MEMOIR 1

MIAMI GEOLOGICAL SOCIETY

A SYMPOSIUM OF RECENT SOUTH FLORIDA FORAMINIFERA

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Additional copies of this memoir are available from the Miami Geological Society, 10 Rickenbacker Causeway, Miami, Florida 33149, at $7.00 each.

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INTRODUCTION

Of the many studies of living and dead Recent and Near-Recent Foraminifera which have been made concerning their ecology and distribution, a majority have been regionally oriented, dealing in greater or lesser degree to a single or restricted area. To date, however, no detailed regional faunal anaysis has been published for the Recent Foraminifera of the South Florida region. It is the purpose of this Symposium to document the occurrences of all extant foraminiferal species, both benthonic and planktonic, from selected areas in South Florida and the Straits of Florida.

The scope of this Symposium requires that the taxonomy and systematics of many of the foraminiferal groups occurring in this region be re-evaluated and, in many cases, redefined. The initial paper of this volume is, therefore, concerned primarily with species definition and the taxonomy of the benthic Foraminifera. The systematics in the other papers in this volume have been based on that developed in this paper by Bock, in his Handbook of South Florida Benthic Foraminifera.

The remaining papers in the volume deal primarily with the distribution and ecology of Foraminifera occurring in selected marine areas of South Florida. Two of the papers (Lynts, Smith) deal with various aspects of the benthic foraminiferal population in Buttonwood Sound and Lower Florida Bay, respectively. The paper by Wright and Hay considers foraminiferal abundance and distribution in the back-reef environment, occurring between the living Florida reef and the Florida Keys; while the final paper (Jones) describes the ecology and distribution of planktonic Foraminifera occurring in the Florida Straits.

A number of individuals, institutions and granting agencies have variously contributed their time, facilities or funds to enable these studies to be completed. It is impossible within reasonable space limitations to thank all those involved, and the omission of individual thanks in no way indicates a lack of appreciation on the part of the authors.

The majority of the work here reported was initiated at the University of Wisconsin under Prof. Roger L. Batten, currently at the American Museum of Natural History. The studies by Bock, Lynts, Smith and Jones were wholly or partially sponsored by the Wisconsin Alumni Research Foundation to whom the authors express their gratitude. In addition, the University of Miami, Lamont Geological Observatory, Duke University, The Office of Naval Research and the University of Illinois are to be thanked for their contribution to various aspects of the study.

The Atlantic-Richfield Company deserves special recognition in these acknowledgments, for providing most of the funds for the publication of this Symposium.

A HANDBOOK OF THE BENTHONIC FORAMINIFERA OF FLORIDA BAY AND ADJACENT WATERS[1]

by

WAYNE D. BOCK

[1]Contribution No. 1360 from the University of Miami, Rosenstiel School of Marine and Atmospheric Science.

ABSTRACT

Sediment samples from 108 stations in and around Florida Bay were examined for their benthonic foraminiferal content. 235 species belonging to 99 genera were identified. Five faunal groups were recognized and these correlated in a general way with areal changes in the physical environment.

INTRODUCTION

Florida Bay and the adjacent waters offer an excellent opportunity to study a warm, shallow-water fauna from an area of dominantly calcareous sediments. This paper deals primarily with the taxonomy of the benthonic foraminiferal species and their distribution in the sediments. The total fauna is described. Sample coverage includes 108 stations from which 99 genera and 235 species were identified.

PREVIOUS WORK

Vaughn (1918) compared shallow-water bottom samples from Murray Island, Australia, with samples from Florida and the Bahamas, including five samples from the Florida Keys and the Tortugas. Cushman identified the species of Foraminifera present in the samples and found Orbiculina adunca (Fichtel and Moll) to be the most abundant form in the Florida Keys.

Later Cushman (1922) made an ecological study of the shallow-water Foraminifera of the Dry Tortugas, and included observations of living Foraminifera.

Norton (1930) conducted an ecological study of Foraminifera from the waters of Australia and from the Floridian-Bahamian region. In this study he grouped the Foraminifera into several ecological zones based on depth and temperature. The Peneroplidae and Miliolidae were found to be the most abundant in the shallowest and warmest waters, and he noted that these families decreased in abundance with depth.

Thorp (1939), in a study of calcareous marine deposits from the Floridian and Bahamian regions found the Foraminifera to be widely distributed, comprising about 9% of the deposits. The most abundant genera were Archaias, Peneroplis, Quinqueloculina, Clavulina and Valvulina. He also noted that occasionally pelagic forms were swept into the shallow waters by waves and currents, contaminating the shallow-water benthonic faunal deposits.

Stubbs (1940) made an investigation of the Foraminifera from the vicinity of Biscayne Bay. He described 23 genera and 61 species of which the Miliolidae and Peneroplidae were the predominant families. Archaias angulatus was found to be the most abundant species.

Bush (1949, 1958) made two studies of the distribution of Foraminifera in Biscayne Bay. The first described the general distribution of the Foraminifera. The second and more comprehensive study described the sediments and ecological distribution of the Foraminifera. He recognized thirteen biotopes in Biscayne Bay which were dominated by porcelaneous species, but with some containing a significant number of agglutinated and perforate species.

Moore (1957) made an ecological study of the Foraminifera in the northern Florida Keys. He divided the Foraminifera into faunal provinces including Florida Bay, back-reef, reef and fore-reef. The Florida Bay environment was dominated by the Peneroplidae, Miliolidae and Nonionidae with the families Amphisteginidae, Textulariidae, Lagenidae and Buliminidae present. He stated that only species of the family Miliolidae were living in the Florida Bay environment, and that the Florida Bay fauna was distributed by current and wave action.

Lynts (1962, 1965) made a study of the distribution of the Foraminifera in upper Florida Bay. He came to the conclusion that sediment size could be a controlling factor in the distribution of certain Foraminifera. In a second study he discussed the following species from Florida Bay: Valvulina oviedoiana d'Orbigny, Triloculina bassensis Parr and Bolivinita rhomboidalis (Millet).

ACKNOWLEDGMENTS

The writer wishes to thank Dr. Roger L. Batten for his direction and guidance during the early period of this investigation. The Wisconsin Alumni Research Foundation provided funds for the initial collection of specimens. The latter portion of this study was carried out at the Institute of Marine Sciences, University of Miami, under ONR contract Nonr 4008(02) (B8260) and NSF Grant GP-2455 (N8821). The U.S. National Museum made type specimens available for comparison. The writer is especially grateful to Dr. William W. Hay and the Department of Geology at the University of Illinois for making available a scanning electron microscope for the photography of specimens.

PROCEDURES

Bottom sediment samples were collected from small boats and the R/V Gerda from 1958 through 1963. These samples were collected from 108 locations by gravity coring, dredging and hand-sampling in an area bounded by 24°20'N--25°40'N and 80°00'W--83°00'W (see Fig. 1). The samples were preserved in buffered formulin during transportation to the laboratory where they were washed and dried. The dried samples were subdivided with a microsplitter and 250 mg. portions were picked of all Foraminifera.

DISTRIBUTION OF BENTHONIC FORAMINIFERA

Five faunal groups may be distinguished in the area investigated:

1) Straits fauna, 2) back-reef fauna, 3) brackish-water fauna, 4) bay fauna and 5) Gulf fauna.

Straits fauna. (Stations 1, depth 507 m.). Although this faunal assemblage was taken from a single station it is included to emphasize the faunal differences between the various habitats. The major factor controlling faunal distribution within this group is depth. The most abundant species are: Cibicides cicatricosus, Hoeglundina elegans and Pyrgo comata. Lesser elements include Cassidulina subglobosa, Ehrenbergina pacifica, Pyrgo fornasinii, Pyrulina cylindoides, Rectobolivina advena, Robertinoides bradyi, Spiroloculina soldanii, Technitella legumen, and Trifarina bradyi.

Back-reef fauna. (Stations 2-4, depth 1.4-8.5 m.). This group has specimens in common with the bay fauna, but is sufficiently different to be recognizable. The major distinguishing species are: Discorbis rosea, Homotrema rubrum and Pyrgo murrhina. Lesser elements include: Fissurina wiesneri, Ammodiscus anguillae, A. tenuis, Laticarenina holophora, Pyrgo elongata, Schlumbergerina alveoliniformis var. occidentalis and Spiroloculina rotunda. It has two characteristic species in common with the Gulf fauna: Textularia agglutinans and Uvigerina flintii.

Brackish-water fauna. (Stations 9-15, depth 1.2-1.8 m.). This group is characteristic of the small bays immediately adjacent to the Florida mainland. These bays are subject to pronounced runoff of fresh water during the wet season and evaporation during the dry season, and therefore the fauna in them is controlled predominantly by salinity. There are only two species characteristic of this group: Ammonia beccarii var. parkinsoniana and Elphidium discoidale. Although these species are preset in other groups they never occur in large percentages other than in the brackish-water areas, where they may be the only species present.

Gulf fauna. (Stations 98-108, depth 14.8-95 m.). This group is characterized by the following species: Bigenerina irregularis, B. nodosaris, B. textularoidea, Eponides repandus, Marginulina planata, Lenticulina calcar, L. iota, Quinqueloculina bicostata, Spiroplectammina floridana, Textularia agglutinans, T. candeiana, Textulariella barrettii, Uvigerina flintii, U. peregrina and Textularia mayori. There are many minor species found in this group. The distribution of individual species is discussed in the section on Systematic Paleontology.

Bay fauna. (Stations 5-8, 16-97, depth 0.3-6.2 m.). This group contains a very large number of species of which only the most abundant are listed here. It includes: Articulina lineata, A. mayori, A. mexicana, A. mucronata, A. multilocularis, A. pacifica, A. sagra, Bolivina lanceolata, B. lowmani, B. paula, B. pulchella var. primitiva, B. striatula, Cyclogyra involvens, C. planorbis, Rosalina floridana, Cymbaloporetta squammosa, Neoconorbina orbicularis, Elphidium advenum, E. sagrum, Cribroelphidium poeyanum, Eponides antillarum, Fursenkoina complanata, F. compressa, F. pontoni, Hauerina bradyi, Miliolinella circularis, M. fichteliana, M. labiosa, M. suborbicularis, Nonion depressulum var. matagordanum, N. grateloupi, Peneroplis pertusus, Broeckina orbitolitoides, Pyrgo denticulata, P. subsphaerica, Quinqueloculina bidentata, Q. bosciana, Q. laevigata, Q. lamarckiana, Q. poeyana, Q. polygona, Q. tenagos, Q. sabulosa, Q. seminula, Q. subpoeyana, Q. tricarinata, Q. wiesneri, Sorites marginalis, Spirillina vivipara, Spiroloculina antillarum, S. arenata, Spirolina acicularis, S. arietinus, Triloculina bassensis, T. bermudezi, T. bicarinata, T. carinata, T. fitterei var. meningoi, T. linneiana, T. oblonga, T. planciana, T. rotunda, T. sidebottomi, T. tricarinata, T. trigonula and Valvulina oviedoiana. All the above species appear to be able to tolerate major changes in both temperature and salinity.

An additional factor in the bay fauna which affects the distribution of dead tests is sorting by wave and current action resulting in the larger species associated with the coarsest sediment while the smaller are seemingly confined to the finest sediment.

CONCLUSIONS

Ninety nine genera and 235 species are represented in the sediments from Florida Bay and adjacent waters. Five faunal groups are recognized which are apparently characteristic of different 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 primarily by salinity. The bay fauna's distribution appears to be secondarily controlled by wave and current action.

SYSTEMATIC PALEONTOLOGY

The classification followed here is the one adopted by Loeblich and Tappan (1964) in the Treatise on Invertebrate Paleontology.

ORDER FORAMINIFERIDA Eichwald, 1830
SUBORDER TEXTULARINA Delage and Herouard, 1896
SUPERFAMILY AMMODISCACEA Reuss, 1862
FAMILY ASTRORHIZIDAE Brady, 1881
SUBFAMILY HIPPOCREPININAE Rhumbler, 1895
GENUS HYPERAMMINA Brady, 1878
Hyperammina elongata Brady, 1878 (Plate 1, Fig. 1)

Hyperammina elongata Brady (part), 1878, Ann. Mag. Nat. Hist., ser. 5, v. 1, p. 433, Pl. 20, Figs. 2a, b.

Bactrammina elongata Eimer and Fickert, 1899, Zeitscher, Woss. Zool., v. 65, p. 673.

Diagnosis. Test elongate, consisting of long tubular portion of small diameter, composed of sand grains, proloculus broadly rounded, usually considerably larger than diameter of tube; wall usually consisting of but single layer of sand grains with varying amount of cement, smooth on interior surface, rougher on exterior; aperture at distal end of tube, little, if at all, constricted; color gray, sometimes brown, depending largely on color of sand grains.

Discussion. This species is represented by a single specimen at station 103.

Hyperammina subnodosa Brady, 1884 (Plate 1, Fig. 2)

Hyperammina subnodosa Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 259, Pl. 23, Figs. 11-14.

Diagnosis. Test elongate, subcylindrical, larger than others of genus, proloculus large, thick walled, tubular chamber of lesser diameter than proloculus usually irregularly constricted at intervals; walls very thick, coarsely arenaceous, somewhat roughened; interior smoother; aperture circular, at distal end of tube; color light grayish.

Discussion. This species is represented by a single specimen at station 103.

GENUS JACULELLA Brady, 1879

Jaculella acuta Brady, 1879 (Plate 1, Fig. 3)

Jaculella acuta Brady, 1879, Quart. Journ. Micr. Sci., v. 19, p. 35, Pl. 3, Figs. 12, 13.

Diagnosis. Test elongate, straight, tubular; proximal end closed, acutely pointed, distal end broader, slightly compressed to form aperture, which is circular; wall thick, composed of coarse sand grains, firmly cemented; exterior rough; proximal end of test often reddish-brown.

Discussion. This species is represented by only a few specimens at station 103.

FAMILY SACCAMMINIDAE Brady, 1884

SUBFAMILY SACCAMMININAE Brady, 1884

GENUS TECHNITELLA Norman, 1878

Technitella legumen Norman, 1878 (Plate 1, Fig. 4)

Technitella legumen Norman, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 279, Pl. 16, Figs. 3, 4.

Diagnosis. Test free, usually elongate, pyriform, subcylindrical, fusiform or elongate oval, consisting of single undivided chamber; wall thin, composed of sponge spicules, fine sand or amorphous white material, spicules usually whole, of nearly same size, those of exterior longitudinally arranged; aperture rounded, at smaller end of test, usually without definite neck; color usually pure white, sometimes grayish.

Discussion. This species is represented by a few specimens at station 1.

FAMILY AMMODISCIDAE Reuss, 1862

SUBFAMILY AMMODISCINAE Reuss, 1862

GENUS AMMODISCUS Reuss, 1862

Ammodiscus anguillae Höglund, 1947 (Plate 1, Fig. 5)

Trochammina incerta (d'Orbigny) Goes, 1882 (part), K. Sv. Vet. Akad. Handl., v. 19, No. 4, p. 136, Pl. 11, Figs. 405, 406.

Ammodiscus incertus (d'Orbigny) Brady, 1884 (part), Rep. Voy. Challenger, Zool., v. 9, p. 330, Pl. 38, Figs. 1, 3.

Ammodiscus incertus (d'Orbigny) Cushman, 1918 (part), Bull. 104, U.S. Nat. Mus., pt. 1, p. 95, Pl. 39, Fig. 1-8.

Ammodiscus anguillae Höglund, 1947, Zool. Bidr. fr. Uppsala, v. 26, p. 128.

Diagnosis. Test large, not especially thin, rather regular in shape; spiral whorls very numerous; sutures between coils distinct; proloculus small; wall arenaceous, composed of sand grains, from about fifth to seventh whorl also of radially arranged sponge spicules neatly cemented together; surface moderately smooth.

Discussion. This species is very rare, with only a single specimen found at station 4.

Ammodiscus tenuis Brady, 1884 (Plate 1, Fig. 6)

Ammodiscus tenuis Brady, 1884, Rep. Voy. Challenger Zool., v. 9, p. 78, Pl. 38, Figs. 5, 6.

Diagnosis. Test free, planispiral, composed of ovoid proloculum followed by long, spirally coiled, undivided second chamber in single plane; in microspheric forms coils very small in center, gradually increasing toward periphery; in megalospheric form coils much larger in central portion, increasing little toward periphery; adult with outer whorls about as wide as high in transverse section; wall finely arenaceous, usually with excess of cement; color usually yellowish or reddish-brown in fresh specimens, in alcohol often with area around aperture whitish; aperture formed by open end of tube.

Discussion. This species is very rare in the area, a single specimen being found at station 4.

SUPERFAMILY LITUOLACEA de Blainville, 1825

FAMILY HORMOSINIDAE Haeckel, 1894

SUBFAMILY HORMOSININAE Haeckel, 1894

GENUS REOPHAX Montfort, 1808

Reophax dentaliniformis Brady, 1881 (Plate 1, Fig. 7)

Reophax dentaliniformis Brady, 1881, Quart. Journ. Micr. Sci., v. 21, p. 49.

Diagnosis. Test slender, tapering, composed of few (5-6) chambers, increasing progressively in length as added, slightly tumid in middle, contracted slightly at ends; arranged in straight or slightly curved line; wall of rather coarse sand grains, but cemented to give smooth even surface, apertural end tapering rather abruptly to short cylindrical neck; aperture circular; color gray.

Discussion. This species is rare occurring at only four stations three of which are located in the slightly deeper waters of the Gulf of Mexico adjacent to Florida Bay and the other at the very deep station 1.

Reophax difflugiformis Brady, 1879 (Plate 1, Fig. 8)

Reophax difflugiformis Brady, 1879, Quart. Journ. Micr. Sci., v. 19, p. 51, Figs. 3a, b.

Diagnosis. Test free, consisting of single elongate oval or pyriform chamber, with more or less distinct tubular neck; chamber undivided; wall fairly thick, composed of closely cemented sand grains of variable size and roughness; aperture simple, terminal; color varying with material of wall.

Discussion. This species is rare, occurring at only two stations in the Gulf of Mexico waters.

Reophax fusiformis (Williamson), 1858 (Plate 1, Fig. 9)

Proteonina fusiformis Williamson, 1858, Recent Foram. Gt. Brit., p. 1, Pl. 1, Fig. 1.

Reophax fusiformis Brady, 1882, Denkschr. Kongl. Akad. Wiss. Wien, v. 43, pt. 2, p. 99.

Diagnosis. Test free, fusiform, asymmetrical, chamber single or somewhat incompletely divided; walls composed of fairly coarse sand grains, rough externally, but closely cemented; aperture terminal, single.

Discussion. This species is represented by single specimens at two stations.

Reophax nodulosus Brady, 1879 (Plate 1, Fig. 10)

Reophax nodulosus Brady, 1879, Quart. Journ. Micr. Sci. v. 19, p. 52, pl. 4, Figs. 7, 8.

Diagnosis. Test elongate, tapering, straight or slightly curved, composed of several (up to 20) chambers, but usually less than 12, pyriform in shape, widest near basal end, thence tapering toward apertural end, chambers gradually increasing in length and diameter as added;

wall in short chambers rough, in those with elongate chambers usually neatly finished on exterior, composed of sand grains with reddish-brown cement; aperture fairly large, circular.

Discussion. This species is represented by a single specimen at station 1, and is common at station 107. It appears to be restricted to fairly deep water.

Reophax scorpiurus Montfort, 1808 (Plate 1, Fig. 11)

Reophax scorpiurus Montfort, 1808, Conch. Syst., v. 1, p. 330.

Diagnosis. Test consisting of a number of chambers, rapidly increasing in size as added, early chambers more or less indistinct, irregularly arcuate, later ones larger, more distinct, nearly in straight line; walls of coarse sand grains, rather roughly cemented, surface rough; aperture simple, small, with short neck.

Discussion. This species is represented by a single specimen from station 105.

Reophax sp. (Plate 1, Fig. 12)

A single specimen of this large species of Reophax occurs at station 103.

FAMILY LITUOLIDAE de Blainville, 1825

SUBFAMILY HAPLOPHRAGMOIDINAE Mayne, 1952

GENUS HAPLOPHRAGMOIDES Cushman, 1910

Haplophragmoides canariensis (d'Orbigny), 1839 (Plate 1, Figs. 13, 14)

Nonionina canariensis d'Orbigny, 1839, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, v. 2, pt. 2, Foraminiferes, p. 128, pl. 2, Figs. 33, 34.

Placopsilina canariensis Parker and Jones, 1857, Ann. Magn. Nat. Hist., ser. 2, v. 19, p. 301, pl. 10, Figs. 13, 14.

Lituola canariensis Carpenter, Parker and Jones, 1862, Intr. Foram., pl. 6, Figs. 39-41.

Lituola nautiloides var. canariensis Parker and Jones, 1865, Philos. Trans., v. 155, p. 406, pl. 15, Figs. 45a, b, pl. 17, Figs. 92-95.

Haplophragmium canariensis Siddall, 1879, Cat. Rec. British Foram., p. 4.

Haplophragmoides canariensis Cushman, 1910, Bull. 71, U.S. Nat. Mus., pt. 1, p. 101, Fig. 149.

Diagnosis. Test free, planispiral, composed of few coils, partially involute or almost completely so, umbilicate; chambers subglobular, somewhat compressed laterally, six or seven chambers in final coil, last chambers somewhat larger than preceding ones, sutures indistinct, periphery somewhat lobulate; wall arenaceous, made up of sand grains, but rather smoothly finished, thin; aperture at base of last-formed chamber, narrow, overhanging portion of wall, slightly extended forming thin lip.

Discussion. This species had rare occurrences at stations 2, 3 and 4 located between the outer reef tract and the Florida Keys.

SUBFAMILY CYLAMMININAE Marie, 1941

GENUS ALVEOLOPHRAGMIUM Shchedrina, 1936

Alveolophragmium subglobosum (G.O. Sars), 1871

Lituola subglobosa G.O. Sars, 1871, Forh. Vid. Selsk. Christiania, p. 253.

Haplophragmium subglobosum Brady, 1881, Denkschr. Kais. Akad. Wiss. Wien, v. 43, p. 100.

Haplophragmoides subglobosum Cushman, 1910, U.S. Nat. Mus., Bull. 71, pt. 1, p. 105.

Alveolophragmium subglobosum Loeblich and Tappan, 1953, Smiths. Misc. Coll., v. 121, no. 7, p. 9.

Diagnosis. Test usually planispiral, consisting of two or more coils, involute, depressed at umbilici, chambers very broad, low; wall arenaceous, somewhat roughened, variable, usually 7 or 8 chambers in last-formed coil making test as whole subglobose; aperture more or less elongated slit at base of apertural face, simple.

Discussion. This species is represented by a single specimen at station 103.

SUBFAMILY LITUOLINAE de Blainville, 1825

GENUS AMMOBACULITES Cushman, 1910

Ammobaculites agglutinans (d'Orbigny), 1846 (Plate 1, Fig. 15)

Spirolina agglutinans d'Orbigny, 1846, Foram. Foss. Bass. Tert. Vienne, p. 137, pl. 7, Figs. 10-12.

Haplophragmium agglutinans Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 301, pl. 32, Figs. 19, 20, 24-26.

Ammobaculites agglutinans Cushman, 1910, Bull. 71, U.S. Nat. Mus., pt. 1, p. 115, Fig. 176.

Diagnosis. Test elongate, early portion closely coiled, planispiral, one or usually more coils each with 5 to 7 chambers, later portion uncoiled, subcylindrical, made up of linear series of chambers, in adult specimens making up larger part of test; wall rather coarsely arenaceous, somewhat variable in its surface, usually roughened, occasionally fairly smooth; aperture in early coiled portion slit-like, at base of apertural face, in uncoiled portion in middle of terminal face, rounded.

Discussion. This species is represented by a single specimen at station 16.

Ammobaculites sp. (Plate 1, Fig. 16)

Diagnosis. This species is similar to Ammobaculites agglutinans, but differs from it in having a relatively larger coiled portion to uncoiled portion, and in having the coiled portion involute.

Discussion. This species is represented by single specimens at stations 28 and 30.

FAMILY TEXTULARIIDAE EHRENBERG, 1838

SUBFAMILY SPIROPLECTAMMININAE Cushman, 1927

GENUS SPIROPLECTAMMINA Cushman, 1927

Spiroplectammina floridana (Cushman), 1922 (Plate 1, Fig. 17)

Textularia transversaria Flint (not Brady), 1897, Rep. U.S. Nat. Mus., p. 283, pl. 28, Fig. 4.

Textularia floridana Cushman, 1922, Publ. 311, Carnegie Inst. Wash., v. 17, p. 24, pl. 1, Fig. 7.

Diagnosis. Test elongate, two to three times as long as wide, much compressed, periphery acute, ends of chambers forming tubular projections, often broken, showing truncate or concave area which is hollow; initial end rather sharply pointed, apertural end broadly rounded; chambers numerous, thickest near center, increasing somewhat in height toward apertural end; sutures indistinct, slightly if at all depressed; wall finely arenaceous, smooth; aperture small, rounded, at base of inner margin of last-formed chamber.

Discussion. This species occurs only at station 107, but there it is abundant.

SUBFAMILY TEXTULARIINAE Ehrenberg, 1838

GENUS TEXTULARIA Defrance, 1824

Textularia agglutinans d'Orbigny, 1839 (Plate 2, Fig. 1)

Textularia agglutinans d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba,"Foraminiferes", p. 136, pl. 1, Figs. 17, 18, 32, 34.

Diagnosis. Test elongate, tapering, compressed, periphery rounded; chambers inflated, increasing in height toward apertural end; sutures distinct, depressed; wall rather coarsely arenaceous, but smoothly finished; aperture an elongate slit in well-marked depression of inner border of chamber.

Discussion. This species has rare occurrences in areas outside Florida Bay proper. It is found between the reef tract and the Florida Keys, and at the stations adjacent to Florida Bay in the Gulf of Mexico.

Textularia candeiana d'Orbigny, 1839 (Plate 2, Fig. 2)

Textularia candeiana d'Orbigny, 1839, in De La Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 143, pl. 1, Figs. 25-27.

Diagnosis. Test elongate, club-shaped, early portion narrow, much compressed, edges almost carinate, slightly tapering to rounded apex, later chambers enlarging rapidly, much inflated; chambers numerous; wall rather coarsely arenaceous; aperture in broad but shallow sinus at base of inner margin of chamber.

Discussion. This species has rare occurrences at four of the Gulf of Mexico stations, all outside of Florida Bay proper.

Textularia conica d'Orbigny, 1839 (Plate 2, Fig. 3)

Textularia conica d'Orbigny, 1839, in De La Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 143, pl. 1, Figs. 19, 20.

Diagnosis. Test usually wider than high, triangular in front view, broadly oval in end view, slightly compressed, apex bluntly pointed; chambers comparatively few, distinct; sutures distinct, slightly depressed; wall arenaceous, smooth, or slightly roughened; aperture narrow slit at base of inner margin of last-formed chamber.

Discussion. A few specimens of this species occur at the two deepest stations only, suggesting a depth control on distribution.

Textularia mayori Cushman, 1922 (Plate 2, Fig. 4)

Textularia mayori Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 23, pl. 2, Fig. 3.

Diagnosis. Test compressed, increasing rapidly in breadth, initial end rounded, apertural end obliquely truncate; sutures slightly depressed; periphery of each chamber with elongate, conical, spinose projection, often broken at tip, those of early portion directed backward, later ones extending straight outward; wall arenaceous, of angular sand-grains with much fine cement; aperture very low, elongate, at inner border of last-formed chamber, in reentrant of border, with thin lip above.

Discussion. This species occurs only at stations 106 and 107 located just south of Rebbecca Shoals. At these two stations it is common, but it is absent from all other stations, suggesting a probable depth control.

GENUS BIGENERINA d'Orbigny, 1826

Bigenerina irregularis Phleger and Parker, 1951 (Plate 2, Fig. 5)

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

Diagnosis. Test elongate, initial portion biserial, compressed, usually at angle to rest of test, which is uniserial; wall coarsely arenaceous, composed partially of sand grains from associated sediment, giving whole test roughened appearance; aperture terminal, rounded, at end of short neck.

Discussion. This species has rare to abundant occurrences at all the stations in the adjacent Gulf of Mexico waters. It is absent from all the Florida Bay stations.

Bigenerina nodosaria d'Orbigny, 1826 (Plate 2, Fig. 6)

Bigenerina nodosaria d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 261, pl. 11, Figs. 9-11.

Diagnosis. Test elongate, early portion composed of biserial group of chambers, considerably flattened, with sutures clearly marked externally; chambers progressively broader, later portion composed of uniserial group of chambers, rounded, usually less in width than biserial portion; wall usually coarsely arenaceous, sometimes of fine material nearly smooth; aperture in early portion as in Textularia, elongate slit between base of inner margin of chamber and adjacent wall of preceding chamber, in later portion rounded, in middle of terminal face of chamber.

Discussion. This species has a generally common occurrence at all the adjacent Gulf of Mexico stations while absent from Florida Bay.

Bigenerina textularoidea (Goes), 1894 (Plate 2, Fig. 7)

Clavulina textularoidea Goes, 1894, Kongl. Sv. Vet. Akad. Handl., v. 25, p. 42, pl. 8, Figs. 387-399.

Diagnosis. Early portion biserial, lanceolate, much compressed, abbreviated, later portion uniserial, making up major part of test; wall usually very coarsely arenaceous; aperture in early portion at inner margin of last-formed chamber, semilunar, in later portion subrounded, in middle of terminal face of chamber, on short neck.

Discussion. This species occurs only at stations 102 and 103 where it is common and abundant respectively.

FAMILY TROCHAMMINIDAE Schwager, 1877

SUBFAMILY TROCHAMMININAE Schwager, 1877

GENUS TROCHAMMINA Parker and Jones, 1860

Trochammina japonica Ishiwada, 1950 (Plate 2, Figs. 8, 9)

Trochammina japonica Ishiwada, 1950, Japan Geol. Survey, Bull., Kawasaki, Japan, v. 1, no. 4, p. 190, pl. , Figs. 2a-c.

Diagnosis. Test free, trochospiral, periphery broadly rounded, umbilical area in ventral side deeply depressed; 5 or 6 chambers in final whorl, inflated, slightly loculate; sutures indistinct in early stages, depressed, not curved, oblique to inner margin on dorsal side, perpendicular to periphery on ventral side; wall rather coarsely arenaceous, smoothly finished; aperture semi-circular opening at base of ventral side of chamber.

Discussion. This species occurred only at station 28 in the northern part of Florida Bay, but there it is common. The arenaceous material of the wall is loosely held together by cement and therefore the test is very fragile. The distribution of this species is probably more widespread than these results show, but due to the nature of the wall the test probably distintegrates shortly after death.

FAMILY ATAXOPHRAGMIIDAE Schwager, 1877

SUBFAMILY GLOBOTEXTULARIINAE Cushman, 1927

GENUS KARRERIELLA Cushman, 1933

Karreriella bradyi (Cushman, 1937) (Plate 2, Fig. 10)

Gaudryina pupoides Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 378, pl. 46, Figs. 1-4.

Gaudryina bradyi Cushman, 1911, Bull. 71, U.S. Nat. Mus., pt. 2, p. 67.

Karreriella bradyi Cushman, 1937, Cush. Lab. Foram. Res., Spec. Publ. No. 8, p. 135.

Diagnosis. Test stout, somewhat elongate, tapering slightly until near initial end where it tapers abruptly to somewhat blunt end; triserial portion nearly circular in cross section, chambers few, later biserial portion making up about three-fourths of test, slightly compressed; chambers overlapping, appearing crowded, broadly elliptical in cross section, inflated; sutures deep, distinct, end strongly convex; wall of fine arenaceous or calcareous shell material, smooth; aperture oval, slightly back from inner margin of chamber, with border raised somewhat, thickened.

Discussion. This species occurs as a single specimen at station 102.

SUBFAMILY VALVULININAE Berthelin, 1880

GENUS VALVULINA d'Orbigny, 1826

Valvulina oviedoiana d'Orbigny, 1839 (Plate 2, Fig. 11)

Valvulina oviedoiana d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 103, pl. 2, Figs. 21, 22.

Diagnosis. Test pyramidal, triangular in transverse section, initial end pointed, apertural end broadly rounded, triserial; wall coarsely arenaceous, principally of sand grains from associated sediment, somewhat roughened; aperture at base of inner margin of last-formed chamber.

Discussion. This species is randomly distributed at ten stations throughout Florida Bay. It displays a wide variation in size and in the nature of its tooth-plate (Lynts, 1964). It appears to be more common in areas of coarse sediment.

GENUS CLAVULINA d'Orbigny, 1826

Clavulina difformis (Brady), 1884 (Plate 2, Fig. 12)

Clavulina angularis d'Orbigny, var. difformis Brady, 1884, Rep. Voy. Challenger, Zool. v. 9, p. 396, pl. 48, Figs. 25-31.

Clavulina difformis (Brady) Cushman, 1921, Bull. 100, U.S. Nat. Mus., v. 4, p. 156, pl. 31, Figs. 2a, b.

Diagnosis. Test elongate, quadrilateral in cross section, early triserial portion limited to few chambers, followed by few chambers biserial in character, main portion of test uniserial, chambers extending back along angles of test, arched upward across faces, leaving slight hollow below; wall arenaceous, smoothly finished on exterior; aperture in middle of apertural face, with single valvular tooth.

Discussion. This species is represented by a single specimen at station 73.

Clavulina mexicana Cushman, 1922 (Plate 2, Fig. 13)

Clavulina parisiensis d'Orbigny, var. humulis Flint (not Brady), 1897, Rep. U.S. Nat. Mus., p. 289, pl. 36, Fig. 1.

Clavulina humilis Brady, var. mexicana Cushman, 1922, U.S. Nat. Mus., Bull. 104, pt. 3, p. 83, pl. 16, Figs. 1-3.

Pseudoclavulina mexicana (Cushman), 1937, Cush. Lab. Foram. Res., Spec. Publ. 7, p. 117, pl. 16, Figs. 5-11.

Diagnosis. Test elongate, early portion sharply triangular, chambers of early portion becoming somewhat more separate, distinct as added, those of last-formed portion flask-shaped with definite neck; sutures indistinct in triserial portion, those of later portion becoming somewhat more distinct, depressed; wall coarsely arenaceous, surface roughened, fairly thick; aperture terminal, central, at end of tubular neck.

Discussion. This species occurs at only two stations in very low frequencies.

Clavulina tricarinata d'Orbigny, 1839 (Plate 2, Fig. 14)

Clavulina tricarinata d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 111, pl. 2, Figs. 16-18.

Diagnosis. Test elongate, early portion triserial, later portion forming large part of test uniserial, triangular in cross section; chambers numerous, angles extending back over preceding chambers; wall coarsely arenaceous, principally of calcareous sand grains from associated sediment; aperture circular, terminal, often with distinct, straight, simple tooth.

Discussion. This species occurs at only eight stations in frequencies from low to medium.

SUBFAMILY ATAXOPHRAGMIINAE Schwager, 1877

GENUS LIEBUSELLA Cushman, 1933

Liebusella soldanii (Jones and Parker), 1860 (Plate 2, Fig. 15)

Lituola soldanii Jones and Parker, 1860, Quart. Journ. Geol. Soc., v. 16, p. 307, No. 184.

Haplostiche soldanii Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 318, pl. 32, Figs. 12-18.

Liebusella soldanii Thalmann, 1937, Eclog. geol. Helvet., v. 30, No. 2, p. 340.

Diagnosis. Test elongate, subcylindrical or ovate, inferior end round or tapering to blunt point, superior end broad, rounded; consisting or numerous, convex, slightly embracing chambers, superimposed in straight or somewhat curved line; exterior rough, slightly constricted at sutures; interior of chambers subdivided by irregular secondary septa; aperture terminal, porous or dendritic.

Discussion. This species is represented by only a few specimens at stations 101, 102 and 103. The specimens are large and seem to be associated with coarse sediment.

FAMILY PAVONITIDAE Loeblich and Tappan, 1961

SUBFAMILY PAVONITINAE Loeblich and Tappan, 1961

GENUS TEXTULARIELLA Cushman, 1927

Textulariella barrettii (Jones and Parker), 1863 (Plate 3, Fig. 1)

Textularia barrettii Jones and Parker, 1863, Rep. British Ass., Newcastle Meeting, p. 80, 105.

Textulariella barrettii Cushman, 1927, Contr. Cush. Lab. Foram. Res., v. 3, pt. 1, No. 39, p. 24.

Diagnosis. Test tapering, about twice as long as broad, very slightly compressed, broadest near apertural end, apical end bluntly pointed, later portion of test often with nearly straight sides; chambers distinct, numerous, labyrinthic; sutures very clearly marked, not depressed; walls finely arenaceous with abundance of cement, very smoothly finished; aperture narrow slit at base of inner margin of last-formed chamber, sides of chamber slightly projecting beyond it on each side, sometimes subdivided into one or more openings.

Discussion. This species had rare occurrences at stations 101, 102 and 103.

SUBORDER MILIOLINA Delage and Herouard, 1896

SUPERFAMILY MILIOLACEA Ehrenberg, 1839

FAMILY FISCHERINIDAE Millett, 1898

SUBFAMILY CYCLOGYRINAE Loeblich and Tappan, 1961

GENUS CYCLOGYRA Wood, 1842

Cyclogyra involvens (Reuss), 1850 (Plate 3, Fig. 2)

Operculina involvens Reuss, 1850, Denkschr. Akad. Wiss. Wien., v. 1, p. 370, Pl. 46, Fig. 30.

Cornuspira involvens Reuss, 1863, Sitz. Akad. Wiss. Wien, v. 48, Abt. 1, p. 39, Pl. 1, Fig. 2.

Diagnosis. Test nearly circular in side view, consisting of proloculum and long, closely coiled, planispiral second chamber of nearly equal diameter throughout; wall smooth, polished; aperture terminal, nearly size of open end of tube.

Discussion. This species differs from Cyclogyra planorbis in having a greater number of coils, and in not increasing the diameter of the second chamber during growth.

This species occurs at only nine stations in very low frequences.

Cyclogyra planorbis Schultze,1854 (Plate 3, Fig. 3)

Cornuspira planorbis Schultze, 1854, Organismus Polythal., p. 40, Pl. 2, Fig. 21.

Diagnosis. Test circular in side view, consisting of proloculum and long second chamber planispirally coiled, making only few coils; diameter of tube increases with growth; wall smooth; aperture open end of tube.

Discussion. Cyclogyra planorbis is similar to Cyclogyra involvens, but differes from it in possessing fewer coils and in increasing the diameter of the second chamber during growth.

This species occurs at thirteen stations, usually in low frequences. It appears to be restricted to those stations with the finest-grained sediment.

GENUS CORNUSPIROIDES Cushman, 1928

Cornuspiroides foliacea (Phillipi), 1844 (Plate 3, Fig. 4)

Orbis foliaceus Phillipi, 1844, Enum. Moll. Sicil., v. 2, p. 147, Pl. 24, Fig. 26.

Cornuspira foliacea Carpenter, Parker and Jones, 1862, Intrad. Foram., p. 68, Pl. 5, Fig. 16.

Diagnosis. Test planispiral, early portion with coils of nearly uniform diameter, later coils rapidly increasing in height, forming broad, flattened test; wall smooth, except for thickening caused by lines of growth; aperture long, narrow slit entire height of chamber, at open end of tube.

Discussion. This species is represented by single specimens at stations 18 and 103.

FAMILY NUBECULARIIDAE Jones, 1875

SUBFAMILY OPHTHALMIDIINAE Wiesner, 1920

GENUS CORNULOCULINA Burbach, 1886

Cornuloculina inconstans (H.B. Brady), 1879 (Plate 3, Figs. 5, 6)

Hauerina inconstans Brady, 1879, Wuart. Journ. Micro. Sci., v. 19, p. 268.

Ophthalmidium inconstans Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 189, Pl. 12, Figs. 5, 7, 8.

Hauerinella inconstans (Brady) Schubert, 1920, Pal. Zeitschr., v. 3, p. 162.

Diagnosis. Test much compressed, planispiral; chambers consist of globular proloculum followed by long planispirally coiled second chamber, making two or more coils; chambers nearly circular in transverse section with wide flange on peripheral border; chambers often slightly less coiled toward apertural end, leaving space filled by thin plate of calcareous material; aperture circular without lip or tooth.

Discussion. Cornuloculina inconstans exhibits variation in the size of the flange on the peripheral border. Some specimens have very thin flanges, while others have very narrow and slightly thicker flanges.

This species occurs at ten stations, always in very low frequencies.

SUBFAMILY SPIROLOCULININAE Wiesner, 1920

GENUS SPIROLOCULINA D'Orbigny, 1826

Spiroloculina antillarum d'Orbigny, 1839 (Plate 3, Fig. 7)

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

Diagnosis. Test elongate, elliptical; chambers nearly circular in cross section, surface ornamented by numerous longitudinal costae, both ends of last-formed chamber projecting; sutures distinct; apertural end projecting, forming cylindrical neck, with slight lip, single tooth, sometimes bifid at tip.

Discussion. This species is relatively rare, occurring at only nine stations and always in low frequencies.

Spiroloculina arenata Cushman, 1921 (Plate 3, Fig. 8)

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

Diagnosis. Test compressed; chambers in single plane, each narrowing towards aperture, both ends of last-formed chamber projecting beyond ends of preceding chamber; sutures indistinct; wall agglutinated, principally of rather coarse sand grains from associated sediment; aperture round, on prominent neck.

Discussion. Spiroloculina arenata differs from other species of Spiroloculina in the area in having an agglutinated wall.

This species is relatively rare, occurring at only nine stations, always in very low frequencies.

Spiroloculina caduca Cushman, 1922 (Plate 3, Fig. 9)

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

Diagnosis. Test broadly elliptical, much compressed, apertural end extended; chambers of adult with sharp translucent keel, usually somewhat lobulated; sutures slightly depressed; surface of chambers with irregular raised costae, more or less oblique in position; wall very thin, brittle; aperture at end of cylindrical neck, rounded, with simple tooth; surface smooth, shining.

Discussion. This species is represented by a few specimens at station 17.

Spiroloculina communis Cushman and Todd, 1944 (Plate 3, Fig. 10)

Spiroloculina grateloupi d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 298.

Spiroloculina excavata Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 151, Pl. 9, Figs. 5, 6.

Spiroloculina communis Cushman and Todd, 1944, Cush. Lab. Foram. Res., Spec. Publ. No. 11, p. 63.

Diagnosis. Test elongate, broadest in center, tapering toward either end; chambers rapidly thickening as added, in end view periphery much the broadest portion of test, central portion deeply excavated; periphery of chambers in end-view convex, especially in central portion, edges broadly rounded; chambers evenly curved, final chamber somewhat projecting, both at base and lip, aperture itself rounded, with either single tooth with bifid tip, two projections forming concave extremity, or in some cases a pair of such bifid teeth opposite one another; surface of test dull, somewhat roughened.

Discussion. A single specimen of this species occurs at station 107.

Spiroloculina cf. S. costifera Cushman, 1917 (Plate 3, Fig. 11)

Spiroloculina costifera Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 34, Pl. 6, Figs. 1-3.

Diagnosis. Test large, planispiral, chambers few in number, early ones close coiled, later ones with tip of apertural end standing away from previous chamber, next chamber added often not filling gap thus made, in adult not reaching to base of preceding chamber; sutures indistinct; surface of test with few longitudinal coarse costae running whole length of chamber; apertural end of chamber produced to form elongated neck which has well-developed phialine lip, single tooth on inner margin of aperture which is flattened on inner side; wall smooth, except for costae, dull.

Discussion. This species is represented by a single specimen at station 16.

Spiroloculina ornata d'Orbigny, 1839

Spiroloculina ornata d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 167, Pl. 12, Fig. 7.

Diagnosis. Test elongate, compressed, biconcave in side view; chambers in single plane, both ends projecting beyond ends of preceding chambers, apertural end extends considerable distance beyond rest of test, last-formed chamber ornamented with secondary costae; wall smooth; aperture quadrangular, on end of very prominent neck, with simple tooth.

Discussion. This species is rare, single specimens occurring at stations 35, 38 and 78.

Spiroloculina planulata (Lamarck), 1805 (Plate 3, Fig. 12)

Miliolites planulata Lamarck, 1805, Ann. Mus., v. 5, p. 352, no. 4.

Spiroloculina planulata Macdonald, 1857, Ann. Mag. Nat. Hist., ser. 2, v. 20, p. 153, Pl. 6, Fig. 28.

Diagnosis. Test irregularly elliptical, periphery concave; apertural end very slightly projecting; chambers in single plane; surface matte; aperture with slight lip, elongate tooth, slightly bifid at tip.

Discussion. The spiroloculine nature of the few specimens present in this area can be seen only by wetting the tests. It is a rare species, single specimens occurring at stations 78, 95, 96 and 106.

Spiroloculina rotunda d'Orbigny, 1826 (Plate 3, Fig. 13)

Frumentaria sigma Soldani, 1789, Testaceographiae etc., Siena, Italy, 4, p. 229, tab. 154, Figs. hh, ii.

Spiroloculina rotunda d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 299.

Diagnosis. Test large, nearly circular in outline, chambers in single plane, periphery of chambers rounded, basal end very slightly projecting; sutures distinct; wall smooth; aperture with lip, elongate tooth, slightly bifid at tip.

Discussion. This species is rare, occurring in low frequencies at stations 2, 3 and 4, which are located between the reef track and the Florida Keys. No specimens occur within Florida Bay proper.

Spiroloculina soldanii Fornasini, 1886 (Plate 4, Fig. 1)

Spiroloculina soldanii Fornasini, 1886, Boll. Soc. geol. Ital., vol. 5, p. 25.

Diagnosis. Test large, about one and one-half times as long as broad, thick, strongly concave, periphery flat or slightly concave, sharply angled, limbate at margins; chambers numerous, strongly projecting beyond neck of previous chamber at base, extending into prominent, slightly recurved neck at apertural end; sutures depressed; wall covered with minute, longitudinal, incised lines parallel to periphery; aperture quadranglular, broadened at outer end, with long bifid tooth.

Discussion. Although there is no record of Spiroloculina soldanii from this area, I have tentatively placed the single specimen from station 1 in this species for it closely resembles comparative specimens from the USNM collections.

SUBFAMILY NODOBACULARIINAE Cushman, 1927

GENUS NODOBACULARIELLA Cushman and Hanzawa, 1937

Nodobaculariella cassis d'Orbigny, 1839 (Plate 4, Fig. 2)

Vertebralina cassis d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 51, Pl. 7, Figs. 14, 15.

Diagnosis. Test compressed, early portion close-coiled, somewhat involute, uncoiled portion usually consisting of one or two chambers; periphery of each chamber with broad, thin keel; surface ornamented with numerous ornamented, somewhat oblique costae; aperture elongate, with everted lip.

Discussion. All specimens of this species were found with only one chamber in the uncoiled portion of the tests. Superfically they resemble specimens of Articulina mucronata, having only single chambers in their uncoiled portions, but differ from them in having a planispiral instead of triloculine early portion and in possessing a thin keel on the periphery of each chamber.

This species has rare to common occurrences at only six stations.

FAMILY MILIOLIDAE Ehrenberg, 1839

SUBFAMILY QUINQUELOCULININAE Cushman, 1917

GENUS QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina agglutinans d'Orbigny, 1839 (Plate 4, Figs. 3-5)

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

Diagnosis. Test large, longer than broad; chambers inflated; sutures indistinct; wall agglutinated, principally of coarse sand grains from associated sediment, imbedded in calcareous cement, whole surface having very rough appearance; last-formed chamber extended at apertural end into slight neck; aperture subcylindrical, with variable tooth structure.

Discussion. This species exhibits a wide range of variability in tooth structure and in the degree of roundness of the chambers. Specimens occur with single, undivided teeth, with or without thickening at the tip; with single, bifid teeth; and with two subequal teeth extending in toward the center of the aperture from opposite sides. In specimens with two subequal teeth, the main tooth may or may not become bifid at the tip. Specimens may have rounded to subangular chambers.

Quinqueloculina agglutinans differs from Quinqueloculina sabulosa in being much larger and in exhibiting a wide range of variability in tooth structure, and from Quinqueloculina bidentata in having a more rounded periphery and a more pronounced neck, although overlap between the two species appears to exist.

This species is common in the area, occurring in frequencies from rare to abundant at 78 stations. Frequencies are highest at those stations within Florida Bay proper, with the coarsest sediment suggesting sorting by wave action, it is however, absent from stations which become quite brackish during the rainy season as well as from the deepest stations.

Quinqueloculina antillarum d'Orbigny, 1839

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

Diagnosis. Test ovate to oblong, compressed, longer than broad, margins irregularly carinate; chambers triangular in cross section, compressed, arcuate; aperture oblong, with single, elongate, bifurcate tooth.

Discussion. This species is rare, occurring at only three stations, 4, 24 and 26, in very low frequencies.

Quinqueloculina bicarinata d'Orbigny, 1826 (Plate 4, Figs. 6-8)

Quinqueloculina bicarinata d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 302.

Diagnosis. Test ovate, anterior truncate, posterior obtuse, triangular in transverse section; sutures distinct, depressed; chambers round, periphery with double carinae; wall smooth, polished; aperture small, oval, with simple tooth.

Discussion. This species is similar to some smaller specimens of Quinqueloculina lamarckiana, but differs from it in possessing double carinae and in having less angular chambers.

This species has common occurrences at only two stations, 95 and 96.

Quinqueloculina bicostata d'Orbigny, 1839 (Plate 4, Figs. 9-11)

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

Diagnosis. Test nearly as broad as long, chambers broad, sutures usually rather indistinct, peripheral margin in earlier chambers sharply carinate, in adult specimens bicostate, wall otherwise smooth, concave adjacent to periphery, inflated near inner margin, in end-view decidedly angled, apertural end slightly, if at all, produced; aperture nearly circular, with smooth, slightly raised lip, tooth simple, not prominent.

Discussion. This species is common at ten stations, all located in the somewhat deeper waters of the Gulf of Mexico immediately adjacent to the western margin of Florida Bay. It is completely absent from all stations in the relatively shallower waters of the Bay itself.

Quinqueloculina bidentata d'Orbigny, 1839 (Plate 4; Fig. 12; Plate 5, Figs. 1-2)

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

Diagnosis. Test large, longer than broad, periphery squarely truncate; chambers angular, almost square; sutures indistinct; wall agglutinated, principally of coarse, calcareous sand grains from associated sediment, imbedded in calcareous cement, whole surface has rough appearance; aperture circular, usually with thin, single tooth with broad bifid tip.

Discussion. Some specimens of this species show a slight development of a secondary tooth opposite the main tooth. It is similar to some specimens of Quinqueloculina agglutinans, but differs in having a more squarely truncate periphery, in possessing almost no neck and in exhibiting little variation in tooth structure. All ranges of variation appear to exist between the two species, from the squarely truncate forms on one end of the range to the completely rounded forms on the other.

Quinqueloculina bidentata occurs at 36 stations in low to medium frequencies. It, like Quinqueloculina agglutinans, appears to be limited to those stations in Florida Bay with the coarsest sediment, and it also is absent from the stations showing the greatest range in salinity and from the stations located in the deepest water in the area.

Quinqueloculina bosciana d'Orbigny, 1839 (Plate 5, Figs. 3-5)

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

Diagnosis. Test small, very elongate; chambers rounded, inflated, last-formed chamber extending over preceding chamber on both sides; sutures distinct; wall calcareous, smooth, translucent; aperture open, at end of last-formed chamber, with simple tooth.

Discussion. This species is similar to Quinqueloculina laevigata, but differs from it in being non-costate and in having a simple, non-bifid tooth.

Quinqueloculina bosciana is the second most abundant species of the entire fauna, occurring at a total of 75 stations, usually in medium to high frequencies. It is almost entirely limited to the stations within Florida Bay proper, with the highest frequencies occurring at those stations with the finer sediment.

Quinqueloculina cf. Q. bradyana Cushman, 1917 (Plate 5, Figs. 6-8)

Miliolina undosa Brady (not Quinqueloculina undosa Karrer), 1884, Rep. Voy. Challenger, Zool., v. 9, p. 176, Pl. 6, Figs. 6-8.

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

Diagnosis. Test stout, usually slightly longer than broad; chambers angular, more or less plicated laterally, outer peripheral angle usually sinuous, early ones very prominently so; surface often with finely agglutinated material; apertural end rarely extended to any considerable length; aperture usually narrow, with simple tooth.

Discussion. This species is rare, being represented by only a few specimens at station 107.

Quinqueloculina candeiana d'Orbigny, 1839

Quinqueloculina candeiana d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 170, Pl. 12, Figs. 24-26.

Diagnosis. Test nearly twice as long as broad; chambers triangular in transverse section, angles subacute, last-formed chamber extended at apertural end forming prominent neck; sutures distinct; wall calcareous, smooth; aperture circular, comparatively small, at end of projecting neck, with simple tooth.

Discussion. This species is rare, occurring at only five stations in very low frequencies.

Quinqueloculina collumnosa Cushman, 1922 (Plate 5, Figs. 9-11)

Miliolina cuvieriana Heron-Allen and Earland (not d'Orbigny), 1915, Trans. Zool. Soc. London, v. 20, p. 571, Pl. 4, Figs. 33-36.

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

Diagnosis. Test slightly longer than broad; chambers somewhat indistinct, periphery angled, projecting, last-formed chamber extending beyond outline of test at both ends, somewhat undulate; wall smooth, dull; apertural end much contracted, extended to form narrow, cylindrical neck, with small rounded aperture with indistinct lip.

Discussion. This species is represented by a single specimen at station 96.

Quinqueloculina crassa var. subcuneata Cushman, 1921 (Plate 5, Figs. 12-14)

Miliolina crassa Heron-Allen and Earland (part) (not d'Orbigny), 1915, Trans. Zool. Soc. London, v. 20, p. 572, Pl. 42, Fig. 41.

Quinqueloculina crassa var. subcuneata Cushman, 1921, Bull. 100, U.S. Nat. Mus., v. 4, p. 423, Pl. 89, Fig. 4.

Diagnosis. Test somewhat longer than broad; chambers wedge-shaped, sharp at peripheral edges, covered with irregular costae, triangular in transverse section; sutures somewhat indistinct; wall calcareous, having rough appearance; aperture circular, with simple tooth.

Discussion. This species is represented by a single specimen at station 93.

Quinqueloculina dilatata d'Orbigny, 1839

Quinqueloculina dilatata d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 192, Pl. 11, Figs. 28-30.

Diagnosis. Test broader than long; in adult last-formed chamber fails to make complete coil, chambers rounded; sutures indistinct; wall calcareous, glossy; aperture elongate, oval, offset to one side, with tooth some distance back from aperture.

Discussion. This species exhibits variability in its overall test shape, ranging from nearly round to broader than long. In most specimens it is impossible to see the tooth without sectioning. The quinqueloculine chamber pattern, in most cases, can be seen only on wetting the specimen or by sectioning.

Quinqueloculina dilatata is relatively rare in the area, occurring at only four stations in very low frequencies.

Quinqueloculina horrida Cushman, 1947 (Plate 6, Figs. 1-3)

Quinqueloculina horrida Cushman, 1947, Contr. Cush. Lab. Foram. Res., v. 23, pt. 4, p. 88, Pl. 19, Fig. 1.

Diagnosis. Test nearly twice as long as broad; chambers rounded, last-formed chamber extended at apertural end into fairly long, cylindrical neck; sutures indistinct; wall coarsely arenaceous, principally of rather coarse sand grains from associated sediment, imbedded in calcareous cement; aperture round, at end of cylindrical neck, with slender, bifid tooth.

Discussion. The tooth structure and cylindrical neck are not preserved in any of the specimens observed, the neck always being partially broken. This species is rare, occurring as single specimens at only six stations.

Quinqueloculina laevigata d'Orbigny, 1826 (Plate 6, Figs. 4-6)

Quinqueloculina laevigata d'Orbigny, 1826, Ann. Soc. Nat., v. 7, p. 301, no. 6.

Diagnosis. Test elongate, much longer than broad, compressed laterally; chambers rounded, surface covered with longitudinal costae, which may not be immediately apparent; sutures distinct; wall calcareous; aperture round, usually at end of slight neck, with bifid tooth.

Discussion. The longitudinal costae which cover the surface of the chambers vary from being very faintly visible to strongly developed. When the costae are hard to distinguish Quinqueloculina laevigata has a strong resemblance to Quinqueloculina bosciana, but differs from it in possessing a bifid tooth. It also differs from Quinqueloculina poeyana in possessing a true bifid tooth, and in being more elongate.

This species is widespread, occurring at 60 stations usually in medium frequencies. It is another species that seems to be limited mainly to the shallow Florida Bay waters.

Quinqueloculina lamarckiana d'Orbigny, 1839 (Plate 6, Figs. 7-9)

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

Diagnosis. Test nearly as long as broad; chambers subacute, usually triangular in transverse section, angles of chambers almost resemble carinae, apertural end of last-formed chamber slightly extended; sutures distinct; wall calcareous, smooth, glossy; aperture round, with narrow, elongate tooth.

Discussion. This species exhibits considerable variability in the relative sizes of length to width, and in the acuteness of the chamber angles. It differs from Quinqueloculina candeiana in being almost as long as broad, in having more acute angles to the chambers and in having a much less pronounced neck, or no neck at all.

This is one of the more widespread species of the entire fauna, occurring at 86 stations in high enough frequencies to make it the sixth most abundant. It is conspicuously absent from the stations in the northern part of Florida Bay bordering the mainland of the Florida Peninsula. These stations are generally located in restricted small bays which are subject to large amounts of runoff during the rainy season, suggesting that Quinqueloculina lamarckiana cannot withstand the lowered salinities prevailing there at those times.

Quinqueloculina parkeri var. occidentalis Cushman, 1921 (Plate 6, Figs. 10-12)

Quinqueloculina parkeri (Brady), var. occidentalis Cushman, 1921, Proc. U.S. Nat. Mus., v. 59, p. 69.

Diagnosis. Test longer than broad; chambers rounded, irregular, covered with fine transverse or slightly oblique ridges or crenulations, last-formed chamber extended to form a neck; wall calcareous; aperture oval, with single tooth.

Discussion. This species is represented by single specimens at stations 4 and 90.

Quinqueloculina poeyana d'Orbigny, 1839 (Plate 6, Figs. 13-15)

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

Diagnosis. Test longer than braod; chambers rounded; surface ornamented by numerous longitudinal costae running parallel to edges of chambers; sutures distinct; wall calcareous; aperture circular, with single, narrow tooth, sometimes slightly bifid at tip.

Discussion. This species varies in its relative size of length to width. Typically, specimens are much longer than broad, but others are wide enough to overlap morphologically with Quinqueloculina tenagos. The tooth structure is usually consistent, but a slight thickening and even a slightly bifid condition at the tip is present is some specimens.

Quinqueloculina poeyana differs from Quinqueloculina tenagos in having a greater length than width, from Quinqueloculina subpoeyana in having a shorter neck and regular costae, and from Quinqueloculina laevigata in being less elongate, less compressed and by not possessing a true bifid tooth. Morphologic overlap based on test shape appears to exist with Quinqueloculina tenagos and Quinqueloculina laevigata at the extreme range, and with Quinqueloculina poeyana in the median range. Overlap based on the character of the costae and the size of the neck appears to exist between Quinqueloculina poeyana and Quinqueloculina subpoeyana. Considering the generally wide morphologic variation exhibited by members of the Miliolidae, it is doubtful if all of the above are valid species.

Quinqueloculina poeyana is the third most abundant speices in the fauna and is quite widespread, occurring at 66 stations within the general confines of Florida Bay. It is most abundant at those stations with the finer-grained sediment, and it too is absent from those stations which experience the lowest salinities.

Quinqueloculina polygona d'Orbigny, 1839 (Plate 7, Figs. 1-3)

Quinqueloculina polygona d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 198, Pl. 12, Figs. 21-23.

Diagnosis. Test longer than broad; chamber angles acute, with projecting carina at either angle, polygonal in transverse section, last-formed chamber extended at apertural end into prominent neck; sutures distinct; wall calcareous, smooth; aperture circular, with single, undivided or bifid tooth.

Discussion. This species varies in tooth structure, relative size of length to width and in the size of the neck. Tooth structure ranges from single, non-bifid to true bifid teeth. Most specimens have tests which are elongate, much longer than broad, but some become less elongate, although never to the point where they are as broad as long. The size of the neck varies from specimens with long protruding necks to those with short slightly protruding necks.

This is one of the more abundant species of the fauna, occurring at 42 stations, usually in medium frequencies. It is another species which appears to be mainly restricted to the shallow waters of Florida Bay.

Quinqueloculina sabulosa Cushman, 1947 (Plate 7, Figs. 4-6)

Quinqueloculina sabulosa Cushman, 1947, Contr. Cush. Lab. Foram. Res., v. 23, pt. 4, p. 87, Pl. 18, Fig. 22.

Diagnosis. Test small, nearly twice as long as broad; chambers rounded; sutures indistinct; wall coarsely arenaceous, principally of sand grains from associated sediment, imbedded in calcareous cement, whole surface has rough appearance; aperture circular, at end of short neck, with short, broad tooth.

Discussion. This species somewhat resembles some specimens of Quinqueloculina agglutinans having single, non-bifid teeth, but it is very much smaller. It occurs at 38 stations in low to medium frequencies. Its distribution appears to be controlled by the grain size of the sediment, occurring only at those stations with the finer-grained sediment.

Quinqueloculina seminulum (Linnaeus), 1767 (Plate 7, Figs. 7-9)

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

Quinqueloculina seminulum d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 503.

Diagnosis. Test longer than broad; chambers inflated, distinct, uniform; wall calcareous, smooth, glossy, polished; aperture large, oval, with simple tooth.

Discussion. Many different specimens from many parts of the world have been placed in this controversial species by various authors. In this study only those specimens are included in this species which closely coincide with the described apertural characterisitics.

This species occurs at 50 stations in low to medium frequencies. It appears to be another typical, shallow-water bay species.

Quinqueloculina sp. (Plate 8, Figs. 3-5)

Only two specimens of this species were found at station 107. It is similar in general shape to Quinqueloculina polygona except that the chambers are rounded instead of polygonal.

Quinqueloculina subpoeyana Cushman, 1922 (Plate 7, Figs. 10-12)

Quinqueloculina subpoeyana Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 66.

Diagnosis. Test much longer than broad; chambers rounded, surface ornamented by numerous, irregular costae running at angles to chamber edges, last-formed chamber extended at apertural end into protruding neck; sutures distinct; wall calcareous; aperture circular, at end of protruding neck, with simple tooth.

Discussion. This species varies in the size of the neck and in the angularity of the costae. Most specimens placed in this species have protruding necks, but the degree of protrusion ranges from very prominent to very slight. The angles at which the costae run to the chamber edges range from sub-parallel to very acute.

Quinqueloculina subpoeyana differs from Quinqueloculina poeyana only in having a more prominent neck and in having costae which are irregular and run at an angle to the chamber edges instead of parallel to them. It may be that Quinqueloculina subpoeyana is merely an extreme variant of Quinqueloculina poeyana.

This species occurs at 12 stations, usually in low frequencies.

Quinqueloculina tenagos Parker, 1962 (Plate 7, Figs. 13-15)

Quinqueloculina costata d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 135.

Quinqueloculina rhodiensis Parker, new name, Parker, Phleger and Pierson, 1953, Cush. Found. Foram. Res., Spec. Publ. no. 2, p. 12, Pl. 2, Figs. 15-17.

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

Diagnosis. Test nearly as broad as long, chambers rounded, surface ornamented by numerous, regular, longitudinal costae; sutures distinct; wall calcareous, aperture circular, with single, narrow tooth.

Discussion. The only character in which this species appears to differ from Quinqueloculina poeyana is in the relative size of length to breadth. Only species with tests nearly as broad as long are placed in the species Quinqueloculina tenagos.

This species occurs at eight stations in low to medium frequencies.

Quinqueloculina tricarinata d'Orbigny, 1839 (Plate 8, Figs. 1-2)

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

Diagnosis. Test large, nearly twice as long as broad, divided into irregular areas by oblique transverse costae; last-formed chamber extends beyond test at either end; sutures indistinct; wall calcareous, irregular areas giving surface corrugated appearance; aperture circular, at end of narrow, cylindrical neck.

Discussion. This species occurs at seven stations in low to medium frequencies.

Quinqueloculina vulgaris d'Orbigny, 1826

Quinqueloculina vulgaris d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 302, no. 33.

Diagnosis. Test short, stout, nearly as broad as long; orbicular in front view; chambers roughly triangular in transverse section, periphery bluntly angled, sides straight or slightly convex; sutures distinct; wall smooth; aperture elongate, narrow, with tooth slightly bifid at tip.

Discussion. This species is represented by two specimens at station 95 and by one at station 96.

Quinqueloculina wiesneri Parr, 1950

Quinqueloculina anguina Terquim var. wiesneri Parr, 1950, B.A.N.Z. Ant. Res. Exped., 1929-1931 Repts., ser. B, v. 5, pt. 6, p. 290, Pl. 6, Figs. 9, 10.

Diagnosis. Test twice as long as broad; chambers rounded, inflated; sutures distinct; wall calcareous, smooth, glossy; aperture opening at end of last-formed chamber, without neck.

Discussion. This species occurs at nine stations, usually in very low frequencies.

GENUS CRUCILOCULINA d'Orbigny, 1839

Cruciloculina triangularis d'Orbigny, 1839 (Plate 8, Figs. 6, 7)

Cruciloculina triangularis d'Orbigny, 1839, Voy. dans. l'Amer. Merid., Foraminiferes, p. 72.

Diagnosis. Test free, triloculine in chamber development, triangular in cross section, with sides equal in breadth, flat to very slightly convex, angles acute; chambers increasing regularly in size with final chamber only moderately overlapping earlier chambers; sutures distinct, very slightly incised; wall calcareous, imperforate, surface smooth; aperture typically cruciform, with extremities tending to become dendritic in larger specimens, bordered with narrow lip.

Discussion. This species is represented by a single specimen at station 103.

GENUS MASSILINA Schlumberger, 1893

Massilina protea Parker, 1953 (Plate 8, Figs. 8, 9)

Massilina protea Parker, 1953, Cush. Found. Foram. Res., Spec. Publ. No. 2, p. 10, Pl. 2, Figs. 1-4, text Fig. 2.

Diagnosis. Test somewhat longer than broad, compressed, with rounded periphery; chambers few in number, not always half coil in length, exposing three to four chambers per side; sutures depressed, often indistinct, especially in central portion; wall thick, variably costate, costae low, running parallel to periphery, but not necessarily continuously; aperture almost circular, with thick, polished lip, short bifid tooth which varies greatly in breadth.

Discussion. This species occurs at stations 16, 26 and 29 in very low frequencies.

Massilina secans d'Orbigny, 1826

Quinqueloculina secans d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 303, no. 43, Modeles no. 96.

Miliolina secans Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 167, Pl. 6, Figs. 1, 2.

Massilina secans Schlumberger, 1893, Mem. Soc. Zool. France, v. 6, p. 218, Pl. 4, Figs. 82, 83.

Diagnosis. Test in early stages quinqueloculine, later with chambers added in one plane, rounded in side view, nearly as broad as long, narrow in end-view; periphery rounded; chambers distinct, usually four or five visible on each side; sutures distinct, depressed; wall smooth; aperture elongate.

Discussion. Some specimens of this species may slightly resemble the more compressed forms of Miliolinella circularis in side-view, but inspection of the number of chambers visible facilitates identification, and the apertures are completely different, elongate in Massilina secans and crescentiform with a broad tooth in Miliolinella circularis.

This species occurs at 14 stations in low to medium frequencies.

GENUS PYRGO Defrance, 1824

Pyrgo comata (Brady), 1884 (Plate 8, Fig. 10)

Biloculina comata Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 144, Pl. 3, Figs. 9a, b.

Pyrgo comata Cushman, 1929, Bull. 104, U.S. Nat. Mus., pt. 6, p. 73.

Diagnosis. Test subglobular, chambers very much inflated, subcircular in end-view; suture distinct, incised; wall ornamented with numerous, fine, longitudinal costae; aperture elongate, with tooth often with wing-like extensions at ends.

Discussion. This species occurs at only two stations. It is represented by a single specimen at station 4, but at station 1 it is quite common. A single occurrence could be explained by transport by storms, while the common occurrence at station 1, 587 m., suggests that this is a true depth-dependent species.

Pyrgo denticulata (Brady), 1884 (Plate 8, Fig. 11)

Biloculina ringens Lamarck, var. denticulata Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 143, Pl. 3, Figs. 4, 5.

Biloculina denticulata Cushman, 1917, Bull. 71, U.S. Nat. Mus., pt. 6, p. 80, Pl. 33, Fig. 1.

Pyrgo denticulata Cushman, 1929, Bull. 104, U.S. Nat. Mus., pt. 6, p. 80, Pl. 33, Fig. 1.

Diagnosis. Test elongate, roughly quadrangular in front-view, somewhat compressed in end-view, biconvex; apertural end broadly rounded,opposite end with series of short, irregular teeth; wall smooth, usually polished; aperture very broad, narrow, ends somewhat expanded, with long, narrow tooth, making inner border of aperture plate-like, somewhat raised above level of surface to which it is attached, as is whole border of aperture.

Discussion. This species occurs at eight stations in low frequencies. It appears to be limited to the waters adjacent to the lower keys.

Pyrgo elongata (d'Orbigny), 1826 (Plate 8, Fig. 12)

Biloculina elongata d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 298, No. 4.

Pyrgo elongata Cushman, 1929, Bull. 104, U.S. Nat. Mus., pt. 6, p. 70, Pl. 19, Figs. 2, 3.

Diagnosis. Test elongate, somewhat pyriform, tapering gradually toward apertural end, rounded at opposite end, subelliptical in end-view, periphery rounded; suture distinct, depressed; wall smooth; aperture generally broadly elliptical with small flattened tooth partially filling opening.

Discussion. This species occurs only at station 4 in low frequency.

Pyrgo fornasinii Chapman and Parr, 1935 (Plate 8, Fig. 13)

Biloculina ringens Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 142, Pl. 2, Fig. 7.

Biloculina bradyi Schlumberger (not Fornasini), 1891, Mem. Soc. Zool. France, v. 4, p. 170, Pl. 10, Figs. 63-71.

Pyrgo fornasinii Chapman and Parr, 1935, Journ. Roy. Soc. W. Australia, v. 21, p. 5.

Diagnosis. Test in front-view nearly circular, ends slightly truncate, in end-view ellipsoidal, periphery angled, somewhat produced, margin subcarinate; wall smooth; aperture very broad in end-view, with tooth curved, concave in middle, ends extended, aperture curving in circle about them.

Discussion. This species is represented by single specimens at stations 1 and 4.

Pyrgo murrhina (Schwager), 1866 (Plate 8, Fig. 14)

Biloculina murrhina Schwager, 1866, Novara Exped., Geol., v. 2, p. 203, Pl. 4, Figs. 15a-c.

Biloculina depressa d'Orbigny, var. murrhyna Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 146, Pl. 2, Figs. 10, 11.

Pyrgo murrhina (Schwager) Cushman, 1929, Bull. 104, U.S. Nat. Mus., pt. 6, p. 71, Pl. 19, Figs. 6, 7.

Diagnosis. Test in front-view in young specimens nearly circular, in adult somewhat longer than broad, in end-view ellipsoidal, with borders extended, carinate, carinae interrupted at point opposite aperture leaving sinus, deep, often with long spine at each angle in young specimens; in adults sinus less deep, spines usually reduced or wanting; wall smooth; aperture in young with neck not exceeding periphery of test, in adults with prominently exserted tubular neck with bifid tooth partially filling circular opening.

Discussion. This species occurs at six stations in very low frequencies. It is absent from Florida Bay, being found in the somewhat deeper waters between the keys and the reef, and in the adjacent Gulf of Mexico.

Pyrgo subsphaerica (d'Orbigny), 1839 (Plate 8, Fig. 15)

Biloculina subsphaerica d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 162, Pl. 18, Figs. 25-27.

Pyrgo subsphaerica Cushman, 1929, Bull. 104, U.S. Nat. Mus., pt. 6, p. 68, Pl. 18, Figs. 1, 2.

Diagnosis. Test small, rotund, slightly longer than broad, somewhat broader than thick; chambers rounded, inflated; sutures distinct, depressed, in side view sinuous line concave toward preceding chamber at opposite end; wall smooth, polished; aperture broadly oval with somewhat flattened tooth, with short lateral extensions at tip only partially filling aperture.

Discussion. Young specimens of Pyrgo subsphaerica are triloculine in chamber arrangement with three chambers always visible on the exterior. Overall test shape must be used for identification to prevent placing young specimens in the genus Triloculina.

This species occurs at 41 stations in low to medium frequencies. It is generally restricted to the shallow waters of Florida Bay.

GENUS SIGMOILINA Schlumberger, 1887

Sigmoilina distorta Phleger and Parker, 1951

Sigmoilina distorta Phleger and Parker, 1951, Mem. Geol. Soc. America, v. 46, pt. 2, p. 8, Pl. 4, Figs. 3-5.

Diagnosis. Test small, compressed, nearly twice as long as broad, sigmoid character; wall smooth, with finely pitted surface; aperture round, on more or less well developed neck.

Discussion. This species has common occurrences at stations 35 and 37.

Sigmoilina schlumbergeri Silvestri, 1904 (Plate 9, Figs. 1-2)

Sigmoilina schlumbergeri Silvestri, 1904, Mem. Pont. Accad, Nuovi, Lincei, v. 22, p. 267.

Diagnosis. Test longer than broad, with distinct sigmoid character; sutures distinct, sometimes not visible; wall agglutinated, principally of sand grains from associated sediment, whole surface has rough appearance; aperture round, on short neck.

Discussion. This species occurs at stations 31, 93 and 96 in very low frequencies.

GENUS TRILOCULINA d'Orbigny, 1826

Triloculina bassensis Parr, 1945 (Plate 9, Figs. 2-8)

Triloculina bassensis Parr, 1945, Roy. Soc. Victoria, Proc., Melbourn, v. 56, pt. 2, p. 198.

Diagnosis. Test longer than broad; chambers angular, typically quadrate, surface may be covered with short, delicate ridges which give matte effect, apertural end of last-formed chamber extended into neck; sutures distinct; wall porcelaneous; aperture subquadrate, with long tooth, which may or may not be bifid.

Discussion. This species varies in tooth structure, specimens occur with non-bifid teeth which nearly fill the aperture while others with bifid teeth, as well as some with non-bifid teeth, only partially fill the aperture. The aperture itself varies from subquadrate to elongate and compressed.

This species occurs at 44 stations in low to medium frequencies. It appears to be another species restricted to Florida Bay, and does not occur at those stations with the lowest salinities.

Triloculina bermudezi Acosta, 1940 (Plate 9, Figs. 9-11)

Triloculina bermudezi Acosta, 1940, Soc. Cubana Hist. Nat. Mem., v. 14, p. 37, Pl. 4, Figs. 1-5.

Diagnosis. Test elongate oval; chambers rounded, inflated, tapering slightly towards apertural end; sutures distinct; wall calcareous, smooth, translucent; aperture very narrow, laterally compressed slit, almost completely filled with narrow, elongate tooth.

Discussion. This species is the fifth most abundant in the fauna. It occurs at 54 stations, usually in medium frequencies. It is another species that appears to be restricted to the shallow bay waters, and is also absent from those stations which have greatly reduced salinities during the rainy season. It is most abundant at stations with the finer-grained sediment, again suggesting sorting by current and wave action.

Triloculina bicarinata d'Orbigny, 1839 (Plate 9, Figs. 12-13); (Plate 10, Fig. 1)

Triloculina bicarinata d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 158, Pl. 10, Figs. 18-20.

Diagnosis. Test longer than broad; typically with chambers with truncate periphery with double keels, angles somewhat extended; sutures distinct, somewhat depressed; surface ornamented by rectangular reticulations both on sides and outer angles; aperture elongate with definite thin lip, slightly everted, with elongate, narrow tooth extending above outline of aperture, may or may not be bifid.

Discussion. This species differs from Triloculina carinata in having a truncate periphery with double keels instead of a carinate periphery and in having rectangular rather than rounded or elliptical reticulations. It is a rare species, occurring at only eleven stations, usually being represented by single specimens.

Triloculina carinata d'Orbigny, 1839 (Plate 10, Figs. 2-4)

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

Diagnosis. Test longer than broad; typically with periphery of three chambers carinate, surface ornamented with small, rounded pits in regular series covering entire surface, except around aperture; sutures distinct, somewhat depressed; aperture elongate, narrow, with distinct everted lip, tooth very long, narrow, may or may not be bifid, projecting somewhat above apertural opening.

Discussion. Triloculina carinata is closely related to Triloculina bicarinata, the only difference being that it has a carinate instead of truncate periphery, and has regular rounded pits instead of rectangular reticulations. It is not an abundant species, exhibiting rare to common occurrences at 19 stations. There seems to be no definite pattern to its distribution.

Triloculina fitterei var. meningoi Acosta, 1940 (Plate 10, Figs. 5-7)

Triloculina fitterei Acosta var. meningoi Acosta, 1940, Torreia, Habana, Cuba, no. 3, p. 25-26, Pl. 4, Figs. 1-5.

Diagnosis. Test elongate; chambers twisted, rounded, tapering toward apertural end; sutures distinct; wall calcareous, surface ornamented with strong longitudinal costae; aperture elongate oval, without dentition.

Discussion. This species occurs at 38 stations, usually in low frequencies. It appears to be restricted to the shallow depths of Florida Bay proper and is not found in the more restricted parts of the bay immediately adjacent to the Florida mainland.

Triloculina gracilis d'Orbigny, 1839

Triloculina gracilis d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 159, Pl. 11, Figs. 10-12.

Diagnosis. Test elongate, slender, small; last-formed chamber extended at apertural end into cylindrical neck, outer end enlarged, with phialine lip, sutures very slightly depressed; surface smooth or very finely striate; aperture circular, with slight tooth.

Discussion. This species is represented by only a single specimen at station 18.

Triloculina linneiana d'Orbigny, 1839 (Plate 10, Figs. 8-10)

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

Diagnosis. Test elongate, typically with three visible chambers in adult, periphery rounded, large, tapering towards either end; sutures somewhat depressed; surface ornamented by few very prominent raised ridges, with deep concave depressions between; aperture rounded, with large bifid tooth projecting beyond outline of test.

Discussion. Triloculina linneiana shows little variation other than size. It resembles

Triloculina planciana, but is much larger and has very prominent ridges in contrast to the fine-lined ornamentation of the latter.

This species is apparently randomly distributed and fairly widespread with rare to common occurrences at 42 stations.

Triloculina linneiana var. comis Bandy, 1956 (Plate 10, Figs. 11-12; Plate 11, Fig. 1)

Triloculina linneiana d'Orbigny var. comis Bandy, 1956, Geol. Surv. Prof. Paper 274G, p. 198, Pl. 29, Fig. 12.

Discussion. This variety differs from the typical form in possessing numerous longitudinal costae, in having the apertural end extended into a cylindrical neck and in having a round aperture with a very small bifid tooth.

This species is present at only five stations at very low frequencies.

Triloculina oblonga (Montague), 1803 (Plate 11, Figs. 2-4)

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

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

Diagnosis. Test elongate, adult with three chambers visible, last-formed chamber broadest near initial end, longer than preceding ones; triangular in end-view, sides broadly curved, angles rounded, chambers inflated; sutures distinct, depressed; wall smooth, polished; aperture oval, with short tooth.

Discussion. This species occurs at 19 stations at low to medium frequencies. Its distribution seems to be limited to the stations with finer-grained sediments.

Triloculina planciana d'Orbigny, 1839 (Plate 11, Figs. 5-7)

Triloculina planciana d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 173, Pl. 9, Figs. 17-19.

Diagnosis. Test elongate; chambers distinct; sutures slightly, if at all, depressed; periphery broadly rounded; wall ornamented by numerous short, incised lines, surface polished; aperture rounded, with bifid tooth projecting slightly above apertural opening.

Discussion. This species somewhat resembles Triloculina linneiana, but differs from it in being smaller and in having fine lines for ornamentation as opposed to the prominent ridges of the latter.

Triloculina planciana is fairly widespread, occurring at 55 stations in low to moderate frequencies. It is absent from the more restricted areas of Florida Bay adjacent to the mainland, and also from those stations with the coarsest sediment. It has its greatest concentrations around the Key West area.

Triloculina rotunda d'Orbigny, 1826 (Plate 11, Figs. 8-10)

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

Diagnosis. Test somewhat longer than broad; chambers rotund, periphery broadly rounded; surface of test made up largely of two last-formed chambers; sutures very slightly depressed; apertural end somewhat contracted, with slightly thickened lip; wall smooth, glossy, often with transverse wrinkles; aperture rounded, with bifid tooth projecting somewhat above outline of aperture.

Discussion. This species occurs at 21 stations, usually in low frequencies. Its distribution seems to be limited to those stations with the coarsest sediment.

Triloculina sidebottomi (Martinotti), 1920 (Plate 11, Figs. 11-13)

Miliolina subrotunda Sidebottom (not Vermiculum subrotundum Montague), 1904, Manchester Lit. Phil. Soc., vol. 68, no. 5, p. 8, Pl. 3, Figs. 1-7.

Sigmoilina sidebottomi Martinotti, 1920, Att., Soc. Ital. Sci. Nat., vol. 59, Pl. 2, Fig. 29.

Triloculina sidebottomi Parker, Phleger and Pierson, 1953, Cush. Lab. Foram. Res., Spec. Publ. no. 2, p. 14, Pl. 2, Figs. 25-28.

Diagnosis. Test much broader than long, large; chambers inflated, with rounded periphery, surface of test largely composed of two last-formed chambers; sutures distinct; wall smooth, glossy; aperture round, with crescentiform tooth seeming to extend into aperture from lip.

Discussion. This is a rare species, occurring at only five stations in low frequencies.

Triloculina squamosa Terquem, 1878

Triloculina squamosa Terquem, 1878, Soc. Geol. France, Mem., ser. 3, tome 1, no. 3, p. 59, Pl. 5, Fig. 26.

Diagnosis. Test longer than broad; chambers rounded, inflated, triangular in transverse section; sutures indistinct; wall arenaceous, principally of sand grains from associated sediment, entire surface with rough appearance; aperture oval, with narrow, slender tooth, thickened at end.

Discussion. This is a rare species, occurring at only six stations as single specimens.

Triloculina tricarinata d'Orbigny, 1826 (Plate 12, Figs. 1, 2)

Triloculina tricarinata d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 299, no. 7.

Diagnosis. Test somewhat longer than broad, triangular in end-view, three chambers visible, angles of chambers sharply angled, often almost carinate, sides straight; sutures distinct; wall smooth, polished; aperture rounded, with narrow, bifid tooth.

Discussion. Triloculina tricarinata varies in degree of length to width proportions and in the sharpness of the chamber angles. Some specimens are nearly as wide as long, while others are much longer than wide. The sharpness of the chamber angles varies from sharply acute (some actually carinate), to subacute, to specimens with the margins of the chambers becoming somewhat rounded.

This species occurs at 38 stations, usually in low frequencies. It is another species absent from the more restricted areas of the bay, and it does not occur at the deeper stations.

Triloculina trigonula (Lamarck), 1804 (Plate 12, Figs. 3, 4)

Miliola trigonula Lamarck, 1804, Ann. Mus., vol. 5, p. 351, no. 3.

Miliolites trigonula Lamarck, 1807, Ann. Nat. Hist. Paris Mus., vol. 9, Pl. 17, Fig. 4.

Triloculina trigonula d'Orbigny, 1858, Ann. Sci. Nat., vol. 7, p. 299, no. 1, Pl. 16, Figs. 5-9.

Diagnosis. Test somewhat longer than broad, periphery broadly convex, triangular in end-view; three chambers visible, angles rounded, sides convex; sutures distinct; wall smooth, polished; aperture round, with bifid tooth.

Discussion. Triloculina trigonula exhibits a wide range of variation in chamber form. Some specimens have chambers with subacute angles, while others have broadly rounded chambers. One specimen was found with a hood growing over the aperture.

This is a widespread species, occurring at 75 stations, usually in medium frequencies. It is absent only from the deeper stations and from the more restricted areas of the bay.

SUBFAMILY MILIOLINELLINAE Vella, 1957

GENUS MILIOLINELLA Wiesner, 1931

Miliolinella circularis (Bornemann), 1855 (Plate 12, Fig. 5)

Triloculina circularis Bornemann, 1855, Geol. Ges. Zeitschr., vol. 7, pt. 2, p. 349, Pl. 19, Figs. 4a-c.

Miliolina circularis Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 169, Pl. 4, Fig. 3, Pl. 5, Figs. 13-14.

Miliolinella circularis Asano, 1951, Ill. Cat. Jap. Tert. Smaller Foram., pt. 6, p. 9, Figs. 65-67.

Diagnosis. Test rounded, compressed, periphery rounded; three chambers making up visible portion of test rounded, inflated; last-formed chamber strongly embracing; sutures distinct, depressed; wall calcareous, smooth, polished; aperture narrow, crescentiform slit, with large, flattened, semicircular tooth, which in side-view appears to be in front of aperture.

Discussion. This species occurs at 53 stations, usually in medium frequencies, but occasionally in very high frequencies. It is absent from those stations immediately adjacent to the Florida mainland and from the stations with the deeper waters. It appears to be a truely diagnostic species for shallow, warm-water, calcareous areas.

Miliolinella fichteliana (d'Orbigny), 1839 (Plate 12, Fig. 6)

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

Diagnosis. Test subcircular in front-view, somewhat compressed; periphery rounded; chambers distinct; sutures slightly depressed; wall calcareous, ornamented by numerous longitudinal costae; aperture semicircular, with slight tooth somewhat in front of aperture.

Discussion. This species occurs at 17 stations in low to medium frequencies. Its distribution seems to be entirely random.

Miliolinella labiosa (d'Orbigny), 1839 (Plate 12, Fig. 7)

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

Miliolina labiosa Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 170, Pl. 6, Figs. 3-5.

Miliolinella labiosa Said, 1950, Contr. Cush. Found. Foram. Res., vol. 1, pts. 1 and 2, p. 5, Pl. 1, Fig. 10.

Diagnosis. Test much broader than long; surface largely composed of two last-formed chambers; chambers often somewhat irregular; periphery rounded; surface smooth, dull; aperture crescentiform, with triangular tooth placed somewhat in front of aperture.

Discussion. Miliolinella labiosa exhibits variation in overall test shape. Although always broader than long, the relative dimensions differ to some degree. Some specimens have a much greater breadth than length, but others exist in which these dimensions are almost equal. Those with nearly equal dimensions may represent young forms, and those which are broader than long may represent the adult stage, for there is a noticeable difference in the dimensions with corresponding difference in size. The two last-formed chambers are very irregular, in some specimens they are in an even plane, while in others they are at an angle to each other.

This species occurs at 37 stations, usually in low to medium frequencies. Its distribution seems to be random, but it is not found in the deeper water.

Miliolinella obliquinoda (Riccio), 1950

Triloculinella obliquinodus Riccio, 1950, Contr. Cush. Lab. Foram. Res., vol. 1, pts. 3, 4, p. 90, Pl. 15, Figs. 1, 7.

Diagnosis. Test elongate, ovate, slightly compressed; three chambers visible, inflated, last-formed chamber broadest at initial end, longer than preceding ones; peripheral edge broadly rounded in end-view; sutures distinct, arcuate, somewhat depressed; wall smooth; aperture oblique, with large, semicircular flap covering most of it.

Discussion. This species occurs at only one station in a low frequency.

Miliolinella suborbicularis (d'Orbigny), 1826 (Plate 12, Fig. 8)

Triloculina suborbicularis d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 300, no. 12.

Miliolina suborbicularis Sidebottomi, 1904, Mem. Proc. Manchester Lit. Philos. Soc., vol. 48, no. 5, p. 9.

Diagnosis. Test compressed laterally, often broader than long, peripheral margin rounded; sutures distinct, depressed; wall longitudinally costate, earliest chambers sometimes nearly smooth, sometimes only peripheral margins costate; aperture subcircular with flattened lip, tooth simple, semicircular, at some distance in front of aperture.

Discussion. This species occurs at nine stations, always in very low frequencies.

SUBFAMILY MILIOLINAE Ehrenberg, 1839

GENUS HAUERINA d'Orbigny, 1839

Hauerina bradyi Cushman, 1917 (Plate 12, Fig. 9)

Hauerina bradyi Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 62, Pl. 23, Fig. 2.

Diagnosis. Test much compressed, earliest coils milioline, later becoming spiroloculine, more than two chambers appear in last-formed coil, three usually making up whole coil; wall very finely striate-reticulate; periphery rounded or subcarinate; aperture seive-plate entire height of chamber, curved, with numerous pores.

Discussion. This species occurs at 19 sations, usually in very low frequencies. There seems to be no distinct pattern to its distribution.

Hauerina speciosa (Karrer), 1868 (Plate 12, Figs. 10, 11)

Spiroloculina speciosa Karrer, 1868, Akad. Wiss. Wien, vol. 58, p. 135, Pl. 1, Fig. 8.

Hauerina speciosa, (Said), 1949, Spec. Publ. 26, Cush. Lab. Foram. Res., p. 17, Pl. 2, Fig. 10.

Diagnosis. Test very small, strongly compressed, 8-15 visible chambers, rounded, often tapering at both ends; each chamber plicated, with plications of last-formed chambers somewhat raised above surface of test; wall of last-formed chambers somewhat corrugated; aperture elongate, sinuous on both sides, with long tooth.

Discussion. A single specimen of this species occurs at station 100.

GENUS SCHLUMBERGERINA Munier-Chalmas, 1882

Schlumbergerina alveoliniformis var. occidentalis, Cushman, 1929 (Plate 12, Fig. 12)

Miliolina alveoliniformis Brady, 1879, Quart. Journ. Micro. Sci., vol. 19, p. 268.

Quinqueloculina alveoliniformis Cushman, 1917, Bull. 71, U.S. Nat. Mus., pt. 6, p. 43.

Schlumbergerina aleveoliniformis (Brady), var. occidentalis Cushman, 1929, U.S. Nat. Mus., Bull. 104, pt. 6, p. 36, Pl. 7, Fig. 2.

Diagnosis. Test elongate, fusiform, composed of numerous chambers, long, fairly narrow, five normally visible from exterior; wall in young thin, porcelanous, in adults covered with sand grains from associated sediment; aperture composed of numerous pores, or radiate, typically cribrate.

Discussion. This species occurs at stations 2, 3, and 4, which are back reef areas.

SUBFAMILY TUBINELLINAE Rhumbler, 1906

GENUS ARTICULINA d'Orbigny, 1826

Articulina antillarum Cushman, 1922 (Plate 12, Fig. 13)

Articulina antillarum Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 71, Pl. 12, Fig. 5.

Diagnosis. Test elongate, early portion in microspheric form milioline, in megalospheric form Cyclogyra-like, remainder, larger portion of test made up of linear series of elongate chambers, gradually increasing in size towards apertural end; chambers truncate at distil end, then somewhat circular, without lip; surface of chambers with several rounded, longitudinal costae; aperture terminal, with everted lip.

Discussion. This species is represented by only a single specimen at station 107.

Articulina lineata Brady, 1884 (Plate 13, Fig. 1)

Articulina lineata Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 183, Pl. 12, Figs. 19-21.

Diagnosis. Test elongate, compressed, early portion triloculine, becoming uniserial in later portion; usually one or two uniserial chambers, rarely three; wall ornamented by numerous longitudinal costae; aperture terminal, very elongate, narrow, with distinctive thickened lip, curved back at ends, extending slightly beyond width of chamber.

Discussion. All the specimens of Articulina lineata examined during this investigation have two uniserial chambers, It is similar to Articulina sagra, but differs from it in having a greater width to the uniserial chambers relative to test length, and in having the aperture only very slightly extending beyond the width of the test, thus constricting the base of the next chamber, which is in contrast to the everted lip of A. sagra extending well beyond the width of the underlying chamber forming a broadened base for the next chamber.

Articulina lineata occurred at only five stations in low frequenices.

Articulina mayori Cushman, 1922 (Plate 13, Fig. 2)

Articulina mayori Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 71, Pl. 13, Fig. 5.

Diagnosis. Test very elongate, slender, slightly curved, circular in transverse section; early portion triserial, later portion uniserial with one to four uniserial chambers, even in size; wall with few, slightly raised, longitudinal costae; aperture terminal, nearly circular, with thickened lip extending slightly beyond chamber wall.

Discussion. This species is represented by single specimens at stations 77, 92 and 95.

Articulina mexicana Cushman, 1921 (Plate 13, Fig. 3)

Vertebralina sp. Cushman, 1921, Proc. U.S. Nat. Mus., vol. 59, p. 64.

Articulina mexicana Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 70, Pl. 11, Figs. 7, 8.

Diagnosis. Test slightly longer than broad; early chambers irregularly triloculine, becoming somewhat loosely coiled, chambers indistinct; wall smooth, thick; aperture terminal, elongate, narrow, with thickened lip.

Discussion. This species occurs at only four stations, usually in low frequencies.

Articulina mucronata (d'Orbigny), 1839 (Plate 13, Fig. 4)

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

Articulina mucronata Cushman, 1944, Spec. Publ. No. 10, Cush. Lab. Foram. Res., pp. 1-21.

Diagnosis. Test variable in shape, much compressed; early stages triloculine, last-coiled chamber expanding at outer end, followed by one to four uniserial chambers, gradually or rapidly expanding in width; sutures depressed; wall ornamented by longitudinal costae; aperture narrow, elongate, with thin flaring lip projecting well beyond body of chamber.

Discussion. The variability in test shape of Articulina mucronata occurs in the uniserial chambers. The initial triloculine chambers are quite similar in all specimens. The shape of the uniserial chambers ranges from fairly narrow to widely flaring. Specimens with narrow chambers are elongate with each succeeding chamber being only slightly wider than the preceding one. Specimens with widely flaring chambers are fan-shaped with each succeeding chamber expanding rapidly in width. The number of uniserial chambers present in specimens is also variable, ranging from one to four. In the area under investigation most specimens possess two uniserial chambers.

Articulina mucronata occurs at 23 stations in medium to high frequencies. Although there is no apparent reason for the distribution of this species it is most abundant at stations 44 through 57, which is an area of shallow mud flats located towards the center of Florida Bay.

Articulina multilocularis Brady, Parker and Jones, 1888 (Plate 13, Fig. 5)

Articulina multilocularis Brady, Parker and Jones, 1888, Trans. Zool. Soc., vol. 12, p. 215, Pl. 40, Fig. 10.

Diagnosis. Test oval, compressed, composed of numerous segments arranged in spiroloculine fashion, lateral faces of segments flat or hollow; sutures distinct; wall ornamented with exceedingly fine costae; aperture broad, very elongate, with everted lip.

Discussion. This species occurs at 10 stations in very low frequenices. Its distribution is apparently random.

Articulina pacifica Cushman, 1944 (Plate 13, Fig. 6)

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

Articulina conico-articulata (Batsch), Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 58, Pl. 22, Fig. 6.

Articulina sagra d'Orbigny, Cushman, 1921, U.S. Nat. Mus., Bull. 100, vol. 4, p. 488.

Articulina pacifica Cushman, 1944, Cush. Lab. Foram. Res., Spec. Publ. no. 10, p. 17, Pl. 14, Figs. 14-18.

Diagnosis. Test somewhat longer than broad; chambers triloculine, close-coiled, may have a single uniserial chamber; sutures distinct; wall ornamented with numerous, fine logitudinal costae; aperture terminal, elongate, extending somewhat beyond chamber.

Discussion. All the specimens of this species examined did not possess a uniserial chamber, but had only the tightly coiled triloculine stage.

Articulina pacifica occurs at 34 stations, usually in medium frequencies. It is most abundant in the shallow mud flats in the middle of Florida Bay, and in the shallow-water inshore areas around the lower Florida Keys.

Articulina sagra d'Orbigny, 1839 (Plate 13, Fig. 7)

Articulina sagra d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 160, Pl. 9, Figs. 23-26.

Diagnosis. Test elongate, slightly arcuate; early portion triloculine, later chambers uniserial, one to four in number; wall ornamented by longitudinal costae; aperture broadest part of test, terminal, circular or elliptical, with everted lip.

Discussion. Articulina sagra exhibits variability in the number and shape of the uniserial chambers. The number of uniserial chambers ranges from one to four with two or three being the most common. The shapes of the uniserial chambers vary in the relative lengths of the individual chambers. They do not increase uniformly in length in all specimens, but range from short, squat chambers to elongate chambers, in no definite sequence. The last-formed chamber is always the most elongate. The short, squat chambers may represent periods of arrested growth.

Articulina sagra differs from Articulina lineata in the shape of the uniserial portion of the test, and in the type of apertural lip. The uniserial chambers are narrower in the former, and the apertural lip is everted and stands well out beyond the width of the test, forming a wide base for the next chamber, whereas the apertural lip of the latter extends very slightly beyond the width of the chamber and constricts the base of the following chamber.

This species occurs at 18 stations in low to medium frequencies, and appears to be randomly distributed.

FAMILY SORITIDAE Ehrenberg, 1839

SUBFAMILY PENEROPLINAE Schultze, 1854

GENUS PENEROPLIS Montfort, 1808

Peneroplis bradyi Cushman, 1930 (Plate 13, Fig. 8)

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

Diagnosis. Test small, very greatly compressed; early portion planispiral, usually partially evolute, later portion broadening, flaring, becoming uniserial; chambers distinct, undivided; aperture a series of pores in central line of apertural face.

Discussion. This species occurs at only five stations, usually as a single specimen.

Peneroplis carinatus d'Orbigny, 1839 (Plate 13, Fig. 9)

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

Diagnosis. Test close-coiled, completely involute; chambers undivided; sutures distinct, not limbate; wall smooth; aperture consists of series of pores in central portion, toward base of apertural face.

Discussion. This species occurs at 70 stations, usually in medium frequencies. It is absent only from those stations in the more restricted parts of Florida Bay adjacent to the mainland and from the deeper-water stations.

Peneroplis pertusus (Forskal), 1775 (Plate 13, Fig. 10)

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

Peneroplis pertusus Jones, Parker and Brady, 1865, Foram. Crag., p. 19.

Diagnosis. Test typically close-coiled throughout, compressed, biumbilicate, coils not completely involute; chambers undivided; sutures distinct; wall ornamented with fine striae parallel to periphery; aperture consists of numerous pores along middle line of apertural face.

Discussion. This species occurs at 17 stations, usually in low frequencies. There is no discernible pattern to its distribution.

Peneroplis proteus d'Orbigny, 1839 (Plate 13, Fig. 11)

Peneroplis protea d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 60, Pl. 7, Figs. 7-11.

Peneroplis proteus Cushman, 1921, Proc. U.S. Nat. Mus., vol. 59, p. 75, Pl. 18, Figs. 13-19.

Diagnosis. Test with early portion close-coiled, completely involute, later portion variously flaring, even becoming uncoiled; chambers undivided; sutures distinct; wall smooth; aperture consists of row of pores along median line of apertural face.

Discussion. Peneroplis proteus exhibits variability in the shape of chamber arrangement in the flaring and uncoiled portion of the test. Most specimens have a simple flaring portion, in which each chamber becomes slightly wider than the preceding one, but some have a buildup of regular uniserial chambers with the few last-formed chambers becoming much wider than the preceding ones. The width of the uncoiled portion in different specimens varies greatly.

This species occurs at 67 stations, usually in medium frequencies. This is another species that is absent only from the more restricted parts of the bay and from those stations with the deepest water.

GENUS MONALYSIDIUM Chapman, 1900

Monalysidium politum Chapman, 1900 (Plate 13, Fig. 12)

Peneroplis (Monalysidium) polita Chapman, 1900, Linn. Soc. London, Journ. Zool., vol. 28, p. 179, p. 4, Pl. 1, Fig. 5.

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

Diagnosis. Test in early stages close-coiled, later uncoiled portion elongate, arcuate, chambers globular; wall imperforate, smooth; aperture circular, terminal.

Discussion. This species occurs as single specimens at stations 37 and 59.

GENUS SPIROLINA Lamarck, 1804

Spirolina acirularis (Batsch), 1791 (Plate 13, Fig. 13)

Nautilus (Lituus) acicularis Batsch, 1791, Conch. See., p. 3, Pl. 6, Fig. 16.

Spirolinites cylindricus Lamarck, 1804, Ann. Mus., vol. 5, p. 245.

Peneroplis cylindricus Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 205, Pl. 13, Figs. 20, 21.

Spirolina acicularis Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 42, Pl. 15, Figs. 1-3.

Diagnosis. Test with earliest chambers close-coiled, making up only small portion of test, later portion uniserial; chambers circular in transverse section, as high as broad; wall ornamented by very fine longitudinal striae; aperture consists of one or more pores in middle of terminal face.

Discussion. This species occurs at eight stations in low frequencies.

Spirolina arietinus (Batsch), 1791 (Plate 13, Figs. 14)

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

Peneroplis arietinus Parker, Jones and Brady, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 26, Pl. 1, Fig. 18.

Peneroplis pertusus (Forskal) var. arietinus Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 88, Pl. 36, Fig. 5.

Spirolina arietinus Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 43, Pl. 15, Figs. 4, 5.

Diagnosis. Test close-coiled in early portion, but not completely involute, somewhat compressed, later portion becomes uncoiled; chambers broadly elliptical in transverse section; sutures distinct; wall longitudinally striate; aperture consists of series of independent pores in central portion of apertural face.

Discussion. This species occurs at only three stations in very low frequencies.

SUBFAMILY MEANDROPSININAE Henson, 1948

GENUS BROECKINA Munier-Chalmas, 1882

Broeckina orbitolitoides (Hofker), 1930 (Plate 13, Fig. 15)

Praesorites orbitoilitoides Hofker, 1930, Sigboda-Expedite, pt. 2, p. 149, Pl. 55, Figs. 8, 10, 11, Pl. 57, Figs. 1-5, Pl. 61, Figs. 3, 14.

Diagnosis. Test discoid; periphery bluntly rounded; early stage planispiral becoming flaring, later stage series of annular chambers, all chambers divided into chamberlets; sutures pronounced, depressed, curved; wall smooth; aperture a series of peripheral pores.

Discussion. This species occurs at only seven stations, in low to medium frequencies.

SUBFAMILY ARCHAIASINAE Cushman, 1927

GENUS ARCHAIAS Montfort, 1808

Archaias angulatus (Fichtel and Moll),1803 (Plate 14, Figs. 1-3)

Nautilus angulatus Fichtel and Moll, 1803, Test. Micr., p. 112, Pl. 21, 2nd. ed.

Nautilus aduncus Fichtel and Moll, 1803, Test. Micr., p. 115, Pl. 23.

Nautilus orbicularis Fichtel and Moll, Test. Micr., p. 112, Pl. 21.

Archaias spirens Montfort, 1808, Conch. Syst., p. 190, 48^{e} genre.

Helenis spatosus Montfort, 1808, Conch. Syst., p. 195, 49^{e} genre.

Ilotus rotalitatus Montfort, 1808, Conch. Syst., p. 199, 50^{e} genre.

Orbulina adunca Lamarck, 1816, Tabl. Encycl. Meth., Pl. 468, Figs. 2a-c.

Orbiculina angulata Lamarck, 1822, Anim. sans Vert., vol. 7, p. 609, no. 2.

Orbulina numismalis Lamarck, 1822, Hist. Anim. sans Vert., vol. 7, p. 609.

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

Diagnosis. Test compressed, early portion close-coiled, in later portion becoming widely flaring, annular, or uniserial; periphery truncate; early chambers simple, later ones divided into series of chamberlets; wall imperforate except for proloculus and following chamber which are perforate; aperture consists of pore series on apertural face.

Discussion. This is the most highly variable species encountered in this investigation. The greatest variability is exhibited in specimens with annular or uniserial adult stages. The types of adult chamber arrangements consist of specimens possessing broadly flaring chambers, chambers arranged in annual series, and those with chambers arranged in a uniserial sequence. Atypical growth occurs among these three types. In some forms with uniserial stages the apertural faces may be thickened so that the aperture appears to be multiple areal instead of a linear series of pores, or the uniserial stage may be twisted giving the whole test an undulating surface. Both uniserial and annular stages may show division into a three-pronged arrangement. The axis of coiling between the planispiral and subsequent stages may change to such a degree that the adult stage may partially or completely envelope the planispiral stage.

Adult specimens of Archaias angulatus with annular chambers are similar to Archaias compressus, the latter, however, is much more compressed and the periphery is not truncate.

Archaias angulatus is the most abundant species encountered in this investigation. It occurred at 95 stations, usually in high frequencies. It is absent from only a few of the stations in the most restricted part of the bay adjacent to the mainland, and from those stations with the greater depths.

Archaias compressus (d'Orbigny), 1839 (Plate 14, Fig. 4)

Orbiculina compressus d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 73, Pl. 8, Figs. 4-7.

Archaias compressus Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 48, Pl. 17, Figs. 1, 2.

Diagnosis. Test circular in outline, early portion with several layers of chamberlets, chambers much thicker than in later growth which is annular, chamberlets in later portion in single or double layer, greatest thickness of test formed by early involute portion; wall calcareous, imperforate, except in porloculus and second chamber; aperture in adult formed by marginal row of pores, single or double.

Discussion. This species resembles adult specimens of Archaias angulatus with annular chambers but is more compressed and does not possess a truncate periphery.

Archaias compressus occurs at 73 stations usually in fairly high frequencies. It is absent from the more restricted parts of the bay and from the deeper-water stations.

SUBFAMILY SORITINAE Ehrenberg, 1839

GENUS SORITES Ehrenberg, 1839

Sorites marginalis (Lamarck), 1816 (Plate 14, Figs. 5, 6)

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

Orbitolites marginalis Carpenter, 1883, Philos. Trans., vol. 174, p. 560, Fig. 1.

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

Diagnosis. Test thin much compressed, circular in outline; whole test composed of single layer of chambers each with single layer of chamberlets throughout; early chambers spiral, later extending back, finally meeting; sutures distinct; chambers, chamberlets clearly visible; aperture consists of single row of pores along periphery of test.

Discussion. Sorites marginalis occurs at 41 stations in low to medium frequencies. Its distribution appears to be centered around the middle of the bay and the lower Florida Keys.

FAMILY ALVEOLINIDAE Ehrenberg, 1839

GENUS BORELIS Montfort, 1808

Borelis pulchra (d'Orbigny), 1839 (Plate 14, Fig. 7)

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

Alveolina melo (part) (not Fichtel and Moll), Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 223, Pl. 17, Figs. 14, 15.

Borelis pulchra Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 55, Pl. 15, Figs. 9, 10.

Diagnosis. Test small, completely involute, globular or slightly fusiform; chambers distinct, usually four in coil, divided into elongate chamberlets, chamberlets not subdivided, growing edge low, connecting two umbilici; wall imperforate, milky-white; apertures consisting of single row of rounded pores, one to each chamberlet, in apertural face.

Discussion. This species is represented by single specimens at only three stations.

SUBORDER ROTALIINA Delage and Herouard, 1896

SUPERFAMILY NODOSARIACEA Ehrenberg, 1838

FAMILY NODOSARIIDAE Ehrenberg, 1838

SUBFAMILY NODOSARIINAE Ehrenberg, 1838

GENUS NODOSARIA Lamarck, 1812

Nodosaria albatrossi Cushman, 1923 (Plate 14, Figs. 8, 9)

Nodosaria vertebralis (Batsch) var. albatrossi Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 87, Pl. 15, Fig. 1.

Diagnosis. Test elongate, gradually tapering, often slightly curved, proloculus often with greater width than those immediately following; chambers numerous, distinct, not inflated, except those near apertural end; sutures broad, of clear shell material, not depressed except near apertural end; wall ornamented by numerous longitudinal costae, typically 15-18 in adult, continuous from one chamber to another, sharp at periphery, broader at base; initial end of test with short stout spine; aperture slightly extended, radiate.

Discussion. This species is represented at only two stations in very low frequencies.

Nodosaria flintii Cushman, 1923 (Plate 14, Fig. 11)

Nodosaria obliqua Brady (part) (not Linnaeus), 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 513, Pl. 64, Figs. 20-22.

Nodosaria flintii Cushman, 1923, U.S. Nat. Mus., Bull. 104, p. 85, Pl. 14, Fig. 1.

Diagnosis. Test very elongate, slender, gracefully tapering, somewhat curved, initial end with stout spine; chambers numerous, early ones indistinct, last-formed ones much more distinct; sutures of early portion often indistinct, not depressed; surface ornamented by longitudinal costae, increasing in number as diameter of test increases, earlier ones spirally twisted, reaching to or onto terminal spine, later ones straight, in adult 15-20, running to apertural end, ends forming tooth-like crown about aperture, costae with peripheral portion rounded, often broadest in central portion of chamber, narrowing over sutures; aperture with tapering neck, usually eccentric.

Discussion. This species is represented at only three stations in very low frequencies.

Nodosaria pyrula d'Orbigny, 1826 (Plate 14, Fig. 12)

Nodosaria pyrula d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 253, no. 13.

Diagnosis. Test elongate, very slender, composed of numerous chambers, either in straight or slightly curved line, pyriform in shape, with long tapering necks; surface smooth, chambers varying little in size; proloculus extended backward in long drawn out point.

Discussion. This species is represented at only one station by a few specimens.

Nodosaria sp. (Plate 14, Fig. 13)

Diagnosis. Test short, blunt, straight, initial end with minute, blunt spine; composed of three chambers with middle chamber of lesser diameter than other two, last-formed chamber tapering toward apertural end; surface ornamented by numerous, fine, longitudinal costae; aperture with tapering neck.

Discussion. Only one specimen of this species occurred, at station 101.

GENUS AMPHICORYNE Schlumberger, 1881

Amphicoryne hirsuta (d'Orbigny), 1826 (Plate 14, Fig. 14)

Nodosaria hirsuta d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 252, no. 7.

Nodosaria hispida d'Orbigny, 1846, For. Foss. Bass. Tert. Vienne, p. 35, Pl. 1, Figs. 24, 25.

Amphicoryne hirsuta Parr 1929, B.A.N.Z. Ant. Res. Exped., Ser. B. vol. 1, no. 2, p. 328.

Diagnosis. Test tapering, elongate, composed of few chambers, globular, surface covered with spines of varying coarseness, chambers close-set or separated by stolon-like connections; aperture at end of tubular neck.

Discussion. This species is represented at only four stations usually in low frequencies.

Amphicoryne scalaris (Batsch), 1791 (Plate 14, Fig. 15)

Nautilus (Orthoceras) scalaris Batsch, Conch. des Seesandes, no. 4, Pl. 2, Fig. 4.

Nodosaria scalaris Parker and Jones, 1865, Phil. Trans., vol. 155, p. 340, Pl. 16, Fig. 2.

Diagnosis. Test straight; segments comparatively few, generally from 3-6 in adult, never more than 8, inflated or subglobular, increasing rapidly, though not always regularly, in size; final chamber drawn out at apertural end into tube of some length with terminal phialine lip, opposite extremity of test commonly mucronate; superficial costae vary in number and thickness.

Discussion. This species is represented by single specimens at only two stations.

GENUS DENTALINA d'Orbigny, 1839

Dentalina communis d'Orbigny, 1826 (Plate 14, Figs. 16, 17)

Nodosaria (Dentalina) communis d'Orbigny, 1826, Ann. Sci. Nat., Vol. 7, p. 254, no. 35.

Dentalina communis d'Orbigny, 1840, Mem. Soc. Geol. France, vol. 4, p. 13, Pl. 1, Fig. 4.

Diagnosis. Test elongate, slender, tapering, straight or slightly curved, composed of numerous chambers, slightly inflated toward apical end, later ones becoming more inflated; sutures oblique; aperture radiate, somewhat eccentric, somewhat elongate; surface smooth.

Discussion. This species is represented by single specimens at only two stations.

Dentalina filiformis (d'Orbigny), 1826 (Plate 15, Fig. 1)

Nodosaria filiformis d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 253, no. 14.

Dentalina filiformis Parker, Jones and Brady, 1871, Ann. Mag. Nat. Hist., ser. 4, vol. 8, p. 156, Pl. 9, Fig. 48.

Diagnosis. Test elongate, slender, arcuate, chambers numerous, elliptical or ovate, elongate, tumid; sutures usually oblique, chambers increasing in length toward apertural end; aperture radiate, slightly eccentric; wall smooth.

Discussion. This species is represented at only three stations by very few specimens.

GENUS FRONDICULARIA Defrance, 1824

Frondicularia sagittula van den Broeck, 1876 (Plate 15, Fig. 2)

Frondicularia alata d'Orbigny var. *sagittula* van den Broeck, 1876, Soc. Belge Micr., Ann., Tome 2, pp. 113, 115, Pl. 2, Figs. 12, 14.

Diagnosis. Test triangular, lanceolate in front view, terminated abruptly behind on level of initial chamber; chambers prolonged in uniform manner, terminated following line perpendicular to grand axis of test on level of initial chamber; wall vitreous, transparent, chambers white, material between chambers clear; aperture terminal, radiate.

Discussion. This species is represented by a single specimen at station 103.

GENUS LAGENA Walker and Boys, 1784

Lagena striata (d'Orbigny), 1839 (Plate 15, Fig. 3)

Oolina striata d'Orbigny, 1839, Foram. Amer. Merid., p. 21, Pl. 5, Fig. 12.

Lagena striata Reuss, 1862; Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, p. 237, Pl. 3, Figs. 44, 45; Pl. 4, Figs. 46, 47.

Diagnosis. Test flask-shaped, nearly circular in cross section, body of test subglobular, neck variable in length, usually rather abruptly contracted from body of test at base; surface ornamented with numerous rather fine costae running entire length of test, apical end typically broadly rounded, occasionally slightly tapering to point.

Discussion. This species is represented by a single specimen at station 107.

Lagena sp. (Plate 15, Figs. 4, 5)

These single specimens of two species of *Lagena* were found at station 106. Due to the extreme small size and slightly eroded condition of the specimens specific identification was not attempted.

GENUS LENTICULINA Lamarck, 1804

Lenticulina calcar (Linnaeus), 1767 (Plate 15, Fig. 7)

Nautilus calcar Linnaeus, 1767, Syst. Nat., 12th ed., p. 1162, no. 272.

Cristellaria calcar Parker, Jones and Brady, 1871, Ann. Mag. Nat. Hist., ser. 4, vol. 8, p. 241, 242, Pl. 10, Figs. 91, 93, 94.

Lenticulina calcar, Thalmann, 1932, Eclog. geol. Helvet., vol. 25, no. 2, p. 304.

Diagnosis. Test biconvex or lenticular, more or less carinate, armed with number of radiating peripheral teeth or spines; sutures sometimes slightly limbate, otherwise exterior smooth, without ornamentation.

Discussion. This species is represented only at station 106, but there it is one of the most abundant. This location has the second greatest depth of any of the sites investigated, 95 m. It is quite probable that this is a species which lives in considerably deeper water than most of those present throughout the area.

Lenticulina iota (Cushman), 1923 (Plate 15, Fig. 7)

Cristellaria cultrata Brady (not Montfort), 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 550, Pl. 70, Figs. 4-6.

Cristellaria iota Cushman, 1923, U.S. Nat. Mus., Bull. 104, p. 111, Pl. 29, Fig. 2; Pl. 30, Fig. 1.

Lenticulina iota Thalmann, 1932, Eclog. geol. Helvet., vol. 25, no. 2, p. 304.

Diagnosis. Test close-coiled, compressed, umbonate, periphery with thin, broad keel, nearly transparent, 13-15 chambers in last-formed coil, narrow; sutures slightly curved, very slightly limbate, but not raised above general outline of test, umbonal region occupied by large, thickened, transparent knob; wall smooth, thin; aperture radiate, at peripheral angle of test, those of early chambers distinct throughout last-formed coil.

Discussion. Like Lenticulina calcar this species is only present at station 106, but is also quite abundant. It, like all the species of Lentaculina observed during this investigation, is probably indicative of deeper water than is normally found in the area.

Lenticulina peregrina (Schwager), 1866 (Plate 15, Fig. 8)

Cristellaria peregrina Schwager, 1866, Wien Geol. Theil. vol. 2, p. 245, Pl. 7, Fig. 89.

Lenticulina peregrina Thalmann, 1932, Eclog. geol. Helvet., vol. 25, no. 2, p. 304.

Diagnosis. Test oblong, elliptical in outline, moderatley inflated in middle, some deposits on sides; four chambers of last coil visible, slightly inflated, increasing rapidly in size, almost at right angle to earlier portion of test; broad, thin flange extends over entire test, of clear material, distinct part of each individual chamber; aperture simple tube, small, at top of last-formed chamber, raised above outline of test, sometimes highly fistulose; shell thin, vitreous.

Discussion. This species, like all the species of Lenticulina in this area, is only present at station 106, where it is common.

Lenticulina sp. (Plate 15, Fig. 9)

Diagnosis. Test close-coiled, compressed, periphery with broad keel, nearly transparent; sutures curved, slightly limbate, even with surface of test; wall smooth thin; aperture radiate, with median slit extending down onto apertural face, at peripheral angle of test, earlier apertures visible throughout last-formed coil.

Discussion. This species is represented by a few specimens at stations 106 and 107. Formerly species with the apertural slit were placed in the genus Robulus, but Loeblich and Tappan (1964) relegated the later as a synonym of Lenticulina. Their findings are followed here.

GENUS MARGINULINA d'Orbigny, 1826

Marginulina planata Phleger and Parker, 1951 (Plate 15, Fig. 10)

Marginulina planata Phleger and Parker, 1951, Mem. 46, G.S.A., pt. 2, p. 9, Pl. 4, Figs. 21, 22; Pl. 5, Figs. 1-3.

Diagnosis. Test large, compressed; periphery rounded on inner side, with thin, plate-like keel on outer side which sometimes is not present along last-formed chambers in adult; 7 or 8 chambers in uniserial portion, distinct, often inflated on inner side of test; sutures distinct, limbate, flush with surface, showing as darkened areas, curving downward toward inner side of test; wall with about 7 thin, plate-like costae on each side, often broken to produce nodular effect in intial part of test, otherwise smooth, finely perforate.

Discussion. This species occurs at seven stations, all located in the somewhat deeper waters of the part of the Gulf of Mexico adjacent to Florida Bay, in low to medium frequencies.

Marginulina sp. (Plate 15, Fig. 11)

Diagnosis. Test laterally compressed, periphery almost truncate, lacking keel; 6 or 7 chambers in uniserial portion of test; sutures distinct, limbate, flush with surface, curving downward toward inner side of test; wall with about ten regular costae on each side, smooth, transparent; aperture produced.

Discussion. This species differs from Marginulina planata in being smaller, having an almost truncate periphery, having one or two less chambers in the uniserial portion of the test, in having more costae which are elongate and not broken, and in being completely transparent. It occurs at only two stations: 103 where it is rare, and 107 where it is common.

GENUS PSEUDONODOSARIA Boomgaart, 1949

Pseudonodosaria comatula (Cushman), 1923 (Plate 14, Fig. 10)

Nodosaria comatula Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 83, Pl. 14, Fig. 5.

Diagnosis. Test short, stout, composed of few chambers, initial end broadly rounded, sometimes with a small central spine, apertural end slightly tapering; chambers inflated, giving somewhat lobulate appearance to periphery; sutures distinct, somewhat depressed; surface ornamented by numerous low, rounded, longitudinal costae, close together, 35-45 in last-formed chamber of adult, continuous from one chamber to another, apertural end of last-formed chamber sometimes smooth in adult; apertural central, terminal, cribrate.

Discussion. This species is represented by rare specimens at stations 101, 102 and 103.

Pseudonodosaria rotundata (Reuss), 1850 (Plate 15, Fig. 12)

Glandulina rotundata Reuss, 1850, Akad. Wiss. Wien. v. 1, p. 366, Pl. 46, Fig. 2.

Nodosaria (Glandulina) rotundata Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 491, Pl. 61, Figs. 17-19.

Pseudoglandulina rotundata Chapman and Parr, 1937, Aus. Ant. Exped., Ser. C, v. 1, pt. 2, p. 62.

Rectoglandulina rotundata Barker, 1960, S.E.P.M. Spec. Publ. 9, p. 61, Figs. 17-19.

Diagnosis. Test oval or subovate, broadest in middle, composed of few chambers, apical end broadly rounded, without spines, apertural end more elongate; aperture radiate; last-formed chamber occupying one-half or more of visible test.

Discussion. This species is represented by a single specimen at station 106.

Pseudonodosaria torrida (Cushman), 1923 (Plate 15, Fig. 13)

Nodosaria laevigata Flint (not d'Orbigny), 1897, Rep. U.S. Nat. Mus., p. 308, Pl. 55, Fig. 3.

Nodosaria (Glandulina) laevigata d'Orbigny var. torrida Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 65, Fig. 10.

Rectoglandulina torrida Barker, 1960, S.E.P.M., Spec. Publ. 9, Pl. 61, Figs. 20-22.

Diagnosis. Test short, tumid, initial end very acute, often with spine in microspheric form, obtuse in megalospheric form, circular in cross section; chambers inflated, very strongly overlapping, arranged at first in biserial series, abruptly becoming uniserial in microspheric form, entirely uniserial in megalospheric form; sutures not depressed, distinct; wall smooth, rather thick; aperture radiate.

Discussion. This species is represented by a single specimen at station 106.

GENUS SARACENARIA Defrance, 1824

Saracenaria latifrons (Brady), 1884 (Plate 15, Fig. 14)

Cristellaria latifrons Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 544, Pl. 68, Fig. 19, Pl. 108, Figs. 11a, b.

Saracenaria latifrons Thalmann, 1932, Eclog. geol. Helvet., vol. 25, no. 2.

Diagnosis. Test spiral, elongate, trihedral, broadest near middle, tapering towards ends; dorsal margin acutely angular, carinate; ventral face broad, oval, somewhat curved, with partially carinate lateral edges; oral extremity pointed, aboral end thin, carinate; early segments small, involute; later chambers long, narrow, slightly curved, obliquely set or almost erect.

Discussion. This species is represented by a single specimen at station 106.

GENUS ASTACOLUS Montfort, 1808

Astacolus crepidulus (Fichtel and Moll), 1803

Nautilus crepidula Fichtel and Moll, 1803, Test. Micr., p. 107, Pl. 19, Figs. g-i.

Cristellaria crepidula d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 64, Pl. 8, Figs. 17, 18.

Astacolus crepidulus Thalmann, 1932, Eclog. geol. Helvet., vol. 25, no. 2, p. 305.

Diagnosis. Test elongate, compressed, early chambers close-coiled, later ones becoming uncoiled, elongate; sutures slightly depressed; wall smooth; periphery rounded, without keel.

Discussion. This species is represented by a single specimen at station 103.

Astacolus reniformis (d'Orbigny), 1846 (Plate 15, Fig. 15)

Cristellaria reniformis d'Orbigny, 1846, For. Foss. Vien., p. 88, Pl. 3, Figs. 39, 40.

Astacolus reiniformis Thalmann, 1932, Eclog. geol. Helvet., vol. 25, no. 2, p. 305.

Diagnosis. Test oval, very compressed, with strongly carinate edge at periphery; wall smooth, polished; composed of 11 chambers, narrow, oblique, not convex, from which complete coil is built, every chamber reaches center; aperture small, radiate; perforate.

Discussion. This species is represented by a single specimen at station 106.

FAMILY POLYMORPHININAE d'Oribgny, 1839

SUBFAMILY POLYMORPHININAE d'Orbigny, 1839

Polymorphinidae, Formae fistulosae (Plate 16, Fig. 1)

Discussion. A few specimens of this form occur at station 104.

GENUS GUTTULINA d'Orbigny, 1839

Guttulina australis (d'Orbigny), 1839 (Plate 16, Fig. 2)

Globulina australis d'Orbigny, 1839, Voy. Amer. Merid., vol. 5, pt. 5, p. 60, Pl. 1, Figs. 1-4.

Polymorphina australis Brady, Parker and Jones, 1869, Trans. Linn. Soc., vol. 27, p. 239, Pl. 41, Figs. 27a, b.

Polymorphina regina Cushman, 1921, U.S.G.S. Prof. Paper 129, p. 194, Pl. 18, Fig. 4.

Diagnosis. Test fusiform, initial end rounded, apertural end acute, margin slightly lobulate; chambers clavate, but little embracing, arranged in counter-clockwise, quinqueloculine series, each succeeding chamber removed from base; sutures depressed, distinct; wall ornamented with fine longitudinal costae, generally well developed on lower half of test; aperture radiate.

Discussion. This species is represented by only a few specimens at station 104.

Globulina sp. (Plate 16, Fig. 3)

This species of Globulina is represented by a single specimen at station 104. It differs from most species of the genus in having the early chambers greatly reduced in size leaving the greater portion of the test made up by the last-formed chamber.

GENUS PYRULINA d'Orbigny, 1839

Pyrulina cylindroides (Roemer), 1838 (Plate 16, Fig. 4)

Polymorphina cylindroides Roemer, 1838, Neues Jahrb., p. 385, Pl. 3, Fig. 26.

Polymorphina fusiformis Cushman (not Roemer), 1926, Bull. A.A.P.G., vol. 10, p. 604, Pl. 20, Fig. 14.

Diagnosis. Test elongate, fusiform to cylindrical, acuminate toward both extremities, almost circular in cross section; chambers elongate, not much embracing, arranged in early triserial series, tending to become biserial, each succeeding chamber farther removed from base; sutures but little depressed; wall smooth; aperture radiate.

Discussion. This species is represented by a few specimens from station 1, which is located in 587 meters of water and is far deeper than any of the other stations.

FAMILY GLANDULINIDAE Reuss, 1860

SUBFAMILY OOLININAE Loeblich and Tappan, 1961

GENUS FISSURINA Reuss, 1850

Fissurina submarginata (Boomgaart),1949 (Plate 16, Figs. 5, 6)

Vermiculum marginatum Montagu, 1803, Test. Brit., p. 524.

Entosolenia submarginata Boomgaart, 1949, Smaller foraminifera from Bodjonegoro (Java): Utrecht Univ., doct. diss., p. 107.

Fissurina submarginata (Boomgaart) Barker, 1960, S.E.P.M. Spec. Publ. 9, p. 124, Pl. 59, Figs. 21, 22.

Diagnosis. Test more or less compressed, rounded in front view; wall smooth, bordered by peripheral keel of greater or less width, solid or with radiating tubuli; aperture usually fissurine.

Discussion. This species is represented by a single specimen at station 103.

Fissurina wiesneri (Walker and Boys), 1784 (Plate 16, Figs. 7, 8)

Serpula (Lagena) Marginata Walker and Boys, 1784, Test. Min., p. 2, Pl. 1, Fig. 7.

Vermiculum marginatum Montagu, 1803, Test. Brit., p. 524.

Entosolenia marginata Williamson (part), 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 17, Pl. 2, Figs. 15-17.

Lagena marginata Brown, 1827, Illus. Conch. Gt. Brit., Pl. 1, Figs. 30, 31.

Fissurina wiesneri Barker, 1960, S.E.P.M., Spec. Publ. no. 9, p. 124, Pl. 59, Fig. 23.

Diagnosis. Test more or less compressed, rounded in front view; wall smooth, bordered by peripheral keel of greater or less width, solid or with radiating tubuli; aperture usually fissurine.

Discussion. This species is represented by a single specimen at station 4.

SUPERFAMILY BULIMINACEA Jones, 1875

FAMILY TURRILINIDAE Cushman, 1927

SUBFAMILY TURRILININAE Cushman, 1927

GENUS BULIMINELLA Cushman, 1911

Buliminella elegantissima d'Orbigny, 1839 (Plate 16, Fig. 9)

Bulimina elegantissima d'Orbigny, 1839, Voy. Amer. Merid., vol. 5, pt. 5, p. 51, Pl. 7, Figs. 13, 14.

Diagnosis. Test elongate spiral; spiral sutures distinct; chambers 3 or more to whorl, twisted; wall calcareous, finely perforate, translucent; aperture flaring, loop-shaped, slightly twisted.

Discussion. This species occurs at four stations in low to medium frequencies.

FAMILY BOLIVINITIDAE Cushman, 1927

GENUS BOLIVINA d'Orbigny, 1839

Bolivina of B. barbata Phleger and Parker, 1951 (Plate 16, Fig. 10)

Bolivina barbata Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 13, Pl. 6, Figs. 12a, b, 13.

Diagnosis. Test small, two and one-half to three times as long as broad, broadest near apertural end, tapering gradually, compressed, with narrow carina broken at basal portion of each chamber into sharp, down-curving projection; chambers somewhat inflated, increasing gradually in size as added, distinct, maximum of fourteen pairs; sutures distinct, narrow, strongly curved, showing as clear, dark lines, slightly depressed; wall smooth, finely perforate, with transparent imperforate area curving across top of inner part of each chamber; aperture very narrow, elongate slit.

Discussion. This species is represented by a single specimen at station 31.

Bolivina fragilis Phleger and Parker, 1951

Bolivina fragilis Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 13, Pl. 6, Figs. 14, 23, 24.

Diagnosis. Test about three times as long as broad, compressed, slightly tapering, usually with short spine at initial end, periphery acute, usually carinate, with keel; numerous chambers, gradually increasing in size; wall with five or less low costae extending from initial end, otherwise smooth, rather coarsely perforate; aperture narrow.

Discussion. This species is represented by single specimens at only three stations.

Bolivina goesii Cushman, 1922 (Plate 16, Fig. 11)

Bolivina goesii Cushman, 1922, Bull. 104, U.S. Nat. Mus., pt. 3, p. 34, Pl. 6, Fig. 5.

Diagnosis. Test rhomboid, tapering toward intial end to blunt point, apertural end angular, much compressed, periphery slightly, if at all, lobulated; chambers fairly numerous, distinct, narrow, at inner end usually with ventral-pointing projection, somewhat rounded; sutures distinct, very slightly depressed, irregular due to peculiar shape of inner end of chambers; wall smooth, finely punctate; aperture narrow, slightly elongate.

Discussion. This species is represented by a single specimen at station 103.

Bolivina hastata Phleger and Parker, 1951

Bolivina hastata Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 13, Pl. 6, Figs. 18, 19.

Diagnosis. Test small, compressed, tapering, initial end subacute, apical end ovate, periphery acute, often with narrow keel extending two-thirds distance up test from initial end; wall usually with several low costae extending from initial end about one-third up test, otherwise smooth, finely perforate; aperture narrow.

Discussion. This species is represented by a single specimen at station 19.

Bolivina inflata Heron-Allen and Earland, 1913 (Plate 16, Fig. 12)

Bolivina inflata Heron-Allen and Earland, 1913, Royal Irish Acad. Proc., vol. 31, pt. 64, p. 68, Pl. 4, Figs. 16-19.

Diagnosis. Test wedge-shaped, consisting of five to nine pairs of chambers rapidly increasing in breadth and thickness, terminal portions of test inflated; marginal edges rounded; sutures slightly depressed; wall coarsely punctate, surface hyaline; aperture somewhat variable, usually bolivine, at extremity of terminal chamber.

Discussion. This species is represented by a single specimen at station 92.

Bolivina lanceolata Parker, 1954 (Plate 16, Fig. 13)

Bolivina lanceolata Parker, 1954, Bull. Comp. Zool., vol. 111, no. 10, p. 514, Pl. 7, Figs. 17-20.

Diagnosis. Test regularly tapered, initial end sometimes with very short spine, compressed, periphery acute, sometimes with narrow keel; chambers numerous, uninflated, narrow, increasing gradually in height as added; wall with medium-size perforations except on clear areas on inner, upper portion of earlier chambers; aperture narrow.

Discussion. This species is randomly distributed, occurring at 18 stations, usually in low frequencies.

Bolivina lowmani Phleger and Parker, 1951 (Plate 16, Fig. 14)

Bolivina lowmani Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 13, Pl. 6, Figs. 20, 21.

Diagnosis. Test small, very slightly tapering to subacute or somewhat rounded initial end, periphery rounded, slightly lobulate; chambers numerous, slightly curved; wall smooth, with medium-sized perforations, often transparent; aperture loop-shaped.

Discussion. This species occurs at only six stations in very low frequencies.

Bolivina paula Cushman and Cahill, 1932 (Plate 16, Fig. 15)

Bolivina paula Cushman and Cahill, 1932, Bull. Fla. State Geol. Surv., vol. 9, p. 84, Pl. 12, Fig. 6.

Diagnosis. Test small, compressed, tapering regularly throughout; chambers increasing gradually in size as added, ten pairs in adult; sutures limbate; wall smooth, perforate; aperture narrow slit.

Discussion. This species occurs at 21 stations in low to medium frequencies. All the stations at which it occurs are in very shallow water.

Bolivina pulchella var. primitiva Cushman, 1930 (Plate 17, Fig. 1)

Bolivina pulchella (d'Orbigny) var. primitiva Cushman, 1930, Bull. Fla. State Geol. Surv., vol. 4, p. 47, Pl. 8, Fig. 12.

Diagnosis. Test small; chambers comparatively few, increasing rapidly in size as added, terminating in sharp downward projections, ornamented by series of short, longitudinal costae; wall translucent, very finely punctate; aperture elongate, narrow opening running width of last-formed chamber.

Discussion. This species is represented by few specimens at only four stations.

Bolivina striatula Cushman, 1922 (Plate 17, Fig. 2)

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

Diagnosis. Test elongate, gradually tapering from somewhat rounded initial end to broad apertural end; chambers numerous; early portion of test with numerous longitudinal striations occupying about half length of test, final chambers smooth; wall finely perforate; aperture narrow slit.

Discussion. This species occurs at six stations in low frequencies.

Bolivina subaenariensis var. mexicana Cushman, 1922 (Plate 17, Fig. 3)

Bolivina subaenariensis Cushman, var. mexicana Cushman, 1922, U.S. Nat. Mus., Bull. 104, pt. 3, p. 44, Pl. 8, Fig. 1.

Diagnosis. Test elongate, much compressed, abruptly tapering especially towards apex of test, periphery acute, often carinate, surface ornamented by numerous costae running nearly to apertural end of test; chambers distinct, curved, widest near center; sutures distinct, slightly depressed; wall finely punctate, translucent; aperture semicircular.

Discussion. This species occurs at only two stations in very low frequencies.

Bolivina subspinescens Cushman, 1922 (Plate 17, Fig. 4)

Bolivina subspinescens Cushman, 1922, U.S. Nat. Mus., Bull. 104, pt. 3, p. 48, Pl. 7, Fig. 5.

Diagnosis. Test minute, elongate, tapering, apical end bluntly pointed, apertural end angular, periphery lobulate; chambers distinct, angular, concave, ventral, outer portion smooth, lower angle finely spinose; sutures distinct, depressed; wall calcareous, outer part smooth, remainder covered with short close-set spines, in early portion granular, roughened; aperture rounded.

Discussion. This species occurs at three stations in very low frequencies.

Bolivina sp.

Diagnosis. Test elongate, tapering towards both ends, periphery rounded; chambers slightly inflated, widest near center, distinct; sutures distinct, slightly depressed; wall smooth, calcareous, finely punctate; aperture narrow slit.

Discussion. This species is represented by single specimens at only three stations.

GENUS RECTOBOLIVINA Cushman, 1927

Rectobolivina advena (Cushman), 1922 (Plate 17, Fig. 5)

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

Rectobolivina advena Hofker, 1951, Monograph 4a, Vitkom. Zool., Bot. Oceanogr., Geol. Geb., Nederlandsch., p. 116, 232.

Diagnosis. Test elongate, somewhat compressed, early portion either twisted or biserial; later portion, which makes up larger portion of test, uniserial; chambers numerous, distinct, inflated; sutures somewhat depressed, early portion and part of uniserial portion with fine, longitudinal costae, more or less broken, followed by two or three chambers slightly spinose, after which remaining chambers are smooth, very finely punctate; aperture elliptical, each one connecting with preceding one by internal funnel-shaped tube.

Discussion. This species is represented by a single specimen at station 1, in 587 meters of water.

FAMILY ISLANDIELLIDAE Loblich and Tappan, 1964

GENUS CASSIDULINOIDES Cushman, 1927

Cassidulinoides bradyi (Norman), 1880 (Plate 17, Fig. 6)

Cassidulina bradyi (Norman) Wright, 1880, Proc. Belfast Nat. Field Club, p. 152.

Cassidulinoides bradyi Cushman, 1930, Fla. Geol. Surv., Bull. 4, p. 58.

Diagnosis. Test spiral, compressed; oval, reniform, or crosier-shaped; lateral faces convex, peripheral edge thin, sharp or slightly rounded; early segments planispiral, embracing, arranged on normal cassiduline plan; later segments oblique, alternating, forming straight or curved biserial line; aperture loop-shaped, situated on inner face of terminal chamber.

Discussion. This species is represented by a single specimen at station 103.

FAMILY BULIMINIDAE Jones, 1875

SUBFAMILY BULUMININAE Jones, 1875

GENUS BULIMINA d'Oribgny, 1826

Bulimina spicata Phleger and Parker, 1951 (Plate 17, Fig. 7)

Bulimina spicata Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 16, Pl. 7, Figs. 25a-c, 30, 31.

Diagnosis. Test small, one-and-one-half to two times as long as broad, initial end sometimes with small spine, consisting of three or four whorls, last-formed whorl forming at least three-fifths of test; chambers fairly distinct, those of each whorl overhanging previous ones slightly, chambers of last-formed whorl somewhat inflated; sutures of last-formed chambers distinct, depressed, earlier ones indistinct; wall of most of last-formed whorl smooth, finely perforate, lower part of last-formed whorl and remainder of test ornamented by indefinite low costae terminated by sharp spines pointing downward below margin of chambers; aperture elongate, extending over apex of test from base of last chamber well above suture joining second and third chambers.

Discussion. This species occurs at seven stations, all of which are in deeper waters outside the actual confines of Florida Bay, usually in low frequencies.

GENUS GLOBOBULIMINA Cushman, 1927

Globobulimina mississippiensis Parker, 1954 (Plate 17, Fig. 8)

Globobulimina mississippiensis Parker, 1954, Bull. Mus. Comp. Zool., vol. 111, no. 10, p. 511, Pl. 7, Figs. 3, 4, 10.

Diagnosis. Test of medium size, ovate, with greatest width usually below or near middle, sometimes almost as long as broad; initial end rounded in megalospheric form, slightly pointed in microspheric; chambers slightly inflated, last-formed whorl making up one-eighth to one-seventh of test; sutures very sligthly depressed; wall thin, translucent, finely perforate; aperture with thickened border, tongue extending from test, curved, with regular, non-tooth border.

Discussion. This species is represented by only a few species at station 103.

SUBFAMILY CHRYSALIDINELLA Schubert, 1908

Chrysalidinella dimorpha (Brady), 1881 (Plate 17, Fig. 9)

Chrysalidina dimorpha Brady, 1881, Quart. Journ. Micro. Soc., vol. 21, p. 24.

Chrysalidinella dimorpha Schubert, 1907, Neues Jahrb. fur Min., vol. 25, p. 243.

Diagnosis. Test about twice as long as broad, triangular in transverse section, early triserial portion with sides nearly parallel, periphery acute, earlier portion typically with backward-projecting spinose processes, sides slightly concave; chambers distinct, not inflated; sutures distinct, not depressed, slightly limbate, strongly curved, especially towards angles of test; wall smooth, distinctly perforate; aperture consisting of series of fine rounded pores on apertural face.

Discussion. This species occurs as single specimens at three stations.

GENUS REUSSELLA Galloway, 1933

Reussella atlantica Cushman, 1947 (Plate 17, Fig. 10)

Reussella spinulosa (Reuss) var. atlantica Cushman, 1947, Contr. Cush. Lab. Foram. Res., vol. 23, pt. 4, p. 91, Pl. 20, Figs. 6, 7.

Diagnosis. Test small, slender; chambers triserial extending downward forming sawtooth edge to periphery; wall thin, transparent, coarsely perforate; aperture triangular.

Discussion. This species occurs at four widely separated stations, in very low frequencies.

FAMILY UVIGERINIDAE Haeckel, 1894

GENUS *UVIGERINA* d'Orbigny, 1826

Uvigerina flintii Cushman, 1923 (Plate 17, Fig. 11)

Uvigerina tenuistriata Flint, (not Reuss), 1897 (1899), Rep. U.S. Nat. Mus., p. 320, Pl. 68, Fig. 1.

Uvigerina flintii Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 165, Pl. 42, Fig. 13.

Diagnosis. Test somewhat elongate, not more than twice as long as broad, fusiform or oval; chambers rather obscure; sutures only slightly depressed, partially hidden by ornamentation of surface which consists of numerous very fine longitudinal costae only slightly raised above general surface, entire test thin, translucent, shiny; apertural end slightly depressed, apertural neck with base in this hollow, outer end with flaring lip, sides of neck with two or three ring-like projections.

Discussion. This species occurs at seven stations, usually in low frequencies. All the stations where it occurs are either located in the adjacent Gulf of Mexico waters or between the Florida Keys and the reef tract.

Uvigerina peregrina Cushman, 1923 (Plate 17, Fig. 12)

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

Uvigerina peregrina Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 166, Pl. 42, Figs. 7-10.

Diagnosis. Test elongate, about two-and-one-half times as long as broad, widest in middle, ends rounded; chambers fairly numerous, inflated, distinct; sutures depressed, lines of sutures indistinct; wall ornamented with longitudinal costae, about ten on full-grown chamber, those of each chamber usually not continuous with those of adjacent chambers, high, very thin, sharp, becoming discontinuous in spinose or irregular short portions at either end of test; wall between costae and costae themselves distinctly granular; aperture circular at end of distinct cylindrical neck, often spinose, with phialine lip.

Discussion. This species occurs at five stations in low frequencies. It occurs at station 1 in the deep water of the Straits of Florida and at four stations in the adjacent Gulf of Mexico waters.

GENUS *TRIFARINA* Cushman, 1923

Trifarina bella (Phleger and Parker), 1951 (Plate 17, Fig. 13)

Angulogerina bella Phleger and Parker, 1951, Mem. U.S. Nat. Mus., vol. 46, p. 12, Pl. 6, Figs. 7, 8.

Diagnosis. Test elongate, nearly uniform breadth in microspheric form, shorter, broader with greatest breadth about middle in megalospheric, initial end subacute often with few short, blunt terminal spines, later portion irregularly triangular in cross section, early portion irregular; periphery of later portion of test sharply angled, of early portion irregular due to chamber overhang; early chambers sharply undercut with pointed projections giving spinose appearance, later chambers with flattened sides projecting into sharp overhang at angles; sutures indistinct in early portion of test, slightly depressed in later portion; wall thin, coarsely perforate with short, blunt spines in initial portion of test; aperture with slender neck, well defined lip.

Discussion. This species is represented by a single specimen at station 106.

Trifarina bradyi Cushman, 1923 (Plate 17, Fig. 14)

Rhabdogonium tricarinatum Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 525, p. 67, Figs. 1-3.

Trifarina bradyi Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 99, Pl. 22, Figs. 3-9.

Diagnosis. Test elongate, slightly tapering toward either end, often somewhat twisted, triangular in transverse section, with carinae at three angles, thin, fragile, high, running from initial end to aperture, even onto neck inself; chambers distinct, those of earlier portion irregularly spiral, later ones less distinctly so; sutures distinct, not depressed; wall thin, translucent, finely punctate, smooth; aperture terminal, central, at end of short, tubular neck, usually with fine phialine lip.

Discussion. This species is represented by two specimens from station 1.

SUPERFAMILY DISCORBACEA Ehrenberg, 1838

FAMILY DISCORBIDAE Ehrenberg, 1838

SUBFAMILY DISCORBINAE Ehrenberg, 1838

GENUS DISCORBIS Lamarck, 1804

Discorbis rosea (d'Orbigny), 1826 (Plate 17, Figs. 15, 16)

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

Truncatulina rosea Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 667, Pl. 96, Fig. 1.

Rotorbinella rosea Bandy, 1944, Journ. Paleont., vol. 18, p. 372.

Discorbina rosea Hornibrook and Vella, 1954, The Micropal., vol. 8, no. 1, p. 26.

Diagnosis. Test trochoid, biconvex, dorsal side often with high spire, periphery acute, or with small spinose projections, or with irregular plate-like extensions at each chamber, umbilical area with distinct plug; chambers usually nine to ten in last-formed whorl, increasing gradually in size as added, not inflated; sutures limbate, not raised, oblique on dorsal side, nearly radial on ventral side, flush on dorsal side, depressed on ventral side; wall coarsely perforate, smooth or ornamented with bead-like projections, especially near periphery; aperture elongate slit at inner margin of ventral side of chamber, with considerable lip developed above it; color rose-red to reddish-brown.

Discussion. This species occurs at only four stations, 2, 3, 4 and 16, but at these stations it is common or abundant. Stations 2, 3 and 4 are located between the reef tract and the Florida Keys and is a typical back reef area. From observing Discorbis rosea from similar areas throughout the Bahama Islands it appears to be characterisitic of back reef environments. In some places such as the pink beach sands of Eleuthera and Cat Islands in the Bahamas tests of this species makes up a considerable portion of the particles which give the pink hue to the sands. The occurrence of this species at station 16 within Florida Bay is unexpected and the reasons for this occurrence problemetical.

Discorbis aguayoi Bermudez, 1935 (Plate 18, Figs. 1, 2)

Discorbis aguayoi Bermudez, 1935, Soc. cubana hist. nat. Mem., vol. 9, p. 204, Pl. 15, Figs. 10-14.

Discorinopsis aguayoi (Bermudez) - Phleger, Parker and Peirson, 1953, Cush. Found. Foram. Res., Spec. Publ. 2, p. 7, Pl. 4, Figs. 23, 24.

Diagnosis. Test vitreous, lightly trochoid, periphery circular, slightly lobulated, margin rounded; dorsal side formed by numerous subglobular chambers, ten in last-formed coil, finely perforate; sutures limbate in first-formed coils, depressed in last-formed coil, in some specimens limbate throughout with initial chambers visible on dorsal side; ventral side flat, with spongy shell material occupying nearly entire surface, formed by layer of radial, rugose costae which do not reach peripheral margin of chambers; aperture slit-like at base of last-formed chamber.

Discussion. This species occurs at only two stations, but at one station it is very abundant and at the other it is common. The stations where it occurs are very shallow with depths of less than one meter.

Discorbis mira Cushman, 1922 (Plate 18, Figs. 3, 4)

Discorbis mira Cushman, 1922, Carnegie Inst. Washington, Publ. 311, p. 39, Pl. 6, Figs. 10, 11.

Discorbis mirus (Cushman). Graham & Militante, 1959, Stanford Univ. Publ., Geol. Sci., v. 6, no. 2, p. 93, Pl. 13, Fig. 23.

Discorbina turbo d'Orbigny, sp.-Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 642, Pl. 87, Fig. 8.

Rotorbinella mira (Cushman). Todd, 1965, U.S. Nat. Mus., Bull. 161, pt. 4, p. 18, Pl. 8, Fig. 2.

Diagnosis. Test plano-convex, dorsal side forming low cone, ventral side flattened, very slightly convex, trochoid, last-formed whorl consisting of about six chambers; sutures oblique, curved very slightly, if at all, depressed on dorsal side, on ventral side depressed, area thus formed often filled by alar prolongations from center; periphery slightly lobulate, on dorsal side sutures often slightly limbate; walls coarsely punctate, on dorsal side irregularly so, punctae near ourter margin of chamber, less frequent elsewhere; aperture elongate, slightly arched slit at inferior margin of chamber.

Discussion. This species occurs at 26 stations, usually in medium frequencies. It appears to be most common in the shallow waters adjacent to the lower Florida Keys.

GENUS LATICARININA Galloway and Wissler, 1927

Laticarinina halophora (Stache), 1864 (Plate 18, Figs. 5, 6)

Pulvinulina repanda var. menardii, subvar. pauperata Parker and Jones, 1865, Philos. Trans., vol. 155, p. 395, Pl. 16, Figs. 50, 51.

Pulvinulina pauperata Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 696, Pl. 104, Figs. 3-11.

Robulina halophora Stache, 1864, Novara Exped. 1857-59, Wien, vol. 1, pt. 2, p.

Laticarinina halophora (Stache) Finlay, 1940, Trans. Roy. Soc. N.Z., vol. 69, p. 467-8.

Diagnosis. Test in young trochoid, in adult becoming planispiral or nearly so, early chambers close-coiled, later ones becoming loosely coiled with broad plate between coils; periphery with broad, thin, transparent carina; chambers numerous, inflated, ten to fifteen in last-formed coil; sutures depressed; aperture narrow opening on ventral side near periphery.

Discussion. A single specimen of this species occurred at station 4.

GENUS NEOCONORBINA Hofker, 1951

Neoconorbina orbicularis (Terquem), 1876 (Plate 18, Figs. 7, 8)

Rosalina orbicularis Terquem, 1876, Ess. Anim. Plage Dunkerque, pt. 2, p. 75, Pl. 9, Figs. 4a, b.

Discorbis orbicularis Berthelin, 1878, Foram. de Borgneuf et Pornichet, p. 39, no. 63.

Discorbina orbicularis Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 647, Pl. 88, Figs. 4-8.

Neoconorbina orbicularis Hofker, 1951, Arch. Neerlandaises Zool., v. 8, pt. 4, p. 357.

Conorbina orbicularis Parker, 1954, Bull. Mus. Comp. Zool., v. 111, no. 10, p. 522, Pl. 8, Figs. 13, 14.

Diagnosis. Test plano-convex, dorsal side forming low cone, ventrally flat or more often somewhat concave, circular in outline, periphery acute; chambers elongate, each often making up nearly half of circumference, distinct; wall finely to coarsely perforate, smooth; aperture ventral, elongate opening beneath somewhat extended central portion of last-formed chamber.

Discussion. This species had rare to common occurrences at eight stations located in Florida Bay and the lower Florida Keys.

GENUS ROSALINA d'Orbigny, 1826

Rosalina candeiana d'Orbigny, 1839

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

Truncatulina candeiana (d'Orbigny) Cushman, 1921, Proc. U.S. Nat. Mus., vol. 59, no. 2360, p. 57, Pl. 13, Figs. 4, 5.

Truncatulina cora Cushman, (not d'Orbigny), 1922, Carnegie Inst. Wash., vol. 17, Publ. 311, p. 48, Pl. 7, Figs. 3-5.

Discorbis candeiana (d'Orbigny) Cushman, 1931, Bull. 104, U.S. Nat. Mus., pt. 8, p. 19, Pl. 7, Fig. 4.

Diagnosis. Test rotaliform, dorsal side convex, ventral side concave; chambers comparatively few, early ones large; wall coarsely punctate on dorsal side, smooth on inner concave portion; aperture elongate, arched opening at base of last-formed chamber, opening into umbilical area.

Discussion. This species closely resembles Rosalina floridana, and probably the two should be considered as a single species. The variability shown by both these species is probably due to their method of attachment, as suggested by Todd (1965, p. 11). Banner and Blow (1960a, p. 37) suggest that Rosalina candeiana be considered a nomen dubium and be abandoned.

Rosalina floridana (Cushman), 1922 (Plate 18, Figs. 9, 10)

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

Rosalina floridana (Cushman) Parker, 1954, Bull. Mus. Comp. Zool., vol. 111, no. 10, p. 524, Pl. 8, Figs. 19, 20.

Diagnosis. Test rotaliform, dorsal side convex, ventral side concave; chambers relatively few, early ones small; wall punctate on dorsal side, punctate near periphery on ventral side, smooth on inner concave portion; aperture elongate, arched opening at base of last-formed chamber, opening into umbilical area.

Discussion. The same discussion as appears under Rosalina candeiana applied here. The two species considered simultaneously occur at 58 stations, all in the shallow waters of Florida Bay proper. They are absent, however, from the stations adjacent to the Florida mainland which become very brackish during the rainy season.

Rosalina floridensis (Cushman), 1931 (Plate 18, Figs. 11, 12)

Discorbis bertheloti (d'Orbigny) var. floridensis Cushman, 1931, Bull. 104, U.S. Nat. Mus., pt. 8, p. 17, Pl. 3, Figs. 3-5.

Diagnosis. Test large, rotaliform, dorsal side convex, ventral side concave; chambers very few; periphery nearly round with keel; last-formed chamber with extension covering umbilical area on ventral side; wall very coarsely punctate; aperture arched opening at base of last-formed chamber on ventral side.

Discussion. This species is present at only three stations in very low frequencies.

GENUS TRETOMPHALUS Mobius, 1880

Tretomphalus atlanticus Cushman, 1934 (Plate 19, Figs. 1-3)

Tretomphalus atlanticus Cushman, 1934, Contr. Cush. Lab. Foram. Res., vol. 10, pt. 4, p. 86, Pl. 11, Fig. 3, Pl. 12, Fig. 7.

Diagnosis. Test in earliest portion close-coiled, later with chambers becoming arranged radially in fours, finally developing a large, globular float chamber, becoming planktonic; chambers distinct, numerous, about six to whorl in early portion, later radiate, generally triangular on ventral side; wall coarsely perforate; aperture arched opening at base of last-formed chamber, opening into umbilical area in benthic portion, consisting of areal pores on pelagic float chamber.

Discussion. This species occurs at 12 stations in very low frequencies. There seems to be no definite pattern to its distribution.

SUBFAMILY BAGGININAE Cushman, 1927

GENUS CANCRIS Montfort, 1808

Cancris oblonga (Williamson), 1858 (Plate 19, Figs. 4, 5)

Rotalina oblonga Williamson, 1858, Rec. Foram. Gt. Brit., p. 51, Pl. 4, Figs. 98-100.

Cancris oblonga Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 20, Pl. 9, Figs. 17-19.

Diagnosis. Test trochoid, large, biconvex; chambers few, rapidly enlarging, lobe-like extension from last-formed chamber covering umbilical area; periphery lobulate; wall perforate; aperture narrow, on inner border of ventral side of last-formed chamber.

Discussion. This species occurs at only five stations in very low frequencies.

Cancris sagra (d'Orbigny), 1839 (Plate 19, Figs. 6, 7)

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

Pulvinulina sagra Cushman, 1918, Bull. 103, U.S. Nat. Mus., p. 70, Pl. 24, Figs. 6a, b.

Pulvinulina semipunctata Cushman, 1922, Publ. 311, Carnegie Inst. Wash., p. 51, Pl. 8, Figs. 5, 6.

Pulvinulina oblonga Brady, Parker and Jones, 1888, Trans. Zool. Soc. London, v. 12, p. 229, Pl. 46, Fig. 5.

Cancris sagra Cushman, 1931, Bull. 104, U.S. Nat. Mus., pt. 8, p. 74, Pl. 15, Figs. 2a-c.

Diagnosis. Test unequally biconvex, dorsal side more flattened than ventral; chambers comparatively few, 7 to 10, rapidly increasing in size in last-formed coil, last-formed chamber on ventral side making up nearly half area of test; periphery sharply carinate; sutures depressed slightly, distinct, curved; wall very finely punctate, except inner part of ventral side, which is of clear shell material without punctate, wall very thin, translucent, or even transparent where no punctae exist; aperture small opening at ventral side of last-formed chamber, narrow, slightly curved.

Discussion. This species was very rare, single specimens only being found at three stations.

GENUS VALVULINERIA Cushman, 1926

Valvulineria cf. V. araucana (d'Orbigny), 1839 (Plate 19, Figs. 8, 9)

Rosalina araucana d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 44, Pl. 6, Figs. 16-18.

Diagnosis. Test trochoid, plano-convex; lobe-like plate extending from last-formed chamber covering umbilical area.

Discussion. This species occurs at eight stations, usually as single specimens.

FAMILY SIPHONINIDAE Cushman, 1927

GENUS SIPHONINA Reuss, 1850

Siphonina pulchra Cushman, 1919 (Plate 19, Figs. 10, 11)

Siphonina pulchra Cushman, 1919, Publ. 291, Carnegie Inst. Wash., p. 42, Pl. 14, Figs. 7a-c.

Siphonina reticulata Cushman (not Czjzek), 1919, Publ. 291, Carnegie Inst. Wash., p. 42.

Diagnosis. Test nearly circular, about equally biconvex, periphery subacute or even somewhat rounded, compressed; chambers usually five in last-formed volution, not inflated; sutures distinct, not depressed, limbate; wall smooth, conspicuously perforate; aperture elliptical, with distinct lip, short, well-marked neck.

Discussion. This species is represented by single specimens at stations 77 and 89.

FAMILY ASTERIGERINIDAE d'Orbigny, 1839

GENUS ASTERIGERINA d'Orbigny, 1839

Asterigerina carinata d'Orbigny, 1839 (Plate 19, Fig. 12; Plate 20, Fig. 1)

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

Diagnosis. Test unequally biconvex, coiled, dorsal side very slightly convex, ventral side strongly so, almost conical; chambers numerous about 3 coils; six or seven chambers forming last-formed coil; sutures oblique, very slightly limbate, produced to form slight translucent keel, sutures curved, oblique on dorsal side, on ventral side supplementary chambers extending nearly to periphery, forming rhomboid areas; sutures distinct, very slightly depressed; wall smooth, finely punctate, usually glistening, often somewhat roughened by lines of small granules near aperture which is elongate, narrow slit extending from umbilical area about halfway to periphery, usually with slight, thin lip.

Discussion. This spcies is represented by a few specimens at station 107.

FAMILY EPISTOMARIIDAE Hofker, 1954

GENUS PSEUDOEPONIDES Uchio, 1950

Pseudoeponides umbonatus (Reuss), 1851

Rotalina umbonata Reuss, 1851, Zietschr. Deutsch. Geol. Res., vol. 3, p. 75, Pl. 5, Figs. 35a-c.

Diagnosis. Test trochoid, plano-convex; umbilical region closed with central plug of clear shell material; wall coarsely perforate; main aperture low opening at base of last-formed chamber between umbilicus - periphery on ventral side, may have supplementary apertures on dorsal side.

Discussion. This species is represented by a single specimen at station 90.

SUPERFAMILY SPIRILLINACEA Reuss, 1862

FAMILY SPIRILLINIDAE Reuss, 1862

SUBFAMILY SPIRILLININAE Reuss, 1862

GENUS SPIRILLINA Ehrenberg, 1843

Spirillina denticulata Brady, 1884 (Plate 20, Fig. 2)

Spirillina limbata Brady var. denticulata Brady, 1884, Rep. Voy. Challenger, Zool. Vol. 9, p. 632, Pl. 85, Fig. 17.

Spirillina denticulata Parr, 1929, B.A.N.Z. Ant. Res. Exped., ser. B, vol. 5, no. 6, p. 351.

Diagnosis. Test planispiral, thin, equilateral, discoidal; lateral faces flat or only slightly concave; peripheral edge square; raised spiral band covering sutural line furnished with buttress-like teeth, set at regular intervals along inner margin.

Discussion. This species occurs at only three stations in very low frequencies.

Spirillina obconica Brady, 1879 (Plate 20, Fig. 3)

Spirillina obconica Brady, 1879, Quart. Journ. Micr. Sci., vol. 19, p. 279, Pl. 8, Fig. 27.

Diagnosis. Test free, spiral; contour elliptical, superior surface conical, inferior surface concave; composed of seven or eight convolutions of narrow, non-septate tube; shell wall very thin, foramina minute.

Discussion. This species is represented by a single specimen at station 102.

Spirillina vivipara Ehrenberg, 1841 (Plate 20, Fig. 4)

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

Diagnosis. Test circular, planispiral, evolute; periphery round; sutures distinct; chamber long spiral, increasing gradually in diameter, overlapping slightly on sides; wall coarsely perforate; aperture at end of tube, simple.

Discussion. This species occurs at eight stations, usually in very low frequencies.

SUPERFAMILY ROTALIACEA Ehrenberg, 1839

FAMILY ROTALIIDAE Ehrenberg, 1839

SUBFAMILY ROTALIINAE Ehrenberg, 1839

GENUS AMMONIA Brünnich, 1772

Ammonia beccarii var. parkinsoniana (d'Orbigny), 1839 (Plate 20, Figs. 5, 6)

Rosalina parkinsoniana d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 99, pt. 4, Figs. 25-27.

Rotalia beccarii (Linne) var. parkinsoniana (d'Orbigny), Phleger and Parker, 1951, Mem. Geol. Soc. Amer., v. 46, pt. 2, p. 23, Pl. 12, Figs. 6a, b.

Diagnosis. Test biconvex, periphery broadly rounded; chambers numerous, last-formed whorl containing 8-12; sutures dorsally limbate, straight, radiate, marked by raised ornamentation of clear shell material; sutures ventrally limbate, straight, radiate, flat; umbilical area usually filled with rounded mass of material surrounded by excavated area running to sutures, encircled by series of small isolated knobs of clear shell material, situated between sutures at extremities; wall smooth; aperture near peripheral margin.

Discussion. This species occurs at 32 stations, but is abundant only at those stations immediately adjacent to the Florida mainland where fresh-water runnoff in the rainy season creates brackish-water conditions. At these stations it may be the dominant species often making up over 90 per cent of the fauna.

FAMILY ELPHIDIIDAE Galloway, 1933

SUBFAMILY ELPHIDIINAE Galloway, 1933

GENUS ELPHIDIUM Montfort, 1808

Elphidium advenum (Cushman), 1922 (Plate 20, Figs. 7, 8)

Polystomella subnodosa Brady, (not von Munster), 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 743, Pl. 110, Fig. 1.

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

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

Diagnosis. Test equally biconvex; periphery acute, with narrow carina, somewhat lobulate; umbilical region depressed, with small central boss of clear shell material; retral processes about one-third width of chamber; wall with very minute perforations; aperture series of small pores at base of apertural face.

Discussion. This species occurs at fifteen stations, usually in very low frequencies.

Elphidium discoidale (d'Orbigny), 1839 (Plate 20, Figs. 9, 10)

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

Elphidium discoidale Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 22, Pl. 8, Figs. 8, 9.

Diagnosis. Test of medium size, somewhat compressed, periphery subacute, margin slightly lobulate, sides convex in peripheral view, umbilical regions each with large rounded boss, in peripheral view protruding beyond outline of test; chambers only sightly inflated, distinct, about ten in last-formed coil; sutures slightly depressed, somewhat broadening toward inner end, marked by retral processes, short, ten to twelve in number; wall smooth, very distinctly perforate, umbones of clear shell material, nearly transparent, with numerous coarse tubules; aperture composed of several small, rounded openings at base of apertural face.

Discussion. This species occurs at 18 stations, usually in low to medium frequencies. All the stations where it was present are in the more restricted areas of Florida Bay adjacent to the Florida mainland. It appears to be indicative of very shallow water where the yearly range of salinity varies greatly.

Elphidium sagrum (d'Orbigny), 1839 (Plate 20, Figs. 11, 12)

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

Polystomella lanieri Cushman, 1920, U.S. Geol. Surv. Prof. Paper 128-B, p. 72, Pl. 11, Fig. 22.

Elphidium sagrum Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 24, Pl. 9, Figs. 5, 6.

Diagnosis. Test biconvex, with periphery broadly rounded, last-formed portion wider than earlier portions; chambers in last-formed portion slightly inflated; sutures not depressed except between last few chambers, marked by short, broad retral processes continuous over earlier portion of test to form ridges slightly oblique to periphery, about ten in number; wall fairly thick, perforate; aperture composed of series of small, round openings at base of apertural face.

Discussion. This species occurs at 12 stations, usually in low frequencies.

GENUS CRIBROELPHIDIUM Cushman and Brönnimann, 1948

Cribroelphidium poeyanum (d'Orbigny), 1839 (Plate 21, Figs. 1, 2)

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

Elphidium poeyanum (d'Orbigny) Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 25, Pl. 10, Figs. 4, 5.

Diagnosis. Test strongly compressed, periphery broadly rounded, sides nearly parallel; umbilical region slightly depressed; chambers distinct; sutures slightly depressed, marked by very short, broad retral processes; wall thin, translucent, smooth, finely perforate; aperture composed of series of small, rounded openings on apertural face.

Discussion. This is the most abundant and widespread of all the species of the Elphidiinae present throughout the area. It occurs at 66 stations in low to high frequencies. Its distribution is restricted to the shallow water of Florida Bay. It is absent from the more restricted bays immediately adjacent to the Florida mainland where the waters become quite brackish during the rainy season.

FAMILY NUMMULITIDAE de Blainville, 1825

SUBFAMILY CYCLOCLYPEINAE Butschli, 1880

GENUS HETEROSTEGINA d'Orbigny, 1826

Heterostegina depressa d'Orbigny, 1826 (Plate 21, Fig. 3)

Heterostegina depressa d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, no. 2, Pl. 17, Figs. 5-7.

Diagnosis. Test in section lenticular, early chambers embracing, thickened, later whorls thin, periphery with thin keel, chambers subdivided into chamberlets by transverse partitions, chamberlets near interior border of whorl much larger than those of peripheral portion, division apparent from exterior.

Discussion. This species is represented by a single specimen at station 107.

Eponides antillarum (d'Orbigny), 1839 (Plate 21, Figs. 4, 5)

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

Truncatulina antillarum Fornasini, 1902, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 10, p. 63.

Pulvinulina incerta Cushman, Publ. 311, Carnegie Inst. Wash., p. 51, Pl. 9, Figs. 1-3.

Eponides antillarum Cushman, 1931, Bull. 104, U.S. Nat. Mus., pt. 8, p. 42, Pl. 9, Fig. 2.

Diagnosis. Test unequally biconvex, dorsal side somewhat more convex than ventral side; chambers numerous; sutures oblique, rather indistinct; wall finely punctate; aperture elongate, at base of last-formed chamber.

Discussion. This species occurs at 17 stations, mainly in the lower Florida Keys, in low to medium frequencies.

Eponides regularis Phleger and Parker, 1951

Eponides regularis Phleger and Parker, 1951, Mem. G.S.A., vol. 46, p. 21, Pl. 11, Figs. 3a, 3b, 4a-c.

Diagnosis. Test small, about four whorls in adult, somewhat compressed, biconvex; periphery subacute; chambers distinct, increasing in size very gradually as added, eight or nine in last-formed whorl, last-formed ones very slightly inflated on ventral side; sutures straight on both sides, slightly limbate, flush with surface except for last-formed ones on ventral side which may be slightly depressed; wall smooth, very finely perforate; aperture low, arched opening slightly below periphery on ventral side.

Discussion. This species is represented by a single specimen at station 107.

Eponides repandus (Fichtel and Moll), 1798 (Plate 21, Figs. 6, 7)

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

Eponides repandus Montfort, 1808, Conch. Syst., vol. 1, p. 127, 32^{e} genre.

Pulvinulina repanda Carpenter, 1862, Introd. Foram., p. 210.

Diagnosis. Test almost equally biconvex, peripheral margin acute, often slightly lobulate, carinate; chambers usually seven or eight in last-formed whorl, distinct, not inflated, increasing rather evenly in size as added, ventral side somewhat truncated; sutures distinct, limbate on both sides, dorsal ones greatly curved, ventral ones nearly radiate; wall smooth except for slightly raised sutures on dorsal side, finely perforate, final chamber often with large pores; aperture about midway between umbilicus, peripheral margin on ventral side.

Eponides turgidus Phleger and Parker, 1951 (Plate 21, Figs. 8, 9)

Eponides turgidus Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 22, Pl. 11, Figs. 9a, 9b.

Diagnosis. Test very small, biconvex, consisting of about four whorls; periphery rounded; chambers distinct, four in last-formed whorl, slightly inflated on dorsal side, very inflated on ventral; sutures distinct, slightly curved, slightly depressed on dorsal side, more depressed on ventral side; wall thin, translucent, finely perforate; aperture long, low, arched opening midway between umbilicus and periphery, with narrow lip.

Discussion. This species is represented by a few specimens at station 107.

FAMILY AMPHISTEGINIDAE Cushman, 1927

GENUS AMPHISTEGINA d'Orbigny, 1826

Amphistegina lessonii d'Orbigny, 1826 (Plate 21, Fig. 10)

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

Diagnosis. Test lenticular, circular in side view, often involute on dorsal side, ventral side with supplementary chambers irregularly rhomboid; wall calcareous, finely perforate; apperture ventral.

Discussion. This species occurs at 14 stations, most of which are located in Gulf of Mexico waters adjacent to Florida Bay, in low to high frequencies.

FAMILY CIBICIDIDAE Cushman, 1927

SUBFAMILY PLANULININAE Bermudez, 1952

GENUS PLANULINA d'Orbigny, 1826

Planulina exorna Phleger and Parker, 1951 (Plate 21, Figs. 11, 12)

Planulina exorna Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 32, Pl. 18, Figs. 5-8.

Diagnosis. Test plano-convex, evolute in early stages, becoming involute in later stages; last-formed chambers lobulate, irregular; sutures limbate, slightly raised in early portion, depressed in later portion; wall of early portion with small bead-like processes, later portion perforate; aperture arched opening extending onto evolute side.

Discussion. This species occurs at four station, usually in low frequencies.

Planulina foveolata (Brady), 1884 (Plate 22, Figs. 1, 2)

Anomalina foveolata Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 674, Pl. 94, Fig. 1.

Planulina foveolata Phleger and Parker, 1951, Mem. Geol. Soc. Amer., v. 46, pt. 2, p. 33, Pl. 18, Figs. 9, 10.

Diagnosis. Test compressed, discoidal, composed of three whorls, more or less visible from both sides, dorsal side flat, somewhat concave near umbilicus, ventral side slightly convex, periphery thick, rounded, final whorl composed of about 9 chambers; sutures limbate on ventral side, slightly raised, slightly depressed on dorsal side; surface more or less areolated by exogenous shelly deposits, especially on ventral side; aperture arched slit, oblique, at inner margin of terminal chamber.

Discussion. This species is represented by a few specimens at station 103.

SUBFAMILY CIBICIDINAE Cushman, 1927

GENUS CIBICIDES Montfort, 1808

Cibicides cicatricosus (Schwager), 1866 (Plate 22, Figs. 3, 4)

Anomalina cicatricosa Schwager, 1866, Geol. Theil, vol. 2, no. 2, p. 260, Pl. 7, Figs. 4, 108.

Cibides cicatricosus Cushman and Stainforth, 1951, Journ. Paleont., vol. 25, p. 163, Pl. 28, Fig. 27.

Diagnosis.. Test circular spiral, moderately thick, somewhat flattened dorsal surface, rounded on ventral side; chambers with simple radial arrangement or somewhat backward sloping, nine to twelve per whorl, initial portion rather low, flat, later arched, on dorsal side sometimes almost spherical, slightly broadened, only last whorl visible on ventral side; umbilicus usually covered with encrusting material, similar encrustations sometimes also found in early portion of dorsal side, usually over chamber partition, remaining chambers with irregularly scattered perforations, sometimes interconnected; surface pitted; sutures sometimes irregularly depressed; aperture simple large slit over periphery of last-formed chamber, sometimes extending down onto ventral side.

Discussion. This spcies occurs at only two stations, being represented by a single specimen at station 3 and being quite common in the deep water of station 1.

Cibicides robustus (Flint), 1897 (Plate 22, Figs. 5, 6)

Cibicides robustus Phleger and Parker, 1951, Mem, G.S.A., vol. 46, pt. 2, p. 31, Pl. 17, Figs. 1-4.

Diagnosis. Test large, biconvex, about three-and-one-half whorls in adult, inner whorls of adult on evolute side covered with shell material forming plug; periphery rounded; sutures limbate; wall thick, smooth, coarsely perforate; aperture peripheral extending over onto evolute side.

Discussion. This species occurs at only three stations;in low frequencies at two, and with a medium frequency at the third.

Cibicides cf. C. rugosa Phleger and Parker, 1951 (Plate 22, Figs. 7, 8)

Cibicides rugosa Phleger and Parker, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 31, Pl. 17, Figs. 5a, b, 6a, b.

Diagnosis. Test large, usually plano-convex with evolute side in some specimens slightly convex, almost circular in outline, partially involute, consisting of 3 whorls; periphery subacute, slightly lobulate in last-formed chambers; chambers distinct, 10-12 in last-formed whorl, narrow, last-formed ones slightly inflated; sutures distinct on evolute side, may be obscured by surface ornamentation on involute, curving back very sharply along periphery on both sides, heavily limbate, raised on evolute side, flush with surface, limbate on involute side, coarsely papillate on involute side, pipillae often form an almost reticulate pattern, with considerable variation in amount of ornamentation in different specimens; aperture peripheral, extending over on dorsal side, inner edges of chambers of last-formed whorl form overlapping processes over earlier chambers.

Discussion. The few specimens of this species found in Florida Bay closely resemble the types of Phleger and Parker. However, the Florida Bay specimens were found in water shallower than 4 m. while the specimens of Phleger and Parker were taken from a depth of 914 m.

FAMILY PLANORBULINIDAE Schwager, 1877

GENUS PLANORBULINA d'Orbigny, 1826

Planorbulina acervalis Brady, 1884 (Plate 22, Figs. 9, 10)

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

Diagnosis. Test typically adherent, composed of numerous chambers, early ones spiral, later ones irregularly annular, those of periphery lobulated, newly added chambers extending outward considerably beyond preceding ones; ventral surface often covered by mass of small acervuline chambers; wall conspicuously porous; aperture lipped.

Discussion. This species occurs at only four stations, usually in low frequencies.

Planorbulina mediterranensis d'Orbigny, 1826 (Plate 22, Figs. 11, 12)

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

Diagnosis. Test in early portion coiled, attached by ventral surface; very earliest chambers slightly trochoid, closely spiraled, later in irregular series of single layers about periphery; wall of last-formed chambers coarsely perforate; sutures depressed, often clearly marked on dorsal side by distinct band of shell material; apertures at either side of the chamber in adult, simple, each with raised lip.

Discussion. This species is represented by single specimens at only three stations.

FAMILY CYMBALOPORIDAE Cushman, 1927

GENUS CYMBALOPORETTA Cushman, 1928

Cymbaloporetta squammosa (d'Orbigny), 1826 (Plate 23, Figs. 1, 2)

Rotalia squammosa d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 272, no. 8.

Rosalina squammosa d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 91, Pl. 3, Figs. 12-14.

Rosalina poeyi d'Orbigny, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 62, Pl. 3, Figs. 18-20.

Cymbalopora poeyi Carpenter, Parker and Jones, 1862, Introd. Foram., p. 215, Pl. 13, Figs. 10-12.

Cymbalopora poeyi Carpenter, Parker and Jones, var. squammosa Chapman, 1902, Journ. Linn. Soc. Zool., v. 28, p. 385, 405.

Cymbalopora squammosa Cushman, 1922, Publ. 311, Carnegie Inst., Wash., p. 41, Pl. 6, Figs. 4-6.

Cymbaloporetta squammosa Cushman, 1928, Contr. Cush. Lab. Foram. Res., v. 4, p. 7.

Diagnosis. Test subconical, trochoid, dorsal side very convex, bluntly pointed, variable height, ventral side flattened or slightly concave, usually consisting of 6 or 7 chambers, widest at outer border, then contracted, widening again, finally contracted again, tapering toward center where all chambers unite; chambers separated by definite depressed area; wall coarsely perforate on dorsal side, pores confined to middle of chambers on ventral side; aperture at margin of base of last-formed chamber, thin extensions of inner end of chamber often arch leaving large openings at either side into central umbilical area.

Discussion. Cymbaloporetta occures at eight stations in very low frequencies.

FAMILY HOMOTREMATIDAE Cushman, 1927

SUBFAMILY HOMOTREMATINAE Cushman, 1927

GENUS HOMOTREMA Hickson, 1911

Homotrema rubrum (Lamarck), 1816 (Plate 23, Fig. 3)

Millipora rubra Lamarck, 1816, Hist. Nat. Anim. sans Vert., v. 2, p. 202.

Polytrema rubra Dujardin, 1841, Hist. Nat. Zooph., p. 259.

Homotrema rubrum Hickson, 1911, Trans. Linn. Soc. London, Zool., ser. 2, v. 14, p. 445, 454, Pl. 30, Fig. 2; Pl. 31, Fig. 9; Pl. 32, Figs. 19, 22, 28.

Diagnosis. Test attached,earliest chambers in whorl trochospiral,later ones forming irregular mass, honeycombed, surface composed of reticulate pattern, central portion of each mesh with thin perforated plate, walls of mesh-work solid, nonporous; whole mass raised into irregular subcylindrical masses in early stages, later fusing, spreading so that whole test becomes irregularly rounded mass rising above surface of attachment with papillae raised above rest of surface; dull to bright red.

Discussion. This species occurs at only four stations. At three of these, located between the outer reef trace and the Florida Keys it is abundant, forming a noticeable portion of the sediment by imparting a pink hue to it. At the fourth station it is very rare. This species is commonly attached to coral, and upon death and breakup becomes part of the sediment.

SUBFAMILY VICTORIELLINAE Chapman and Crespin, 1930

GENUS CARPENTERIA Gray, 1858

Carpenteria proteiformis Goës, 1882 (Plate 23, Fig. 4)

Carpenteria balaniformis Gray, var. proteiformis Goës, 1882, Kongl. Svensk. Vet. Akad. Handl., v. 19, no. 4, p. 94, Pl. 6, Figs. 208-214; Pl. 7, Figs. 215-219.

Carpenteria proteiformis Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 679, Figs. 8-14.

Diagnosis. Test attached, columnar, basal portion usually somewhat spreading, buttressed; early chambers coiled, attached by dorsal side, covered by later chambers which become much inflated, built up into irregular, subcylindrical column of few chambers; wall coarsely perforate; aperture often with tubular neck, slight lip.

Discussion. This species is represented by only a few specimens at station 103.

SUPERFAMILY CASSIDULINACEA d'Orbigny, 1839

FAMILY PLEUROSTOMELLIDAE Reuss, 1860

SUBFAMILY PLEUROSTOMELLINAE Reuss, 1860

GENUS PLEUROSTOMELLA Reuss, 1860

Pleurostomella sp. (Plate 23, Fig. 5)

Discussion. Only a single specimen of this species was found in the deep water at station 1.

FAMILY CAUCASINIDAE Bykova, 1959

SUBFAMILY FURSENKOININAE Loeblich and Tappan, 1961

GENUS FURSENKOINA Loeblich and Tappan, 1961

Fursenkoina complanata (Egger), 1893 (Plate 23, Fig. 6)

Virgulina schreibersiana Czjzek var. complanata Egger, 1893, Abhandl. K. bay. Akad. Wiss. Muchen, vol. 18, p. 292, Pl. 8, Figs. 91, 92.

Diagnosis. Test elongate; early chambers strongly triserial, later ones irregularly biserial; whole test twisted; wall smooth, finely perforate; aperture broadly loop-shaped.

Discussion. This species occurs at 12 stations, usually in low frequencies.

Fursenkoina compressa (Bailey), 1851 (Plate 23, Fig. 7)

Bulimina compressa Bailey, 1851, Smiths. Contr., vol. 2, art. 3, p. 12, Pl. 12, Figs. 35-37.

Bulimina presli Reuss, var. (Virgulina) schreibersii (part) Parker and Jones, 1865, Philos. Trans., vol. 155, p. 375, Pl. 17, Fig. 72.

Virgulina schreibersiana Flint (not Czjzek), 1897 (1899), Rep. U.S. Nat. Mus., p. 291, Pl. 37, Fig. 6.

Virgulina compressa Cushman, 1922, U.S. Nat. Mus., Bull. 104, pt. 3, p. 116, Pl. 24, Figs. 2, 3.

Diagnosis. Test large, elongate; chambers numerous, early few triserial, later ones biserial, somewhat twisted; wall smooth, thick, polished, finely perforate; aperture loop-shaped.

Discussion. This species occurs at three stations in low to medium frequencies.

Fursenkoina mexicana (Cushman), 1922 (Plate 23, Fig. 8)

Virgulina mexicana Cushman, 1922, U.S. Nat. Mus., Bull. 104, pt. 3, p. 120, Pl. 23, Fig. 8.

Diagnosis. Test elongate, compressed, broadly fusiform, broadly rounded at initial end, apertural end bluntly pointed; chambers few, rounded, not well distinguished from one another;

sutures indistinct, not depressed; wall smooth, polished, translucent; aperture elongate, oval, broadest at inner end, narrowing toward edge of chamber.

Discussion. This species is represented by single specimens at only three stations.

Fursenkoina pontoni (Cushman), 1932 (Plate 23, Fig. 9)

Virgulina pontoni Cushman, 1932, Contr. Cush. Lab. Foram. Res., vol. 8, pt. 1, p. 17, Pl. 3, Fig. 7.

Diagnosis. Test elongate, tapering, greatest breadth formed by two last-formed chambers, early chambers triserial, later ones biserial, somewhat twisted; wall smooth, finely perforate; aperture elongate, narrow.

Discussion. This species occurs at nine stations, always in very low frequencies.

FAMILY LOXOSTOMIDAE Loeblich and Tappan, 1962

GENUS LOXOSTOMUM Ehrenberg, 1854

Loxostomum abruptum Phleger and Parker, 1951

Loxostomum truncatum Phleger and Parker, 1951, Mem. G.S.A., vol. 46, pt. 2, p. 17, Pl. 7, Figs. 15-19.

Loxostomum abruptum Phleger and Parker, 1952, Contr. Cush. Found. Foram. Res., vol. 3, pt. 1, P. 14.

Diagnosis. Test small, gradually tapering; chambers extending at base into overhangering ridges, very slightly at initial end, uniformly increasing toward apical end; wall smooth with coarse perforations, except at sutures which are raised; aperture loop-shaped, terminal.

Discussion. This species is represented by a single specimen at station 93.

Loxostomum mayori (Cushman), 1922 (Plate 23, Fig. 10)

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

Loxostomum mayori Bermudez, 1935, Mem. Soc. Cubana Hist. Nar., vol. 9, p. 197.

Diagnosis. Test elongate, slender, often arcuate or somewhat twisted, somewhat compressed, periphery rounded, early portion somewhat tapering, later with sides nearly parallel throughout their length; chambers numerous, distinct, becoming gradually higher as added until, in later development, height becomes greater than breadth, last-formed chambers uniserial, usually with oblique sutures, somewhat more rounded in form than early portion; sutures distinct, limbate, slightly depressed, more so in later portion, in early portion oblique, nearly straight, later becoming sigmoid as chambers tend to become uniserial, wall coarsely perforate, perforations often in longitudinal lines, surface with few, short, weakly developed costae; aperture in adult terminal, narrowly elliptical, often with slight rounded lip.

Discussion. This species is represented by a single specimen at station 104.

Loxostomum porrectum (Brady), 1884 (Plate 23, Fig. 11)

Bolivina porrecta Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 106, Pl. 52, Fig. 22.

Bifarina porrecta Millett, 1900, Jour. Roy. Micr. Soc., p. 540, Pl. 4, Fig. 3.

Loxostomum porrectum Cushman, 1937, Cush. Lab. Foram. Res., Spec. Publ. 9, p. 190.

Diagnosis. Test elongate, slightly tapering, apex rounded; apertural end truncate, compressed, edges rounded; chambers high, later ones triangular, sutures in later growth passing entirely across test forming almost uniserial stage; wall smooth, perforate; aperture subterminal, removed from inner edge of chamber, elongate, with raised border.

Discussion. This species is represented by a single specimen at station 104.

FAMILY CASSIDULINIDAE d'Orbigny, 1839

GENUS CASSIDULINA d'Orbigny, 1826

Cassidulina subglobosa Brady, 1881 (Plate 23, Fig. 12)

Cassidulina subglobosa Brady, 1881, Quart. Journ. Micr. Sci., vol. 21, p. 60.

Diagnosis. Test subglobular, somewhat compressed on two lateral faces, inequilateral; segments few, slightly inflated; alternation irregular; aperture oblique or nearly erect loop-shaped slit on face of projecting terminal segment.

Discussion. A single specimen of this species occurs at station 1.

GENUS EHRENBERGINA Reuss, 1850

Ehrenbergina pacifica Cushman, 1927 (Plate 23, Fig. 13)

Ehrenbergina serrata Brady (part) (not Reuss), 1884, Rep. Voy. Challenger, Zool., vol. 9, Pl. 55, Figs. 6, 7.

Ehrenbergina serrata Cushman (not Reuss), 1911, U.S. Nat. Mus., Bull. 71, pt. 2, p. 101, Figs. 155a, b.

Ehrenbergina pacifica Cushman, 1927, Proc. U.S. Nat. Mus., vol. 70, no. 2665, p. 5, Pl. 2, Fig. 2.

Diagnosis. Test triangular in front view, chambers numerous, low, broad, dorsal side convex, ventral side with narrow median furrow which may be entirely closed; sutures distinct, on dorsal side flush with surface, on ventral side depressed; periphery with long spinose processes from upper angle of each chamber extending straight out from test, each chamber with ventral angle having raised ridge continuing to spine at periphery; aperture elongate, narrow.

Discussion. This species is represented by only a few specimens at station 1.

FAMILY NONIONIDAE Schultze, 1854

SUBFAMILY NONIONINAE Schultze, 1854

GENUS NONION Montfort, 1808

Nonion depressulum var. matagordanum Kornfeld, 1931 (Plate 23, Fog. 14)

Nonion depressulum (Walker and Jacob) var. matagordanum Kornfeld, 1931, Stanford Univ., Dept. Geol., Contr., vol. 1, no. 3, p. 87, Pl. 13, Figs. 2a, b.

Diagnosis. Test nearly circular in side view, eight to nine chambers in last whorl, in apertural view with parallel sides, broadly rounded angles, narrow, slightly longer than wide; very slightly, if at all, depressed at umbilicus; chambers somewhat inflated, sutures depressed, forming lobulated periphery; umbilical regions with slight tendency toward filling in of shell material, slight trace of stellate extension of this material along sutures; wall smooth, finely punctate; aperture narrow arched slit at base of apertural face.

Discussion. This species occurs at 58 stations, all within Florida Bay proper, in low to medium frequencies. It appears to be concentrated in the shallow water around the Keys, and the very shallow water over grass flats and mud banks.

Nonion grateloupi (d'Orbigny), 1826 (Plate 23, Fig. 15)

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

Nonion grateloupi Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 10, Pl. 3, Figs. 9-11, Pl. 4, Figs. 1-4.

Diagnosis. Test planispiral, bilaterally symmetrical, periphery rounded; chambers numerous, increasing rapidly in length, especially in last few chambers; sutures distinct; wall smooth, finely perforate; aperture small, at base of last-formed chamber.

Discussion. This speices occurs at 15 stations, usually in very low frequencies.

GENUS ASTRONONION Cushman and Edwards, 1937

Astrononion stelligerum (d'Orbigny), 1839 (Plate 24, Figs. 1-3)

Nonionina stelligera d'Orbigny, 1839, in Webb and Berthelot, Hist. Nat. des Iles Canaries, vol. 2, pt. 2, p. 128, Pl. 3, Figs. 1, 2.

Astrononion stelligerum Cushman and Edwards, 1937, Contr. Cush. Lab. Foram. Res., vol. 13, p. 31, Pl. 3, Figs. 7A, B.

Diagnosis. Test strongly compressed, umbilical region slightly depressed, periphery rounded; chambers of primary coil distinct, of rather uniform shape, increasing regularly in size as added, slightly if at all inflated, apertural face much higher than broad, supplementary chambers elongate, narrow, very irregularly rhomboid, with very sharp, distinct angle toward umbilical end, pointing posteriorly; sutures distinct, rather strongly curved, little if at all depressed, those between supplementary chambers very distinct; wall smooth, finely perforate; aperture low, arched, opening at base of apertural face at median line.

Disucssion. This species is represented by a single specimen at station 107.

FAMILY OSANGULARIIDAE Loeblich and Tappan, 1964

GENUS OSANGULARIA Brotzen, 1940

Osangularia cultur (Parker and Jones), 1865 (Plate 24, Figs. 4, 5)

Planorbulina cultur Parker and Jones, 1865, Philos. Trans., p. 421, Pl. 19, Fig. 1.

Truncatulina cultur (Parker and Jones) Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 668, Pl. 96, Fig. 3.

Pulvinulinella cultur (Parker and Jones) Cushman, 1927, Bull. Scripps Inst. Oceanography, Tech. Ser., vol. 1, no. 10, p. 164, Pl. 5, Figs. 8, 9.

Parella cultur (Parker and Jones) Hofker, 1951, Siboga-Exped., Mon. IVa, pt. III, p. 336, Text Figs. 229-232.

Osangularia cultur (Parker and Jones) Phleger, Parker and Peirson, 1953, Rep. Swedish Deep-Sea Exped., vol. 7, no. 1, p. 42, Pl. 9, Figs. 11, 16.

Diagnosis. Test trochoid, close-coiled, biconvex; umbilical area with distinct solid mass; sutures strongly oblique; periphery acute, with irregular keel forming sawtooth edge; wall perforate; aperture narrow opening into umbilical area on ventral side.

Discussion. This species occurs at only five stations, usually being represented by single specimens.

GENUS GYROIDINOIDES Brotzen, 1942

Gyroidinoides soldanii var. altiformis (R.E. and K.C. Stewart), 1930

Gyroidina soldanii d'Orbigny var. altiformis R.E. and K.C. Stewart, 1930, Journ. Paleont., vol. 4, no. 3, p. 67, Pl. 9, Fig. 2.

Diagnosis. Test trochoid, plano-convex, dorsal side flattened, ventral side convex, umbilicate; all chambers visible from dorsal side, only those from last-formed whorl from ventral side; umbilical area large; sutures dorsally raised, ornate; wall perforate; aperture elongate slit at base of last-formed chamber on ventral side.

Discussion. This species is represented by single specimens at only two stations.

FAMILY ANOMALINIDAE Cushman, 1927

SUBFAMILY ANOMALININAE Cushman, 1927

GENUS ANOMALINA d'Orbigny, 1826

Anomalina globulosa Chapman and Parr, 1937 (Plate 24, Fig. 6)

Anomalina globulosa Chapman and Parr, 1937, Aust. Atn. Exped., Sci. Repts., Ser. C, vol. 1, pt. 2, p. 117.

Diagnosis. Test consisting of about two and one-half coils, all visible on superior surface, only last-formed coil showing on inferior face; about seven chambers in last coil, strongly inflated; periphery rounded; sutures deeply impressed; superior face more or less flattened, inferior face depressed in umbilical region, otherwise strongly convex; surface of test deeply pitted; aperture crescentric, placed almost symmetrically in median line.

Discussion. This species is represented by a single specimen at station 103.

SUPERFAMILY ROBERTINACEA Reuss, 1850

FAMILY CERATOBULIMINIDAE Cushman, 1927

SUBFAMILY EPISTOMININAE Wedekind, 1937

GENUS HOEGLUNDINA Brotzen, 1948

Hoeglundina elegans (d'Orbigny), 1826 (Plate 24, Figs. 7-10)

Rotalia (Turbinulina) elegans d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 276, no. 54.

Pulvinulina elegans Parker, Jones and Brady, 1871, Ann. Mag. Nat. Hist., ser. 4, vol. 8, p. 174, Pl. 12, Fig. 142.

Epistomina elegans Martinotti, 1926, Boll. R. Ufficio geol. Ital., vol. 51, p. 3.

Hoeglundina elegans Brotzen, 1948, Sver. Geol. Undersok., vol. 42, no. 2, p. 92.

Diagnosis. Test biconvex, either with sides nearly equally convex or ventral side more strongly so, especially in microspheric form, periphery rounded or in small specimens more acute; chambers usually distinct, typically seven to nine in megalospheric form, increasing to as many as fourteen in largest microspheric specimens; sutures distinct, limbate, not raised, on dorsal side strongly oblique, on ventral side obliquely radial ending at center in umbonate mass; wall finely perforate, in thin-walled specimens often showing complex pattern of thickenings, in thick-walled specimens opaque; aperture usually narrow, on ventral side at base of last-formed chamber toward periphery, with supplementary aperture in axis of coiling, parallel to peripheral margin, just ventral to it, elongate.

Discussion. This occurs at only three stations, but where it is present it is common or abundant. It is most abundant at station 1 where the water depth is 587 meters. The other two stations where it occurs also have greater depths than the rest of the area.

FAMILY ROBERTINIDAE Reuss, 1850

GENUS ROBERTINOIDES Höglund, 1947

Robertinoides bradyi Cushman and Parker, 1936 (Plate 24, Fig. 11)

Bulimina subteres Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, Pl. 50, Figs. 18a, b.

Robertina bradyi Cushman and Parker, 1936, Contr. Cush. Lab. Foram. Res., vol. 12, p. 99.

Robertinoides bradyi Hofker, 1956, Spolia. Zool. Mus. Hauniensis, vol. 15, p. 128.

Diagnosis. Test somewhat longer than broad, fusiform, initial end bluntly pointed, apertural end broadly rounded; chambers slightly inflated, four to five pairs in last-formed whorl, increasing rapidly in size as added, next to last chamber in series with apertural one meeting median line; sutures distinct, slightly depressed, strongly limbate; wall smooth, polished, fairly thick; aperture very elongate, open, only slightly curved in median line of axis, supplementary aperture short, fairly high.

Discussion. This species is represented only at station 1 by a very few specimens. (In Table 1 this species is listed under two genera, Robertina and Robertinoides, they should both be placed under Robertinoides.)

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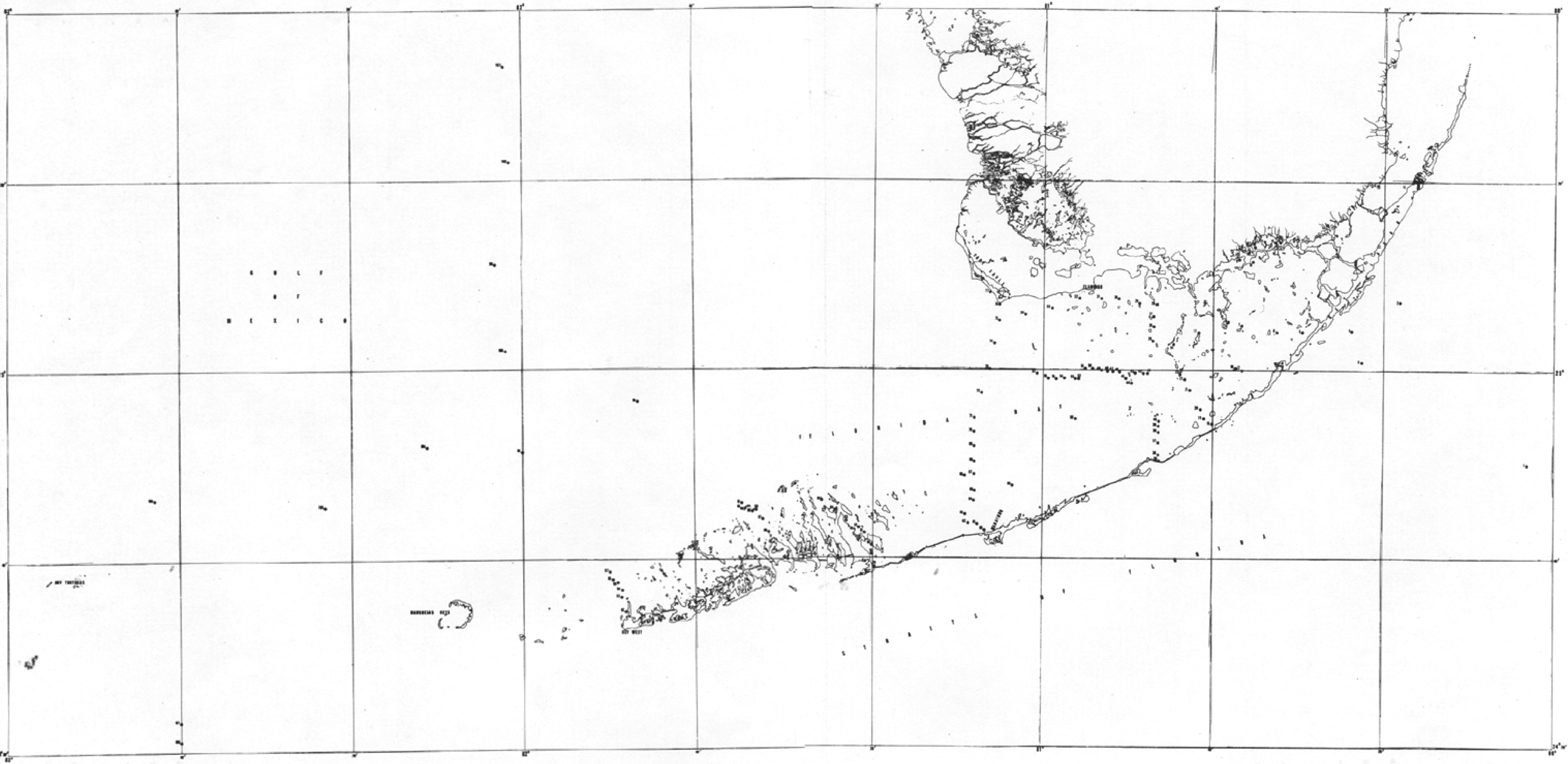
NORTH LATITUDE / WEST LONGITUDE / DEPTH (IN METERS) / STATION NUMBER	Distribution by station (R, C, A)
Alveophragmium subglobosum	[illegible]
Ammobaculites agglutinans	[illegible]
A. sp.	[illegible]
Ammonia beccarii parkinsoniana	[illegible]
Amphicoryna hirsuta	[illegible]
A. scalaris	[illegible]
Amphistegina lessonii	[illegible]
Angulogerina bella	[illegible]
Anomalina globulosa	[illegible]
Archaias angulatus	[illegible]
A. compressus	[illegible]
Articulina antillarum	[illegible]
A. lineata	[illegible]
A. mayori	[illegible]
A. mexicana	[illegible]
A. mucronata	[illegible]
A. multilocularis	[illegible]
A. pacifica	[illegible]
A. sagra	[illegible]
Astacolus crepidulus	[illegible]
A. reniformis	[illegible]
Asterigerina carinata	[illegible]
Astrononion stelligerum	[illegible]
Bigenerina irregularis	[illegible]
B. nodosaria	[illegible]
B. textularoidea	[illegible]
Bolivina cf. barbata	[illegible]
B. fragilis	[illegible]
B. goësii	[illegible]
B. hastata	[illegible]
B. inflata	[illegible]
B. lanceolata	[illegible]
B. lowmani	[illegible]
B. paula	[illegible]
B. pulchella primitiva	[illegible]
B. striatula	[illegible]
B. subaenariensis mexicana	[illegible]
B. subspinensis	[illegible]
B. sp.	[illegible]
Bulimina spicata	[illegible]
Buliminella elegantissima	[illegible]
Cancris oblonga	[illegible]
C. sagra	[illegible]
Carpenteria proteiformis	[illegible]
Cassidulina subglobosa	[illegible]
Cassidulinoides bradyi	[illegible]
Chrysalidinella dimorpha	[illegible]
Cibicides cicatricosus	[illegible]
C. robertsonianus	[illegible]
C. robustus	[illegible]
Clavulina difformis	[illegible]
C. tricarinata	[illegible]
Cornuspiroides foliaceus	[illegible]
Cruciloculina triangularis	[illegible]
Cyclogyra involvens	[illegible]
C. planorbis	[illegible]
Dentalina communis	[illegible]
D. filiformis	[illegible]
Discorbis rosea	[illegible]
D. aguayoi	[illegible]
Rosalina candeiana	[illegible]
R. floridana	[illegible]
R. floridensis	[illegible]
R. cf. nitida	[illegible]
R. rosacea	[illegible]
Ehrenbergina pacifica	[illegible]
Elphidium advenum	[illegible]
E. crispum	[illegible]
E. discoidale	[illegible]
E. poeyanum	[illegible]
E. sagrum	[illegible]
Eponides antillarum	[illegible]
E. regularis	[illegible]
E. repandus	[illegible]
E. turgidus	[illegible]
Fissurina submarginata	[illegible]
F. wiesneri	[illegible]
Frondicularia sagittula	[illegible]
Fursenkoina complanata	[illegible]
F. compressa	[illegible]
F. mexicana	[illegible]
F. pontoni	[illegible]
Globobulimina mississippiensis	[illegible]
Globulina sp.	[illegible]
Guttulina australis	[illegible]
Gyroidinoides soldanii altiformis	[illegible]
Haplophragmoides canariensis	[illegible]
Hauerina bradyi	[illegible]
H. speciosa	[illegible]
Hauerinella inconstans	[illegible]
Heterostegina depressa	[illegible]
Hoglündina elegans	[illegible]
Hyperammina elongata	[illegible]
H. subnodosa	[illegible]
Ammodiscus anguillae	[illegible]
A. tenuis	[illegible]
Jaculella acuta	[illegible]
Karreriella bradyi	[illegible]
Lagena striata	[illegible]
L. sp.	[illegible]
L. sp.	[illegible]
Laticarinina holophora	[illegible]
Lenticulina calcar	[illegible]
L. iota	[illegible]
L. peregrina	[illegible]
Liebusella soldanii	[illegible]
Loxostomum abruptum	[illegible]
L. mayori	[illegible]
L. porrectum	[illegible]
Marginulina planata	[illegible]
M. sp.	[illegible]
Massilina protea	[illegible]
M. secans	[illegible]
Miliolinella circularis	[illegible]
M. fichteliana	[illegible]
M. labiosa	[illegible]
M. obliquinoda	[illegible]
M. suborbicularis	[illegible]
Miniacina miniacea	[illegible]
Monalysidium politum	[illegible]
Neoalveolina cf. schlumbergeri	[illegible]
Nodobaculariella cassis	[illegible]
Nodosaria albatrossi	[illegible]
N. flintii	[illegible]
N. pyrula	[illegible]
N. sp.	[illegible]
Nonion depressulum matagordanum	[illegible]
N. grateloupi	[illegible]
Osangularia cultur	[illegible]
Peneroplis bradyi	[illegible]
P. carinatus	[illegible]
P. pertusus	[illegible]
P. proteus	[illegible]
Planorbulina acervalis	[illegible]
P. mediterranensis	[illegible]
Planulina exorna	[illegible]
P. foveolata	[illegible]
Pleurostomella sp.	[illegible]
Polymorphinidae fistulose form	[illegible]
Broeckina orbitolitoides	[illegible]
Pseudoclavulina mexicana	[illegible]
Pseudoeponides umbonatus	[illegible]
Pseudoglandulina comatula	[illegible]
Pyrgo comata	[illegible]
P. denticulata	[illegible]
P. elongata	[illegible]
P. fornasinii	[illegible]
P. murrhina	[illegible]
P. subsphaerica	[illegible]
Pyrulina cylindroides	[illegible]
Quinqueloculina agglutinans	[illegible]
Q. antillarum	[illegible]
Q. bicarinata	[illegible]
Q. bicostata	[illegible]
Q. bidentata	[illegible]
Q. bosciana	[illegible]
Q. cf. bradyana	[illegible]
Q. candeiana	[illegible]
Q. collumnosa	[illegible]
Q. crassa subcuneata	[illegible]
Q. dilatata	[illegible]
Q. horrida	[illegible]
Q. laevigata	[illegible]
Q. lamarckiana	[illegible]
Q. parkeri occidentalis	[illegible]
Q. poeyana	[illegible]
Q. polygona	[illegible]
Q. tenagos	[illegible]
Q. sabulosa	[illegible]
Q. seminulum	[illegible]
Q. sp.	[illegible]
Q. subpoeyana	[illegible]
Q. tricarinata	[illegible]
Q. vulgaris	[illegible]
Q. wiesneri	[illegible]
Rectobolivina advena	[illegible]
Rectoglandulina rotundata	[illegible]
R. torrida	[illegible]
Reophax dentaliniformis	[illegible]
R. difflugiformis	[illegible]
R. fusiformis	[illegible]
R. nodulosus	[illegible]
R. scorpius	[illegible]
R. sp.	[illegible]
Reussella atlantica	[illegible]
Robertina bradyi	[illegible]
Robertinoides bradyi	[illegible]
Robulus sp.	[illegible]
"Rotalia" translucens	[illegible]
Saracenaria latifrons	[illegible]
Schlumbergerina alveoliniformis occidentalis	[illegible]
Sigmoilina distorta	[illegible]
S. schlumbergeri	[illegible]
Siphonina bradyana	[illegible]
Sorites marginalis	[illegible]
Spirillina denticulata	[illegible]
S. obconica	[illegible]
S. vivipara	[illegible]
Spirolina acicularis	[illegible]
S. arietinus	[illegible]
Spiroloculina antillarum	[illegible]
S. arenata	[illegible]
S. caduca	[illegible]
S. communis	[illegible]
S. cf. costifera	[illegible]
S. ornata	[illegible]
S. planulata	[illegible]
S. rotunda	[illegible]
S. soldanii	[illegible]
Spiroplectammina floridana	[illegible]
Technitella legumen	[illegible]
Textularia agglutinans	[illegible]
T. candeiana	[illegible]
T. conica	[illegible]
T. mayori	[illegible]
Textulariella barrettii	[illegible]
Tretomphalus atlanticus	[illegible]
Trifarina bradyi	[illegible]
Triloculina bassensis	[illegible]
T. bermudezi	[illegible]
T. bicarinata	[illegible]
T. carinata	[illegible]
T. fitterei meningoi	[illegible]
T. gracilis	[illegible]
T. linneiana	[illegible]
T. linneiana comis	[illegible]
T. oblonga	[illegible]
T. planciana	[illegible]
T. rotunda	[illegible]
T. sidebottomi	[illegible]
T. squamosa	[illegible]
T. tricarinata	[illegible]
T. trigonula	[illegible]
Trochammina japonica	[illegible]
Uvigerina flintii	[illegible]
U. peregrina	[illegible]
Valvulina oviedoiana	[illegible]
Valvulineria cf. araucana	[illegible]

TABLE 1. Distribution and relative abundance of total benthonic foraminiferal tests (R Rare, C Common, A Abundant).



DISTRIBUTION AND MODEL STUDIES ON FORAMINIFERA LIVING IN BUTTONWOOD SOUND, FLORIDA BAY

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ABSTRACT

Distribution of foraminiferal standing crop in Buttonwood Sound, Florida Bay, was investigated to define ecological factors controlling or influencing species distributions. A total of 74 samples were collected from a grid system consisting of 19 stations. Stations were occupied three times during August 1962, and once during February 1963. The following environmental parameters of the water-sediment interface were measured: depth, temperature, salinity, pH and Eh. Each sample was analyzed for foraminiferal standing crop and ratio of sand, silt and clay. Q-modal factor-vector analysis divided the standing crop into 17 faunal assemblages, consisting of three to five assemblages in a single collection. Distribution of most of these assemblages appeared to be controlled by an interaction of ecological parameters. A fauna which was related to sediment size and one which was related to bathymetry persisted throughout all collections. Distribution of foraminiferal species and environmental parameters indicated some species were influenced by the measured environmental parameters, but most species showed no such relationships. The faunal information indicated there was no simple linear relationship between distribution of Foraminifera and environmental parameters. Distribution of Foraminifera living in Buttonwood Sound was controlled by a complex interplay of physicochemical and biologic factors, only partially reflected by the measured parameters.

INTRODUCTION

This investigation is part of a project begun at the University of Wisconsin in the summer of 1958, to expand knowledge of Foraminifera living in Florida Bay and environs. Additional samples were collected during the winters of 1960, and 1963.

Benda and Puri (1962) described a similar foraminiferal fauna from the Cape Romano region, located about 80 miles north of Florida Bay on the west coast of Florida. Wilcoxon (1964) described the distribution of Foraminifera off the south Atlantic coast of the United States. Additional work on the foraminiferal fauna of Florida Bay was reviewed in Lynts (1962).

Seventy-four samples were collected from 19 stations located in Buttonwood Sound (Fig. 1). The 19 stations were occupied at three day intervals on August 14th, 17th, 20th, 1962, and once on February 9th, 1963. Two samples from the February 9th, 1963 collection were not used in the study. The majority of samples were collected using short cores, but a few were grab samples.

The relationship between foraminiferal species and physioco-chemical parameters was analyzed quantitatively to ascertain influence of ecologic factors on distribution of Foraminifera.

ACKNOWLEDGMENTS

The study was supported in part by a National Science Foundation Fellowship, Penrose Bequest Grant number 909-62 from the Geological Society of America and Public Health Service Grant number 1-Ti-DE-132-01. The Numerical Analysis Laboratory, University of Wisconsin, and Columbia Computer Center, Columbia University, furnished computer time. I wish to thank the Institute of Marine Science, University of Miami, for use of their facilities and equipment at various times during the study.

LOCATION

Buttonwood Sound is part of Florida Bay located south of the Florida Peninsula, lying between the Florida mainland and Florida Keys. Buttonwood Sound is in the southeastern part of Florida Bay, adjacent to Largo Key. It lies between 25^{o} 5-8' North Latitude and 80^{o} 26-29' West Longitude. Figure 1 gives the location of the stations.

METHOD OF STUDY

Upon completion of the survey of the foraminiferal fauna and ecological parameters of Florida Bay (Lynts 1961, 1962), it was decided to conduct a study of the benthonic faraminiferal standing crop of Buttonwood Sound. Samples were collected over a relatively short time period, on August 14th, 17th, 20th, 1962. This time interval was used because little was known about the rates of change of ecologic parameters and distribution patterns of organisms in Florida Bay (Greenfield and Oppenheimer, 1962, personal communication).

A sample design was formulated to obtain a valid series of the standing crop and environmental parameters. This consisted of a systematic stratified grid of stations approximately 900 meters apart which was randomly superimposed on the study area. Stations were marked with floats, and compass bearings were taken to allow reoccupation. Sediment cores, with an inside diameter of 4.8 centimeters, were taken at each station on the 14th, 17th, 20th of August 1962. Samples were preserved in a buffered formalin solution. At each station the following environmental parameters of the water-sediment interface were measured: 1) depth, 2) temperature, 3) salinity, 4) pH and 5) Eh (Tables 1, 2, 3, 4 and 5). These parameters were measured in the field, because many of them change rapidly when removed from in situ position (Oppenheimer, 1963, personal communication). Details of measurement of environmental parameters and their relationships are discussed elsewhere (Lynts, 1966a). It was believed that the stations should be reoccupied under as different environmental conditions as possible to act as a control on earlier collections. Stations were therefore resampled on February 9th, 1963. A total of 74 samples were collected.

These samples were treated with rose Bengal, following the procedure described by Walton (1952). Counts of a maximum of 300 stained specimens were made from the 14th and 17th of August 1962 collections, to estimate the standing crop, while all of the stained specimens in the top centimeter of cores were counted from the August 20th, 1962 and February 9th, 1963 collections. Percentages of standing crop values for each collection are given in Tables 1, 2, 3 and 4.

Shenton (1957) and Lynts (1962) have quantitatively investigated the relationship between foraminiferal-sediment size distributions and indicated that the sediment size might be an ecologic factor influencing the distribution of some species. Bandy (1963, personal communication) indicated that some foraminiferal species could be used to predict size of sediment in which they occur. The values for the percent of sand ($\geq 74\mu$), silt and clay are given in Tables 1, 2, 3 and 4.

The above data were analyzed quantitatively to determine the ecological influence upon the distribution of Foraminifera. Linear relationships between foraminiferal species and ecological parameters were analyzed by means of a factor-vector program (Imbrie, 1963; Manson and Imbrie, 1964). This program has been used to analyze foraminiferal faunas of the northwestern Great Bahama Bank (Streeter, 1963, 1964a) and Orinoco-Trinidad-Paria Shelf (Streeter, 1964b).

ENVIRONMENTAL REALM

Florida Bay is a shallow, triangular-shaped body of water containing many low mangrove keys. The Everglades swamps and the mangrove keys, along with turtle grass (*Thalassia testudinum* Konig), supply many organic nutrients. It is an area of active organically derived carbonate deposition: (Baars, 1963; Gorsline, 1963; Taft and Harbaugh, 1964; Ginsburg, 1964), divided into a series of shoals and basins. Shoals regions consist of fine grained sediments which have been trapped by *Thalassia testudinum*, while the basins contain mainly shell gravels. The environment of the bay is characterized by its shallow depth, low tides and widely fluctuating physiochemical parameters (Ginsburg, 1956, 1964; Lloyd, 1964; Taft and Harbaugh, 1964).

Buttonwood Sound

Oceanography. Buttonwood Sound is a restricted portion of Florida Bay adjacent to Largo Key (Fig. 1). It is bounded by mangrove keys on the northeast and southwest, and opens to Florida Bay in the northwest. It is shallow, with a maximum depth of approximately 2.7 meters (Fig. 2).

Little information has been published on the hydrography of the sound. Lloyd (1964) has measured salinities and oxygen isotope ratios from two stations during August 1958, and January 1959 reporting values of 36.5% and 2.3, and 31.7% and 1.9, respectively.

The salinity and pH of the water column were measured at each collecting station during the February 9th, 1963 effort. The water column at each station showed a uniform salinity and pH of 39.6% and 8.2, respectively.

Sediments. Each sample was analyzed for percent sand ($\geq 74\mu$), silt and clay. The ratios are given in Tables 1, 2, 3 and 4. The variations between collections at each station are the result of the inability to reoccupy each station exactly. The ratios from the four collections have been used to prepare a sediment size distribution map (Fig. 3). Details of how this map was prepared have been discussed elsewhere (Lynts, 1966a).

Finer sediments were restricted to regions of Thalassia testudium, which effectively traps them (Ginsburg and Lowenstam, 1958). The sediment at station 12 (Fig. 1) had been thoroughly reworked, as indicated by an abundance of fecal pellets similar to those attributed to holothuroids by Baars (1963). An area of coarser sediment was found adjacent to Largo Key (Fig. 3).

Composition of the sediments was almost wholly carbonate, presumably derived from organic activity. Most of the finer fraction consisted of triturated remains of shells and tests. Clay minerals made up a very minor part of the clay grade-size (Gorsline, 1963). The fine fraction had a high organic content, a result of the breakdown of mangrove and turtle grass debris. This organic matter was not rapidly removed from the sediments by microbial action because of the strongly reducing environment of the sediments. The coarser fraction consisted mainly of molluscan debris, with foraminiferal tests adding significantly to this size grade. Remains of other organisms: ostracodes, echinoids, bryozoans, sponge spicules, ophuiroids and alcyonarians; and a small number of quartz grains, made up the remainder of the fraction.

The environmental parameters of the water-sediment interface did not coincide with those of the overlying waters because of a lag in adjustment between the two phases (Oppenheimer, 1963, personal communication). The only reliable Eh potentials were from the February 1963 collection as the August 1962 measurements were taken after disturbing the water-sediment interface (Lynts, 1966a). Redox potentials of the August 1962 collections may be higher than in situ values, but not any lower (Oppenheimer, 1963, personal communication). Although little information on Eh potentials from carbonate sediments was available (Baas Becking, et al., 1960), the February 1963 redox potentials coincided quite well with the few other measurements taken in Florida Bay (Lindblom and Lupton, 1961).

FAUNAL ANALYSIS

Buttonwood Sound has a maximum depth of approximately 2.7 meters (Fig. 2) and therefore lies within the porcelaneous foraminiferal zone (Phleger, 1960). This is substantiated by the fact that 92 percent of the standing crop was composed of porcelaneous species. A significant part of the fauna is made up of perforate and agglutinate species, five and three percent, respectively. The most abundant porcelaneous species are:

Quinqueloculina bosciana d'Orbigny

Triloculina bermudezi Acosta

Quinqueloculina poeyana d'Orbigny

Quinqueloculina laevigata d'Orbigny

Hauerina bradyi Cushman

while the most common perforate species are Ammonia translucens (Phleger and Parker) and Rosalina floridana Cushman; the most abundant agglutinate species are Valvulina oviedoiana d'Orbigny and Schenckiella occidentalis (Cushman).

August 14th, 1962 Collection

The standing crop was dominated by porcelaneous species (91%), but there were significant numbers of perforate and agglutinate species (6 and 3% respectively). The most common species was Triloculina bermudezi (Table 1), which was found at every station and made up 20 percent of the fauna, while dominant perforate and agglutinate forms were Ammonia translucens and Schenckiella occidentalis, occurring at six and nine stations, respectively, and each making up two percent of the population.

The standing crop was analyzed in terms of a simple, linear mathematical model known as factor-vector analysis (Imbrie, 1963; Manson and Imbrie, 1964; Imbrie and Van Andel, 1964; Gould, 1967). This procedure resolves each sample into contributions from a small number of reference, or end-member, samples. The objective of this analysis is to account for a large fraction of the total information* in the collection in terms of a simple causal scheme.

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* The sum of squares of all entries in data table is defined as total information.

Considering the August 14th, 1962 collection, the Q-modal analysis yielded five reference samples (faunal assemblages) (Table 6a, Figs. 4a-e) which together accounted for 93 percent of the total information.

Using the same approach, the ecologic parameters (depth, temperatures, salinity, pH, Eh and sediment size) were investigated. The result, Environmental Model I (Table 6b, Fig. 5), accounts for 95 percent of the total information.

Environmental Model I is an attempt to integrate available information on environmental parameters and to display systematic patterns of geographic variations in the physical portion of the ecosystem. Admittedly, the number of available parameters is few, but this model does, on an objective and reproducible basis, reveal significant geographic patterns. By comparing the assemblage maps, in this instance, the analysis reveals that much of the variance is closely interlocked, so that only one dimension of environmental change is shown. In the study of other environments, however, where more parameters are measured or where more complex systems occur, it can be anticipated that more than one dimension will be revealed.

Assemblage I (Fig. 4a) is characterized by a dominance of Triloculina bermudezi and the rarer occurrence of Discorbis mira, Rosalina floridana and Clavulina tricarinata d'Orbigny. Though the relationship is not strong, it appears to be inversely related to Environmental Model I (Fig. 5).

Assemblage II (Fig. 4b) is dominated by Quinqueloculina poeyana. Discorbis mira and Schenckiella occidentalis are the most common perforate and agglutinate species, respectively. This assemblage is restricted to the southern and southeastern parts of the sound and appears to be inversely related to both depth (Fig. 2) and salinity (Table 1).

Assemblage III (Fig. 4c) is characterized by the dominance of Archaias angulatus (Fichtel and Moll) and rarer occurrences of Elphidium galvestonense Kornfeld and Valvulina oviedoiana (group 1). This assemblage is located adjacent to Largo Key and appears to be directly related to the coarser sediments (clayey sand) found there (Fig. 3).

Assemblage IV (Fig. 4d) is dominated by Triloculina bermudezi. Rosalina floridana is the most abundant perforate species, while Schenckiella occidentalis and Ammodiscus incertus (d'Orbigny) are the most common agglutinate forms. It is distinguished from Assemblage I by lack of abundant Discorbis mira and the presence of Ammodiscus incertus. This assemblage is restricted to the central portion of the sound and though the relationship is not strong, appears to be directly related to depth of water (Fig. 2).

Assemblage V (Fig. 4e) is characterized by a dominance of Quinqueloculina bosciana and the rarer occurrence of Rosalina floridana. The pattern of the assemblage does not fit any of the measured environmental information well, but may indicate current influence.

The linear relationship between distribution of foraminiferal species and environmental parameters was investigated using factor-vector R-modal analysis. As would be expected, the analysis indicated that the species most sensitive to changes in ecology are rarer forms. Species having similar linear ecological adaptations are grouped together. These reaction groups cut across taxonomic lines, for example the following species are indicated to have similar ecological adaptations:

Cribroelphidium poeyanum (d'Orbigny)

Planorbulina mediterranensis d'Orbigny

Elphidium advenus (Cushman)

Pyrgo subsphaerica (d'Orbigny)

Triloculina sidebottomi (Martinotti)

Bolivina lanceolata Parker

The analysis indicates that the distributions of some species appear to be linearly related to the environmental parameters which were measured. The distribution of Cribroelphidium poeyanum is inversely related to temperature. Distribution of Clavulina tricarinata is directly related to the ratio of clay and inversely related to pH and depth. Distributions of Elphidium galvestonense, Massilina secans (d'Orbigny) and Ammonia beccarii (Linnaeus) are directly related to ratio of sand. Distribution of Quinqueloculina bosciana is inversely related to salinity. These relationships are not particularly strong and probably do not control distributions, but only partially influence them.

August 17th, 1962 Collection

Porcelaneous species made up 91 percent of the standing crop, while perforate and agglutinate forms made up five and four percent, respectively. The dominant species was Triloculina bermudezi (Table 2) which occurred at 18 of the 19 stations and made up 20 percent of the fauna. Rosalina floridana occurred at 12 stations, making up two percent of the population, while Schenckiella occidentalis occurred at nine stations and made up two percent of the fauna. These two species were the most common perforate and agglutinate forms, respectively.

Q-modal factor-vector analysis of the standing crop yielded five faunal assemblages (Table 7a, Figs. 6a-e). These account for 96 percent of the total information. Distribution of environmental parameters was also analyzed and resulted in Environmental Model II (Table 7b, Fig. 7) which account for 98 percent of the total information.

Assemblage VI (Fig. 6a) is dominated by Triloculina bermudezi. Rosalina floridana and Schenckiella occidentalis are the most important perforate and agglutinate species, respectively. This model does not fit any of the available environmental information.

Assemblage VII (Fig. 6b) is characterized by the dominance of Quinqueloculina poeyana and the rarer occurrence of Rosalina floridana. This faunal assemblage appears to be inversely related to both Environmental Model II (Fig. 7) and depth (Fig. 2).

Assemblage VIII (Fig. 6c) is dominated by Quinqueloculina bosciana. Rosalina floridana is the most abundant perforate species. This faunal assemblage does not fit any measured environmental information. Its pattern suggests a possible partial current influence.

Assemblage IX (Fig. 6d) is characterized by dominance of Hauerina bradyi and rarer occurrence of Rosalina floridana. This assemblage is restricted to the central part of the sound and appears to be directly related to water depth (Fig. 2).

Assemblage X (Fig. 6e) is dominated by Quinqueloculina subpoeyana Cushman. Elphidium galvestonense and Valvulina oviedoiana group 1 are the most common perforate and agglutinate species, respectively. This assemblage occurs adjacent to Largo Key where coarser sediments (clayey sand) are found and appears to be directly related to sediment size (Fig. 3).

Linear relationships between distribution of foraminiferal species and environmental parameters were investigated using R-modal factor-vector analysis. The following linear relationships were indicated: Distribution of Quinqueloculina subpoeyana is directly related to ratio of sand. Distributions of Quinqueloculina laevigata and Quinqueloculina bosciana are directly related to temperature. These relationships are not extremely strong and probably do not control distributions, but only partially influence them. The distribution of Schenckiella occidentalis shows a strong direct relationship to salinity. Clavulina tricarinata and Discorbis mira distributions are inversely related to depth.

August 20th, 1962 Collection

This fauna was dominated by porcelaneous species (92%), but had significant numbers of perforate and agglutinate forms (5 and 3%, respectively). Quinqueloculina bosciana and Quinqueloculina poeyana (Table 3) were the most common species, both occurring at 18 of 19 stations and each making up 14 percent of the standing crop. Dominant perforate species were

Discorbis mira and Rosalina floridana, which occurred at ten and nine stations, respectively, each making up one percent of the fauna. Schenckiella occidentalis occurred at 11 stations, composing one percent of the fauna, and was the most abundant agglutinate form.

Q-modal factor-vector analysis of the standing crop yielded four reference samples (Table 8a, Figs. 8a-d) that accounted for 89 percent of the total information. Environmental parameters were similarly analyzed, yielding Environmental Model III (Table 8b, Fig. 9), which accounted for 98 percent of the total information.

Assemblage XI (Fig. 8a) is characterized by dominance of Quinqueloculina bosciana and rarer occurrence of Schenckiella occidentalis, Discorbis mira and Rosalina floridana. This assemblage appears to be directly related to temperature (Table 3).

Assemblage XII (Fig. 8b) is dominated by Hauerina bradyi. Elphidium glavestonense and Rosalina floridana are the most common perforate species. This faunal assemblage appears to be directly related to depth of water (Fig. 2). Its pattern indicates that it is probably also partially influenced by currents.

Assemblage XIII (Fig. 8c) is characterized by dominance of Quinqueloculina bosciana and rarer occurrence of Schenckiella occidentalis and Discorbis mira. It is distinguished from Assemblage XI by lack of abundant Rosalina floridana. Though the relationship is not strong, it appears to be directly related to Environmental Model III (Fig. 9).

Assemblage XIV (Fig. 8d) is dominated by Quinqueloculina poeyana. Discorbis mira and Schenckiella occidentalis are the most important perforate and agglutinate forms, respectively. This faunal assemblage appears to be inversely related to Environmental Model III (Fig. 9).

R-modal factor-vector analysis indicated that the distributions of Clavulina tricarinata and Discorbis mira are inversely related to water depth. These relationships are not particularly strong and this parameter probably does not control distribution, but only partially influences it.

February 9th, 1963 Collection

The standing crop from this collection was dominated by porcelaneous species, which made up 93 percent of the fauna. Significant numbers of perforate and agglutinate forms did occur, making up four and three percent of the population, respectively. The porcelaneous forms Quinqueloculina laevigata, which occurred at 16 of 17 stations and made up 24 percent of the standing crop, and Quinqueloculina bosciana, which occurred at all 17 stations and made up 23 percent of the population, were the most abundant species in the collection (Table 4). The most common agglutinate form was Valvulina oviedoiana (group 1) which occurred at five stations and made up two percent of the standing crop. None of the perforate species were important constituents of the fauna.

Q-modal factor-vector analysis of the standing crop yielded three faunal assemblages (Table 9a, Figs. 10a-c), accounting for 83 percent of the total information. The environmental parameters were investigated in a similar manner and yielded Environmental Model IV (Table 9b, Fig. 11), which accounted for 99 percent of the total information.

Assemblage XV (Fig. 10a) is dominated by Quinqueloculina bosciana. Discorbis mira is the most important perforate species. This assemblage does not fit any of the available environmental information and therefore is probably not influenced by the measured environmental parameters.

Assemblage XVI (Fig. 10b) is characterized by dominance of Quinqueloculina laevigata and rarer occurrence of Rosalina floridana and Discorbis mira. This faunal assemblage appears to be inversely related to sediment size (Fig. 3).

Assemblage XVII (Fig. 10c) is dominated by Hauerina bradyi. It is found in the northeastern and central parts of the sound and does not fit any of the measured environmental information.

R-modal factor-vector analysis was used to investigate linear relationships between distribution of foraminiferal species and environmental parameters. It indicates that Quinqueloculina seminulum and Quinqueloculina poeyana distributions are inversely related to ratio of silt. Distribution of Archaias angulatus is inversely related to salinity. These relationships are not strong and therefore probably do not control distributions, but only partially influence them.

Ecological Relationships Among Species

All of the foraminiferal faunal and environmental data from the four collections were used in an attempt to define those ecological parameters which control or partially influence species distributions in Buttonwood Sound.

R-modal factor-vector analysis indicated that species distributions were not strongly related to depth, temperature, salinity, pH, Eh or ratios of sand, silt or clay. It did indicate that some species had similar ecological adaptations. The following three groups of species were obtained:

Rosalina floridana Cushman
Conorbina orbicularis (Williamson)

Quinqueloculina agglutinans d'Orbigny
Triloculina bassensis Parr
Archaias agnulatus (Fichtel and Moll)

Quinqueloculina poeyana d'Orbigny
Miliolinella obliquinoda (Riccio)
Quinqueloculina bosciana d'Orbigny

The species within each group have similar ecological adaptations, but what these adaptations are is not evident.

Variations Between Collections

Inspection of Tables 1-4 indicates there are differences in faunal composition at some stations between collections. Statistical analysis indicates these variations are significant.

Previously, it had been mentioned it was not possible to reoccupy stations exactly. Samples at each station were probably collected within a three meter radius. It does not appear that the measured environmental parameters varied enough between the August 1962 collections to cuase significant changes in faunal composition. It is believed hhat faunal differences which are observed between these collections result from variation of foraminiferal standing crop over short lateral distances (Lynts, 1966b).

Differences in faunal composition at some stations between the August 1962 collections and February 1963 collection are probably the result of variation of environmental parameters between these two times of the year (Table 5). Significant variation in faunal composition does not occur at every station indicating that many foraminiferal species are tolerant to changes in their environment of these magnitudes.

Summary

The foraminiferal standing crop of Buttonwood Sound is dominated by porcelaneous species, 92 percent, but there are significant numbers of perforate and agglutinate forms, five and three percent, respectively. There were minor fluctuations in these percents between collections, but the relative compositions did not vary.

Each collection was subdivided into faunal assemblages. Five of the faunal assemblages (V, VI, VIII, XV, XVII) do not appear to be linearly related to any of the measured environmental data, but the pattern of two of these assemblages (V, VIII) does indicate a probable current influence. Four of the assemblages (K, VII, XIII, XIV) appear to be linearly related to the environmental models (I, II, III).

Four faunal assemblages (II, IV, IX, XII) appear to be linearly related to bathymetry. A fauna which persists throughout all four collections is related to bathymetry. It consists of Assemblages IV and IX, and other assemblages that occur in both the August 20th, 1962 and February 9th, 1963 collections but which are not illustrated because they did not account for enough total information in their respective collections. Two of the assemblages which are related to depth (II, XII) also appear to be partially influenced by other factors. Distribution of Assemblage II appears to be related to both depth and salinity, while Assemblage XII

appears to be related to depth and currents.

Three assemblages (III, X, XVI) appear to be linearly related to sediment size. A fauna related to sediment size persists throughout all of the collections. Faunal Assemblages III and X are part of this fauna, as are assemblages from the August 20th, 1962 and February 9th, 1963 collections. The assemblages from these latter two collections are not illustrated because they did not answer enough total information.

A single faunal assemblage (XI) related to temperature was also defined.

Ecological relationships of the faunal assemblages suggest that most assemblage distributions are controlled by interaction of ecological parameters, including physicochemical and biologic factors which were not measured.

Linear relationship between distribution of foraminiferal species and environmental parameters was also investigated. Each of the four collections was analyzed, and the distribution of several species appears to be linearly related to measured environmental parameters. These relationships are not extremely strong, in most cases, and probably do not control distribution, but only partially influence it. Analysis utilizing data from all of the collections indicated that some foraminiferal species have similar ecological adaptations. Exactly what ecological adaptation the Foraminifera had in common was not evident, because no linear relationships were defined. This again suggests that the distribution is probably controlled by interaction of physicochemical and biologic factors.

CONCLUSIONS

1. The ecology of Buttonwood Sound fluctuates considerably from summer to winter.

2. The foraminiferal fauna is dominated by porcelaneous species, but there are significant numbers of perforate and agglutinate forms. Q-modal factor-vector analysis divided the standing crop of each collection into faunal assemblages. Most of the distributions of these assemblages are controlled by interacting physicochemical and biologic factors.

3. Investigation of linear relationships between distribution of foraminiferal species and environmental parameters for each collection indicates some species are influenced by the measured environmental parameters. Most species showed no such relationship. Analysis of all collections combined indicates that some species have similar ecological adaptations, but exactly how these ecological adaptations affect the Foraminifera is not evident. Species least tolerant to changes in their ecology were the rarer forms.

4. No simple linear relationship exists between Buttonwood Sound foraminiferal species and ecological distributions. The distribution of species is controlled by a complex interplay of physicochemical and biologic factors acting upon the species.

DISCUSSION OF SPECIES

In the following discussion, terms will be used as herein defined: 1) Collection means specimens collected on a certain date, for example, the August 14th, 1962 collection; 2) All Collections include those specimens collected on August 14th, 17th, 20th, 1962, and February 9th, 1963; 3) Fauna consists of specimens of all collections; and 4) Standing crop and Population consist of specimens from a collection.

ORDER FORAMINIFERIDA Eichwald, 1830

SUBORDER TEXTULARINA Delage and Herouard, 1896

SUPERFAMILY AMMODISCACEA Reuss, 1862

FAMILY AMMODISCIDAE Reuss, 1862

SUBFAMILY AMMODISCINAE Reuss, 1862

GENUS *AMMODISCUS* Reuss, 1862

Ammodiscus incertus (d'Orbigny), 1839+

+ Loeblich and Tappan (1954) examined d'Orbigny's types of *Operculina incerta* from Cuba and figured a lectotype. They placed the species in *Cornuspira* which is a junior synonym of *Cyclogyra*. The specimens probably should be reffed to *Ammodiscus anguillae* Höglund.

Operculina incerta d'Orbigny, 1839, *in* De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 49, Pl. 6, Figs. 16, 17.

This species occurred in all collections but the August 20th, 1962. It was very rare, with frequencies of less than one percent.

GENUS *GLOMOSPIRA* Rzehak, 1885

Glomospira charoides (Jones and Parker), 1862

Trochammina charoides Jones and Parker, 1862, *in* Carpenter, Parker and Jones, Introd. Foram., p. 141, Pl. 11, Fig. 3.

This species occurred in all collections. It was quite rare, with frequencies of less than one percent at all but two stations. It occurred in frequencies of four and one percent at two stations, 5 and 7, of the August 20th, 1962 collection.

SUPERFAMILY LITUOLACEA de Blainville, 1825

FAMILY LITUOLIDAE de Blainville, 1825

SUBFAMILY LITUOLINAE de Blainville, 1825

GENUS *AMMOBACULITES* Cushman, 1910

Ammobaculites dilatatus Cushman and Bronnimann, 1948

Ammobaculites dilatatus Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, p. 39, Pl. 7, Figs. 10, 11.

Specimens of this species showed considerable variation in chamber inflation. There was gradation from deflated specimens (Plate 1, Fig. 3) to inflated specimens (Plate 1, Fig. 4). Quite possibly if only deflated specimens were found they would be placed in the genus *Ammoscalaria* Höglund.

This species occurred in all collections except February 9th, 1963. It was quite rare, with frequencies of less than one percent at all but two stations. It occurred with a frequency of one percent at station 1 of the August 14th, 1962 collection and two percent at station 3 of the August 20th, 1962 collection.

Ammobaculites exiguus Cushman and Bronnimann, 1948

Ammobaculites exiguus Cushman and Bronnimann, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, p. 38, Pl. 7, Figs. 7, 8.

This species occurred as a single specimen at station 1 of the August 20th, 1962 collection. Dead specimens occurred in the total population at most stations.

FAMILY ATAXOPHRAGMIIDAE Schwager, 1887

SUBFAMILY VALVULININAE Berthelin, 1880

GENUS *VALVULINA* d'Orbigny, 1826

Valvulina oviedoiana d'Orbigny, 1839

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

This species was divided into two groups based upon presence (group 1) or absence (group 2) of valvular flap over the aperture (Lynts, 1965). Group 1 was the dominant form making up 81 percent of the specimens of this species.

This was the most abundant agglutinate form. It occurred in all collections. It had a maximum frequency of 27 percent at station 1 of the February 9th, 1963 collection.

GENUS CLAVULINA d'Orbigny, 1826

Clavulina tricarinata d'Orbigny, 1839

Clavulina tricarinata d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 111, Pl. 2, Figs. 16-18.

This species occurred in all collections. It had a maximum frequency of nine percent at station 4 of the August 20th, 1962 collection. Its distribution was inversely related (r = -0.584) to pH and directly related (r = +0.540) to clay-size sediment in the August 14th, 1962 collection. The correlation coefficients were significant, but not numerically high so the importance of these parameters to its distribution was not clear. Its distribution was inversely related to depth in the August 1962 collections (r = -0.550, -0.821 and -0.664, respectively). It appears, because this relationship was fairly strong and consistent in the August 1962 collections, that it probably prefers shallower water.

GENUS SCHENCKIELLA Thalman, 1942*

* Loeblich and Tappan (1964) indicated Schenckiella is a junior synonym of Martinottiella Cushman, 1933.

Schenckiella occidentalis (Cushman), 1922

Clavulina occidentalis Cushman, 1922, U.S. Nat. Mus. Bull. 104, pt. 3, p. 87, Pl. 17, Figs. 1, 2.

This species was the most abundant agglutinate form in the August 14th and 17th, 1962 collections. It occurred in all collections with a frequency up to 11 percent at station 17 of the August 17th, 1962 collection. In the August 17th, 1962 collection, its distribution appeared to have been directly related, quite strongly (r = +0.812), to temperature.

SUBORDER MILIOLINA Delage and Herouard, 1896

SUPERFAMILY MILIOLACEA Ehrenberg, 1839

FAMILY FISCHERINIDAE Millet, 1898

SUBFAMILY CYCLOGYRINAE Loeblich and Tappan, 1961

GENUS CYCLOGYRA Wood, 1842

Cyclogyra involvens (Reuss), 1850

Operculina involvens Reuss, 1850, Denschr. Akad. Wiss. Wien, vol. 1, p. 370, Pl. 46, Fig. 30.

This species occurred in all collections. It was fairly rare, with a maximum frequency of six percent at station 7 of the August 14th, 1962 collection.

FAMILY NUBECULARIIDAE Jones, 1875

SUBFAMILY SPIROLOCULININAE Wiesner, 1920

GENUS SPIROLOCULINA d'Orbigny, 1826

Spiroloculina antillarum d'Orbigny, 1839

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

This species occurred in all collections but the August 20th, 1962. It was very rare, occurring in frequencies of less than one percent.

Spiroloculina eximia Cushman, 1922

Spiroloculina eximia Cushman, 1922, Carnegie Inst. Washington Publ., no. 311, p. 61, Pl. 11, Fig. 2.

This species occurred in the August 14th and 17th, 1962 collection. Only two specimens were found. One occurred at station 5 of the August 14th, 1962 collection and one at station 1 of the August 17th, 1962 collection.

SUBFAMILY NODOBACULARIINAE Cushman, 1927

GENUS NODOBACULARIELLA Cushman and Hanzawa, 1937

Nodobaculariella cassis (d'Orbigny), 1839

Vertebralina cassis d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 51, Pl. 7, Figs. 14, 15.

This species occurred as a single specimen at station 6 of the August 20th, 1962 collection.

FAMILY MILIOIDAE Ehrenberg, 1839

SUBFAMILY QUINQUELOCULININAE Cushman, 1917

GENUS QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina agglutinans d'Orbigny, 1839

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

This species occurred in all collections. It was most abundant in the August 14th, 1962 collection when it had a maximum frequency of eight percent at station 2.

Quinqueloculina bosciana d'Orbigny, 1839

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

This species was the predominant form in the fauna. It occurred in all collections and made up 17 percent of the fauna. It was most important in the February 9th, 1963 collection when it made up 23 percent of the standing crop. It had a maximum frequency of 100 percent at station 9 of the August 17th, 1962 collection. Its distribution was inversely related (r = -0.532) to salinity in the August 14th, 1962 collection and directly related (r = +0.510) to temperature in the August 17th, 1962 collection. The correlation coefficients were significant, but not numerically high so the importance of these parameters to its distribution was not clear.

Quinqueloculina laevigata d'Orbigny, 1826

Quinqueloculina laevigata d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 301, No. 6.

This species occurred in all collections. It was fairly common, making up 12 percent of the fauna. It was most abundant in the February 9th, 1963 collection when it made up 24 percent of the standing crop. It had a maximum frequency of 89 percent at station 9 of the February 9th, 1963 collection. Its distribution was directly related (r = +0.544) to temperature in the August 17th, 1962 collection. The correlation coefficient was significant, but not numerically high so the importance of this parameter to its distribution was not clear.

Quinqueloculina lamarckiana d'Orbigny, 1839

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

This species occurred in all collections. It was fairly rare, with a maximum frequency of eight percent at station 2 of the August 14th, 1962 collection.

Quinqueloculina poeyana d'Orbigny, 1839

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

This species occurred in all collections. It was fairly common, making up 12 percent of the fauna. It was most abundant in the August 20th, 1962 collection when it made up 14 percent of the standing crop and had a maximum frequency of 36 percent at station 10. Its distribution was inversely related (r = -0.546) to the ratio of silt-size sediment in the February 9th, 1963 collection. The correlation coefficient was significant, but not numerically high so the importance of this parameter to its distribution was not clear.

Quinqueloculina polygona d'Orbigny, 1839

Quinqueloculina polygona d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 198, Pl, 12, Figs. 21-23.

This species occurred in all collections. It was quite rare, with a maximum frequency of three percent at station 15 of the August 17th, 1962 collection.

Quinqueloculina sabulosa Cushman, 1947

Quinqueloculina sabulosa Cushman, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, p. 87, Pl. 18, Fig. 22.

Specimens were generally larger in the February 9th, 1963 collection than in the August 1962 collections.

This species occurred in all collections. It was fairly rare, making up two percent of the fauna. It had a maximum frequency of 43 percent at station 8 of the August 20th, 1962 collection.

Quinqueloculina seminulum (Linnaeus), 1758

Serpula seminulum Linnaeus, 1758, Syst. Nat., ed. 10, p. 786.

This species occurred in all collections. It was fairly rare, making up two percent of the fauna. It had a maximum frequency of eight percent at station 18 of the August 14th, 1962 collection. Its distribution was inversely related (r = -0.572) to the ratio of silt-size sediment in the February 9th, 1963 collection. The correlation coefficient was significant, but not numerically high so the importance of the parameter to its distribution was not clear.

Quinqueloculina subpoeyana Cushman, 1922

Quinqueloculina subpoeyana Cushman, 1922, Carnegie Inst. Washington Publ., no. 311, p. 66.

This species occurred in all collections, being most important in the February 9th, 1963 collection when it made up six percent of the standing crop. It was fairly rare, making up three percent of the fauna. It had a maximum frequency of 28 percent at station 2 of the February 9th, 1963 collection. Its distribution was directly related (r = +0.677) to the ratio of sand-size sediment in the August 17th, 1962 collection. The correlation coefficient was highly significant, but not numerically high so the importance of this parameter to its distribution was not clear.

Quinqueloculina tenagos Parker, 1962

Quinqueloculina costata d'Orbigny (nomen nudum, fide Parker, 1953), 1826, Ann. Sci. Nat., vol. 7, p. 301, No. 3.

Quinqueloculina rhodiensis Parker, 1953, in Parker, Phleger, Peirson, Cushman Found. Foram. Res., Spec. Publ. No. 2, p. 12, Pl. 2, Figs. 15-17; Lynts, 1962, Contr. Cushman Found. Foram. Res., vol. 13, p. 141.

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

This species occurred in all collections. It was quite rare, never occurring in frequencies greater than one percent.

GENUS MASSILINA Schlumberger, 1893

Massilina secans (d'Orbigny), 1826

Quinqueloculina secans d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 303, No. 43.

This species occurred in all collections. It was quite rare, with a maximum frequency of four percent at station 17 of the February 9th, 1963 collection. It was directly related (r = +0.598) to the ratio of sand-size sediment in the August 14th, 1962 collection. The correlation coefficient was highly significant, but not numerically high so the importance of this parameter to its distribution was not clear.

GENUS PYRGO Defrance, 1824

Pyrgo subsphaerica (d'Orbigny), 1839

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

This species occurred as a single specimen at station 1 of the August 14th, 1962 collection.

GENUS TRILOCULINA d'Orbigny, 1826

Triloculina bassensis Parr, 1945

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

This species occurred in all collections. It was fairly rare, with a maximum frequency of 13 percent at station 2 of the August 14th, 1962 collection.

Triloculina bermudezi Acosta, 1940

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

This species was one of the most common forms, making up 15 percent of the fauna. It was the predominant species in the August 14th and 17th, 1962 collections making up 20 percent of the standing crop in each collection. It had a maximum frequency of 43 percent at two stations, 5 and 7, of the August 14th, 1962 collection.

Triloculina linneiana d'Orbigny, 1839

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

This species occurred in all collections. It was fairly rare, making up three percent of the fauna. Its maximum frequency was 11 percent at station 10 of the August 14th, 1962 collection.

Triloculina oblonga (Montagu), 1803

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

This species occurred in all collections. It was fairly rare, with a maximum frequency of 17 percent at station 13 of the August 17th, 1962 collection.

Triloculina rotunda d'Orbigny, 1826

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

This species occurred in all collections. It was fairly rare, with a maximum frequency of six percent at station 5 of the August 17th, 1962 collection.

Triloculina sidebottomi (Martinotti), 1920

Sigmoilina sidebottomi Martinotti, 1920, Atti. Soc. Ital. Sci. Nat., vol. 59, p. 280, Pl. 2, Fig. 29, Text Figs. 59-61.

This species occurred in the August 14th and 20th, 1962 collections. Only four specimens were found. Three occurred at station 1 of the August 14th, 1962 collection and one at station 2 of the August 20th, 1962 collection.

Triloculina trigonula (Lamarck), 1804

Miliola trigonula Lamarck, 1804, Ann. Mus., vol. 5, p. 351, No. 3.

This species occurred in all collections. It was quite rare, with a maximum frequency of five percent at station 14 of the August 20th, 1962 collection.

SUBFAMILY MILIOLINELLINAE Vella, 1957

GENUS MILIOLINELLA Wiesner, 1931

Miliolinella circularis (Bornemann), 1855

Triloculina circularis Bornemann, 1855, Zeitschr. deutsch. geol. Ges., vol. 7, pt. 2, p. 349, Pl. 19, Figs. 4a-c.

This species was fairly common, occurring in all collections. It made up six percent of the fauna. It was most important in the August 20th, 1962 collection when it made up 14 percent of the standing crop and had a maximum frequency of 31 percent at station 18.

Miliolinella fichteliana (d'Orbigny), 1839

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

This species occurred in only the August 14th and 20th, 1962 collections. It was very rare, with frequencies of less than one percent.

Miliolinella labiosa (d'Orbigny), 1839

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

This species occurred in only the August 20th, 1962 and February 9th, 1963 collections. It was very rare, with frequencies of less than one percent.

Miliolinella obliquinoda (Riccio), 1950

Triloculinella obliquinoda Riccio, 1950, Contr. Cushman, Found. Foram. Res., vol. 1, p. 90, Pl. 15, Figs. 1, 2.

This species occurred in all collections. It was quite rare, with a maximum frequency of 16 percent at station 13 of the August 14th, 1962 collection.

Miliolinella suborbicularis (d'Orbigny), 1826

Triloculina suborbicularis d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 300, No. 12.

This species occurred as a single specimen at station 18 of the August 14th, 1962 collection.

SUBFAMILY MILIOLINAE Ehrenberg, 1839

GENUS HAUERINA d'Orbigny, 1839

Hauerina bradyi Cushman, 1917

Hauerina bradyi Cushman, 1917, U.S. Nat. Mus. Bull. 71, pt. 6, p. 62, Pl. 23, Fig. 2.

This species was fairly common, making up 11 percent of the fauna. It occurred in all collections. It was most abundant in the August 17th and 20th, 1962 collections when it made up 14 percent of the standing crop in each collection. Its maximum frequency was 76 percent at station 11 of the August 17th, 1962 collection.

FAMILY SORITIDAE Ehrenberg, 1839

SUBFAMILY ARCHAIASINAE Cushman, 1927

GENUS ARCHAIAS de Montfort, 1808

Archaias angulatus (Fichtel and Moll), 1803

Nautilus angulatus Fichtel and Moll, 1803, Test. Micr., p. 112, Pl. 21.

This species occurred in all collections. It was fairly rare, with a maximum frequency of 20 percent at station 2 of the August 14th, 1962 collection. Its distribution was inversely related (r = -0.594) to salinity in the February 9th, 1963 collection. The correlation coefficient was significant, but not numerically high so the importance of this parameter to its distribution was not clear.

SUBORDER ROTALIINA Delage and Herouard, 1896

SUPERFAMILY NODOSARIACEA Ehrenberg, 1838

FAMILY GLANDULINIDAE Reuss, 1860

SUBFAMILY OOLININAE Loeblich and Tappan, 1961

GENUS FISSURINA Reuss, 1850

Fissurina cf. F. lucida (Williamson), 1848

Entosolenia marginata Montagu, var. lucida Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 17, Pl. 2, Fig. 17.

This species occurred in the August 20th, 1962 and February 9th, 1963 collections. It was very rare, with a maximum frequence of four percent at station 15 of the August 20th, 1962 collection.

SUPERFAMILY BULIMINACEA Jones, 1875

FAMILY TURRILINIDAE Cushman, 1927

SUBFAMILY TURRILININAE Cushman, 1927

GENUS BULIMINELLA Cushman, 1911

Buliminella elegantissima (d'Orbigny), 1839

Bulimina elegantissima d'Orbigny, 1839, Voy. Amer. Merid., vol. 5, pt. 5, "Foraminiferes", p. 51, Pl. 7, Figs. 13, 14.

This species occurred as a single specimen at station 2 of the February 9th, 1963 collection.

FAMILY BOLIVINITIDAE Cushman, 1927

GENUS BOLIVINA d'Orbigny, 1839

Bolivina lanceolata Parker, 1954

Bolivina lanceolata Parker, 1954, Mus. Compar. Zool., Bull., vol. 111, no. 10, p. 514, Pl. 7, Figs. 17-20.

This species occurred in all collections. It was very rare, with frequencies of less than one percent.

Bolivina lowmani Phleger and Parker, 1951

Bolivina lowmani Phleger and Parker, 1951, Geol. Soc. America, Mem., vol. 46, pt. 2, p. 13, Pl. 6, Figs. 20a, b, 21.

This species occurred as a single specimen at station 1 of the August 17th, 1962 collection.

Bolivina striatula Cushman, 1922

Bolivina striatula Cushman, 1922, Carnegie Inst. Washington Publ., no. 311, p. 27, Pl. 3, Fig. 10.

This species occurred as a single specimen at station 19 of the February 9th, 1963 collection.

SUPERFAMILY DISCORBACEA Ehrenberg, 1838

FAMILY DISCORBIDAE Ehrenberg, 1838

SUBFAMILY DISCORBINAE Ehrenberg, 1838

GENUS ROSALINA d'Orbigny, 1826

Rosalina floridana Cushman, 1922

Discorbis floridana Cushman, 1922, Carnegie Inst. Washington Publ., no. 311, p. 39, Pl. 5, Figs. 11, 12.

This was one of the most common perforate species, making up one percent of the fauna. It occurred in all collections. It was most common in the August 17th, 1962 collection when it made up two percent of the standing crop. It was quite rare, with a maximum frequency of seven percent at station 10 of the August 17th, 1962 collection.

GENUS CONORBINA Brotzen, 1936

Conorbina orbicularis, Williamson, 1858

Rotalina nitida Williamson (not Reuss), 1858, Rec. British Foram., p. 54, Pl. 4, Figs. 106-108.

This species occurred in all collections. It was very rare, with a maximum frequency of four percent at station 2 of the February 9th, 1963 collection.

Rosalina rosacea (d'Orbigny), 1826

Rotalia rosacea d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 273, No. 15.

This species occurred in all collections except the August 14th, 1962. It was very rare, with a maximum frequency of five percent at station 3 of the February 9th, 1963 collection.

SUPERFAMILY ROTALIACEA Ehrenberg, 1839

FAMILY ROTALIIDAE Ehrenberg, 1839

SUBFAMILY ROTALIINAE Ehrenberg, 1839

GENUS AMMONIA Brünnich, 1772

Ammonia beccarii (Linnaeus), 1758

Nautilus beccarii Linnaeus, 1758, Syst. Nat., ed. 10, p. 710, Pl. 1, Figs. 1a-c, Pl. 19, Figs. h, i.

This species occurred in all collections. It was most abundant in the August 14th, 1962 collection when it made up one percent of the standing crop. It was quite rare, with a maximum frequency of ten percent at station 16 of the August 14th, 1962 collection. Its distribution was directly related (r = +0.485) to the ratio of sand-size sediment in the August 14th, 1962 collection. The correlation coefficient was significant, but not numerically high so the importance of this parameter to its distribution was not clear.

GENUS DISCORBIS Lamarck, 1804

Discorbis mira (Phleger and Parker), 1951

"Rotalia" translucens Phleger and Parker, 1951, Geol. Soc. America, Mem., vol. 46, pt. 2, p. 24, Pl. 12, Figs. 11a, b, 12a, b.

This was the most common perforate species, making up one percent of the fauna. It occurred in all collections. It was most important in the August 14th, 1962 collection when it made up two percent of the standing crop. It was fairly rare, with a maximum frequency of 13 percent at station 5 of the August 20th, 1962 collection. Its distribution was inversely related (r = -0.870 and -0.728) to depth in the August 17th and 20th, 1962 collections, respectively. It appears, because of the quite strong relationship observed, that it probably prefers shallower water.

FAMILY ELPHIDIIDAE Galloway, 1933

SUBFAMILY ELPHIDIINAE Galloway, 1933

GENUS ELPHIDIUM de Montfort, 1808

Elphidium advenum (Cushman), 1922

Polystomella advena Cushman, 1922, Carnegie Inst. Washington Publ., no. 311, p. 56, Pl. 9, Figs. 11, 12.

This species occurred in the August 14th and 17th, 1962 collections. Only two specimens were found. One occurred at station 1 of the August 14th, 1962 collection and one at station 18 of the August 17th, 1962 collection.

Elphidium galvestonense Kornfeld, 1931

Elphidium gunteri Cole, var. galvestonense Kornfeld (part), 1931, Contr. Dept. Geol. Stanford Univ., vol. 1, no. 3, p. 87, Pl. 15, Figs. 1a, b (not 2a, b, 3a).

This species occurred in all collections. It was most abundant in the August 14th, 1962 collection when it made up one percent of the standing crop. It was quite rare, with a maximum frequency of nine percent at station 3 of the August 14th, 1962 collection. Its distribution was directly related (r = +0.610) to the ratio of sand-size sediment in the August 14th, 1962 collectin. The correlation coefficient was highly significant, but not numerically high so the importance of this parameter to its distribution was not clear.

GENUS CRIBROELPHIDIUM Cushman and Bronnimann, 1948

Cribroelphidium poeyanum (d'Orbigny), 1839*

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* This species is equated to the genotype of Cribroelphidium Cushman and Bronnimann, 1948, by Loeblich and Tappan (1964).

Polystomella poeyana d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 55, Pl. 6, Figs. 25, 26.

This species occurred in all collections. It was quite rare, with a maximum frequency of five percent at station 1 of the February 9th, 1963 collection. Its distribution was inversely related (r = -0.503) to temperature in the August 14th, 1962 collection. The correlation coefficient was significant, but not numerically high so the importance of this parameter to its distribution was not clear.

Elphidium sagrum (d'Orbigny), 1839

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

This species occurred as a single specimen at station 2 of the August 14th, 1962 collection.

SUPERFAMILY ORBITOIDACEA Schwager, 1876

FAMILY PLANORBULINIDAE Schwager, 1877

GENUS PLANORBULINA d'Orbigny, 1826

Planorbulina mediterranensis d'Orbigny, 1826

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

This species occurred as a single specimen at station 1 of the August 14th, 1962 collection.

SUPERFAMILY CASSIDULINACEA d'Orbigny, 1839

FAMILY NONIONIDAE Schultze, 1854

SUBFAMILY NONIONINAE Schultze, 1854

GENUS NONION de Montfort, 1808

Nonion depressulum (Walker and Jacob), 1798

Nautilus depressulum Walker and Jacob, 1798, in Adam's Essays, Kanmacher's ed., p. 641, Pl. 14, Fig. 33.

This species occurred in the August 14th and 20th, 1962 collections. It was very rare, with a maximum frequency of three percent at station 10 of the August 14th, 1962 collection.

Nonion grateloupi (d'Orbigny), 1826

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

This species occurred in the August 14th and 20th, 1962 collections. Only three specimens were found. One occurred at station 10 of the August 14th, 1962 collection and two were found at station 2 of the August 20th, 1962 collection.

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STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
NUMBER OF SPECIMENS	347	368	307	308	301	208	117	307	231	208	303	56	31	223	182	58	309	39	307
Ammodiscus incertus					0.3	0.5	0.8												
Glomospira charoides	0.9	0.3			0.3														
Ammobaculites dilatatus									0.4	1									
A. exiguus																			
Schenckiella occidentalis	10		0.3	0.6	1			6		1	1		6						0.3
Clavulina tricarinata	0.6			2	2			0.3											
Valvulina oviedoiana (Group 1)	2	1	1	2															0.3
V. oviedoiana (Group 2)	0.3	0.8																	
Cyclogyra involvens			2			2	6	0.7	2	3	1				0.5		0.3	3	
Nodobaculariella cassis																			
Miliolinella circularis	2	1	10	4	8	12	3	2	6	4	7		3	4	2		1		19
M. fichteliana		0.5																	
M. labiosa																			
M. obliquinoda	0.6	0.5	0.3	0.3	0.3		0.8		1	2	1	2	16		1		0.3		3
M. suborbicularis																		3	
Massilina secans		0.8	2	0.3	1	0.5	2	0.7	0.9										
Pyrgo subsphaerica	0.3																		
Quinqueloculina agglutinans	0.9	8	3				0.8		0.4				3				0.6		
Q. bosciana	10	3	7	15	10	18	7	16	45	18	6	36	3	7	16	14	17	46	18
Q. laevigata	3	1	3	8	4	3	0.8	28	9	7	14	16	3	3	7	2	3	5	6
Q. lamarckiana	3	8	5														4	3	
Q. poeyana	25	8	8	25	6	18	3	10	7	11	4	30		7	4	9	9	5	9
Q. polygona	1	0.8						0.3	0.4		0.3					2			0.6
Q. sabulosa	3	2	1	3	0.3	0.5	3	2	0.4	1	2						2		2
Q. seminulum	3	0.8	3	4		0.5	0.8	2	0.4	2	0.7	2	3	0.9	0.5		1	8	1
Q. subpoeyana	0.6	6	3	6		0.5	2	1	0.9	1	2	2		0.4	0.5	2	3		1
Q. tenagos	0.6	0.8																	
Spiroloculina antillarum				0.3		0.5													
S. eximia					0.3														
Triloculina bassensis	0.6	13	3	0.3				0.7	0.4	0.5					1				
T. bermudezi	8	4	7	9	43	12	43	23	11	23	29	5	39	27	25	33	29	15	32
T. linneiana	2	2	5	2	2	1	2	1	2	11	3	2		7	4	5	8	3	4
T. oblonga	3	1	3	6	5	5	3	4	1	2	1			1	1		1		
T. rotunda	0.6	0.5	1	0.6	2	1	0.8	0.3		0.5	1	4			0.5		1	3	1
T. sidebottomi	0.9																		
T. trigonula	0.9	2		0.3															0.6
Hauerina bradyi	3	3	5	3	5	21	15	2	9	7	25	2	6	41	33	7	15	8	1
Archaias angulatus		20	6				0.8									5			0.6
Fissurina cf. F. lucida																			
Buliminella elegantissima																			
Bolivina lanceolata	0.6																		
B. lowmani																			
B. striatula																			
Discorbis floridana	0.9	1	0.6	1	3	2	5		0.9		2		6	2	2	2	0.6		0.3
D. nitida		0.5			0.3														0.3
D. rosacea																			
Planorbulina mediterranensis	0.3																		
Ammonia beccarii	2	2	9													10			0.3
A. translucens	5			9	6			1					10			2			
Elphidium advenum	0.3																		
E. galvestonense		4	9					1	0.4							7			
E. poeyanum	4	0.8	0.3				0.8		0.9	0.5	0.3					2	0.3		
E. sagrum		0.3																	
Nonion depressulum										3									
N. grateloupi										0.5									
DEPTH (meters)	1.2	2.0	2.3	0.9	2.1	2.4	2.6	2.4	2.4	2.4	2.3	1.8	2.0	2.6	2.4	2.0	1.8	2.4	2.3
TEMPERATURE (C)	28.1	28.2	29.7	29.5	29.6	30.0	31.0	30.1	30.0	32.4	30.4	32.0	30.1	29.9	30.0	31.0	31.1	29.8	30.1
SALINITY (‰)	25.3	26.5	26.5	25.7	26.1	25.9	25.8	25.5	25.3	25.7	26.1	25.8	26.3	26.1	25.9	26.3	26.5	26.2	26.1
pH	7.9	7.7	7.7	6.9	7.3	7.6	7.9	8.0	8.0	8.0	8.1	7.6	7.3	7.3	7.8	7.7	7.9	8.1	7.9
Eh (mv)	318	382	-42	-210	-115	-71	10	202	203	100	113	-43	39	-47	-41	173	293	179	156
SAND (%)	24	66	68	37	25	30	38	23	67	24	29	12	23	25	20	31	58	11	46
SILT (%)	38	5	6	20	21	44	11	35	11	62	41	37	51	54	45	31	8	71	27
CLAY (%)	38	29	26	43	54	26	51	42	22	14	30	51	26	21	35	38	34	18	27

TABLE 1. Faunal composition in percent of August 14th, 1962 collection.

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
NUMBER OF SPECIMENS	305	322	322	298	68	277	184	122	166	30	33	9	6	243	69	60	350	407	342
Ammodiscus incertus								0.8											
Glomospira charoides														0.4					
Ammobaculites dilatatus	0.6		0.6						0.6								0.3		
A. exiguus																			
Schenckiella occidentalis	4			0.3	1	0.4		0.8	1							2	11	0.2	
Clavulina tricarinata	3			6	4			0.8						0.4					
Valvulina oviedoiana (Group 1)	2	4		3															0.3
V. oviedoiana (Group 2)	0.6	0.6						0.8											0.3
Cyclogyra involvens	1					1	1		2	3	3			0.4		2	0.6	0.2	0.3
Nodobaculariella cassis																			
Miliolinella circularis	2	5	0.9	0.3	1	2	2	0.8	0.6	3				1		5	3	4	5
M. fichteliana																			
M. labiosa																			
M. obliquinoda	0.3	0.9	0.3	2	1	0.7			0.6					0.4			1	2	0.3
M. suborbicularis																			
Massilina secans		0.3	0.3																
Pyrgo subsphaerica																			
Quinqueloculina agglutinans	0.3	1	1																1
Q. bosciana	16	9	33	14	7	9	15	11	38	10	3	100	17	21	22	12	9	12	12
Q. laevigata	6	12	26	8	6	6	5	11	4	10					7	13	2	1	7
Q. lamarckiana	0.6	0.6	3			0.4											3		0.9
Q. poeyana	22	11	15	31	35	9	3	20	13	10	6		33	3	4	7	11	5	15
Q. polygona		2						0.8						0.4	3			0.7	0.6
Q. sabulosa	3	3	0.3	0.3			4	15	0.6						1	2	3	0.5	7
Q. seminulum	3	0.6	0.6	4	3		0.5	2	2					1			2	1	5
Q. subpoeyana	2	14	1	0.7			2	3	2								1	0.5	1
Q. tenagos		0.6																	0.9
Spiroloculina antillarum	0.6																		
S. eximia	0.3																		
Triloculina bassensis	0.3	3	0.3	0.3	3	0.4								0.4			1		0.3
T. bermudezi	9	5	3	14	7	39	23	19	8	27	12		33	28	20	37	28	33	22
T. linneiana	6	3	2	3	10	3	5	3	5	3				2	3	5	3	9	6
T. oblonga	0.3	0.9	0.3	1		2	5	4		3			17		1		3		
T. rotunda	3	2	0.6	3	6			0.8	2	3				0.4			1	1	2
T. sidebottomi																			
T. trigonula	0.3		0.3																
Hauerina bradyi	3	5	5	1	1	21	34	2	17	20	76			33	35	12	13	24	6
Archaias angulatus		4	0.6															0.2	2
Fissurina cf. F. lucida																			
Buliminella elegantissima																			
Bolivina lanceolata	1																		
B. lowmani	0.3																		
B. striatula																			
Discorbis floridana	2	0.3		0.3		4	0.5	2	1	7				5	1			2	3
D. nitida		1																	
D. rosacea		0.6																	
Planorbulina mediterranensis																			
Ammonia beccarii		4	1	0.3	1				1					0.4		2	0.8	0.7	
A. translucens	5			7	10			0.8								2	1		
Elphidium advenum																		0.2	
E. galvestonense		4	2					2	0.6							2	1	0.5	0.3
E. poeyanum	2	0.6						0.8						1	1		0.8	0.5	0.3
E. sagrum																			
Nonion depressulum																			
N. grateloupi																			
DEPTH (meters)	1.2	2.0	2.3	0.9	2.1	2.4	2.6	2.4	2.4	2.4	2.3	1.8	2.0	2.6	2.4	2.0	1.8	2.4	2.3
TEMPERATURE (C)	32.1	31.1	32.1	31.9	31.6	32.0	31.4	31.7	31.0	30.8	30.9	31.1	31.1	31.3	31.4	31.4	31.6	31.6	31.8
SALINITY (‰)	26.2	26.5	26.7	26.4	25.8	26.2	26.4	26.3	26.1	26.7	26.3	25.6	25.8	25.3	26.2	25.4	28.9	25.9	25.6
pH	7.8	7.9	8.2	7.9	7.3	8.2	7.8	7.9	7.6	7.8	8.1	7.9	7.9	8.0	7.9	8.2	8.0	8.2	8.9
Eh (mv)	92	234	253	6	-121	76	192	36	17	-3	103	109	74	89	30	175	236	244	69
SAND (%)	25	74	52	33	18	42	23	24	43	37	32	12	20	24	12	38	34	6	44
SILT (%)	45	13	19	40	45	29	32	63	25	44	23	29	7	38	25	10	40	53	28
CLAY (%)	30	13	29	27	37	29	45	13	32	19	45	59	73	38	63	52	26	41	28

TABLE 2. Faunal composition in percent of August 17th, 1962 collection.

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
NUMBER OF SPECIMENS	245	388	265	233	25	317	162	30	179	55	12	4	81	18	78	55	201	931	229
Ammodiscus incertus																			
Glomospira charoides				0.8	4		1											0.3	
Ammobaculites dilatatus			2				0.6												
A. exiguus	0.4																		
Schenckiella occidentalis	3	0.2	0.7	0.4	8	0.3	7	7	2		8		1						
Clavulina tricarinata		0.2		9															
Valvulina oviedoiana (Group 1)	1	3	0.7	3									1						
V. oviedoiana (Group 2)	0.4	3		0.4															0.4
Cyclogyra involvens	0.4		0.7			1			2							2		0.3	
Nodobaculariella cassis						0.3													
Miliolinella circularis	1	5	2	7		11	15		12				5	22	26	16	10	31	2
M. fichteliana				0.4													0.5		
M. labiosa		0.5																	
M. obliquinoda				2		0.3	0.6											0.5	
M. suborbicularis																			
Massilina secans			0.4																
Pyrgo subsphaerica																			
Quinqueloculina agglutinans	0.4	3	2			0.3											0.5		
Q. bosciana	26	7	11	12	12	8	7	13	36	34	8	75	28		11	24	7	6	47
Q. laevigata	9	16	12	8	20	9	10	7	4	4		25	15	5	5	14	2	4	10
Q. lamarckiana		4	6	0.4					0.5								6	0.1	3
Q. poeyana	15	13	35	9	16	6	10	10	11	36	33		6	17	5	5	28	8	24
Q. polygona		1											1				2		
Q. sabulosa	2	0.8	1			0.3	4	43		4						4	14	0.3	4
Q. seminulum	8	2	0.4	3	8	2	2		2	4	8		7				2	2	0.9
Q. subpoeyana	0.4	6	2	2				3	0.5	2			1				5	1	1
Q. tenagos			0.4										1					0.1	
Spiroloculina antillarum																			
S. eximia																			
Triloculina bassensis	0.4	1	1			0.6			0.5				2				0.5		0.4
T. bermudezi	16	2	2	16	16	28	17	7	13	4	8		14	11	10	14	8	10	3
T. linneiana	0.8	2	4	1		1	6		3				6		3	4	2	5	0.9
T. oblonga	1	1		0.4		0.3	1		0.5	4							0.5		
T. rotunda	2	1	2	2	4	0.6	0.6			4			1			5	1		
T. sidebottomi		0.2																	
T. trigonula		0.2		0.4										5			0.5		
Hauerina bradyi	6	6	2	4		25	11		13	5	25		5	39	32	11	5	27	2
Archaias angulatus		8	4															0.2	
Fissurina cf. F. lucida	0.4						0.6								4		0.5	0.3	
Buliminella elegantissima																			
Bolivina lanceolata		0.5																	
B. lowmani																			
B. striatula																			
Discorbis floridana	0.4	0.2		3	4	4	2						1		3			1	
D. nitida			0.4																
D. rosacea		1	0.4																
Planorbulina mediterranensis																			
Ammonia beccarii		2	1				0.6	3									1	0.1	
A. translucens	2	1	1	1	13	8		7			8		2				0.5		0.4
Elphidium advenum																			
E. galvestonense		3	2	0.4											1		0.5	0.5	0.4
E. poeyanum	1	2	1	0.4			2										1	0.8	
E. sagrum																			
Nonion depressulum			0.4				0.6												
N. grateloupi		0.5																	
DEPTH (meters)	1.2	2.0	2.3	0.9	2.1	2.4	2.6	2.4	2.4	2.4	2.3	1.8	2.0	2.6	2.4	2.0	1.8	2.4	2.3
TEMPERATURE (C)	30.3	30.1	30.0	30.4	30.7	30.4	30.7	31.0	31.0	30.7	31.0	31.4	30.9	30.8	30.5	31.2	30.4	30.9	31.3
SALINITY (‰)	27.1	26.6	26.9	26.4	26.1	26.1	26.8	27.0	27.0	26.8	26.5	26.1	26.4	25.9	26.4	26.5	26.6	26.6	25.9
pH	7.6	8.0	7.7	7.7	7.6	7.6	8.0	7.8	7.8	7.7	8.0	7.3	8.1	7.9	7.9	8.1	8.2	8.2	7.9
Eh (mv)	113	180	230	80	-97	-37	114	116	224	165	60	14	137	66	119	209	250	225	94
SAND (%)	15	88	46	21	13	36	36	25	70	26	18	9	38	14	2	41	34	6	32
SILT (%)	25	6	36	59	52	37	40	38	24	37	47	55	31	43	35	15	28	31	54
CLAY (%)	60	6	18	20	35	27	24	37	6	37	35	36	31	43	63	44	38	63	14

TABLE 3. Faunal composition in percent of August 20th, 1962 collection.

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
NUMBER OF SPECIMENS	170	532	518	122		347	232	17	80	138	30	9	399		12	28	23	305	1250
Ammodiscus incertus			0.8																
Glomospira charoides		0.2	0.8				0.4												0.1
Ammobaculites dilatatus																			
A. exiguus																			
Schenckiella occidentalis	3		0.2	5															
Clavulina tricarinata	1	0.4		5															
Valvulina oviedoiana (Group 1)	25	4	2										0.2						0.4
V. oviedoiana (Group 2)	2	2																	0.2
Cyclogyra involvens			0.2				2						0.2						0.2
Nodobaculariella cassis																			
Miliolinella circularis	0.6	2	5	5		5	3		5	6	3		2					0.6	0.6
M. fichteliana																			
M. labiosa													0.2						
M. obliquinoda	2	0.6	0.6				0.4				3		2						1
M. suborbicularis																			
Massilina secans																		4	0.1
Pyrgo subsphaerica																			
Quinqueloculina agglutinans		0.4	0.2																0.1
Q. bosciana	6	6	21	9		6	10	6	39	35	13	11	58		58	36	52	13	30
Q. laevigata	3	20	30	12		29	34	53	14	31	13	89	21		33	14		7	28
Q. lamarckiana		3	1															1	0.6
Q. poeyana	9	5	9	22		1	5	29	22	4	17		0.2				9	12	19
Q. polygona		0.7	0.6															0.3	
Q. sabulosa	8	3	1	2		0.3	3			0.7			1			4			2
Q. seminulum	2	2	1	3		0.3			1	0.7	3						4	0.6	1
Q. subpoeyana	5	28	3	2		0.3	3		4	0.7	3					21	17	4	2
Q. tenagos		0.4																	0.1
Spiroloculina antillarum	0.8																		
S. eximia																			
Triloculina bassensis		1	0.6			0.3	0.4											2	1
T. bermudezi	8	2	4	9		41	16		9	8	27		9			4	9	12	2
T. linneiana	0.6	1	4	5		3	5			3			0.2			7	4	3	4
T. oblonga	2	0.4	1	2		0.3							0.5			4			
T. rotunda		0.6		4					1	0.7			0.2					2	0.6
T. sidebottomi																			
T. trigonula	0.6		0.2																
Hauerina bradyi	3	3	3	0.8		11	17		5	9	17		3		8	7		37	6
Archaias angulatus		4	1										0.2			4		1	0.1
Fissurina cf. F. lucida	2	0.2	0.4															0.3	
Buliminella elegantissima		0.2																	
Bolivina lanceolata	0.6																		
B. lowmani																			
B. striatula																			0.1
Discorbis floridana	1	0.6	0.6	5		0.9	0.4	6										0.6	
D. nitida		4	1																
D. rosacea		3	5																
Planorbulina mediterranensis																			
Ammonia beccarii		0.6	0.6																
A. translucens	10			8				6		0.7							4		
Elphidium advenum																			
E. galvestonense		0.4	0.8																0.2
E. poeyanum	5	0.6	2																0.2
E. sagrum																			
Nonion depressulum																			
N. grateloupi																			
DEPTH (meters)	1.2	2.3	2.4	1.5		2.7	2.7	2.4	2.6	2.6	2.6	1.5	2.4		2.4	1.8	1.5	2.6	2.6
TEMPERATURE (C)	20.0	19.5	20.0	19.5		20.2	20.3	20.5	20.5	20.7	21.0	20.9	20.7		20.9	21.1	21.2	21.3	22.0
SALINITY (‰)	38.6	40.0	40.8	39.3		40.0	39.3	39.3	39.3	40.8	39.3	38.6	38.6		38.6	39.3	39.3	37.9	38.6
pH	7.8	7.9	7.8	7.9		7.7	8.0	8.0	8.0	7.7	7.8	7.0			7.8	7.9	8.0	7.8	7.6
Eh (mv)				-100		-130	-140	-140	-70	-50	-10	-100			-100	-100	-90	-110	-30
SAND (%)	25	74	70	44		35	34	18	41	40	29	18	44		26	45	41	41	52
SILT (%)	32	11	12	29		40	44	35	38	39	47	42	39		54	35	47	40	28
CLAY (%)	43	15	18	27		25	22	47	21	21	24	40	17		20	20	12	19	20

TABLE 4. Faunal composition in percent of February 9th, 1963 collection.

TABLE 5. Observed ranges of environmental parameters in Buttonwood Sound.

PARAMETER AND PERIOD	OBSERVED RANGE	VARIATION
Depth	0.9 - 2.7 m	1.8 m
Temperature		
Summer	28.1 - 32.4°C	4.3°C
Winter	19.5 - 22.0°C	2.5°C
Total	19.5 - 32.4°C	12.9°C
Salinity		
Summer	25.3 - 29.6	4.3
Winter	37.9 - 40.8	2.0
Total	25.3 - 40.8	15.5
pH		
Summer	6.9 - 8.9	2.0
Winter	7.0 - 8.0	1.0
Total	6.9 - 8.9	2.0
Eh		
Summer	(-210 - +382 mv)*	(592 mv)*
Winter	-140 - -10 mv	130 mv
Sediment Size		
Sand	2 - 88%	86%
Silt	5 - 71%	66%
Clay	6 - 63%	57%

* Summer Eh potentials not reliable due to measurement techniques.

TABLE 6a. Comparison of faunal composition from August 14th, 1962 samples in terms of proportional contribution of five reference samples. (Roman numerals refer to text figures 4a-e.)

STATION	I	II	III	IV	V
1	0.000	1.000	0.000	0.000	0.000
2	0.000	0.000	1.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000
4	0.560	0.913	0.118	0.174	0.122
5	0.842	0.073	0.111	0.168	-0.175
6	0.780	0.508	-0.018	0.798	0.343
7	0.552	0.065	0.146	0.417	-0.158
8	0.000	0.000	0.000	0.000	0.000
9	0.201	0.058	-0.029	0.127	0.984
10	0.000	0.000	0.000	0.000	0.000
11	0.179	-0.146	-0.012	0.748	0.130
12	0.146	0.570	0.056	0.000	0.556
13	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	1.000	0.000
15	-0.023	-0.064	-0.016	0.874	0.275
16	0.000	0.000	0.000	0.000	0.000
17	0.123	-0.002	0.121	0.319	0.074
18	0.000	0.000	0.000	0.000	0.000
19	1.000	0.000	0.000	0.000	0.000

TABLE 6b. Comparison of environmental parameters from August 14th, 1962 stations in terms of proportional contribution of the reference station. (Roman numeral refers to text figure 5.)

STATION	I
1	0.967
2	1.000
3	0.459
4	0.000
5	0.279
6	0.393
7	0.556
8	0.847
9	0.852
10	0.696
11	0.732
12	0.435
13	0.619
14	0.450
15	0.461
16	0.801
17	0.915
18	0.818
19	0.793

TABLE 7a. Comparison of faunal composition from August17th, 1962 samples in terms of proportional contribution of five reference samples. (Roman numerals refer to text figures 6a-e.)

STATION	VI	VII	VIII	IX	X
1	-0.410	0.600	0.242	-0.152	0.049
2	0.000	0.000	0.000	0.000	1.000
3	0.000	0.000	0.000	0.000	0.000
4	0.033	0.642	0.006	-0.028	-0.018
5	0.000	1.000	0.000	0.000	0.000
6	0.557	-0.008	0.072	0.098	-0.009
7	0.458	-0.113	0.257	0.705	0.045
8	0.000	0.000	0.000	0.000	0.000
9	-0.148	0.217	0.740	0.231	0.060
10	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	1.000	0.000
12	0.000	0.000	1.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000
14	0.299	0.024	0.512	0.413	0.013
15	0.375	-0.052	0.315	0.656	-0.027
16	1.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000
18	0.727	0.813	0.425	0.248	0.085
19	0.060	0.298	0.329	-0.255	0.073

TABLE 7b. Comparison of environmental parameters from August 17th, 1962 stations in terms of proportional contribution of the reference station. (Roman numeral refers to text figure 7.)

STATION	II
1	0.683
2	0.992
3	1.000
4	0.450
5	0.000
6	0.650
7	0.906
8	0.532
9	0.509
10	0.435
11	0.734
12	0.749
13	0.667
14	0.701
15	0.531
16	0.894
17	0.948
18	0.988
19	0.641

TABLE 8a. Comparison of faunal composition from August 20th, 1962 samples in terms of proportional contribution of four reference samples. (Roman numerals refer to text figures 8a-d.)

STATION	XI	XII	XIII	XIV
1	0.462	-0.524	0.210	0.069
2	0.000	0.000	0.000	0.000
3	0.165	0.218	0.968	0.605
4	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	1.000
6	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000
9	0.769	-0.165	0.232	-0.393
10	0.631	-0.004	0.837	0.231
11	0.000	0.000	0.000	0.000
12	1.000	0.000	0.000	0.000
13	0.570	-0.492	-0.120	-0.154
14	0.000	1.000	0.000	0.000
15	0.275	0.790	-0.228	-0.425
16	0.572	0.343	0.237	0.100
17	0.000	0.000	1.000	0.000
18	0.127	0.707	-0.115	-0.520
19	0.850	-0.025	0.606	0.083

TABLE 8b. Comparison of environmental parameters from August 20th, 1962 stations in terms of proportional contribution of the reference station. (Roman numeral refers to text figure 9.)

STATION	III
1	0.708
2	0.907
3	0.972
4	0.618
5	0.000
6	0.267
7	0.709
8	0.792
9	0.956
10	0.824
11	0.551
12	0.402
13	0.772
14	0.580
15	0.714
16	0.923
17	1.000
18	0.932
19	0.652

TABLE 9a. Comparison of faunal composition from February 9th, 1963 samples in terms of proportional contribution of three reference samples. (Roman numerals refer to text figures 10a-c.)

STATION	XV	XVI	XVII
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
6	0.000	0.000	0.000
7	-0.025	0.363	0.333
8	0.000	1.000	0.000
9	0.000	0.000	0.000
10	0.698	-0.090	0.082
11	-0.330	0.133	0.310
12	0.654	0.651	-0.065
13	0.822	-0.231	-0.141
15	1.000	0.000	0.000
16	0.000	0.000	0.000
17	0.298	-0.191	-0.206
18	0.000	0.000	1.000
19	-0.204	0.538	0.071

TABLE 9b. Comparison of environmental parameters from February 9th, 1963 stations in terms of proportional contribution to the reference station. (Roman numeral refers to text figure 11.)

STATION	IV
4	0.625
6	0.902
7	0.966
8	1.000
9	0.407
10	0.314
11	0.000
12	0.647
15	0.631
16	0.635
17	0.559
18	0.674
19	0.096

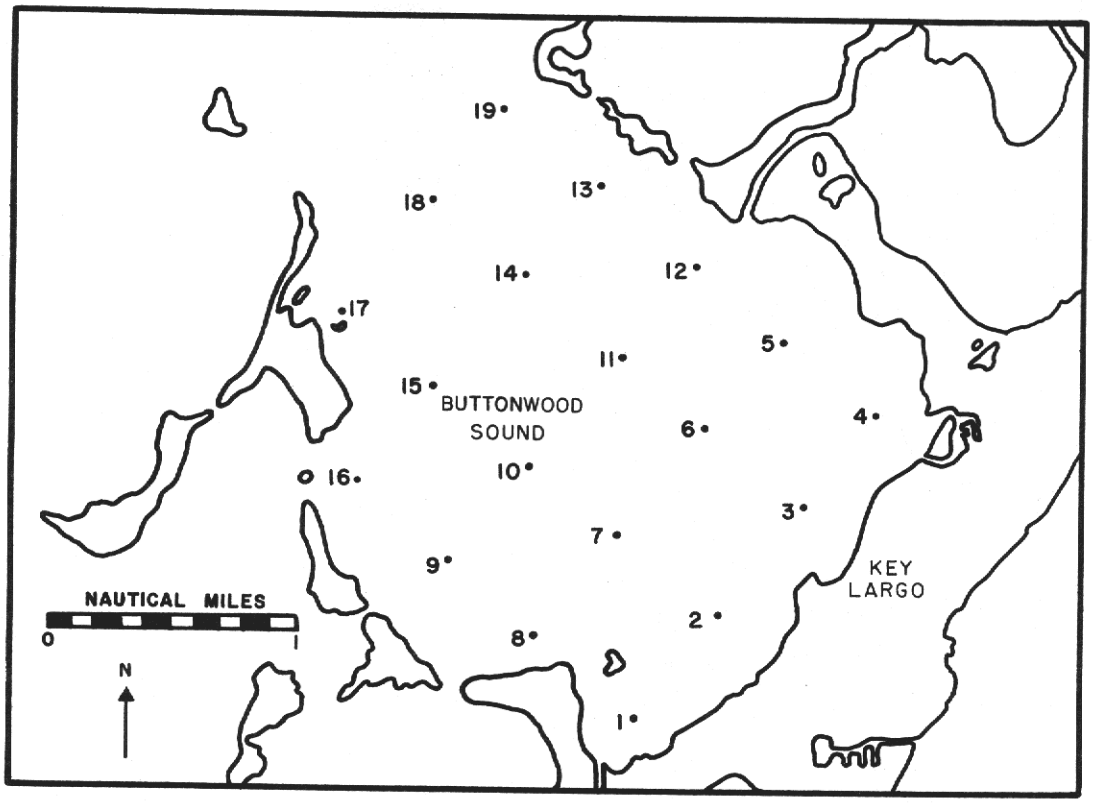

FIGURE 1. Station location

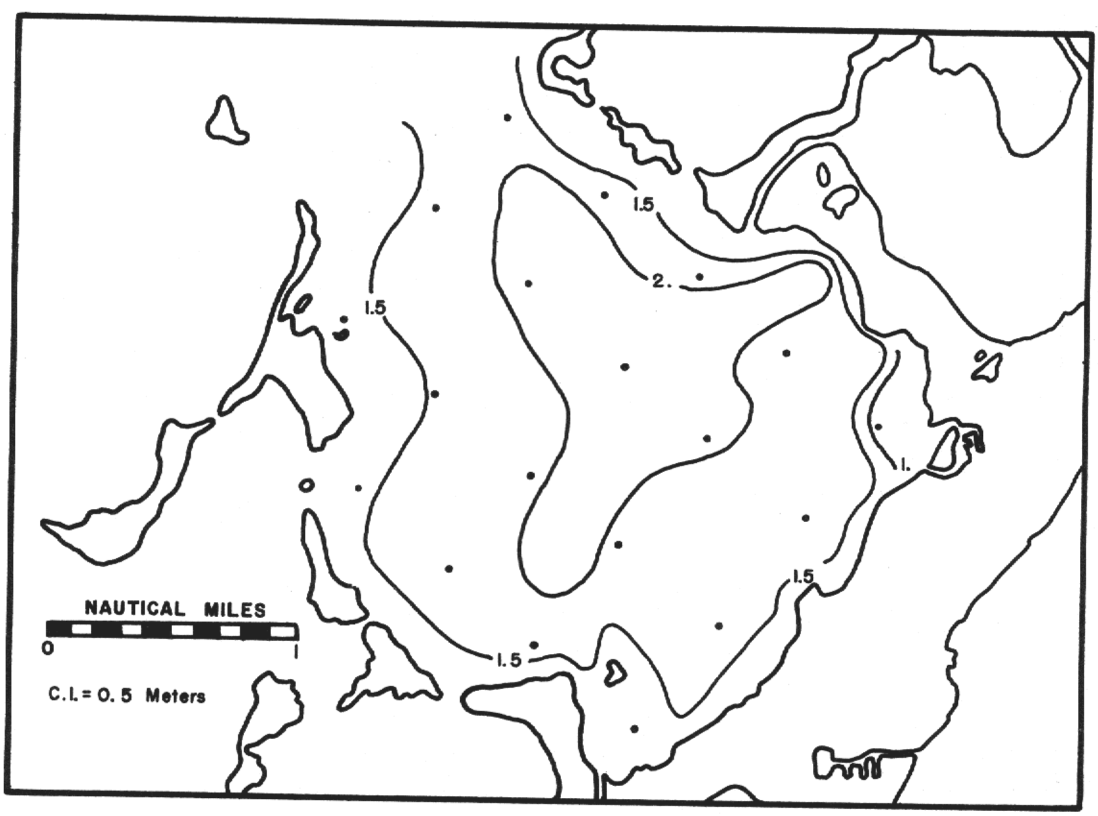

FIGURE 2. Bathymetry of Buttonwood Sound.

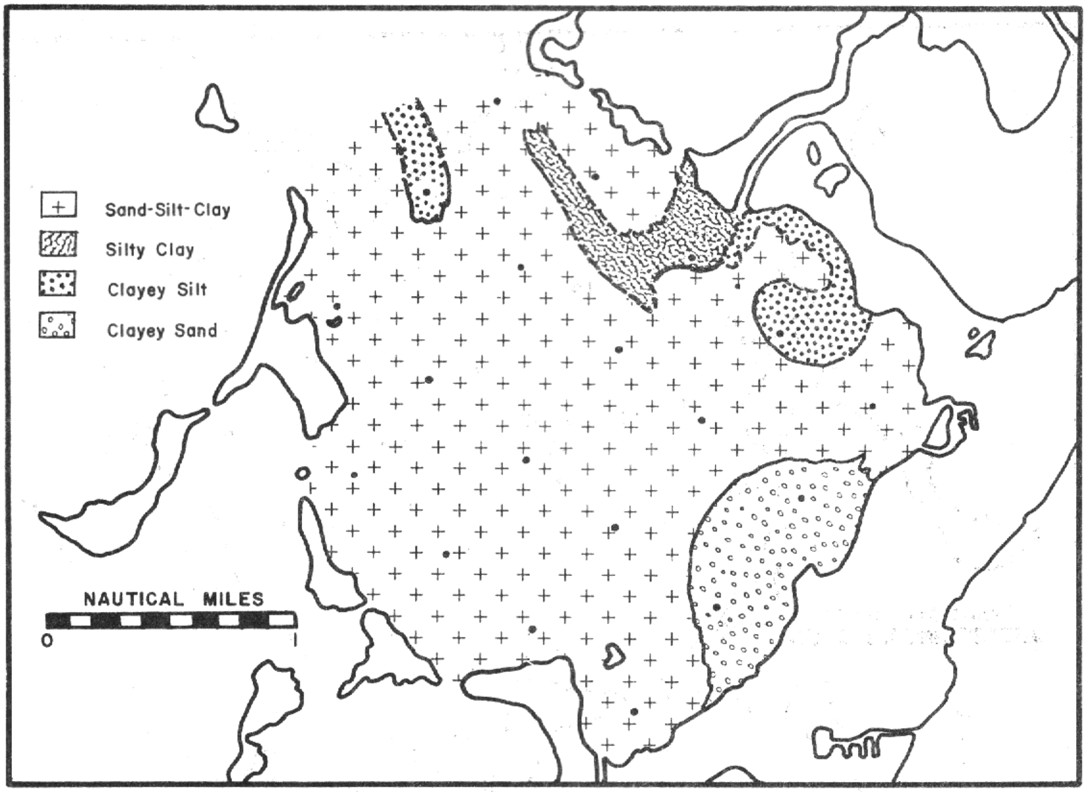

FIGURE 3. Sediment-size distribution map of Buttonwood Sound.

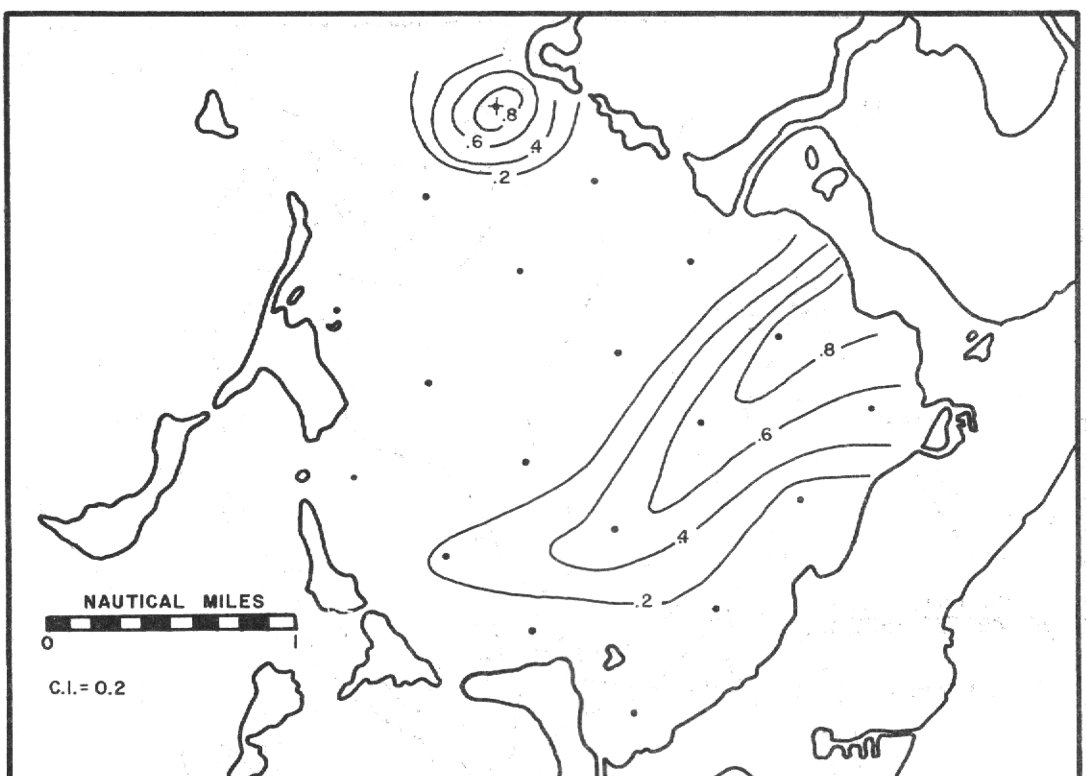

FIGURE 4a. Proportional contribution of Assemblage I, August 14th, 1962. (Reference sample indicated by +.)

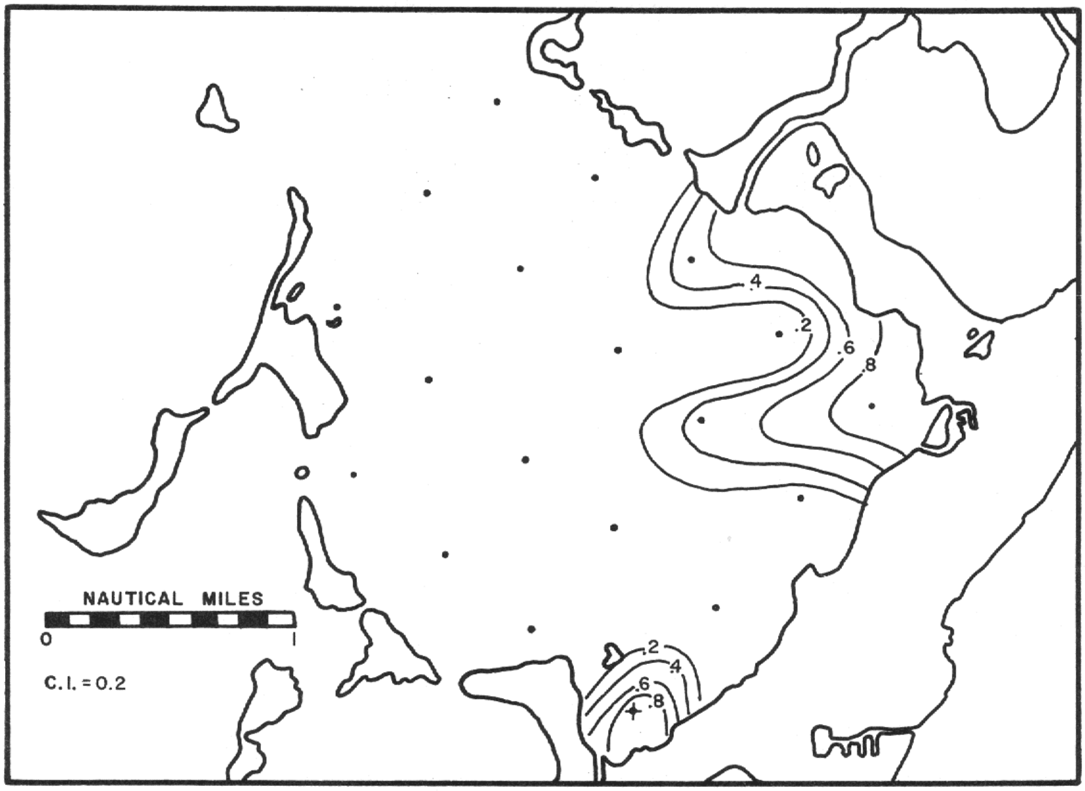

FIGURE 4b. Proportional contribution of Assemblage II, August 14th, 1962. (Reference sample indicated by +.)

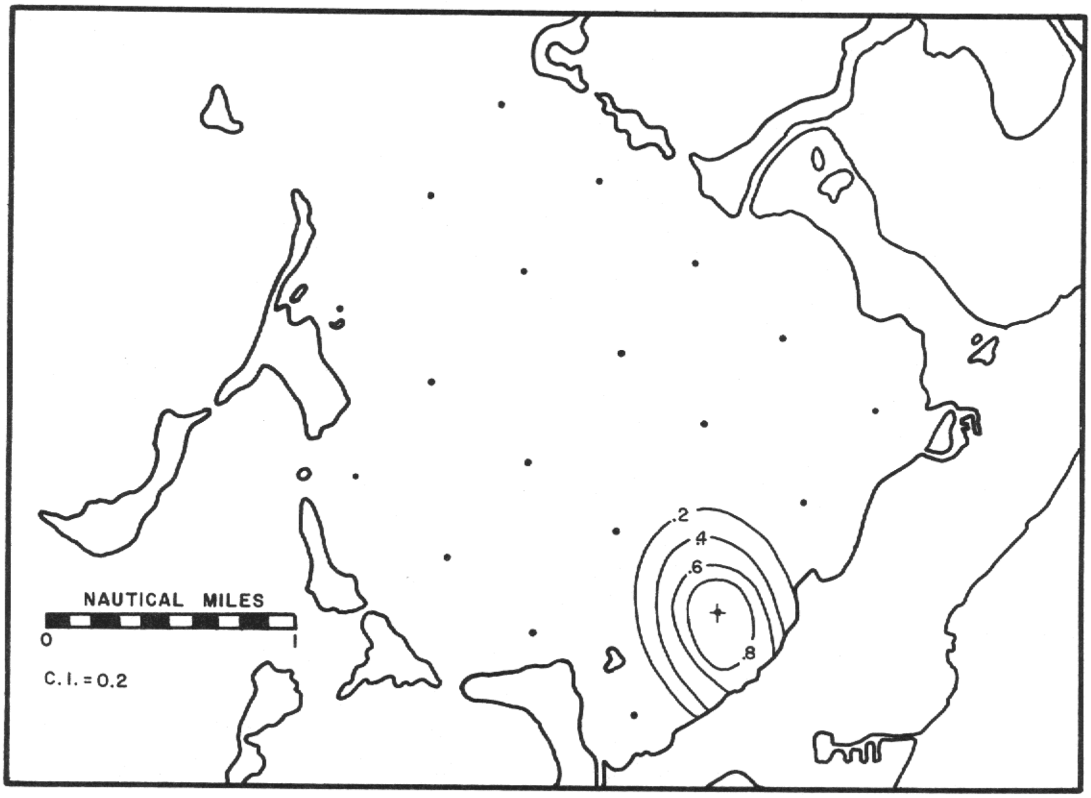

FIGURE 4c. Proportional contribution of Assemblage III, August 14th, 1962. (Reference sample indicated by +.)

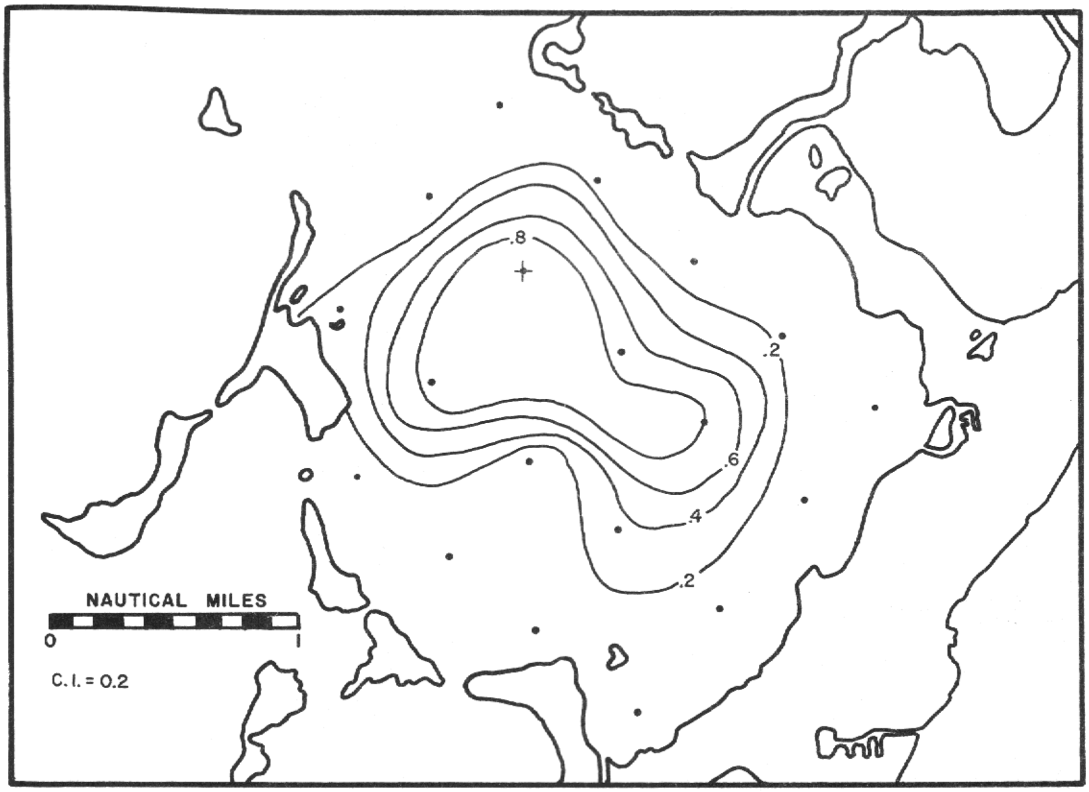

FIGURE 4d. Proportional contribution of Assemblage IV, August 14th, 1962. (Reference sample indicated by +.)

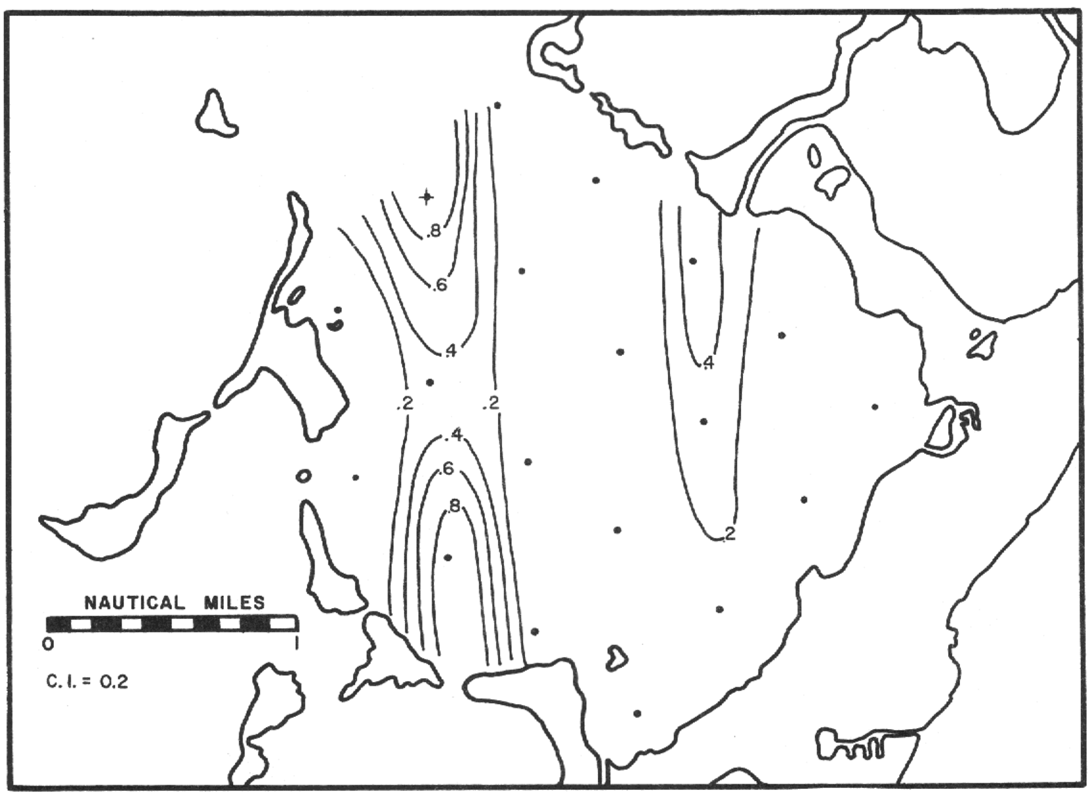

FIGURE 4e. Proportional contribution of Assemblage V, August 14th, 1962. (Reference sample indicated by +.)

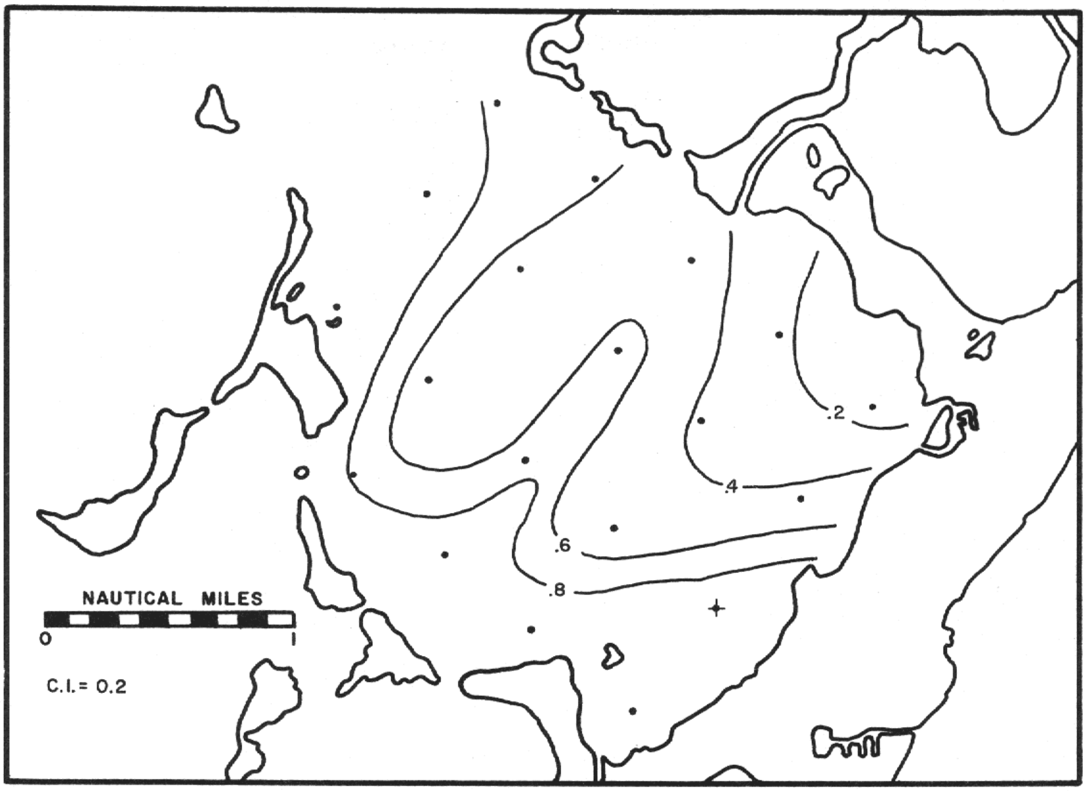

FIGURE 5. Proportional contribution of Environmental Model I, August 14th, 1962. (Reference station indicated by +.)

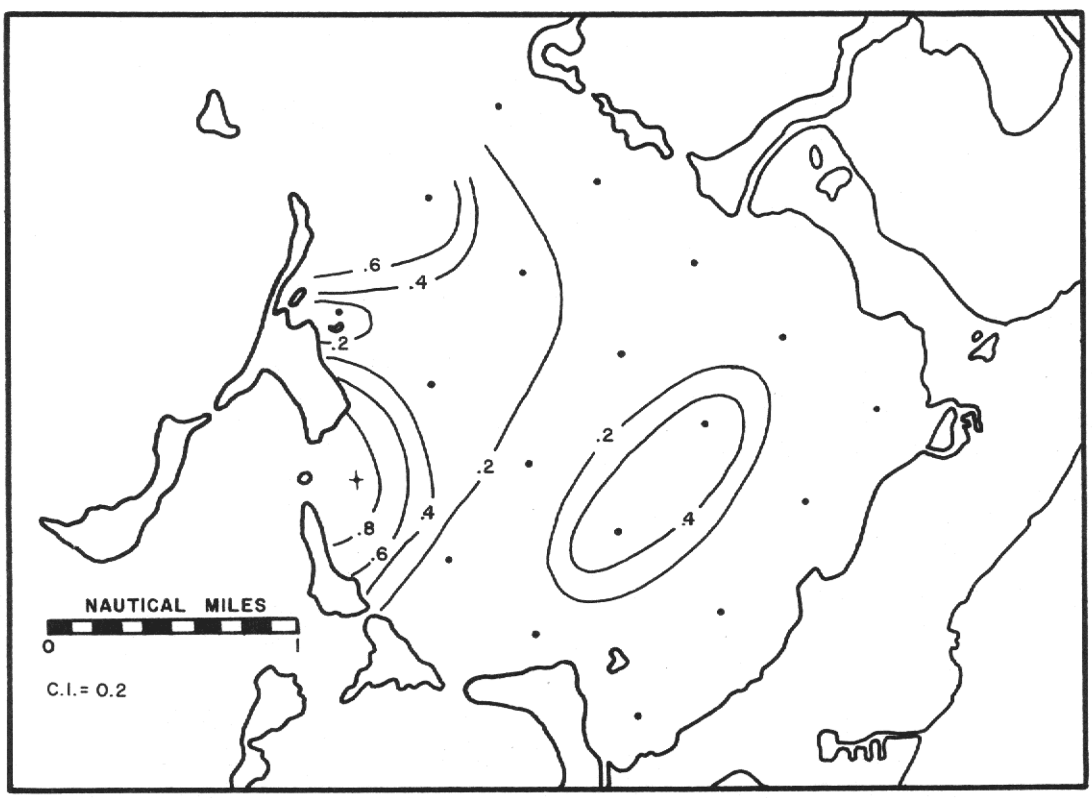

FIGURE 6a. Proportional contribution of Assemblage VI, August 17th, 1962. (Reference sample indicated by +.)

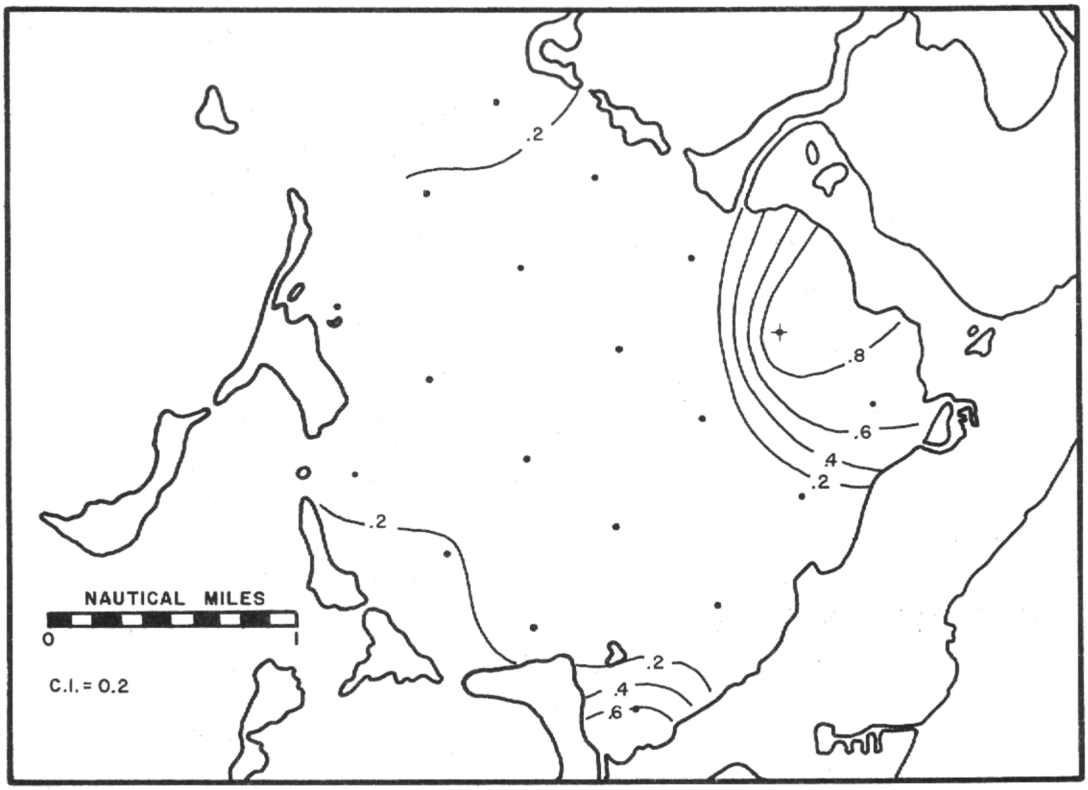

FIGURE 6b. Proportional contribution of Assemblage VII, August 17th, 1962. (Reference sample indicated by +.)

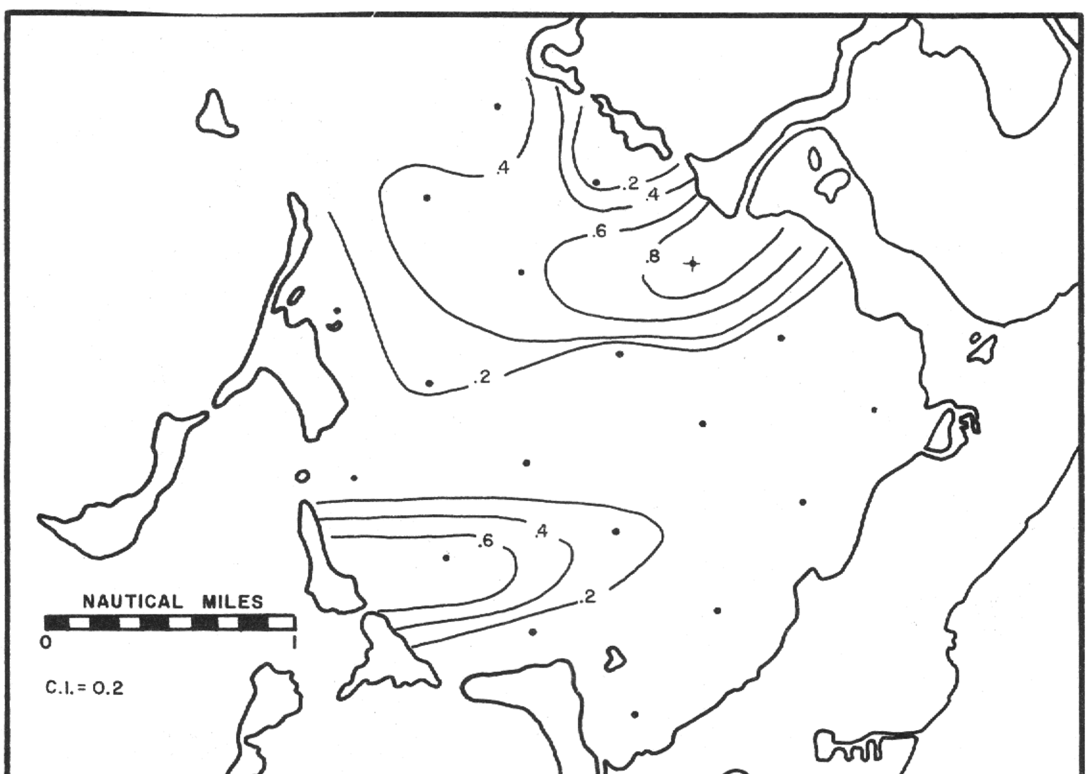

FIGURE 6c. Proportional contribution of Assemblage VIII, August 17th, 1962. (Reference sample indicated by +.)

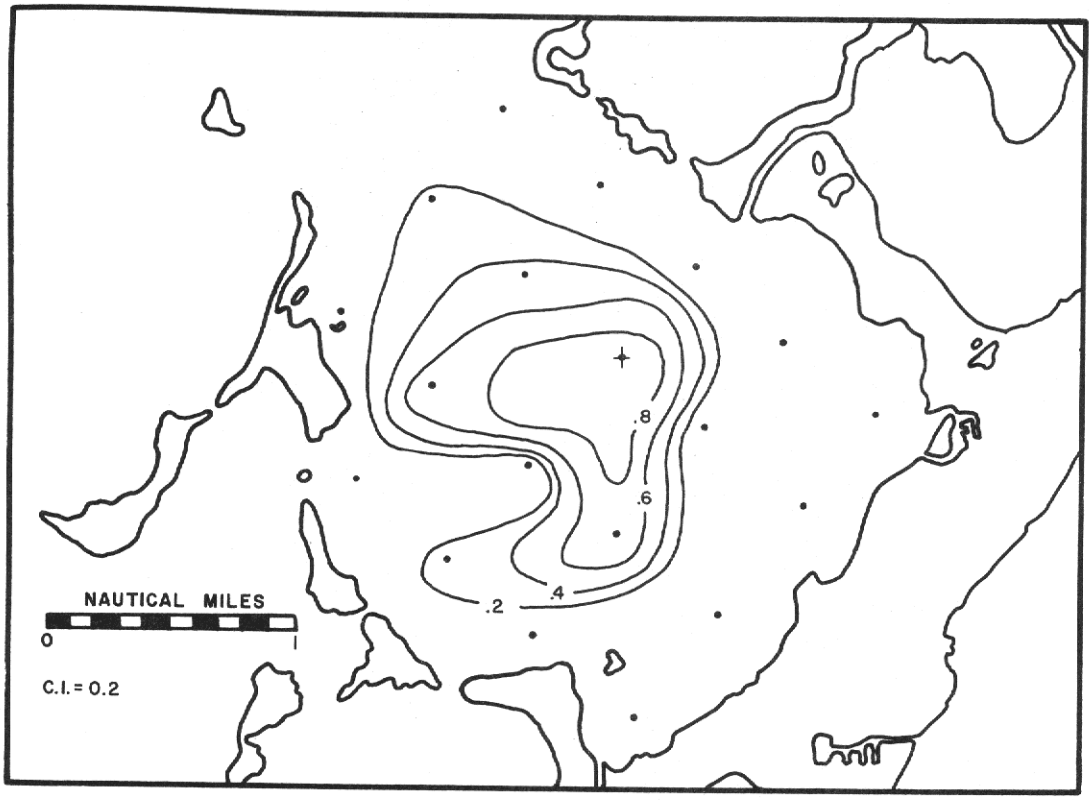

FIGURE 6d. Proportional contribution of Assemblage IX, August 17th, 1962. (Reference sample indicated by +.)

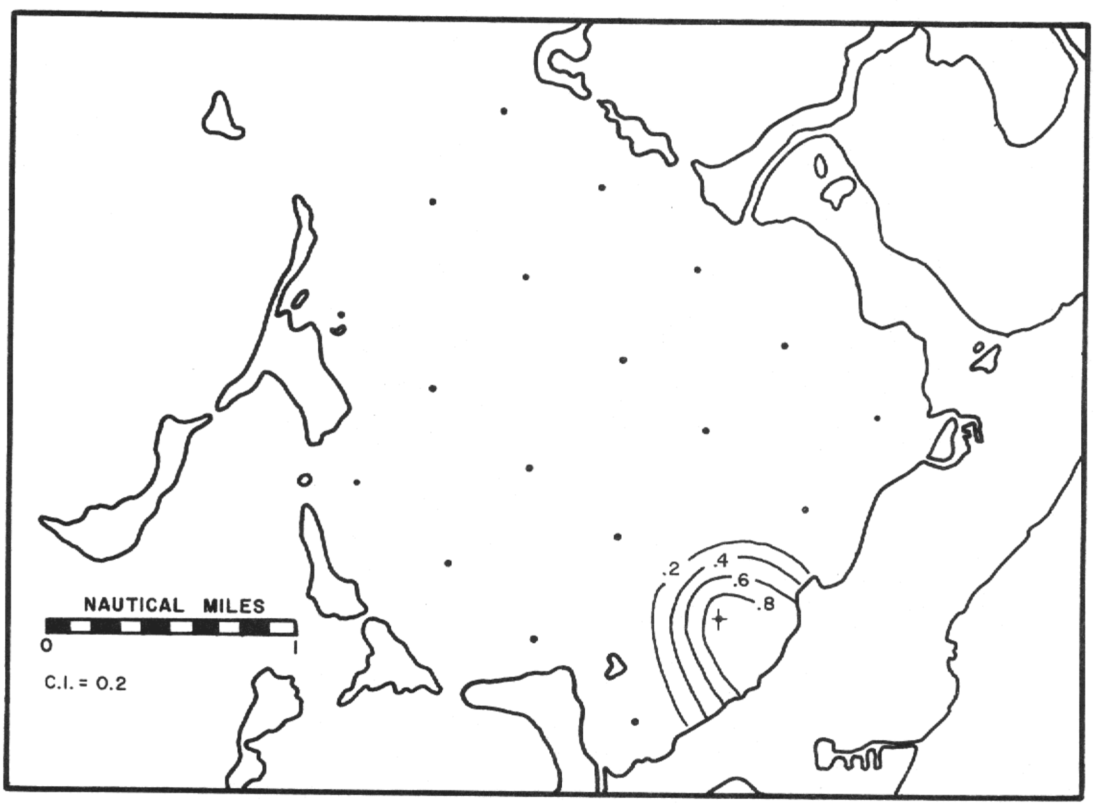

FIGURE 6e. Proportional contribution of Assemblage X, August 17th, 1962. (Reference sample indicated by +.)

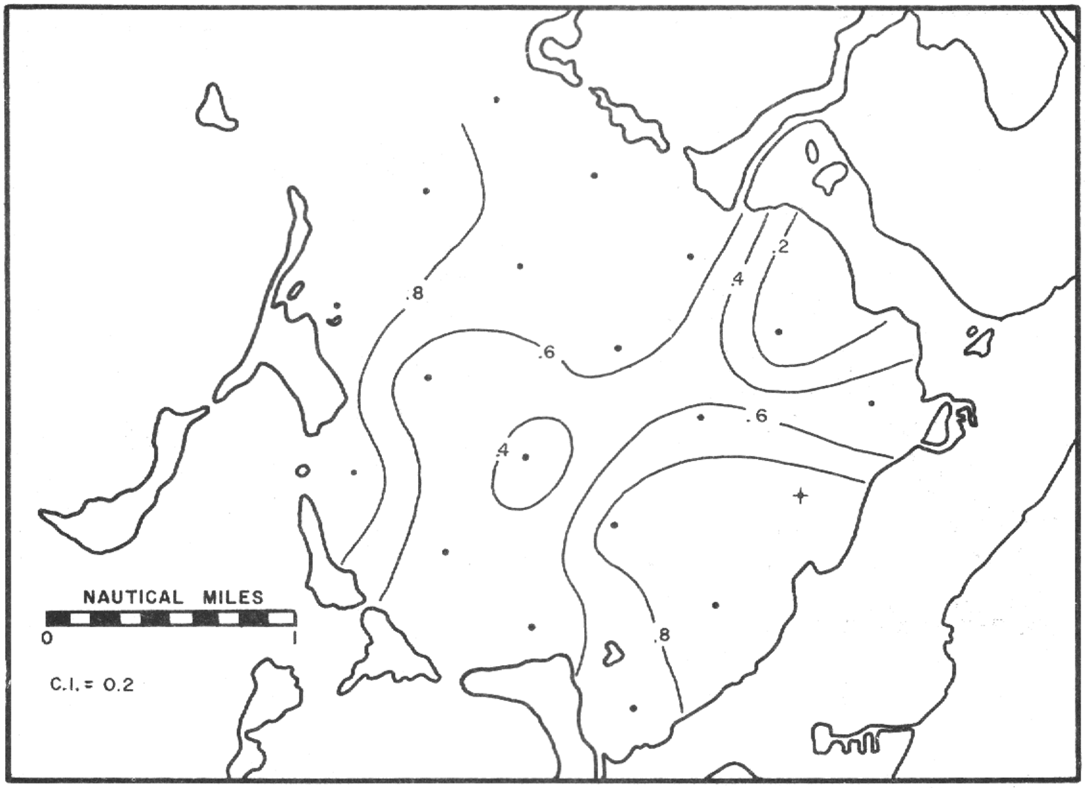

FIGURE 7. Proportional contribution of Environmental Model II, August 17th, 1962. (Reference station indicated by +.)

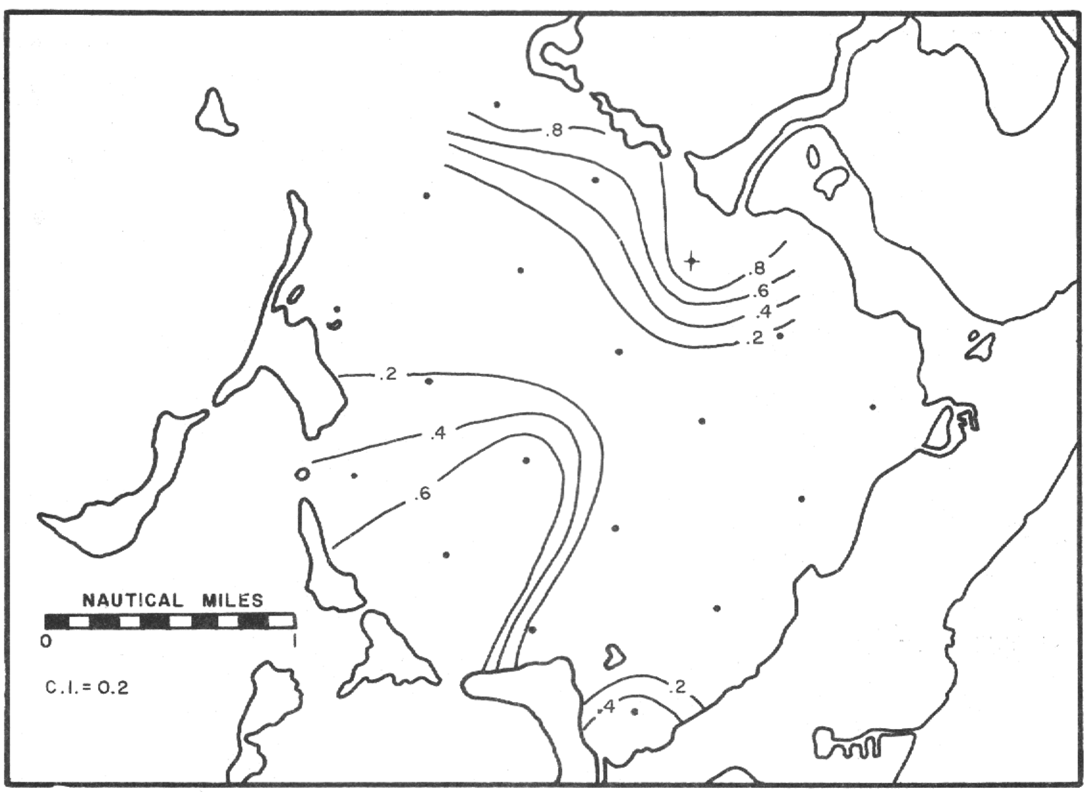

FIGURE 8a. Proportional contribution of Assemblage XI, August 20th, 1962. (Reference sample indicated by +.)

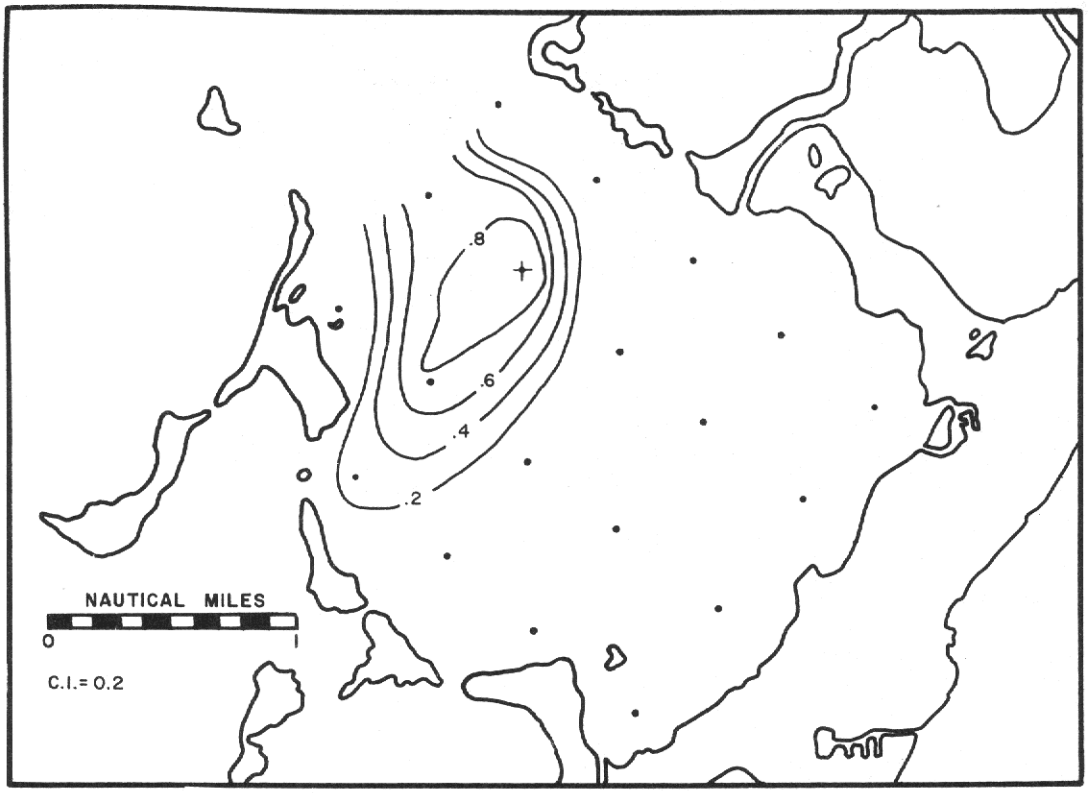

FIGURE 8b. Proportional contribution of Assemblage XII, August 20th, 1962. (Reference sample indicated by +.)

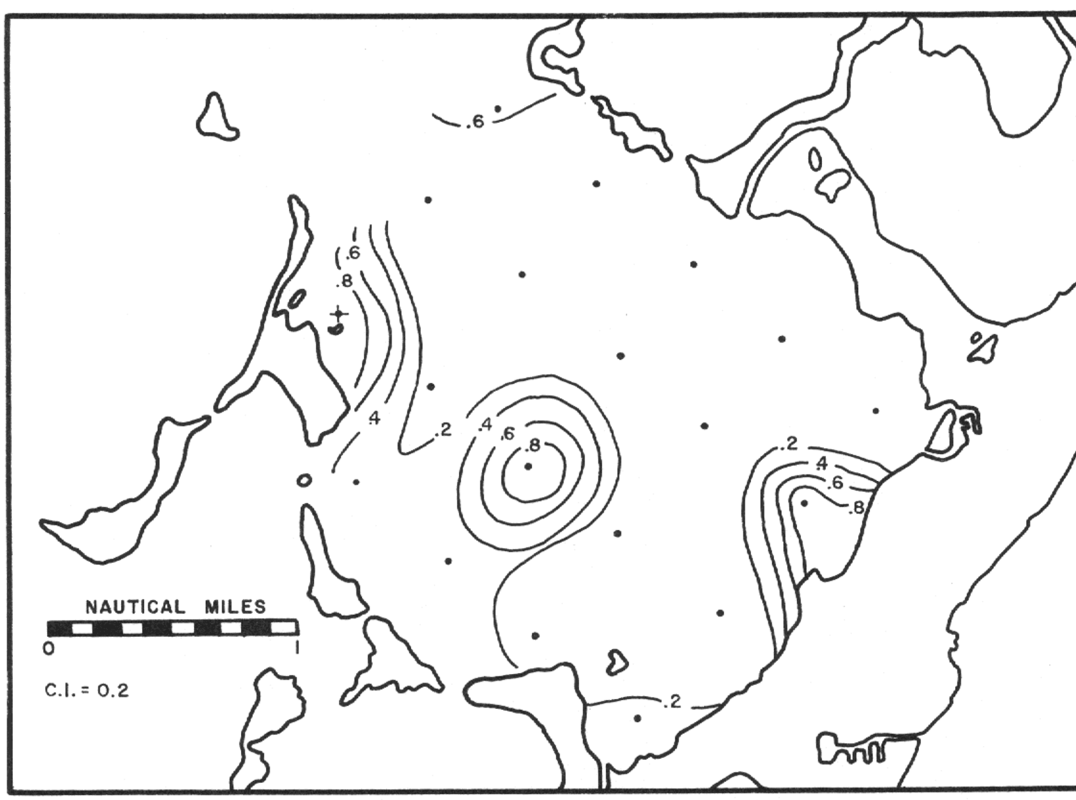

FIGURE 8c. Proportional contribution of Assemblage XIII, August 20th, 1962. (Reference sample indicated by +.)

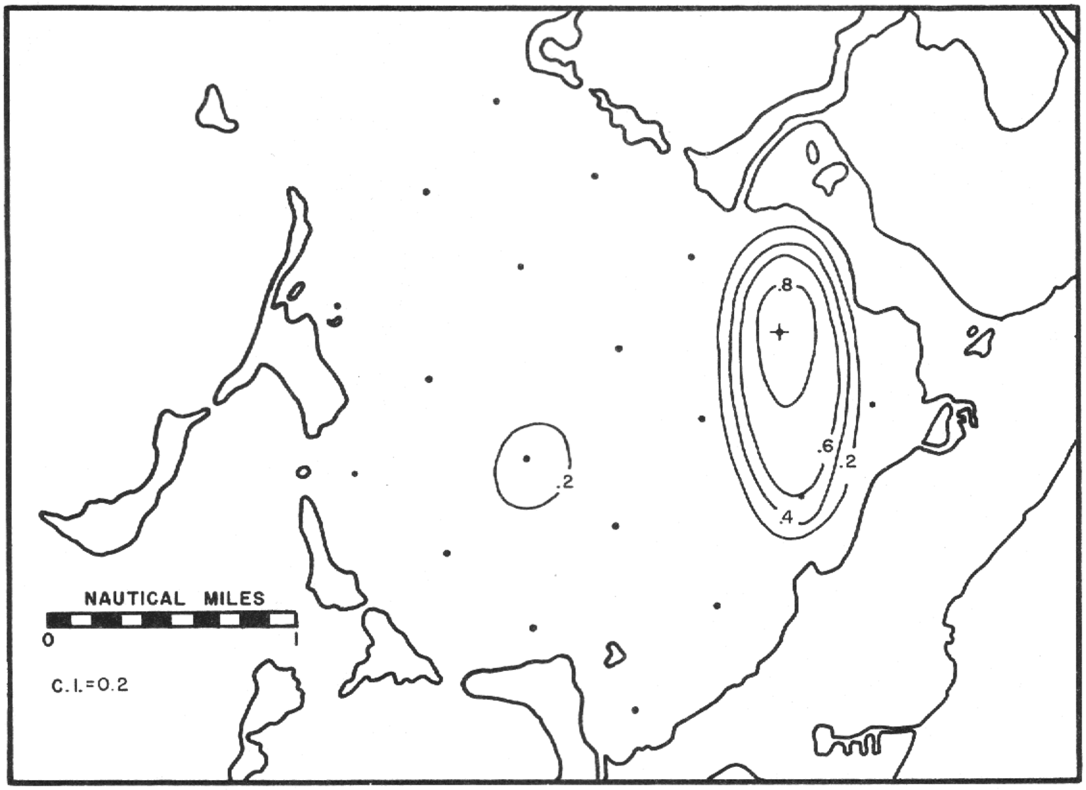

FIGURE 8d. Proportional contribution of Assemblage XIV, August 20th, 1962. (Reference sample indicated by +.)

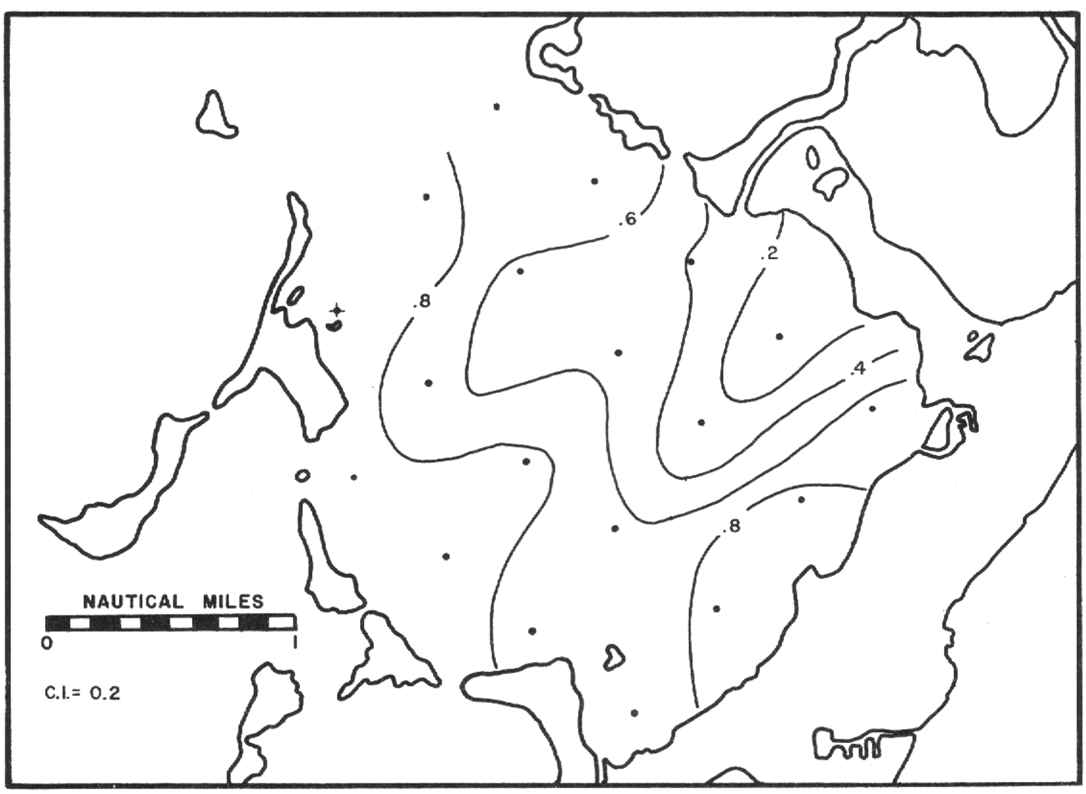

FIGURE 9. Proportional contribution of Environmental Model III, August 20th, 1962. (Reference station indicated by +.)

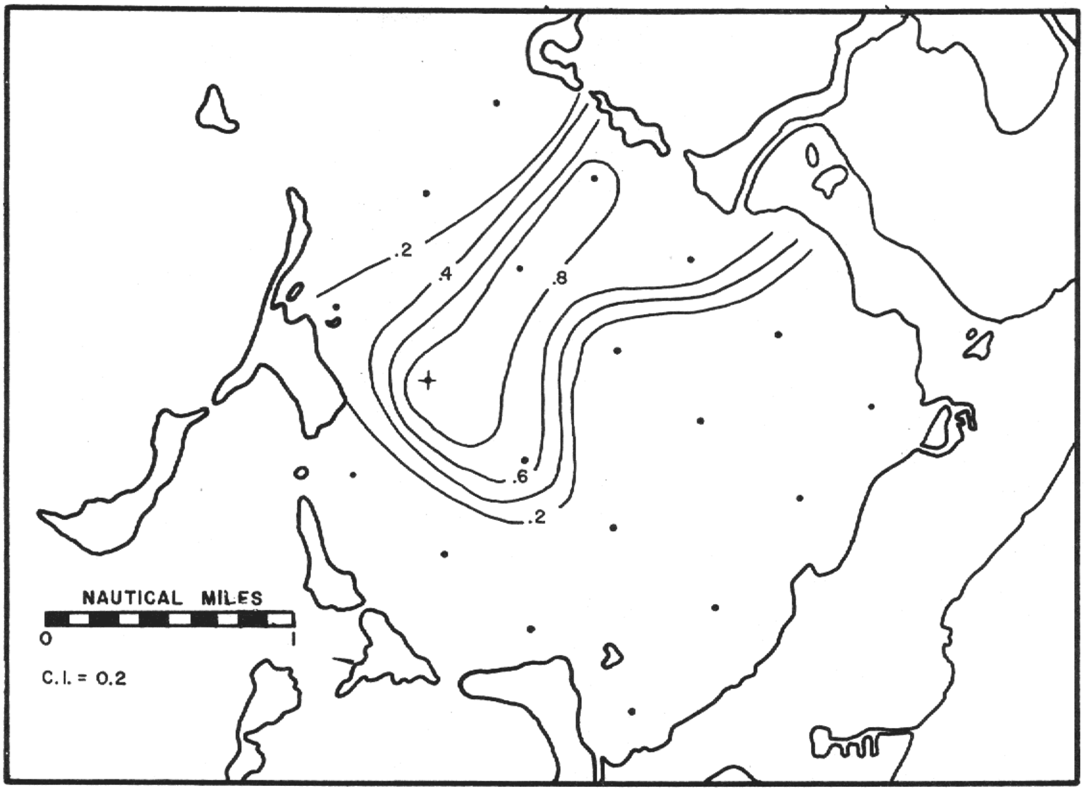

FIGURE 10a. Proportional contribution of Assemblage XV, February 9th, 1963. (Reference sample indicated by +.)

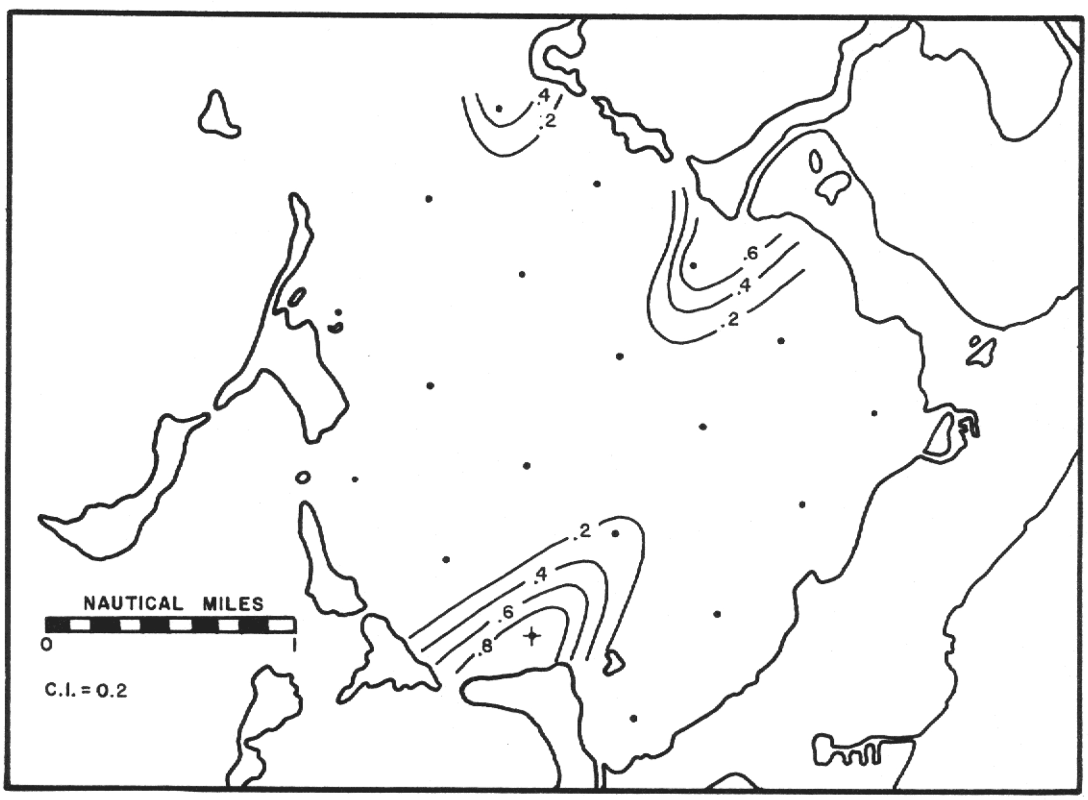

FIGURE 10b. Proportional contribution of Assemblage XVI, February 9th, 1963. (Reference sample indicated by +.)

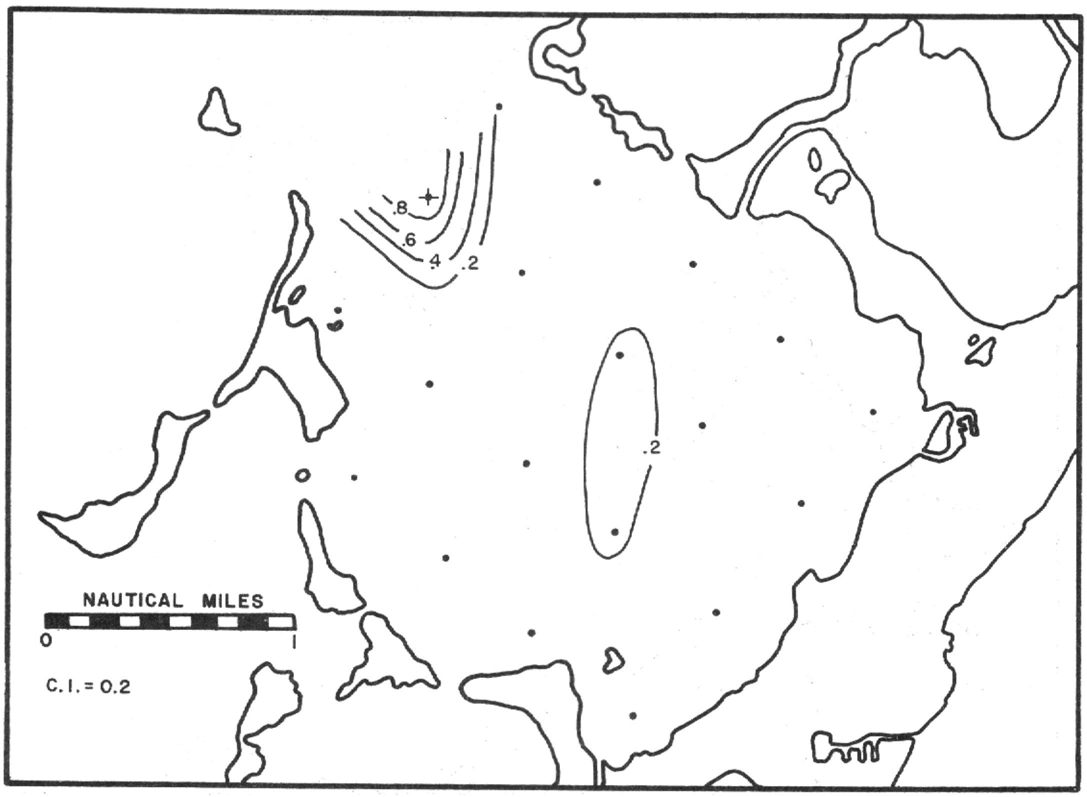

FIGURE 10c. Proportional contribution of Assemblage XVII, February 9th, 1963. (Reference sample indicated by +.)

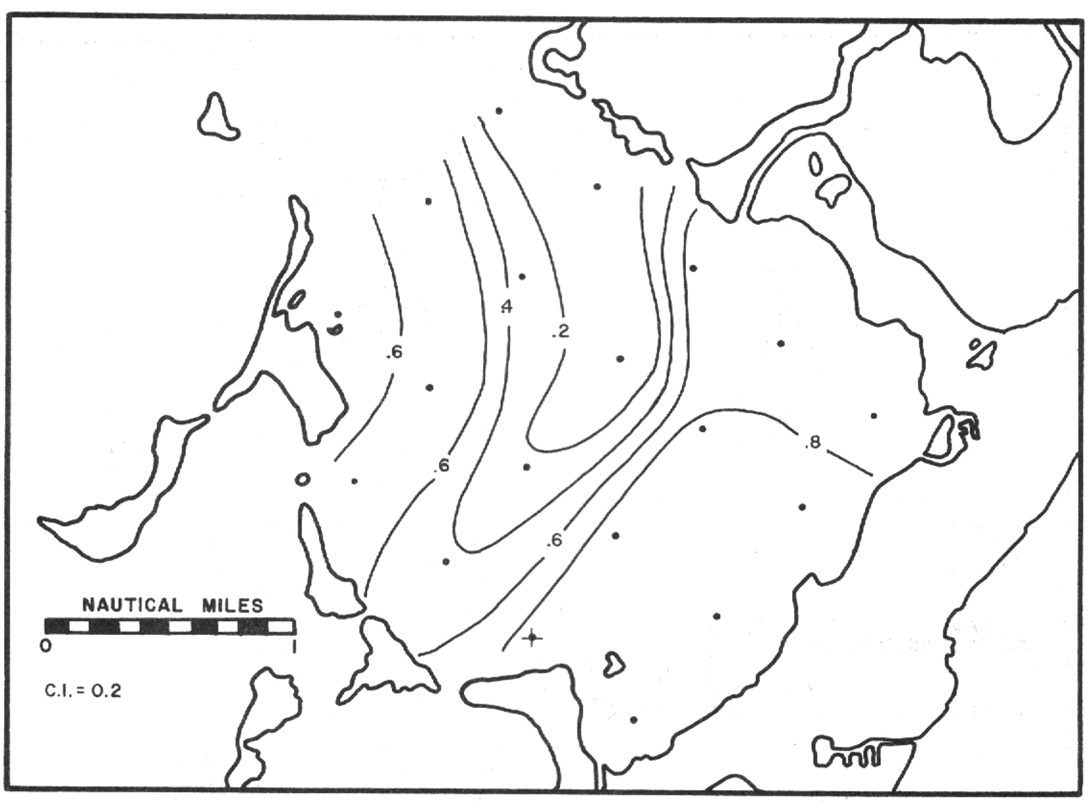

FIGURE 11. Proportional contribution of Environmental Model IV, February 9th, 1963. (Reference station indicated by +.)

DISTRIBUTION OF RECENT

FORAMINIFERA IN LOWER FLORIDA BAY

by

SHARON LYNNE SMITH

INTRODUCTION

This study was undertaken as part of a reconnaissance study of the present benthonic Foraminifera of Florida Bay and adjacent waters. Its primary purpose is to describe the fauna and its distribution and, secondarily, to consider ecologic factors as they may influence observed distribution patterns. The study area consisted of the western portion of Lower Florida Bay, a shallow carbonate shelf with waters depths ranging from less than one foot to as much as seventeen feet.

Twenty-six samples were collected in March 1963. Most were obtained by coring, but a few were taken by grab-samplers where the bottom sediment was too thin or too coarse to allow the recovery of sediment cores. At each station bottom temperature, water depth, and bottom community information were recorded and hydrographic samples were collected.

PREVIOUS WORK

Vaughan (1918) studied shallow water bottom samples from Murray Island, Australia, Florida, and the Bahamas. Cushman identified the foraminiferal species in the five samples from the Florida Keys and the Tortugas, finding Orbiculina adunca the most abundant species.

Cushman (1922) completed an ecological study of the shallow water Foraminifera of the Dry Tortugas including observations of living Foraminifera.

Norton (1930) made an ecologic study of samples from Australia and the Florida-Bahama region where he recognized ecologic zones based on temperature and depth. The families Peneroplidae and Miliolidae were most abundant in the shallowest and warmest waters, exhibiting decreasing abundance with increasing depth.

Thorp (1939) investigated calcareous marine deposits from the Florida-Bahama region. He found Foraminifera widely distributed, making up nine percent of the sediment. Archaias, Peneroplis, Quinqueloculina, Clavulina, and Valvulina were the most common genera.

Stubbs (1940) investigated the Foraminifera occurring in the Biscayne Bay area, finding the Miliolidae and Peneroplidae the predominant families and Archaias angulatus the most common species.

Bush (1949, 1958) first studied the distribution of Foraminifera in Biscayne Bay and in a later and more comprehensive study, examined the sediments and the ecological distribution of the Foraminifera. He divided the area into thirteen biotopes, dominated by porcelaneous species but also with significant numbers of agglutinated and perforate species.

Moore (1957), in an ecologic study of Foraminifera in the northern Florida Keys, established four faunal provinces: Florida Bay, back-reef, reef and fore-reef. The Peneroplidae, Milioidae and Nonionidae dominated the Florida Bay environment with the families Amphisteginidae Textulariidae, Lagenidae and Buliminidae absent. Ammonia beccarii and Cornuspiramia antillarum were restricted to the Florida Bay environment. He stated that only the Miliolidae were living in that environment and that the fauna was wave and current sorted.

Lynts (1961) made a study of the sediments and the benthonic Foraminifera in Upper Florida Bay. He found the fauna to be cosmopolitan and to lie within the porcelaneous zone. Ammonia beccarii and Elphidium galvestonense were inversely related, and the family Miliolidae, Quinqueloculina lamarckiana and Rosalina floridana directly related, to salinity. Living representatives of most of the families were identified in the area. He concluded that the lack of a high correlation between Foraminifera occurrence and sediment distribution indicated that the Foraminifera were not wave- or current-sorted. He further concluded that sediment size may influence the distribution of some species.

Bock (1961) investigated the benthonic Foraminifera of Southwestern Florida Bay and recognized current and wave sorting as the dominant factor affecting distribution. Archaias angulatus, Quinqueloculina bosciana, and Quinqueloculina poeyana were the most common species.

Scholz (1962) studied Foraminifera distribution in Hawk Channel, Florida finding Archaias angulatus and Quinqueloculina lamarckiana the most abundant species. She found significant associations of Quinqueloculina bosciana with Triloculina bermudezi and Triloculina circularis.

Distribution of Quinqueloculina bosciana seemed to be correlated with bottom sediment and depth of water.

Benda and Puri (1962) worked with the benthonic Foraminifera in the Cape Romano area of Florida and recognized four faunal assemblages: marsh river; lagoon; mangrove island; open gulf. Porcelaneous Foraminifera were most abundant in the open gulf environment with arenaceous forms most abundant in the others, with largest populations in the lagoons and greatest speciation in the open gulf environment. He considered grain size and organic carbon content of the sediment, salinity and temperature of the bottom water, and submarine topography important factors influencing foraminiferal distribution.

Wilcoxon (1964) in his study of the distribution of the Foraminifera of the Southern Atlantic Coast recognized four faunal depth zones: Beach Fauna, 0-1 meters; Inner Shelf Fauna, 1-15 meters; Middle Shelf Fauna, 15-61 meters; Open Shelf-Upper Continental Slope Fauna, 61-192 meters. Elphidium rugulosum and Ammonia tepida were most abundant in the Beach Fauna and were probably washed into the area. The Inner Shelf Fauna was characterized by species of Elphidium and Quinqueloculina. He concluded that sediment size was more important than sediment type in influencing foraminiferal distribution. Porcelaneous species were most abundant in near-shore shallow waters.

LOCATIONS OF STATIONS

Lower Florida Bay is located south of the Florida Peninsula between the mainland and the Florida Keys. The area studied lies between approximately 24°58' and 25°09' North Latitude and 80°47' and 81°08' West Longitude. The water depth varies from one foot to seventeen feet. Figure 1 shows the station locations while Table 1 gives the geographic position and water depth at each station.

METHOD OF STUDY

The top centimeter of each sediment core sample was separated, providing 4.8 cubic centimeters of sample from each station for analysis. Buffered formalin was added to each sample to preserve the protoplasm of the Foraminifera that were living at the time of collection. The samples were washed through number 20 and 200 sieves to a Foraminifera-size fraction. The coarse fraction was examined and any Foraminifera found therein were transfered to the Foraminifera size portion. Rose bengal (Walton, 1952) was then added to each sample.

The wet samples were washed through a microsplitter. One-half of the sample was then examined and the standing crop identified and counted. A one-sixteenth sample split was taken from the remaining half and distributed evenly in a gridded plastic counting tray. Three hundred Foraminifera were identified and counted. Representative specimens from each sample were wet-picked and retained. Population percentages (Bandy, 1954) and Foraminifera numbers were then calculated for the total population and the standing crop from each station.

FAUNAL ANALYSIS

Thirty-three families, sixty-one genera and one hundred fifty species were present in the total population. Thirty families, sixty-two genera and one hundred nineteen species were identified in the standing crop. The most abundant species found in the total population in order of abundance were:

Ammonia beccarii
Elphidium galvestonense
Nonion depressulum
Cribroelphidium poeyanum
Archaias angulatus
Quinqueloculina lamarckiana
Quinqueloculina seminulum
Quinqueloculina poeyana
Quinqueloculina laevigata
Miliolinella obliquonoda
Peneroplis proteus

Conorbina orbicularis
Triloculina bermudezi
Bolivina lowmani
Quinqueloculina bosciana
Bolivina striatula

The species most common in the standing crop in order of abundance were:

Ammonia beccarii
Quinqueloculina poeyana
Quinqueloculina laevigata
Quinqueloculina seminulum
Archaias angulatus
Nonion depressulum
Quinqueloculina lamarckiana
Triloculina trigonula
Triloculina bermudezi
Bolivina striatula
Nonion grateloupi
Elphidium galvestonense
Quinqueloculina bosciana
Bolivina lowmani

The Miliolidae generally constituted a larger percentage of the standing crop than of the total population,while the Rotaliidae formed a larger percentage of the total population than of the standing crop. These two families, with the families Elphidiidae, Nonionidae and Soritidae, formed the majority of the fauna in both the total population and the standing crop although their percentages from one to the other vary considerably (Figs. 2-5).

The area investigated may be conveniently divided into a north-south traverse consisting of stations one to fifteen and an east-west traverse consisting of stations seventeen to twenty-four and twenty-six. Stations sixteen and sixteen "a" are beach samples which do not relate to either traverse.

The Miliolidae and Soritidae tended to increase in abundance to the south toward more open-ocean conditions and away from the mainland. The Miliolidae increased in abundance to the east. The Rotaliidae and Elphidiidae decreased in abundance to the south and to the east (Figs. 2-5).

Each species, except for rare ones, was present in both the total population and the standing crop. Some species, however, such as Quinqueloculina poeyana, were more numerous in the standing crop than in the total population. This may indicate that their tests were perferentially removed or destroyed in the sediment, or that they had a longer reproductive cycle or fewer offsrping than other species (Fig. 6). Some other species, notably Ammonia beccarii (Fig. 7), were much more common in the total population than in the standing crop. This probably indicates that their tests are resistant to breakage and that they were washed in by currents. Seasonal population variability also undoubtedly is a factor in the observed distribution patterns (Phleger, 1960).

Except for the increase of Miliolidae and Soritidae and the decrease of Rotaliidae and Elphidiidae with increasing distance from shore, no definitive relationships were determined between the ecologic factors measured and the observed population distribution. It appears that the benthonic Foraminifera population in the lower Florida Bay reacts as a unit to the ecologic factors measured within the limits of accuracy under which they were measured. The area is environmentally rigorous, with major fluctuations in turbidity, salinity, temperature and water depth (Ginsburg, 1956). The species living in this environment appear to be generally tolerant to environmental fluctuation and do not react to small changes in the measured ecologic factors.

The number of living Foraminifera in a sample ranged from thirty to nine hundred, but this variation is not readily related to any of the factors measured, indicating that the productivity of any given area was related to an unmeasured variable, probably nutritional (Phleger, 1960).

The fauna approximates Phleger's (1960) porcelaneous zone and Wilcoxon's (1964) inner-shelf fauna.

CONCLUSIONS

1. The most abundant species was Ammonia beccarii.

2. The Rotaliidae, Miliolidae, Elphidiidae, Nonionidae and Soritidae were the most abundant families with Rotaliidae more important in the total population and Miliolidae more important in the standing crop.

3. Miliolidae and Soritidae increase as conditions approach those of the open-ocean. Rotaliidae and Elphidiidae decrease with increasing distance from shore.

4. Most species were found in both the total population and standing crop.

5. Species occurring more numerously in the standing crop than in the total population were assumed to indicate preferential test removal or destruction, or a longer reproductive cycle, or fewer offspring than other species.

6. Species significantly more common in the total population were interpreted as having resistant tests, having been washed in by currents, or indicating Foraminifera population season variations.

7. The foraminiferal fauna of Lower Florida Bay seems to be highly environmentally tolerant, and to react as a unit to the ecologic factors measured.

8. The productivity of an area did not demonstrate a close relationship to any measured environmental parameter. The principle determinant is assumed to be nutritional.

9. The Lower Florida Bay foraminiferal fauna corresponds to the porcelaneous zone and the inner shelf fauna as defined by Phleger and Williamson.

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

by

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ABSTRACT

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

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

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

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

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

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

INTRODUCTION

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

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

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

PREVIOUS INVESTIGATIONS

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

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

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

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

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

METHODS OF STUDY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DESCRIPTION OF AREA

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

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

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

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

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

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

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

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

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

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

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

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

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

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

OCCURRENCE AND DISTRIBUTION OF FORAMINIFERS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CONCLUSIONS

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

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

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

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

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

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

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

Scutuloris bocki
Schlumbergerina alveoliniformis
Quinqueloculina bosciana
Quinqueloculina bradyana
Peneroplis carinatus

Archaias angulatus
Sorites marginalis
Rosalina candeiana

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

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

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

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

FAUNAL LIST

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

FAMILY HORMOSINIDAE

SUBFAMILY HORMOSININAE

Reophax atlantica (Cushman)

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

Hypotypes: T-1611, T-1611-A

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

FAMILY RZEHAKINIDAE

Miliammina fusca (Brady)

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

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

Hypotype: T-1612

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

FAMILY LITUOLIDAE

SUBFAMILY HAPLOPHRAGMOIDINAE

Haplophragmoides sp.

Hypotype: T-1613

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

SUBFAMILY LITUOLINAE

Ammobaculites exilis Cushman and Brönniman

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

Hypotype: T-1614

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

FAMILY TEXTULARIIDAE

SUBFAMILY TEXTULARIINAE

Bigenerina irregularis Phleger and Parker

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

Hypotype: T-1615

Only one specimen of this species was observed.

Textularia agglutinans d'Orbigny

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

Hypotypes: T-1616, T-1616-A

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

FAMILY TROCHAMMINIDAE

SUBFAMILY TROCHAMMININAE

Trochammina advena Cushman

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

Hypotype: T-1617

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

FAMILY ATAXOPHRAGMIIDAE

SUBFAMILY GLOBOTEXTULARIINAE

Eggerella bradyi (Cushman)

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

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

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

Only one specimen of this species was found.

SUBFAMILY VALVULININAE

Clavulina nodosaria d'Orbigny

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

Hypotype: T-1618

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

Clavulina pacifica Cushman

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

Hypotype: T-1619

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

Clavulina tricarinata d'Orbigny

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

Hypotype: T-1620

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

Valvulina oviedoiana d'Orbigny

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

Hypotype: T-1621

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

FAMILY NUBECULARIIDAE

SUBFAMILY OPHTHALMIDIINAE

Wiesnerella auriculata (Egger)

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

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

Hypotypes: T-1622, T-1622-A

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

SUBFAMILY SPIROLOCULININAE

Spiroloculina antillarum d'Orbigny

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

Hypotype: T-1623

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

Spiroloculina caduca Cushman

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

Hypotype: T-1624

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

Spiroloculina communis Cushman and Todd

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

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

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

Hypotype: T-1625

This species is very rare and is sporadically distributed.

FAMILY MILIOIDAE

SUBFAMILY MILIOLINELLINAE

Miliolinella circularis (Bornemann)

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

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

Hypotype: T-1626

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

Miliolinella fichteliana (d'Orbigny)

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

Hypotype: T-1659

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

Miliolinella labiosa (d'Orbigny)

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

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

Hypotypes: T-1628, T-1632

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

Scutuloris bocki nov. sp.

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

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

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

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

Holotype: X1233 University of Illinois Type Collection

Paratype: X1234

Type stratus: Recent

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

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

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

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

SUBFAMILY TUBINELLINAE

Articulina mucronata (d'Orbigny)

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

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

Hypotype: T-1629

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

Articulina pacifica (Cushman)

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

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

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

Hypotype: T-1630

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

Articulina sagra d'Orbigny

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

Hypotype: T-1631

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

SUBFAMILY QUINQUELOCULININAE

Pyrgo denticulata (Brady)

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

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

Hypotype: T-1633

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

Pyrgo subsphaerica (d'Orbigny)

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

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

Hypotype: T-1634

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

Quinqueloculina agglutinans d'Orbigny

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

Hypotypes: T-1635, T-1635-A

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

Quinqueloculina akneriana d'Orbigny

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

Hypotypes: T-1653, T-1653-A

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

Quinqueloculina antillarum d'Orbigny

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

Hypotype: T-1636

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

Quinqueloculina biocostata d'Orbigny

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

Hypotype: T-1638

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

Quinqueloculina bidentata d'Orbigny

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

Hypotype: T-1639

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

Quinqueloculina bosciana d'Orbigny

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

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

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

Quinqueloculina bradyana Cushman

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

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

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

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

Quinqueloculina collumnosa Cushman

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

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

Hypotype: T-1642

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

Quinqueloculina crassa d'Orbigny

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

Hypotype: T-1643

This species occurs only rarely.

Quinqueloculina funafutiensis (Chapman)

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

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

Hypotype: T-1644

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

Quinqueloculina horrida Cushman

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

Hypotype: T-1645

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

Quinqueloculina laevigata d'Orbigny

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

Hypotype: T-1646

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

Quinqueloculina lamarckiana d'Orbigny

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

Hypotype: T-1647

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

Quinqueloculina lata Terquem

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

Hypotype: T-1648

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

Quinqueloculina poeyana d'Orbigny

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

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

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

Quinqueloculina polygana d'Orbigny

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

Hypotypes: T-1650, T-1650-A

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

Quinqueloculina sclerotica Karrer

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

Hypotype: T-1652

This species occurs only once on the bottom.

Quinqueloculina tenagos Parker

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

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

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

Hypotype: T-1651

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

Quinqueloculina tricarinata d'Orbigny

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

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

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

Sigmoilina arenata (Cushman)

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

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

Hypotype: T-1655

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

Triloculina bassensis Parr

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

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

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

Triloculina bermudezi Acosta

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

Hypotype: T-1657

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

Triloculina carinata d'Orbigny

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

Hypotypes: T-1658, T-1658-A

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

Triloculina fiterrei meningoi Acosta

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

Hypotype: T-1660

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

Triloculina linneiana d'Orbigny

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

Hypotype: T-1663

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

Triloculina oblonga (Montagu)

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

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

Hypotypes: T-1662, T-1662-A

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

Triloculina rotunda d'Orbigny

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

Hypotype: T-1666

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

Triloculina sidebottomi Martinotti

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

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

Hypotype: T-1667

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

Triloculina terquemiana (Brady)

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

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

Hypotype: T-1668

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

Triloculina transversestriata (Brady)

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

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

Hypotype: T-1669

This species is rare and occurs sporadically throughout the traverse.

Triloculina trigonula (Lamarck)

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

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

Hypotype: T-1670

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

SUBFAMILY MILIOLINAE

Hauerina bradyi Cushman

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

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

Hypotype: T-1671

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

Hauerina ornatissima (Karrer)

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

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

Hypotype: T-1672

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

Schlumbergerina alveoliniformis (Brady)

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

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

Hypotypes: T-1673, T-1637

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

FAMILY SORITIDAE

SUBFAMILY PENEROPLINAE

Monalysidium polita (Chapman)

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

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

Hypotype: T-1674

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

Peneroplis bradyi Cushman

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

Hypotype: T-1675

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

Peneroplis carinatus d'Orbigny

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

Hypotype: T-1676

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

Peneroplis pertusus (Førskal)

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

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

Hypotype: T-1677

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

Peneroplis proteus d'Orbigny

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

Hypotype: T-1678

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

Spirolina arietina (Batsch)

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

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

Hypotype: T-1679

This species occurs sporadically with frequencies less than 1 percent.

SUBFAMILY MEANDROPSININAE

Broeckina orbitolitoides (Hofker)

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

Hypotype: T-1680

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

SUBFAMILY ARCHAIASINAE

Archaias angulatus (Fichtel and Moll)

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

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

Hypotype: T-1681

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

SUBFAMILY SORITINAE

Sorites marginalis (Lamarck)

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

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

Hypotype: T-1682

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

FAMILY ALVEOLINELLIDAE

Borelis pulchra (d'Orbigny)

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

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

Hypotype: T-1683

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

FAMILY GLANDULINIDAE

SUBFAMILY OOLININAE

Fissurina quadricostulata (Reuss)

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

Hypotype: T-1684

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

FAMILY POLYMORPHINIDAE

SUBFAMILY POLYMORPHININAE

Guttulina plancii d'Orbigny

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

Hypotype: T-1685

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

Guttulina problema (d'Orbigny)

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

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

Hypotype: T-1686

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

FAMILY TURRILINIDAE

SUBFAMILY TURRILININAE

Buliminella milletti Cushman

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

Hypotypes: T-1687, T-1687-A

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

FAMILY BOLIVINITIDAE

Bolivina lowmani Phleger and Parker

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

Hypotype: T-1688

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

Bolivina rhomboidalis (Millett)

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

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

Hypotypes: T-1689, T-1689-A

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

Bolivina striatula Cushman

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

Hypotypes: T-1690, T-1690-A

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

Rectobolivina advena (Cushman)

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

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

Hypotype: T-1691

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

FAMILY BULIMINIDAE

SUBFAMILY BULIMININAE

Bulimina spicata Phleger and Parker

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

Hypotype: T-1692

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

SUBFAMILY PAVONONINAE

Reussella atlantica Cushman

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

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

Hypotype: T-1693

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

FAMILY UVIGERINIDAE

Sagrina pulchella d'Orbigny

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

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

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

Uvigerina bellula Bandy

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

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

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

Hypotype: T-1695

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

Uvigerina peregrina Cushman

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

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

Hypotype: T-1696

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

FAMILY DISCORBIDAE

SUBFAMILY DISCORBINAE

Buccella hannai (Phleger and Parker)

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

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

Hypotype: T-1697

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

Discorbis mira Cushman

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

Hypotype: T-1700

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

Discorbis rosea (d'Orbigny)

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

Hypotype: T-1701

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

Neoconorbina terquemi (Rzehak)

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

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

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

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

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

Rosalina candeiana d'Orbigny

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

Hypotype: T-1698

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

Rosalina floridana (Cushman)

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

Hypotype: T-1699

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

SUBFAMILY BAGGININAE

Cancris sagra (d'Orbigny)

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

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

Hypotypes: T-1704, T-1704-A

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

FAMILY GLABRATELLIDAE

Glabratella pulvinata (Brady)

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

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

Hypotype: T-1703

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

FAMILY SIPHONINIDAE

Siphonina pulchra Cushman

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

Hypotype: T-1705

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

FAMILY ASTERIGERINIDAE

Asterigerina carinata d'Orbigny

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

Hypotypes: T-1706, T-1706-A

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

FAMILY SPIRILLINIDAE

SUBFAMILY SPIRILLININAE

Spirillina vivipara Ehrenberg

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

Hypotype: T-1707

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

FAMILY ROTALIIDAE

SUBFAMILY ROTALINNAE

Ammonia advena (Cushman)

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

Hypotype: T-1708

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

Ammonia avalonensis Natland

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

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

Hypotype: T-1709

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

Ammonia beccarii sobrina (Shupack)

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

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

Ammonia beccarii tepida (Cushman)

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

Hypotype: T-1710

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

FAMILY ELPHIDIIDAE

SUBFAMILY ELPHIDIINAE

Cribroelphidium poeyanum (d'Orbigny)

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

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

Hypotype: T-1711

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

Elphidium advenum (Cushman)

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

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

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

Hypotypes: T-1712, T-1712-A

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

Elphidium articulatum rugulosum Cushman and Wickenden

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

Hypotype: T-1713

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

Elphidium crispum (Linnaeus)

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

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

Hypotype: T-1714

This species is rare.

Elphidium discoidale (d'Orbigny)

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

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

Hypotype: T-1715

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

Elphidium sagrum (d'Orbigny)

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

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

Hypotype: T-1716

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

FAMILY EPONIDIDAE

Eponides antillarum (d'Orbigny)

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

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

Hypotype: T-1717

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

Eponides repandus (Fichtel and Moll)

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

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

Hypotype: T-1718

This species is rare.

FAMILY AMPHISTEGINIDAE

Amphistegina lessonii d'Orbigny

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

Hypotype: T-1719

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

FAMILY CIBICIDAE

SUBFAMILY CIBICIDINAE

Cibicides pseudoungeriana (Cushman)

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

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

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

Hypotype: T-1720

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

FAMILY PLANORBULINIDAE

Planorbulina acervalis Brady

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

Hypotype: T-1721

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

Planorbulina mediterranensis d'Orbigny

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

Hypotype: T-1722

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

FAMILY CYMBALOPORIDAE

Cymbaloporetta squammosa (d'Orbigny)

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

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

Hypotype: T-1723

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

FAMILY CAUCASINIDAE

SUBFAMILY FURSENKOININAE

Fursenkoina punctata (d'Orbigny)

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

Hypotype: T-1724

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

Sigmavirgulina tortuosa (Brady)

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

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

Hypotype: T-1725

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

FAMILY LOXOSTOMIDAE

Loxostomum limbatum (Brady)

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

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

Hypotype: T-1726

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

Loxostomum mayori (Cushman)

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

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

Hypotype: T-1727

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

FAMILY CASSIDULINIDAE

Cassidulina subglobosa Brady

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

Hypotype: T-1728

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

FAMILY NONIONIDAE

SUBFAMILY NONIONINAE

Astrononion sidebottomi Cushman and Edwards

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

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

Hypotype: T-1729

This species is rare.

Nonion grateloupi (d'Orbigny)

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

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

Hypotype: T-1730

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

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TABLE 1

LOCATION AND DISTRIBUTION OF STATIONS

Station	Position	Depth	Distance from Reef (Miles)	Vegetation	M_z (ϕ)	σ_g (ϕ)	Foraminiferal Number
1	25° 3.2' N 80° 26.7' W	2	4.8	Thalassia	1.39 1.11 1.25	2.28 2.01 2.00	2394 2092 1921
2	25° 2.5' N 80° 25.8' W	11	3.7	Thalassia	1.80 1.90 1.49	2.08 1.88 2.31	---- 1630 2408
3	25° 2.3' N 80° 25.2' W	16	3.0	Thalassia	1.24 .98 1.02	1.70 1.95 1.90	768 611 1035
4	25° 1.8' N 80° 24.6' W	20	2.2	Thalassia	2.33 2.25 2.21	1.66 1.66 1.76	2605 3704 3300
5	25° 1.6' N 80° 24.1' W	14	1.6	Thalassia	2.25 2.29 2.34	1.16 1.27 1.15	3437 2686 3514
6	25° 1.5' N 80° 23.8' W	10	1.4	Thalassia	1.26 1.03 .86	1.13 1.06 1.26	522 282 342
8	25° 1.4' N 80° 23.6' W	15	1.1	Thalassia	2.07 1.51 1.85	1.52 1.93 1.46	1905 3618 2818
9	25° 1.3' N 80° 23.5' W	30	1.0	None	.98 .69 1.03	1.08 1.29 1.07	156 228 241
9a	25° 1.3' N 80° 23.5' W	30	1.0	Thalassia	1.29 1.06 1.18	1.36 1.90 1.36	962 722 759
10	25° 0.9' N 80° 23.2' W	14	0.5	None	.64 .45 .71	1.11 1.13 1.10	95 56 59
10a	25° 0.9' N 80° 23.2' W	14	0.5	Thalassia	1.21 .76 1.54	1.40 1.84 1.02	1126 870 2016
11	25° 0.8' N 80° 23.0' W	18	0.2	Sargassum	.27 .16 .50	1.00 1.16 1.02	31 102 42
12	25° 0.7' N 80° 22.9' W	14	0.0	Sargassum	.19 -.03 .07	.69 .87 .85	25 44 60

TABLE 2 SUMMARY OF FORAMINIFERAL POPULATION DATA FOR EACH STATION

	Total Population		Bottom Samples					Vegetation Samples			
Stat.	Number of Specimens	Number of Species	Number of Specimens	Number of Living Specimens	Percent Living	Number of Species	Foraminiferal Number	Number of Specimens	Number of Living Specimens	Percent Living	Number of Species
1	11096	86	9736	133	1.4	85	2136	1360	73	5.4	70
2	5169	81	4814	92	1.9	81	2019	355	77	21.7	50
3	2625	89	2219	10	.5	88	805	406	140	34.5	33
4	2663	91	2528	57	2.3	91	3203	135	3	2.2	27
5	2844	98	2487	26	1.0	97	3212	357	48	13.5	56
6	1426	86	1213	59	4.9	84	382	213	17	8.0	46
8	3091	90	2037	28	1.4	89	2780	1054	576	54.6	61
9	1917	88	1614	105	6.5	87	208	304	150	49.4	44
9a	1474	79	1474	21	1.4	79	814	No Sample			
10	1176	86	986	53	5.4	75	70	190	66	34.7	53
10a	2063	96	2063	80	3.9	96	1337	No Sample			
11	1075	80	938	55	5.9	77	58	137	59	43.1	34
12	737	79	655	39	6.0	78	43	82	9	11.0	34

TABLE 3 PERCENTAGE DISTRIBUTION OF FORAMINIFERS

Station	1		2		3		4		5		6		8		9		9a		10		10a		11		12	
Species																										
Reophax atlantica							.1				.1		.1						.1		*				.3	
Miliammina fusca	1.9		.5		.1		.3		.2		1.0		.3	#	.3		.2		.2		.7		.4		.6	
Haplophragmoides sp.							*		.1		.1		.1		.1		.1		.2		.6				.6	
Ammobaculites exilis	*				.1													No Sample				No Sample			.2	
Bigenerina irregularis							*																			
Textularia agglutinans	*		.1		1.3	1	.9		.6		.9		1.1		2.7		2.8		.7		3.0		1.8		2.1	
Trochammina advena									*		.1										.2					
Eggerella bradyi									*																	
Clavulina nodosaria	.3		.3																							
Clavulina pacifica	1.1	4	.3		.5																					
Clavulina tricarinata	1.4	1	.9		.7		*		.1				*		.1				.1		.1		.2		.2	
Valvulina oviedoiana	1.9		.9		.4				*		.1	6			.1		.1		1.0		.2		.3		.9	
Wiesnerella auriculata									.5		.2		.6		.2		.3		.7		1.6		.7		.3	
Spiroloculina antillarum	1.1		.1		.4		.1		.2		.1		.1		.1		.2				.4					
Spiroloculina caduca	*		*		*		.4																			
Spiroloculina communis	.1		.1		.1		.1		.1						.1						.1					
Miliolinella circularis	2.7	1	1.6	4	.8	2	2.2	33	3.2		2.2	6	3.0	#	1.1		2.2		.6	2	1.5		.7		1.1	
Miliolinella fichtelliana	*		*		*				.1						.5		.3		.1		.5		.3		.3	
Miliolinella labiosa	1.5	3	1.4		.2		.4		.4		.4		.3		.4	1	.5		.1		.9				.3	
Scutuloris bocki	3.2	8	7.3	1	1.9	1	3.2		3.6		4.2		2.4		1.9	1	1.6		1.1		4.3		1.9	8	1.8	11
Articulina mucronata	.2		.3	4	.4		.6		.4		.1		.2		.7		.4		.2		.5		.7		1.4	11
Articulina pacifica	.3		1.7	1	1.6		2.5		2.2		.8		2.4	#	1.9	1	2.2		1.1		2.5		1.3	22	1.2	
Articulina sagra	.4		.6		.3		.5		.8		.2		.4		.3		.5		.2		.7		.2			
Pyrgo denticulata	.2				*		*		.2		.2		*		.6		.3		.1		.4		.7	2	.5	
Pyrgo subsphaerica	.4		.2		*		.1		.1				.3		.4		1.0		.1		.6		.5		.3	
Quinqueloculina agglutinans	4.1		1.8	1	2.3		1.4		.8		.8		.5		1.4		1.0		1.9		.6		2.1		2.6	
Quinqueloculina akneriana	1.6	1	1.3		1.0		.3		.3		.2	6	.1		4.0		2.0		1.3		.3		.4		.5	
Quinqueloculina antillarum					.1		.1		.2		.2		.3		.3		.2		.1		.3		.1		.2	
Quinqueloculina bicostata					.3		*		*		.1		*				.1		.1		.1		.1			
Quinqueloculina bidentata	1.0		2.4		3.2		.8		.6		.2		.2		1.4		.6		.9	1	.1		1.6		1.1	
Quinqueloculina bosciana	8.0	18	4.3		3.6		5.4		5.0	2	6.9	24	4.6		1.9		2.3		2.0	2	5.1		3.2		2.6	11
Quinqueloculina bradyana	6.4	10	4.2		6.5		4.7		4.7		3.1		4.2		1.6		2.0		.3		3.2		.6		2.4	
Quinqueloculina collumnosa																			.1		*				.2	
Quinqueloculina crassa															.1				.1							
Quinqueloculina funafutiensis	1.4		1.7		3.3		2.4		.9		.7		1.5	#	1.1		1.2		.5		.3		.5		.3	
Quinqueloculina horrida	.4		.8		.5		.2		.2		.7		.5		.3		.1				1.0		.1			
Quinqueloculina laevigata	1.3	1	1.2		1.1		.7		.4				*		.1						.3		1.0			
Quinqueloculina lamarckiana	2.6	1	2.6		3.9	1	1.0		.6	4	.7		.4		.8	1	.9		.1		.6		.3	2	.6	
Quinqueloculina lata	.4	1	.6	3	.9		.6		.2		.1		.5		.2		.2		.3		.5		.6		1.4	
Quinqueloculina poeyana	3.6	7	3.5		2.3		5.0		6.0	2	5.0		5.9		1.2		2.2		.2		1.0		.4		.4	
Quinqueloculina polygona	1.0		.6		.9		1.2		.7		.5		.8		.6		.3		.1		1.4		.4	2	1.1	
Quinqueloculina sclerotica																					*					
Quinqueloculina tenagos	1.5	4	1.3		1.4		1.7		2.5	2	.8		.4		.1	1	.5		.1		.1					
Quinqueloculina tricarinata																			.4		*		.1		.7	
Sigmoilina arenata	.5		.9		1.0		.2		.1		.2		.1				.1				.1				.5	
Triloculina bassensis	1.7		2.8	3	.9		.7		.8		.3		.8		1.4		1.8		.5		.8		.7		.5	
Triloculina bermudezi	5.3	4	1.3	4	.9	1	3.0		2.5	6	2.0		2.0		.6		.3		.5		2.0		.7	2	1.1	
Triloculina carinata	.7		.8		.5		.2		.1		.1		*		.6		.3		.2		.1		.5		1.1	
Triloculina fiterrei meningoi									.4		1.2		1.4	#			.5				1.6		.7		.8	
Triloculina linneiana	1.4		.8		1.1		.5		1.4		1.3		.5		1.7		1.4		.6	2	.9		1.4		1.2	
Triloculina oblonga	2.9	1	1.0		.4		.2		.8		.6		.2		.5		.8				.2		.3		.5	
Triloculina rotunda	.2	1	.5	12	.5		.3		.9	4	.6		.3	#	1.2		1.4		.2		1.2		.6		.5	
Triloculina sidebottomi																			*					2		
Triloculina terquemiana	.4		.3		*		.2		.2		.1		.2		.1						*					
Triloculina transversestriata	*		*						*				*													
Triloculina trigonula	1.4	3	3.4	8	3.0	4	3.9		4.1	6	4.0	6	3.0	#	.7		.7		.2		.9		1.0		.9	
Hauerina bradyi	.2		*				.4		.4	2	.1		.3	#	.2		.8		.1		.7		.4		.5	
Hauerina ornatissima							*		.3		.2		.4	2	.1	1	.3		.1		.1		.1			
Schlumbergerina alveoliniformis	.8	3	1.3	6	2.6	2	3.0	33	4.9	10	4.6	6	5.5	2	1.5	3	2.8		.7		4.2		1.1	3	1.2	
[illegible]ysidium politum	.1		*		.2		.2		.2												*					
Peneroplis bradyi	.1		.9		1.4		1.1		1.2		.8		.9		1.4		2.2		.1	1	1.1		.4		1.5	
Peneroplis carinatus	9.4		7.9		8.3	1	9.5		9.7	2	6.1		10.7	1	9.2	2	8.7		1.5		6.0		2.7	2	1.5	
Peneroplis pertusus	.8		.5		.1		.5		.8		1.0		.9		.4		.7			1	1.3		.3	3	.6	
Peneroplis proteus	1.5		.3	1	.4		.2		.2		.2		.1		1.1		1.0		1.3		.3		1.0		.9	
Spirolina arietina	*		.1				.1						*		.1						*				.2	
Broeckina orbitolitoides	*		.1						.2						.7		.6		.8		.2		.3		.2	
Archaias angulatus	5.2		7.2	1	14.2		8.1		4.6		4.2		2.0		25.5		16.6		57.7	5	8.1		34.6	3	25.8	
Sorites marginalis	.9		.6		.9		1.0		3.3		1.1	6	.8	1	.6	4	1.2		.3	8	.9		.5	3	1.5	
Borelis pulchra	*						.1				.2				.1		.1		.2		.7		.3		.6	
Fissurina quadricostulata	*	1	.1		.2		.4		.3				*		.1				.1		.1		.3		.2	
Guttulina plancii							.1				.1								.1							
Guttulina problema									*		.1		*		.1				.2							
Buliminella milletti	.4		.4		.4		.6	33	.7	2	.3		.6	3	.2	7	.4			3	.7		.5		.2	
Bolivina lowmani	.1		*		.2		.4		.2		.1		.2				.1				.2		.1		.2	
Bolivina rhomboidalis	.5		.3		.3		.9		.6	2	.6	6	1.0	1	.2		.3				.8		.3	3	.5	
Bolivina striatula	.2	7	.5		.4	1	.4		.4		.1		.1				.1				.1		.3			
Rectobolivina advena									.1				*													
Bulimina spicata			*		.1		.1		.1		.2		*		.1						.1					
Reussella atlantica	*		*		.1		.1		.1				.1													
Sagrina pulchella	.1		.6		.9	1	2.4		1.4		.4		1.4	1	.4	1	.5			1	.7			5		
Uvigerina bellula	*	1	*		.2				*												.1					
Uvigerina peregrina	.3	4	.7		.4		.4		.2		.6		.5		.5		.6		.1		.5		.5		.5	
Buccella hannai	*		.1		*		.2		*																	
Discorbis mira	2.2		.8		.7		.4		.2		.7		.1		.4				.2		1.1		.8		.6	
Discorbis rosea					.1		.1		.1		2.1		.1		1.8		1.2		4.7		2.5		4.9		3.1	
Neoconorbina terquemi	.4		.5		.3		.5		1.0		2.0		.8	#	.9		.7		.8		1.8		1.7		.9	
Rosalina candeiana	1.4	3	1.8	35	3.4	82	2.3		5.1	37	12.5	29	6.1	86	6.6	74	6.7		3.1	73	5.1		3.5	29	3.8	33
Rosalina floridana	1.2		1.2	3	1.1		3.9		3.3		4.3		5.6		1.5		2.2		1.5		5.1		2.2		3.4	
Cancris sagra											.2		*		.1		.1				.1		.3			
Glabratella pulvinata	.2	3	.2	4	.4	3	.3		.4	8	1.0		.3	#	.1	3	.1		.2		.7		.1		.6	
Siphonina pulchra	.1		*		*				.1				*		.2						.7		.1		.2	
Asterigerina carinata							.2		1.3		1.2		.3		4.8	1	5.8		1.8		8.5		2.3	2	2.1	
Spirillina vivipara	.1	1	.4	4	.4		1.0		.7	2	.5		.1	#	.2		.1		.1		.8		1.5		.8	
Ammonia advena					.1		.6		.3		.1		.1		.1		.5		.5		.3		.2		.3	
Ammonia avalonensis	2.3		1.4	1	1.7	1	.6		2.1		3.3		2.2	#	.9	1	1.8		.5		1.6		.3	3	.3	
Ammonia beccarii sobrina	.1				*				.1		.4		.7		.9		3.0		.6		1.6		.4		.5	
Ammonia beccarii tepida	1.6		6.0	1	4.2	1	3.0		2.4	2	1.8		3.2		1.5		1.7		.4		1.3		.4		.9	
Cribroelphidium poeyanum	1.6		5.2		2.3		3.8		1.6		.7		2.1		.2		.5		.3		*					
Elphidium advenum	2.0		1.5		1.6		1.1		1.1	2	.7		1.2		.2		.1				.4					
Elphidium articulatum rugulosum	1.0	5	1.4	1	.8		2.5		1.1		.7	6	2.0	#	.2		.4		.1	1	.2		.1		.2	
Elphidium crispum	*				*		*																			
Elphidium discoidale			*		.5		.4		.4		.1		*		.1		.1		.2		.2		.5			
Elphidium sagrum	.2		.4		.1								.1		.1											
Eponidies antillarum	*								*																.3	
Eponides repandus																									.2	
Amphistegina lessonii							.1		.1		.1		.1		.2		.7		2.0		.6		4.6		4.7	
Cibicides pseudoungeriana	.2		.4		.9		.4		.9	2	2.0		2.3		.9		1.2		.2		1.6		1.4		2.4	
Planorbulina acervalis					.5		.3		.4		.6		.1		.2		.9				.5		.1	2	.9	22
Planorbulina mediterranensis	.3		.2	1	.5		.2		.4		.8		.2		.7		.7		.4		1.4		1.0	2	2.6	
Cymbaloporetta squammosa							.1		.1		.1				.6		.4		1.1		.4		1.0		1.4	
Fursenkoina punctata	*		.1		.3		.4		.2				.3		.1		.1		.1							
Sigmavirgulina tortuosa	.1		.1		.1		*		.1		.4		.1				.3		.1		.2				.2	11
Loxostomum limbatum					*		*		*		.1				.1		.1				*					
Loxostomum mayori					.1																		.1		.2	
Cassidulina subglobosa							.1		.2		.4		*		.1				.1		.1		.3		1.1	
Astrononion sidebottomi					.1		*																			
Nonion grateloupi	.1		.3		*		.9		.7		.2		.1		.2						.1		.1			

* less than 0.1 percent
\# less than

For each station, the first column represents the percentage occurrance of a species in the total bottom population. The second column represents the percentage occurrance of a species in the population living on the vegetation.

TABLE 4

CHI-SQUARE TEST OF 3 ADJACENT SAMPLES FROM THE SAME LOCATION

Sample	Degrees of Freedom	$\chi^2_{.95}$	Computed Chi-Square	Results
1	98	122.10	542.11	Samples from different populations
2	108	133.25	217.03	Samples from different populations
3	72	92.79	158.19	Samples from different populations
4	62	81.39	144.88	Samples from different populations
5	74	95.10	150.79	Samples from different populations
6	36	50.99	89.29	Samples from different populations
8	56	74.49	65.36	Samples from same population
9	28	41.34	52.09	Samples from different populations
9a	48	65.16	71.46	Samples from different populations
10	20	31.41	73.17	Samples from different populations
10a	64	83.67	83.26	Marginal
11	6	12.59	31.13	Samples from different populations
12	4	9.49	11.96	Samples from different populations

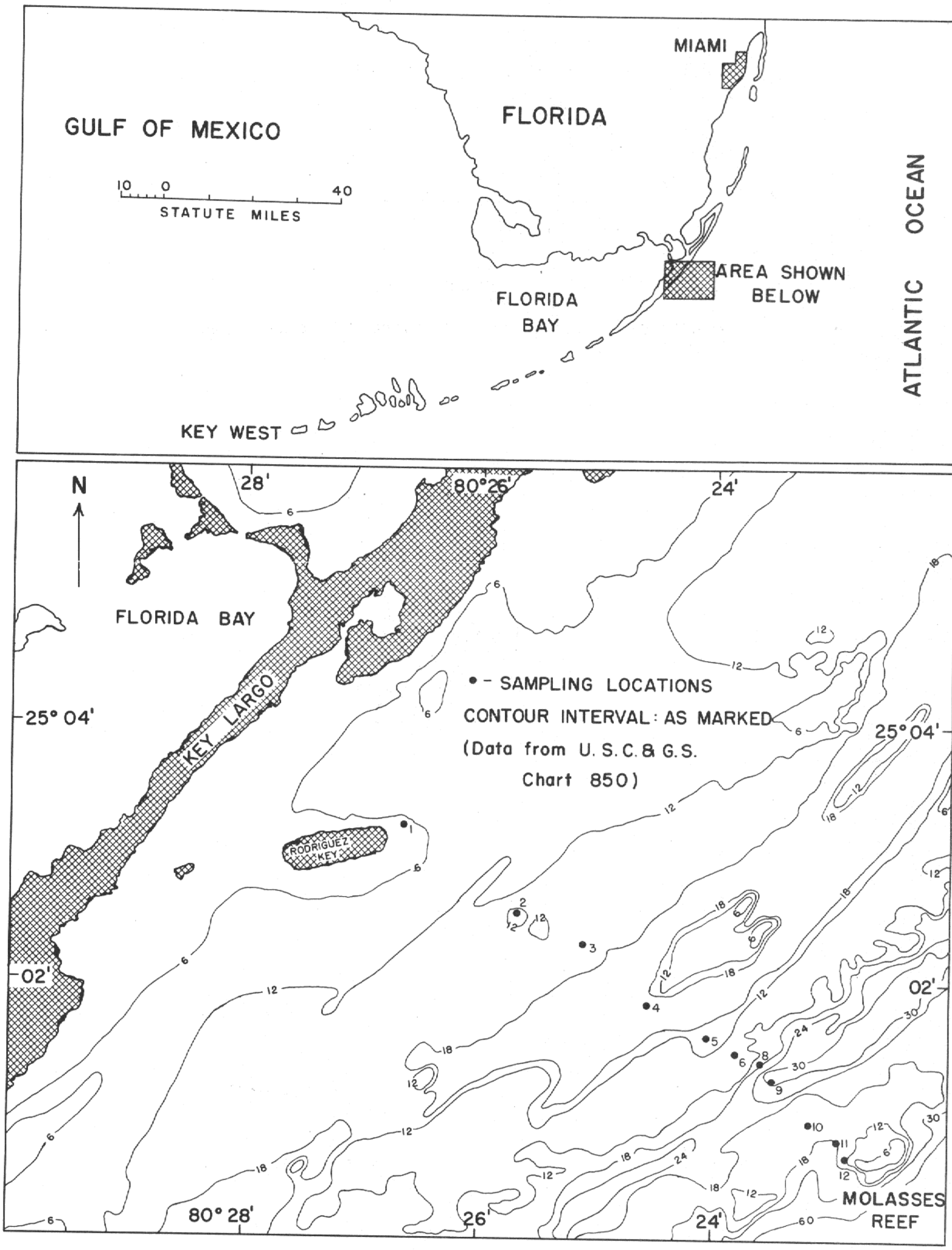


FIGURE I. LOCATION MAP

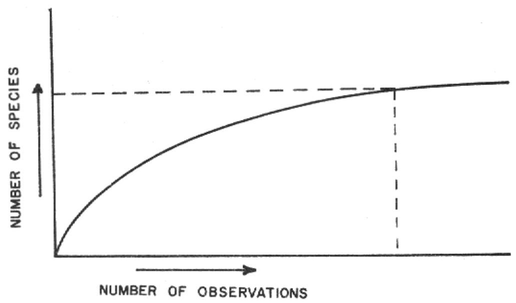


FIGURE 2

RELATIONSHIP OF SPECIES ABUNDANCE TO SAMPLE SIZE

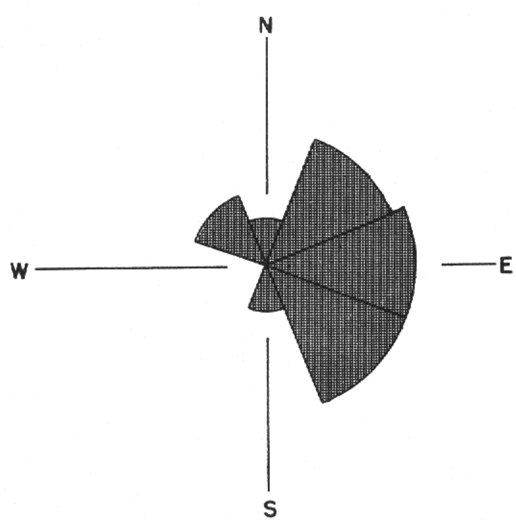


FIGURE 3.
PREVAILING WINDS IN THE REEF TRACT
(after Vaughn, 1910)

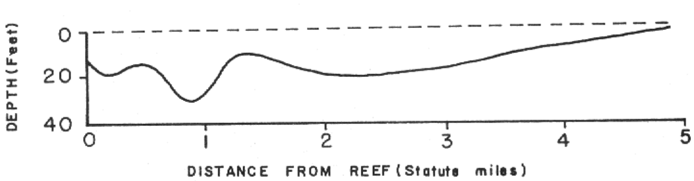


FIGURE 4.
BOTTOM PROFILE ALONG TRAVERSE

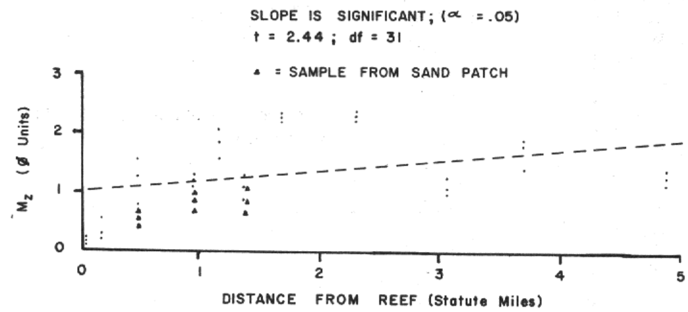


FIGURE 5

RELATIONSHIP OF MEAN GRAIN SIZE TO DISTANCE

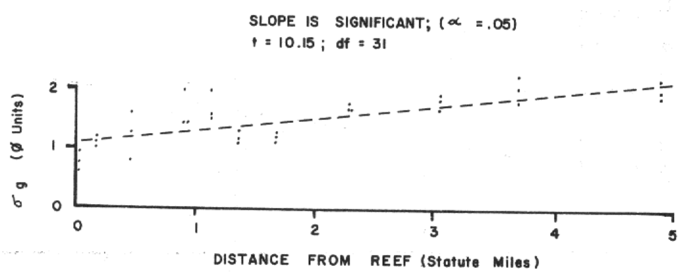


FIGURE 6

RELATIONSHIP OF SORTING TO DISTANCE

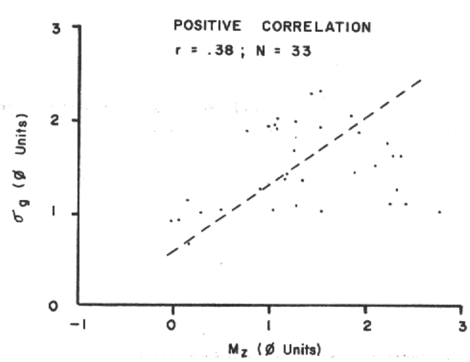


FIGURE 7

RELATIONSHIP BETWEEN MEAN GRAIN SIZE AND SORTING

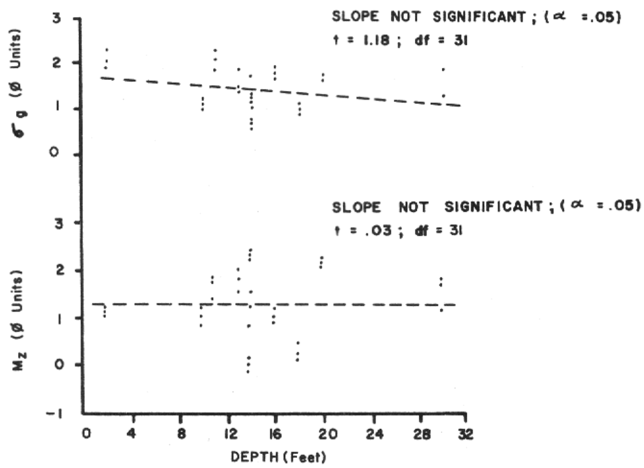


FIGURE 8

RELATIONSHIP OF SEDIMENT PARAMETERS TO DEPTH

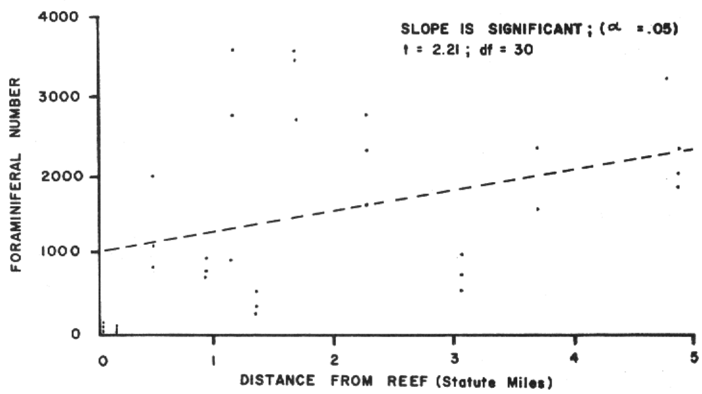


FIGURE 9

RELATIONSHIP OF FORAMINIFERAL NUMBER TO DISTANCE

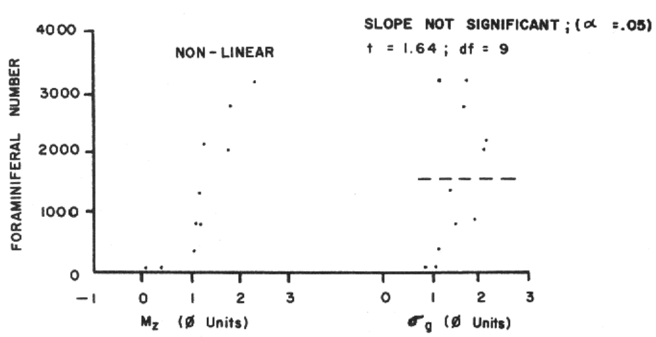


FIGURE 10

RELATIONSHIP OF FORAMINIFERAL NUMBER TO SEDIMENT PARAMETERS

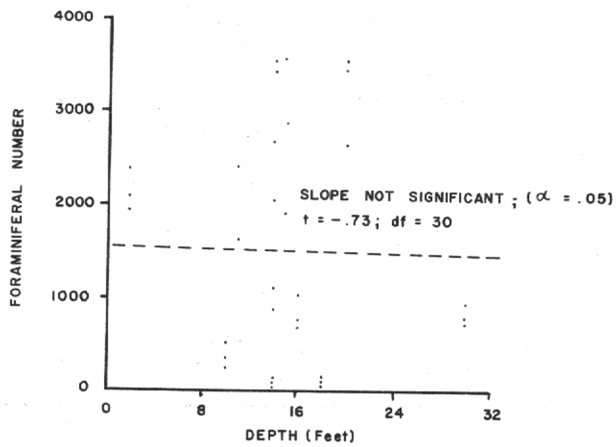


FIGURE 11

RELATIONSHIP BETWEEN FORAMINIFERAL NUMBER AND DEPTH

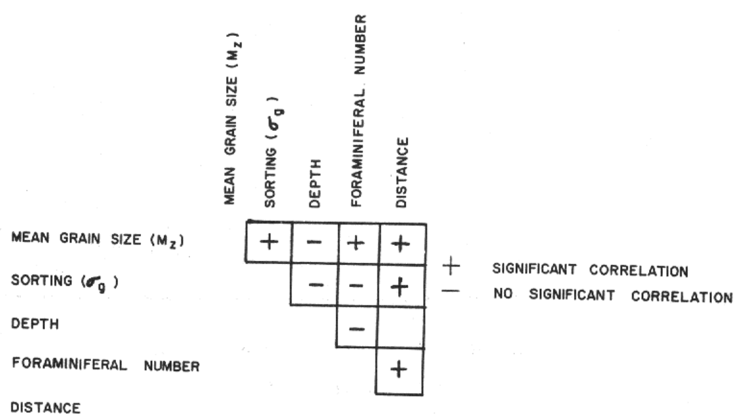


FIGURE 12

RELATIONSHIPS BETWEEN MEASURABLE PARAMETERS

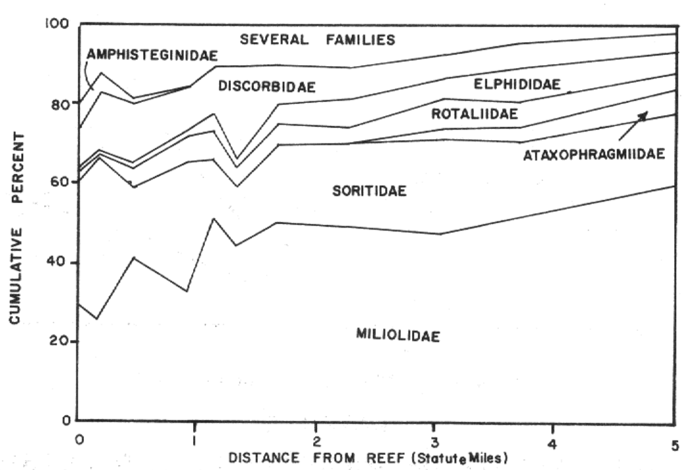
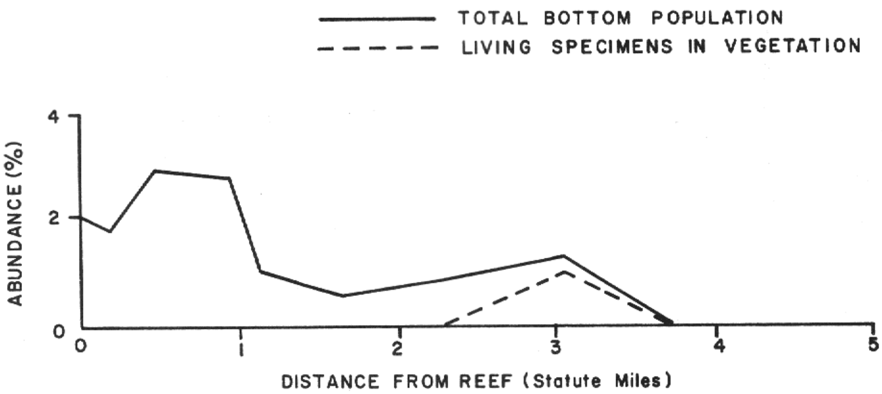


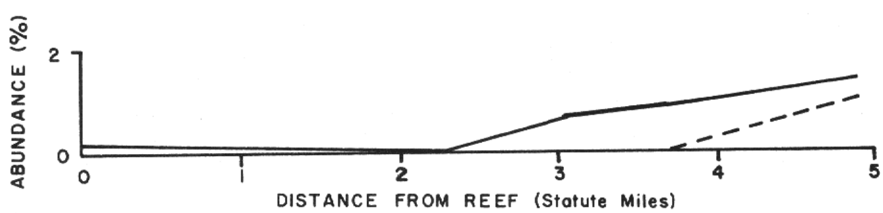
FIGURE 13

DISTRIBUTION OF FAMILIES



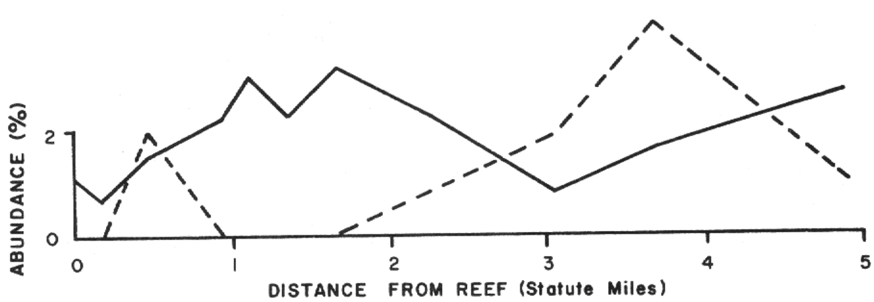
GRAPH 1

DISTRIBUTION OF TEXTULARIA AGGLUTINANS



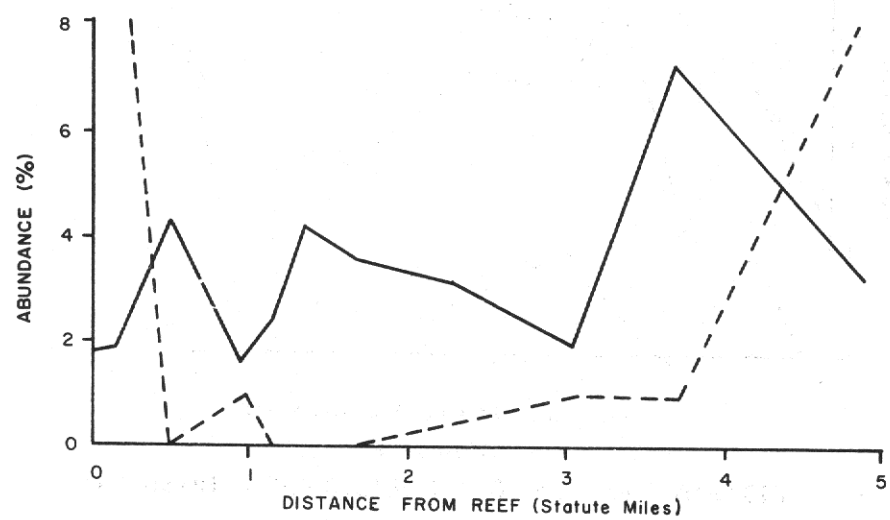
GRAPH 2

DISTRIBUTION OF CLAVULINA TRICARINATA

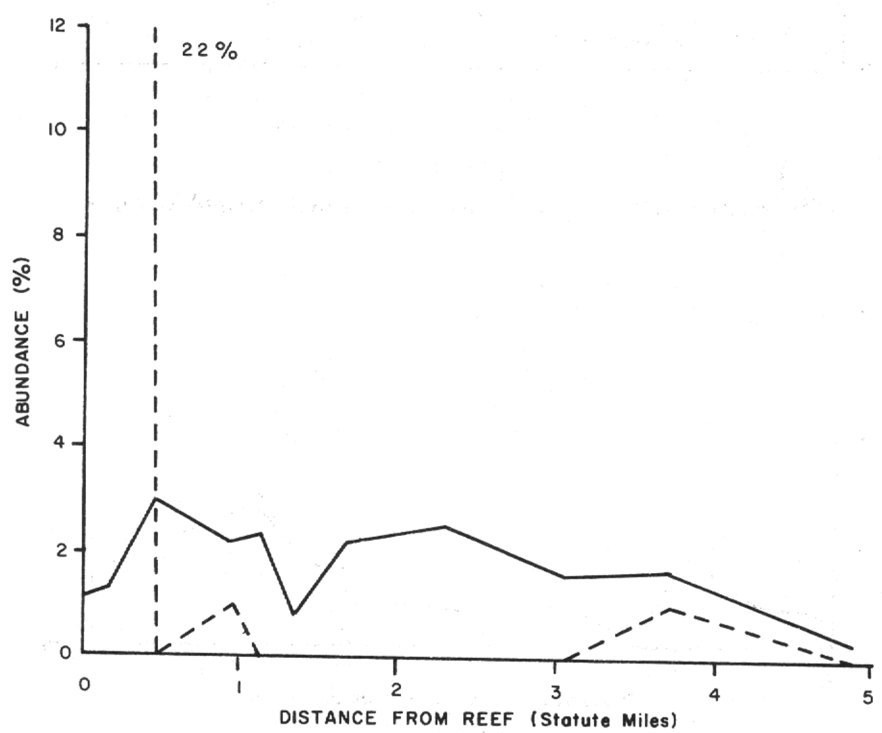


GRAPH 3

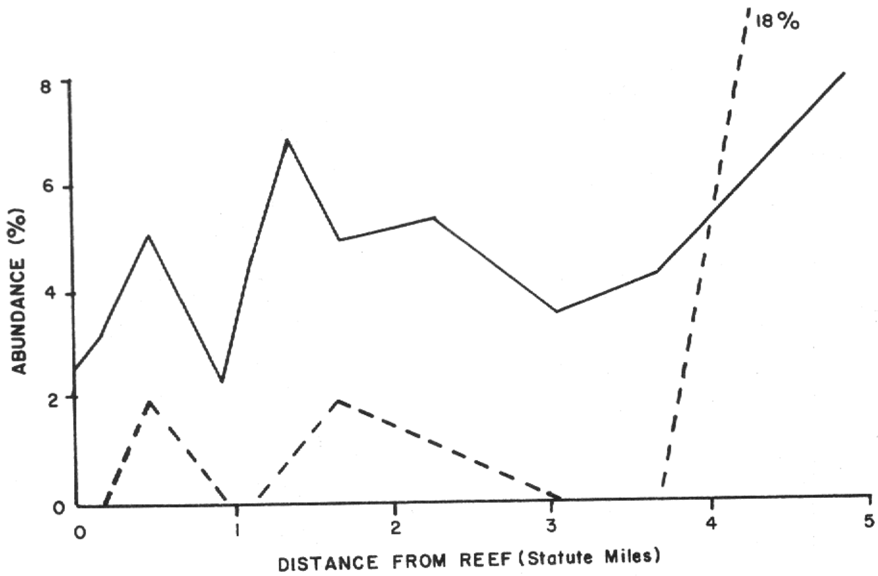
DISTRIBUTION OF MILIOLINELLA CIRCULARIS



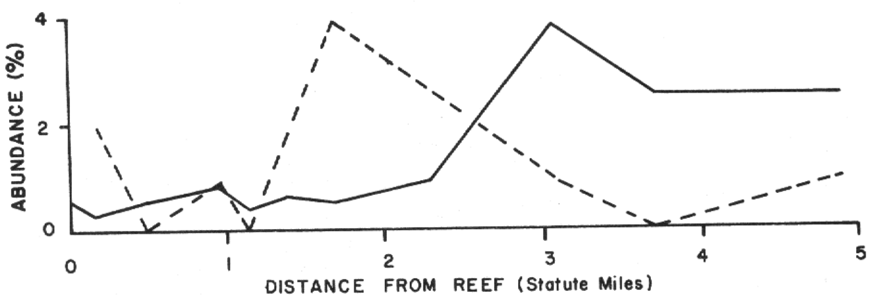
GRAPH 4
DISTRIBUTION OF SCUTULORIS BOCKI



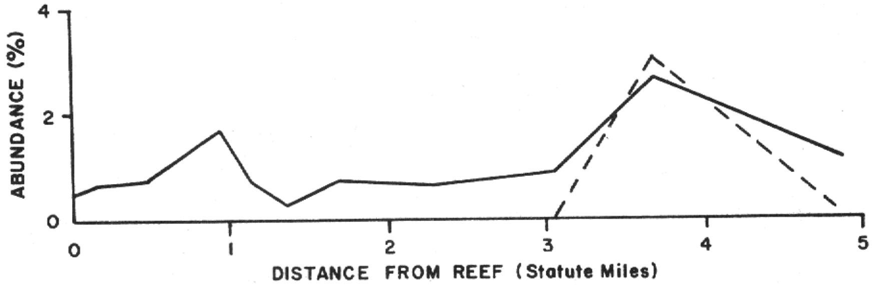
GRAPH 5
DISTRIBUTION OF ARTICULINA PACIFICA



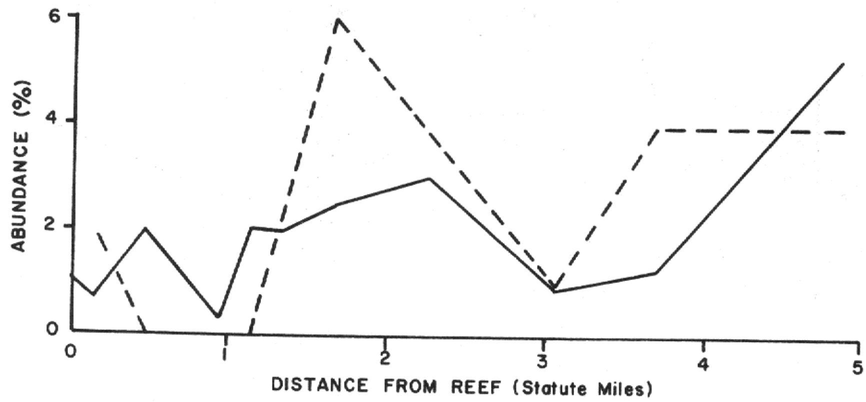
GRAPH 6
DISTRIBUTION OF QUINQUELOCULINA BOSCIANA



GRAPH 7
DISTRIBUTION OF QUINQUELOCULINA LAMARCKIANA

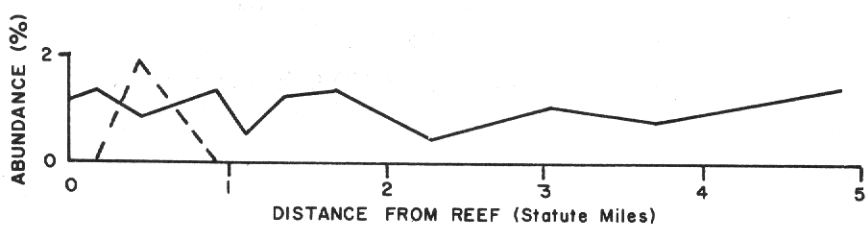


GRAPH 8
DISTRIBUTION OF TRILOCULINA BASSENSIS



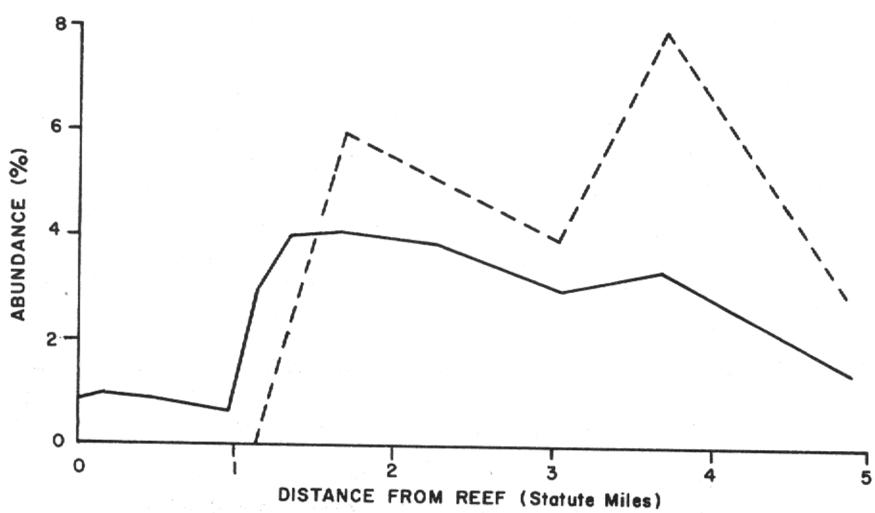
GRAPH 9

DISTRIBUTION OF TRILOCULINA BERMUDEZI



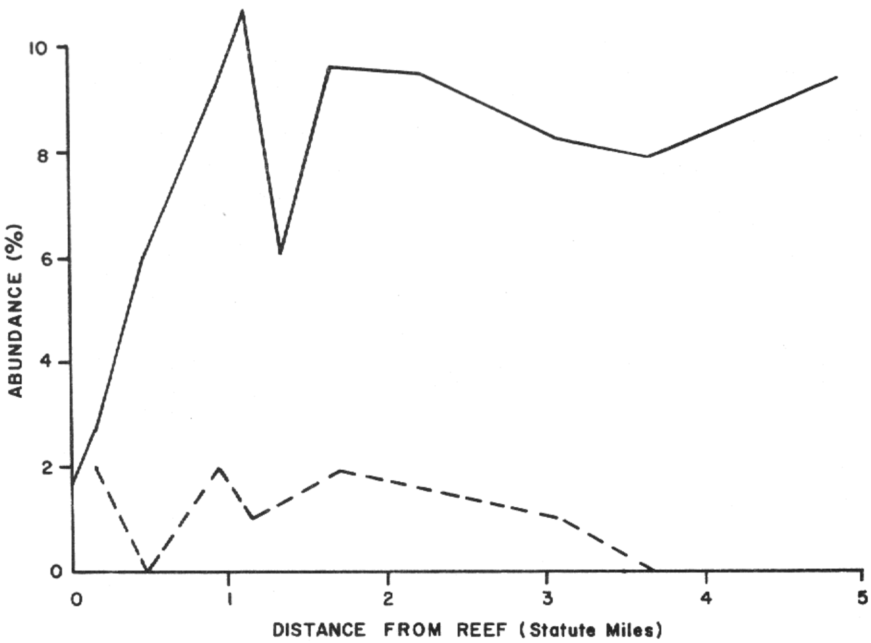
GRAPH 10

DISTRIBUTION OF TRILOCULINA LINNEIANA



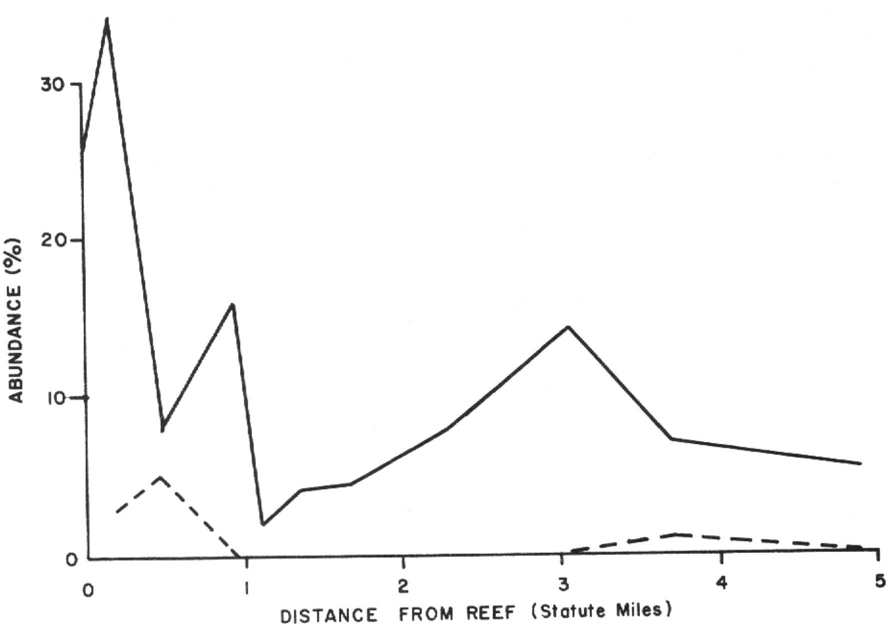
GRAPH 11

DISTRIBUTION OF TRILOCULINA TRIGONULA



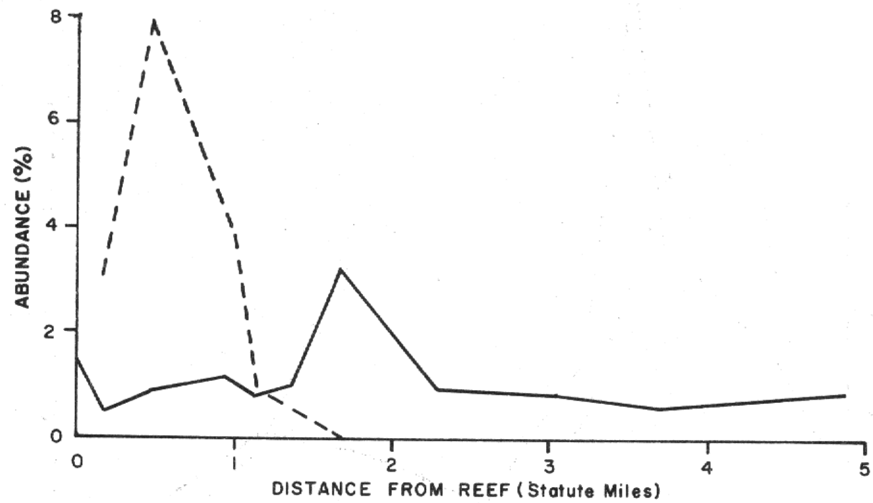
GRAPH 12

DISTRIBUTION OF PENEROPLIS CARINATUS

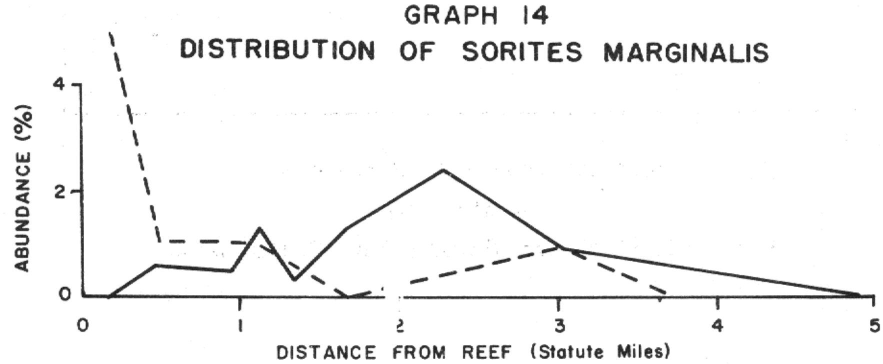


GRAPH 13

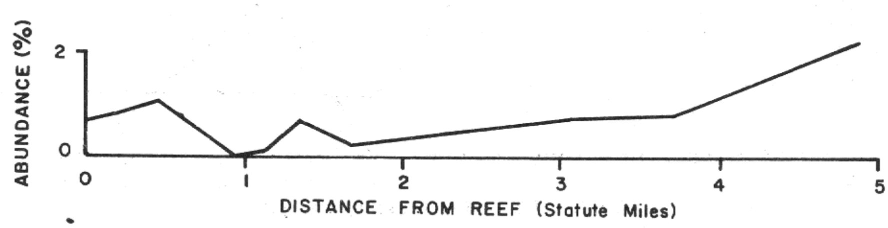
DISTRIBUTION OF ARCHAIAS ANGLATUS



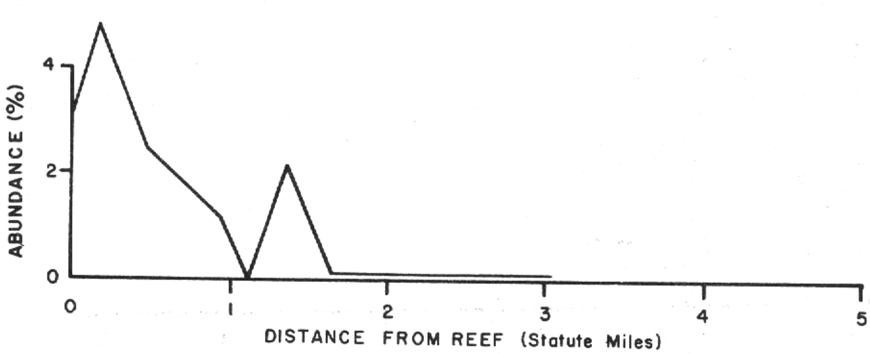
GRAPH 14
DISTRIBUTION OF SORITES MARGINALIS



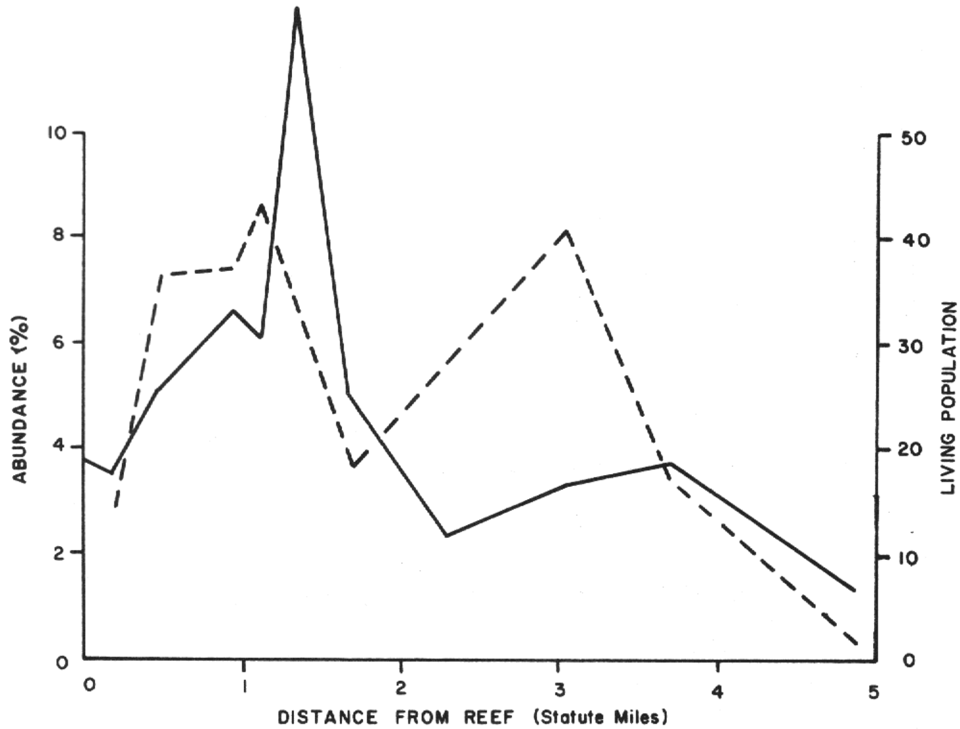
GRAPH 15
DISTRIBUTION OF SAGRINA PULCHELLA



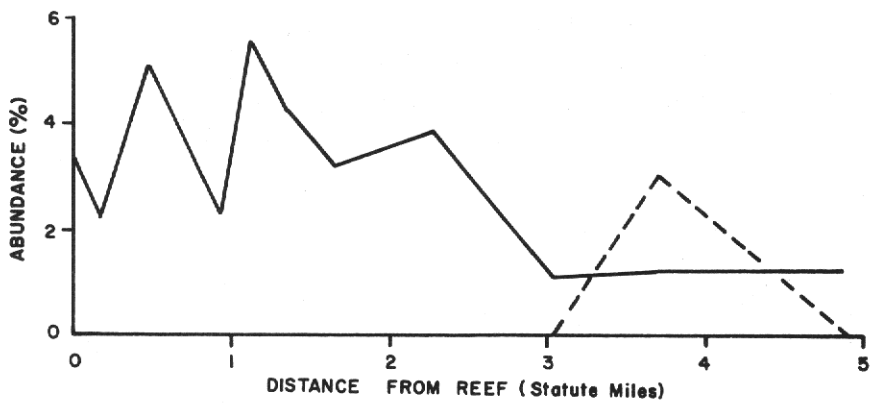
GRAPH 16
DISTRIBUTION OF DISCORBIS MIRA



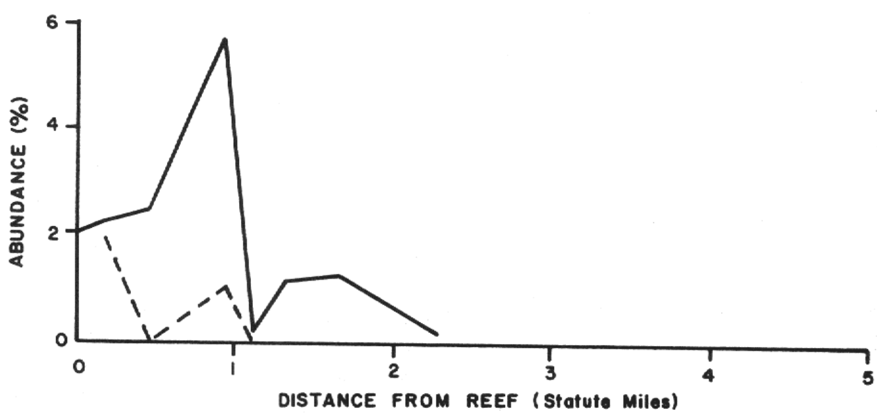
GRAPH 17
DISTRIBUTION OF DISCORBIS ROSEA



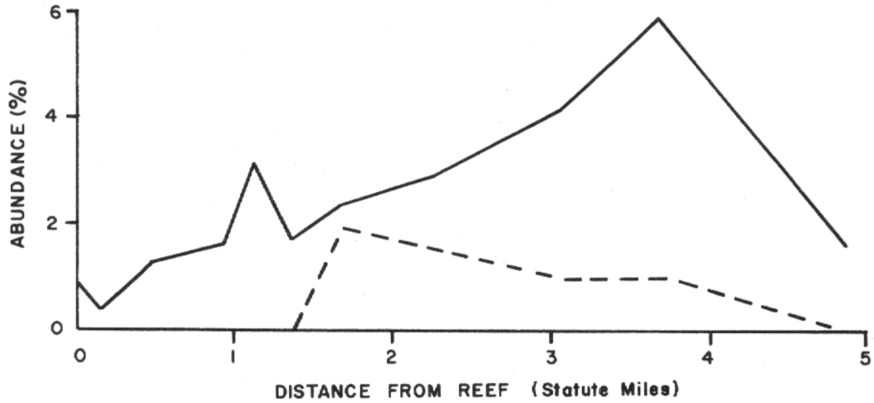
GRAPH 18
DISTRIBUTION OF ROSALINA CANDEIANA



GRAPH 19
DISTRIBUTION OF ROSALINA FLORIDANA

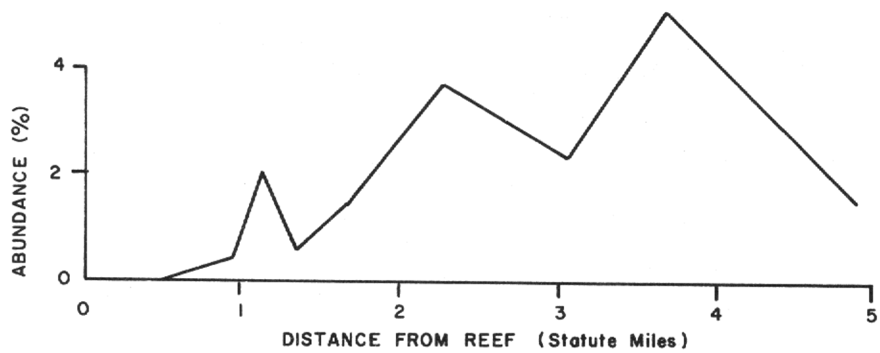


GRAPH 20
DISTRIBUTION OF ASTERIGERINA CARINATA



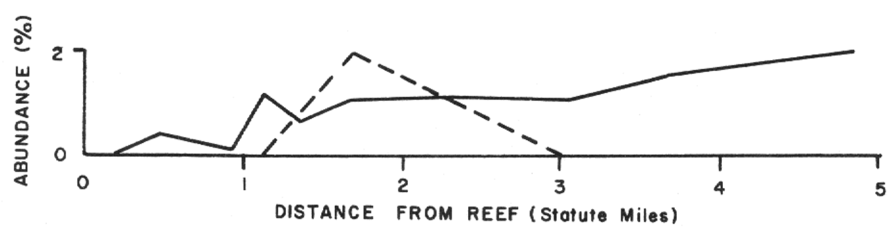
GRAPH 21

DISTRIBUTION OF AMMONIA BECCARII TEPIDA



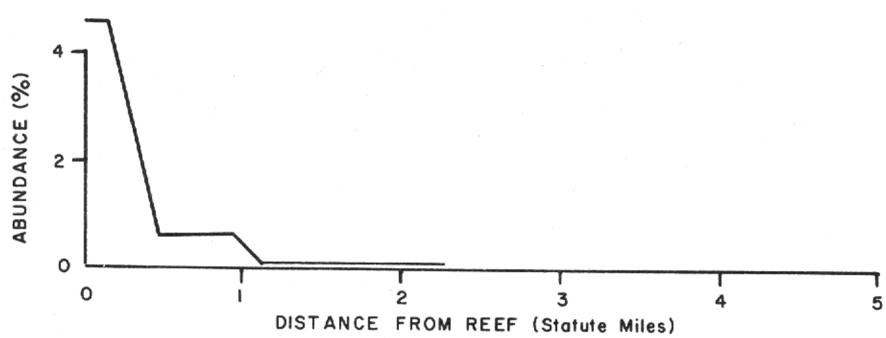
GRAPH 22

DISTRIBUTION OF CRIBROELPHIDIUM POEYANUM



GRAPH 23

DISTRIBUTION OF ELPHIDIUM ADVENUM



GRAPH 24

DISTRIBUTION OF AMPHISTEGINA LESSONII

THE ECOLOGY AND DISTRIBUTION OF LIVING PLANKTONIC FORAMINIFERA IN THE STRAITS OF FLORIDA

by

JAMES I. JONES

DEPARTMENT OF OCEANOGRAPHY

FLORIDA STATE UNIVERSITY

TALLAHASSEE, FLORIDA

ABSTRACT

Seasonal, diurnal, and depth distribution patterns of living planktonic foraminiferal populations from the Florida Straits have been analyzed to determine their relationships to measured environmental parameters. Maximum seasonal foraminiferal concentrations were found in January and July. Maximum populations were measured in the 50 and 150 meter depth range, commonly associated with the 26°C isotherm, and restricted to a temperature range from 22°C to 30°C. A vertical diurnal population migration was observed, with maximum concentrations occurring during daylight hours in the near-surface waters. No apparent relationship was found to exist between foraminiferal distribution and nutrient concentration, determined from phosphate measurements. Phytoplankton concentrations and foraminiferal distribution patterns coincided. Seasonal, depth, temperature and salinity preferred ranges have been established for the foraminiferal species occurring in this study.

INTRODUCTION

Interest in the study of deep-sea marine sedimentary phenomena and their relationships to interpretation of ancient marine environments has recently provided considerable new information relating to these topics. In particular, accelerated collection of deep-sea sediment cores, both by conventional means and by deep-sea drilling techniques, has produced much new sedimentary and paleontologic data. For these data to be correctly interpreted a re-evaluation of many classic or traditional concepts is required, and correspondingly, the development of new interpretational criteria is desirable.

Characteristically, fossil faunas of planktonic Foraminifera have been interpreted with little or no knowledge of the ecology of their living counterparts. It is apparent that meaningful interpretations of fossil populations of these organisms is highly dependent upon information which may be obtained only by ecologic and zoogeographic studies of living representatives of this group. It is the purpose of this study to document the temporal and vertical population distribution of these forms within the waters of the Florida Straits, and further, to speculate on the environmental-faunal relationships which are shown to exist in this area. It is hoped that this information may prove useful in the interpretation of Recent and near-Recent fossil populations of these organisms occurring in deep-sea cores.

METHODS OF STUDY

Field Techniques and Procedures

The plankton and hydrographic samples were collected aboard the Institute of Marine Science Research Vessel GERDA. Midday and Midnight collections were made in the Florida Straits at latitude 24°33' North and longitude 79°25' West between April, 1958 and February, 1959 in the months of April, May, June, July, September, October, December, January and February. The sampling area has been referred to as the Forty Mile Station, due to its location approximately forty miles due east of Miami. Plankton samples were collected from the surface, 38, 75, 100, 150, 200, 250, 300 and 350 meter depth levels. Thirty minute tows were made with closing plankton nets. Depth recorders were not used, and the quoted depths have been calculated on the basis of wire length and wire angle. This method at best provides only approximate depth information, although the error is probably more or less consistent throughout the study. Therefore, the quoted depths, particularly for the deeper nets, may be in error by as much as 10 percent. Hydrographic samples were collected from the surface, 50, 100, 150, 200, 300, 500 and 700 meter depth levels. It should be emphasized that collecting methods employed in this investigation, while adequate for the general interpretation of foraminiferal ecology and distribution within the context of the study, are not of a level of precision sufficiently accurate to allow more than general conclusions to be reached relating to the detailed ecology of these forms. In spite of this limitation, however, there is little reason to doubt the validity of the results which are quoted, particularly as applied to relative seasonal and vertical population characteristics or to the observed preferred environmental ranges which have been provisionally established for each species.

Laboratory Techniques and Procedures

The physico-chemical data presented in this paper are the results of analyses obtained by Drs. Eugene Corcoran and James Alexander. Their work is the basis for the environmental information included within this study and for the chemical oceanographic data. Their techniques and results are included in the Second Summary Report, Oceanic Productivity Studies, The Marine

Laboratory, University of Miami, May 1960, submitted to the Rockefeller Foundation. Additional information on nutrition and productivity is contained in the publication by Alexander (1963).

Laboratory Techniques

The planktonic Foraminifera were separated from the remainder of the plankton by means of a density separation technique modified from that described by Bé 1959. Total foraminiferal counts were made on both the high and low density fractions, although the species distribution was determined from the high density fraction only. A further discussion of the various techniques which have been applied to foraminiferal separation, and their reliability, is discussed in a paper by Boltovskoy (1966) to which the interested reader is referred. A minimum of 500 specimens from each sample were specifically identified. Where there were fewer than 500 specimens in the sample the total population was identified. Three population parameters based on these population analyses have been computed. These are the Standing Crop, the Percent of Total Population, and the Percent of Individual Population values. The Standing Crop is an absolute value, describing within the limits of the sampling error the abundance of a selected organism per unit volume of water. The Percent of Total Population value (%Tot.) and the Percent of Individual Population value (%Ind.) are both relative values. The former is derived from the relative abundance of each species compared to all other species, within a single sample. The latter describes the relative abundance of each species for each station (series of samples), relative only to itself at that particular station. It is useful in determining preferred environmental or temporal ranges for individual species, considering as it does, each species as a separate entity, relative only to itself. These three population parameters have been used to compute the seasonal, and depth preferences of the individual foraminiferal species occurring in this study, and also to define preferred seasonal and depth distribution patterns as exhibited by the total planktonic foraminiferal population.

DISCUSSION

General Characteristics of the Study Area

The Florida Straits contain the Florida Current, a major subdivision of the Gulf Stream. Depths in the Florida Straits average 450 fathoms, the main channel being defined approximately by the 400 fathom contour. The physico-chemical characteristics of the Florida Current are acquired outside the area of the Florida Straits, the water coming variously from the Equatorial Atlantic through the Caribbean via the Yucatan Channel; from the western Atlantic, via Old Bahama Channel; and from a number of areas in the Gulf of Mexico. The water at the Forty Mile Station is primarily Yucatan Water (Parr, 1937, Wennekens, 1959) as classically defined by the temperature-salinity relationships. Seasonal temperature flucturations are restricted to the upper 150 meters, with no seasonal fluctuations observed below that depth. The 24.0^{o}C isotherm is present throughout the year at approximately 100 meters. The upper 100 meters are generally warmer than 26.0^{o}C and exhibit a maximum temperature value in excess of 30.0^{o}C at the surface in September. The temperature variations occurring within the upper 100 meters are predominantly seasonal. The overall salinity range to the maximum sampling depth was from 35.98 ppt to 39.96 ppt. April to July surface highs, and August to November surface lows were observed. Surface waters were generally nutrient deficient over the period of observation, suggesting little or no vertical mixing, and a rapid rate of regeneration. No seasonal phosphorus or nitrogen cycle, as occurs in temperate and northern waters, was observed. Although the values were relatively stable over the observational period, a December high and February low were measured. Consistent increase in concentration with depth was observed. Nitrogen concentration also exhibited this increased concentration with depth, as well as a surface-water high, from July through November. Marked highs also occurred in the depth range from approximately 100 to 200 meters in June, July, October and January. Below 300 meters only September and February highs were observed.

FAUNAL-ENVIRONMENTAL RELATIONSHIPS

One of the principal goals of any ecological study is to determine as precisely as possible, within the limits of the available sampling and analytical techniques, the range of environmental variation within which any particular related group or species may live and reproduce. A field environmental study is necessarily limited by the type and amount of data which can be collected in a field situation. In the present study these limitations consisted primarily of the difficulties of making high-precision collections and physico-chemical measurements in the open ocean from a relatively small vessel, as well as by the limited temporal range of the study, lasting through a period of a single year with only monthly collection of data. These limitations restrict the reliability with which the cause-and-effect relationships existing between the experimental organism and its environment may be defined. It has been possible, however, to observe the broader aspects of these relationships by documenting a number of preferred environmental ranges for the total foraminiferal population and for a number of selected species.

Temperature

Temperature has long been recognized as one of the major controlling factors in the distribution of organisms. In the present study a maximum temperature range of 14°C was observed. Populations maxima occurred when surface water temperatures were between 26°C and 29°C. Below 100 meters only minor seasonal temperature flucturations were measured. The maximal foraminiferal populations occurred within the upper 100 meters, with maximum values attained in January and July, at which time temperatures in this depth interval ranged from 24°C to 30°C. The measured temperature range within the upper 150 meters was 22°C to 30°C. There is some indication that total maximum populations were associated with the 26°C isotherm, exhibiting a depth depression coinciding with the level of this isotherm from May through September. There is good evidence to indicate that the maximum total foraminiferal population from June through January occurred in deeper waters than during the period from February through May. This could be related to a Spring population bloom in the upper waters during the February to May period, although corroborating evidence for this is lacking. The listed temperature ranges for each species is here considered to be the preferred range. Absolute ranges could not be estimated as there is too little temperature fluctuation in this region to objectively define the absolute limit of any species. Specimens of most species were found at all sampling depths, although a preferred depth could be established for most. The collecting technique, utilizing closing nets, tends to broaden the observed environmental limits due to contamination by specimens occurring in upper water levels while the nets are being lowered to their sampling depths. In general, the planktonic Foraminifera appear to have rather broad temperature tolerances.

It is interesting to compare the species temperature ranges measured in this study with those established by Emiliani (1954), based on isotopic analyses of fossil specimens. Of the nine species common to both studies, seven exhibit a temperature range which includes the preferred temperatures of Emiliani. These species also exhibit depth ranges either including or very close to those hypothesized by Emiliani.

Salinities

Salinities values measured within the sampling interval varied but little throughout the study. The effect of differences in salinity on planktonic Foraminifera is poorly known. The most definitive information available to date is that published by the author in two earlier papers (Jones, 1967, 1969). The ranges obtained from those studies, which were based on considerably more reliable biologic and hydrographic sampling and analyses than those of the present study, coincide generally with those measured in this study. Significant exceptions to this are discussed below under the appropriate species. Salinity appears to be a major limiting environmental factor in the distribution of the planktonic Foraminifera. The species distribution in this and the earlier studies (op. cit.) exhibited a markedly greater correspondence to variations in the salinity field than has previously been reported.

Nutrients

The data available for measurement of the nutrient concentration consist of measurements of total phosphate, inorganic phosphorus, and nitrate and nitrite nitrogen. As these parameters generally exhibit a consistent relationship one to the other, only the phosphate data will be considered in detail. Seasonal nutrient concentrations were very low, with little evidence to indicate the pronounced seasonal cycle common to higher latitudes. Maximum nutrient values were observed during the August to September and the April through May periods. Maximum surface values were measured in November and December. There is no apparent correlation between the observed foraminiferal population variations and those of phosphate-phosphorus concentration. In the water samples analyzed, inorganic phosphate varied between zero at the surface to more than 0.3 microgram-atoms-per-liter at 300 meters depth. A seasonal increase occurred in surface waters during the summer. It is apparent that no large-scale mixing occurred between the surface waters and those below the permanent thermocline. There was no measurable seasonal intrusion by different water masses. This stability suggests that the renewal of nutrients is dependent on mineralization and regeneration occurring in the upper waters (Alexander, 1963). It has been established that maximum zooplankton concentrations coincide with maximum inorganic phosphate concentrations. This is due to the dependency by zooplankton on the nutrient material in the water, which is reflected by the high phosphate values. This reasoning led Bradshaw (1959) to investigate the relationship of planktonic foraminiferal distribution to inorganic phosphate concentration. He found a relationship which was later confirmed by Parker (1960) in their studies of Pacific planktonic Foraminifera. Smith (1963) was unable to document any such relationship in his study. The present investigation similarly shows no evidence of such a relationship, with minimal inorganic phosphate concentrations measured in the upper 150 meters where foraminiferal concentrations were greatest. Additionally, phosphate concentrations in all cases increased with depth, with maximum values at the lowest sampled depths, where measured foraminiferal concentrations were least. Seasonal measurements of this parameter also failed to demonstrate a relationship between this variable and planktonic foraminiferal concentrations.

Oxygen

The available oxygen data do not indicate a relationship to any measured foraminiferal population parameter variation. This was expected, since observed oxygen concentrations in the sampled area maintain a level which theoretically would not exert limiting effect on plankton distribution.

Light

Illumination is the most obvious factor controlling diurnal population variation, although this may in reality be a secondary effect upon foraminiferal distribution, with the phytoplankton responding directly to light and the Foraminifera responding secondarily, relative to the phytoplankton response. It has not been possible to establish whether or not the observed foraminiferal diurnal pattern is related to symbiotic zooxanthellae associated with foraminiferal protoplasm, or if it occurs due to a feeding response by the Foraminifera related to phytoplankton migration; or as the result of an entirely different factor or combination of factors. It was observed in this study that diurnal depth fluctuations occurred at depths well below those having sufficient illumination for photosynthetic activity by the phytoplankton. Whether or not these low levels of illumination are likewise too small to be used by the foraminiferal zooxanthellae is a matter of conjecture. The majority of the species of Foraminifera appeared to exhibit some degree of diurnal depth fluctuation relative to the euphotic zone. This could be due to zooxanthellae light requirements, or to a feeding pattern established by the Foraminifera which coincides with phytoplankton diurnal migration. This possibility has not been considered by previous investigations.

Phytoplankton abundances in this study were determined at each station by the measurement of chlorophyll a. The technique and data relating to these measurements are included in the Rockfeller Foundation Report referred to previously. The measurement of phytoplankton concentrations indicated maximum phytoplankton concentrations in the upper 100 meters throughout the year, with the greatest concentrations occurring in the 50 to 100 meter depth range. These concentrations coincide with maximum foraminiferal concentrations. The phytoplankton provide the bulk of the nutritional requirements for the Foraminifera, therefore it is not unreasonable to hypothesize the existence of a causal relationship within these two variables. The fact that the Foraminifera exhibit a diurnal pattern similar to the phytoplankton, and markedly different from that shown by the zooplankton, further suggests this possibility. To summarize, while no apparent relationship was observed between foraminiferal concentration and high nutrient values, as determined by phosphate concentrations; an apparent positive correlation was shown between foraminiferal and phytoplankton concentrations. It is suggested, therefore, that the observed diurnal pattern of the Foraminifera may be partially a consequence of a feeding response by the Foraminifera to maximum phytoplankton concentrations.

FORAMINIFERAL SYSTEMATICS AND ECOLOGY

Species Characteristics

It is not the purpose of this study to investigate the detailed systematics of this group, but rather to suggest other criteria which may be of value in understanding and interpreting the systematics of the planktonic Foraminifera. The taxonomic information included here, therefore, is minimal. The references which are cited are those most representative of the author's concept of each species, and are ones which contain adequate reviews of the prior taxonomic treatment of each species. These species are familiar to all students of this group and their definition should cause no difficulty.

Globigerina bulloides d'Orbigny, 1826 (Plate 27, Fig. 4)

Globigerina bulloides d'Orbigny, 1826, Ann. Sci. Nat., Ser. 1, v. 7, p. 277.

This form occurred but rarely. The specimens referred to this species are comparable to the forms figured by Parker (1962, Pl. 1, Figs. 1, 3), Bé (1959, Pl. 1, Figs. 15-17) and Bradshaw (1959, Pl. 6, Figs. 1-4). No specimens with the umbilical bulla as figured by Parker (1962, Pl. 1, Fig. 4) were observed. This species has been reported throughout the oceans of the world, with maximum occurrences in mid-latitudes or temperate regions, associated with the cooler oceanic waters. It occurs in tropical regions, but at low frequencies. Bradshaw (1959) suggested that it might live at greater depths in the equatorial Pacific than in higher latitudes. No evidence of this equatorial depression was observed in either the present study, or in an earlier investigation based on material from the Tropical Atlantic (Jones, 1966, 1969).

Maximum concentrations in the Florida Straits were measured in the surface to 38 meter depth-range. No seasonal depth preference was demonstrated. Maximum populations were measured in May. This species was present only in minor concentrations, at no time representing more than 3% of the total foraminiferal population. Upper-water daytime concentrations were consistently larger than nighttime concentrations. Populations were inadequate to establish preferred ranges for temperature or salinity.

Globigerina siphonifera (d'Orbigny), 1839 (Plate 25, Fig. 1)

Globigerina siphonifera d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 83, Pl. 4, Figs. 15-18.

Globigerina aequilateralis Brady, 1879, Quart. Journ. Micr. Sci., new ser., v. 19, p. 285.

Globigerina aequilateralis Brady var. involuta Cushman, 1917, U.S. Nat. Mus. Proc., v. 51, no. 2172, p. 662.

Hastigerina (Hastigerina) siphonifera (d'Orbigny), - Banner and Blow, 1960, Micropaleontology, v. 6, no. 1, p. 22, Text-Figs. 2 (lectotype), 3.

Included under this taxon are the typical "aequilateralis" form, as well as the "involuta" form of Cushman and others. These two types were separated in the population anaysis. Their observed occurrence and distribution does not justify their separation into two distinct species. Maximum concentrations were observed in the 75 to 200 meter depth range, with an overall maximum at 75 meters. Upper-water daytime concentrations were generally larger than at nighttime. This form exhibited relatively high populations during both summer and winter, with the overall maximum in July. The single preferred depth was 75 meters. The preferred temperature range was 19.5°C to 26.0°C, with a single preferred temperature of 23.5°C. The preferred salinity range was 36.14 to 36.67 ppt, with a single preferred salinity value of 36.39 ppt.

Hastigerina pelagica (d'Orbigny), 1839 (Plate 25, Figs. 3, 4)

Nonionia pelagica d'Orbigny, 1839, Voy. Amer. Merid. "Foraminiferes", v. 5, pt. 5, p. 27, Pl. 3, Figs. 13-14).

Hastigerina murrayi Thompson, 1876, Roy. Soc. London, Proc., v. 24, p. 534, Pl. 22, 23.

Hastigerina pelagica (d'Orbigny), - Brady, 1884, Rept. Voy. Challenger, Zool., v. 9, p. 613, Pl. 83, Figs. 1-8.

This species exhibited little morphologic variation. Although it is a common element of the plankton it has been reported infrequently in deep-sea surface sediments, probably because of its fragile nature which is not easily preserved in bottom sediments. A preferred depth range from 38 to 150 meters was measured, with maximum populations occurring at 75 meters. It had a maximum value of 13% of the total foraminiferal population in April and May, and a minimum in October. The Standing Crop maximum also occurred in April. Larger populations were generally found in the upper waters in daylight hours. A well defined preference for the upper 100 meters was exhibited throughout the sampling period. A preferred temperature range from 25.2°C to 27.5°C and a single preferred temperature of 25.8°C were measured. Both Bé (1959) and Bradshaw (1959) have considered this form a warm-water species. The present study agrees with their determination, but another investigation by the author on materials collected in the Tropical Atlantic (Jones, 1966, 1969) gives conflicting data. Further analysis of the ecology of this form is therefore indicated, to resolve this apparent discrepancy. The preferred salinity range measured in the present study was from 36.12 to 36.42 ppt, with a single preferred salinity value of 36.25 ppt.

Globigerinoides conglobatus (Brady), 1879 (Plate 25, Fig. 5)

Globigerina conglobata Brady, 1879, Quart. Jour. Micr. Sci., new ser., v. 19, p. 286.

The form referred to by Bradshaw (1959) on page 42 and figured on his Plate 7, Figures 16 and 17 has been included in this taxon. The bullae observed by Parker (1962, Pl. 3, Fig. 3) were not observed on any of the specimens of this study. This form exhibited a preferred depth range from 100 to 200 meters. It was found in most of the samples, generally representing 5% or less of the total foraminiferal population. Maximum population values occurred at 150 meters. It represented 7% of the total population in July, at which time it also had its highest Standing Crop value. Daytime values in the upper 100 meters were higher than nighttime values in this depth range. It demonstrated a well-defined preference for depths greater than 100 meters. A preferred temperature range from 20.7°C to 25.2°C and a single preferred temperature value of 24.0°C were measured. A preferred salinity range from 36.28 to 36.68 ppt and a single preferred salinity value of 36.42 ppt were computed.

Globigerinoides trilobus (Reuss), 1850 (Plate 25, Figs. 6, 7, 8)

Globigerina trilobus Reuss, 1850, Denkschr. Akad. Wiss., Wien, v. 1, p. 374, Pl. 47, Fig. 11.

Globigerinoides quadrilobatus sacculifer, Parker, 1962, Micropaleontology, v. 8, no. 2, p. 229, Pl. 3, Figs. 13-15.

Globigerinoides trilobus (Reuss), forma typica, Boltovskoy, 1964, Alm. Naut., B. Aires, H. 639, p. 13-15, Pl. 2, Figs. 6-9.

Globigerinoides trilobus (Reuss), forma sacculifera (Brady), Boltovskoy, 1964, Alm. Naut., B. Aires, H. 639, p. 15, Pl. 3, Fig. 2.

Included within this taxon are two distinct morphologic types, the forma typica and the forma sacculifer, as recognized by Boltovskoy (1966) and others. On the basis of the present study, as well as an earlier one (Jones, 1967, 1969), there is evidence to indicate that these two morphotypes have different preferred environmental habitats, although with a considerable range of overlap, and that there is some justification in considering them true biologic subspecies. In this and the previously cited study (Jones, op. cit.) the preference by the forma sacculifer for colder temperatures and/or deeper water was well documented. This observation contradicts the hypothesis of Bermudez (1961) which assumed that the sac-like final chamber acted as a more efficient float mechanism than the normal chamber, and that the forma sacculifer would therefore occupy shallower waters than the forma typica.

This species exhibited a preferred range from the surface to 100 meters, with maximum values in the 75 to 100 meter interval. Its maximum Standing Crop occurred in July, although it was present throughout the year in significant numbers, representing one of the major elements of the foraminiferal population from July through November. Its preference for water-depths in the 75 to 100 meter range was marked. The forma typica was always by far the more abundant of the two forms, generally constituting 98% to 99% of the total G. trilobus population. A preferred temperature range from 24.6°C to 28.8°C was measured, with a single preferred temperature value of 26.0°C. The measured preferred salinity range was 35.98 ppt to 36.48 ppt, with a single preferred salinity value of 36.29 ppt.

Globigerinoides ruber (d'Orbigny), 1839 (Plate 25, Fig. 10)

Globigerina rubra d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 82, v. 8, Pl. 4, Figs. 12-14.

The full range of variation illustrated by Parker (1962) was observed in the samples of this study. The most common form was that illustrated by her in Plate 3, Figures 11 through 13. Variants from this form constituted only a small fraction of the G. ruber population. The colored and non-colored (red and white) forms of this species were separated in the faunal analysis. A distribution pattern was observed which indicated a pronounced preference by the white form for deeper and/or colder waters than the red. This agrees with the distribution reported by Bé (1960) in which he reported a preference by the red form for warmer waters in the Bermuda area. There were inadequate numbers of other morphologic variants of this species to allow any conclusion as to their possible phenotypic or genetic significance.

In the present study this species was present throughout the year, but exhibited maximum population values in September. It represented almost 50% of the total population in October. Maximum concentrations occurred during the daytime, in the upper 100 meters of water. A marked preference for the surface to 100 meter depth range was demonstrated, with a maximum single value occurring at 38 meters. This form generally exhibited relatively low population values throughout the year in the range from 150 to 350 meters, with only one major exception occurring in September, where relatively high population values were measured below 100 meters. A preferred temperature range from 24.0°C to 28.8°C was measured, with a single preferred temperature value of 26.6°C. A preferred salinity range from 35.98 to 36.78 ppt was observed, with a single preferred salinity value of 36.25 ppt.

Orbulina universa d'Orbigny, 1839 (Plate 26, Fig. 1)

Orbulina universa d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 3, v. 8, Pl. 1, Fig. 1.

The interpretation of this "species" is a source of disagreement among students of the planktonic Foraminifera. Different conclusions have been drawn in regard to the significance of the "juvenile", or spiral stage occurring within the outer globular chamber. It appears that two or more species may be represented, all of which develop the characteristic enclosing globular chamber diagnostic of Orbulina universa, as commonly recognized. Bé (1958) and others have discussed this problem. In the present study only two different spiral forms were observed, one similar to Globigerina bulloides in general form and the other similar to Globigerinoides conglobatus, although neither of these spiral stages were conspecific with either of the species they have been compared to. The spiral stage similar to G. bulloides was also routinely recognized in the samples when not enclosed by the enveloping final chamber. It seems best, at the present stage of knowledge, to consider O. universa a distinct species for purposes of this ecological study, in the hope that the information presented here, combined with past and future information, may ultimately resolve the problem of the taxonomic significance of this form.

In the present study this species consistently constituted a major element of the total foraminiferal population, often occurring as the most abundant element of the population. Maximum Standing Crops occurred in July. A consistent preference was shown for the 75 meter depth level, with a preferred depth range from 50 to 150 meters. Significant numbers were found at all sampled depths, however, a preferred temperature range from 17.6°C to 27.7°C was observed with a preferred single temperature value of 23.7°C. A preferred salinity range from 36.14 ppt to 36.55 ppt was measured, with a single preferred salinity value occurring at 36.32 ppt.

Pulleniatina obliquiloculata (Parker and Jones), 1862 (Plate 26, Figs. 2, 3)

Pullenia obliquiloculata Parker and Jones, 1862, in Carpenter, Introd. Foram., p. 183.

Pullenia sphaeroides (d'Orbigny) var. obliquiloculata Parker and Jones, 1865, Roy. Soc. London, Philos. Trans., v. 155, p. 365, 368, Pl. 19, Fig. 4a-b.

This form exhibited no significant morphologic variation in the samples analyzed, where it was found only rarely. Both adult and juvenile forms have been included in the population analyses. It has been reported from many warm-water regions of the world and had been considered by most workers to be indicative of these conditions when found as fossils.

A preferred depth-range from 50 to 200 meters was measured, with maximum population values occurring at 75 and 150 meters. It was present throughout the sampling period, but generally at low frequencies, with the exception of the January collection when large numbers of juvenile forms were observed. Maximum population values occurred consistently in the upper 150 meters. A preferred temperature range from 17.6°C to 24.6°C, and a single preferred temperature value of 21.8°C were measured. A preferred salinity range from 36.14 ppt to 36.83 ppt and a preferred salinity value of 36.51 ppt were calculated.

Sphaeroidinella dehiscens (Parker and Jones), 1865

Sphaeroidina bulloides d'Orbigny var. dehiscens Parker and Jones, 1865, Roy. Soc. London, Philos. Trans., v. 155, p. 369, Pl. 19, Fig. 5.

This distinctive species has generally been regarded as a warm-water form due to its reported occurrences in surface sediments and in the plankton. Its rarity in the samples of the present study does not conform to this concept. It occurred only rarely, in few samples at very low frequencies. Provisional depth and temperature preferred-ranges are 200 to 350 meters and 16.0°C to 20.0°C, but the small number of specimens collected make these values highly speculative.

Globorotalia crassaformis (Galloway and Wissler), 1927 (Plate 26, Figs. 4, 5, 6)

Pulvinulina crassa (d'Orbigny), - Brady, 1884 (not Rotalina crassa d'Orbigny), Rept. Voy. Challenger, Zool., v. 9, p. 694, Pl. 103, Figs. 11-12.

Globigerina crassaformis Galloway and Wissler, 1927, Jour. Pal., v. 1, p. 41, Pl. 7, Fig. 12.

?Globorotalia pseudocrassa Chapman and Parr, 1937, Australian Antarct. Exped. 1911-14, Sci. Repts., ser. C (Zool., Botany), v. 1, pt. 2, p. 115, Pl. 9, Fig. 25.

Globorotalia (Turborotalia) oceanica Cushman and Bermudez, 1949, Cushman Lab. Foram. Res., Contr., v. 25, p. 43, Pl. 8, Figs. 13-15.

Globorotalia punctulata (Fornasini), - Phleger, Parker and Peirson, 1953, Swedish Deep-Sea Exped., Repts., v. 7, Fasc. 1, p. 20, Pl. 4, Figs. 8-12.

This species has been reported from tropical regions of both the Atlantic and Pacific oceans, both in sediment samples and in the plankton. It was well represented in the present study, where it showed little morphologic variation, conforming in all respects to its traditional concept. It exhibited a marked preference for waters deeper than 100 meters, attaining a Maximum Standing Crop value at 150 meters, with significant amounts of its population present to 350 meters. It was generally rare in the upper 100 meters and completely absent in the upper 38 meters. It was present at relatively low values through most of the year, but was absent in December, January and February. A preferred temperature range from 16.0°C was calculated, with a single preferred temperature of 23.0°C. A single preferred salinity value of 36.61 ppt was measured.

Globorotalia cultrata (d'Orbigny), 1826 (Plate 26, Figs. 7, 8)

Rotalia (Rotalie) menardii d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 273, no. 26; Modeles no. 10.

Rotalia limbata d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 274, no. 30.

Rotalia nitida d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 274, no. 31.

Rotalina (Rotalina) cultrata d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 76, v. 8, Pl. 5, Figs. 7-9.

Rotalina cultrata d'Orbigny, - Banner and Blow, 1960, Cushman Found. Foram. Res., Contr., v. 11, p. 34, Pl. 6, Fig. 1.

Rotalia menardii Parker, Jones and Brady, 1865, Ann. Mag. Nat. Hist., v. 16, ser. 3, p. 20, Pl. 3, Fig. 81.

This species is a commonly occurring form in the warm and temperate oceans of the world. Boltovskoy (1962) has considered it the best warm-water indicator form in his studies of water masses of the South Atlantic. Be (1958) has reported it as occurring most abundantly in the Gulf Stream system when surface water temperatures were between 21° and 24°C. An unsuccessful attempt was made to separate this species into the two forms recognized by Bermudez (1961) as Globorotalia menardii. It was abandoned when it became apparent that such a separation was artificial, and that there was a complete morphologic gradation between these two forms.

A preferred depth range from 50 to 150 meters, and a single preferred depth value of 75 meters was established for this species. It was present in moderate abundances throughout the sampled water column, and in the deeper portions formed a sizeable portion of the total foraminiferal population. Maximum Standing Crop values were observed in January. A preferred temperature range from 17.6°C to 27.7°C and a single preferred temperature value of 23.8°C were measured. The preferred salinity range was from 36.14 ppt to 36.57 ppt, with a single average preferred value of 36.35 ppt.

Globorotalia hirsuta (d'Orbigny), 1839

Globorotalia hirsuta d'Orbigny, 1839, in Barker-Webband Berthelot, Hist. Nat. Iles Canaris, "Foraminiferes", v. 2, pt. 2, Zool., p. 136, Pl. 1, Figs. 37-39.

This species has been considered by most students of this group to show a preference for temperate waters, being more or less intermediate between the more pronounced warm- and cold-water species. Bé (1958) has reported it occurring most abundantly when surface water temperatures were below 18°C. In the present study it occurred rarely, generally at less than 1% of the total foraminiferal population. The form most commonly observed was the "form 3" of Parker (1962), which she reported as the most common form of this species in the south Pacific plankton.

Globorotalia hirsuta formed only a minor element of the total foraminiferal population in the Florida Straits, with its only occurrence in May, at which time it showed a preference for waters within the 200 to 250 meter depth range. Based on this single occurrence the environmental ranges which are listed must be considered extremely tentative. The preferred temperature range was from 18.0°C to 21.0°C, with a maximum of the population at 20.2°C. The preferred salinity value was 36.61 ppt.

Globorotalia truncatulinoides (d'Orbigny), 1839 (Plate 26, Figs. 11, 12)

Globorotalia truncatulinoides (d'Orbigny), 1839, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaris, "Foraminiferes", v. 2, pt. 2, p. 132, Pl. 2, Figs. 25-27.

This species is common in the temperate and warm water areas of the world's oceans. The specimens examined in the present study exhibited a marked constancy of form, showing essentially no morphologic variation within the samples of this investigation.

This species exhibited one of the more pronounced depth preferences documented in this study, with maximum values almost exclusively limited to the 200 meter depth level, and occurring only within a narrow depth range, from 125 to 225 meters. Although present throughout the water column in varying minor abundances, the only significant populations were restricted to depths of 200 meters or more. It occurred rarely in only minor amounts in the upper 125 meters. Maximum populations were observed in the months of January and April. A preferred temperature range from 18.8°C to 21.5°C, and a preferred average single temperature value of 20.0°C; and a preferred salinity range from 36.56 ppt to 36.85 ppt and a single average preferred value of 36.66 ppt were calculated.

Globorotalia scitula (Brady), 1882

Pulvinulina scitula Brady, 1882, Roy. Soc. Edinburgh, Proc., v. 11 (1880-82), no. 111, p. 716.

Pulvinulina patagonica d'Orbigny sp., Brady, 1884, (not Rotalina patagonica d'Orbigny, 1839), Rept. Voy. Challenger, Zool., v. 9, p. 693, Pl. 103, Fig. 7.

This species has been considered a temperate to warm water species by most previous workers. Bradshaw (1959) referred it to his "transition" fauna, and Parker (1962) found it most abundant north of 50° south latitude. It occurred only rarely in the material from the Florida Straits, where it was not recorded during most of the year, attaining its maximum concentration in October. When present, it occurred sporatically, occurring at one time or another at most sampling depths. A preferred depth of 75 meters was observed. A preferred temperature range from 24.0°C to 28.0°C, and a single preferred temperature value of 27.7°C were calculated. A preferred salinity value of 36.22 ppt was established. Due to the relative scarcity of this species these values must be considered highly tentative.

Globigerina dutertrei d'Orbigny, 1839 (Plate 27, Figs. 2, 3)

Globigerina rotundata d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 277, no. 6.

Globigerina dutertrei d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 84, v. 8, Pl. 4, Figs. 19-21.

Globigerina eggeri Rhumbler, 1901, in Brandt, Nordisches Plankton, no. 14, p. 19, Text-Fig. 20.

Globigerina subcretacea Lomnicki, 1901, Naturf. Ver. Berlin, Bd. 39 (1900), Abb., p. 17.

This species, as recognized here, encompassed the full range of variation illustrated by Parker (1962), with the majority of the species conforming to the specimens figured by her on Plate no. 7, Figures 1 through 10. An attempt was made to separate the two "species" Globigerina eggeri and Globigerina dutertrei, after Banner and Blow (1960) and Bermudez (1961), but was abandoned when the complete intergradation of these two morphotypes was established, making any separating of elements other than the extreme end members of the series meaningless from any objective systematic criteria.

There is some disagreement among students of this group as to the temperature preference of this form. Both Bradshaw (1959) and Bé (1959) have suggested a cold water preference, or at least a transitional population element from cold to tropical waters. Boltovskoy (1962), on the other hand, reported it in his "warm water" group. Parker (1960) found it throughout her area of study. Jones (1966, 1969) found it abundantly in material collected from the tropical Atlantic, and established a definite tropical temperature range for it.

It occurred most abundantly in the Florida Straits from April through July, although it was present throughout the year, representing a low but significant portion of the foraminiferal population over the entire period of study. It exhibited a marked preference for the 75 meter depth level, with a preferred depth range from 50 to 100 meters. A preferred temperature range from 19.1^{o}C to 24.8^{o}C, a preferred single temperature value of 22.9^{o}C, a preferred salinity range from 36.13 ppt to 36.49 ppt, and a single preferred salinity value of 36.29 ppt were calculated.

Candeiana nitida d'Orbigny, 1839

Candeiana nitida d'Orbigny, 1839, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, "Foraminiferes", p. 108, Pl. 2, Figs. 27, 28.

This species has generally been reported as showing a preference for warm waters, having been found in the plankton of the temperate and tropical regions of both the Atlantic and Pacific. Its scarcity in the samples of this study was therefore unexpected. It occurred at only a single station (July) with occurrences at 38, 75, and 200 meters. Due to its scarcity no attempt has been made to calculate any of its preferred environmental characteristics.

Globigerinita glutinata (Egger), 1893

Globigerinita glutinata Egger, 1893, Abhandl. K. Bayer. Akad. Wiss. München, CL 11, v. 18, p. 371, Pl. 13, Figs. 19-21.

No specimens containing the bulla, such as those illustrated by Parker (1962, Pl. 9, Figs. 7-9 and 12-16) and by Phleger et al. (1953, Figs. 14, 15) were observed in the samples of this study. The temperature preference of this species has been a matter of controversy, with Be (1959) reporting it in his "cold-tolerant" group, and Bradshaw (1959) and Boltovskoy (1962) considering it a warm-water species. Parker (1960) found it only rarely in her study of the Pacific planktonic Foraminifera.

Although present in only limited numbers in the present study it has been possible to establish a distinct preference for warm waters, where it has demonstrated a higher average preferred temperature range than any of the other species occurring in this investigation. A marked preference for surface water was observed, with a preferred depth range from the surface to 38 meters. A preferred temperature range from 25.0^{o}C to 28.0^{o}C and a preferred single temperature value of 28.8^{o}C, and a single preferred salinity value of 35.98 ppt were calculated.

Total Population Characteristics

Analyses of the monthly total foraminiferal Standing Crop at the Forty Mile Station show the following characteristics: January and July highs, with relatively low values in June, December and February; July and January highs corresponding in general with the total zooplankton high values which are known to occur in this area in the late Spring and Winter. The Foraminifera did not show any demonstratable relationship to the temporal population of any other zooplankton group analyzed, (Rockefeller Report) nor did they correspond with the total zooplankton highs and lows as measured volumetrically. The generally higher daytime than nighttime values for the total foraminiferal population were well documented.

Calculations of the average total Standing Crop in the upper 350 meters demonstrated maximum values for January and July within the 50 to 150 meter depth range. Relatively high near-surface values throughout the year were well shown (Figure 1).

The average total foraminiferal Standing Crop for all samples collected at the Forty Mile Station over the full period of the study indicated maximum average concentrations at 75 meters, with the maximum day value at 100 meters and the maximum night value at 75 meters. Day values were considerably higher than night values in the upper 125 meters, with the night values greater or very close to the day value from 125 to 350 meters. An increase in the Standing Crop values from the surface to a maximum at 75 to 100 meters, followed by a corresponding decrease to a minimum value at 350 meters was observed. The markedly higher daytime values occurred only within the euphotic zone, decreasing rapidly below that level. Some controversy has existed concerning the photic response of the planktonic Foraminifera. The present investigation indicates a positive photic response, with their maximum concentrations occurring in the upper waters during the daylight hours.

The planktonic Foraminifera exhibited different distributional patterns than any other measured planktonic element. The majority of the zooplankton occurred below the euphotic zone during the daytime, when the Foraminifera were most abundant in this zone. Seasonal zooplankton highs in the summer and winter show a general correspondence to those demonstrated by the Foraminifera.

Population analyses of the individual species of Foraminifera have revealed preferred seasonal, depth, temperature and salinity ranges. These data have been discussed under the appropriate species, and are summarized in Table 1 . The preferred depth ranges listed are those within which a significant portion of the population consistently occurred, while the maximum population depth (single preferred value) is the single value at which the majority of the specimens of each species was found. The depth of maximum population occurrence is probably a more reliable index to preferred depth than the preferred depth range, which in most cases included 100 meters or more. The preferred-depth single values and ranges for selected species are shown graphically in Figure 2. The single preferred values for temperature and salinity are considered a more reliable index to the actual species preference than are the preferred ranges for these values.

This investigation is one of few studies yet completed which attempts to define the specific depth-distribution patterns and related preferred environmental values of living planktonic Foraminifera. It should be clearly understood that the values quoted here are provisional. They will undoubtedly require re-evaluation and modification when future studies provide additional data relating to this problem. This study does, however, provide basic criteria for future studies and the information here included, while of a relatively general nature, is accurate within the limits previously defined. It is hoped that it will prove useful in future studies of foraminiferal ecology and paleoecology.

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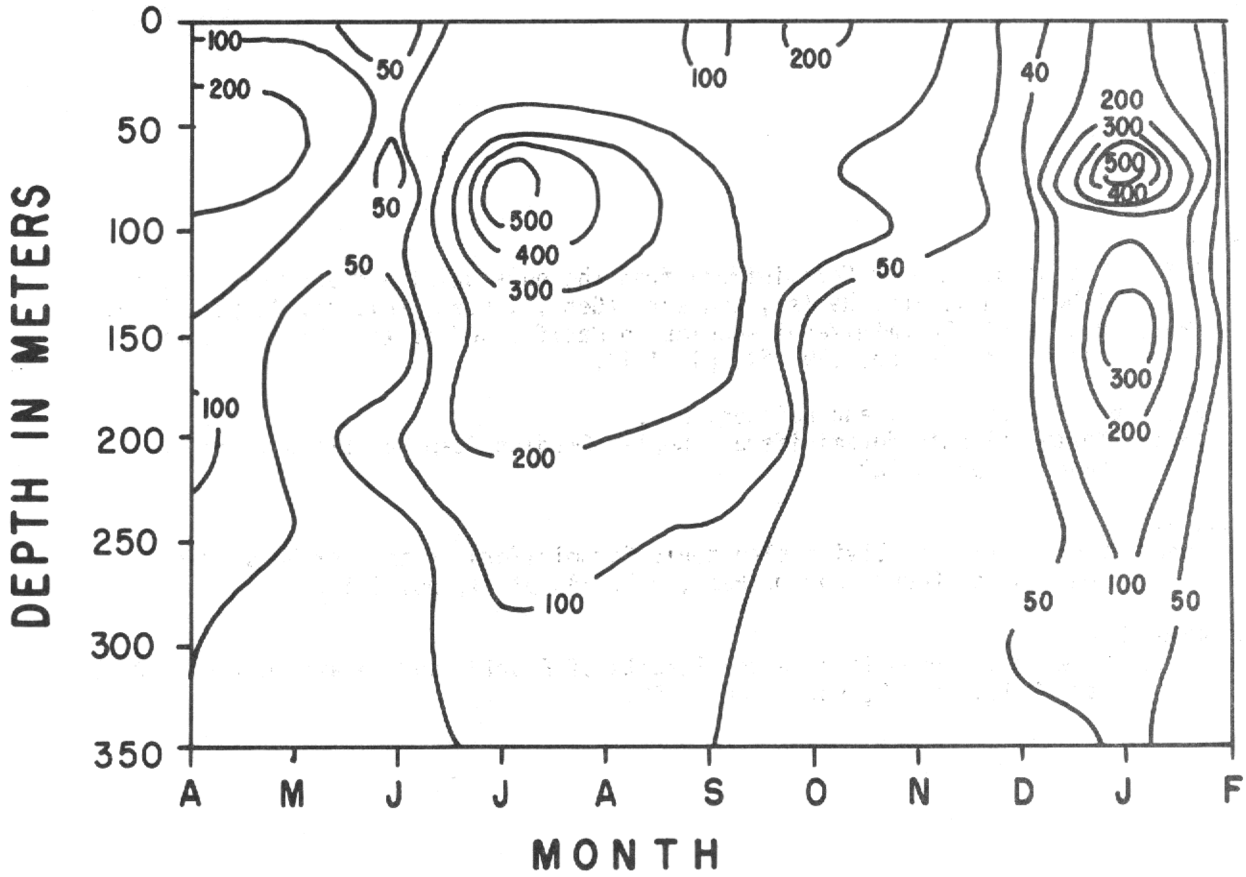

Figure 1 Average total standing crop values for the upper 350 meters at the Forty Mile Station, by month.

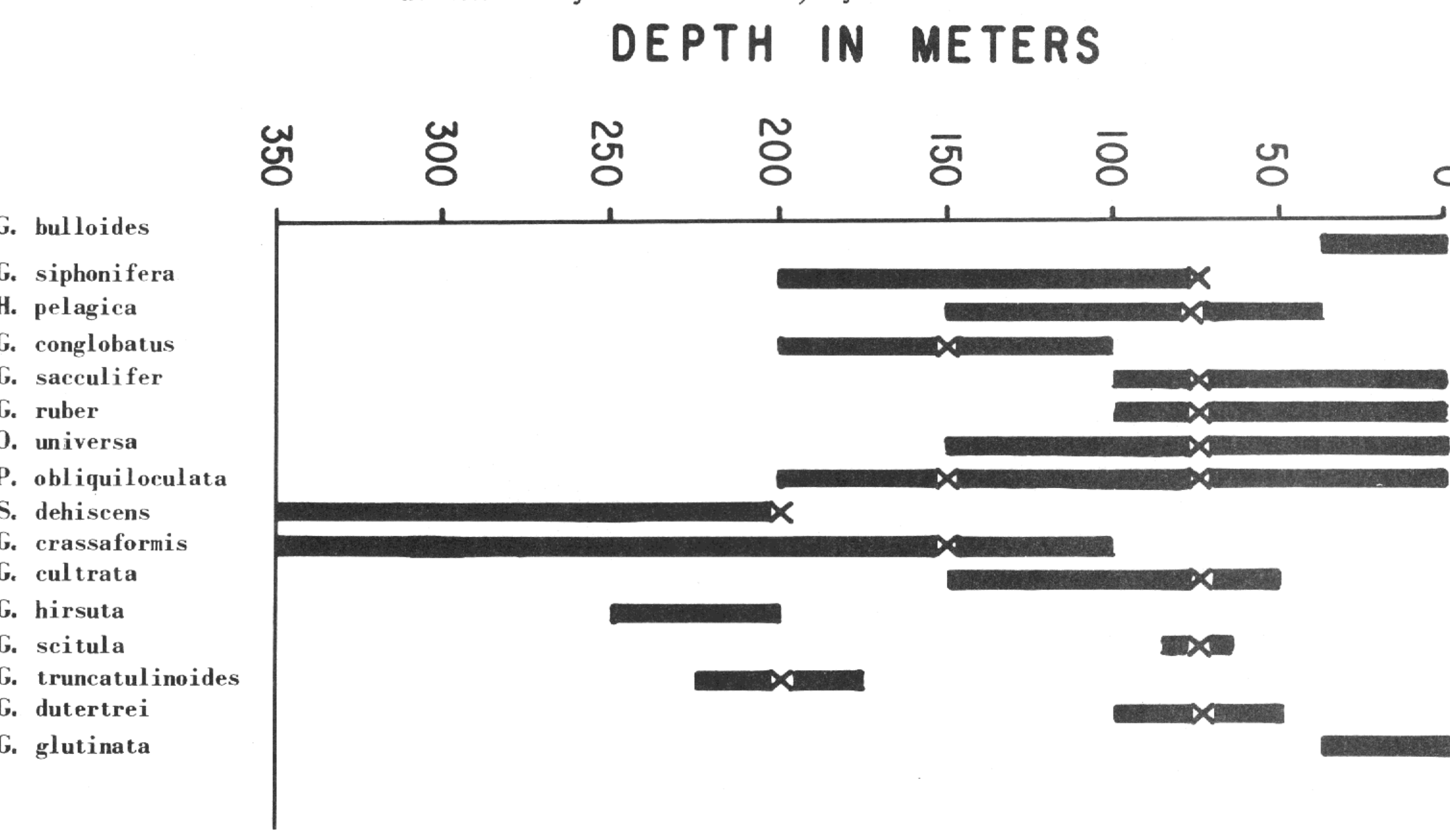

Figure 2 Preferred depth ranges and maximum foraminiferal population occurrences, (X) Forty Mile Station.

Samples no. SL52-60	Depth in Meters for A and B Series																	
	Surface A	Surface B	38 A	38 B	75 A	75 B	100 A	100 B	150 A	150 B	200 A	200 B	250 A	250 B	300 A	300 B	350 A	350 B
G. bulloides	3	1-	1			1-	1-	1-		1-	1-	1-	1-	1-	1-	1-	1-	
G. pachyderma																		
G. adamsi																		
G. siphonifera	5	4	8	2	22	16	16	10	13	16	16	18	7	5	1	7	3	7
H. pelagica	5	2	16	3	13	11	15	10	2	7	5	6	3	2	4	4	5	2
G. conglobatus	3	1	2	1	3	2	6	2	5	3	3	3	2	3	1-	2	2	1-
G. sacculifer	34	7	36	14	45	27	46	22	7	27	9	9	9	7	5	4	4	4
G. ruber	69	7	53	40	34	41	56	15	7	11	12	21	14	7	3	7	4	3
O. universa	14	11	41	16	82	64	71	53	41	46	35	33	21	11	24	12	9	7
P. obliquiloculata	5	5	7	3	12	9	6	8	16	3	9	6	5	1	5	2	3	1
S. dehiscens	1-				1-		1-	1-			1-		1-	1-	1-	1-		
G. crassaformis					1-		1-			1-	1-		1-	1-				1-
G. cultrata	6	3	6	2	8	7	8	5	6	5	3	5	5	2	5	2	2	3
G. hirsuta											1-	1-	1-	1-			1-	
G. scitula	1-				1	1-			1-		1-					1-		
G. truncatulinoides	1-	1-		1-	1-	1-	1-	1-		1-	3	2	1-	1	1	1-	1-	2
G. tumida		1-	1-			1-				1-				1-			1-	
G. dutertrei	1-	1-	1-		1	1-	1-		1-		1-	1-				1-	1-	1-
G. glutinata	1-			1-			1-					1-			1-			1-
C. nitida			1-		1-											1-		
T. atlanticus																		

Table 1 Average total standing crops, day (A) and night (B) for the Florida Straits.

EXPLANATION OF PLATES

(In the following plates all electron micrographs taken with the scanning electron microscope are designated SEM while all photographs taken through a microscope are designated LM. All specimens on deposit in the U.S. National Museum are designated by U.S. National Museum numbers, and those on deposit at the School of Marine and Atmospheric Science, University of Miami, are designated by BRC-SMAS.)

PLATE 1.

ASTRORHIZIDAE, SACCAMMINIDAE, AMMODISCIDAE, HORMOSINIDAE, LITUOLIDAE, TEXTULARIIDAE.

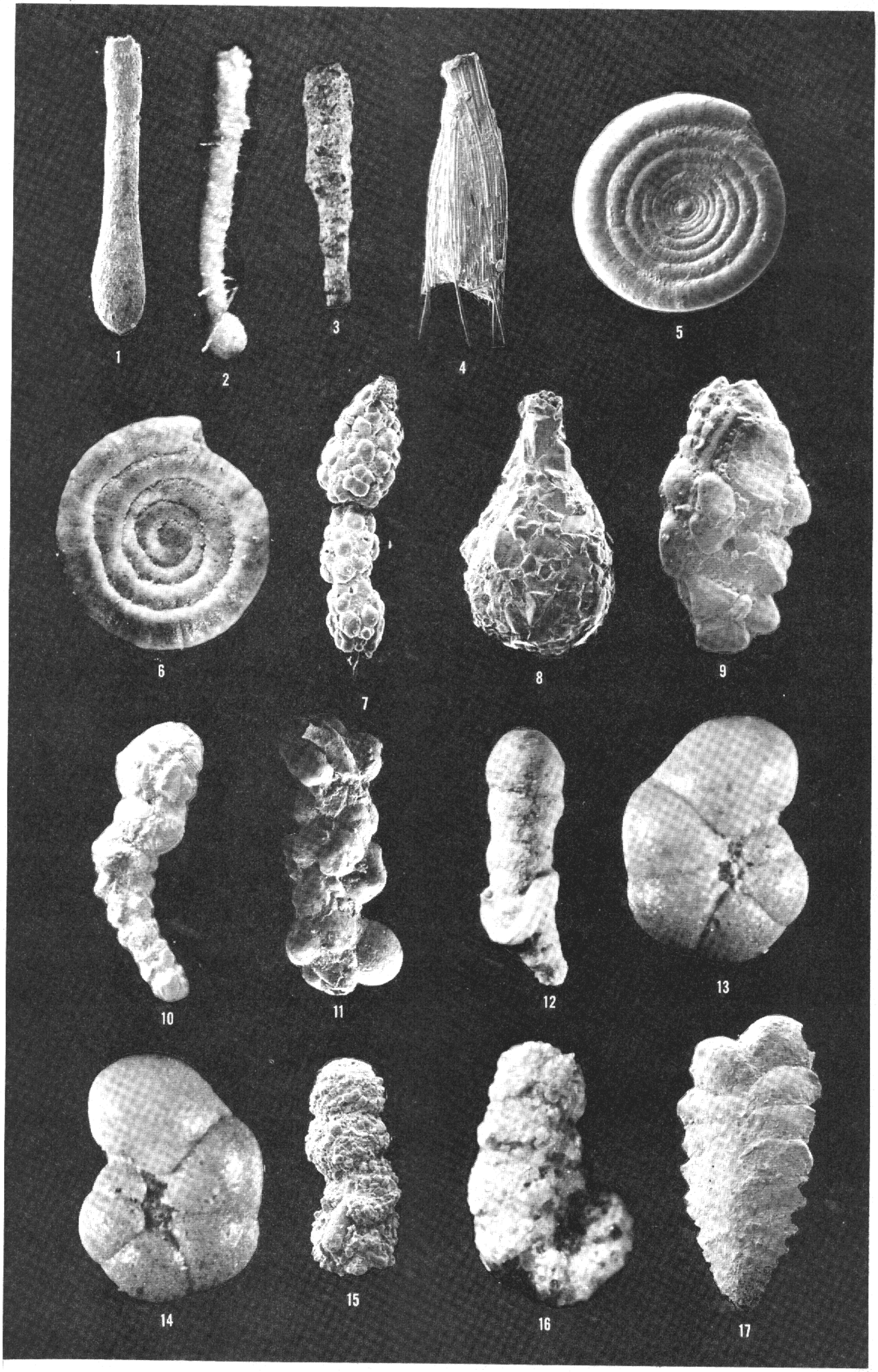

Plate 1. ASTRORHIZIDEA, SACCAMMINIDAE, AMMODISCIDAE, HORMOSINIDAE, LITUOLIDAE, TEXTULARIIDAE.

PLATE 2.

TEXTULARIIDAE, TROCHAMMINIDAE, ATAXOPHRAGMIIDAE.

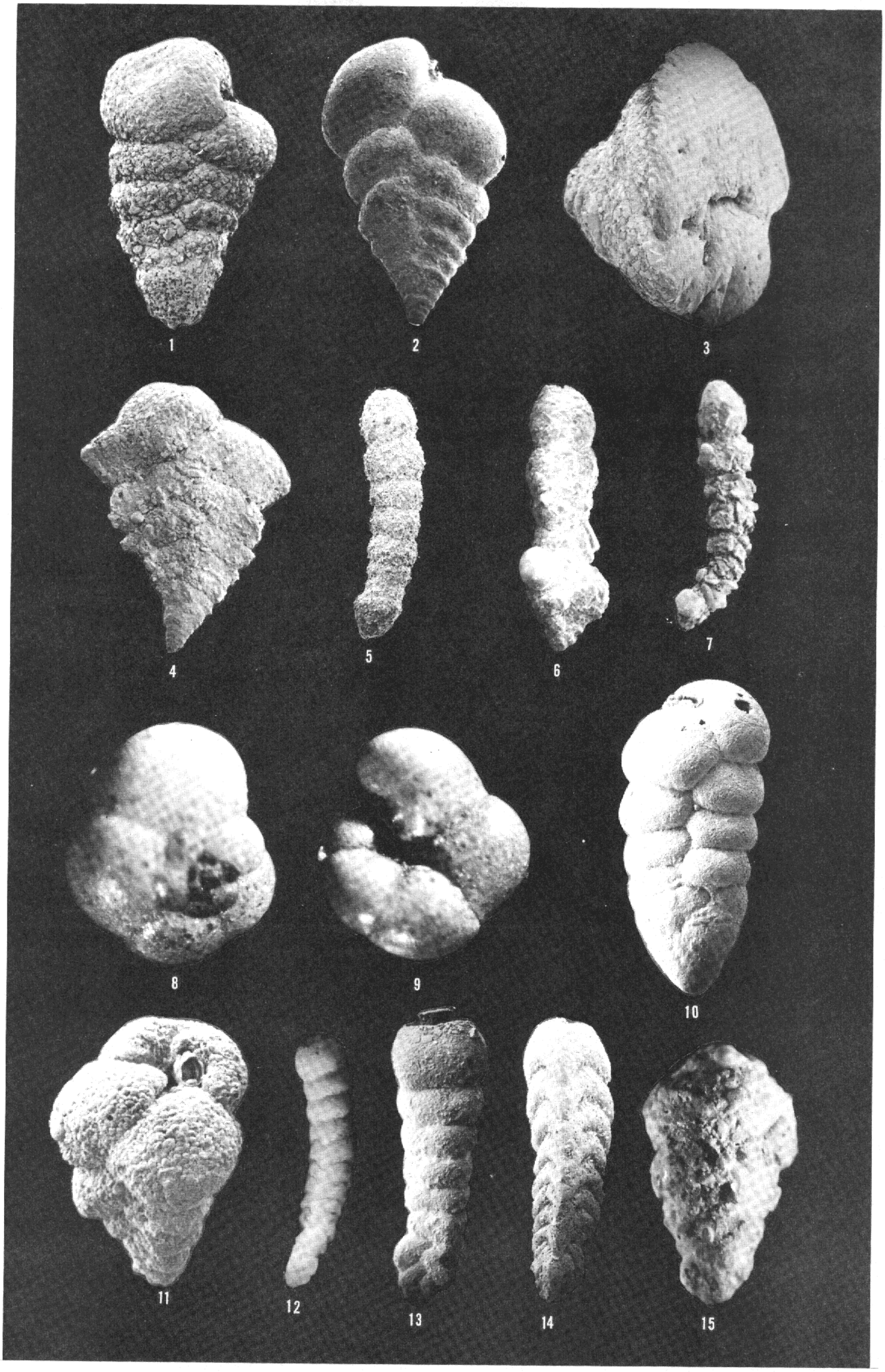

Plate 2. TEXTULARIIDAE, TROCHAMMINIDAE, ATAXOPHRAGMIIDAE.

PLATE 3.

PAVONITIDAE, FISCHERINIDAE, NUBECULARIIDAE.

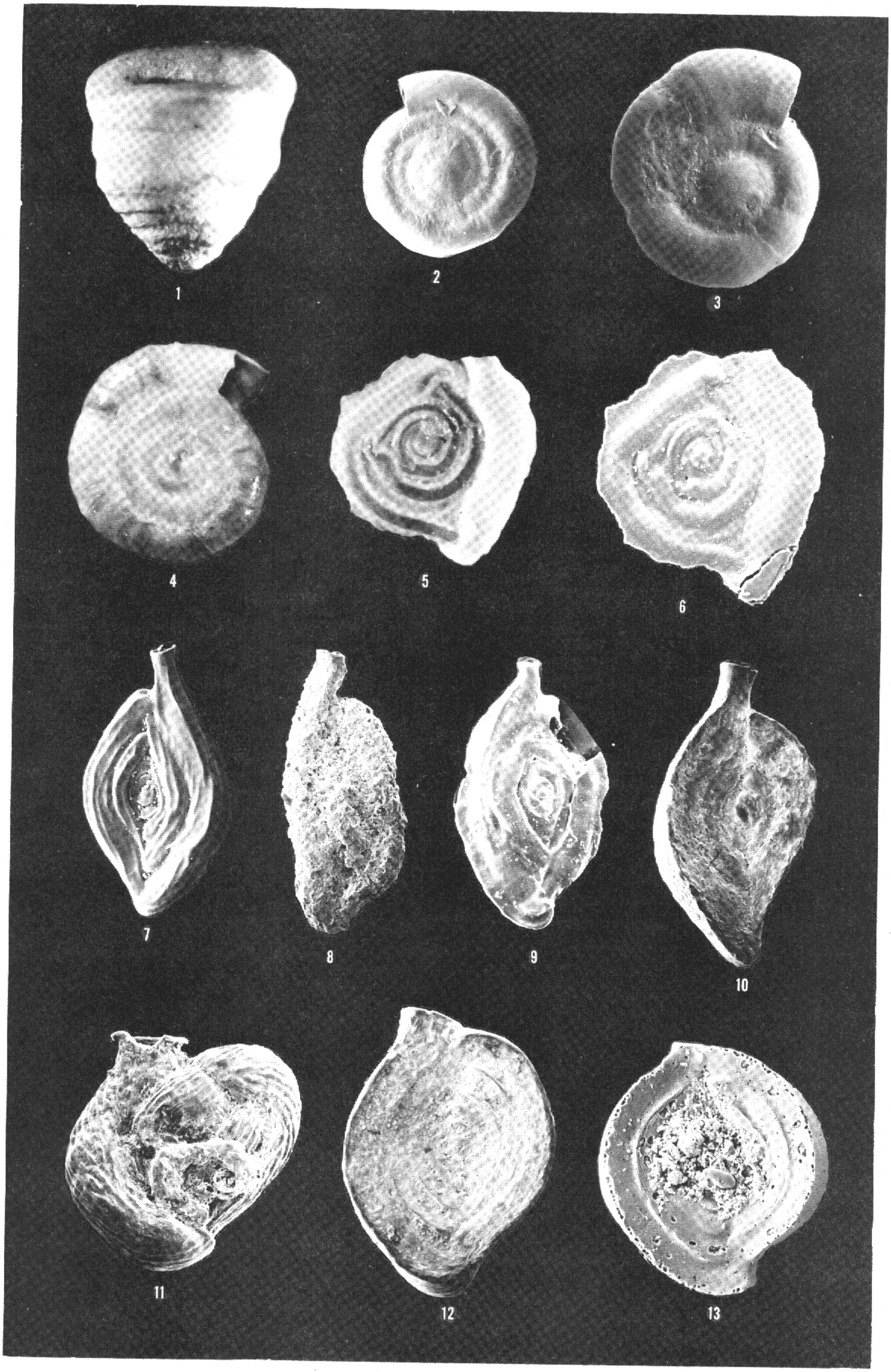

Plate 3. PAVONITIDAE, FISCHERINIDAE, NUBECULARIIDAE.

PLATE 4.

NUBECULARIIDAE, MILIOLIDAE.

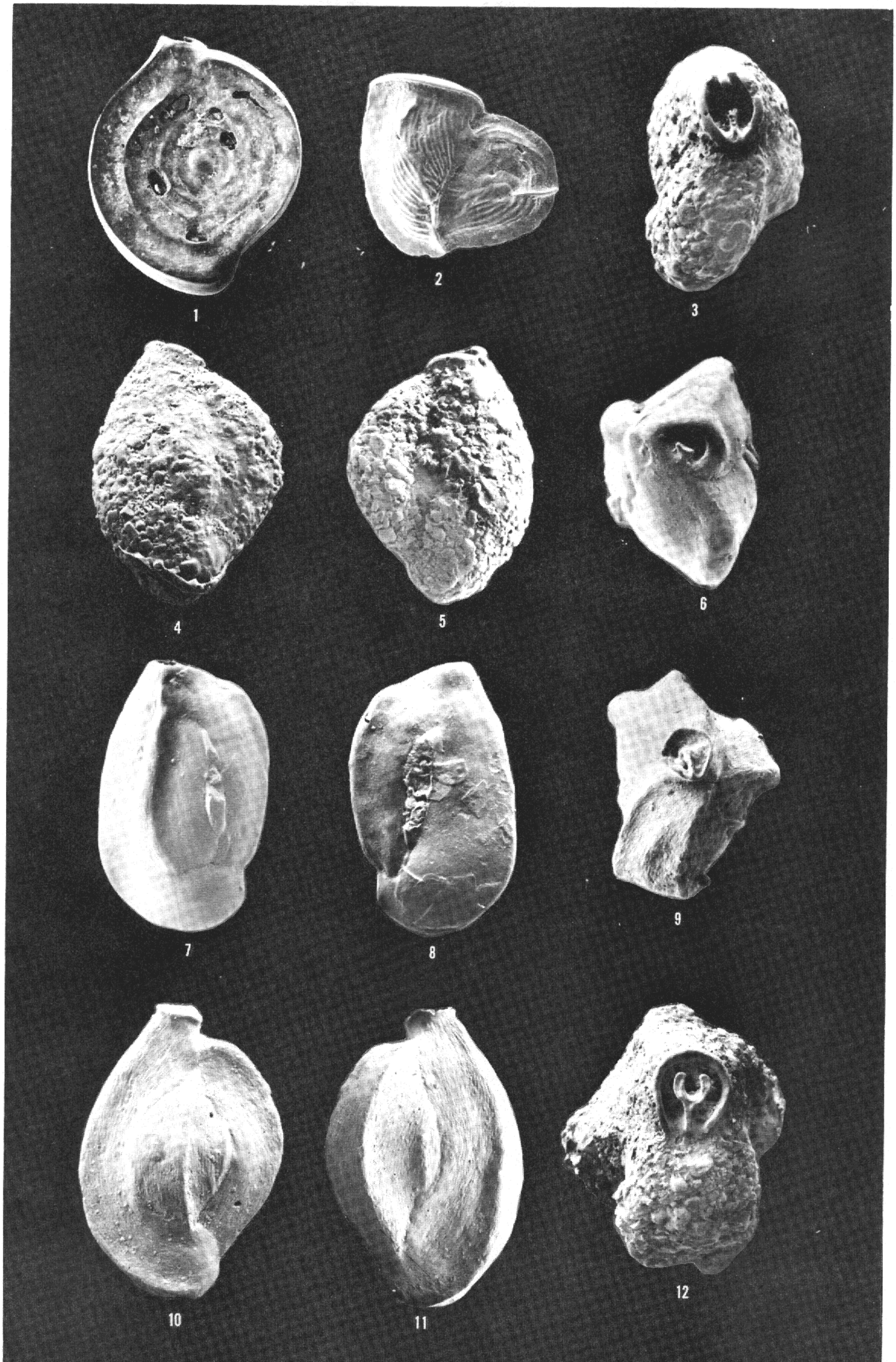

Plate 4. NUBECULARIIDAE, MILIOLIDAE.

PLATE 5.

MILIOLIDAE.

Figure		Page
1,2.	Quinqueloculina bidentata d'Orbigny. U.S. Nat. Mus. No. 643262, SEM, Fig. 1, Side view, X54, Fig. 2, Side view, X50.	17
3-5.	Quinqueloculina bosciana d'Orbigny. U.S. Nat. Mus. No. 643263, SEM, Figs. 3, 4, Side views, X100, Fig. 5, Apertural view, X180.	17
6-8.	Quinqueloculina cf. Q. bradyana Cushman. U.S. Nat. Mus. No. 643264, SEM, Figs. 6, 7, Side views, X32, Fig. 8, Apertural view, X45	17
9-11.	Quinqueloculina collumnosa Cushman. U.S. Nat. Mus. No. 643265, SEM, Fig. 9, Side view, X63, Fig. 10, Side view, X59, Fig. 11, Apertural view, X80	18
12-14.	Quinqueloculina crassa var. subcuneata Cushman. BRC-SMAS No. 143, SEM, Figs. 12, 13, Side views, X36, Fig. 14, Apertural view, X54	18

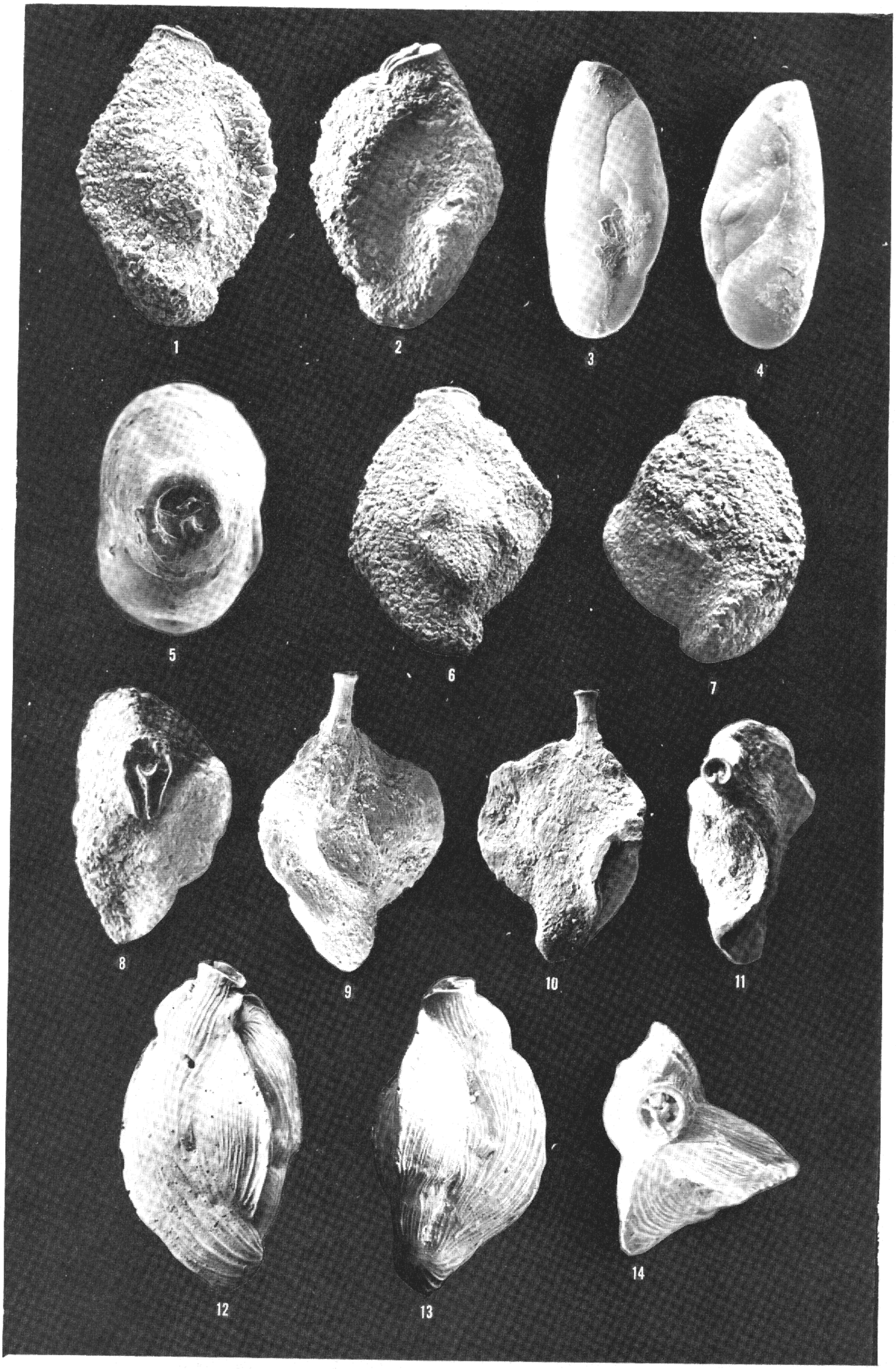

Plate 5. MILIOLIDAE.

PLATE 6.

MILIOLIDAE.

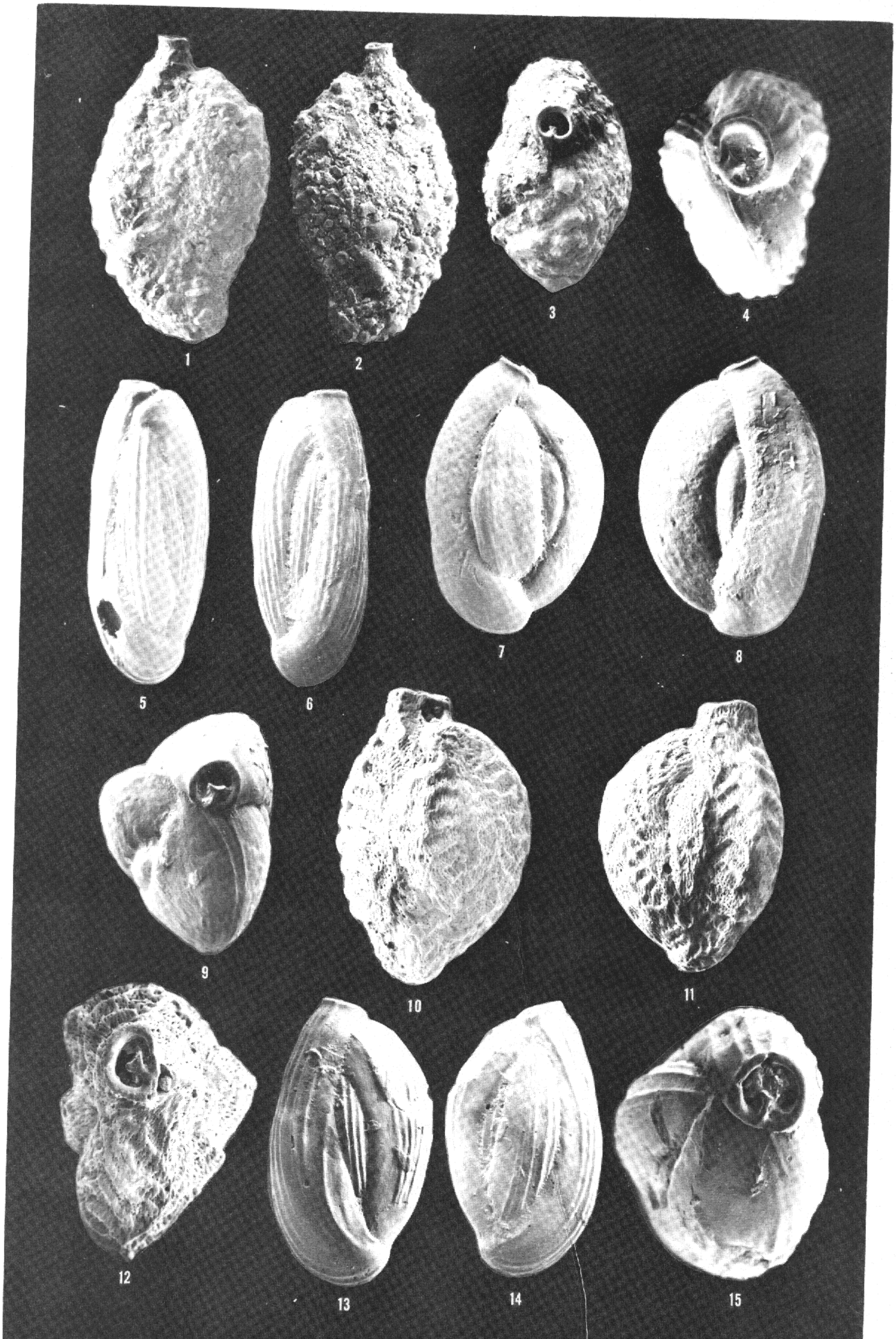

Plate 6. MILIOLIDAE.

PLATE 7.

MILIOLIDAE.

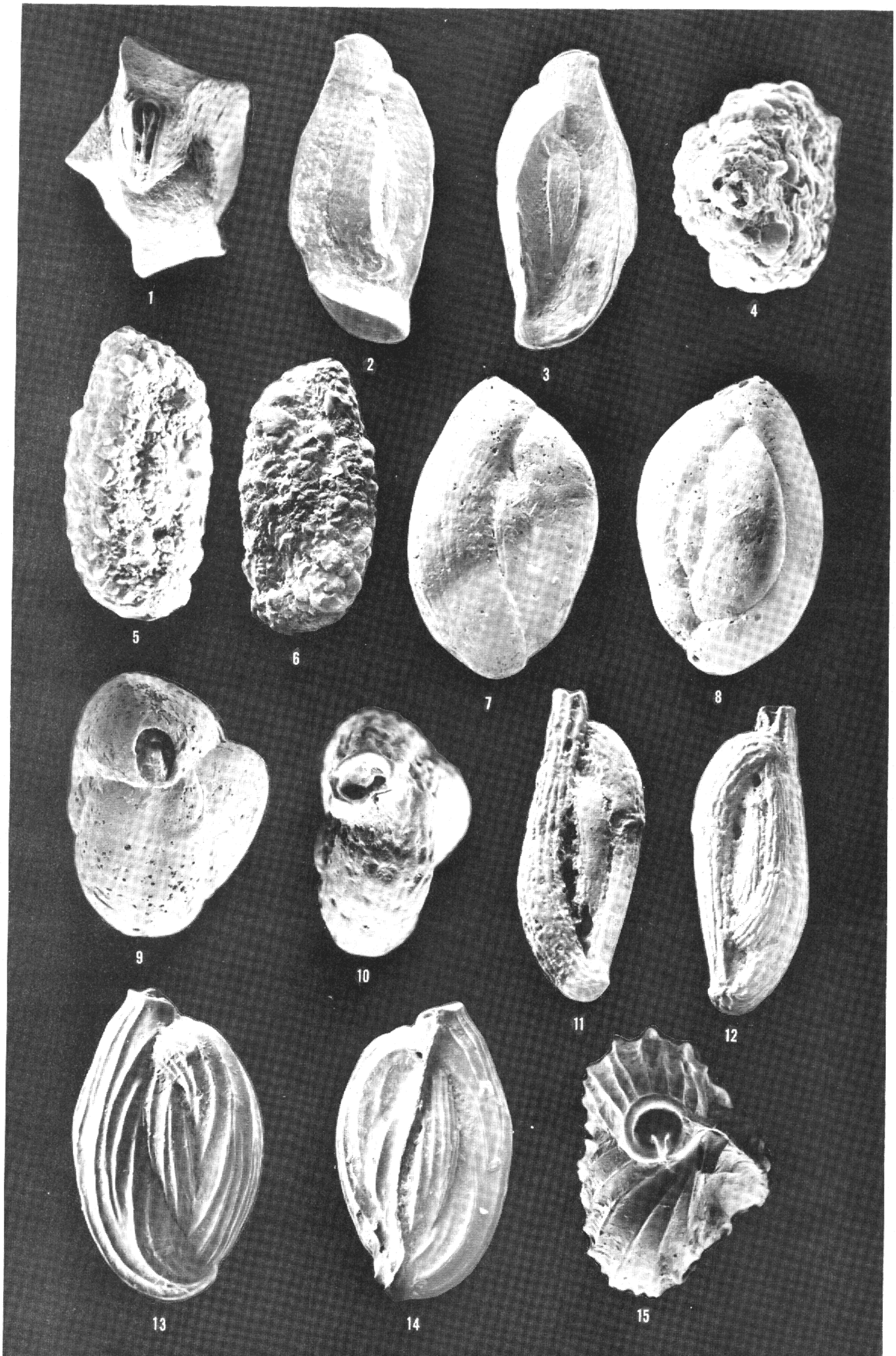

Plate 7. MILIOLIDAE.

PLATE 8.

MILIOLIDAE.

Figure		Page
1,2.	Quinqueloculina tricarinata d'Orbigny. U.S. Nat. Mus. No. 643276, SEM, Fig. 1, Side view, X23, Fig. 2, Apertural view, X63	22
3-5.	Quinqueloculina sp. BRC-SMAS No. 154, SEM, Figs. 3, 4, Side views, X45, Fig. 5, Apertural view, X145	21
6,7.	Cruciloculina triangularis d'Orbigny. BRC-SMAS No. 55, SEM, Fig. 6, Apertural view, X113, Fig. 7, Front view, X78	22
8,9.	Massilina protea Parker. U.S. Nat. Mus. No. 643231, SEM, Fig. 8, Side view, X22, Fig. 9, Apertural view, X54	22
10.	Pyrgo comata (Brady). U.S. Nat. Mus. No. 643252, SEM, Front view, X36	23
11.	Pyrgo denticulata (Brady). U.S. Nat. Mus. No. 643253, SEM, Front view, X40	23
12.	Pyrgo elongata (d'Orbigny). U.S. Nat. Mus. No. 643254, SEM, Front view, X68	23
13.	Pyrgo fornasinii Chapman and Parr. U.S. Nat. Mus. No. 643255, LM, Front view, X14	24
14.	Pyrgo murrhina (Schwager). U.S. Nat. Mus. No. 643256, SEM, Front view, X32	24
15.	Pyrgo subsphaerica (d'Orbigny). U.S. Nat. Mus. No. 643257, SEM, Front view, X80	24

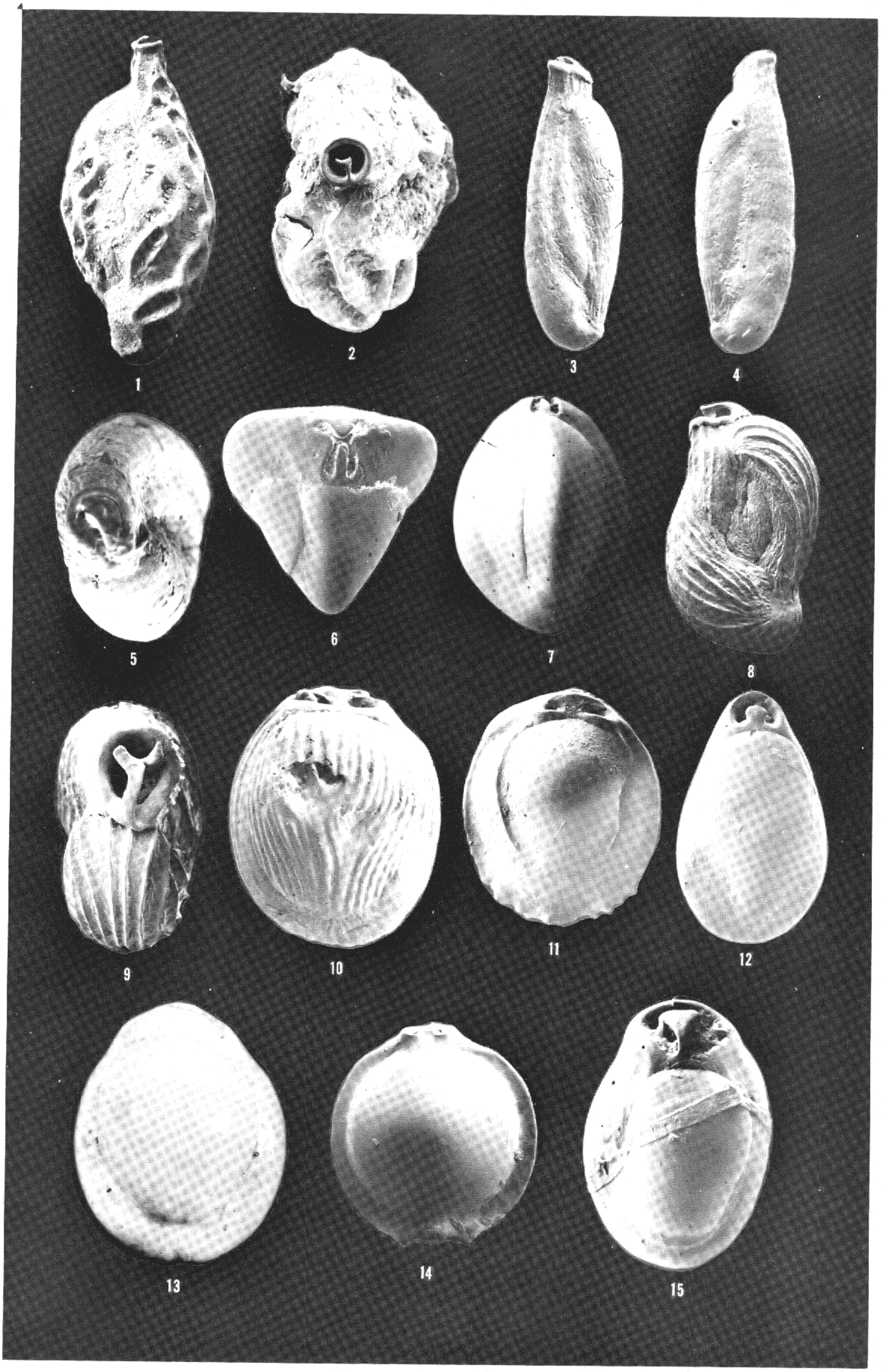

Plate 8. MILIOLIDAE.

PLATE 9.

MILIOLIDAE.

Figure		Page
1,2.	*Sigmoilina schlumbergeri* Silvestri. U.S. Nat. Mus. No. 643285, SEM, Fig. 1, Side view, X59, Fig. 2, Apertural view, X80	25
2-8.	*Triloculina bassensis* Parr. Figs. 3-5, U.S. Nat. Mus. No. 643305, Figs. 6-8, BRC-SMAS No. 207, SEM, Figs. 3, 4, Side views, X68, Fig. 5, Apertural view, X85, Fig. 6, Apertural view, X180, Figs. 7, 8, Side views, X63	25
9-11.	*Triloculina bermudezi* Acosta. U.S. Nat. Mus. No. 643306, SEM, Figs. 9, 10, Side views, X90, Fig. 11, Apertural view, X200	25
12,13.	*Triloculina bicarinata* d'Orbigny. U.S. Nat. Mus. No. 643307, SEM, Side views, X32	25

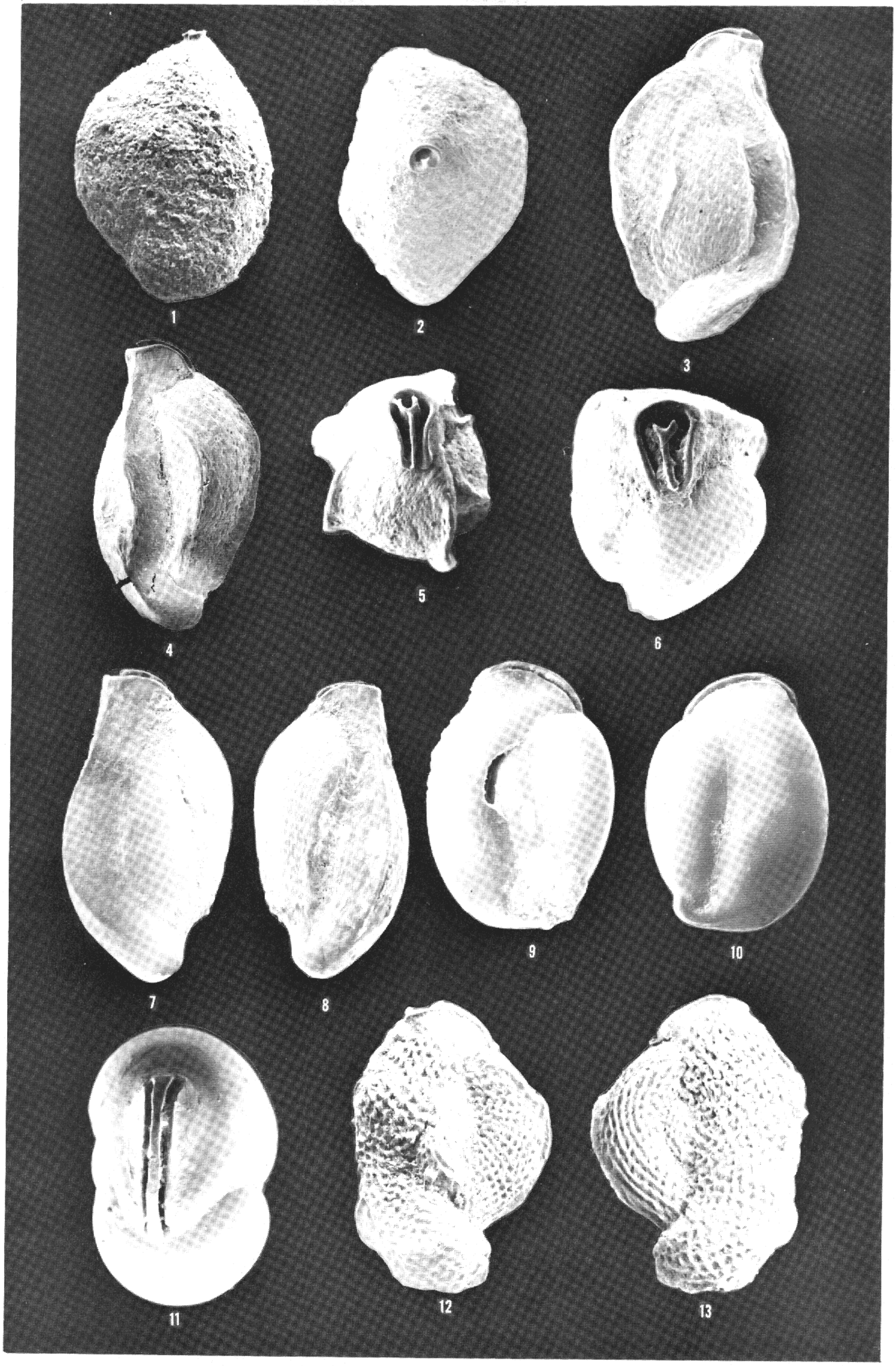

Plate 9. MILIOLIDAE.

PLATE 10.

MILIOLIDAE.

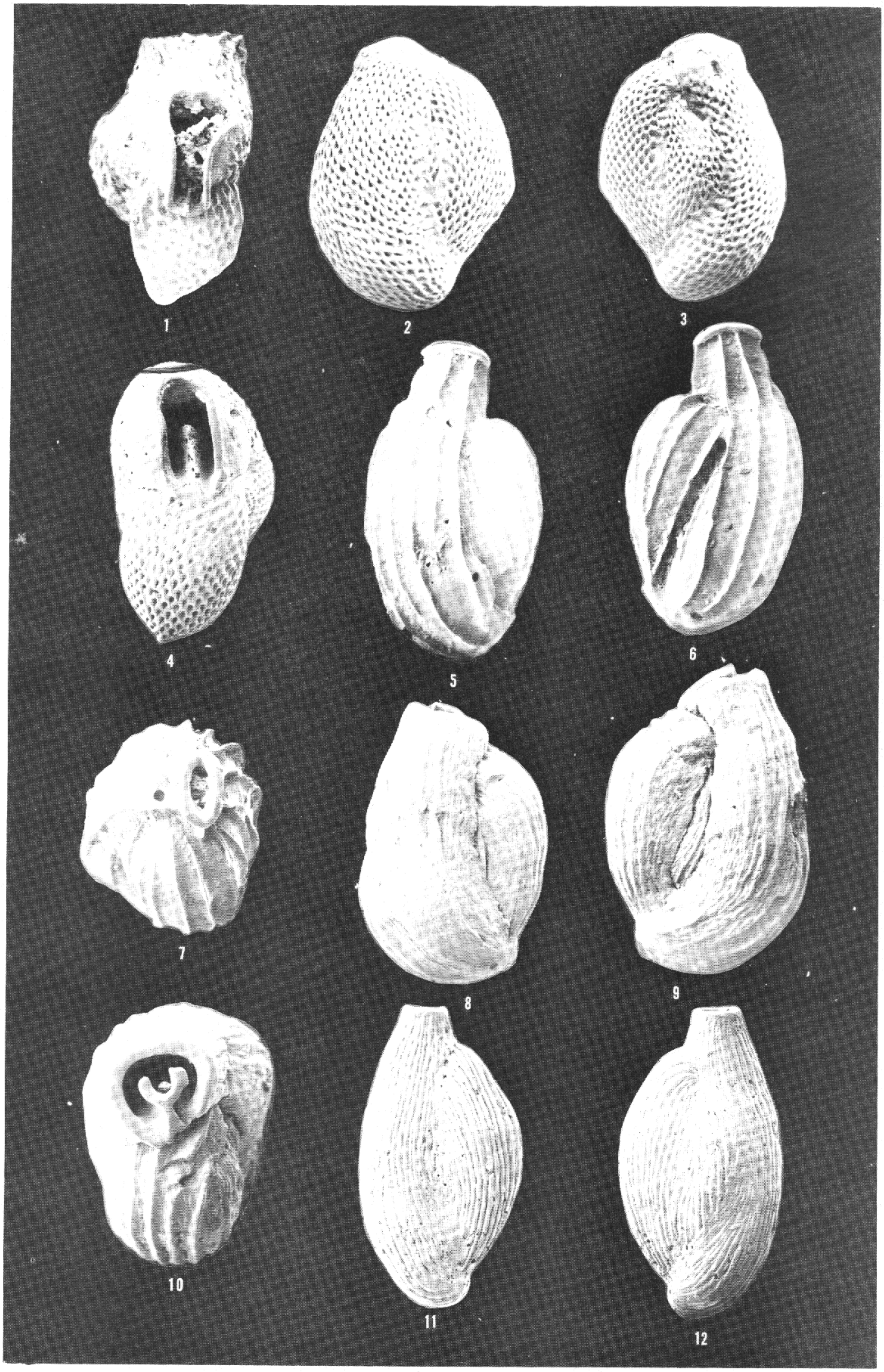

Plate 10. MILIOLIDAE.

PLATE 11.

MILIOLIDAE.

Figure		Page
1.	*Triloculina linneiana* var. *comis* Bandy. U.S. Nat. Mus. No. 643311, SEM, Apertural view, X85.	27
2-4.	*Triloculina oblonga* (Montague). U.S. Nat. Mus. No. 643312, SEM, Figs. 2, 3, Side views, X52, Fig. 4, Apertural view, X80.	27
5-7.	*Triloculina planciana* d'Orbigny. U.S. Nat. Mus. No. 643313, SEM, Fig. 5, Apertural view, X80, Figs. 6, 7, Side views, X50.	27
8-10.	*Triloculina rotunda* d'Orbigny. U.S. Nat. Mus. No. 643314, LM, Figs. 8, 9, Side views, X45, Fig. 10, Apertural view, X45	27
11-13.	*Triloculina sidebottomi* (Martinotti). U.S. Nat. Mus. No. 643315, LM, Figs. 11, 12, Side views, X45, Fig. 13, Apertural view, X45	28

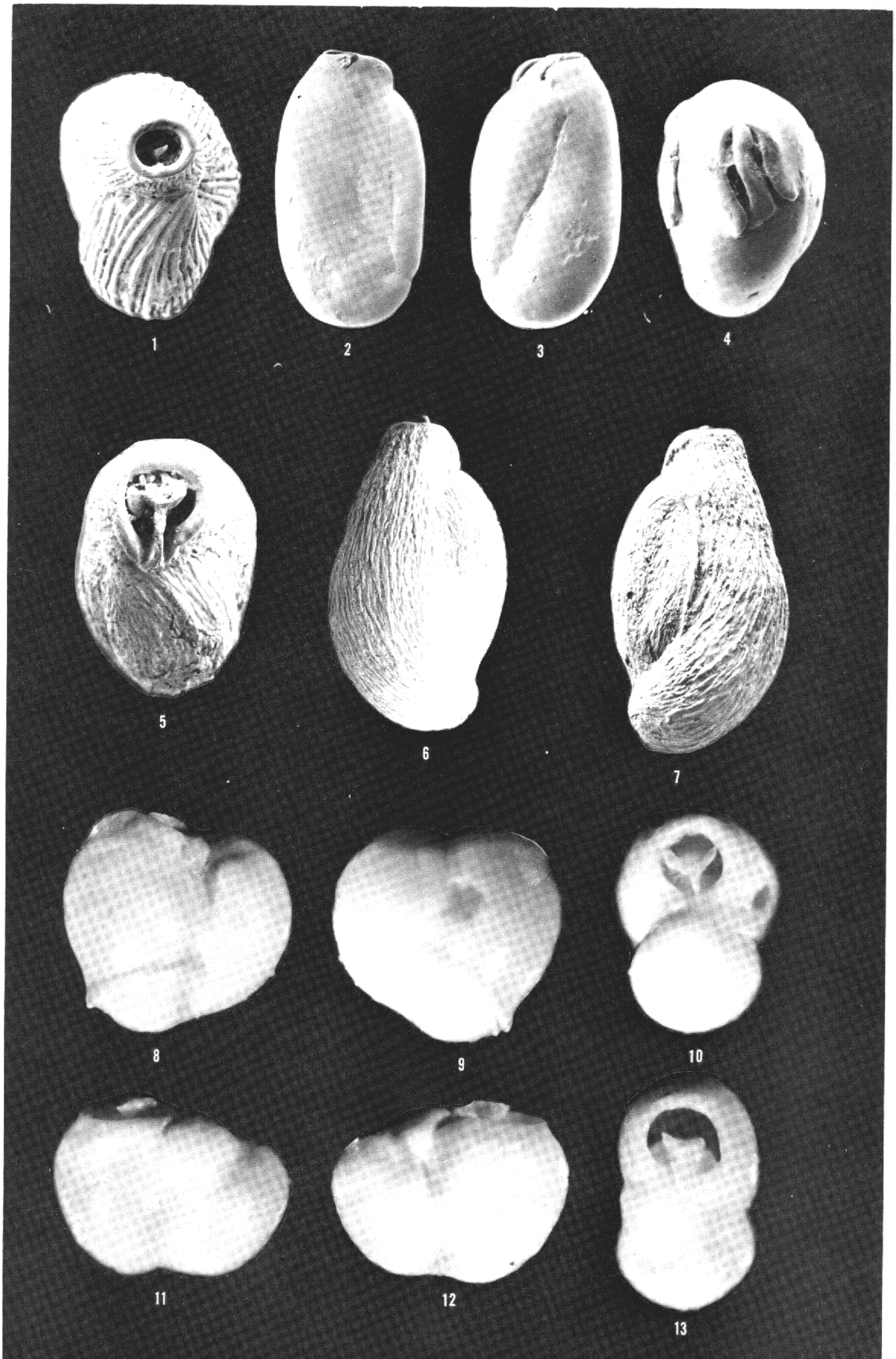

Plate 11. MILIOLIDAE.

PLATE 12.

MILIOLIDAE.

Figure | Page

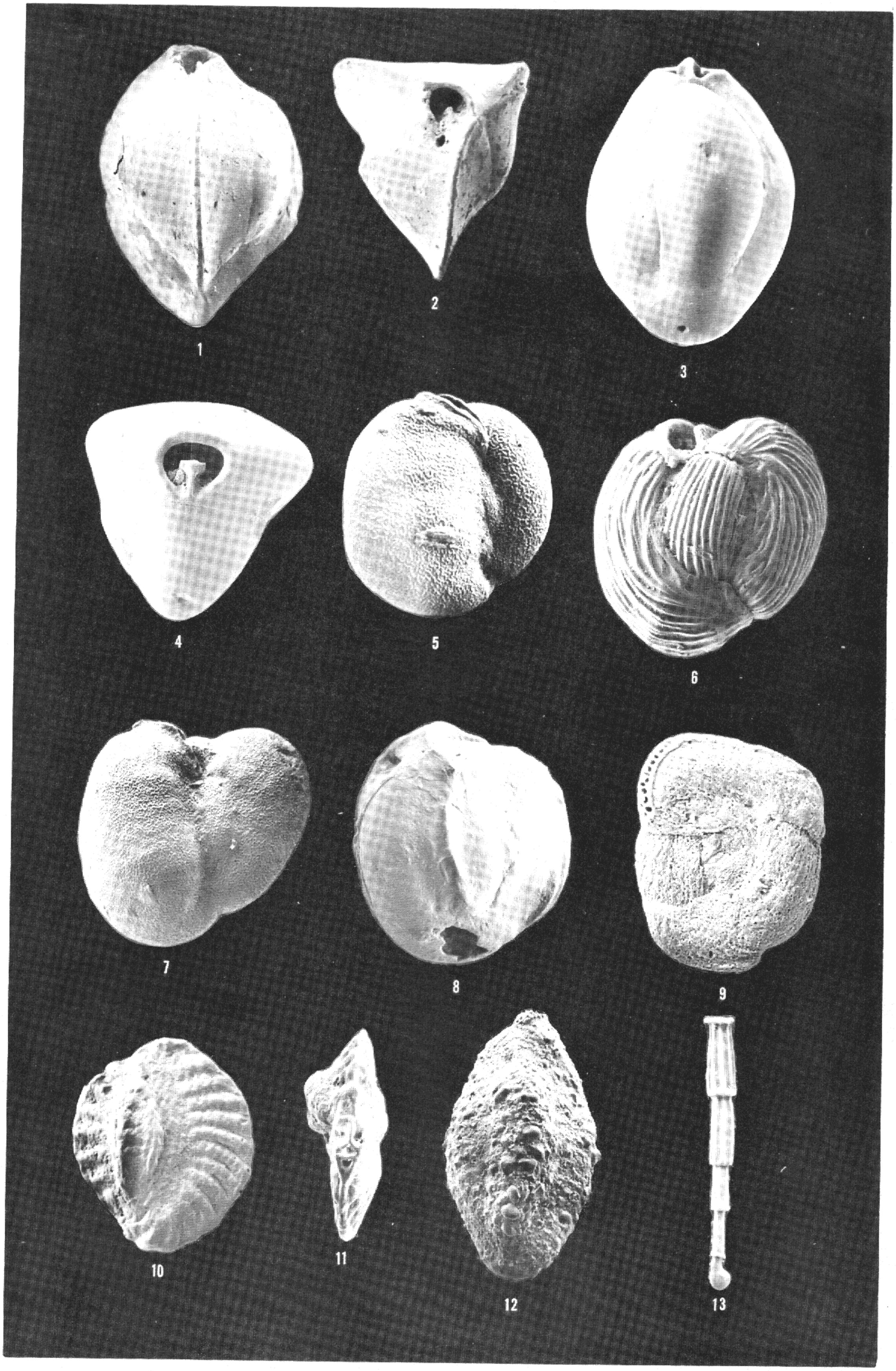

Plate 12. MILIOLIDAE.

PLATE 13.

MILIOLIDAE, SORITIDAE.

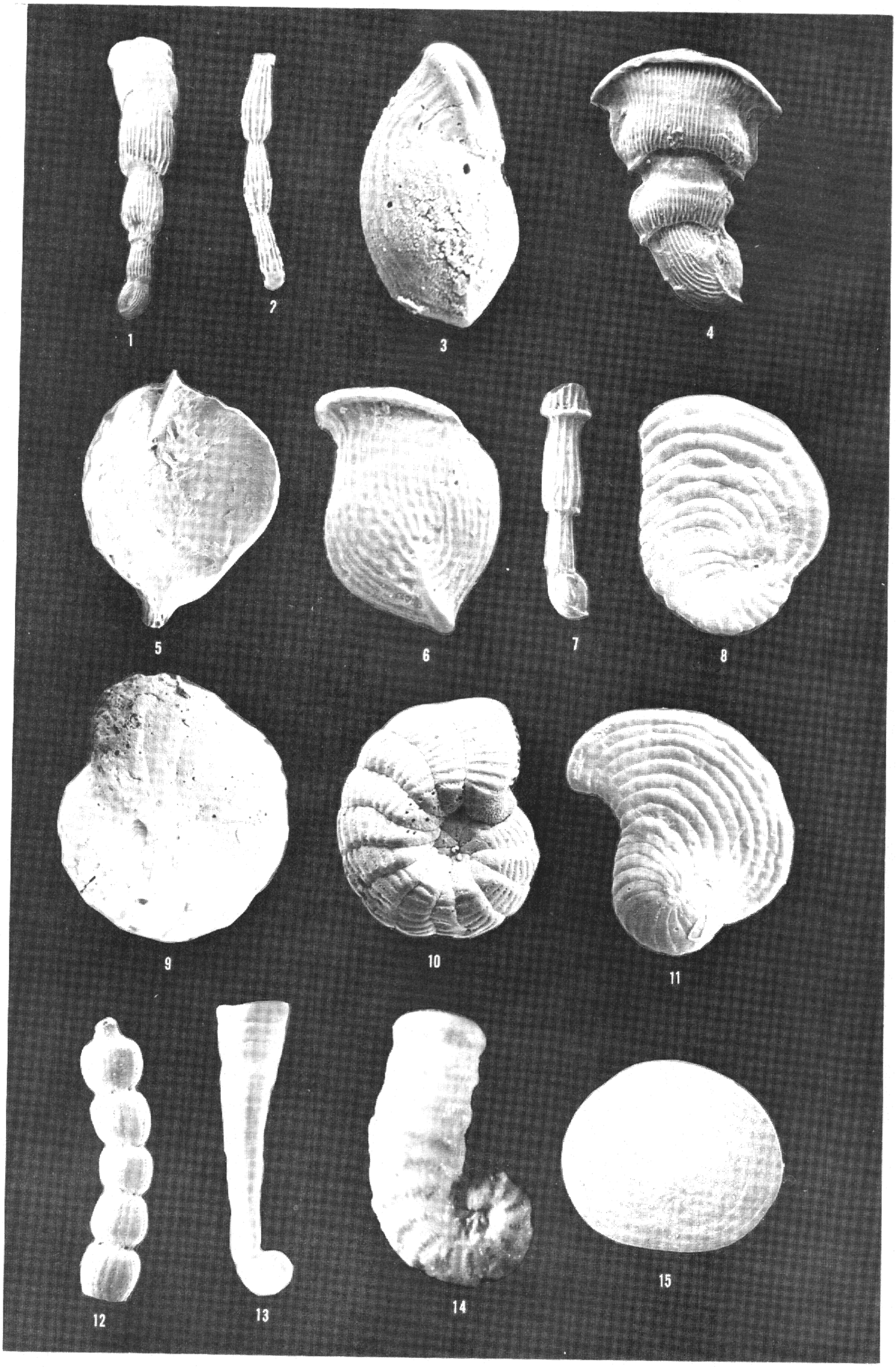

Plate 13. MILIOLIDAE, SORITIDAE.

PLATE 14.

SORITIDAE, ALVEOLINIDAE, NODOSARIIDAE.

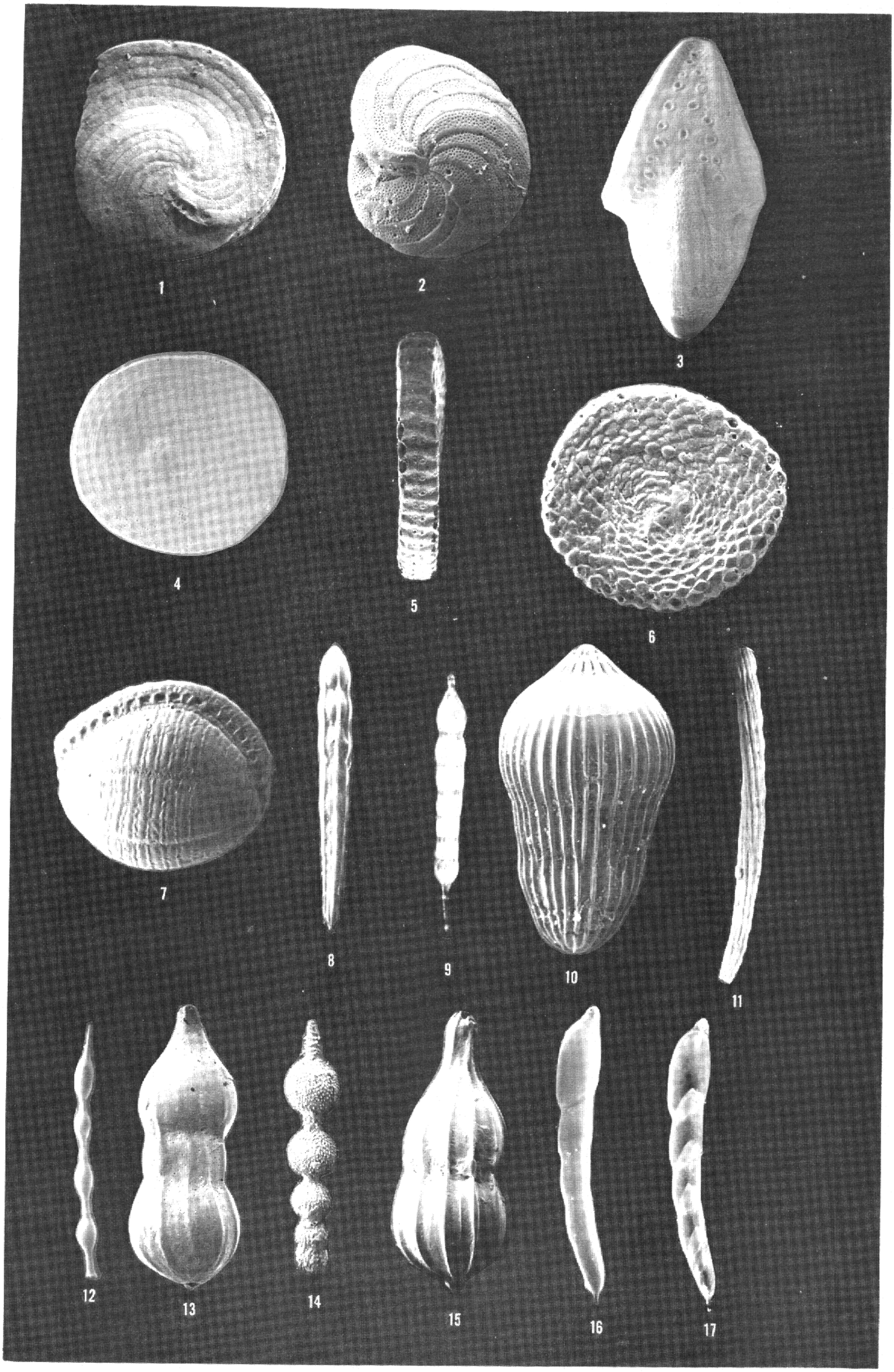

Plate 14. SORITIDAE, ALVEOLINIDAE, NODOSARIIDAE.

PLATE 15.

NODOSARIIDAE.

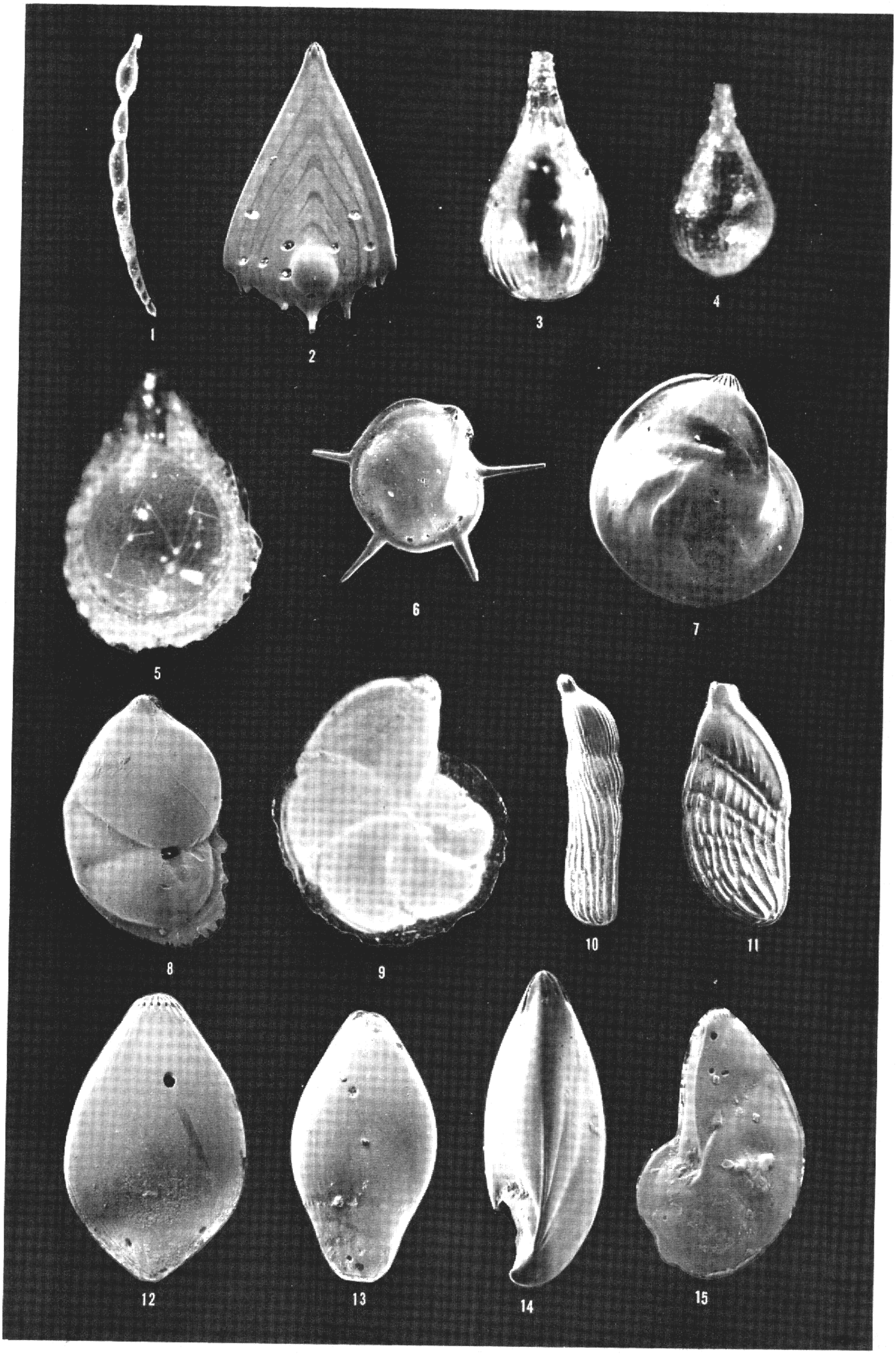

Plate 15. NODOSARIIDAE.

PLATE 16.

POLYMORPHINIDAE, GLANDULINIDAE, TURRILINIDAE, BOLIVINITIDAE.

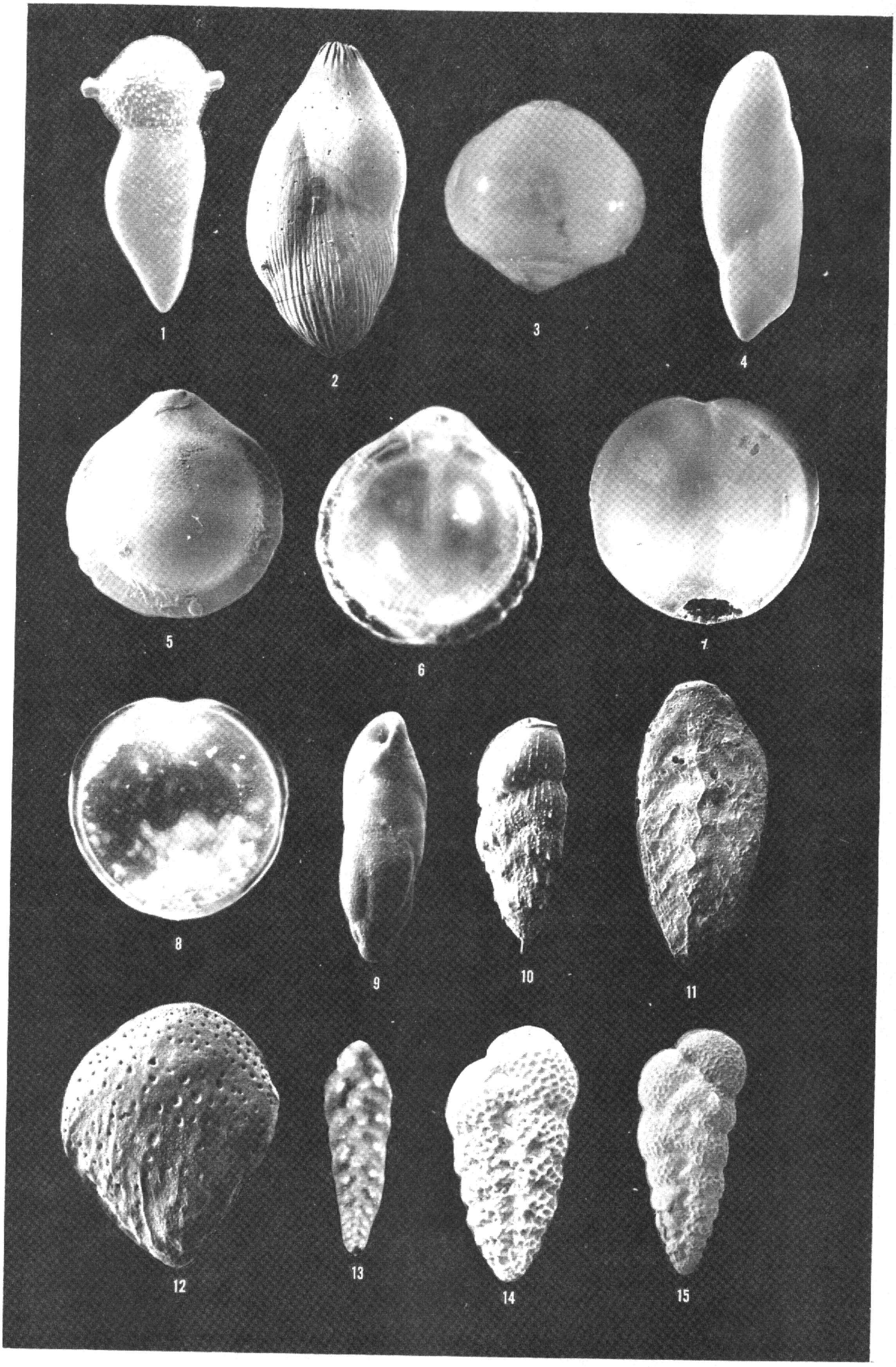

Plate 16. POLYMORPHINIDAE, GLANDULINIDAE, TURRILINIDAE, BOLIVINITIDAE.

PLATE 17.

BOLIVINITIDAE, ISLANDIELLIDAE, BULIMINIDAE, UVIGERINIDAE, DISCORBIDAE.

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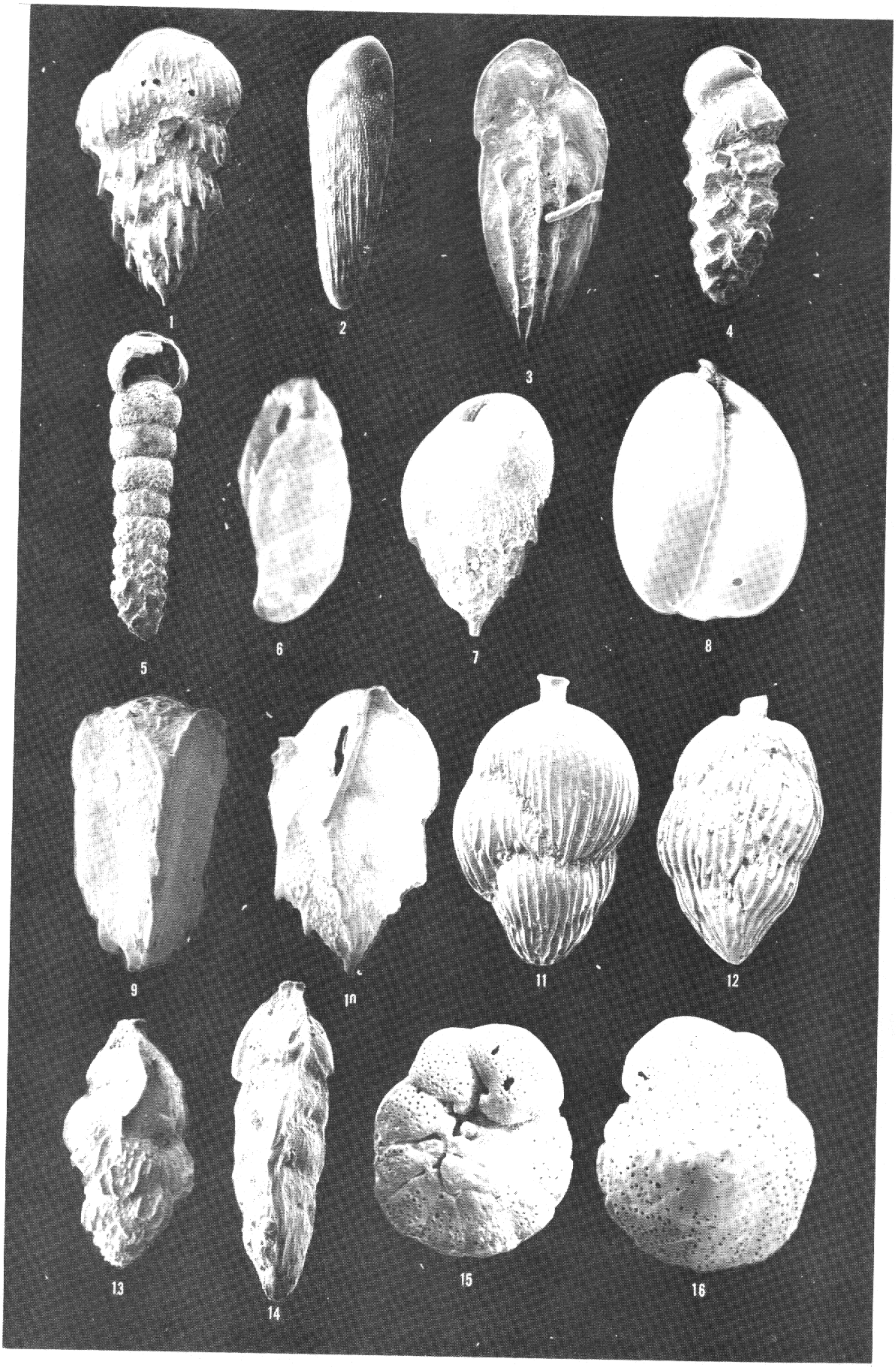

Plate 17. BOLIVINITIDAE, ISLANDIELLIDAE, BULIMINIDAE, UVIGERINIDAE, DISCORBIDAE.

PLATE 18.

DISCORBIDAE.

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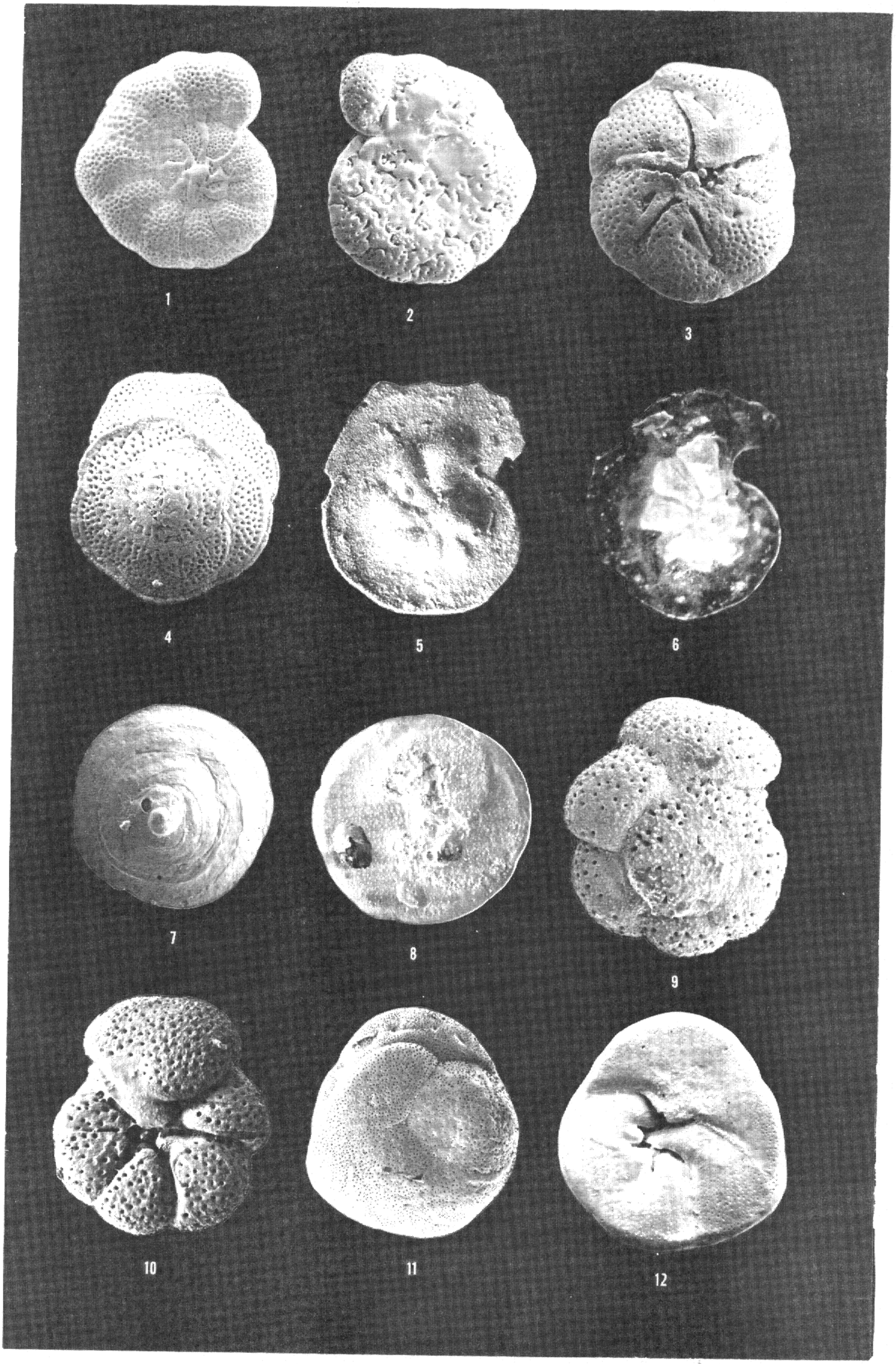

Plate 18. DISCORBIDAE.

PLATE 19.

DISCORBIDAE, SIPHONINIDAE, ASTERIGERINIDAE.

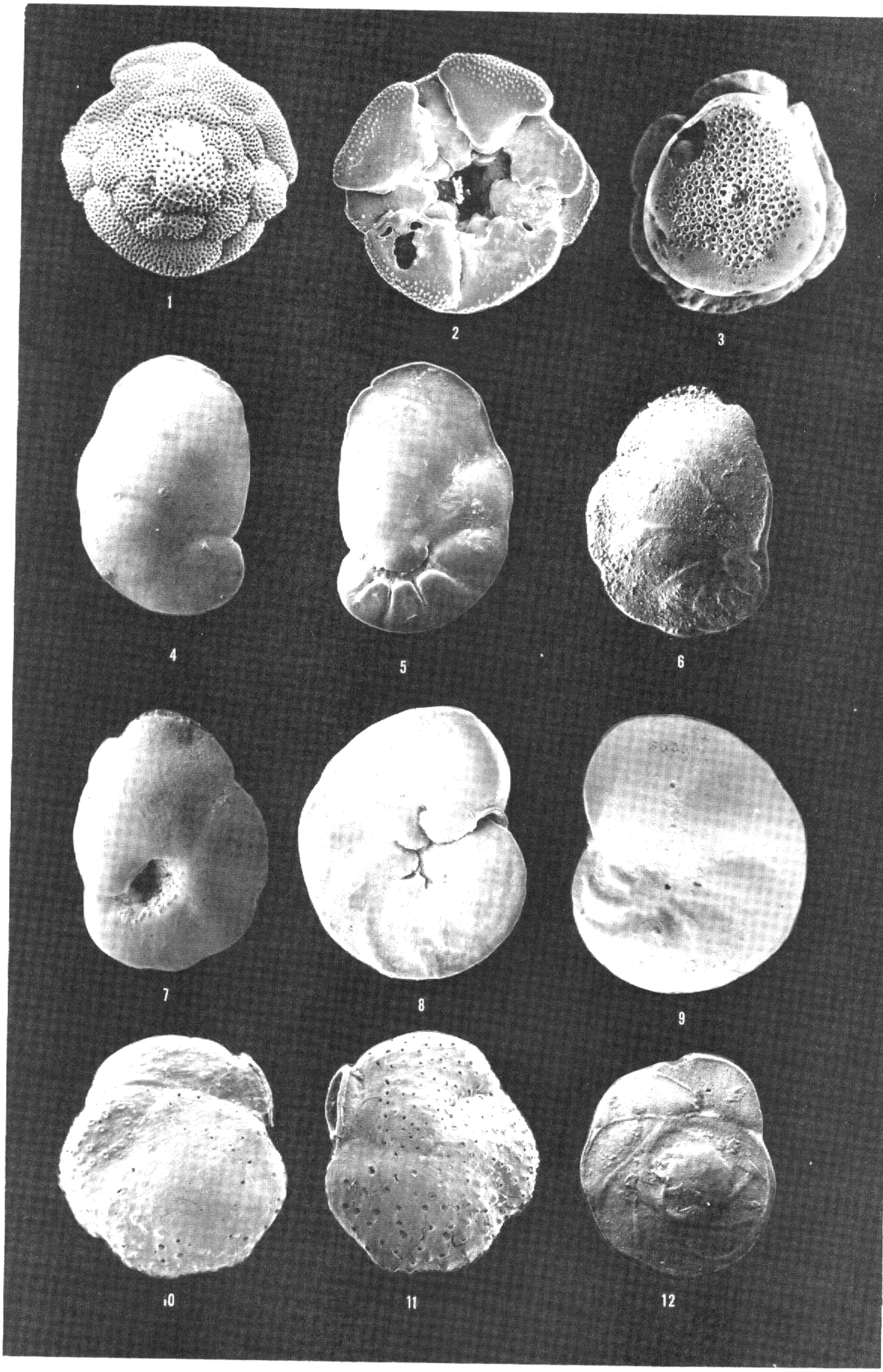

Plate 19. DISCORBIDAE, SIPHONINIDAE, ASTERIGERINIDAE.

PLATE 20.

ASTERIGERINIDAE, SPIRILLINIDAE, ROTALIIDAE, ELPHIDIIDAE.

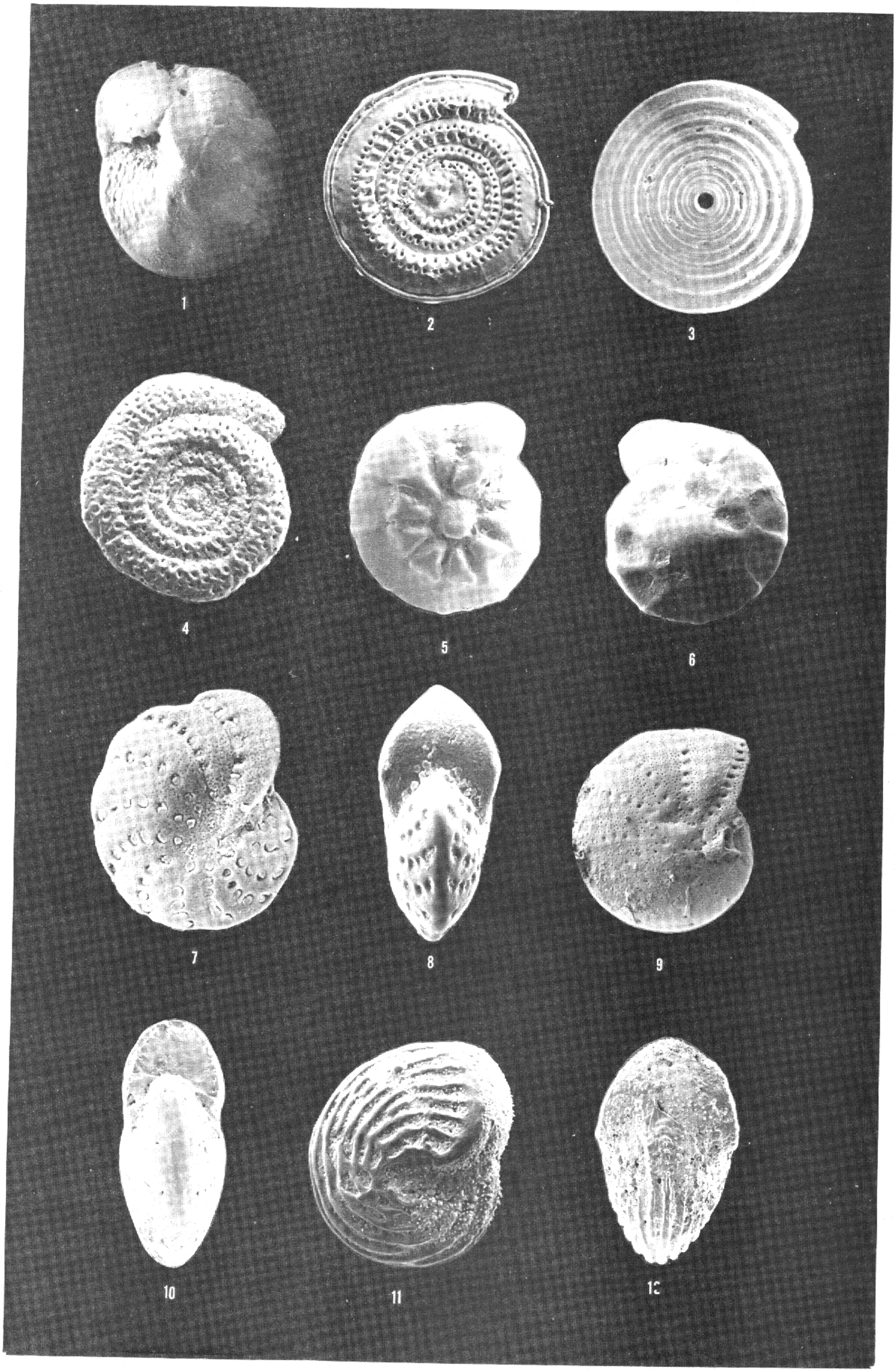

Plate 20. ASTERIGERINIDAE, SPIRILLINIDAE, ROTALIIDAE, ELPHIDIIDAE.

PLATE 21.

ELPHIDIIDAE, NUMMULITIDAE, EPONIDIDAE, AMPHISTEGINIDAE, CIBICIDIDAE.

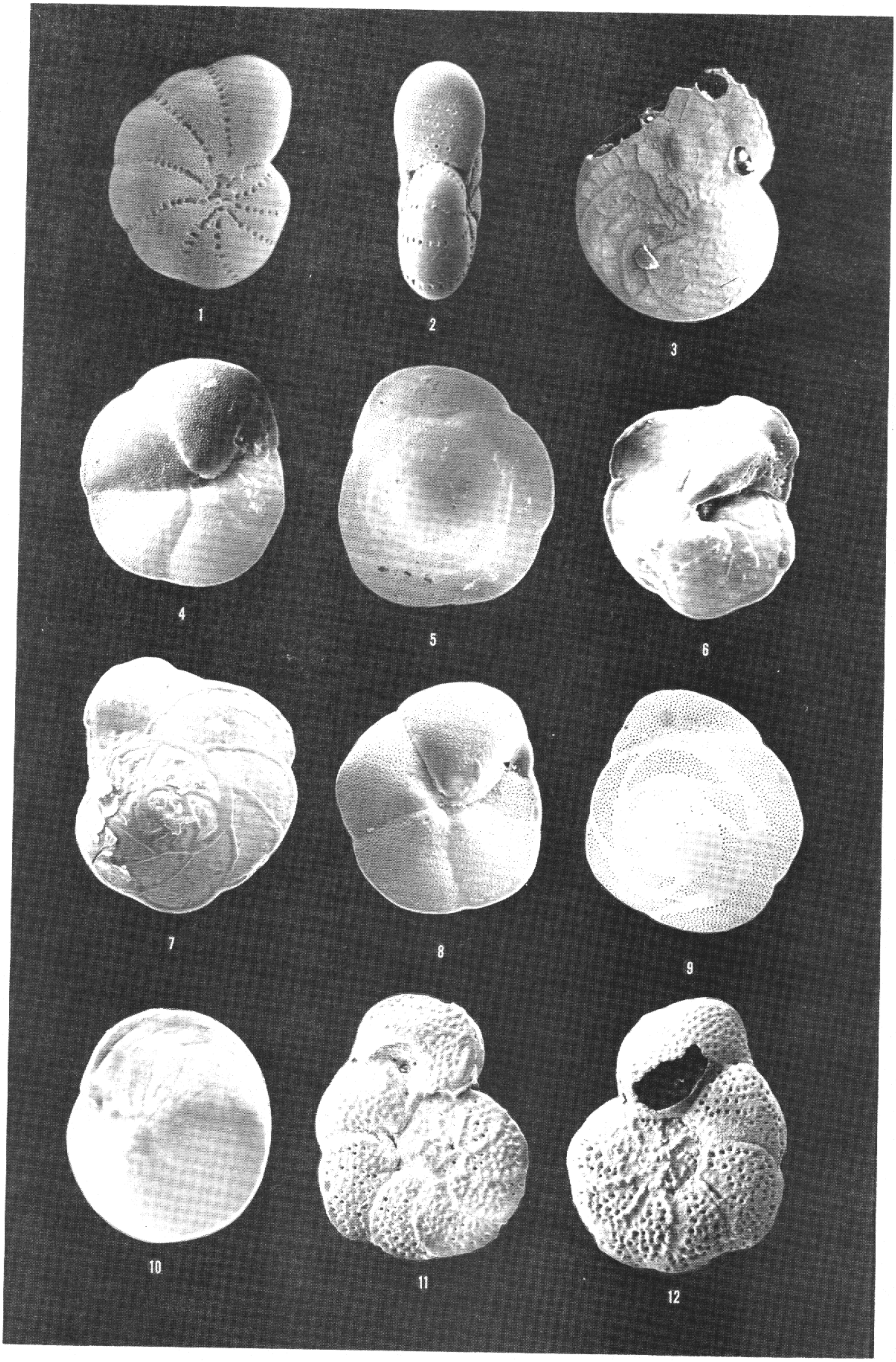

Plate 21. ELPHIDIIDAE, NUMMULITIDAE, EPONIDIDAE, AMPHISTEGINIDAE, CIBICIDIDAE.

PLATE 22.

CIBICIDIDAE, PLANORBULINIDAE.

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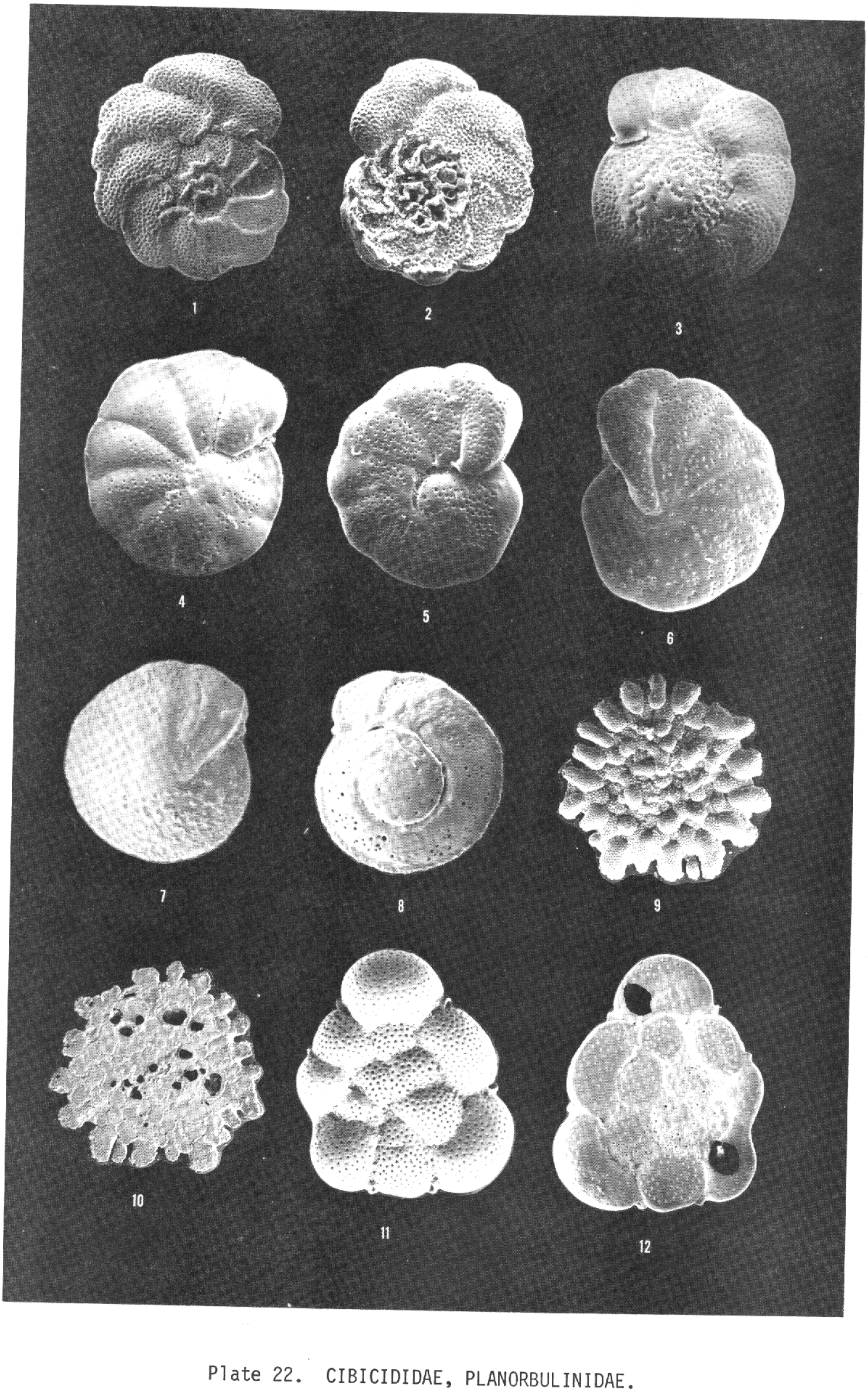

Plate 22. CIBICIDIDAE, PLANORBULINIDAE.

PLATE 23.

CYMBALOPORIDAE, HOMOTREMATIDAE, PLEUROSTOMELLIDAE, CAUCASINIDAE, LOXOSTOMATIDAE, CASSIDULINIDAE, NONIONIDAE.

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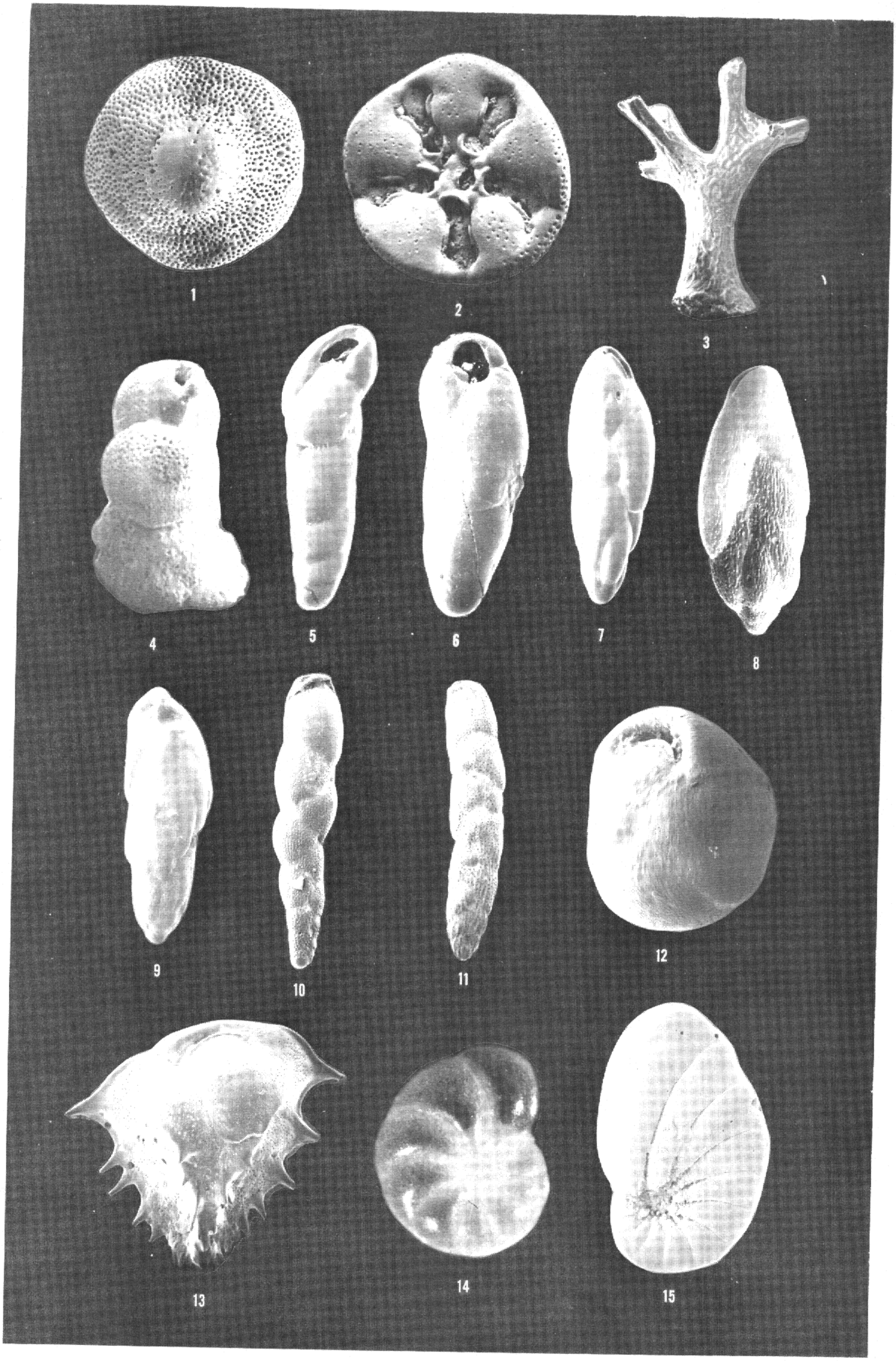

Plate 23. CYMBALOPORIDAE, HOMOTREMATIDAE, PLEUROSTOMELLIDAE, CAUCASINIDAE, LOXOSTOMATIDAE, CASSIDULINIDAE, NONIONIDAE.

PLATE 24.

NONIONIDAE, OSANGULARIIDAE, ANOMALINIDAE, CERATOBULIMINIDAE, ROBERTINIDAE.

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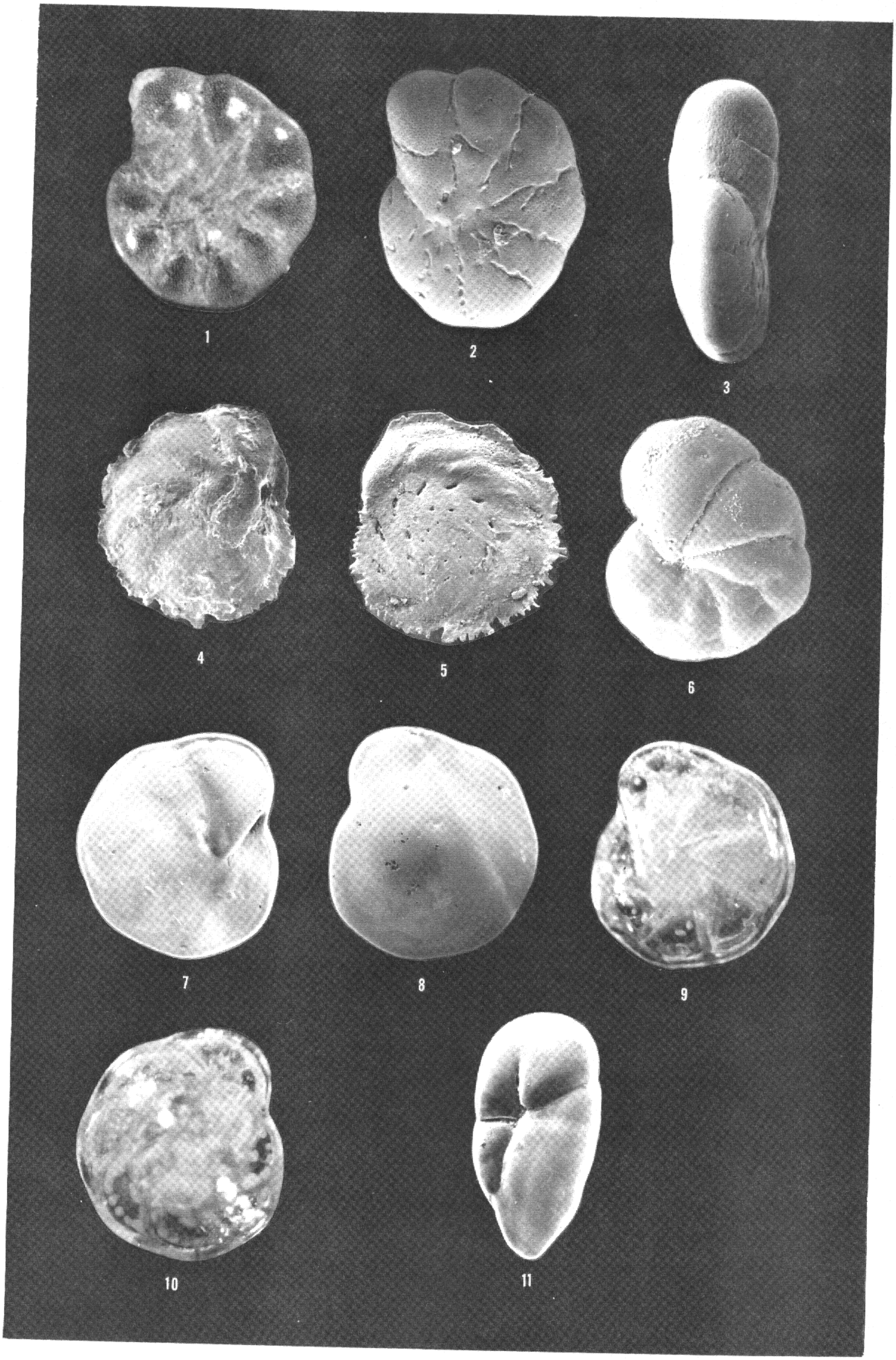

Plate 24. NONIONIDAE, OSANGULARIIDAE, ANOMALINIDAE, CERATOBULIMINIDAE, ROBERTINIDAE.

PLATE 25.

HANTKENINIDAE, GLOBIGERINIDAE.

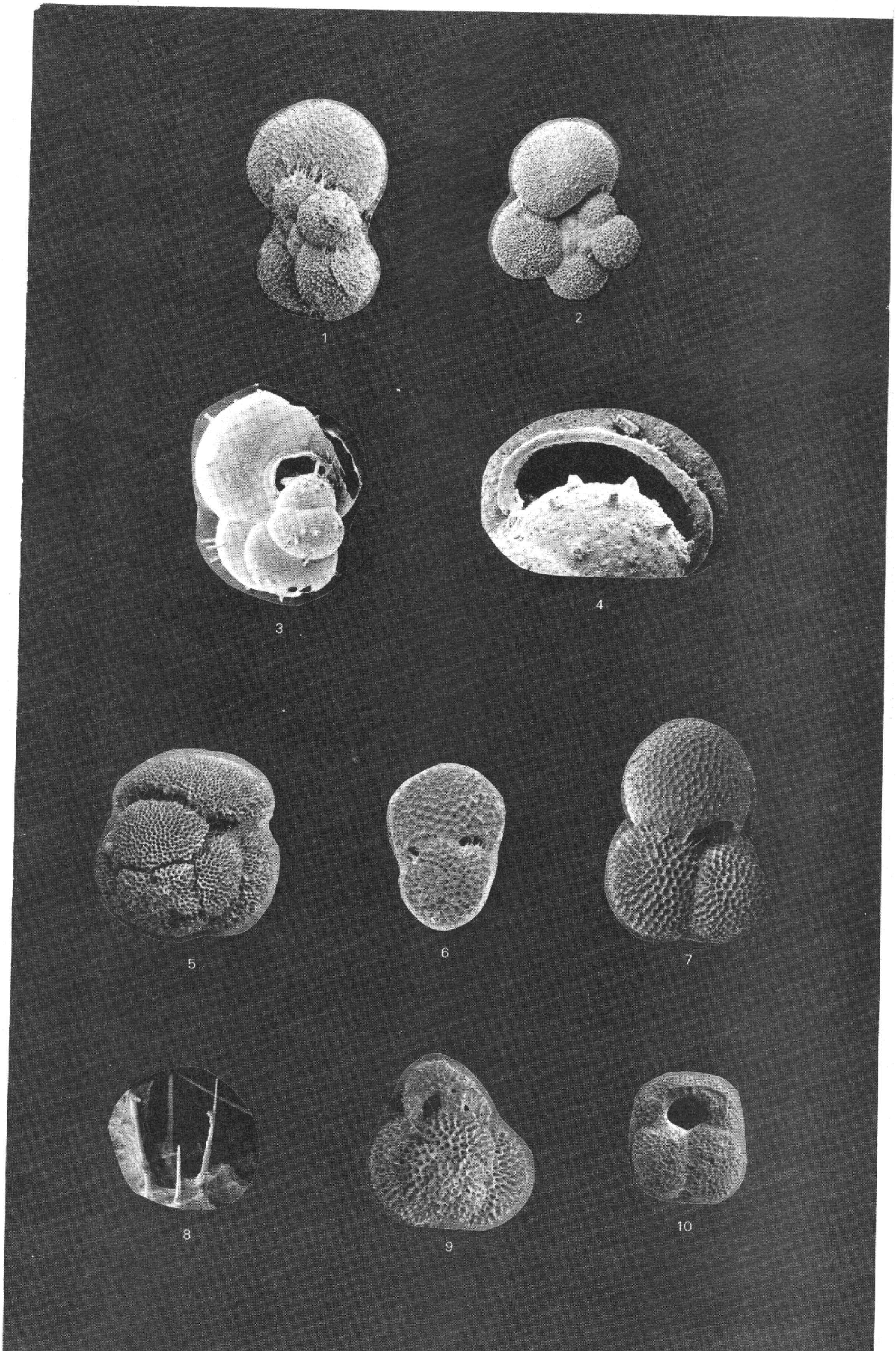

Plate 25. HANTKENINIDAE, GLOBIGERINIDAE.

PLATE 26.

GLOBIGERINIDAE, GLOBOROTALIDAE.

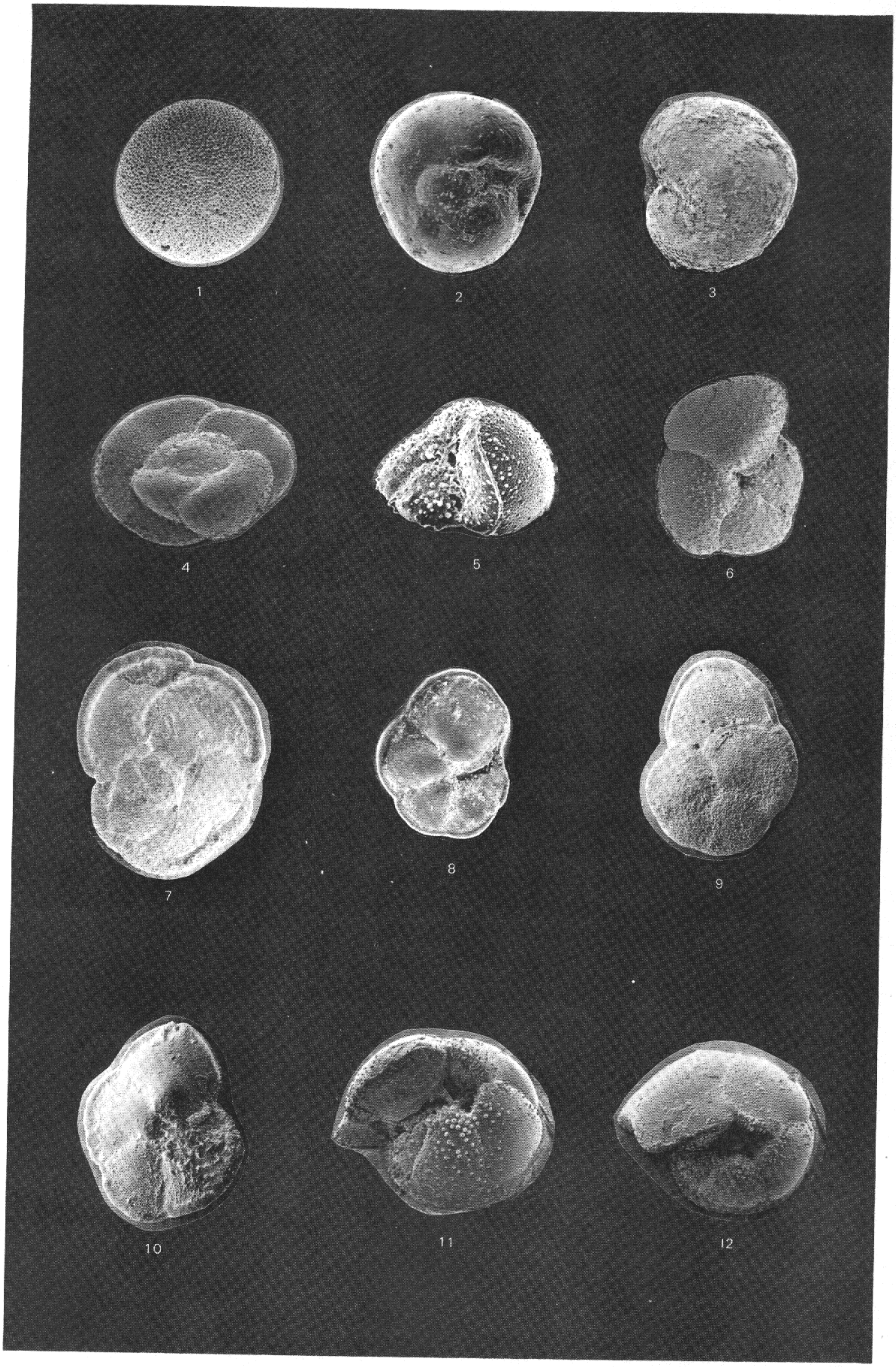

Plate 26. GLOBIGERINIDAE, GLOBOROTALIDAE.

PLATE 27.

GLOBOROTALIDAE, GLOBIGERINIDAE.

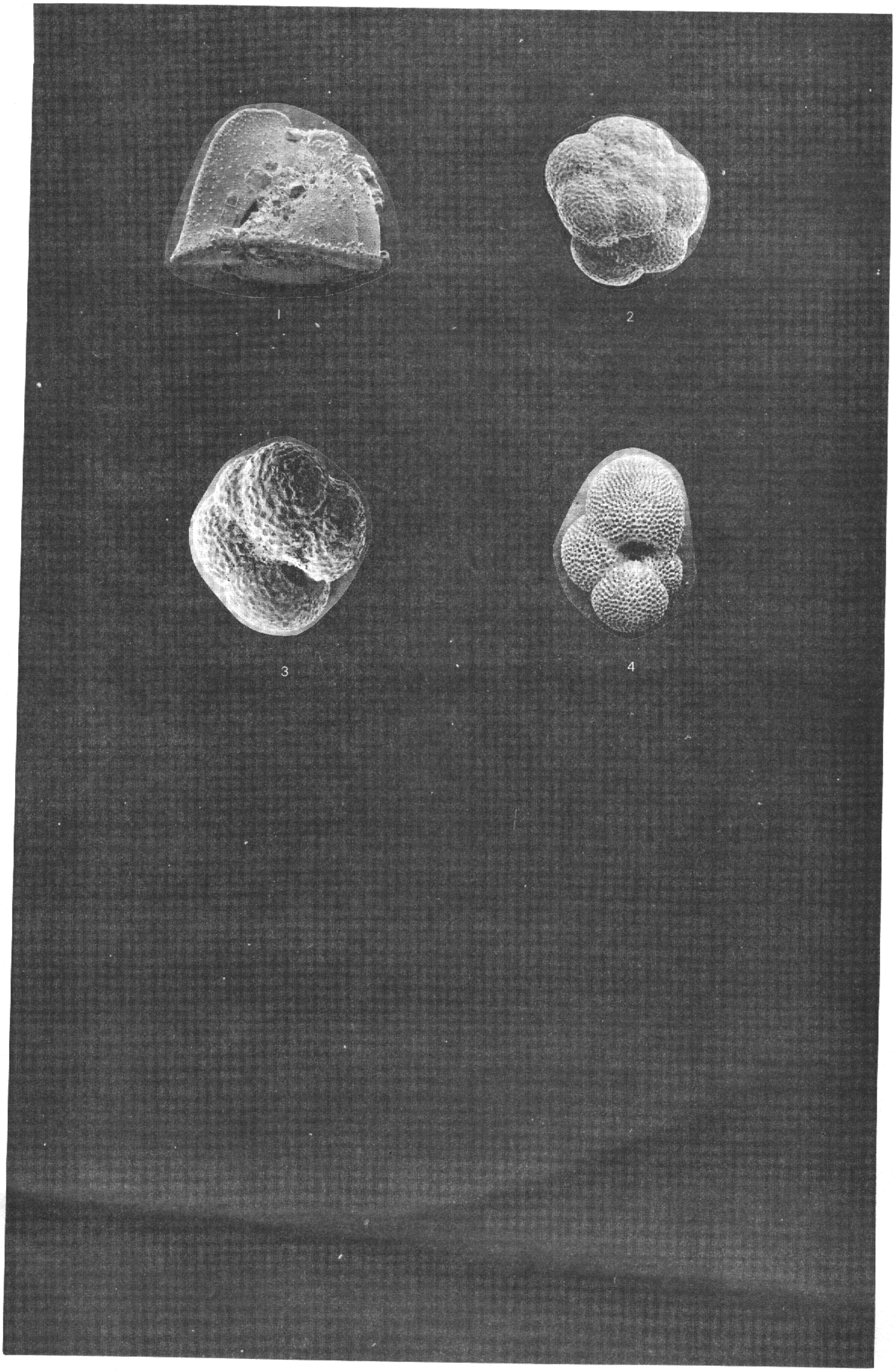

Plate 27. GLOBOROTALIDAE, GLOBIGERINIDAE.