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INTRODUCTION

DURING THE SPRING of 1957 the American Museum of Natural History and the late Mr. Harry J. Bauer co-sponsored the Puritan-American Museum of Natural History Expedition to Western Mexico (Emerson, 1958). Eighty-one bottom samples were collected in the Gulf of California by Dr. Donald F. Squires, then Assistant Curator of Invertebrate Paleontology at the American Museum of Natural History and a member of the expedition. The majority of the samples were collected by hand, by dredging, and by skin diving in shallow bays and inlets along the western coast of the Gulf, and several were similarly taken on the eastern side.

The Foraminifera in these samples were studied, and their geographic distribution in the Gulf was analyzed. The populations were studied quantitatively so that observations could be made on the specific changes in the populations from the southern to the northern ends of the Gulf.

It is hoped that the present study of the Foraminifera, while interesting in the sense that it describes a group of animals from a relatively unexplored area, will also offer some solutions to basic zoogeographical problems that the Gulf presents. A study of the present distribution of the Foraminifera in the Gulf of California may contribute greatly to an understanding of late Tertiary and Quaternary environmental conditions in the Gulf.

BASIC ZOOGEOGRAPHIC PROBLEMS

The term "Panamic fauna" is generally applied to the shelf fauna inhabiting the eastern tropical Pacific, the "Panamic Province" being the geographic term for this area. Its southern limit is situated at latitude 4° 30′ S., near Paita, north of Sechura Bay, Peru (Steinbeck and Ricketts, 1941, p. 299). This boundary fluctuates with the variations in the cold Humboldt Current flowing from the south.

The northern boundary has been placed approximately at Cape San Lucas, at latitude 23° N. The actual boundary probably extends farther north, because common Panamic forms have been noted in Magdalena Bay on the west coast of Baja California. Ricketts (*in* Steinbeck and Ricketts, 1941, p. 299) claims that important tropical shore forms, such as *Grapsus grapsus* (Sally Lightfoot crab), have their northern limit at Cedros Island, and many elements of the northern fauna last appear there. The coast line between Magdalena Bay and Cedros Island probably marks a transitional zone between the tropical and subtropical fauna of the eastern Pacific. Some tropical forms, however, have been reported from as far north as Point Conception, at latitude 34° 30′ N. More detailed collecting is needed along the west coast of Baja California before the northern limit of the Panamic Province can be more accurately defined.

Considerable disagreement exists as to the nature of the Gulf fauna. Cooper (1895, p. 37) states: "From small collections hitherto made in the northern end of the Gulf, quoted by Carpenter or Stearns, it appears that the species found there are more largely of the temperate fauna, many of them identical with those from the same latitude on the west coast of the peninsula. This seems to indicate that the dividing ridge, now 3000 feet or more in altitude, was crossed by one or more channels within geologically recent times." Steinbeck and Ricketts (1941, pp. 177–179, 306–307) state that the northern and southern portions of the Gulf are well marked in most groups, and that, except for the sponges and tunicates, "the color of the Gulf littoral as a whole is distinctly tropical."

It was hoped that, with the use of the Foraminifera, which occur commonly and in prolific numbers so that they are available for statistical treatment, the following questions would be answered:

1. What general differences in the foraminiferal fauna exist throughout the extent of the Gulf?

2. What percentage of the species are restricted to the northern, and what to the southern, half of the Gulf?

3. Finally, what general conclusions about zoogeographical affinities of the Gulf can be made from the study of the Foraminifera?

Previous Studies

Compared to the Foraminifera of other bodies of water adjacent to the United States, those of the Gulf of California have hardly been investigated. The writer knows of only three papers dealing with the Foraminifera of this area: one on fossil and two on Recent Foraminifera. The first papers dealing with the Foraminifera of the Gulf of California were published in 1939 and 1940 by Cushman and McCulloch as a result of the Allan Hancock Pacific Expeditions. Bottom samples were collected from shallow waters along the eastern edge of the Pacific from Seward, Alaska, to the coast of Peru. Fifty of these were taken in the Gulf of California, and the foraminiferal content was recorded and beautifully illustrated. However, no distributional studies of the Foraminifera in the Gulf were made.

In 1940, Natland studied 16 samples from Pliocene and Pleistocene outcrops along the eastern coast of the peninsula of Baja California. By knowing the ecology of the Recent forms, he was able to postulate past depositional conditions. In 1941, Natland published a short paper on the bathymetric and temperature distribution of Foraminifera in the Gulf of California and along the western coast of Central America.

To the writer's knowledge, the present paper represents the first attempt to analyze the geographical distribution of the Foraminifera in the Gulf of California.[1]

[1] A paper by O. L. Bandy (1961) appeared after the completion of the present paper, which is confined to samples from depths no greater than 50 fathoms and emphasizes taxonomic and zoogeographic aspects of the shallow-water assemblages. Bandy's study, on the other hand, includes samples of Foraminifera from the intertidal zone to depths of more than 1000 fathoms and is largely ecological in approach.

Acknowledgments

To Dr. Donald F. Squires, formerly Associate Curator of Invertebrate Paleontology at the American Museum of Natural History, who collected the samples for this study and offered much constructive advice during the course of the work, I offer my greatest thanks.

I wish to thank Dr. William K. Emerson, Associate Curator of Invertebrates at the American Museum of Natural History, for his helpful suggestions.

To Dr. Brooks F. Ellis and Miss Angelina R. Messina I offer my gratitude and appreciation for the use of the laboratory and library facilities of the Department of Micropaleontology at the American Museum of Natural History. I wish also to thank Dr. Brooks F. Ellis for his encouragement throughout this study.

Finally, I thank my wife Barbara for her untiring efforts in helping me to prepare this paper.

This paper is a revision of the author's Master's thesis, submitted to the Department of Geology of New York University as partial fulfillment towards the Master of Science degree.

DESCRIPTION OF THE AREA

Physiography and Geology

The following information was taken from Anderson (1950) and Beal (1948). The Gulf of California is a body of water rectangular in outline, between latitude 23° N. and latitude 32° N., bounded on the west by the mountainous peninsula of Baja California and on the east by the state of Sonora and the northern part of the state of Sinaloa, Mexico. The Gulf is 680 miles long, 100 miles wide near its head at the delta of the Colorado River, and about 120 miles wide at its entrance near Cape San Lucas.

The western margin of the Gulf rises abruptly out of the sea, with mountains from 1000 to 10,000 feet in height forming the backbone of the peninsula. The eastern side of the Gulf is bordered primarily by desert plains, with some mountainous areas. South of Guayamas these desert plains are followed by the alluvial coastal plain of the deltas of the Yagui, Mayo, and Fuerte rivers. The eastern side of the Gulf has a narrow shelf area, but on the western coast shelf areas are for the most part absent.

The floor of the Gulf is extremely irregular, except in the northern area near the Colorado Delta. Numerous submarine faults are believed to have formed deep northwest-southeast trenches. Small islands lie off the west coast of the Gulf, and two large islands, off the east coast, Angel de la Guarda and Tiburón, are situated at about latitude 29° N.

The northern half of the western side of the Gulf is composed primarily of granitic and metamorphic rocks believed to be related to the late Cretaceous batholith of Baja California. This northern district is essentially a westward-sloping block of crystalline rocks, owing its great elevation to the extensive faulting on the eastern side of the peninsula. The rocks along the western coast south of the twenty-eighth parallel consist mainly of Miocene volcanic sediments and some marine Pliocene beds of the Salada group.

The islands on the western side of the Gulf are composed primarily of tilted Miocene volcanics (Comondu formation) overlain unconformably by Pliocene sediments (Salada group).

Some evidence suggests that the Gulf of California was formed by diastrophic movements that uplifted the peninsula by early Pliocene time. These movements continued into the Pleistocene, as evidenced by terraces of that age that have been faulted. The development of the peninsula was probably contemporaneous with the formation of the Central American barrier between the Atlantic and Pacific oceans.

Oceanographic and Meteorological Aspects

The climate of the Gulf is not appreciably influenced by the Pacific Ocean. The long chain of high mountains reduces the cooling effects of the Pacific and decreases the precipitation enormously. According to Sverdrup (1939) the surface temperature during the February to March interval ranges from about 20° C. at the mouth to about 14° C. near the head of the Gulf. Anderson states that the "surface salinity varies from about 34.5 per cent near the mouth of the Gulf to 35.5 per cent north of Angel de la Guarda Island and 35.12 per cent at a point about 40 miles from the mouth of the Colorado River." It seems, therefore, that, because of excessive evaporation, the influx of fresh water from the Colorado River has little effect on the salinity of the Gulf.

January and February appear to be the coldest months of the year, August and September the warmest. The following are mean monthly sea-surface temperatures for January and August at La Paz (approximate latitude 24° 10′ N.) from 1950 to 1957, Guayamas (latitude 28° N.) from 1950 to 1953, and Puerto Peñasco (approximate latitude 31° N., on the east side of the Gulf) from 1952 to 1955 (Roden and Groves, 1959, p. 14).

	La Paz	Guayamas	Puerto Peñasco
January	19.8° C.	17.7° C.	14.9° C.
August	29.1° C.	31.5° C.	31.2° C.

Temperatures as low as 15° C., in February and March, are reported north of the twenty-ninth parallel (Roden, 1958, p. 41). Little has been done to investigate monthly surface-

water temperature in the northern part of the Gulf. The information available suggests temperatures of 16° C. or less for a large part of the year in the northern regions of the Gulf. From the information available, it appears that the latitude near La Paz rarely has surface-water temperatures below 17° C.

From isotherm maps of the Pacific coast of North America (Steinbeck and Ricketts, 1941, pp. 279, 280), it seems that much warmer surface-water temperatures are to be found throughout the Gulf than in opposing latitudes on the Pacific coast of Baja California.

TABLE 1

DISTRIBUTION AND PERCENTAGE OCCURRENCE OF THE FORAMINIFERA IN THE GULF OF CALIFORNIA

Bottom Sample	Textularia panamensis	Textularia conica	Amphisorus hemprichii	Quinqueloculina lamarckiana	Rotalia rosea	Siphogenerina raphanus	Loxostomum limbatum var. costulatum	Textularia agglutinans	Streblus beccarii var. sobrinus	Elphidium gunteri	Quinqueloculina costata	Triloculina trigonula	Spiroloculina planulata	Textularia corrugata	Quinqueloculina laevigata	Quinqueloculina poeyana	Quinqueloculina cf. angulostriata	Peneroplis pertusus	Hauerina ornatissima
1	15	44	4	25	4	4	4	—	—	—	—	—	—	—	—	—	—	—	—
2	—	7	—	—	—	14	—	7	14	36	7	7	7	—	—	—	—	—	—
3	—	9	9	5	3	—	—	—	1	—	—	—	—	4	3	4	8	7	4
4	—	2	1	—	—	—	—	—	—	—	—	—	—	1	—	4	—	8	—
5	—	20	1	—	—	—	—	—	—	—	—	—	—	—	—	3	2	14	1
6	—	12	9	—	1	—	1	—	—	—	—	—	—	3	—	3	—	11	4
7	—	10	—	5	—	—	—	—	—	x[a]	—	—	x	—	—	5	—	—	2
8	—	25	—	6	—	—	—	—	—	2	—	—	—	—	—	10	18	—	4
9	—	14	2	14	—	—	—	—	—	—	—	—	—	5	—	2	11	5	2
10	—	1	3	—	3	—	—	—	—	x	—	—	—	8	3	3	x	10	5
11	—	12	2	1	—	—	—	1	—	3	—	—	—	—	2	9	7	3	2
12	—	2	2	11	—	—	—	—	—	—	—	—	2	—	2	4	4	—	—
13	—	4	2	—	—	—	7	—	—	—	—	—	—	2	6	7	4	4	2
14	—	2	2	10	—	—	—	—	—	2	4	—	—	—	2	—	—	18	8
15	—	—	1	22	—	—	—	—	—	—	—	—	—	2	—	—	1	63	—
16	—	29	—	5	—	—	—	—	—	4	—	—	—	4	2	5	9	5	—
17	—	—	8	12	—	—	—	—	—	—	—	—	—	—	—	24	—	8	—
18	—	—	3	—	—	—	—	—	64	—	—	—	—	—	—	—	3	—	—
19	—	—	—	44	—	—	—	18	4	2	—	—	—	—	—	2	4	—	—
20	—	11	4	2	—	—	—	—	—	1	—	—	—	—	—	14	13	3	8
21	—	5	7	2	—	—	—	—	—	—	—	—	—	—	5	5	4	7	7
22	—	9	2	—	—	—	—	2	—	—	—	—	—	2	—	7	5	7	—
23	—	5	15	40	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—
24	—	2	—	—	—	—	2	—	—	7	5	—	—	5	5	—	14	7	—
25	—	4	—	4	—	—	—	—	—	—	—	—	—	—	—	—	8	17	—
26	—	—	2	—	—	—	—	1	—	6	—	—	—	—	9	12	9	18	—
27	—	8	—	24	—	1	—	—	—	19	—	—	9	5	—	6	1	3	—
28	—	7	—	21	—	—	—	3	—	—	—	—	3	—	x	—	2	x	—
29	—	x	—	11	—	—	—	—	—	—	—	3	—	—	x	—	x	—	—
30	—	1	—	x	—	—	—	—	—	—	—	—	—	—	—	1	4	—	—
31	—	5	2	52	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
32	—	3	10	—	—	—	—	—	—	—	3	—	—	—	—	—	11	6	4
33	—	3	2	8	—	2	—	4	—	—	—	—	1	4	3	—	2	—	1
34	—	—	—	7	—	1	—	—	—	13	—	—	—	1	—	10	6	1	1
35	—	—	7	—	—	—	—	10	—	—	—	—	—	—	1	—	—	14	—
36	—	10	15	—	—	—	—	—	—	—	—	—	—	10	—	—	—	15	—
37	—	4	3	—	—	—	—	—	—	—	—	—	—	3	3	3	4	5	7
38	—	3	3	8	—	—	—	—	—	1	—	—	—	4	3	7	5	6	2
39	—	10	x	4	—	—	—	2	—	—	—	—	x	—	x	4	8	2	x
40	—	3	6	—	—	—	2	—	—	3	—	—	—	2	3	—	5	18	10
41	—	5	x	—	—	—	x	2	—	3	9	—	x	x	1	—	5	x	—
42	—	7	2	11	—	—	—	5	—	7	—	—	—	—	1	8	5	4	4
43	—	15	—	8	—	—	—	—	—	2	—	—	—	—	2	—	7	—	—
44	—	—	—	—	—	—	—	6	—	9	—	—	—	—	3	8	11	37	3
45	—	4	3	4	—	—	—	—	—	—	—	—	—	2	—	—	2	5	2
46	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
47	—	7	—	3	—	—	—	—	—	—	—	—	x	—	x	—	6	—	—
48	—	7	—	14	—	—	—	—	—	—	—	—	—	1	3	10	13	—	—
49	—	1	—	6	—	—	—	—	—	—	—	1	—	—	2	—	3	—	—
50	—	3	—	—	—	—	—	—	—	—	—	—	—	15	—	—	9	—	—
51	—	11	x	2	—	—	—	—	—	4	x	—	x	—	x	21	3	—	x
52	—	9	—	22	—	—	—	x	—	9	—	—	—	—	2	5	8	—	—
53	—	2	—	2	—	—	—	—	—	—	—	—	—	2	—	3	—	—	—
54	—	10	—	21	—	—	x	4	—	6	—	—	4	—	2	2	2	—	—
55	—	9	—	3	—	—	—	2	—	—	5	—	—	x	4	—	2	2	4
56	—	—	—	—	—	—	—	—	31	11	—	—	—	—	—	—	—	—	—
57	—	—	—	x	—	—	—	—	22	2	—	—	—	—	—	—	—	—	—
58	—	4	—	2	—	—	—	—	—	—	—	—	—	—	—	—	2	—	2
59	—	2	—	5	—	—	—	x	—	2	—	—	—	2	2	9	4	—	x
60	—	3	—	—	—	—	—	x	—	—	1	—	—	3	—	—	1	x	—
61	—	18	—	4	—	—	—	—	—	—	—	—	x	3	2	x	4	—	—
62	—	5	—	7	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—
63	—	10	—	10	—	—	—	4	—	1	6	—	—	—	4	—	—	—	—
64	—	6	—	—	—	—	—	—	—	—	—	—	—	—	3	—	3	—	3
65	—	1	—	—	—	—	—	4	—	—	—	—	—	—	3	—	13	—	—
66	—	2	—	2	—	—	—	7	—	—	6	—	2	—	4	—	4	—	—
67	—	10	—	3	—	—	—	—	—	—	—	—	—	5	—	—	5	—	—
68	—	9	—	13	—	—	—	—	—	x	—	—	—	2	—	x	5	—	—
69	—	—	—	5	—	—	—	—	—	1	14	—	—	—	7	—	7	—	—
70	—	—	—	4	—	—	—	2	—	—	—	—	—	—	4	9	21	—	2
71	—	6	—	5	—	—	—	3	—	—	6	—	—	—	4	—	2	—	—
72	—	10	—	—	—	—	—	3	—	5	—	—	—	5	—	5	2	2	—
73	—	3	—	8	—	—	—	—	—	3	—	—	1	1	4	6	—	—	—
74	—	4	—	9	—	—	—	2	—	10	—	—	—	—	2	9	—	—	2
75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
76	—	1	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
77	—	1	—	26	—	—	—	4	—	3	—	—	1	—	1	—	—	—	—
78	—	2	—	2	—	—	—	—	—	19	—	—	—	—	x	—	x	—	—
79	—	—	—	—	—	—	—	—	—	77	—	—	—	—	—	—	—	—	—
80	—	—	—	—	—	—	—	—	2	80	—	—	—	—	—	—	—	—	—
81	—	—	—	x	—	—	—	—	42	30	—	—	—	—	x	—	—	—	—

Bottom Sample	Discorbis obtusus	Cymbaloporetta squammosa	Tretomphalus bulloides	Nodobaculariella atlantica	Bolivina rhomboidalis	Eponides hannai	Globigerina bulloides	Elphidium crispum	Cibicides refulgens	Cibicides lobatulus	Pyrgo denticulata	Spiroloculina antillarum	Triloculina circularis	Planorbulina acervalis	Cibicidella variablis	Quinqueloculina angulostriata	Quinqueloculina baueri, new species	Globorotalia menardii
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	1	1	1	3	3	1	3	4	4	8	1	1	1	3	1	1	1	1
4	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—
5	—	—	—	—	—	—	—	1	—	4	—	—	—	—	—	—	—	1
6	1	—	—	—	—	—	—	2	3	—	—	1	1	3	—	3	—	—
7	—	—	—	—	—	x	11	—	x	—	—	—	—	—	—	—	—	3
8	—	—	—	2	—	4	—	2	—	6	—	—	—	—	—	—	—	—
9	7	2	—	—	2	—	7	—	5	5	—	—	—	2	—	—	—	—
10	—	—	2	—	x	—	—	4	1	x	x	1	—	3	—	—	—	—
11	x	2	x	2	x	1	1	—	2	—	1	x	2	2	—	3	1	x
12	—	2	—	2	—	—	13	—	4	—	—	—	—	—	—	—	—	—
13	—	—	—	2	—	4	—	—	4	—	—	6	—	4	—	—	6	—
14	—	—	2	4	—	—	—	—	—	2	2	8	—	4	—	—	—	—
15	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	1	—
16	—	—	—	—	—	—	2	—	2	—	—	—	—	—	—	—	—	2
17	—	—	—	—	—	—	—	—	—	—	—	—	—	8	—	4	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—
20	—	—	2	—	—	—	—	—	2	3	—	2	1	1	—	—	—	2
21	—	—	2	x	2	x	8	5	3	5	2	—	—	3	—	—	4	—
22	—	—	—	—	—	2	—	7	—	5	2	—	—	2	—	—	2	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
25	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	8	8	—
26	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	2	2	—
27	1	—	—	1	—	4	—	—	—	1	—	—	—	—	1	—	—	—
28	—	x	—	—	—	—	9	—	—	—	—	—	—	x	—	—	—	6
29	2	—	—	2	—	—	8	—	x	—	—	—	—	—	—	3	—	3
30	x	—	—	—	—	—	18	—	—	—	—	—	—	—	—	—	—	5
31	—	—	5	—	—	—	—	—	—	—	10	—	—	12	—	—	—	—
32	—	—	5	—	—	—	3	7	6	—	2	—	9	3	—	4	—	—
33	1	—	1	5	—	3	2	7	2	—	1	—	—	3	—	—	1	—
34	—	—	—	7	—	3	4	—	1	—	—	—	—	—	1	4	—	—
35	—	—	3	—	—	—	—	14	7	—	—	—	—	3	—	—	—	—
36	—	—	—	—	—	—	—	10	—	—	—	—	5	—	—	—	—	—
37	—	x	5	x	3	—	1	5	4	3	1	x	—	—	—	—	—	x
38	x	—	—	x	1	x	2	2	4	4	2	—	1	3	x	3	5	x
39	—	—	4	3	x	—	13	x	3	—	x	1	x	—	2	2	1	x
40	—	—	—	—	2	—	—	2	—	—	—	—	—	12	—	—	—	—
41	1	—	5	—	x	2	5	x	x	4	x	2	x	x	1	1	—	1
42	5	—	x	2	1	—	x	2	—	x	—	x	2	2	3	3	x	—
43	—	—	—	—	—	1	7	—	x	3	—	—	—	x	x	—	—	—
44	—	—	x	2	—	3	—	—	—	—	—	x	—	1	—	4	—	—
45	—	—	2	—	1	—	2	6	7	2	2	1	2	1	—	2	3	—
46	—	—	—	—	—	—	19	—	3	—	—	—	—	—	—	—	—	—
47	—	—	—	—	x	x	19	—	—	—	—	—	—	—	—	x	—	1
48	—	1	4	1	—	—	1	—	—	1	3	—	—	3	—	—	10	—
49	—	—	—	—	1	—	6	—	1	—	—	—	—	—	1	—	—	—
50	3	—	29	—	—	—	—	9	—	—	—	—	—	—	3	—	—	—
51	3	—	x	3	2	—	x	2	—	7	—	—	—	—	—	x	x	—
52	—	—	—	x	—	5	—	—	x	—	—	—	—	—	—	x	—	—
53	—	—	—	2	2	—	—	—	2	—	—	—	—	2	—	—	—	—
54	—	—	—	x	—	12	1	2	1	x	—	3	—	—	—	—	—	—
55	—	—	—	4	—	—	—	9	—	2	x	—	—	4	—	—	—	—
56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
57	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	x
58	—	—	—	—	—	—	—	24	—	2	—	—	—	9	—	—	—	—
59	—	—	x	14	—	6	3	x	x	2	—	—	—	—	—	—	—	—
60	—	x	x	x	—	3	1	2	—	1	x	—	—	—	1	—	—	—
61	2	—	—	—	—	x	1	3	x	4	—	—	—	—	—	—	—	2
62	—	—	—	—	—	—	17	—	—	2	—	—	—	—	—	—	—	—
63	1	—	—	1	—	—	—	1	5	1	—	2	—	—	—	—	—	—
64	—	—	—	—	—	3	—	31	6	—	—	—	—	—	—	3	—	—
65	3	—	—	1	—	—	9	16	7	—	—	—	—	—	—	1	—	—
66	—	—	—	—	—	13	—	7	2	—	—	—	—	—	—	—	—	—
67	—	—	—	—	—	5	5	x	—	6	—	—	—	—	—	—	—	—
68	x	—	—	—	x	7	7	—	5	—	—	—	—	—	—	—	—	—
69	—	—	—	4	—	—	—	4	—	—	—	—	—	—	—	5	—	—
70	—	—	—	1	1	—	—	10	—	—	—	—	—	—	—	2	—	—
71	1	—	—	4	—	—	—	5	3	—	—	—	—	—	—	1	—	—
72	—	—	—	8	—	—	—	7	—	2	—	—	—	2	—	3	—	—
73	—	—	—	1	—	5	2	—	—	—	—	—	—	—	—	—	—	—
74	—	—	—	—	—	16	—	1	—	—	—	—	—	—	—	—	—	—
75	—	—	—	—	—	11	—	—	—	—	—	—	—	—	—	—	—	—
76	—	—	—	—	—	16	1	—	—	—	—	—	—	—	—	—	—	1
77	—	—	—	—	—	3	3	—	—	—	—	1	—	—	—	1	—	—
78	—	—	—	2	x	7	7	—	2	—	—	—	—	—	—	x	—	—
79	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—
80	—	—	—	—	—	8	1	—	—	—	—	—	—	—	—	—	—	—
81	—	—	—	—	—	21	—	—	—	—	—	—	—	—	—	—	—	—

Bottom Sample	Trochammina pacifica	Quinqueloculina microcostata	Massilina sp.	Bolivina seminuda	Bolivina paula	Elphidium articulatum	Discorbis bertheloti	Rotalia avalonensis	Discorbis patelliformis	Cassidulina subglobosa	Cushmanella primitiva	Quinqueloculina crassa var. subcuneata	Articulina lineata	Cornuspira planorbis	Cibicides floridanus	Elphidium incertum	Globigerinoides rubra
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	2	3	20	5	15	2	2	23	6	1	2	—	—	—	—	—	—
5	—	7	2	—	3	—	—	16	—	1	—	1	1	1	1	5	1
6	—	8	2	—	—	—	—	7	—	—	—	—	7	1	—	—	—
7	—	—	x	—	7	x	—	—	—	16	—	—	x	2	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	2	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
10	—	26	—	—	x	—	—	1	—	—	—	7	1	—	—	x	—
11	—	13	—	x	1	—	—	3	—	—	—	—	—	—	—	2	2
12	—	—	—	—	2	—	—	—	—	—	—	—	—	2	—	—	—
13	—	9	—	—	2	—	—	—	—	—	—	—	2	—	—	6	—
14	—	—	—	—	4	—	—	—	—	—	—	—	2	—	—	8	—
15	—	4	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
16	—	2	—	—	—	—	—	—	—	—	—	—	—	—	2	—	2
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	12	—
19	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	8	—	1	—	—	—	—	—	—	—	—	4	—	—	2	—
21	x	x	2	—	—	x	—	x	—	—	x	2	2	—	—	2	—
22	—	25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
23	—	—	—	—	—	—	—	—	—	—	—	—	10	—	—	10	—
24	—	21	—	—	2	—	—	—	—	—	—	12	5	—	—	2	—
25	—	—	—	—	—	—	—	—	—	—	—	13	—	—	—	17	—
26	—	2	—	—	—	—	—	—	—	—	—	12	—	—	—	8	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
29	—	—	—	—	x	—	—	—	—	6	—	—	—	—	6	—	8
30	—	—	—	—	—	—	—	—	—	8	—	—	—	—	8	—	8
31	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
32	—	4	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—
33	—	8	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
34	—	—	—	1	3	—	—	—	—	—	—	—	—	—	—	9	—
35	—	10	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37	—	9	—	—	1	—	—	—	—	—	—	2	1	—	—	1	—
38	—	—	—	x	1	—	—	x	—	—	—	—	—	—	—	3	—
39	—	—	—	—	2	x	—	3	—	—	—	—	—	—	—	4	5
40	—	2	—	—	2	—	—	5	—	—	—	3	—	2	3	2	—
41	—	8	—	1	x	x	—	2	—	—	—	5	2	x	—	5	—
42	—	1	—	—	—	—	—	3	—	1	—	—	x	—	—	—	—
43	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	2	—
44	—	3	—	—	—	—	—	—	—	—	—	x	—	—	—	6	—
45	—	—	—	—	—	—	—	4	—	—	—	1	1	2	—	—	—
46	—	—	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—
47	—	—	—	—	x	—	—	—	—	3	—	—	—	—	—	—	3
48	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
49	—	—	—	—	—	—	—	8	—	17	—	—	—	—	10	—	—
50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
51	—	—	—	—	x	—	—	2	—	x	—	—	—	—	3	4	—
52	—	—	—	—	2	—	—	—	—	—	—	x	—	—	—	—	—
53	—	—	—	—	—	—	—	31	—	—	—	—	—	—	2	—	—
54	—	—	—	—	—	—	—	x	—	—	—	12	—	—	—	1	—
55	—	9	—	—	x	—	—	8	—	—	—	—	x	—	—	13	—
56	—	—	—	—	—	18	—	—	—	—	—	—	—	—	—	—	—
57	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
58	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
59	—	—	—	—	2	—	—	x	—	—	—	19	—	—	—	4	—
60	—	18	—	—	—	—	—	x	—	—	—	19	—	x	—	3	—
61	—	3	—	—	—	—	—	—	—	x	—	—	—	—	x	—	—
62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	—	2
63	—	3	—	—	—	—	—	1	—	—	—	9	—	—	—	—	—
64	—	—	—	—	—	—	—	—	—	—	—	9	—	—	—	3	—
65	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	4	—
66	—	4	—	—	—	2	—	—	—	—	—	11	—	—	—	7	—
67	—	—	—	—	—	—	—	4	—	2	—	—	—	—	—	x	—
68	—	—	—	—	—	—	—	4	—	x	—	—	—	—	4	—	—
69	—	—	—	—	5	—	—	4	—	—	—	—	1	—	—	8	—
70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—
71	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
72	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	—	—
73	—	4	—	—	5	—	—	4	—	—	—	—	1	—	—	17	—
74	—	—	—	—	2	—	—	12	—	—	—	—	1	—	—	—	—
75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—
76	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—
77	—	—	—	—	23	—	—	4	—	—	—	—	—	—	—	4	—
78	—	—	—	—	11	—	—	6	—	8	—	—	—	—	—	8	—
79	—	—	—	—	2	2	—	—	—	2	—	—	—	—	—	—	—
80	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—
81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Bottom Sample	Bolivina minuta	Tretomphalus atlanticus	Triloculina oblonga	Discorbis floridanus	Patellina corrugata	Triloculina inflata	Bolivina advena	Cassidulina laevigata	Spirillina vivipara	Reussella aequa	Discorbis floridensis	Bolivina advena var. striatella	Gaudryina atlantica	Chrysalidinella dimorpha	Cibicides concentricus	Bulimina denudata	Angulogerina angulosa	Planulina exorna
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	4	1	7	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—
6	1	3	2	—	—	4	1	1	2	1	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	11	4	x	x	6	4	x	2
8	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—
9	—	2	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	x	—	—	2	x	—	—	1	—	—	—	—	—	—	—	—
11	—	x	—	—	x	—	—	—	x	2	—	—	—	—	—	—	—	2
12	—	2	2	—	—	2	—	—	—	—	2	—	—	—	7	4	—	2
13	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—
14	2	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	2	—	—	—	2	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—
20	—	—	—	—	—	1	—	—	—	4	1	—	—	—	—	—	—	—
21	x	2	—	—	—	5	—	—	—	x	x	—	—	—	—	—	—	—
22	—	—	—	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—
27	—	3	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—
28	—	x	—	—	—	—	—	—	—	x	—	2	—	—	8	—	—	3
29	—	—	—	—	—	—	—	2	—	x	—	6	2	—	13	3	x	4
30	—	2	—	—	—	—	—	4	—	—	—	6	—	x	3	1	5	4
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	—	1	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—
33	—	—	—	—	—	—	—	—	—	2	2	—	—	—	—	—	1	3
34	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37	—	9	—	—	—	2	—	—	—	2	—	—	—	x	—	x	—	—
38	—	3	—	—	—	3	—	—	—	—	—	—	—	x	—	—	—	—
39	—	—	2	—	x	—	—	—	x	2	—	—	—	x	—	x	x	—
40	—	2	—	5	—	—	—	—	—	2	—	—	—	—	—	—	—	—
41	—	5	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—
42	1	1	—	—	—	—	—	—	—	1	x	—	—	—	—	—	—	—
43	—	1	—	—	x	—	—	—	—	1	x	3	—	—	19	3	—	x
44	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
45	—	8	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
46	—	—	—	—	—	—	—	1	—	—	—	14	—	—	—	7	—	4
47	—	—	—	—	—	x	—	x	x	1	—	3	—	—	11	13	3	2
48	—	—	—	—	—	6	—	—	—	3	—	—	—	—	—	—	—	—
49	—	—	—	—	—	—	—	2	—	1	—	2	—	—	3	4	7	5
50	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
51	—	—	—	—	—	2	—	—	x	3	—	—	—	x	—	—	—	x
52	—	3	—	—	—	—	—	—	—	5	—	—	—	—	4	6	—	—
53	—	—	31	3	—	—	—	2	—	2	—	—	—	—	—	—	—	—
54	5	—	—	1	—	2	—	—	—	—	—	—	—	—	3	5	—	—
55	—	—	x	—	—	5	—	—	—	—	—	—	—	x	—	—	—	—
56	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	9	—	—
57	—	—	x	—	—	—	—	—	—	—	—	3	—	—	3	26	—	—
58	—	—	2	—	—	—	—	—	—	2	—	—	—	—	—	—	—	2
59	x	—	—	—	—	—	—	—	—	5	—	—	—	—	x	x	—	—
60	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—
61	—	—	x	—	—	—	—	5	—	—	—	x	—	—	—	—	—	2
62	—	—	—	—	—	—	—	—	—	1	—	—	—	—	4	1	2	19
63	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
64	—	—	—	—	—	3	3	—	—	—	—	—	—	—	—	—	—	—
65	—	—	—	—	1	16	—	—	3	—	—	—	—	—	—	—	—	1
66	2	—	—	—	—	—	—	—	—	2	11	—	—	—	—	—	—	—
67	—	—	—	—	—	—	—	5	—	x	—	9	—	x	6	—	—	x
68	—	—	—	—	—	—	—	8	—	5	—	—	—	x	11	3	—	3
69	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
70	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
71	1	—	—	—	—	—	—	—	—	4	—	—	—	—	3	—	—	—
72	—	—	10	—	—	12	—	—	—	—	—	—	—	—	8	—	—	—
73	—	—	—	—	—	—	—	—	—	3	—	—	—	—	8	2	—	—
74	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	4	—	—
75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	57	—	—
76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	38	22	—	—
77	1	—	—	—	—	—	—	3	—	—	—	—	—	—	4	9	—	—
78	—	—	—	7	—	—	—	4	—	4	—	—	—	—	—	2	—	—
79	2	—	—	—	—	—	—	—	—	2	—	—	—	—	—	4	—	—
80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—
81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Bottom Sample	Virgulina complanata	Quinqueloculina agglutinans	Bolivina subexcavata	Quinqueloculina catalinensis	Nonion grateloupi	Gypsina globulus	Globorotalia truncatulinoides	Pyrgo elongata	Triloculina fichteliana	Textularia candeiana	Quinqueloculina flexuosa	Hauerina bradyi	Poroeponides cribrorepandus	Discorbis globosus	Lamellodiscorbis sp.	Cymbaloporetta bradyi	Dyocibicides biserialis
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	2	2	2	6	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	2	2	2	2	—	—	—	—	—	—	—	—
10	—	—	x	—	—	1	—	—	—	x	2	1	x	x	2	1	—
11	—	1	—	—	1	—	—	x	—	—	—	2	—	x	—	—	2
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
13	—	—	—	—	—	—	—	—	—	—	2	2	—	—	2	9	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	9	2	—	—	—	—	2	5	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	7	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	1	—	—	—	—	—	2	—	—	1	—	—	—
21	—	—	—	—	—	—	—	—	x	2	—	—	—	3	x	x	—
22	—	—	—	—	2	—	—	—	—	—	—	—	—	5	—	—	—
23	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—
27	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
28	x	—	—	—	2	x	—	x	—	—	—	—	—	—	—	—	x
29	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—
30	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	2	—	—	—	—	—	—	5	—	—	—	—
32	—	—	—	—	—	—	—	—	4	—	—	—	1	4	—	—	2
33	—	—	—	—	1	1	—	—	—	1	—	1	2	—	2	3	5
34	—	—	—	—	3	—	—	—	—	—	—	—	—	1	1	—	—
35	—	—	—	—	—	3	—	—	—	—	—	3	10	—	—	—	—
36	—	—	—	15	—	—	—	—	5	—	—	—	5	—	—	—	—
37	—	—	—	2	—	3	—	—	x	—	—	—	x	—	6	—	—
38	—	—	—	—	x	x	x	—	1	—	—	x	1	4	3	—	—
39	—	2	x	—	x	—	—	x	—	—	—	—	x	1	—	1	3
40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	5	—
41	—	—	—	1	—	x	—	1	—	—	—	2	—	2	—	—	—
42	—	—	—	—	—	—	—	—	—	—	—	—	—	8	—	—	x
43	4	—	3	—	3	—	—	—	—	—	—	—	—	—	—	—	x
44	—	1	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—
45	—	—	—	—	—	—	—	—	1	—	—	1	—	2	—	—	8
46	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
47	1	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	x
48	—	—	—	—	—	3	—	—	—	—	—	—	3	—	—	—	—
49	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
50	—	—	—	15	—	3	—	—	—	—	—	—	—	—	—	—	—
51	—	x	—	x	—	—	—	—	—	—	—	—	—	2	—	2	—
52	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
53	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	2
54	—	—	—	6	x	—	—	—	—	—	—	—	—	2	—	x	—
55	—	—	—	x	—	—	—	—	—	—	—	—	2	2	3	—	—
56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
57	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
58	—	—	2	—	—	—	—	—	5	—	—	—	—	22	—	—	4
59	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—
60	—	—	—	2	—	—	x	—	—	—	—	—	3	1	x	—	—
61	—	x	—	—	—	—	—	—	—	—	—	—	5	x	—	—	—
62	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
63	—	—	—	—	—	—	—	—	1	—	—	3	—	3	—	—	—
64	—	—	—	—	—	3	—	—	3	—	—	—	3	3	—	—	—
65	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	9
66	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—
67	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
69	—	—	—	—	—	—	—	—	—	—	18	—	—	—	—	—	—
70	—	—	—	2	1	—	—	—	—	—	8	—	—	—	—	—	—
71	—	—	—	13	—	—	—	—	—	—	—	—	—	—	—	—	2
72	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	3	2
73	—	—	—	—	7	—	—	—	—	—	—	—	—	—	—	—	—
74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
75	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
76	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
77	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
79	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Bottom Sample	Discorbis orbicularis	Discorbis consobrinus	Textularia foliacea var. oceanica	Eponides antillarum	Cancris auricula	Nonionella atlantica	Quinqueloculina seminulum	Eponides babsae, new species	Rectobolivina bifrons	Massilina robustior	Vertebralina striata	Globigerina quinqueloba	Cyclocibicides vermiculatus	Triloculina rotunda	Loxostomum limbatum	Textularia foliacea	Quinqueloculina samoaensis	Bifarina hancocki
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	x	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	2	—	7	9	5	5	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	6	6	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	2	—	—	—	—	—	2	—	2	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	32	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	9	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	2	4	—	2	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	—	—	—
21	—	—	—	—	—	—	x	—	—	—	—	—	2	—	—	—	—	—
22	—	—	—	—	—	—	2	—	—	—	—	—	2	2	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	4	2	—	—	—	—	—	—	2	—	—	—
25	—	—	—	—	—	—	—	13	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	7	—	—	—	—	—	1	—	—	—	—
27	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	2	6	4	2	—	—	—	—	—	—	—	2	—	4	x	x
29	—	—	—	2	—	—	—	—	2	—	—	—	—	—	—	—	4	2
30	x	—	—	—	1	—	—	—	1	—	—	—	5	—	—	2	x	3
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
33	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	—	1	—
34	—	3	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	—	—
37	—	—	—	—	—	—	1	—	—	—	—	2	x	—	x	—	—	—
38	—	—	—	—	—	—	x	—	x	—	x	—	x	2	—	—	—	—
39	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—
40	—	—	—	—	—	—	2	—	—	—	—	—	—	—	2	—	—	—
41	—	—	—	—	—	3	—	2	—	—	—	—	—	x	x	—	x	—
42	—	—	—	—	—	—	2	2	1	—	—	—	1	—	x	—	—	1
43	—	—	1	2	—	2	—	—	1	—	—	x	—	—	—	1	x	—
44	x	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—
45	—	—	—	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—
46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
47	—	—	—	3	1	—	—	—	—	—	—	—	—	—	—	4	3	1
48	4	—	—	—	—	—	—	1	—	3	—	—	—	—	—	—	—	—
49	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2	1	4
50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
51	—	3	—	—	x	3	—	3	—	—	—	—	—	—	—	—	—	—
52	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	x	—	—
53	8	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
54	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
55	—	—	—	—	—	—	—	x	—	x	—	—	—	x	—	—	—	—
56	—	—	—	—	—	8	5	—	—	—	—	—	—	—	—	—	—	—
57	—	—	—	—	—	5	3	—	—	—	—	—	—	—	—	—	—	—
58	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—
59	2	2	—	—	x	—	5	—	—	—	—	—	—	—	x	—	—	—
60	x	—	—	—	—	—	2	—	—	—	—	x	—	3	—	—	—	—
61	—	—	—	4	—	—	2	—	2	—	—	—	—	—	—	—	—	—
62	—	—	—	—	—	—	—	—	1	—	—	5	—	—	—	—	—	—
63	—	—	—	—	—	—	—	23	—	1	—	—	—	8	—	—	—	—
64	—	—	—	—	—	—	—	—	—	—	—	—	—	9	—	—	—	—
65	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
66	—	—	—	—	—	—	—	—	—	—	—	—	—	9	—	—	—	—
67	x	—	x	x	—	5	—	—	x	—	—	2	—	2	—	x	x	—
68	—	—	—	—	—	2	—	—	3	—	—	—	—	—	—	x	x	x
69	—	—	—	—	—	—	1	9	—	1	—	—	—	3	—	—	—	—
70	—	—	—	—	—	—	—	11	—	—	1	—	—	7	—	—	—	—
71	—	—	1	—	—	4	—	19	1	2	—	—	—	—	—	—	—	—
72	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—
73	—	—	—	—	—	5	—	—	—	—	—	—	—	3	—	—	—	—
74	—	—	—	—	—	4	—	—	1	—	—	—	—	—	—	—	—	—
75	—	—	—	—	—	—	—	—	—	—	—	6	—	2	—	—	—	—
76	—	—	4	—	—	6	—	—	—	—	—	1	—	—	—	—	—	—
77	—	—	—	—	—	3	—	—	1	—	—	—	—	—	—	—	—	—
78	—	—	—	—	—	—	—	—	2	—	—	2	—	—	x	—	—	—
79	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
80	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Bottom Sample	Globulina gibba	Bolivina costata	Bolivina acuminata	Uvigerina peregrina	Cibicides umbonatus	Angulogerina occidentalis	Cancris inflata	Frondicularia advena	Lagena squamosa	Bolivina acerosa var. pacifica	Triloculina labiosa	Reophax ellisi, new species	Quinqueloculina funafutiensis	Pyrgo subphaerica	Rotalia translucens	Cibicides basiloba	Valvulineria laevigata	Angulogerina hughesi	Uvigerina attenuata	Cassidulina cushmani	Planispirina exigua
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	—	x	2	x	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	3	2	—	x	1	2	x	x	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—	10	1	—	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
38	—	—	—	—	—	—	—	—	—	—	—	—	—	x	3	—	—	—	—	—	—
39	x	—	—	—	—	—	—	—	—	—	—	—	—	2	—	x	2	x	—	—	—
40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
41	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	x	—
42	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x
43	—	—	—	—	—	2	—	—	—	1	—	x	—	—	—	—	—	x	—	—	—
44	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
46	—	—	—	—	2	32	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
47	—	—	2	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
48	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
49	—	—	3	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
50	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—
51	—	—	—	—	—	—	—	—	—	—	—	x	x	—	—	—	—	—	—	—	—
52	—	—	—	—	x	x	—	—	—	—	—	—	4	3	—	—	—	—	—	—	—
53	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—
54	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	x
55	—	—	—	—	x	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—
56	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—
57	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
60	—	—	—	—	—	9	x	—	—	—	—	—	—	1	—	—	—	—	—	—	—
61	—	—	—	—	—	—	2	—	—	—	—	—	—	—	x	9	—	—	—	—	—
62	—	—	—	—	—	—	—	1	—	2	—	—	—	1	—	—	—	1	—	—	—
63	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	4	—	—	—	—	—
64	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
66	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
67	x	—	—	x	—	—	—	2	—	3	—	—	—	—	—	—	—	2	—	—	—
68	—	—	x	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—
69	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
71	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
73	—	—	—	—	—	—	—	1	—	—	—	—	—	2	—	—	—	—	—	—	—
74	—	—	—	—	—	—	15	—	—	—	—	—	1	—	—	—	—	—	—	—	—
75	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—
76	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
77	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
78	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
79	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Bottom Sample	Ammobaculites catenulatus	Eponides polius	Lagena sulcata	Discorbis candeianus	Buliminella elegantissima var. tenuis	Nonionella miocenica	Elphidium spinatum	Pullenia quinqueloba	Epistominella exigua	Eponides umbonatus	Lagena amphora	Foraminiferal Number (No. of Tests per Gram of Dry Sediment)	Depth in Meters	Bottom Temperature in Degrees Centigrade	Silt-Clay in Per Cent
1	—	—	—	—	—	—	—	—	—	—	—	4	2.5	21.4	0
2	—	—	—	—	—	—	—	—	—	—	—	21	9.2	21.8	3
3	—	—	—	—	—	—	—	—	—	—	—	259	14.8	22.0	0
4	—	—	—	—	—	—	—	—	—	—	—	44	5.5	22.0	0
5	—	—	—	—	—	—	—	—	—	—	—	110	3.7	22.0	0
6	—	—	—	—	—	—	—	—	—	—	—	29	3.1	22.0	0
7	—	—	—	—	—	—	—	—	—	—	—	622	46.2	—	45
8	—	—	—	—	—	—	—	—	—	—	—	30	14.8	22.0	0
9	—	—	—	—	—	—	—	—	—	—	—	24	3.7	21.5	0
10	—	—	—	—	—	—	—	—	—	—	—	123	3.7	21.0	1
11	—	—	—	—	—	—	—	—	—	—	—	4800	12.9	22.0	1
12	—	—	—	—	—	—	—	—	—	—	—	3782	46.2	—	3
13	—	—	—	—	—	—	—	—	—	—	—	301	.8	24.4	38
14	—	—	—	—	—	—	—	—	—	—	—	53	.9	26.0	1
15	—	—	—	—	—	—	—	—	—	—	—	150	2.5	22.0	3
16	—	—	—	—	—	—	—	—	—	—	—	291	10.2	22.0	0
17	—	—	—	—	—	—	—	—	—	—	—	38	3.4	23.9	0
18	—	—	—	—	—	—	—	—	—	—	—	28	5.5	22.0	0
19	—	—	—	—	—	—	—	—	—	—	—	35	.9	24.0	1
20	—	—	—	—	—	—	—	—	—	—	—	379	9.2	22.0	0
21	—	—	—	—	—	—	—	—	—	—	—	2624	3.7	22.0	3
22	—	—	—	—	—	—	—	—	—	—	—	150	6.2	22.0	0
23	—	—	—	—	—	—	—	—	—	—	—	28	3.7	23.5	1
24	—	—	—	—	—	—	—	—	—	—	—	15	.8	23.5	0
25	—	—	—	—	—	—	—	—	—	—	—	32	3.1	23.5	2
26	—	—	—	—	—	—	—	—	—	—	—	299	3.1	23.5	3
27	—	—	—	—	—	—	—	—	—	—	—	538	19.4	22.0	54
28	—	—	—	—	—	—	—	—	—	—	—	960	43.4	—	3
29	—	—	—	—	—	—	—	—	—	—	—	726	46.7	—	0
30	—	—	—	—	—	—	—	—	—	—	—	4659	70.7	—	3
31	—	—	—	—	—	—	—	—	—	—	—	37	18.3	22.0	0
32	—	—	—	—	—	—	—	—	—	—	—	6	6.2	22.0	0
33	—	—	—	—	—	—	—	—	—	—	—	148	10.2	22.0	0
34	—	—	—	—	—	—	—	—	—	—	—	47	12.9	—	19
35	—	—	—	—	—	—	—	—	—	—	—	7	4.6	23.0	0
36	—	—	—	—	—	—	—	—	—	—	—	24	6.2	23.0	0
37	—	—	—	—	—	—	—	—	—	—	—	258	5.0	22.0	0
38	—	—	—	—	—	—	—	—	—	—	—	549	1.4	22.0	1
39	—	—	—	—	—	—	—	—	—	—	—	849	21.2	—	1
40	—	—	—	—	—	—	—	—	—	—	—	100	7.7	21.0	1
41	—	—	—	—	—	—	—	—	—	—	—	1019	12.0	—	10
42	—	—	—	—	—	—	—	—	—	—	—	614	1.5	—	1
43	—	—	—	—	—	—	—	—	—	—	—	994	22.2	—	25
44	—	—	—	—	—	—	—	—	—	—	—	328	1.5	26.0	0
45	—	—	—	—	—	—	—	—	—	—	—	205	.9	26.0	0
46	—	—	—	—	—	—	—	—	—	—	—	1454	35.1	—	30
47	—	—	—	—	—	—	—	—	—	—	—	890	79.4	—	3
48	—	—	—	—	—	—	—	—	—	—	—	107	19.4	20.0	0
49	1	2	—	—	—	—	—	—	—	—	—	2115	75.3	—	15
50	—	—	—	—	—	—	—	—	—	—	—	5	9.2	21.0	10
51	—	—	x	—	—	—	—	—	—	—	—	701	11.1	19.0	2
52	—	—	—	—	—	—	—	—	—	—	—	1132	19.8	19.0	9
53	—	—	—	2	—	—	—	—	—	—	—	4	2.5	19.0	0
54	—	—	—	—	—	—	—	—	—	—	—	393	13.8	22.0	3
55	—	—	—	—	—	—	—	—	—	—	—	126	2.7	22.0	0
56	—	—	—	—	11	1	—	—	—	—	—	462	5.5	—	100
57	—	—	—	—	12	7	7	—	—	—	—	569	10.2	—	100
58	—	—	—	—	—	—	—	—	—	—	—	4	5.5	20.0	0
59	—	—	—	x	—	—	—	—	—	—	—	45	11.1	22.0	0
60	—	—	—	—	x	—	—	—	—	—	—	74	5.5	16.0	0
61	—	—	—	—	—	—	—	—	—	—	—	34	38.3	—	0
62	—	—	—	—	—	—	—	1	7	8	—	84	73.8	—	0
63	—	—	—	—	—	—	—	—	—	—	—	406	11.1	—	0
64	—	—	—	—	—	—	—	—	—	—	—	36	4.6	16.6	0
65	—	—	—	—	—	—	—	—	—	—	—	7	5.5	16.6	0
66	—	—	—	—	—	—	—	—	—	—	2	64	3.7	16.6	0
67	—	—	x	—	x	—	—	—	—	—	—	172	31.4	—	13
68	—	—	—	—	x	—	—	x	—	—	—	386	33.2	19.5	0
69	—	—	—	—	—	—	—	—	—	—	—	43	.9	22.0	0
70	—	—	—	—	—	—	—	—	—	—	—	262	2.2	22.0	0
71	—	—	—	—	—	—	—	—	—	—	—	829	4.6	22.0	0
72	—	—	—	—	—	—	—	—	—	—	—	8	5.5	22.0	0
73	—	—	—	1	—	—	1	—	—	—	—	1222	16.6	22.0	10
74	—	—	—	—	1	—	—	—	—	—	—	472	18.5	22.0	9
75	—	—	—	—	—	7	—	—	2	—	—	175	36.9	22.0	85
76	—	—	—	—	—	—	—	—	—	—	—	197	51.7	—	15
77	—	—	—	—	—	—	—	—	—	—	—	555	15.7	—	15
78	—	—	—	—	x	—	—	—	—	—	—	15	12.9	—	1
79	—	—	—	—	—	—	2	—	—	—	—	95	31.4	—	85
80	—	—	—	—	1	—	1	—	—	—	—	688	29.5	—	85
81	—	—	—	—	—	—	7	—	—	—	—	232	5.5	—	85

[a] x equals less than 1 per cent.

METHODS OF STUDY

A QUANTITATIVE ANALYSIS of the foraminiferal population in each of the 81 bottom samples was made. Ten grams of dried sediment from each sample were washed through a 200-mesh sieve, and the residue was dried and weighed. In this way the percentage of particles in the silt-clay range was calculated.

The Foraminifera in the 10-gram residue were then removed by sprinkling the residue into a shallow dish containing carbon tetrachloride and decanting the float onto a filter paper. This procedure was repeated until no float remained. The residue was then examined for Foraminifera, and a brief lithologic description of the sediment was made. In all cases the flotation was significantly complete.

The dry float was then split into a workable fraction and spread onto a picking tray with a grid background. Each square (3.57 mm.), under ×40 magnification, was neatly inscribed in the microscopic field. A tabulator was used to record the entire number of tests on the tray. This number multiplied by the denominator of the fraction and divided by 10 gave the number of tests in 1 dry gram of sediment. This value is designated as the "foraminiferal number" (F.N.), which is a standard expression of the population density (Said, 1950). The factors that determine the number of tests in any unit measure of sediment are both physical and biological, and no attempt was made to investigate the significance of the F.N. values.

After the population was counted, the percentage of each species to the F.N. was calculated by picking all the tests from a representative area of the grid and mounting them on faunal slides. The percentage of each species in the number of picked tests can then be expressed as a percentage of the total foraminiferal number.

Table 1 records all the statistical data in this study. Stations 1 to 81 are listed in the vertical column on the left, and 139 species are listed horizontally as they first occurred from sample 1 to sample 81 (consequently from south to north). Species restricted to the north are thus situated towards the right side of the table, and the geographic range of each species can easily be seen at a glance.

The occurrence of a species in a sample is stated as a percentage of the total population in the sample. The number of tests of any particular species in a garm of dry sediment can be computed by multiplying the fractional percentage of the species by the foraminiferal number of the sample.

Using the data from table 1 made it possible to construct graphs showing the changing character of the population from south to north. About halfway up the length of the Gulf, the area was arbitrarily divided into two halves by means of a line drawn from Guayamas on the eastern side to Santa Rosalia on the western side. Each half was then divided into eight equal sections. The 81 samples fell into the following 16 sections (see fig. 1):

SOUTHERN HALF

SECTION	SAMPLES
1	1–7
2	8
3	9–19
4	20–31
5	32–40
6	41–49
7	None
8	50–57

NORTHERN HALF

SECTION	SAMPLES
9	58–59
10	None
11	60–65
12	66
13	67–77
14	78
15	79–81
16	None

Figure 2 is a cumulative curve showing at each point geographically the percentage of the total number of species that have already occurred. The absolute values were easily taken from table 1, as the species are arranged in order of first occurrence.

Sections 1 to 3 (samples 1–19) were arbitrarily selected as an area that contained species representing the southern fauna of the

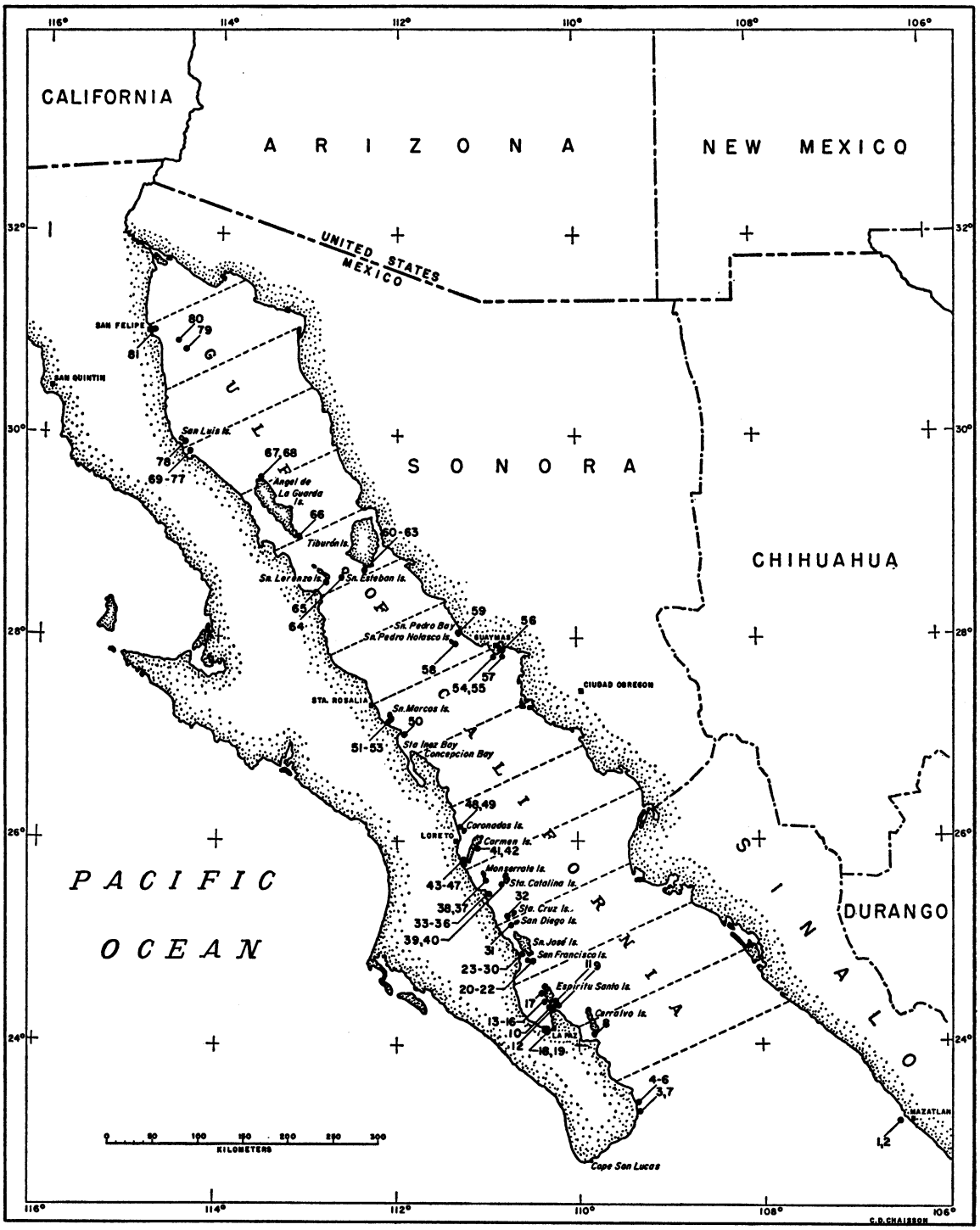


FIG. 1. Map of Baja California, showing the location of bottom samples.

Gulf. A total of 99 species were found within this area. The number of these species still found in each section to the north was then plotted on a bar graph (fig. 3), i.e., of the original 99 species, 95 were present at the end of sample 19.

Figure 4 is a bar graph derived by the same method as that for figure 3. In this case, however, the population is a northern one containing the 108 species found between sample 60 and sample 81. Both bar graphs show the "absolute" change in their populations and do not distinguish between rare and common forms.

Environmental data for each sample is given in the Appendix.

ANALYSIS

Geographic Distribution and Ecology of the Foraminifera

The Foraminifera found in 81 samples were qualitatively and quantitatively studied for significent population changes throughout the extent of the Gulf of California. One hundred and thirty-nine species are recognized, of which three are new: *Eponides babsae*, *Quinqueloculina baueri*, and *Reophax ellisi*.

Of the 139 species, 108 were found in both the southern and northern halves of the Gulf, 26 were restricted to the southern half, and only four were restricted to the northern half. Of the 108 found both in the north and south, 11 species were more abundant in the south, and two species were more abundant in the north.

The following 26 species were found only in the southern half of the Gulf:

Ammobaculites catenulatus Cushman and McCulloch
Bolivina costata d'Orbigny
Bolivina seminuda Cushman
Cassidulina cushmani Stewart and Stewart
Cibicides umbonatus Phleger and Parker
Cushmanella primitiva Palmer and Bermudez
Cyclocibicides vermiculatus (d'Orbigny)
Discorbis bertheloti (d'Orbigny)
Discorbis patelliformis (H. B. Brady)
Eponides polius Phleger and Parker
Gaudryina atlantica Bailey
Lagena squamosa (Montagu)
Loxostomum limbatum (H. B. Brady) variety *costulatum* (Cushman)
Massilina species
Pyrgo elongata (d'Orbigny)
Quinqueloculina baueri, new species
Rotalia rosea d'Orbigny
Siphogenerina raphanus (Parker and Jones)
Textularia panamensis Cushman
Tretomphalus atlanticus Cushman
Triloculina circularis Cushman
Triloculina labiosa d'Orbigny
Triloculina trigonula (Lamarck)
Trochammina pacifica Cushman
Uvigerina attenuata Coryell and Mossman
Valvulineria laevigata (Cushman)

The following six species were found to be more common in the southern half of the Gulf than elsewhere:

Cibicidella variablis Cushman
Cornuspira planorbis Schultze
Globigerinoides rubra (d'Orbigny)
Hauerina ornatissima (Karrer)
Pyrgo denticulata (H. B. Brady)
Tretomphalus bulloides (d'Orbigny)

The following six forms are strictly tropical and are restricted primarily to the southern half of the Gulf:

Amphisorus hemprichii Ehrenberg
Articulina lineata H. B. Brady
Gypsina globulus (Reuss)
Peneroplis pertusis (Forskål)
Planorbulina acervalis H. B. Brady
Spiroloculina antillarum d'Orbigny

The following four species were found only in the northern half of the Gulf:

Epistominella exigua (H. B. Brady)
Eponides umbonatus (Reuss)
Lagena amphora Reuss
Pullenia quinqueloba (Reuss)

These four species are deeper-water forms and occur in low frequencies, so the accuracy of this distribution is doubtful.

The following two species were situated primarily in the north:

Buliminella elegantissima (d'Orbigny) variety *tenuis* Cushman and McCulloch
Nonionella miocenica Cushman

The following species were found both in the northern and southern halves of the Gulf:

Angulogerina angulosa (Williamson)
Angulogerina hughesi Galloway and Wissler
Angulogerina occidentalis (Cushman)
Articulina lineata H. B. Brady
Bifarina hancocki Cushman and McCulloch
Bolivina acerosa Cushman variety *pacifica* Cushman and McCulloch
Bolivina acuminata Natland
Bolivina advena Cushman
Bolivina advena variety *striatella* Cushman
Bolivina minuta Natland
Bolivina paula Cushman and Cahill
Bolivina rhomboidalis (Millett)
Bolivina subexcavata Cushman and Wickenden
Bulimina denudata Cushman and Parker
Buliminella elegantissima (d'Orbigny) variety *tenuis* Cushman and McCulloch

Cancris auricula (Fichtel and Moll)
Cancris inflata (d'Orbigny)
Cassidulina laevigata d'Orbigny
Cassidulina subglobosa H. B. Brady
Chrysalidinella dimorpha (H. B. Brady)
Cibicidella variabilia (d'Orbigny)
Cibicides basiloba (Cushman)
Cibicides concentricus (Cushman)
Cibicides floridanus (Cushman)
Cibicides lobatulus (Walker and Jacob)
Cibicides refulgens (Montfort)
Cornuspira planorbis Schultze
Cymbaloporetta bradyi (Cushman)
Cymbaloporetta squammosa (d'Orbigny)
Discorbis candeianus (d'Orbigny)
Discorbis consobrinus (d'Orbigny)
Discorbis floridanus Cushman
Discorbis floridensis Cushman
Discorbis globosus (Sidebottom)
Discorbis obtusus (d'Orbigny)
Discorbis orbicularis (Terquem)
Dyocibicides biserialis Cushman and Valentine
Elphidium articulatum (d'Orbigny)
Elphidium crispum Cushman and Grant
Elphidium gunteri Cole
Elphidium incertum (Williamson)
Elphidium spinatum Cushman and Valentine
Eponides antillarum (d'Orbigny)
Eponides babsae, new species
Eponides hannai Phleger and Parker
Frondicularis advena Cushman
Globigerina bulloides d'Orbigny
Globigerina quinqueloba Natland
Globigerinoides rubra (d'Orbigny)
Globorotalia menardii (d'Orbigny)
Globorotalia truncatulinoides (d'Orbigny)
Globulina gibba d'Orbigny
Gypsina globulus (Reuss)
Hauerina bradyi Cushman
Hauerina ornatissima (Karrer)
Lagena sulcata (Walker and Jacob)
Lamellodiscorbis species
Loxostomum limbatum (H. B. Brady)
Massilina robustior Cushman and Valentine
Nodobaculariella atlantica Cushman and Hanzawa
Nonion grateloupi (d'Orbigny)
Nonionella atlantica Cushman
Nonionella miocenica Cushman
Patellina corrugata Williamson
Peneroplis pertusis (Forskål)
Planispirina exigua (H. B. Brady)
Planorbulina acervalis H. B. Brady
Planulina exorna Phleger and Parker
Poroeponides cribrorepandus Asano and Uchio
Pyrgo denticulata (H. B. Brady)
Pyrgo subsphaerica (d'Orbigny)
Quinqueloculina angulostriata Cushman and Valentine
Quinqueloculina cf. *angulostriata* Cushman and Valentine
Quinqueloculina agglutinans Natland
Quinqueloculina catalinensis Natland
Quinqueloculina costata d'Orbigny
Quinqueloculina crassa variety *subcuneata* Cushman
Quinqueloculina flexuosa d'Orbigny
Quinqueloculina funafutiensis (Chapman)
Quinqueloculina laevigata d'Orbigny
Quinqueloculina lamarckiana d'Orbigny
Quinqueloculina microcostata Natland
Quinqueloculina poeyana d'Orbigny
Quinqueloculina samoaensis Cushman
Quinqueloculina seminulum (Linnaeus)
Rectobolivina bifrons Cushman
Reophax ellisi, new species
Reussella aequa Cushman and McCulloch
Rotalia avalonensis Natland
Rotalia translucens Phleger and Parker
Spirillina vivipara Ehrenberg
Spiroloculina antillarum d'Orbigny
Spiroloculina planulata (Lamarck)
Streblus beccarii (Linné) variety *sobrinus* (Shupack)
Textularia agglutinans d'Orbigny
Textularia candeiana d'Orbigny
Textularia conica d'Orbigny
Textularia corrugata Heron-Allen and Earland
Textularia foliacea Heron-Allen and Earland
Textularia foliacea Heron-Allen and Earland variety *oceanica* Cushman
Tretomphalus bulloides (d'Orbigny)
Triloculina fichteliana d'Orbigny
Triloculina inflata d'Orbigny
Triloculina oblonga (Montagu)
Triloculina rotunda d'Orbigny
Uvigerina peregrina Cushman
Vertebralina striata d'Orbigny
Virgulina complanata Egger

Of the 139 species found, three (*Quinqueloculina* cf. *angulostriata*, *Quinqueloculina lamarckiana*, and *Textularia conica*) are very abundant, occurring throughout the entire Gulf and comprising a large percentage of some populations. In some samples these species comprise 50 per cent of the population. They are present in almost all samples except the dark organic clays, which contain a *Streblus beccarii* variety *sobrinus* and *Elphidium gunteri* assemblage.

The northern half of the Gulf appears to have no significant number of restricted forms. In this sense, it could never be considered a separate province, as was indirectly suggested by Cooper (1895, p. 37)

when he claimed that the fauna of the northern regions of the Gulf were largely of temperate affinity. None of the 139 species is a strictly temperate form. A few are eurythermal forms, occurring in both temperate and subtropical regions.

From the character of the populations it is evident that certain species which are considered typically tropical in their world distribution are rarely found north of Carmen Island. These species, listed in order of abundance, are:

Peneroplis pertusus (Forskål)
Hauerina ornatissima (Karrer)
Amphisorus hemprichii Ehrenberg
Spiroloculina antillarum d'Orbigny
Planorbulina acervalis H. B. Brady
Pyrgo denticulata (H. B. Brady)
Gypsina globulus (Reuss)

The first four of these species are indicators of a typical tropical marine environment and are often associated with coral reefs. They have not been reported north of Cape San Lucas on the western coast of Baja California. They usually occur together in the shallow sublittoral zone, averaging 15 per cent, often as high as 64 per cent, of the population. The absence of these tropical forms in the north suggests the existence of a major ecological barrier.

Temperature is probably the most important factor in the division of faunas. The northern limit of range of tropical faunas is believed to be at approximately the isotherm for 20° C. water temperature at the coldest time of the year. From oceanographic information available, the La Paz area does not usually experience sustained water temperatures below 17° C. Elements of tropical faunas, however, probably can survive in higher latitudes during the warmer months of the year.

The following species are more abundant

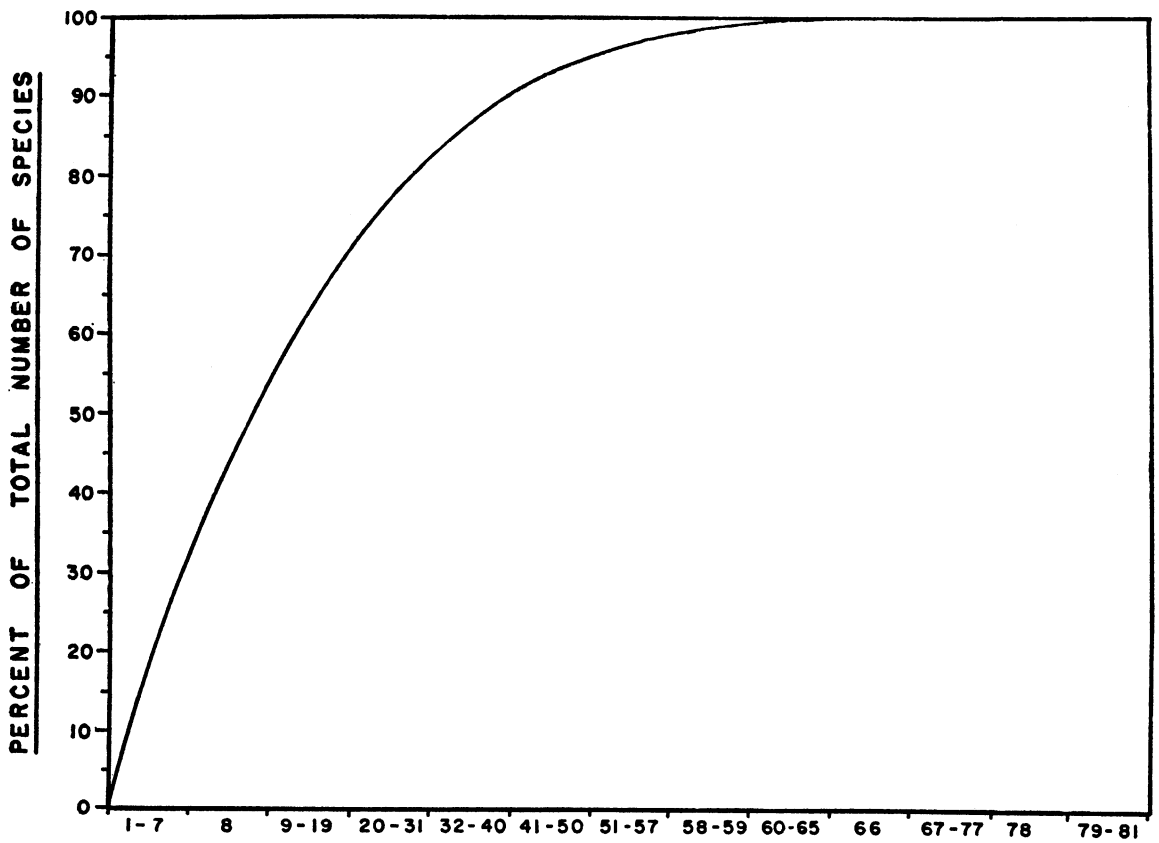


FIG. 2. Cumulative curve showing the percentage of the total number of species that occurred at each geographic segment.

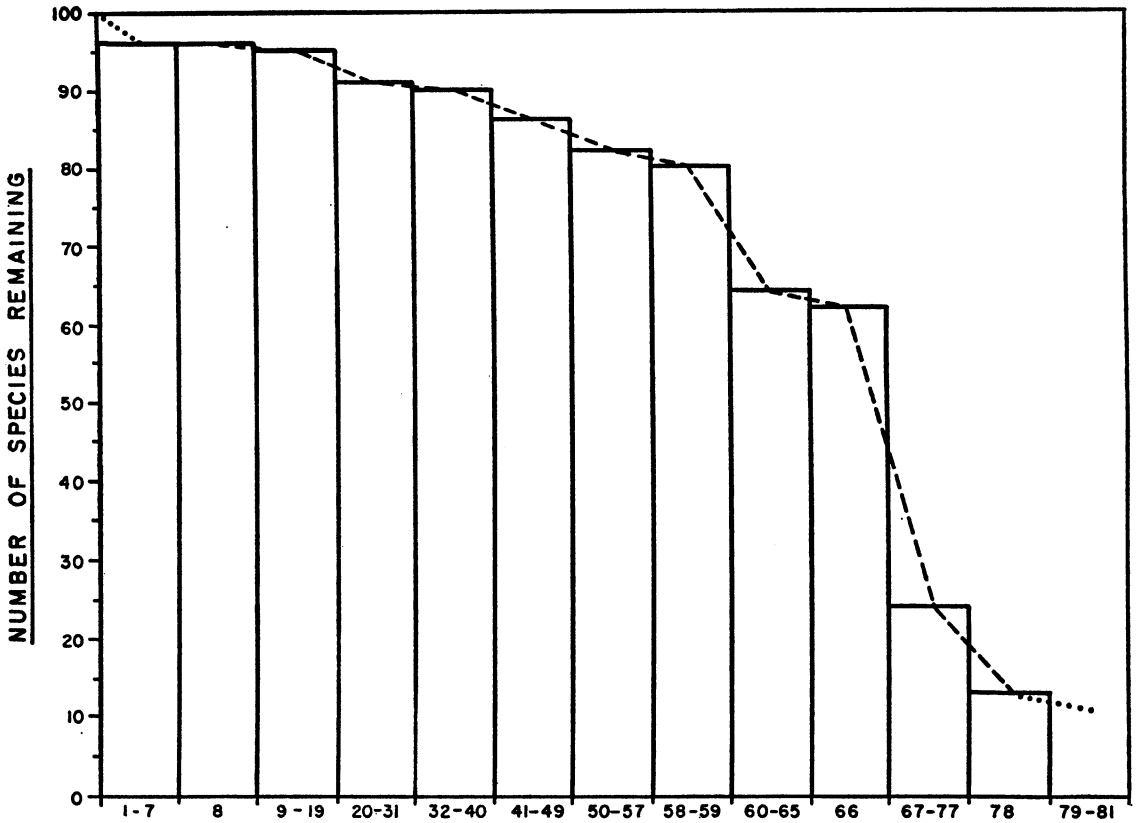


FIG. 3. Change in the southern population from south to north.

in the northern half of the Gulf than in the southern half:

Eponides hannai Phleger and Parker
Elphidium crispum Cushman and Grant
Elphidium gunteri Cole
Cibicides concentricus (Cushman)
Nonionella atlantica Cushman
Bulimina denudata Cushman and Parker

The absence, in the northern half of the Gulf of California, of *Peneroplis pertusus*, *Hauerina ornatissima*, *Amphisorus hemprichii*, and *Spiroloculina antillarum*, together with an increased appearance of the above six species, characterizes the typical northern population of the Gulf. The increased abundance of *Bulimina denudata* is due to the greater average depth of the samples taken in the north and therefore has no zoogeographic significance. It is interesting to note that *Eponides hannai*, *Elphidium gunteri*, *Cibicides concentricus*, and *Nonionella atlantica* are very abundant in the subtropical shelf of the Gulf of Mexico (Phleger and Parker, 1951). Subtropical conditions in the northern portions of the Gulf of California may explain the success of these forms.

GRAPHIC ANALYSIS

Figure 2 shows the percentage of the total number of species (139) that already have appeared in the samples from south to north in each geographic segment. From this graph it can be seen that 90 per cent of the total number of species have already occurred before the Carmen Island area (41–50) is reached and shows the paucity of species restricted to the northern portions of the Gulf. If the northern half of the Gulf contained a larger number of species, the curve would slope more gently, i.e., if 50 per cent of the species occurred in the south and 50 per cent in the north, the curve would assume a 45-degree angle with the axes.

For figure 3, 99 species found in samples 1

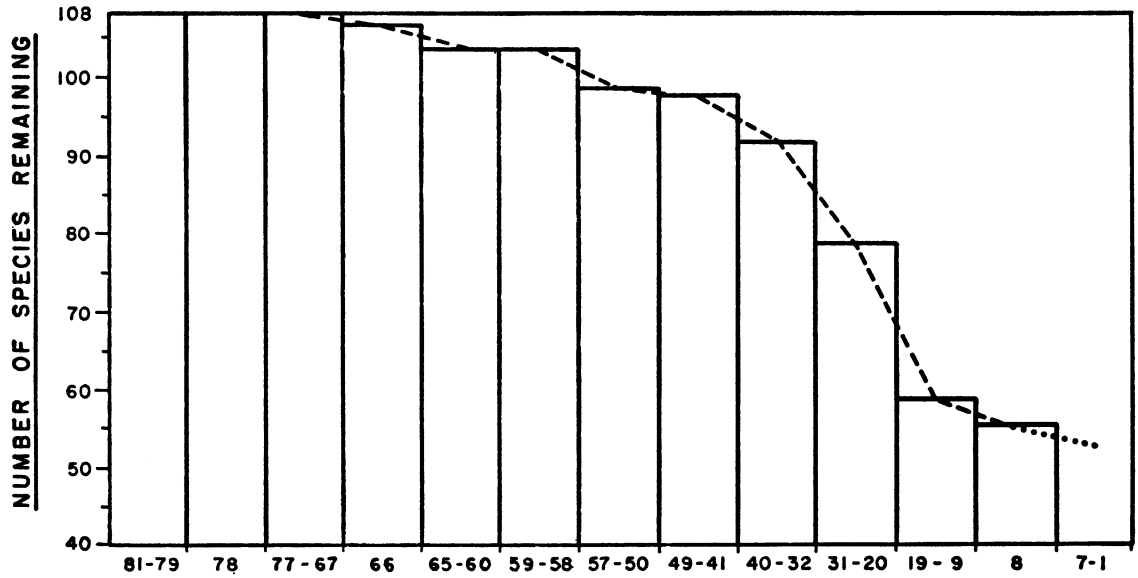


FIG. 4. Change in the northern population from north to south.

to 19 were arbitrarily chosen as forms typical of the southern tropical assemblage of the Gulf. The histogram illustrates the number of this original 99 species that were still to be found at each geographic segment in a northern direction.

Figure 4 is essentially the same type of histogram except that it traces the change in 108 species found between sample 66 and sample 81 in the north.

A comparison of the two curves indicates that the number of species in the north drops off more gradually than that of the species in the south, probably owing to the fact that a significant number of southern species are more sensitive to the geographical thermal gradient than more eurythermal forms inhabiting the northern areas and extending into the more tropical southern regions of the Gulf.

A marked decrease in the number of southern forms occurs north of the Carmen Island area, as is indicated by the sudden change in slope at this segment in figure 3. The northern population also decreases more rapidly in this segment, as can be seen in figure 4.

PROVINCIAL AFFINITIES OF THE GULF FORAMINIFERA

The following is a breakdown of the geographic affinities of the 139 species in this collection:

	NUMBER OF SPECIES
Endemic to American tropical Pacific	38
In both the American tropical Pacific and American tropical Atlantic, but not elsewhere	28
In both the American tropical Pacific and Indo-Pacific, but not elsewhere	6
Circumtropical forms	43
Eurythermal forms	24

The largest number of species are circumtropical forms which constitute 30.9 per cent of the total population. It appears that the remainder of the Gulf foraminiferal population (27.3%) have their greatest affinity with the Panamic Province, whereas 20.2 per cent are Amphi-American. A small percentage (4.3%) show affinities with the Indo-Pacific. Eurythermal forms found in temperate and tropical regions consitute 17.3 per cent of the total population.

A study of this type was made on 390 species of crabs and 210 species of echinoderms from the American Pacific warm-water region (Eckman, 1953, p. 40). The number of circumtropical forms in these groups constituted 2 per cent of the total number of species. The larger number of circumtropical Foraminifera may be due to the greater

capacity of these small and lighter forms to attach to floating material and to be transported for great distances by ocean currents. The crabs and echinoderms, as do the Foraminifera, show a greater percentage (75%–76%) of endemic eastern Pacific than Amphi-American species. In the Foraminifera, however, the number of endemic species is only 7.1 per cent higher than that of the Amphi-American.

Sedimentary Types

The sediments in these collections fall into five major groups: (1) bioclastic deposits; (2) clastics derived from granitic and metamorphic crystallines and containing large quantities of mica and quartz; (3) clastics derived from volcanic sediments and containing quartz, obsidian, felsite, and limonite; (4) clastics derived from extrusives and containing fragments of basalt, obsidian, pumice, and often granitic pebbles; and (5) dark organic clays with large numbers of *Streblus beccarii* variety *sobrinus* and *Elphidium gunteri.*

Of the 81 samples collected, 40 are of clastic sediments composed primarily of the remains of mollusks, echinoid spines, Foraminifera, coralline algae, and bryozoan fragments. Bioclastics were found in numerous bays and inlets along the east and west coasts of the Gulf and along the islands. The majority of the bioclastics are composed of molluscan fragments. Bioclastics derived from coral and algal reefs are found at Pulmo (sample 4), San Lorenzo Channel (sample 9), San Gabriel Bay (samples 13, 14, and 15), and off the southwest coast of San Francisco Island (samples 21 and 22).

The second most dominant type of sediment in this collection is primarily a micaceous quartz sand derived from metamorphic and intrusive crystallines, of which samples from Gonzaga Bay south of San Luis Island are excellent examples. About 28 per cent of the samples in this collection belong to this group.

The sediments found off San Pedro Nolasco Island are composed primarily of basaltic and granitic fragments, which indicate intrusive and extrusive source material. Fragments of pumice and scoria are being deposited along the coast of San Luis Island. Samples 76, 77, and 78 consist almost entirely of this material.

The remaining samples are organic clays, with very unusual foraminiferal populations, as mentioned above. Samples 79, 80, and 81 are from black deltaic clays derived from the Colorado River. Only eight samples in this collection are classified as mud or clay.

FAMILY **RHEOPHACIDAE**

GENUS **REOPHAX** MONTFORT, 1808

Reophax ellisi, new species

Plate 40, figure 3

DIAGNOSIS: This species is similar to *Reophax communia* Lacroix, 1930, but differs from it by having a smoother surface, smaller grains in the test material, and greater obscurity of the sutures.

Test very minute, elongate, axis usually straight; composed of six to eight chambers gradually increasing in size, the individual chambers almost entirely obscured by agglutinating material except for the last few chambers which can be distinguished more easily; proloculum distinct from subsequent chambers; wall composed of large grains of quartz and some obsidian firmly cemented into a fine-grained matrix and giving the surface a smooth appearance; aperture terminal, round, and very small. Holotype: Length, 0.196 mm.; maximum width, 0.046 mm.

Holotype (Department of Micropaleontology at the American Museum of Natural History No. FT 1188) from bottom sample 34, center of Aqua Verde Bay, Baja California; latitude 25° 31′ N., longitude 110° 4′ W.,

FAMILY **LITUOLIDAE**

SUBFAMILY **HAPLOPHRAMIINAE**

GENUS **AMMOBACULITES** CUSHMAN, 1910

Ammobaculites catenulatus Cushman and McCulloch

Ammobaculites catenulatus CUSHMAN AND MCCULLOCH, 1939, Allan Hancock Pacific Exped., vol. 6, no. 1, p. 90, pl. 7, figs. 11–14.

Only a single specimen of this species was found, in bottom sample 49 off Coronados Island in 75.3 meters.

It is distinguished by its involuted coiled portion, indistinct sutures, and attenuated later stage.

FAMILY **TEXTULARIIDAE**

SUBFAMILY **TEXTULARIINAE**

GENUS **TEXTULARIA** DEFRANCE, 1824

Textularia agglutinans d'Orbigny

Textularia agglutinans D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 136, pl. 1, figs. 17, 18, 32, 34.

This species ranges infrequently throughout most of the Gulf from Mazatlan to San Luis Island at latitude 29° 56′ 30″ N.

It was originally described from the shore sands of Cuba and is typical of the West Indian region. It has been reported from off the west coast of Central America and the Indo-Pacific, but is not common.

Textularia candeiana d'Orbigny

Textularia candeiana D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 143, pl. 1, figs. 25–27.

Textularia sagittula Defrance var. *candeiana*, MILLET, 1899, Jour. Roy. Micros. Soc., p. 562, pl. 7, fig. 2.

The slender early portion of the test and the inflated later portions are characteristic of this species.

It is found only in the southern half of the Gulf at very shallow depths, usually less than 6 meters.

This species is quite common in waters adjacent to the West Indies. It is, however, circumtropical in distribution.

Textularia conica d'Orbigny

Plate 40, figure 2

Textularia conica D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 143, pl. 1, figs. 13, 14.

Test distinctly triangular in front view, with a subacute periphery. Chambers increasing rapidly in size but not in height, resulting in a short stout test; last septal faces flat, causing a truncated end.

This species is one of the most abundant in the Gulf. It ranges throughout the length of the Gulf and occurs in most of the samples. Because of its extreme range it is not useful in geographic zonation.

This species is common in the West Indies. It also occurs in the Indo-Pacific area and off the west coast of Central America, but is not reported from southern California. It is probably strictly tropical.

Textularia corrugata Heron-Allen and Earland

Textularia conica d'Orbigny var. *corrugata* HERON-ALLEN AND EARLAND, 1915, Trans. Zool. Soc. London, vol. 20, p. 629, pl. 47, figs. 24–27.
Textularia corrugata, CUSHMAN (not Costa), 1932, Bull. U. S. Natl. Mus., no. 161, pt. 1, pl. 3, figs. 2, 4.

This form seems to be genetically related to *Textularia conica* but differs from it in its strongly depressed sutures, which become more numerous in the later stages of growth, giving the test a pustulose appearance. Many samples contain transitional types difficult to categorize.

It commonly occurs throughout the Gulf with *Textularia conica* but is not so numerous.

It has been reported from the Kerimba Archipelago and from various localities in the Indo-Pacific area. Cushman and McCulloch (1939, p. 126) report this species from the Gulf of California, off Mexico, Central America, Columbia, Ecuador, and the Galapagos Islands.

Textularia foliacea Heron-Allen and Earland

Plate 40, figure 1

Textularia foliacea HERON-ALLEN AND EARLAND, 1915, Trans. Zool. Soc. London, vol. 20, p. 628, pl. 47, figs. 17–20.

The roughly finished, highly arenaceous test is a marked character of this species. The grains are large, irregular in shape, and diversified in mineral composition.

This species is recorded in the Gulf from bottom sample 28, on the western side of the tip of San José Island, to bottom sample 68, off the northern coast of Angel de la Guarda, in depths ranging from 19.5 to 79.4 meters.

This species is characteristic of the Indo-Pacific waters. Its only other recorded locality is in the tropical eastern Pacific area.

Textularia foliacea Heron-Allen and Earland variety **oceanica** Cushman

Textularia foliacea Heron-Allen and Earland var. *oceanica* CUSHMAN, 1932, Bull. U. S. Natl. Mus., no. 161, pt. 1, p. 8, pl. 1, figs. 11, 12.

This variety differs from the typical form in having a broader aperture, thicker test, more rounded periphery, and more roughly finished surface.

It is infrequent in the Gulf, from Espíritu Santo Island in the south to San Luis Island in the north.

This common Indo-Pacific species is also reported from the tropical eastern Pacific region.

Textularia panamensis Cushman

Textularia panamensis CUSHMAN, 1918, Bull. U. S. Natl. Mus., no. 103, p. 53, pl. 20, figs. 1a, 1b.
Textularia espersoni APPLIN, 1925, Bull. Amer. Assoc. Petrol. Geol., vol. 9, no. 1, p. 97, pl. 3, fig. 2.

This species can be distinguished by its very compressed test and rhomboidal shape in front view.

It is rare in this collection. It occurs only once, in sample 1, at Mazatlan, in 2.5 meters of water, where it comprised 15 per cent of the population.

The original form described by Cushman is from the Miocene of the Panama Canal Zone. It is also reported by the Allan Hancock expeditions to the Pacific in the Gulf of California, southward off Central America, Ecuador, and Peru.

FAMILY **VERNEUILINIDAE**

GENUS **GAUDRYINA** D'ORBIGNY, 1839

Gaudryina atlantica Bailey

Textularia atlantica BAILEY, 1851, Smithsonian Contrib. Knowl., vol. 2, art. 3, p. 12, figs. 38–43.
Gaudryina atlantica (Bailey) PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., vol. 46, p. 6, pl. 2, figs. 13a, 13b.

This species, rare in this collection, occurs only twice: off Espíritu Santo Island (sample 9) and off San José Island (sample 29).

This record is the first in the Gulf of California, and in the present collection the species is found in only the southern half of the Gulf.

Until the present record, *Gaudryina atlantica* had been recorded living only off the west coast of Central America.

FAMILY **TROCHAMMINIDAE**

GENUS **TROCHAMMINA** PARKER AND JONES, 1859

Trochammina pacifica Cushman

Trochammina pacifica CUSHMAN, 1925, Con-

trib. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 39, pl. 6, figs. 3a, 3b, 3c.

Specimens are rare and occur in samples 3 and 22.

This species is reported only from the western coast of America, from Cordova, Alaska, southward to Sechura Bay, Peru.

FAMILY MILIOLIDAE

GENUS QUINQUELOCULINA d'ORBIGNY, 1826

Quinqueloculina angulostriata Cushman and Valentine

Quinqueloculina angulostriata CUSHMAN AND VALENTINE, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 12, pl. 2, figs. 5a, 5b, 5c.

This species commonly occurs throughout most of the Gulf in very shallow waters. Previously, it had been recorded off the west coast of Central America and southern California.

Quinqueloculina cf. angulostriata Cushman and Valentine

Plate 40, figure 6

This species is very similar in form to *Quinqueloculina angulostriata*, but it lacks the costate ornamentation characteristic of that species. In all probability it is a geminate species deserving a new specific name.

It is one of the most abundant forms in the whole Gulf, where it occurs mostly on shallow, near-shore bottoms.

Similar species have been reported from the eastern Atlantic and off the coast of France. This species appears identical with the form described under this name by Natland (1950, p. 8) from the Pliocene and Pleistocene of the Gulf of California.

Quinqueloculina agglutinans d'Orbigny

Quinqueloculina agglutinans d'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 195, pl. 12, figs. 11–13.

This species is common in the shallow waters of the West Indian region and rare in the Gulf. It is found at depths ranging from 1.5 to 38.3 meters.

Quinqueloculina baueri, new species

Plate 40, figures 7, 8

DIAGNOSIS: This species is similar to *Quinqueloculina parkeri* (H. B. Brady) from the Indo-Pacific, but has finer and more numerous costae on each chamber.

Test large, about one and one-half times as long as wide; periphery subacute to subrounded; chambers distinct and ornamented with many fine parallel costae extending the entire length of each chamber; costae having subacute ridges and broad troughs forming, approximately, a 30-degree angle with the axis of coiling and having from 18 to 21 costae in the last chamber; aperture rounded, with a simple tooth, not extending beyond the periphery. Holotype: length, 0.488 mm.; maximum width, 0.368 mm.

Quinqueloculina baueri appears to have evolved from *Quinqueloculina catalinensis* Natland by the further development and parallelism of the surface corrugations.

Quinqueloculina lamarckiana is similar in size and form to *Quinqueloculina baueri* but lacks the pronounced costate ornamentation. It differs from *Quinqueloculina angulostriata* in its broader width and lack of angularity.

Holotype (Department of Micropaleontology at the American Museum of Natural History No. FT 1189) from sample 48, southwestern side of Coronados Island, Baja California; latitude 26° 6′ 30″ N., longitude 111° 18′ 30″ W.

Quinqueloculina catalinensis Natland

Quinqueloculina catalinensis NATLAND, 1938, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 4, no. 5, p. 142, pl. 4, figs. 3a, 3b, 3c.

The validity of this form as a distinct species is questioned by the present writer. The species occurs almost invariably with *Quinqueloculina lamarckiana* d'Orbigny. The latter species contains specimens in the population in which the surface becomes slightly crenulated. *Quinqueloculina catalinensis* was considered a distinct species by Natland, and it is possible that this form, which represents only a normal variant in a population of *Quinqueloculina lamarckiana* in the Gulf, is recognized as a distinct species in southern California.

Natland (1950) reports this form from Santa Catalina Island and off the west coast of Central America.

Quinqueloculina costata d'Orbigny

Quinqueloculina costata d'ORBIGNY, 1878, Mem. Soc. Geol. France, ser. 3, vol. 1, no. 3, p. 63, figs. 6, 6a, 6b.

This species occurs infrequently in the Gulf, is restricted to rather shallow water, in depths ranging from 0.8 meter to 12 meters, and is distributed throughout the whole Gulf.

It is circumtropical in distribution and is often confused with *Quinqueloculina poeyana* d'Orbigny. The latter is not so broad as *Quinqueloculina costata*, its length being three times its width.

Quinqueloculina crassa d'Orbigny var. **subcuneata** Cushman

Miliolina crassa HERON-ALLEN AND EARLAND (part, not d'Orbigny), 1915, Trans. Zool. Soc. London, vol. 20, p. 572, pl. 42, fig. 41 (not figs. 37–40).

Quinqueloculina crassa d'Orbigny var. *subcuneata* CUSHMAN, 1921, Bull. U. S. Natl. Mus., no. 100, vol. 4, p. 423, pl. 89, figs. 4a, 4b, 4c; 1932, Bull. U. S. Natl. Mus., no. 161, pt. 1, p. 21, pl. 5, fig. 89c.

This species is found in the shallow waters of the Gulf, in depths ranging from 0.9 meter to 19.8 meters. It has a wide distribution and is found in both the northern and the southern ends of the Gulf.

This species is a common form in the Indo-Pacific. In the West Indies it is reported from Puerto Rico.

Quinqueloculina flexuosa d'Orbigny

Quinqueloculina flexuosa D'ORBIGNY, 1839, Voyage dans l'Amerique Meridionale, p. 73, pl. 14, figs. 4–6.

This species rarely occurs in the Gulf. It is absent along the coast between San José Island, in the south, and San Luis Island, in the north.

It has been reported off the coast of southern California and the west coast of Central America.

Quinqueloculina funafutiensis (Chapman)

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

Quinqueloculina funafutiensis, CUSHMAN, 1922, Publ. Carnegie Inst. Washington, no. 311, p. 67, pl. 13, fig. 3.

This species was originally described by Chapman from the lagoon at Funafuti in the Pacific. It has also been reported from the Tortugas in the West Indian region.

In the Gulf it occurs infrequently from Aqua Verde Bay, in the south, to Gonzaga Bay, in the north, in depths of from 2.5 to 19.8 meters.

Quinqueloculina laevigata d'Orbigny

Quinqueloculina laevigata D'ORBIGNY, 1839, *in* Barker-Webb and Berthelot, Histoire naturelle des Iles Canaries, vol. 2, pt. 2, p. 143.

Quinqueloculina seminula (Linné) NATLAND (not Linné), 1938, Bull. Scripps. Inst. Oceanogr., tech. ser., vol. 3, no. 10, line 61 of included chart.

In many specimens the costae are extremely subdued and often absent. These specimens, however, appear to be in the range of normal variation of the species.

This species has been reported from southern California, off the west coast of Central America, and from the Florida region.

Quinqueloculina lamarckiana d'Orbigny

Quinqueloculina lamarckiana D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 189, pl. 11, figs. 14, 15.

Quinqueloculina auberiana D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 193, pl. 12, figs. 1–3.

Quinqueloculina cuvieriana H. B. BRADY (not d'Orbigny), 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 162, pl. 5, figs. 12a, 12b, 12c.

This species is the most abundant in the Gulf. Variations in its population have been given specific rank by some authors, such as *Quinqueloculina catalinensis* Natland and *Quinqueloculina microcostata* Natland. The present writer has maintained the taxonomic status of these three "species" until comparisons with the type material can be made.

This species is not restricted to any particular part of the Gulf and is therefore of no use in zonation.

From the available literature, it appears that this species is circumtropical in distribution.

Quinqueloculina microcostata Natland

Quinqueloculina microcostata NATLAND, 1938, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 4, no. 5, p. 142, pl. 4, figs. 6a, 6b, 6c.

This species differs from *Quinqueloculina lamarckiana* d'Orbigny by having fine costae parallel to the length of the chambers.

In the Gulf this form occurs as a normal variant in the population of *Quinqueloculina*

lamarckiana. It therefore occurs less frequently than *Quinqueloculina lamarckiana*, but has the same general distribution in the Gulf.

Natland (1950) reports this form from southern California and off the west coast of Central America.

Quinqueloculina poeyana d'Orbigny

Quinqueloculina poeyana D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 191, pl. 11, figs. 25–27.

This species has often been confused with *Quinqueloculina costata* d'Orbigny. *Quinqueloculina poeyana* d'Orbigny is more elongate, being at least three times as long as broad.

This species is distributed throughout the entire Gulf and is very common in the present collection. It is a common form in the West Indies region.

Quinqueloculina samoaensis Cushman

Quinqueloculina samoaensis CUSHMAN, 1924, Publ. Dept. Marine Biol., Carnegie Inst. Washington, no. 342, p. 59, pl. 21, figs. 4–7.

In samples 28 through 68 are a few specimens which seem to be identical with the type species described from 17 fathoms at Samoa. The peculiar twisted nature of the chambers and the extended cylindrical neck are distinguishing characteristics of this form.

In the Gulf it seems to inhabit slightly deeper waters than most miliolids. It is found in depths ranging from 12 to 79.4 meters. Its distribution is skewed towards the deeper end of its range.

Quinqueloculina seminulum (Linné)

Serpula seminulum LINNÉ, 1767, Systema naturae, ed. 12, no. 791, p. 1264.

Quinqueloculina seminulum, D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 44, p. 303. CUSHMAN, 1917, Bull. U. S. Natl. Mus., no. 71, pt. 6, p. 44, pl. 11, fig. 2.

Miliolina seminulum, WILLIAMSON, 1858, On the Recent Foraminifera of Great Britain, p. 85, pl. 7, figs. 183–185.

This ubiquitous species occurs infrequently in both the northern and the southern halves of the Gulf. It seems to favor water shallower than 12 meters.

GENUS **MASSILINA** SCHLUMBERGER, 1893

Massilina robustior Cushman and Valentine

Massilina robustior CUSHMAN AND VALENTINE, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 13, pl. 3, figs. 5a, 5b, 5c.

This species is rare in the Gulf, occurring in a few samples in both the northern and southern halves. Its maximum occurrence is in *Lithophyllum* gravel off Coronados Island (sample 48) where it comprises 3 per cent of the population.

Natland (1950) reports this species as common in *Lithothamnion* bottom in the Bay of Avalon, Santa Catalina Island. It seems to prefer clear, warm, shallow water.

Massilina species

Very minute forms resembling representatives of the genus *Massilina* occur in the extreme southern half of the Gulf, in only a few samples, and they are abundant in sample 4 only, where they comprise 20 per cent of the population. Possibly these specimens are juvenile stages of a larger miliolid.

GENUS **SPIROLOCULINA** D'ORBIGNY, 1826

Spiroloculina antillarum d'Orbigny

Spiroloculina antillarum D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 166, pl. 9, figs. 3, 4.

This circumtropical species occurs occasionally in the Gulf but drops off materially north of sample 46. It is considered a strictly tropical form, absent in cooler waters.

Spiroloculina planulata (Lamarck)

Miliolites planulata LAMARCK, 1804, Ann. Mus. d'Hist. Nat., Paris, vol. 5, no. 4, p. 352.

Spiroloculina planata (Lamarck) MCDONALD, 1857, Ann. Mag. Nat. Hist., ser. 2, vol. 20, p. 153, pl. 6, fig. 28.

This species is rarely found in the southern half of the Gulf. It has been previously reported from the British Isles, Mason Inlet in North Carolina, the West Indies, and southern California. There are some dubious records from the Pacific.

GENUS **ARTICULINA** D'ORBIGNY, 1826

Articulina lineata H. B. Brady

Articulina lineata H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S.

Challenger, Zoology, vol. 9, p. 183, pl. 12, figs. 19–21.

This species, common in the West Indies and less common in the Indo-Pacific area, is restricted to strictly tropical waters.

In the Gulf, its frequency diminishes considerably north of San José Island (latitude 24° 52′ 30″ N.).

GENUS **HAUERINA** d'ORBIGNY, 1839

Hauerina bradyi Cushman

Hauerina bradyi CUSHMAN, 1917 (part), Bull. U. S. Natl. Mus., no. 71, pt. 6, p. 62 (not pl. 23, fig. 2); 1946, Contrib. Cushman Lab. Foram. Res., vol. 22, p. 11, pl. 2, figs. 14, 20, 21.

Hauerina compressa H. B. BRADY (not d'Orbigny), 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 11, figs. 12, 13.

This species is common in the Indo-Pacific region and is also reported from Cuba and the Tortugas region off Florida.

In the Gulf of California it is found occasionally in the north and the south, but does not represent more than 4 per cent of the population. Specimens occur in shallow depths only, not greater than 12 meters.

Hauerina ornatissima (Karrer)

Quinqueloculina ornatissima KARRER, 1868, Sitz. Akad. Wiss. Wien, vol. 58, p. 151, pl. 3, fig. 2.

Hauerina ornatissima, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 192, pl. 7, figs. 15–22.

This species is a common shallow-water form in the Indo-Pacific. It occurs more sparingly in the West Indies.

It is distributed throughout most of the Gulf, but is more common in the south, decreasing notably north of Carmen Island.

GENUS **TRILOCULINA** d'ORBIGNY, 1826

Triloculina circularis Bornemann

Triloculina circularis BORNEMANN, 1855, Zeitschr. Deutschen Geol. Gesell., vol. 7, p. 349.

Miliolina circularis, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 169, pl. 4, figs. 3a, 3b, 3c, pl. 5, figs. 13, 14.

This species differs from other forms in its plate-like tooth and in the fact that the test is very much broader than long, with highly inflated chambers.

In southern California and off the west coast of Central America it is found in shallow water less than 40 meters deep. It is also common in the Pacific and the West Indies.

In the Gulf it is more commonly found in the southern half (becoming sparse north of Carmen Island), in depths of less than 19.4 meters.

Triloculina fichteliana d'Orbigny

Triloculina fichteliana D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 171, pl. 9, figs. 8–10.

This is a typically West Indian species, less commonly found in the Indo-Pacific. It is rare in the Gulf and is absent from areas north of San Esteban Island in the present collection.

Triloculina inflata d'Orbigny

Triloculina inflata D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, p. 300.

This species occurs throughout most of the Gulf in waters usually less than 10 meters deep. It is generally abundant, comprising a small percentage of the samples.

Previously it had been reported off the west coast of Central America.

Triloculina labiosa d'Orbigny

Triloculina labiosa D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 178, pl. 10, figs. 12–14.

Miliolina labiosa, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 170, pl. 6, figs. 3–5.

The broader-than-long chambers, irregular crescentic form, and triangular tooth are characteristic of this species.

It is common in the Indo-Pacific and the West Indies, also having been reported from southern California.

This species is very rare in the present collection; only one specimen was found, in sample 33, at a depth of 10.2 meters.

Triloculina oblonga (Montagu)

Vermiculum oblongum MONTAGU, 1803, Testacea Britannica, p. 522, pl. 14, fig. 9.

Triloculina oblonga, D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 16, p. 300; Modeles no. 95.

This species has been reported off southern California and off the west coast of Central America in water shallower than 60 meters. It is also found in the West Indies and in Indo-Pacific waters.

It is distributed throughout most of the Gulf, but is abundant in only a few samples, being found in depths of usually less than 22 meters.

Triloculina rotunda d'Orbigny

Triloculina rotunda d'Orbigny, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 4, p. 299. Cushman, 1929, Bull. U. S. Natl. Mus., no. 104, pt. 6, p. 59, pl. 14, figs. 3a, 3b, 3c.

Specimens of this species were infrequent but were distributed throughout most of the Gulf. In the present collection, its depth ranged from 0.9 meter to 73.8 meters.

This species has been reported from the West Indies and off the west coast of Central America.

Triloculina trigonula (Lamarck)

Miliola trigonula Lamarck, 1804, Ann. Mus. d'Hist. Nat., Paris, vol. 5, p. 351; 1807, Ann. Mus. d'Hist. Nat., Paris, vol. 9, pl. 17, fig. 4.

Triloculina trigonula, d'Orbigny, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 1, p. 299, pl. 16, figs. 5–9; Modeles no. 93.

Miliolina trigonula, Williamson, 1858, On the Recent Foraminifera of Great Britain, p. 84, pl. 7, figs. 180–182.

This species is rare in the southern half and absent in the northern half of the Gulf. It is found in depths ranging from 21.8 to 75.3 meters and is a circumtropical form.

Genus **PYRGO** Defrance, 1824

Pyrgo denticulata (H. B. Brady)

Biloculina ringens Lamarck var. *denticulata* H. B. Brady, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 143, pl. 3, figs. 4, 5.

Biloculina denticulata Cushman, 1917, Bull. U. S. Natl. Mus., no. 71, pt. 6, p. 80, pl. 33, fig. 1.

Pyrgo denticulata, Cushman, 1929, Bull. U. S. Natl. Mus., no. 104, pt. 6, pl. 18, figs. 3, 4.

This circumtropical species is primarily restricted to the southern half of the Gulf, where it reaches a maximum frequency of 10 per cent of the population in sample 31. Most samples, however, contain less than 2 per cent of *Pyrgo denticulata*. Its most northern extent is at sample 60, the southern tip of Tiburón Island.

Pyrgo elongata (d'Orbigny)

Biloculina elongata d'Orbigny, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 4, p. 298.

Pyrgo elongata (d'Orbigny) Cushman, 1929, Bull. U. S. Natl. Mus., no. 104, pt. 6, p. 70, pl. 19, figs. 2, 3.

A small number of specimens of *Pyrgo elongata* were found in five southern samples; the depths range from 3.7 to 43.4 meters.

This species is common in the Indo-Pacific, off southern California, and off the west coast of Central America. There are some reports of it from the east coast of the United States and the West Indies.

Pyrgo subsphaerica (d'Orbigny)

Biloculina subsphaerica d'Orbigny, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 162, pl. 8, figs. 25–27.

Pyrgo subsphaerica (d'Orbigny) Cushman, 1929, Bull. U. S. Natl. Mus., no. 104, pt. 6, p. 68, pl. 18, figs. 1, 2.

This species is present in low frequencies in several shallow-water samples. A maximum frequency of 5 per cent was found at its southernmost occurrence off Point San Marcial (sample 36). It is a characteristic West Indian species.

Family **OPHTHALMIDIIDAE**

Subfamily **CORNUSPIRINAE**

Genus **CORNUSPIRA** Schultze, 1854

Cornuspira planorbis Schultze

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

Cornuspira involens Cushman (not Reuss), 1932, Bull. U. S. Natl. Mus. no. 161, pt. 7, p. 67, pl. 16, figs. 2a, ab.

This species is present in a few samples from the Gulf in frequencies of less than 2 per cent, in water shallower than 46.2 meters.

It has been reported from the Indo-Pacific, off the west coast of Central America, and off the coast of southern California.

Subfamily **NODOPHTHALMIDIINAE**

Genus **NODOBACULARIELLA** Cushman and Hanzawa, 1937

Nodobacullariella atlantica Cushman and Hanzawa

Nodobacullariella atlantica Cushman and

HANZAWA, 1937, Contrib. Cushman Lab. Foram. Res., vol. 13, pt. 2, p. 42, pl. 5, figs. 7, 8.

This form is common in the tropical and subtropical waters of America. The early stages of *Articulina lineata* Brady resemble the adult form of *Nodobaculariella atlantica*. The former, however, has an early quinqueloculine stage.

This species occurs throughout the Gulf at depths of usually less than 21 meters.

GENUS **VERTEBRALINA** D'ORBIGNY, 1826

Vertebralina striata d'Orbigny

Vertebralina striata D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 1, p. 283; Modeles no. 81.

Early portions coiled, later uncoiling into broad uniserial chambers that are ornamented with fine longitudinal striae, which serve to identify early ontogenetic forms.

This species is rare in the Gulf, occurring in both the north and the south in low frequencies.

Vertebralina striata is a typical Indo-Pacific form; it occurs less commonly in the West Indian region.

SUBFAMILY **OPHTHALMIDIINAE**

GENUS **PLANISPIRINA** SEGUENZA, 1880

Planispirina exigua (H. B. Brady)

Hauerina exigua H. B. BRADY, 1879, Quart. Jour. Micros. Sci., vol. 19, p. 53.

Planispirina exigua, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 196, pl. 12, figs. 1–4.

This species is rare in the Gulf. It is common in the tropical waters of the Pacific and the West Indies.

FAMILY **TROCHAMMINIDAE**

GENUS **TROCHAMMINA** PARKER AND JONES, 1859

Trochammina pacifica Cushman

Trochammina pacifica CUSHMAN, 1925, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 39, pl. 6, figs. 3a, 3b, 3c.

This species has a wide geographic range along the eastern Pacific coast. It has been recorded from Cordova, Alaska, southward to Sechura Bay, Peru. It is rare in the present collection and is found in only two samples in the south.

FAMILY **LAGENIDAE**

GENUS **FRONDICULARIA** DEFRANCE, 1824

Frondicularia advena Cushman

Frondicularia advena CUSHMAN, 1933, Bull. U. S. Natl. Mus., no. 104, pt. 4, p. 141, pl. 20, figs. 1, 2.

This species was found in low frequencies in a few samples, coming from depths averaging 39 meters.

It has been reported from southern California and off the west coast of Central America.

GENUS **LAGENA** WALKER AND JACOB, 1798

Lagena amphora Reuss

Lagena amphora REUSS, 1858, Zeitschr. Deutschen Geol. Gesell., vol. 10, pt. 4, art. 4, pp. 433–438.

Lagena costata (Williamson) var. *amphora* Reuss of authors.

This species differs from the typical *Lagena costata* (Williamson) in its elongate, flask-shaped test and its much-extended apertural end.

It has previously been reported from southern California, off the west coast of Central America, and in the Gulf of California. A single specimen was found in sample 66 at a depth of 16.6 meters.

Lagena squamosa (Montagu)

Vermiculum squamosum MONTAGU, 1803, Testacea Britannica, p. 526, pl. 14, fig. 2.

Entosolenia squamosa, WILLIAMSON, 1858, On the Recent Foraminifera of Great Britain, p. 12, pl. 1, fig. 29.

Lagena squamosa, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 471, pl. 63, figs. 28–31.

One specimen of this species was found in sample 30 at a depth of 70.7 meters.

Lagena sulcata (Walker and Jacob)

Serpula (Lagena) striata sulcata rotunda WALKER AND BOYS, 1784, Testacea minuta, p. 2, pl. 1, fig. 6.

Serpula (Lagena) sulcata, WALKER AND JACOB, 1798, Adams Essays, Kanmacher's ed., p. 634, pl. 14, fig. 5.

Lagena sulcata, PARKER AND JONES, 1865, Phil. Trans., vol. 155, p. 351.

A few specimens of this cosmopolitan species occur in samples 51 and 67.

FAMILY POLYMORPHINIDAE

SUBFAMILY POLYMORPHININAE

GENUS GLOBULINA D'ORBIGNY, 1839

Globulina gibba d'Orbigny

Globulina gibba D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, p. 266; Modeles no. 63.
Polymorphina gibba (d'Orbigny) BRADY, PARKER, AND JONES, 1870, Trans. Linnean Soc. London, vol. 27, p. 216, pl. 39, figs. 2a, 2b.

This species is rare in the Gulf. It is found in three samples (28, 29, and 61) at depths greater than 20 meters. It has a world-wide distribution.

FAMILY NONIONIDAE

GENUS NONION MONTFORT, 1808

Nonion grateloupi (d'Orbigny)

Nonionina grateloupi D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 19, p. 294.
Nonion grateloupi, CUSHMAN, 1930, Bull. U. S. Natl. Mus., no. 104, pt. 7, p. 10, pl. 3, figs. 9–11.
Nonionina punctulata, D'ORBIGNY, 1839, Voyage dans l'Amerique Meridionale, vol. 5, p. 28, pl. 5, figs. 21, 22.

This species is found both in the north and in the south at depths averaging 22 meters. It has been reported from the West Indies, off the coast of California, and off the west coast of Central America.

GENUS NONIONELLA CUSHMAN, 1926

Nonionella atlantica Cushman

Nonionella atlantica CUSHMAN, 1947, Contrib. Cushman Lab. Foram. Res., vol. 23, pt. 4, p. 90, pl. 20, figs. 4, 5.

This species was found distributed throughout the whole Gulf. It is a common species in the warm waters of the western Atlantic. In the Gulf its frequency ranges from 1 per cent to 8 per cent, with increased representation in the northern half.

Nonionella miocenica Cushman

Nonionella miocenica CUSHMAN, 1926, Contrib. Cushman Lab. Foram. Res., vol. 2, pt. 3.
Nonionina auris CUSHMAN (not d'Orbigny), 1926, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 4, pl. 91, pl. 13, figs. 4a, 4b, 4c.

This species occurs in a few samples at, and north of, Guaymas (sample 56). Its maximum frequency is 7 per cent.

It has been recorded off the eastern Pacific coast from Alaska to Costa Rica.

GENUS CUSHMANELLA PALMER AND BERMUDEZ, 1936

Cushmanella primitiva Cushman and McCulloch

Cushmanella primitiva CUSHMAN AND MCCULLOCH, 1940, Allan Hancock Pacific Exped., vol. 6, no. 3, p. 163, pl. 18, figs. 6–8, 10.

This species was first described by Cushman and McCulloch from Darwin Bay, Tower Island, Galapagos, in 17 fathoms.

Two specimens were found in two samples in the southern half of the Gulf in very shallow water.

GENUS ELPHIDIUM MONTFORT, 1808

Elphidium articulatum (d'Orbigny)

Polystomella articulata D'ORBIGNY, 1839, Voyage dans l'Amerique Meridionale, vol. 5, pt. 5, p. 30, pl. 3, figs. 9, 10.
Elphidium articulatum, CUSHMAN, 1930, Bull. U. S. Natl. Mus., no. 104, no. 7, p. 26, pl. 10, figs. 5, 6–8.

This species is found in several samples throughout the Gulf, its frequency ranging from 0.6 per cent to 18 per cent. It is a common species in southern California, off the west coast of Central America, and in the West Indies.

Elphidium crispum (Linné)

Nautilus crispus LINNÉ, 1758, Systema naturae, ed. 10, p. 709.
Polystomella crispa, LAMARCK, 1882, Histoire naturelle des animaux sans vertèbres, vol. 7, p. 625.
Elphidium crispum, CUSHMAN AND GRANT, 1927, Trans. San Diego Soc. Nat. Hist., vol. 5, no. 6, p. 73, pl. 7, figs. 3a, 3b.

This species is found in numerous samples throughout the Gulf. In the south its frequency ranges from 0.8 per cent to 19 per cent and in the north from 0.8 per cent to 31 per cent. While common in the south, *Elphidium crispum* composes a large percentage of the northern population.

It has been reported from off the coast of California southward to Ecuador.

Elphidium gunteri Cole

Elphidium gunteri COLE, 1931, Bull. Florida Geol. Surv., no. 6, p. 34, pl. 4, figs. 9, 10.

This species is commonly found throughout the Gulf. It is very abundant in mud bottoms with a high organic content, in which poor circulation causes a reducing environment. In these organic clays, it, with *Streblus beccarii* var. *sobrinus*, forms the major element in the population.

This species was first described from the Pliocene of Florida and has been reported off Beaufort, North Carolina, and in the Gulf of Mexico.

Elphidium incertum Williamson

Polystomella umbilicatula var. *incerta* WILLIAMSON, 1858, On the Recent Foraminifera of Great Britain, p. 44, pl. 3, fig. 82a.

Polystomella striato-punctata var. *incerta*, KIAER, 1900, Rept. Norwegian Fish. Mar. Invest., vol. 1, no. 7, p. 51.

Polystomella decipiens HERON-ALLEN AND EARLAND (not Costa), 1916, Trans. Linnean Soc. London, ser. 2, vol. 11, p. 282, pl. 43, figs. 20–22.

Elphidium incertum, CUSHMAN, 1930, Bull. U. S. Natl. Mus., no. 104, pt. 7, p. 18, pl. 7, figs. 4–9.

This species is widely distributed in the Atlantic Ocean. It occurs commonly both in the northern and southern halves of the Gulf where its frequency ranges from 0.4 per cent to 17 per cent of the population.

Elphidium spinatum Cushman and Valentine

Elphidium spinatum CUSHMAN AND VALENTINE, 1930, Conbrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 21, pl. 6, fig. 5.

The short spines which appear on the later chambers and extend forward are a common feature of this species. It is rare in the Gulf, occurring in only five samples in the north and ranging from 1 per cent to 7 per cent of the population.

This form is known from California southward to the Ecuador coasts only.

FAMILY **PENEROPLIDAE**

SUBFAMILY **SPIROLININAE**

GENUS **PENEROPLIS** MONTFORT, 1808

Peneroplis pertusus (Forskål)

Plate 40, figures 9, 10

Nautilus pertusus FORSKÅL, 1775, Descriptiones animalium, p. 125, no. 65.

Nautilus (*Lituus*) *arientinus* BATSCH, 1871 (part), Conchylien des Seesandes, p. 4, pl. 6, fig. 15c.

Peneroplis pertusus, JONES AND PARKER, 1865, Monograph of Foraminifera of the Crag, p. 19. CUSHMAN, 1930, Bull. U. S. Natl. Mus., no. 104, pt. 7, p. 35, pl. 12, figs. 3–6.

Peneroplis arientinus, PARKER, JONES, AND BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 26, pl. 1, fig. 18.

Spirolina arientinus, CUSHMAN, 1930, Bull. U. S. Natl. Mus., no. 104, pt. 7, p. 43, pl. 15, figs. 4, 5.

This species is very common in the southern half of the Gulf; it becomes sparse north of the Carmen Island area. It is highly plastic in its growth and some individuals often become uniserial in the gerontic stage. Erroneously these have been called "*Spirolina arientinus*," but they are obviously part of the normal variation in the population and not taxonomically distinct.

This species is considered typically tropical, and in the Gulf it seems to favor bioclastic areas, especially the reef environments. It is rare in the West Indies, being replaced there by *Peneroplis proteus*. There are no reports of this form from off the west coast of Central America and off southern California, and there is no record of it north of Cape San Lucas.

SUBFAMILY **ARCHAIASINAE**

GENUS **AMPHISORUS** EHRENBERG, 1840

Amphisorus hemprichii Ehrenberg

Amphisorus hemprichii EHRENBERG, 1838, Abhandl. K. Akad. Wiss. Berlin, pl. 3, fig. 3.

This species is common in the southern half of the Gulf; its frequency drops off noticeably north of the Carmen Island area.

Amphisorus hemprichii is a common tropical form in the Florida region. It is not known north of Cape San Lucas and is rare along the west coast of Central America.

FAMILY **BULIMINIDAE**

SUBFAMILY **TURRILININAE**

GENUS **BULIMINELLA** CUSHMAN, 1911

Buliminella elegantissima (d'Orbigny) variety **tenuis** Cushman and McCulloch

Buliminella elegantissima (d'Orbigny) var. *tenuis* CUSHMAN AND MCCULLOCH, 1940, Allan Hancock Pacific Exped., vol. 6, no. 5, p. 238, pl. 29, fig. 6.

This variety differs from the typical one in its long slender form and its small, rounded,

subterminal aperture. It occurs primarily in the northern half of the Gulf, with frequencies ranging from 0.6 per cent to 12 per cent and in depths usually greater than 25 meters.

This variety is known only from southern California southward along the coast of Mexico.

Subfamily BULIMININAE

Genus BULIMINA d'Orbigny, 1826

Bulimina denudata Cushman and Parker

Bulimina denudata Cushman and Parker, 1938, Contrib. Cushman Lab. Foram. Res., vol. 14, p. 57, pl. 10, figs. 1, 2.

Bulimina marginata Galloway and Wissler (not d'Orbigny), 1927, Jour. Paleont., vol. 1, p. 73, pl. 11, fig. 17.

Bulimina pulchella Cushman (not d'Orbigny), 1927, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 1, p. 152, pl. 2, fig. 13.

This species is found throughout the Gulf; it occurs most frequently and in greatest abundance below 30 meters. Its frequency ranges from 0.8 per cent to 37 per cent, with the higher percentages in the deeper samples, and it is present in depths ranging from 5 to 79 meters.

The species is abundant in the Pliocene and Pleistocene of the Lomita Quarry, Los Angeles. It has been reported off California and southward to Ecuador.

Subfamily VIRGULININAE

Genus VIRGULINA d'Orbigny, 1826

Virgulina complanata Egger

Virgulina sheibersiana Czjzek var. *complanata* Egger, 1893, Abhandl. K. Bayerischen Akad. Wiss., vol. 18, p. 292, pl. 8, figs. 91, 92.

This species was found infrequently throughout the Gulf in depths ranging from 10.2 to 79.4 meters.

Previous records of this species are confined primarily to the Pacific. It has also been reported from the Gulf of Mexico and the Atlantic Ocean.

Genus BOLIVINA d'Orbigny, 1839

Bolivina acerosa Cushman variety pacifica Cushman and McCulloch

Bolivina acerosa Cushman var. *pacifica* Cushman and McCulloch, 1942, Allan Hancock Pacific Exped., vol. 6, no. 4, p. 185, pl. 21, figs. 2, 3.

The lack of ornamentation in the early portion of the test and the clear areas at the upper and inner portion of each chamber serve to distinguish this variety from the typical form.

This species is rare in the Gulf, being present in a few samples, both in the north and the south, at depths ranging from 10.2 to 73.8 meters. Its frequency ranges from 2 per cent to 4 per cent of the population.

It has been reported from the eastern Pacific coast from Alaska to Columbia.

Bolivina acuminata Natland

Bolivina subadvena Cushman var. *acuminata* Natland, 1946, *in* Cushman and Gray, Special Publ. Cushman Lab. Foram. Res., no. 19, p. 34, pl. 24, fig. 46.

This species was originally reported off the coast of Southern California. Cushman and McCulloch (1942) record it from Santa Cruz and Santa Barbara Island, southward off Mexico and in the Gulf of California.

It occurs in several samples at depths ranging from 33.2 to 79.4 meters. Its frequency ranges from 0.9 per cent to 3 per cent of the population.

Bolivina advena Cushman

Bolivina advena Cushman, 1925, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 29, pl. 5, figs. 1a, 1b; 1926, *ibid.*, vol. 2, pt. 3, 1926, p. 54.

This species is present in a few Gulf samples in low frequencies.

Bolivina advena Cushman variety striatella Cushman

Bolivina advena Cushman var. *striatella* Cushman, 1925, Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 30, pl. 3, figs. 3a, 3b.

This species was found in several samples throughout the Gulf in depths generally greater than 22 meters and as deep as 79.4 meters. Its frequency ranges from 0.9 per cent to 14 per cent of the population.

This species has been reported from off the coasts of California, Mexico, Costa Rica, Ecuador, Japan, and Singapore.

Bolivina costata d'Orbigny

Bolivina costata d'Orbigny, 1839, Voyage dans l'Amérique Meridionale, vol. 5, pt. 5, p. 62, pl. 8, figs. 8, 9.

This species is present in a few samples, in the southern half of the Gulf, at very low frequencies, all less than 1 per cent of the population. It is common off the west coast of South America and particularly abundant off Peru.

Bolivina minuta Natland

Bolivina minuta NATLAND, 1938, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 4, pl. 5, fig. 10.

This species is present in several samples throughout the Gulf in depths ranging from 0.9 meter to 31.4 meters, but usually less than 6 meters; frequencies range from 0.5 per cent to 4 per cent of the population.

Natland (1950) reports it from off the coast of southern California and off the west coast of Central America.

Bolivina paula Cushman and Cahill

Bolivina paula CUSHMAN AND CAHILL, *in* Cushman and Ponton, 1932, Bull. Florida Geol. Surv., no. 9, p. 84, pl. 12, figs. 6a, 6b.

Bolivina paula is a common species of *Bolivina* in the Gulf, occurring in numerous samples at depths ranging from 0.9 meter to 46.2 meters, with an average depth of 12.7 meters. Its frequencies range from 0.8 per cent to 15 per cent of the population.

There are records of this species from the Miocene and Oligocene of Florida, and from Recent deposits in the Bay of Naples, Ketchikan in Alaska, off the west coast of Mexico, Colombia, Peru, and the Galapagos Islands.

Bolivina rhomboidalis (Millett)

Textularia rhomboidalis MILLETT, 1899, Jour. Roy. Micros. Soc., p. 559, pl. 7, fig. 4.

Bolivina rhomboidalis, CUSHMAN, 1932, Bull. U. S. Natl. Mus., no. 161, pt. 3, p. 19, pl. 6, figs. 7, 8.

This species was originally described from the Malay Archipelago and is a common Indo-Pacific form.

Although more common in the southern half of the Gulf, it is found as far north as San Luis Island. Specimens were found at depths ranging from 2.2 to 79.4 meters, the majority at depths of less than 15 meters. The frequencies range from 0.4 per cent to 4 per cent of the population.

Bolivina seminuda Cushman

Bolivina seminuda CUSHMAN, 1911, Bull. U. S. Natl. Mus., no. 71, pt. 2, p. 34, fig. 55.

This species is widely distributed along the eastern Pacific coast from Bowers Bank in the Bering Sea to the western coast of Panama.

In the Gulf, this species is found in several samples in the southern half, at depths averaging 7.6 meters and in frequencies of from 0.5 per cent to 1 per cent of the population.

Bolivina subexcavata Cushman and Wickenden

Bolivina subexcavata CUSHMAN AND WICKENDEN, 1929, Proc. U. S. Natl. Mus., vol. 75, art. 9, p. 9, pl. 4, figs. 4a, 4b.

This species is present at low frequencies in a few samples, the northernmost at Guaymas. Most of the samples were from depths of less than 7 meters.

It has been reported from Monterey, California, in 25 fathoms, in the Channel Islands in 20 to 52 fathoms, off Mexico and in the Gulf of California in 9 to 22 fathoms, off the Galapagos in 10 to 35 fathoms, and off Ecuador in 10 to 19 fathoms.

GENUS **LOXOSTOMUM** EHRENBERG, 1854

Loxostomum limbatum (H. B. Brady)

Bolivina limbata H. B. BRADY, 1881, Quart. Jour. Micros. Sci., vol. 21, p. 27; 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 419, pl. 52, figs. 26–28.

Loxostomum limbatum, CUSHMAN, 1937, Special Publ. Cushman Lab. Foram. Res., no. 9, p. 186, pl. 21, figs. 26–29; 1942, Bull. U. S. Natl. Mus., no. 161, pt. 3, p. 35, pl. 10, figs. 1a, 1b.

This species is present in a few samples at low frequencies. It is common in warm, shallow waters, especially in the Indo-Pacific region.

Loxostomum limbatum (H. B. Brady) variety **costulatum** (Cushman)

Bolivina limbata H. B. Brady var. *costulata* CUSHMAN, 1922, Publ. Carnegie Inst. Washington, no. 311, p. 26, pl. 3, fig. 8.

Loxostoma limbata (Brady) var. *costulata*, PALMER AND BERMUDEZ, 1935, Mem. Soc. Cubana Hist. Nat., vol. 9, p. 248.

Bolivina limbata, CHAPMAN, 1901, Jour. Linnean Soc., London, Zool., vol. 28, p. 409, pl. 36, fig. 12.

Loxostoma mayori CUSHMAN AND PARKER (not Cushman), 1931, Proc. U. S. Natl. Mus., vol. 80, art. 3, p. 16, pl. 3, fig. 24.

This species is rare in the Gulf, occurring at low frequencies in only a few samples from the south. It has not been reported from southern California. It has been recorded from the Hawaiian Islands, Socorro Island, Mexico, and off the western coast of Ecuador.

GENUS **BIFARINA** PARKER AND JONES, 1872

Bifarina hancocki Cushman and McCulloch

Bifarina hancocki CUSHMAN AND MCCULLOCH, 1942, Allan Hancock Pacific Exped., vol. 6, no. 4, p. 225, pl. 28, figs. 13–19.

This species has not been reported from southern California. Its northernmost locality known to the writer is Todos Santos Bay on the western coast of Baja California. It is also found off the west coast of Central America.

In the Gulf it is present in a few samples at frequencies of from 0.8 per cent to 4 per cent of the population and at depths usually greater than 30 meters.

GENUS **RECTOBOLIVINA** CUSHMAN, 1927

Rectobolivina bifrons (H. B. Brady)

Sagrina bifrons H. B. BRADY, 1881, Quart. Jour. Micros. Sci., vol. 21, p. 64; 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 582, pl. 75, figs. 18–20.

Siphogenerina (Sagrina) bifrons, EGGER, 1893, Abhandl. K. Bayerischen Akad. Wiss., vol. 18, p. 317, pl. 9, figs. 25, 26, 29.

Siphogenerina bifrons, CUSHMAN, 1913, Bull. U. S. Natl. Mus., no. 7, pt. 3, p. 105, pl. 45, figs. 1, 2, 5–7.

Rectobolivina bifrons, CUSHMAN, 1929, Contrib. Cushman Lab. Foram. Res., vol. 3, p. 68; 1937, Special Publ. Cushman Lab. Foram. Res., no. 9, 204, pl. 23, figs. 13, 14.

This species occurs in several samples throughout the Gulf at frequencies ranging from 0.4 per cent to 2 per cent and at depths averaging 26 meters. Records of this form are primarily from the Indo-Pacific area.

SUBFAMILY **REUSSELLINAE**

GENUS **REUSSELLA** GALLOWAY, 1933

Reussella aequa Cushman and McCulloch

Reussella aequa CUSHMAN AND MCCULLOCH, 1948, Allan Hancock Pacific Exped., vol. 6, no. 5, p. 263, pl. 31, figs. 7a, 7b, 7c, 7d.

Reussella aequa is similar to *Reussella aculeata* Cushman, but differs from it in having nearly straight sides, with little or no dentition, no spine on the apical end, and in the fact that the pores of the wall are limited almost entirely to the border of the chamber.

The depth range of this species is 0.9 meter to 79.4 meters in the Gulf, the majority being in less than 35 meters. Its frequencies range from 0.8 per cent to 5 per cent of the population.

Cushman and McCulloch (1948, p. 256) record this species from the Gulf of California southward to Ecuador and off the Galapagos Islands.

GENUS **CHRYSALIDINELLA** SCHUBERT, 1907

Chrysalidinella dimorpha (H. B. Brady)

Chrysalidinella dimorpha H. B. BRADY, 1881, Quart. Jour. Micros. Sci., vol. 21, p. 54.

Chrysalidinella dimorpha, CUSHMAN, 1929, Jour. Washington Acad. Sci., vol. 19, p. 159, fig. 3.

This usually widely distributed, tropical species was found in several samples throughout the Gulf at very low frequencies, usually less than 1 per cent of the population.

SUBFAMILY **UVIGERININAE**

GENUS **UVIGERINA** D'ORBIGNY, 1826

Uvigerina attenuata Coryell and Mossman

Uvigerina striata CORYELL AND MOSSMAN (not d'Orbigny), 1942, Jour. Paleont., vol. 16, no. 2, p. 245, pl. 36, figs. 53–54.

Uvigerina striata var. *attenuata* CORYELL AND MOSSMAN, 1942, Jour. Paleont., vol. 16, no. 2, p. 245, pl. 36, fig. 55.

Four specimens of this species are found in sample 41 at 12.2 meters. Previous records of this species are from off the coast of southern California and off the western coast of Central America.

Uvigerina peregrina Cushman

Uvigerina peregrina CUSHMAN, 1923, Bull. U. S. Natl. Mus., no. 104, pt. 4, p. 166, pl. 42, figs. 7–10.

Only two specimens of this species, in two samples, were found in the Gulf, at frequencies of less than 1 per cent of the population.

This species has been reported from the Atlantic continental shelf at depths usually greater than 600 meters.

GENUS **SIPHOGENERINA** SCHLUMBERGER, 1883

Siphogenerina raphanus (Parker and Jones)

Uvigerina (Sagrina) raphanus PARKER AND JONES, 1865, Phil. Trans., vol. 155, p. 364, pl. 18, figs. 16, 17.

Sagrina raphanus, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 585, pl. 75, figs. 21–24.

Siphogenerina raphanus, CUSHMAN, 1926, Proc. U. S. Natl. Mus., vol. 67, art. 25, p. 4, pl. 1, figs. 1–4.

This species occurs in only a few samples in the southern half of the Gulf, with frequencies ranging from 1 per cent to 4 per cent and at depths of from 2.5 to 19.4 meters. It has been reported from numerous localities in the warm, shallow waters of the Indo-Pacific.

GENUS **ANGULOGERINA** CUSHMAN, 1927

Angulogerina angulosa (Williamson)

Uvigerina angulosa WILLIAMSON, 1858, On the Recent Foraminifera of Great Britain, p. 67, pl. 5, fig. 140.

Angulogerina angulosa, CUSHMAN AND MOYER, 1930, Contrib. Cushman Lab. Foram. Res., vol. 6, p. 60, pl. 8, fig. 7.

A few samples scattered throughout the Gulf contained specimens of *Angulogerina angulosa*. This species appears to prefer depths greater than 50 meters and is almost invariably associated with *Bulimina denudata*. Its frequencies range from 0.6 per cent to 7 per cent of the population.

Its distribution is world-wide, and in boreal waters it is found at shallower depths than in tropical areas. It has been reported from Alaska in 2 fathoms, and the Channel Islands in 7–125 fathoms.

Angulogerina hughesi (Galloway and Wissler)

Uvigerina hughesi GALLOWAY AND WISSLER, 1927, Jour. Paleont., vol. 1, p. 76, pl. 12, fig. 5.

Angulogerina hughesi, CUSHMAN, STEWART, STEWART, AND STEWART, 1930, Trans. San Diego Soc. Nat. Hist., vol. 6, p. 70, pl. 5, fig. 16.

Angulogerina hughesi is found in only a few samples between Santa Catalina Island and the northern tip of Angel de la Guarda Island in very low frequencies and at depths ranging from 0.4 meter to 2 meters.

Pleistocene and Recent sediments of southern California are reported to contain this species.

Angulogerina occidentalis (Cushman)

Uvigerina occidentalis CUSHMAN, 1923, Bull. U. S. Natl. Mus., no. 104, pt. 4, p. 169.

Angulogerina occidentalis (Cushman), CUSHMAN, 1930, Bull. Florida Geol. Surv., no. 4, p. 50, pl. 9, figs. 8, 9.

Angulogerina angulosa NATLAND (not Williamson), 1933, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 3, no. 10, line 153 on included chart.

This species occurs in several samples in the Gulf at low frequencies, except for sample 46, in which it comprises 32 per cent of the population, at a depth of 35.1 meters.

It has been reported off the coast of southern California, off the west coast of Central America, and from the Tortugas region of Florida.

FAMILY **ROTALIIDAE**

SUBFAMILY **SPIRILLININAE**

GENUS **SPIRILLINA** EHRENBERG, 1843

Spirillina vivipara Ehrenberg

Spirulina vivipara EHRENBERG, 1841, Abhandl. K. Akad. Wiss. Berlin, p. 144 (*nomen nudum*).

Spirillina vivipara, EHRENBERG, 1843, Abhandl. K. Akad. Wiss. Berlin, 1841, pt. 1, pp. 323, 422, pl. 3, VII, fig. 41.

This species has a world-wide distribution. In the Gulf it is present in a few samples at very low frequencies, usually less than 2 per cent of the population.

SUBFAMILY **DISCORBINAE**

GENUS **PATELLINA** WILLIAMSON, 1858

Patellina corrugata Williamson

Patellina corrugata WILLIAMSON, 1858, On the Recent Foraminifera of Great Britain, p. 46, pl. 3, figs. 86–89.

Patellina corrugata has a world-wide distribution and is extremely eurybathic, having been found in the Atlantic at depths ranging from the surface to 2180 meters.

It is exceedingly rare in the present collection, being found in only a few samples, at frequencies ranging from 0.4 per cent to 1 per cent of the population.

GENUS **DISCORBIS** LAMARCK, 1804

Discorbis bertheloti (d'Orbigny)

Rosalina bertheloti D'ORBIGNY, *in* Barker-Webb and Berthelot, 1839, Histoire naturelle des Iles Canaries, vol. 2, pt. 2, p. 135, pl. 1, figs. 28–30.

Discorbina bertheloti, H. B. BRADY, 1864, Trans.

Linnean Soc., London, Zool., vol. 24, p. 469, pl. 48, fig. 10.

Discorbina turbo var. *parisiensis*, subvar. *berthelotina* PARKER AND JONES, 1865, Phil. Trans., vol. 155, p. 387, pl. 16, figs. 26, 27.

Discorbina berthelotiana, GOES, 1882, K. Svenska Vetensk. Akad. Handl., vol. 19, no. 4, p. 107, pl. 8, figs. 266–268.

Discorbis bertheloti, CUSHMAN, 1915, Bull. U. S. Natl. Mus., no. 71, pt. 5, p. 20, pl. 7, fig. 3.

Two specimens belonging to this species were found in sample 4. This species was originally described from the Canary Islands. It is reported from both the Atlantic and the Pacific oceans.

Discorbis candeianus (d'Orbigny)

Rosalina candeiana D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 97, pl. 4, figs. 2–4.

Truncatulina candeiana, CUSHMAN, 1921, Proc. U. S. Natl. Mus., vol. 59, p. 57, pl. 13, figs. 4, 5.

Truncatulina cora CUSHMAN (not d'Orbigny), 1922, Publ. Carnegie Inst. Washington, no. 311, p. 48, pl. 7, figs. 3–5.

Discorbis candeiana, CUSHMAN, 1931, Bull. U. S. Natl. Mus., no. 104, pt. 8, p. 19, pl. 7, figs. 4a, 4b, 4c.

This species occurred in only three samples at very low frequencies. It is common in the West Indies, Florida, and the Gulf of Mexico.

Discorbis consobrinus (d'Orbigny)

Rosalina consobrina D'ORBIGNY, 1839, Voyage dans l'Amérique Meridionale, vol. 5, pt. 5, p. 46, pl. 7, figs. 4–6.

Discorbis consobrina (d'Orbigny) CUSHMAN AND KELLET, 1929, Proc. U. S. Natl. Mus., vol. 75, art. 25, p. 10, pl. 4, figs. 1, 2.

This species was originally described from the coast of Peru. Cushman and Kellet (1929) report this species in their material from Payta and Eten, Peru, and Corral, Chile. It is rare in the present collection and is found in only a few samples at low frequencies.

Discorbis floridanus Cushman

Discorbis floridanus CUSHMAN, 1922, Publ. Carnegie Inst. Washington, no. 311, p. 39, pl. 5, figs. 11, 12.

Discorbis floridanus was found in a few samples in the Gulf, in frequencies ranging from 1 per cent to 7 per cent of the population, and at depths ranging from 2.5 to 13.8 meters.

It has been reported from Florida, Cuba, Rio de Janeiro Harbor, and the Gulf of Mexico.

Discorbis floridensis Cushman

Discorbis bertheloti (d'Orbigny) var. *floridensis* CUSHMAN, 1931, Bull. U. S. Natl. Mus., no. 104, pt. 8, p. 17, pl. 3, figs. 3–5.

This species is present in several samples throughout the Gulf at frequencies ranging from 0.5 per cent to 11 per cent. It is reported chiefly from south of Cape Hatteras and in the Gulf of Mexico.

Discorbis globosus (Sidebottom)

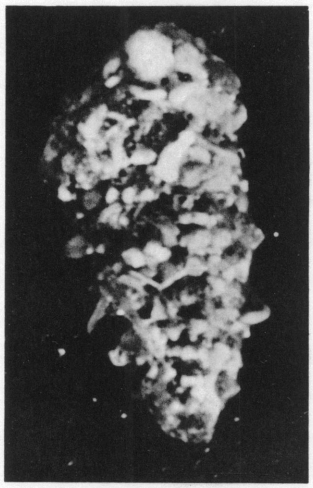
Pulvinulina globosa SIDEBOTTOM, 1909, Mem. and Proc. Manchester Lit. and Phil. Soc., vol. 53, no. 21, pt. 6, p. 9, fig. 3.

Discorbina globosa (Sidebottom) HERON-ALLEN AND EARLAND, 1915, Trans. Zool. Soc. London, vol. 20, pt. 17, p. 702, pl. 52, figs. 27–31.

Discorbis globosa (Sidebottom) BERMUDEZ, 1935, Mem. Soc. Cubana Hist. Nat., vol. 9, p. 202, pl. 17, figs. 7–10.

PLATE 40

1. *Textularia foliacea* Heron-Allen and Earland, Amortajada Bay, San José Island.
2. *Textularia conica* d'Orbigny, Monserrate Island.
3. *Reophax ellisi*, new species, holotype (A.M.N.H. No. FT 1188), center of Aqua Verde Bay.
4, 5. *Eponides babsae*, new species, north side of bay between Isla Partida and Espíritu Santo Island. 4. Holotype (A.M.N.H. No. FT 1190), dorsal view. 5. Paratype, ventral view.
6. *Quinqueloculina* cf. *angulostriata* Cushman and Valentine, southern end of Cerralvo Island.
7, 8. *Quinqueloculina baueri*, new species, Coronados Island. 7. Holotype (A.M.N.H. No. FT 1189), side view. 8. Paratype, opposite view.
9, 10. *Peneroplis pertusus* (Forskål), lagoon at Puerto Escondido. 9. Coiled state. 10. Uncoiled stage.
All specimens ×93.
Photographs by G. R. Adlington.



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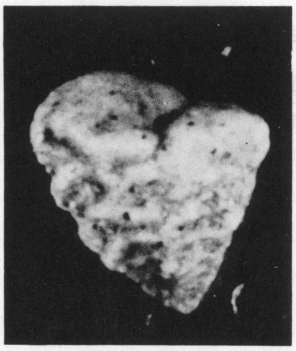

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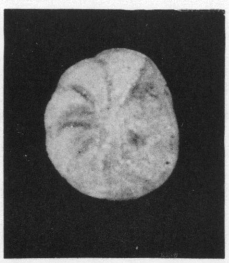

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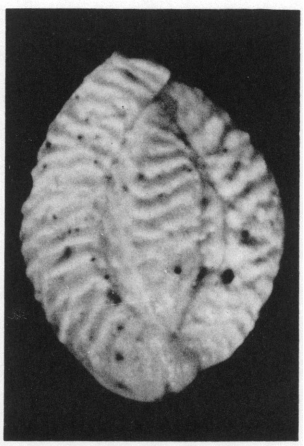

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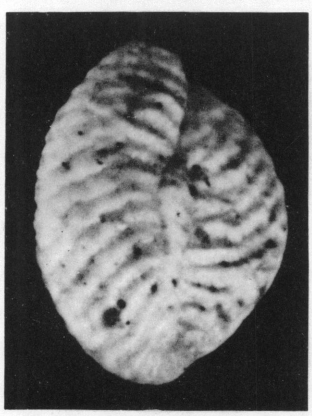

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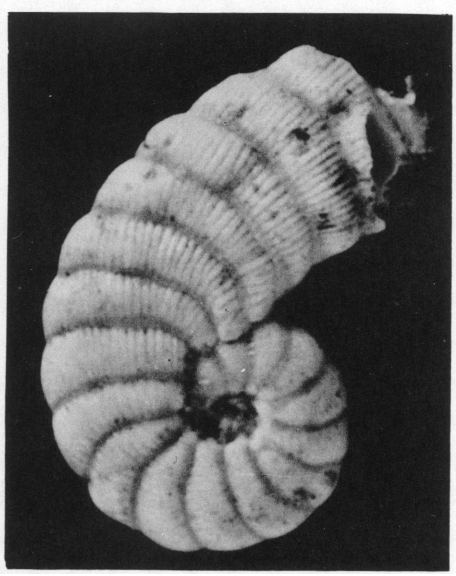

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The types of this species were described from the island of Delos, Greece. It has also been reported from the northern coast of Cuba.

This species is characterized by its distinct globigerine-like chambers and its deeply sunken umbilical region, with fine radiating lines.

In the Gulf, it is found in several samples, from the southern tip of Espíritu Santo Island to San Esteban Island, in depths ranging from 0.9 meter to 38.3 meters, and averaging 8.8 meters. Frequencies ranged from 0.6 per cent to 22 per cent of the population.

Discorbis obtusus (d'Orbigny)

Rosalina obtusa D'ORBIGNY, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 179, pl. 11, figs. 4–6.

Discorbis obtusa (d'Orbigny) HERON-ALLEN AND EARLAND, 1932, Discovery Reports, vol. 4, p. 415, pl. 14, figs. 19–21.

This species was present in several samples taken primarily in the southern half of the Gulf. It is not abundant in the present collection, and its frequencies range from 0.6 per cent to 7 per cent of the population.

Discorbis orbicularis (Terquem)

Rosalina orbicularis TERQUEM, 1876, Animaux sur la plage de Dunkerque, p. 75, pl. 9, figs. 4a, 4b.

Discorbis orbicularis, BERTHELIN, 1878, Foraminifères de Borgneuf et Pornichet, p. 39, no. 63.

Discorbis orbicularis is widely distributed in several samples in the Gulf. It has been reported from tropical Pacific and Atlantic waters and off the southern California coast.

Discorbis patelliformis (H. B. Brady)

Discorbina patelliformis H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 647, pl. 88, figs. 3a, 3b, 3c, pl. 89, figs. 1a, 1b, 1c.

Discorbis patelliformis, CUSHMAN, 1915, Bull. U. S. Natl. Mus., no. 71, pt. 5, p. 17, pl. 5, figs. 5a, 5b, 5c.

This typical Indo-Pacific form is rare in the Atlantic. Only six specimens of this species were found in the Gulf, in sample 4 at a depth of 5.5 meters.

GENUS **LAMELLODISCORBIS** BERMUDEZ, 1952

Lamellodiscorbis species

This form is very similar to the form described by Walton (1955, p. 952, pl. 102, figs. 30, 31) from Todos Santos Bay, Baja California, but differs in that the limbate sutures on the ventral side are relatively shorter, do not bend, and the periphery is less lobate.

GENUS **VALVULINERIA** CUSHMAN, 1926

Valvulineria laevigata Phleger and Parker

Valvulineria laevigata PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 25, pl. 13, figs. 11, 12.

Five specimens of this species were found in sample 39 at a depth of 21.2 meters. Deep-water occurrences are reported in the Gulf of Mexico and on the Atlantic continental shelf.

SUBFAMILY **ROTALIINAE**

GENUS **EPONIDES** MONTFORT, 1808

Eponides antillarum (d'Orbigny)

Rotalina antillarum D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 75, pl. 5, figs. 4–6.

Eponides antillarum (d'Orbigny) PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 75, pl. 5, figs. 4–6.

The few samples containing this species are from depths ranging from 22.2 to 79.4 meters, with frequencies of from 0.8 per cent to 9 per cent of the population. Phleger and Parker (1951) report this species from the Gulf of Mexico in depths ranging from 20 to 262 meters.

Eponides babsae, new species

Plate 40, figures 4, 5

DIAGNOSIS: *Eponides babsae* appears to be closely related to *Eponides meridionalis* Cushman and Kellet, 1929, originally described from off the coast of Corral, Chile. It differs from the latter by having a larger number of papillae, a greater curvature of the dorsal sutures, and a greater thickening of the peripheral border.

Text biconvex, nearly circular, periphery acute and slightly carinate; chambers slightly involute on dorsal side, only the last formed chambers visible on ventral side, which has about nine chambers in the last formed whorl; sutures strongly limbate and raised above surface on dorsal and ventral sides; sutures curved on both dorsal and ventral sides, with increasing curvature towards periphery,

surface on ventral side ornamented by numerous papillae on early chambers of last whorl; early limbate sutures on the ventral side not continuous, but broken up into linear series of papillae which diminish after a few chambers and form normal limbations; aperture, a narrow slit at the base of the last formed chamber, often obscured by papillae. Holotype: maximum diameter, 0.207 mm.

This species differs from *Eponides antillarum* by its smaller size, biconvexity, and presence of numerous papillae on the ventral side. *Eponides hannai* is somewhat similar to *Eponides babsae*, except that in the latter species the sutures are limbate on both the dorsal and ventral sides and not depressed as in the former species. The ventral sutures of *Eponides babsae* are curved, while those of *Eponides hannai* are more or less straight. *Eponides polius* does not have ventral papillae.

Holotype (Department of Micropaleontology at the American Museum of Natural History No. FT 1190) from sample 17, bay on north side of bay between Isla Partida and Espíritu Santo Island; latitude 24° 31′ N., longitude 110° 23′ 25″ W.

Eponides hannai Phleger and Parker

Eponides hannai PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 21, pl. 10, figs. 11–14.

This species is very common in the present collection, occurring at numerous stations in both the northern and southern halves of the Gulf. It was found in more samples and in greater frequencies in the north than in the south.

Eponides hannai is a common species in the Gulf of Mexico and the West Indies. Morphologically it appears related to *Eponides frigidus*, a species of colder waters.

Eponides polius Phleger and Parker

Eponides polius PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer. no. 46, p. 21, pl. 11, figs. 1–2.

Only one specimen of this species was found, in sample 49 at a depth of 75.3 meters. The species is found in depths greater than 1000 meters in the Gulf of Mexico.

Eponides umbonatus (Reuss)

Rotalina umbonata REUSS, 1851, Zeitschr. Deutschen Geol. Gesell., vol. 3, p. 75, pl. 5, figs. 35a, 35b, 35c.

Eponides umbonatus (Reuss) PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 22, pl. 11, figs. 10a, 10b, 13a, 13b, 14a, 14b.

Eponides umbonatus comprises 8 per cent of the population of sample 62, in 73.8 meters of water. This is the only record of this species in the Gulf.

In the Atlantic, specimens are found in depths between 42 and 5200 meters. The species has been reported from off the coast of southern California.

GENUS **ROTALIA** LAMARCK, 1804

Rotalia avalonensis Natland

Rotalia depressa NATLAND (not Münster), 1938, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 4, no. 5, p. 147, pl. 5, figs. 15a, 15b, 15c (preoccupied).

Rotalia avalonensis NATLAND, 1950, Mem. Geol. Soc. Amer., no. 43, p. 30, pl. 8, figs. 4a, 4b, 4c.

Reddish brown early ontogenetic portions, thick carinae, small umbilical plug, and large perforations all characterize this species.

Rotalia avalonensis is a common form in the Gulf, occurring at depths ranging from 0.9 meter to 75.3 meters, and averaging 13.3 meters. Frequencies range from 0.5 per cent to 31 per cent of the population.

This species is common along the southern California coast and off the west coast of Central America.

Rotalia rosea d'Orbigny

Rotalia rosea D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 7, p. 272; Modeles no. 36. PARKER, JONES, AND BRADY, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 24, pl. 3, fig. 79.

Rotalina rosea, D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 72, pl. 3, figs. 9–11.

Truncatulina rosea, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 667, pl. 96, fig. 1.

This species is a common form restricted to the tropical waters of the West Indies and eastern Pacific region. In the Gulf it occurs in only a few samples south of Espíritu Santo Island.

Rotalia translucens Phleger and Parker

Rotalia translucens PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 24, pl. 12, figs. 11–12.

This species, which is common in the Gulf of Mexico, is found in a few samples in the Gulf of California, at very low frequencies.

GENUS **STREBLUS** FISCHER, 1817

Streblus beccarii (Linné) variety **sobrinus** (Shupack)

Rotalia beccarii (Linné) var. *sobrina* SHUPACK, 1934, Amer. Mus. Novitates, no. 737, p. 9, figs. 4a, 4b, 4c.

The specimens in the present collection have strongly limbate sutures, a lobate periphery, and rod-like projections of the ventral chambers into the umbilical region. This form appears to be the same as that illustrated by Lehmann (1957, p. 349, pl. 3, figs. 29–31) from the Gulf of Mexico.

The number of samples in the Gulf containing this variety are few. This form, when present (often with *Elphidium gunteri*), usually comprises the major part of the population. Many of the samples in which this species was found contained a large amount of dark, putrefying, organic matter. Both *Elphidium gunteri* and this variety of *Streblus* seem to show a high degree of tolerance to the reducing conditions usually associated with such sediments.

GENUS **POROEPONIDES** CUSHMAN, 1944

Poroeponides cribrorepandus Asano and Uchio

Poroeponides cribrorepandus ASANO AND UCHIO, *in* Asano, 1951, Illustrated catalogue of Japanese Tertiary smaller Foraminifera, pt. 14, p. 18, figs. 134, 135.

This species was found in several samples at depths averaging 11.3 meters and in frequencies between 0.7 per cent and 3 per cent of the population.

Although circumtropical in distribution, records of this form extend into temperate waters.

SUBFAMILY **BAGGININAE**

GENUS **CANCRIS** MONTFORT, 1808

Cancris inflata (d'Orbigny)

Valvulina inflata D'ORBIGNY, 1839, Voyage dans l'Amérique Meridionale, vol. 5, pt. 5, p. 48, pl. 7, figs. 7–9.

Rosalina hitchcockae GALLOWAY AND WISSLER, 1927, Jour. Paleont., vol. 1, no. 1, p. 62, pl. 10, figs. 2a, 2b, 2c.

Valvulineria inflata (d'Orbigny), CORYELL AND MOSSMAN, 1942, Jour. Paleont., vol. 16, no. 2, p. 235, pl. 36, figs. 7–9.

Valvulineria johnsoni CORYELL AND MOSSMAN, 1942, Jour. Paleont., vol. 16, no. 2, p. 235, pl. 36, figs. 10–12.

Cancris inflata (d'Orbigny) NATLAND, 1950, Mem. Geol. Soc. Amer., no. 43, pt. 4, p. 31, pl. 7, figs. 3–4.

This highly variable form possesses a distinct, clear area on the final apertural face and therefore belongs to the genus *Cancris* as suggested by Natland. In the Gulf it occurs in only a few samples, in frequencies ranging from 0.6 per cent to 15 per cent.

This species has not been observed in any Recent samples off the coast of southern California. It is, however, known from off the west coast of Central America.

Cancris auricula (Fichtel and Moll)

Nautilus auricula FICHTEL AND MOLL, 1803, Testacea Microscopica, var. *A*, p. 108, pl. 20, figs. a–c.

Nautilus auricula FICHTEL AND MOLL, 1803, Testacea Microscopica, var. *B*, p. 108, pl. 20, figs. d–f.

Cancris auricula, CUSHMAN, 1931, Bull. U. S. Natl. Mus., no. 104, pt. 8, p. 72, pl. 15, figs. 1a, 1b, 1c.

This species was found in several samples in frequencies ranging from 0.8 per cent to 5 per cent of the population.

It has been reported from the Pliocene, Pleistocene, and Recent sediments of southern California. Off the west coast of Central America it is found in depths ranging from 18 to 1911 meters.

FAMILY **CYMBALOPORIDAE**

GENUS **CYMBALOPORETTA** CUSHMAN, 1928

Cymbaloporetta bradyi (Cushman)

Cymbaloporetta poeyi (d'Orbigny) var., H. B. BRADY, 1884, Report on the scientific results of H.M.S. Challenger, Zoology, vol. 9, p. 637, pl. 102, figs. 14a, 14b, 14c, 14d.

Cymbalopora poeyi, RHUMBLER (not d'Orbigny), 1906, Zool. Jahrb., Abt. Syst., vol. 24, p. 71, pl. 15, figs. 59a, 59b.

Cymbalopora poeyi (d'Orbigny) var. *bradyi* CUSHMAN, 1915, Bull. U. S. Natl. Mus., no. 71, pt. 5, p. 25, pl. 10, figs. 2a, 2b, 2c, pl. 14, figs. 2a, 2b, 2c.

Cymbalopora bradyi, CUSHMAN, 1924, Publ.

Carnegie Inst. Washington, no. 342, p. 34, pl. 10, figs. 2–4.

Cymbaloporetta bradyi, CUSHMAN, 1931, Bull. U. S. Natl. Mus., no. 104, pt. 8, p. 85.

The flat irregular spire, with numerous chambers in each whorl all visible on the ventral side, is typical of this species, which is a common inhabitant of the Indo-Pacific waters but is less commonly found in the tropical Atlantic.

It is present in several samples throughout the Gulf at depths ranging from 0.8 meter to 18.5 meters and frequencies of from 0.5 per cent to 9 per cent of the population.

Cymbaloporetta squammosa (d'Orbigny)

Rotalia squammosa D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 8, p. 272.

Rosalina squammosa D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 91, pl. 3, figs. 12–14.

Cymbalopora squammosa, CUSHMAN, 1922, Publ. Carnegie Inst. Washington, no. 311, p. 41, pl. 6, figs. 4–6.

Cymbaloporetta squammosa, CUSHMAN, 1928, Contrib. Cushman Lab. Foram. Res., vol. 4, p. 7; 1931, Bull. U. S. Natl. Mus., no. 104, pt. 8, pl. 16, fig. 4.

This high-spired form is common in the West Indian region and extends into the Indo-Pacific and the Mediterranean.

This species is not common in the Gulf. It is found in the southern half and as far north as Tiburón Island.

GENUS **TRETOMPHALUS** MOEBIUS, 1880

Tretomphalus atlanticus Cushman

Tretomphalus atlanticus CUSHMAN, 1934, Contrib. Cushman Lab. Foram. Res., vol. 10, pt. 4, p. 86, pl. 11, figs. 3a, 3b, 3c, pl. 12, fig. 7.

Forms without the float chamber may be misidentified as *Cymbaloporetta*. A careful examination, however, reveals the broken edges of the float chamber where it once joined the ventral side. In the type reference, Cushman differentiated this form, with the "cymbaloporid" early stage, from *Tretomphalus bulloides* with the "discorbislike" test.

This species is not found north of San Marcos Island. It occurs in several samples in frequencies ranging from 0.6 per cent to 9 per cent and is reported from all tropical areas.

Tretomphalus bulloides (d'Orbigny)

Rosalina bulloides D'ORBIGNY, 1839, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 104, pl. 3, figs. 2–5.

Tretomphalus bulloides (d'Orbigny) CUSHMAN, 1931, Bull. U. S. Natl. Mus., no. 104, pt. 8, p. 86, pl. 16, figs. 5a, 5b, 5c.

This species is found in low frequencies in several samples from the Gulf. It has been reported from the West Indies, southern California, and off the west coast of Central America.

FAMILY **CASSIDULINIDAE**

SUBFAMILY **CASSIDULININAE**

GENUS **EPISTOMINELLA** HUSESIMA AND MARUHASO, 1944

Epistominella exigua (H. B. Brady)

Pulvinulina exigua H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 696, pl. 103, figs. 13, 14.

Epistominella exigua (Brady) PHLEGER, PARKER, AND PIERSON, 1953, *in* Reports of the Swedish Deep-Sea Expedition, Göteborg, vol. 7, fasc. 1, pp. 3–22.

Seven specimens of this form were found in sample 62, at a depth of 73.8 meters.

GENUS **CASSIDULINA** D'ORBIGNY, 1826

Cassidulina cushmani Stewart and Stewart

Cassidulina cushmani STEWART AND STEWART, 1930, Jour. Paleont., vol. 4, no. 1, p. 71, pl. 9, figs. 5a, 5b. CORYELL AND MOSSMAN, 1942, Jour. Paleont., vol. 16, no. 2, p. 243, pl. 36, fig. 48.

One specimen was found in sample 41 at 12.0 meters. This species is common in the Pliocene of Carmen Island. Since this sample was taken off Carmen Island, it is possible that the specimen is a reworked test.

Cassidulina laevigata d'Orbigny

Cassidulina laevigata D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 1, p. 282, pl. 15, figs. 4, 5.

Cassidulina laevigata was found in numerous samples throughout the Gulf, at depths averaging 37 meters, in frequencies of from 0.9 per cent to 8 per cent of the population.

This species is common in the warm waters of the eastern Pacific, in the Gulf of Mexico, and on the Atlantic continental shelf.

Cassidulina subglobosa H. B. Brady

Cassidulina subglobosa H. B. BRADY, 1881, Quart. Jour. Micros. Sci., vol. 21, p. 60; 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 430, pl. 54, fig. 170c.

This species was found in numerous samples throughout the Gulf. It occurred in depths ranging from 3.7 to 79.4 meters, with the largest percentage in depths greater than 30 meters.

Records of this species are from both the Atlantic and the Pacific oceans, at depths of 10 to 1610 meters.

FAMILY **CHILOSTOMELLIDAE**

SUBFAMILY **ALLOMORPHINELLINAE**

GENUS **PULLENIA** PARKER AND JONES, 1862

Pullenia quinqueloba (Reuss)

Nonionina quinqueloba REUSS, 1851, Zeitschr. Deutschen Geol. Gesell., vol. 3, p. 47, pl. 5, figs. 31a, 31b.

Pullenia quinqueloba, H. B. BRADY, 1882, Proc. Roy. Soc. Edinburgh, vol. 11, p. 712.

A few specimens of this species are present in two samples from the northern half of the Gulf. Previous records indicate that this form is generally restricted to cold, deep water.

FAMILY **GLOBIGERINIDAE**

SUBFAMILY **GLOBIGERININAE**

GENUS **GLOBIGERINA** D'ORBIGNY, 1826

Globigerina bulloides d'Orbigny

Globigerina bulloides D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 1, p. 277; Modeles nos. 17, 76.

Globigerina bulloides is the most abundant planktonic form in this collection. Its frequencies range from 0.5 per cent to 19 per cent, with the greatest percentages in depths below 20 meters.

Globigerina quinqueloba Natland

Globigerina quinqueloba NATLAND, 1938, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 4, no. 5, p. 149, pl. 6, figs. 7a, 7b, 7c.

This is a common eastern Pacific species reported from southern California to Central America.

It is not common in this collection and is present in only a few samples in low frequencies, usually less than 6 per cent.

GENUS **GLOBIGERINOIDES** CUSHMAN, 1927

Globigerinoides rubra (d'Orbigny)

Globigerina rubra D'ORBIGNY, 1893, *in* de la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, p. 94, pl. 4, figs. 12–14.

Globigerinoides rubra, CUSHMAN, 1941, Amer. Jour. Sci., vol. 239, pl. 2, fig. 3.

This species is common in warm-water regions. It has been reported from the West Indies, off the west coast of Central America, and in the Pacific Ocean.

This species is not common in the Gulf. In most cases it is fewer in numbers than *Globigerina bulloides* d'Orbigny.

FAMILY **GLOBOROTALIIDAE**

GENUS **GLOBOROTALIA** CUSHMAN, 1927

Globorotalia menardii (d'Orbigny)

Rotalia menardii D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 26, p. 273; Modeles no. 10.

Pulvinulina repanda var. *menardii*, PARKER AND JONES, 1865, Phil. Trans., vol. 155, p. 394, pl. 16, figs. 35–37.

Pulvinulina menardii, OWEN, 1867, Jour. Linnean Soc., London, Zool., vol. 9, p. 148, pl. 5, fig. 16.

Rotalina cultrata BAILEY, 1851, Smithsonian Contrib. Knowl., vol. 2, art. 3, p. 11, pl., figs. 14–16.

Globorotalia menardii, CUSHMAN, 1927, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 1, no. 10, p. 175.

Pulvinulina menardii var. *cultrata*, BROECK, 1876, Ann. Soc. Belge Micros., vol. 2, p. 141, pl. 3, figs. 13, 15.

Rotalia canariensis D'ORBIGNY, *in* Barker-Webb and Berthelot, 1839, Histoire naturelle des Iles Canaries, vol. 2, pt. 2, p. 130, pl. 1, figs. 34–36.

This circumtropical species was present in several samples throughout the Gulf, in frequencies ranging from 0.6 per cent to 6 per cent.

Globorotalia truncatulinoides (d'Orbigny)

Rotalina truncatulinoides D'ORBIGNY, *in* Barker-Webb and Berthelot, 1839, Histoire naturelle des Iles Canaries, vol. 2, pt. 2, p. 132, pl. 2, figs. 25–27.

Globorotalia truncatulinoides, CUSHMAN AND WICKENDEN, 1929, Proc. U. S. Natl. Mus., vol. 75, art. 9, p. 14, pl. 6, figs. 3a, 3b, 3c.

This species is common in the tropical Pacific and is present in all oceans. In the Gulf it is found in only three samples and in low frequencies.

FAMILY **ANOMALINIDAE**

SUBFAMILY **ANOMALININAE**

GENUS **PLANULINA** D'ORBIGNY, 1826

Planulina exorna Phleger and Parker

Planulina exorna PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 32, pl. 18, figs. 5–8.

This form is closely related to *Planulina ariminensis* d'Oobigny. It differs, however, from the latter in its thicker, smaller test, straighter sutures, and beaded early stages.

It is common in numerous samples in the Gulf at depths ranging from 5.5 to 79.4 meters and usually exceeding 38 meters. Frequencies range from 0.5 per cent to 19 per cent, the larger numbers in the deeper samples.

SUBFAMILY **CIBICIDINAE**

GENUS **CIBICIDES** MONTFORT, 1808

Cibicides basiloba (Cushman)

Truncatulina basiloba CUSHMAN, 1918, Bull. U. S. Geol. Surv., no. 676, p. 64, pl. 21, fig. 2.

Cibicides basiloba, NATLAND, 1933, Bull. Scripps Inst. Oceanogr., tech. ser., vol. 3, no. 10, line 90 on included chart.

Specimens of this species were found in only three samples.

The species has previously been reported from off the coast of southern California and off the west coast of Central America.

Cibicides concentricus (Cushman)

Truncatulina concentricus CUSHMAN, 1918, Bull. U. S. Geol. Surv., no. 676, p. 64, pl. 21, fig. 3.

Cibicides concentricus (Cushman) PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 29, pl. 15, figs. 14, 15.

This species is common in the Gulf, becoming more abundant north of the Carmen Island area. It was found in depths averaging 33.5 meters and is often associated with *Bulimina denudata*. In the north it occasionally occurs at shallower depths.

Previous records report it from the tropical Atlantic and the Gulf of Mexico.

Cibicides floridanus (Cushman)

Truncatulina floridana CUSHMAN, 1918, Bull. U. S. Geol. Surv., no. 676, p. 62, pl. 19, fig. 2.

Cibicides floridana (Cushman), CUSHMAN, 1930, Bull. Florida Geol. Surv., no. 4, p. 61, pl. 12, figs. 3a, 3b, 3c.

This species is present in several samples throughout the Gulf in depths ranging from 2.5 to 75 meters, and at frequencies from 0.9 per cent to 10 per cent of the population. It is very common in the Gulf of Mexico and the West Indian region.

Cibicides lobatulus (Walker and Jacob)

Nautilus spiralia lobatus WALKER AND BOYS, 1784, Testacea minuta, p. 20, pl. 3, fig. 71.

Nautilus lobatulus WALKER AND JACOB, 1798, Adams Essays, Kanmacher's ed., p. 642, pl. 14, fig. 36.

Serpula lobatula, MONTAGU, 1803, Testacea Britannica, p. 515, Supp. p. 160.

Truncatulina lobatula, D'ORBIGNY, 1839, *in* Barker-Webb and Berthelot, Histoire naturelle des Iles Canaries, vol. 2, pt. 2, p. 134, pl. 2, figs. 22–24.

Cibicides lobatula (Walker and Jacob) CUSHMAN, 1931, Bull. U. S. Natl. Mus., no. 104, p. 118, pl. 21, fig. 3.

This species was found commonly throughout the Gulf in numerous samples. Frequencies range from 0.7 per cent to 8 per cent. The species is morphologically highly variable; the mode of attachment often determines the concavity of the ventral side. It is world-wide in distribution.

Cibicides refulgens (Montfort)

Cibicides refulgens MONTFORT, 1808, Conchyliologie systématique et classification méthodique des coquilles, vol. 1, p. 122.

Truncatulina refulgens, D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 3, p. 279, pl. 13, figs. 8–11.

This species is abundant and widely distributed in the Gulf. It is found in more than half of the samples, with frequencies ranging from 0.6 per cent to 7 per cent. It has been reported from numerous localities in both the Atlantic and the Pacific.

Cibicides umbonatus Phleger and Parker

Cibides umbonatus PHLEGER AND PARKER, 1951, Mem. Geol. Soc. Amer., no. 46, p. 31, pl. 17, figs. 7–9.

This species is rare in the present collection. It is found in only a few samples, in the south, at frequencies not greater than 2 per cent of the population.

Previously it had been known only from the Gulf of Mexico, in depths below 100 meters.

GENUS **DYOCIBICIDES** CUSHMAN AND VALENTINE, 1930

Dyocibicides biserialis Cushman and Valentine

Dyocibicides biserialis CUSHMAN AND VALENTINE, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 31, pl. 10, figs. 1–2.

This species seems to prefer water shallower than 23 meters. It ranges in frequency from 0.5 per cent to 9 per cent of the population.

It is abundant off the west coast of Central America and off southern California.

GENUS **CYCLOCIBICIDES** CUSHMAN, 1927

Cyclocibicides vermiculatus (d'Orbigny)

Planorbulina vermiculata D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 3, p. 280.

Pulvinulina vermiculata, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 687, pl. 115.

Cyclocibicides vermiculata (d'Orbigny) CUSHMAN, 1927, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 1, no. 39, p. 93.

This very interesting species is found in very shallow water in a few samples, in frequencies not greater than 5 per cent of the population.

The only Atlantic records are those of Heron-Allen and Earland from Selsey Bill, England, and one from the Clare Island region.

GENUS **CIBICIDELLA** CUSHMAN, 1927

Cibicidella variabilis (d'Orbigny)

Truncatulina variabilis D'ORBIGNY, 1826, Ann. Sci. Nat., Paris, ser. 1, vol. 7, no. 8, p. 279.

Cibicidella variabilis, CUSHMAN, 1927, Contrib. Cushman Lab. Foram. Res., vol. 3, p. 93.

This highly variable form was found in several samples in the Gulf, the northernmost at Tiburón Island. The early stages are like *Cibicides*, but the later ones are highly variable, depending on the mode of attachment.

It has a wide distribution in the Atlantic and the Pacific.

FAMILY **PLANORBULINIDAE**

GENUS **PLANORBULINA** D'ORBIGNY, 1826

Planorbulina acervalis H. B. Brady

Planorbulina acervalis H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 657, pl. 92, fig. 4.

This species is common in the Gulf south of the Carmen Island area. In frequency it ranges from 0.6 per cent to 12 per cent of the population. It is a common form in the Indo-Pacific and West Indian regions.

GENUS **GYPSINA** CARTER, 1877

Gypsina globulus (Reuss)

Ceriopora globulus REUSS, 1847, Haidinger's Naturwiss. Abhandl., vol. 2, p. 33, pl. 5, fig. 7.

Gypsina globulus, H. B. BRADY, 1884, Report on the scientific results of the voyage of H.M.S. Challenger, Zoology, vol. 9, p. 717, pl. 101, fig. 8.

This species is found in a few samples at frequencies not greater than 3 per cent of the population. It is common in the tropical Atlantic and Pacific.

SUMMARY

THE CARMEN ISLAND area appears to be of significant ecologic importance with respect to the Foraminifera in the Gulf of California. Both northern and southern faunas show increased rates of change in this region. Squires (1959, p. 395) shows that a gradual diminution of hermatypic coral fauna occurs in the Gulf from El Pulmo (latitude 23° 26′ N.) to South San Lorenzo (latitude 28° 35′ N.) north of Salinas Bay, Carmen Island. At South San Lorenzo kelp replaces *Porites*, and *Pavona* and *Pocillopora* were not found.

This area also marks the approximate northern limit of several tropical forms that were found in the present collection, of which the frequencies range as high as 65 per cent, and average 15 per cent of those of the southern populations. The distinctive character of the northern populations is due not only to the absence of these significent tropical species, but also to the greater abundance of several previously mentioned subtropical species, such as *Eponides hannai*, *Elphidium gunteri*, and *Cibicides concentricus*. A graphic analysis of the southern and northern populations shows a greater decrease in the number of species in the Carmen Island area (samples 41–49).

With respect to the Foraminifera, the Gulf, therefore, is believed to support a tropical fauna as far north as the twenty-sixth parallel (Carmen Island area). To the north the Gulf supports a more or less thinned-out, warm-water fauna which has most of its species in common with the southern population, but with a greater frequency of some typical subtropical forms.

Colder minimum temperatures to the north are presumed to be the main factor influencing this distribution.

In general the Buliminidae and Cassidulinidae dominated the deeper-water samples; *Cassidulina subglobosa* and *Bulimina denudata* are typical examples.

A study of the geographical affinities of the foraminiferal population of the Gulf indicates that the number (27.3%) of species that are endemic to the eastern Pacific warm water is larger than the number that are Amphi-American (20.2%), although the difference is not so great as that shown in a similar study made on crabs and echinoderms of the eastern Pacific (Eckman, 1953, p. 40). The percentage of circumtropical species in the Foraminifera (30.9%) was larger than in the megafauna (2%). This fact may be attributed to the greater capacity of the Foraminifera to be carried by ocean currents for great distances. Only a small percentage (4.3%) of the Foraminifera show affinities with the Indo-Pacific region.

Depth is considered to be the main factor that influences the foraminiferal number of the samples. The deeper samples usually contain the highest F.N. values, except for a few bioclastic areas supporting prolific populations.

The writer wishes to suggest further directions of study that might lead to the solution of important zoogeographical problems in this area. Foraminiferal populations can be studied in Recent samples collected between San Diego, California, and Cape San Lucas, at the tip of Baja California. With methods similar to those of this study, it may be possible to delineate more accurately the northern limits of the Panamic (tropical) Province. Late Tertiary samples taken throughout the extent of Baja California can be statistically analyzed, and the geographic ranges of the Foraminifera can be compared with those in this study. Such studies might indicate significant shifts in the tropical and subtropical fauna and aid in the interpretation of broad paleoecological problems.

APPENDIX 1: DESCRIPTION OF SAMPLES

THE FOLLOWING LIST of the bottom samples gives pertinent information about each. The samples are deposited in the Department of Micropaleontology at the American Museum of Natural History.

The examination of the sediments was made with a stereoscopic microscope, at a maximum magnification of ×80. Sediments in the clay range were not analyzed microscopically.

For the 81 samples, the following data are given: (1) general locality description, (2) position in terms of latitude and longitude, (3) date of collection in 1957, (4) depth of sample, (5) water temperature, (6) collecting method, (7) bottom type (wet sediment), (8) megascopic description of sediment (dried sample), (9) microscopic description of sediment (dried sample), and (10) associations and environment. The complete information for each sample was not always available.

BOTTOM SAMPLE 1: Center of Olas Altas Bay, Mazatlán, Sonora, 400 feet off the center of a crescentic beach; 23° 11′ 15″ N., 106° 26′ 45″ W.; April 13; 2.5 meters; surface, 21.4° C., bottom, similar; skin diving; beach sand; medium-grained, reddish brown sand, no silt-clay fraction; angular grains of quartz and water-worn shell fragments, many of the quartz grains coated with limonite; no plant life and no epifauna, small infaunal snails, sand in motion on flowing tide, not on falling tide.

BOTTOM SAMPLE 2: Off dock in dredged channel, Mazatlán, Sonora; 23° 11′ 15″ N., 106° 26′ 45″ W.; April 15; 9.2 meters; surface, 21.8° C., bottom, similar; dredge; soft muddy bottom; fine-grained, brown sand, 3.1 per cent silt-clay fraction; primarily clear angular grains of quartz and feldspar (some iron-stained), with minor amounts of olivine and biotite grains; sewage disposal area, high flora, large molluscan epifauna, radical changes in salinity.

BOTTOM SAMPLE 3: Northern side of Los Frailes Bay, Baja California; 23° 21′ 45″ N., 109° 25′ W. April 18; 14.8 meters; bottom, 22° C.; dredge; gravel over sand; medium-grained, gray sand, no silt-clay fraction; large quantities of shell fragments, biotite, and muscovite, with smaller quantities of quartz; molluscan epifauna, no apparent plant life.

BOTTOM SAMPLE 4: Northern side of Pulmo Bay, Baja California, on leeward (northern) side of La Barra Grande Reef; 23° 25′ 30″ N., 109° 25′ W.; April 18; 5.5 meters; surface, 22.5° C., bottom, 22° C.; skin diving; gravel; fine grained, bioclastic gravel with large pieces of coralline algae, no silt-clay fraction; primarily shell fragments with small quantities of rounded quartz grains; reef environment, calcareous and green algae, quiet bottom, with turbid water.

BOTTOM SAMPLE 5: Northern side of Pulmo Bay, Baja California, on leeward (northern) side of La Barra Grande Reef; same as bottom sample 4; April 18; 3.7 meters; bottom, 22° C., surface, 22.5° C.; skin diving; gravel; shelly, light-colored gravel, no silt-clay fraction; subangular to rounded clear and milky quartz grains, with small quantities of feldspar and shell material.

BOTTOM SAMPLE 6: Northern side of Pulmo Bay, Baja California, on leeward (northern) side of La Barra Grande Reef; 23° 25′ 30″ N., 109° 25′ W.; April 18; 3.1 meters; surface, 22.5° C., bottom, 22° C.; skin diving; fine sand; fine-grained, tan sand, no silt-clay fraction; a well-sorted, clean quartz sand, composed almost entirely of angular grains of clear and frosted quartz, with minute quantities of biotite and shell material.

BOTTOM SAMPLE 7: Los Frailes Bay, Baja California, 23° 21′ 45″ N., 109° 25′ W.; April 19; 46.2 meters; surface, 22° C.; dredge; clay; brown silt, silt-clay fraction 45 per cent.

BOTTOM SAMPLE 8: Midway between Piedras Giordas Point and Montona Rock, southern end of Cerralvo Island; 24° 8′ N., 109° 51′ W.; April 21; 14.8 meters; surface, 22° C., bottom, similar; dredge; fine sand, no rock ledges; fine-grained, light brown sand, with some large pebbles and shell fragments, no silt-clay fraction; angular quartz grains with smaller amounts of biotite; thinly scattered algal growth, no other epifauna noted.

BOTTOM SAMPLE 9: San Lorenzo Reef, San Lorenzo Channel; 24° 23′ N., 110° 19′ W.; April 21; 3.7 meters; surface, 22° C., bottom, 22.5° C.; skin diving; sand between boulders which lie loose on a sand base; bioclastic, coarse-grained sand, no silt-clay fraction; shell bioclastic; boulders covered with anemones, some *Pocillopora*, *Porites*, and sponges, no apparent infauna.

BOTTOM SAMPLE 10: South of Bonanza Point, Espíritu Santo Island; 24° 25′ 30″ N., 110° 19′ W.; April 21; 3.7 meters; surface, 22° C., bottom, 21° C.; skin diving; sand pockets between loose rock ledges, ledges 10 feet in height and 20 feet in diameter; medium- to coarse-grained bioclastic sand, 1 per cent silt-clay fraction; primarily a

bioclastic sediment composed of shell fragments and echinoid spines; algae, starfish, holothuroids abundant, some coral, Alcyonaria, and anemones, fish abundant, molluscan infauna present.

BOTTOM SAMPLE 11: Midway between Bonanza Point and the Boulder Mound, southeast side of Espíritu Santo Island; 24° 27′ N., 110° 8′ W.; April 21; 12.9 meters; surface, 22° C., bottom, similar; dredge; fine sand, some rock ledges, but widely scattered; fine-grained white sand, silt-clay fraction 3 per cent; bioclastic, calcareous fragments; very high percentage of molluscan infauna, large and abundant specimens, epifauna consisting mostly of *Pennatularia* and algae, widely scattered, fish abundant.

BOTTOM SAMPLE 12: South of Dispensa Point, Espíritu Santo Island, in San Lorenzo Channel; 24° 23′ N., 110° 21′ W.; April 22; 46.2 meters; surface, 23° C.; dredge; sand and mud, brown in color; brown silty clay, 38 per cent silt-clay fraction; bioclastic; molluscan infauna, particularly snails, considerable long "grass," no epifauna.

BOTTOM SAMPLE 13: Northern side of San Gabriel Bay, Espíritu Santo Island; 24° 23′ N., 110° 21′ W.; April 22; 0.8 meter; surface, 24.4° C., bottom, similar; skin diving; sand, with patches of algae, rock bottom about 3 inches below sand; fine-grained, white sand, 1 per cent silt-clay fraction; bioclastic; a back-reef facies with algae and molluscan infauna, probably exposed at low or spring tide.

BOTTOM SAMPLE 14: Oyster pen on southeast coast of San Gabriel Bay, Espíritu Santo Island; 24° 25′ N., 110° 21′ W.; April 22; 9 meters; surface, 26° C., bottom, 26° C.; skin diving; mucky bottom; fine-grained, white sand, 3 per cent silt-clay fraction; shell bioclastic; high algal growth, molluscan infauna and epifauna, corals and echinoids, water quiet.

BOTTOM SAMPLE 15: Reef, center of San Gabriel Bay, Espíritu Santo Island; 24° 25′ N., 110° 21′ W.; April 23; 2.5 meters; surface, 21° C., bottom, 22° C.; skin diving; fine, white sand; medium-grained bioclastic sand, no silt-clay fraction; mostly molluscan fragments and some echinoid spines; reef association, corals, algal growth, molluscan epifauna and infauna.

BOTTOM SAMPLE 16: Center of San Gabriel Bay, Espíritu Santo Island; 24° 31′ 30″ N., 110° 23′ W.; April 23; 10.2 meters; surface, 22° C., bottom, 22° C.; dredge; coarse sand; coarse-grained bioclastic sand, no silt-clay fraction; shell bioclastic.

BOTTOM SAMPLE 17: Bay on north side of bay between Isla Partida and Espíritu Santo; 24° 31′ 30″ N., 110° 23′ 25″ W.; April 24; 3.4 meters; surface, 23.9° C., bottom, similar; skin diving; white sand; coarse-grained bioclastic sand, no silt-clay fraction; bioclastic; algal content high, molluscan infauna, turbidity high.

BOTTOM SAMPLE 18: Anchorage in La Paz Harbor, Baja California; 24° 9′ 30″ N., 110° 19′ 30″ W.; April 26; 5.5 meters; surface, 23° C., bottom, 22° C.; dredge; coarse sand; fine- to medium-grained, gray sand, 1 per cent silt-clay fraction; mostly clear, angular quartz grains, some of the quartz well rounded and frosted, pieces of sandstone and shells present.

BOTTOM SAMPLE 19: On southern side of bar on north side of La Paz anchorage, Baja California; 24° 9′ 30″ N., 110° 19′ 30″ W.; April 26; 0.9 meter; surface, 24° C., bottom, 24° C.; dredge; fine sand, high in organic content; coarse-grained bioclastic, no silt-clay fraction; shell bioclastic; high molluscan infauna, no epifauna.

BOTTOM SAMPLE 20: Center of bay on southwestern shore of San Francisco Island; 24° 49′ N., 110° 35′ 30″ W.; April 27; 9.2 meters; surface, 25° C., bottom, 22° C.; dredge; fine sand; medium-grained, brown sand with shell fragments, no silt-clay fraction; large amount of bioclastic material and angular quartz grains, small quantities of olivine, gypsum, and fragments of tuff.

BOTTOM SAMPLE 21: Outside rock reef lying parallel to the beach, but 50 to 100 feet off shore, on the eastern coast of bay, southwest coast of San Francisco Island; 24° 49′ N., 110° 35′ 30″ W.; April 27; 3.7 meters; surface, 25° C., bottom 22° C.; skin diving; fine sand between boulders approximately 18 inches in diameter; medium-grained, light brown, bioclastic sand, 3 per cent silt-clay fraction; shell bioclastic; boulders with thick algal growth, some echinoderms, no apparent infauna.

BOTTOM SAMPLE 22: Reef off northeastern shore of bay on southwest side of San Francisco Island; 24° 49′ N., 110° 35′ 30″ W.; April 27; 6.2 meters; surface, 25° C., bottom, 22° C.; skin diving; boulders, 15 to 30 feet in diameter, with sand pockets between, sand coarse; fine-grained shelly gravel, no silt-clay fraction; large fragments of tuffaceous rock and molluscan shells, smaller amounts of quartz; boulders with lush algal growth, sponges, Alcyonaria, Mollusca, and worms, echinoids, and starfish, no infauna noted.

BOTTOM SAMPLE 23: Southeastern extremity, lagoon, Amortajada Bay, San José Island; 24° 52′ 30″ N., 110° 34′ W.; April 28; 3.7 meters; surface, 23.5° C., bottom, similar; skin diving; boulders with sand covering; medium- to coarse-grained sand, 1 per cent silt-clay fraction; shell coquina and large, angular quartz grains; algal mat, occasionally torn loose so that sponges, corals, and echinoids gain foothold, molluscan infauna, epifauna.

BOTTOM SAMPLE 24: Across from southern entrance to lagoon, Amortajada Bay, San José Island; 24° 52′ 30″ N., 110° 34′ 30″ W.; April 28; 0.8 meter; surface, 23.5° C., bottom, 23.5° C.;

skin diving; sand veneer approximately 6 inches deep on hard sandstone; coarse-grained, bioclastic sand, no silt-clay fraction; bioclastic, composed of calcareous algae, molluscan fragments, and echinoid spines; bordered by mangroves, molluscan infauna and epifauna, scattered patches of sand surrounded by algae.

BOTTOM SAMPLE 25: East of mouth of lagoon, at first bend, Amortajada Bay, San José Island; 24° 53′ 30″ N., 110° 33′ 45″ W.; April 28; 3.1 meters; surface, 23.5° C., bottom, 23.5° C.; skin diving; sand; medium- to coarse-grained, buff sand, 2 per cent silt-clay fraction; sand composed of fragments of a quartz shell conglomerate, smaller quantities of microgastropod shells and calcareous algae; thick algal mat with molluscan epifauna, bordered by mangroves.

BOTTOM SAMPLE 26: One hundred feet off shore, south of lagoon channel, Amortajada Bay, San José Island; 24° 53′ N., 110° 34′ W.; April 28; 3.1 meters; surface, 24.5° C., bottom, 23.5° C.; skin diving; deep sand and mud, shell material not broken up; medium-grained, light brown, shelly sand, 3 per cent silt-clay fraction; almost entirely fragments of mollusks, with smaller amounts of calcareous algae, quartz, and biotite; thenatocoenose of Mollusca and coral, molluscan infauna, scattered algal growth.

BOTTOM SAMPLE 27: Five hundred yards off shore, slightly south of mouth of channel, Amortajada Bay, San José Island; 24° 53′ N., 110° 34′ W.; April 28; 19.4 meters; surface, 23.5° C., bottom, 22° C.; dredge; fine mud and sand; brown silt, 54 per cent silt-clay fraction; algae in sampler.

BOTTOM SAMPLE 28: In northern section of Amortajada Bay, San José Island; 24° 53′ 40″ N., 110° 36′ W.; April 28; 43.4 meters; surface, 22° C.; dredge; fine sand with shell debris; fine-grained, buff sand, 3 per cent silt-clay fraction; bioclastic quartz sand; molluscan infauna with some epifauna, dead cyclosurids.

BOTTOM SAMPLE 29: Just north of Salinas Point, San José Island; 24° 56′ N., 110° 14′ W.; April 29; 46.7 meters; dredge; plastic sand; very fine-grained, micaceous, brown sand; angular quartz grains with some biotite grains; molluscan infauna and epifauna with attached Bryozoa and dead cyclosurids, high in Crustacea.

BOTTOM SAMPLE 30: North of Salinas Point, San José Island; 24° 57′ N., 110° 41′ 20″ W.; April 29; 70.7 meters; surface, 22° C.; dredge; plastic sand with boulders; fine, medium-grained, buff sand, 3 per cent silt-clay fraction; quartz bioclastic sand with minor amounts of biotite; high crustacean fauna, molluscan infauna and epifauna, dead cyclosurids, *Balanophyllia*, Bryozoa.

BOTTOM SAMPLE 31: Southeastern tip of San Diego Island; 25° 10′ 30″ N., 110° 43′ W.; April 29; 18.5 meters; surface, 22.5° C., bottom, 22° C.; dredge; coarse sand, bioclastic; coralline algae, bioclastic gravel, no silt-clay fraction; bioclastic.

BOTTOM SAMPLE 32: Southeastern extremity of Santa Cruz Island; 25° 15′ N., 110° 44′ W.; April 30; 6.2 meters; surface, 22° C., bottom, similar; skin diving; dirty gray sand; medium-grained sand, no silt-clay fraction; angular grains of frosted quartz and secondary amounts of bioclastics and biotite; algae sparse, molluscan infauna, no epifauna.

BOTTOM SAMPLE 33: Bay at Point Tulmo, Baja California, approximate center; 25° 18′ N., 110° 56′ W.; May 2; 10.2 meters; surface, 22° C., bottom, similar; dredge; sand; medium- to coarse-grained bioclastics, no silt-clay fraction; shell bioclastic; high algal growth (ropy green algae).

BOTTOM SAMPLE 34: Center of Aqua Verde Bay, Baja California; 25° 31′ N., 110° 4′ W.; May 2; 12.9 meters; dredge; sand; fine-grained, gray sand, 19 per cent silt-clay fraction; mostly clear angular quartz grains, with some sandstone and obsidian fragments, gypsum grains present; dense algal growth, sargassum present, first notice of decrease in reef corals, especially *Porites* heads.

BOTTOM SAMPLE 35: South side of Aqua Verde Bay, Baja California, off rock island; 25° 31′ N., 111° 4′ W.; May 2; 4.6 meters; surface, 22.5° C., bottom, 23° C.; skin diving; sand between boulders; coarse-grained bioclastic sand; abundant grains of hornblende and sandstone fragments; high in sargassum, boulders with *Porites* and algal streamers.

BOTTOM SAMPLE 36: Off rocks at Point San Marcial, Baja California; 25° 32′ 45″ N., 111° 1′ 10″ W.; May 2; 6.2 meters; surface, 24.5° C., bottom, 23° C.; skin diving; sand between rock outcroppings; fine-grained, bioclastic gravel, no silt-clay fraction; echinoid spines with shell fragments; great algal growth, good epifauna.

BOTTOM SAMPLE 37: Off southwest end of Monserrate Island; 25° 40′ N., 111° 3′ 30″ W.; May 2; 5 meters; surface, 22° C., bottom, similar; dredge; sand; medium- to coarse-grained bioclastic sand; bioclastic sand, fragments of gastropods, echinoid spines, and Bryozoa; little algae, clean sand with filamentous algae.

BOTTOM SAMPLE 38: Off southwestern end of Monserrate Island; 25° 40′ N., 110° 3′ 30″ W.; May 3; 7.4 meters; surface, 22° C., bottom, similar; dredge; sand with scattered boulders; medium-grained, light brown sand, abundant shell material, 1 per cent silt-clay fraction; bioclastic, with echinoid spines and plates, molluscan fragments, worm tubes, gastropod and bryozoan fragments, and alcyonarian spicules, some quartz and obsidian grains; water very clear, algal growth on boulders.

BOTTOM SAMPLE 39: Off southwestern end of Santa Catalina Island; 25° 36′ 15″ N., 110° 48′

05″ W.; May 3; 21.2 meters; surface, 22° C.; dredge; sand; fine-grained, brown sand, 1 per cent silt-clay fraction; subangular to subrounded quartz, with large amounts of biotite grains and bioclastics; rocks having less algae than Aqua Verde and poor epifauna.

BOTTOM SAMPLE 40: In bay, between rocks, southeastern side of Santa Catalina Island; 25° 36 15″ N., 110° 48′ 05″ W.; May 3; 7.7 meters; surface, 21° C., bottom, similar; skin diving; sand; medium-grained, brown sand, 1 per cent silt-clay fraction; subrounded to rounded milky quartz grains, biotite common, some shell material; less algal growth on rocks than on southeastern end of the island, epifauna rather sparse.

BOTTOM SAMPLE 41: Salinas Bay, Carmen Island; 25° 59′ N., 111° 7′ W.; May 4; 12 meters; dredge; sand; fine- to medium-grained, light brown sand, 10 per cent silt-clay fraction; bioclastics composed mostly of molluscan fragments and echinoid spines and plates, some angular grains of clear quartz; Mollusca, coral, dead epifauna, water saline.

BOTTOM SAMPLE 42: West side of Salinas Bay, Carmen Island; 25° 59′ 24″ N., 111° 8′ 15″ W.; May 4; 1.5 meters; skin diving; clean sand; fine-grained, buff-colored sand, 1 per cent silt-clay fraction; bioclastics with some clear, angular quartz grains and some felsite fragments; kelp bottom with high molluscan content.

BOTTOM SAMPLE 43: Anchorage outside of inner harbor, Puerto Escondido, Baja California; 25° 48′ 45″ N., 111° 18′ 45″ W.; May 5; 22.2 meters; surface, 25° C.; dredge; mud and sand; brown, silty sand, 25 per cent silt-clay fraction; bioclastics composed of molluscan fragments, echinoid spines, and triaxons, some grains of clear angular quartz and muscovite.

BOTTOM SAMPLE 44: Northwestern end of inner lagoon, Puerto Escondido, Baja California; 25° 49′ 45″ N., 111° 19′ W.; May 5; 1.5 meters; surface, 26° C., bottom, 26° C.; skin diving; clean sand; coarse-grained, light-colored sand, with large amounts of shell material; shell bioclastic, with pieces of graywacke; off shore from coral bank, with mangroves on shore, some algae and molluscan infauna.

BOTTOM SAMPLE 45: Mouth of inner harbor, Puerto Escondido, Baja California; 25° 48′ 50″ N., 111° 19′ W.; May 5; 0.9 meter; surface, 26° C., bottom, 26° C.; skin diving; coarse sand; medium-grained, brown sand, no silt-clay fraction; angular grains of clear quartz, some round, iron-stained quartz grains and grains of hematite; no visible epifauna, subject to wash during inflowing and outflowing tides.

BOTTOM SAMPLE 46: Off Puerto Escondido, on heading for northern Danzante Island, Baja California; 25° 48′ 35″ N., 111° 18′ W.; May 6; 35.1 meters; dredge; mud; silty sand, 30 per cent silt-clay fraction; angular quartz grains; infauna.

BOTTOM SAMPLE 47: Off Puerto Escondido, on heading towards northern end of Danzante Island, Baja California; 25° 49′ 37″ N., 111° 17′ 00″ W.; May 6; 79.4 meters; surface, 23.5° C.; dredge; mud; very fine-grained sand, 3 per cent silt-clay fraction; large amount of bioclastics, grains of calcite and obsidian; epifauna, Crustacea, Mollusca, coral, infauna.

BOTTOM SAMPLE 48: Anchorage on southwestern side of Coronados Island; 26° 6′ 30″ N., 111° 18′ 30″ W.; May 8; 19.4 meters; surface, 21° C., bottom, 20° C.; dredge; gravel; white *Lithophyllum* gravel, no silt-clay fraction; bioclastic, mainly *Lithophyllum*, some echinoid spines and plates.

BOTTOM SAMPLE 49: Off west side of Coronados Island; 28° 07′ 18″ N., 111° 18′ 15″ W.; May 8; 75.3 meters; dredge; mud; silty sand, 15 per cent silt-clay fraction; bioclastic; poor molluscan infauna.

BOTTOM SAMPLE 50: Between Santa Inez Point and the largest of the Santa Inez Islands (northern tip); 27° 3′ N., 111° 59′ W.; May 9; 9.2 meters; surface, 21° C., bottom, similar; dredge; coarse sand and boulders; coarse to gravelly bioclastic sand, with *Lithophyllum*, no silt-clay fraction; bioclastic, with *Lithophyllum* and molluscan fragments.

BOTTOM SAMPLE 51: Off southwestern side of San Marcos Island; 27° 10′ N., 112° 05′ W.; May 10; 11.1 meters; surface, 19° C., bottom, similar; dredge; muddy sand; fine-grained, light brown sand, 2 per cent silt-clay fraction; angular, clear quartz grains and bioclastics, some green glass fragments and iron-stained quartz; molluscan infauna, and epifauna.

BOTTOM SAMPLE 52: Off southwestern side of San Marcos Island; 27° 10′ N., 112° 05′ W.; May 10; 19.8 meters; surface, 19° C.; dredge; very fine-grained, greenish gray sand, 9 per cent silt-clay fraction; angular quartz, gray obsidian, olivine, hematite, and bioclastics; some coral, molluscan infauna and epifauna.

BOTTOM SAMPLE 53: Lobos Rock off southwestern side of San Marcos Island; 27° 10′ N., 112° 05′ W.; May 10; 2.5 meters; surface, 19° C., bottom, 19° C.; skin diving; coarse sand; rounded pebbles of volcanics, tuff, basalt, and felsites, no silt-clay fraction; algal growth sparse, mostly long sargassum with molluscan infauna.

BOTTOM SAMPLE 54: Entrance to San Carlos Bay, Sonora, Mexico; 27° 56′ 30″ N., 111° 05′ 15″ W.; May 11; 13.8 meters; surface, 22° C., bottom, 22° C.; dredge; coarse sand bottom; medium-grained, light brown sand with shell fragments, 3 per cent silt-clay fraction; bioclastic composed mostly of molluscan fragments.

BOTTOM SAMPLE 55: Seaward side of Las Tetas de Cabra, San Carlos Bay, Sonora; 27° 56′ 30 N., 111° 05′ 58″ W.; May 12; 5.5 meters; surface 22° C., bottom 22° C.; skin diving; sand with small rocks and large boulders; medium-grained, light brown sand with shell material; bioclastic composed primarily of molluscan fragments; corals, sponges, anemones, high molluscan epifauna and some infauna.

BOTTOM SAMPLE 56: Off Permex Water Docks, Isla Ardilla, Guayamas, Sonora; 27° 54′ 55″ N., 110° 53′ 55″ W.; May 14; 5.5 meters; dredge; muck, high in organic content; black organic, 100 per cent silt-clay fraction; monaxons, fecal pellets, diatoms, muscovite, biotite, angular, clear quartz grains; no visible macrofauna, may be brackish, polluted by human sewage.

BOTTOM SAMPLE 57: West of Isla de Parjaros and east of Isla Pitabaya, in center of channel to outer harbor, Guaymas, Sonora; 27° 52′ 43″ N., 110° 52′ 35″ W.; May 14; 10.2 meters; dredge; muck; black organic, 100 per cent silt-clay fraction; residue with angular quartz grains and some sponge spicules; no macrofauna visible, a reducing environment.

BOTTOM SAMPLE 58: Off boulder beach on the southeastern side of San Pedro Nolasco Island; 27° 56′ N., 111° 23′ 45″ W.; May 14; 5.5 meters; surface, 20° C., bottom, similar; skin diving; sand and boulders; angular pebbles of granite and basalt, no silt-clay fraction; shrimp-like crustaceans (isopods?) in carbon tetrachloride float; algal growth and sargassum.

BOTTOM SAMPLE 59: Center, San Pedro Bay, Sonora, Mexico; 27° 56′ 45″ N., 111° 05′ W.; May 14; 11.1 meters; surface, 22° C., bottom, similar; dredge; sand; fine-grained, gray sand, no silt-clay fraction; angular to subangular, milky to clear quartz grains, some biotite.

BOTTOM SAMPLE 60: Off rocks, to east of Red Bluff Point and north of Monument Point, Tiburón Island; 28° 45′ N., 112° 21′ 15″ W.; May 16; 5.5 meters; surface, 16° C., bottom, 16° C.; skin diving; sand between large rock faces; bryozoan sand, not silt-clay fraction; bioclastic composed mostly of fragile bryozoan debris, some echinoid spines and sponge spicules; alcyonarians, some molluscan epifauna, no apparent infauna.

BOTTOM SAMPLE 61: Off Red Bluff Point, Tiburón Island; 28° 45′ 30″ N., 112° 23′ 15″ W.; May 18; 38.3 meters; dredge; sand and rocks(?); medium- to coarse-grained bryozoan sand, no silt-clay fraction; bioclastic: primarily bryozoan fragments, with some shells and echinoid spines, some angular quartz grains present; dead Mollusca and Bryozoa, some infauna.

BOTTOM SAMPLE 62: Off Red Bluff Point, Tikurón Island, Sonora; 28° 45′ 30″ N., 112° 24′ W.; May 18; 73.8 meters; dredge; sand; medium-grained, brown sand, some pebbles; bioclastic composed of shell and bryozoan material, some subrounded to rounded grains of quartz; dead Mollusca and considerable bryozoan fauna, no infauna.

BOTTOM SAMPLE 63: Red Bluff Point anchorage, Tiburón Island; 28° 40′ N., 112° 23′ W.; May 18; 11.1 meters; dredge; sand; fine- to medium-grained, light gray sand, no silt-clay fraction; bioclastic with some clear angular grains of quartz.

BOTTOM SAMPLE 64: East of reef off detached rock, southwest side of San Esteban Island; 28° 41′ 15″ N., 112° 34′ W.; May 18; 4.6 meters; surface, 16.6° C., bottom, 16.6° C.; skin diving; sand between rocks; light brown gravel sand, no silt-clay fraction; shell and sandstone fragments; sparse fauna, mainly epifauna, some algae.

BOTTOM SAMPLE 65: Bay, just north of southern tip of South San Lorenzo Island on San Si Puede Archipelago; 28° 34′ 30″ N., 112° 49′ W.; May 19; 5.5 meters; surface, 16.6° C., bottom, 16.6° C.; skin diving; coarse sand and boulders; medium-grained sand with granite pebbles, no silt-clay fraction; clear angular grains of quartz with small amounts of biotite, some chitinous gastropod shells and large amount of discoid diatom fustrules; encrusting corals, sponges, and Alcyonaria, fauna sparse.

BOTTOM SAMPLE 66: South of Pond Islands, southern tip of Angel de la Guarda Island, southeastern tip; 28° 35′ 45″ N., 112° 50′ W.; May 20; 3.7 meters; surface, 16.6° C., bottom, 16.6° C.; skin diving; sand; medium- to coarse-grained, dark brown sand, no silt-clay fraction; iron-stained, angular quartz grains and sandstone fragments; exclusively infauna, sand in motion.

BOTTOM SAMPLE 67: Puerto Refugio, north end of Angel de la Guarda Island; 29° 32′ 45″ N., 113° 33′ 20″ W.; May 22; 31.4 meters; dredge; mud and fine sand; brown silt, 13 per cent silt-clay fraction; subangular to rounded quartz, small percentage of biotite, bioclastic material about 50 per cent of the sample, composed of molluscan fragments, sponge spicules, and echinoid spines.

BOTTOM SAMPLE 68: Puerto Refugio, north end of Angel de la Guarda Island; 29° 32′ 45″ N., 113° 33′ 20″ W.; May 22; 33.23 meters; bottom, 19.5° C.; dredge; coarse sand; medium-grained, brown sand, no silt-clay fraction; subangular quartz grains, some iron-stained.

BOTTOM SAMPLE 69: Gonzaga Bay, Baja California; 29° 45′ N., 114° 21′ W.; May 22; 0.9 meter; surface, 22° C., bottom, 22° C.; skin diving; clean sand bottom; medium- to coarse-grained sand, muscovite, quartz grains and shell material, no silt-clay fraction; angular grains of clear quartz, some biotite, muscovite and large number of microgastropod shells; no epifauna, some algae.

BOTTOM SAMPLE 70: Gonzaga Bay, Baja California; 29° 45′ N., 114° 21′ W.; May 22; 2.2 meters; surface, 22° C., bottom, 22° C.; skin diving; sand; medium-grained, gray biotite sand, no silt-clay fraction; large amount of diatom fustrules, angular to subrounded quartz grains, and biotite.

BOTTOM SAMPLE 71: Gonzaga Bay, Baja California; 29° 45′ N., 114° 21′ W.; May 22; 4.6 meters; surface, 22° C., bottom, 22° C.; skin diving; sand; medium-grained, light brown, biotite sand, with shell material, no silt-clay fraction; quartz biotite sand with large amounts of molluscan and diatom shells.

BOTTOM SAMPLE 72: Gonzaga Bay, Baja California; 29° 45′ N., 114° 21′ W.; May 22; 5.5 meters; surface, 22° C., bottom, 22° C.; skin diving; sand; light brown micaceous sand with shell fragments, no silt-clay fraction; limonite-stained, angular quartz grains, biotite common, pumice present.

BOTTOM SAMPLE 73: Gonzaga Bay, Baja California; 29° 45′ N., 114° 21′ W.; May 22; 16.6 meters; surface, 22° C., bottom, 22° C.; dredge; fine sand bottom; fine-grained micaceous sand, 10 per cent silt-clay fraction.

BOTTOM SAMPLE 74: Gonzaga Bay, Baja California; 29° 46′ N., 114° 21′ W.; May 22; 18.5 meters; surface, 22° C., bottom, 22° C.; dredge; fine sand; medium-grained, brown micaceous sand, 9 per cent silt-clay fraction; biotite quartz sand.

BOTTOM SAMPLE 75: Gonzaga Bay, Baja California; 29° 47′ 25″ N., 114° 21′ W.; May 22; 36.9 meters; surface, 22° C., bottom, 22° C.; dredge; mud; dark greenish gray clay, 85 per cent silt-clay fraction.

BOTTOM SAMPLE 76: Off lee side of San Luis Island; 29° 56′ N., 114° 23′ 30″ W.; May 22; 51.7 meters; dredge; coarse sand and pebbles; dark gray sand, 15 per cent silt-clay fraction; pumice with smaller amounts of obsidian.

BOTTOM SAMPLE 77: San Luis Island; 29° 56′ 30″ N., 114° 25′ W.; May 23; 15.7 meters; dredge; coarse sand; dark gray, fine sand, 15 per cent silt-clay fraction; pumice sand with smaller amounts of scoria; volcanic island.

BOTTOM SAMPLE 78: South side of San Luis Island; 29° 56′ 30″ N., 114° 25′ W.; May 24; 12.9 meters; dredge; mud with pebbles of scoria and pumice; dark gray sand, 5 per cent silt-clay fraction; pumice, scoria, and obsidian, very few organic clastics.

BOTTOM SAMPLE 79: Approximately 17 miles south of Consag Rock; 30° 48′ N., 114° 30′ W.; May 24; 31.4 meters; dredge; fathometer showing penetration of 3 fathoms into clay mud; brown organic clay, 85 per cent silt-clay fraction; dead Mollusca predominant, some infauna, no apparent epifauna.

BOTTOM SAMPLE 80: Fourteen miles southwest of Consag Rock, approximately 7 miles off the rock; 30° 54′ 30″ N., 114° 42′ W.; May 24; 29.5 meters; dredge; clay mud, fathometer showing penetration of 3 fathoms; dark gray, organic clay, 85 per cent silt-clay fraction; dead Mollusca predominant, some infauna, no apparent epifauna.

BOTTOM SAMPLE 81: San Felipe anchorage, Baja California, approximately 2 miles east of rocks on shore; May 24; 5.5 meters; dredge; clay mud; dark gray organic clay.

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