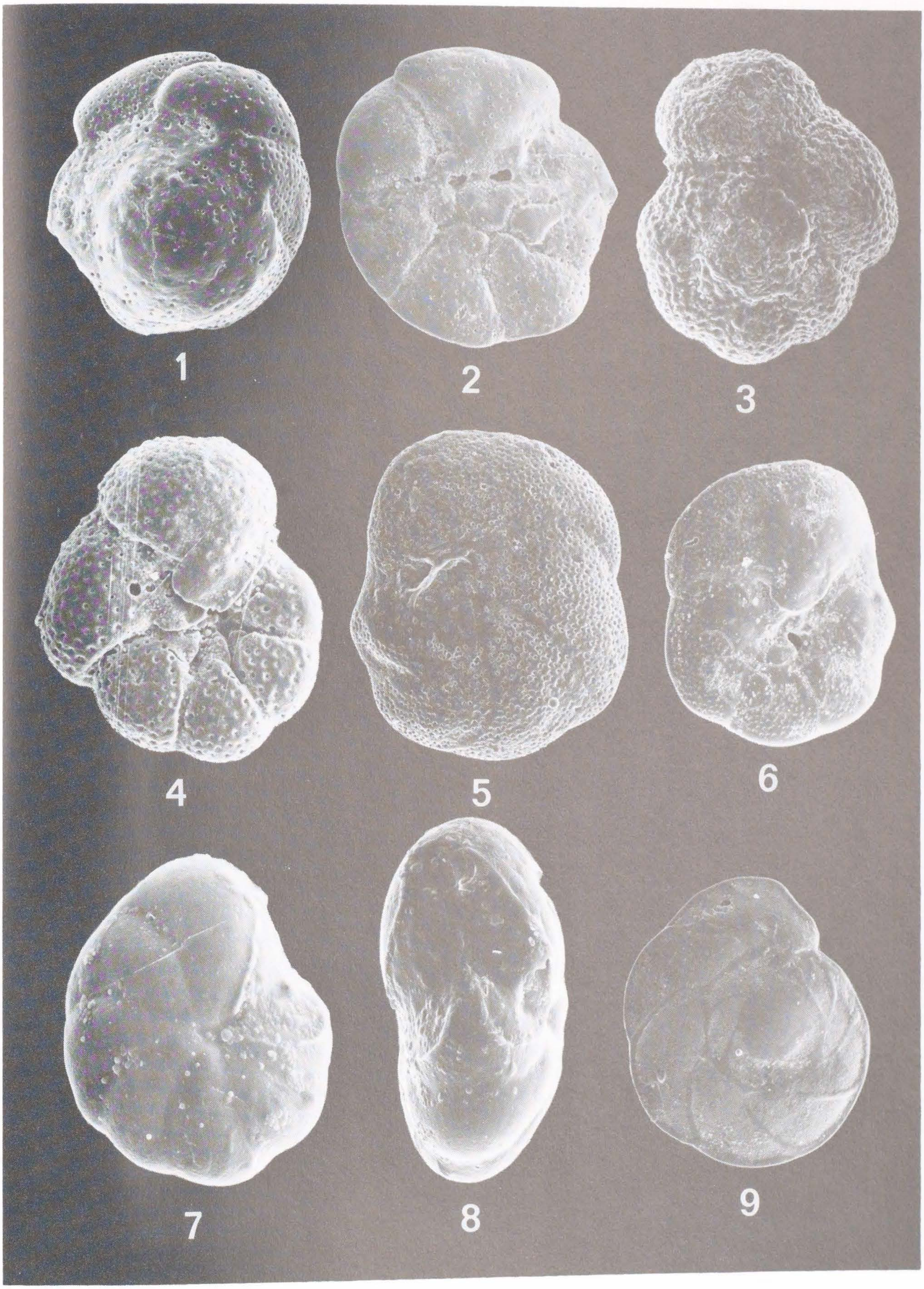

PLATE 8

Discussion: This species occurred at four stations in frequencies less than 1%.

Superfamily CASSIDULINACEA d'Orbigny, 1839

Family CAUCASINIDAE Bykova, 1959

Subfamily FURSENKOININAE Loeblich and Tappan, 1961

Genus FURSENKOINA Loeblich and Tappan, 1961

FURSENKOINA COMPRESSA (Bailey)

Plate 10, fig. 6

Bulimina compressa BAILEY, 1851, Smithsonian Contr., vol. 2, art. 3, p. 12, pl. 12, figs. 35-37.

Virgulina compressa (Bailey). CUSHMAN, 1922, U.S. Natl. Mus., Bull. 104, pt. 3, p. 116, pl. 24, figs. 2, 3.

Fursenkoina compressa (Bailey). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 62, pl. 23, fig. 7.

Discussion: This species occurred at 11 stations in low to fairly common frequencies.

FURSENKOINA MEXICANA (Cushman)

Plate 10, fig. 7

Virgulina mexicana CUSHMAN, 1922, U.S. Natl. Mus., Bull. 104, pt. 3, p. 120, pl. 23, fig. 8.

Fursenkoina mexicana (Cushman). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 62, pl. 23, fig. 8.

Discussion: This species occurred at four stations in very low frequencies.

FURSENKOINA PONTONI (Cushman)

Virgulina pontoni CUSHMAN, 1932, Contr. Cushman Lab. Foram. Res., vol. 8, pt. 1, p. 17, pl. 3, fig. 7.

Fursenkoina pontoni (Cushman). BOCK, 1971, Miami Geol. Soc., Mem. 1, p. 63, pl. 23, fig. 9.

Discussion: This species was present at five stations in very low frequencies.

Genus SIGMAVIRGULINA Loeblich and Tappan, 1957

SIGMAVIRGULINA TORTUOSA (Brady)

Plate 10, fig. 8

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

Sigmavirgulina tortuosa (Brady). LOEBLICH and TAPPAN, 1957, U.S. Natl. Mus., Bull. 215, p. 227, pl. 73, figs. 1, 2.

Discussion: This species occurred at ten stations, always in frequencies less than 1%.

Family LOXOSTOMIDAE Loeblich and Tappan, 1962

Genus LOXOSTOMUM Ehrenberg, 1854

LOXOSTOMUM PORRECTUM (Brady)

Bolivina porrecta BRADY, 1881, Quart. Jour. Micr. Sci., vol. 21, p. 57.

Loxostomum porrectum (Brady). CUSHMAN, 1937, Cushman Lab. Foram. Res., Spec. Publ. 9, p. 190.

Discussion: This species was represented by a single specimen from the "6A" sample.

LOXOSTOMUM SP.

Discussion: Two specimens of this species were present in the "7A" sample.

Family CASSIDULINIDAE d'Orbigny 1839

Genus CASSIDULINA d'Orbigny, 1826

PLATE 9

Figure		Page
1.	*Asterigerina carinata* d'Orbigny. Sample 9A, Ventral view, X90	288
2.	*Spirillina vivipara* Ehrenberg. Sample 4B, Side view, X450	288
3,4.	*Ammonia beccarii parkinsoniana* (d'Orbigny). Sample 2A, fig. 3, Dorsal view, X155, fig. 4, Ventral view, X135	288
5,6.	*Ammonia beccarii tepida* (Cushman). Sample 2A, fig. 5, Dorsal view, X290, fig. 6, Ventral view, X225	290
7.	*Elphidium advenum* (Cushman). Sample 8B, Side view, X205	290
8,9.	*Elphidium gunteri galvestonense* Kornfeld. Sample 2A, fig. 8, Side view, X145, fig. 9, Apertural view, X135	290
10.	*Elphidium sagrum* (d'Orbigny). Sample 9A, Side view, X115	292

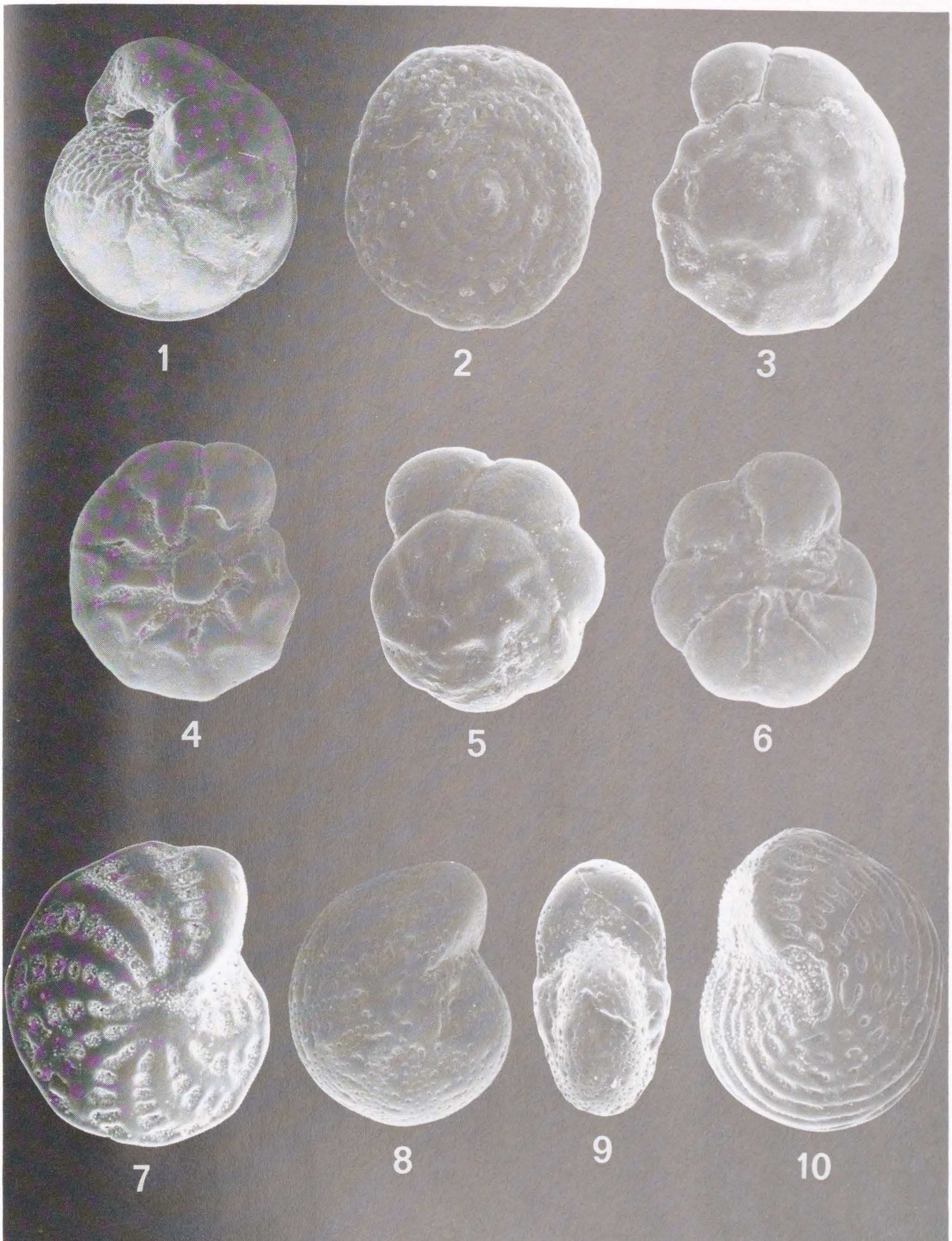

PLATE 9

CASSIDULINA SUBGLOBOSA Brady

Cassidulina subglobosa BRADY, 1881, Quart. Jour. Micr. Sci., vol. 21, p. 60.

Discussion: This species occurred at nine stations in low to very low frequencies.

Family NONIONIDAE Schultze, 1854
Subfamily NONIONINAE Schultze, 1854
Genus NONION Montfort, 1808

NONION BARLEEANUM (Williamson)

Nonionina barleeana WILLIAMSON, 1858, Rec. Foram. Great Britain, p. 32, pl. 3, figs. 68, 69.
Nonion barleeanum (Williamson). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, p. 11, pl. 4, fig. 5.

Discussion: A single specimen occurred in the "9A" sample. The species normally occurs in deeper waters, and this specimen had been transported inshore.

NONION DEPRESSULUM MATAGORDANUM Kornfeld
Plate 10, fig. 9

Nonion depressula (Walker and Jacob), var. *matagordana* KORNFELD, 1931, Contr. Dept. Geol. Stanford Univ., vol. 1, no. 3, p. 87, pl. 13, figs. 2a, b.

Discussion: This species occurred at ten stations in low to very low frequencies.

Genus ASTRONONION Cushman and Edwards, 1937

ASTRONONION STELLIGERUM (d'Orbigny)

Nonionina stelligera D'ORBIGNY, 1839, *in* BARKER-WEBB and BERTHELOT, Hist. Nat. Îles Canaries, vol. 2, pt. 2, p. 128, pl. 3, figs. 1, 2.
Astrononion stelligerum (d'Orbigny). CUSHMAN and EDWARDS, 1937, Contr. Cushman Lab. Foram. Res., vol. 13, p. 31, pl. 3, figs. 7a, b.

Discussion: A single specimen was found in the "9B" sample.

Genus FLORILUS Montfort, 1808

FLORILUS GRATELOUPI (d'Orbigny)
Plate 10, fig. 10

Nonionina grateloupi D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 294, no. 19.
Nonion grateloupi (d'Orbigny). CUSHMAN, 1930, U.S. Natl. Mus., Bull. 104, pt. 7, p. 10, pl. 3, figs. 9-11; pl. 4, figs. 1-4.

Discussion: This species was present at 12 stations, always in frequencies less than 2%.

Genus NONIONELLA Cushman, 1926

NONIONELLA OPIMA Cushman

Nonionella opima CUSHMAN, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, p. 90, pl. 20, figs. 1-3.

Discussion: This species was present at four stations in low to very low frequencies.

PLATE 10

Figure — Page

1. *Cribroelphidium kugleri* Cushman and Bronnimann.
   Sample 6A, Side view, X225 292
2,3. *Cribroelphidium poeyanum* (d'Orbigny).
   Sample 9A, fig. 2, Side view, X125, fig. 3, Apertural view, X115 292
4,5. *Cibicides floridana* (Cushman).
   Sample 5B, fig. 4, Ventral view, X270, fig. 5, Dorsal view, X295 294
6. *Fursenkoina compressa* (Bailey).
   Sample 6A, Side view, X180 296
7. *Fursenkoina mexicana* (Cushman).
   Sample 6A, Side view, X225 296
8. *Sigmavirgulina tortuosa* (Brady).
   Sample 11B, Side view, X225 296
9. *Nonion depressulum matagordanum* Kornfeld.
   Sample 6A, Side view, X385 298
10. *Florilus grateloupi* (d'Orbigny).
   Sample 6A, Side view, X155 298
11. Incertae sedis (unidentified yellow-colored attached form).
   Sample 9A, Attached to a carbonate fragment 300

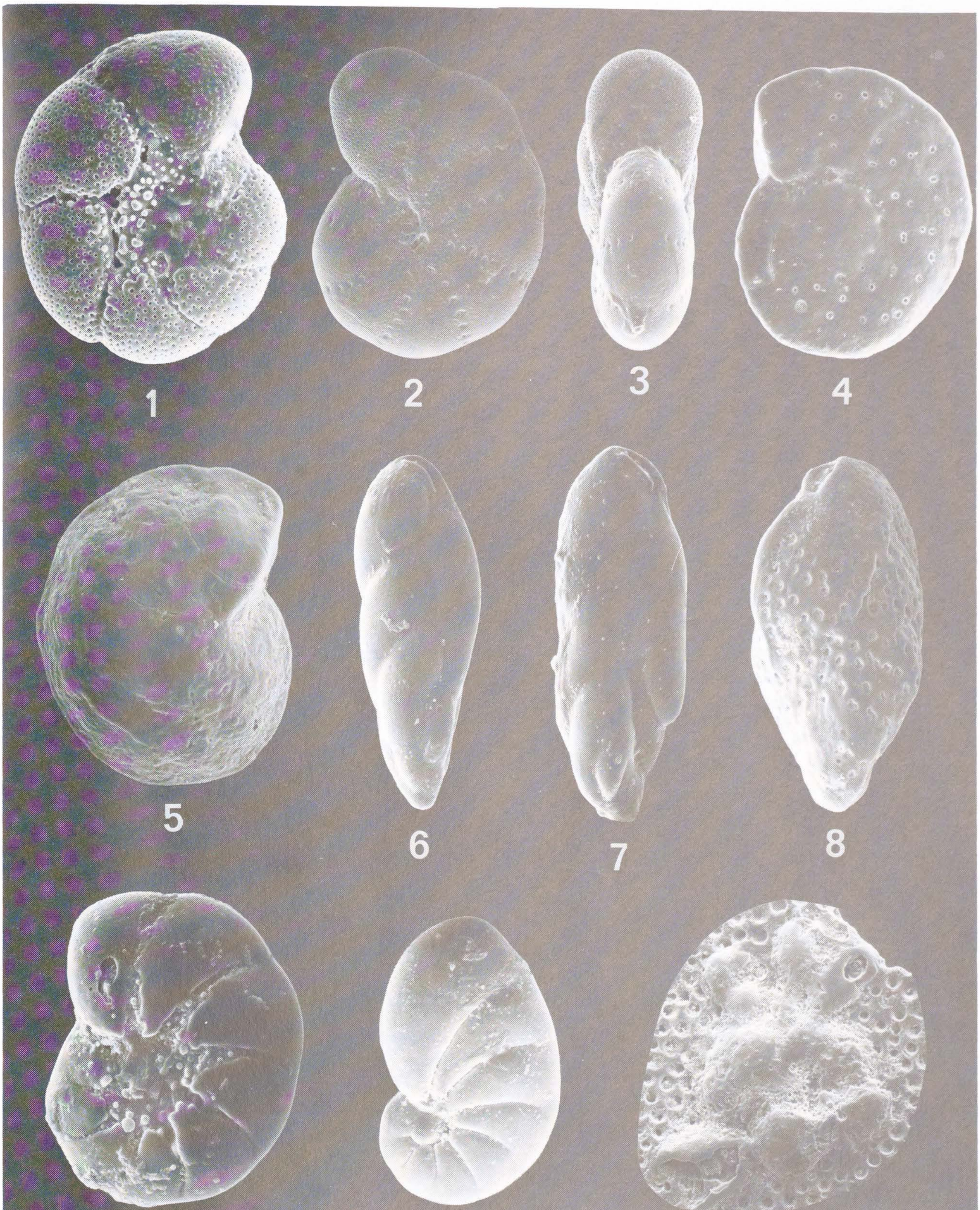

PLATE 10

Family ANOMALINIDAE Cushman, 1927
Subfamily ANOMALININAE Cushman, 1927
Genus HANZAWAIA Asano, 1944
HANZAWAIA STRATTONI (Applin)

Truncatulina americana Cushman var. *strattoni* APPLIN, 1925, Bull. Amer. Assoc. Petr. Geol., vol. 9, no. 1, p. 99, pl. 3, fig. 3.
Hanzawaia strattoni (Applin). BANDY, 1956, U.S. Geol. Surv. Prof. Paper 274-G, p. 195.

Discussion: This species was absent only from station 12. It was present in low frequencies near the western margin of the bay and was fairly common nearer the bay's eastern margin.

Suborder ROTALIINA Delage and Hérouard, 1896
Superfamily ROBERTINACEA Reuss, 1850
Family CERATOBULIMINIDAE Cushman, 1927
Subfamily CERATOBULIMININAE Cushman, 1927

Genus LAMARCKINA Berthelin, 1881
LAMARCKINA ATLANTICA Cushman

Lamarckina atlantica CUSHMAN, 1931, U.S. Natl. Mus., Bull. 104, pt. 8, p. 35, pl. 7, figs. 7a-c.

Discussion: Single specimens of this species were found at stations 7, 9, and 14.

INCERTAE SEDIS
Plate 10, fig. 11

Discussion: A single specimen of this attached species (yellow in color) was found at each of stations 9 and 13.

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