SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 121, NUMBER 7

Charles D. and Mary Vaux Walcott Research Fund

STUDIES OF ARCTIC FORAMINIFERA

(With 24 Plates)

BY
ALFRED R. LOEBLICH, JR.
U. S. National Museum
AND
HELEN TAPPAN
U. S. Geological Survey

(Publication 4105)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
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The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

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INTRODUCTION

The present study was originally begun with the hope of learning more about the Arctic foraminiferal faunas and their ecology. Increased interest in these Arctic faunas had been stimulated by a study of the fossil faunas of northern Alaska obtained in the course of petroleum exploration in Naval Petroleum Reserve No. 4.

During 1950 a grant was obtained by the writers from the Office of Naval Research for the collection of samples from the ocean bottom off northern Alaska. Dredged samples were collected by Alfred R. Loeblich, Jr., during July and August, 1950, with the aid of Dr. G. E. MacGinitie, then director of the Naval Arctic Research Laboratory at Point Barrow, Alaska.

Unfortunately, bad weather conditions during the summer of 1950 somewhat limited the number of trips for the collection of samples. We have therefore added to this study some dredged samples collected by the *Albatross* in the Arctic and sub-Arctic, and others collected by Capt. Robert A. Bartlett from the Greenland and Canadian Arctic areas.

PREVIOUS WORK AND SCOPE OF THE PRESENT STUDY

It was intended at first to make a strictly ecologic study, as various earlier papers had described Arctic faunal assemblages. After a very short time it became quite evident that no comparisons could be made of the Alaskan foraminiferal faunas with those of other regions without first making a complete taxonomic study of the species concerned.

The Arctic faunas had been studied by many authors over the past century, but the later authors almost invariably followed the original identifications of Parker and Jones and Brady, from the days when it was thought that no evolutionary changes could be observed in such simple creatures as protozoans.

For example, Parker and Jones (1865, p. 346) stated: "It is impossible to fix on any distinctive character, or set of characters, sufficiently limited in development to be of real importance in dividing the Lagenae into even two *species*" (italics supplied by the original authors). In contrast, modern workers have separated Parker and Jones's single species (and 10 varieties) into 4 distinct *genera* and recognize hundreds of species of these unilocular Foraminifera.

These authors stated further (p. 335): "In comparing our specimens with figured forms, we have been satisfied when a near approach to identity is shown; minute differences are ignored, such differences not being of essential value."

Nearly a century later, authors are still following the identifications of Parker and Jones, who admitted they were satisfied with a *near* approach, although these more modern workers apparently have considered these identifications to be as detailed and accurate as the type of work now done on fossil faunas. If such wide latitude were allowed in fossil species there would be no economic micropaleontologists, as the "minute differences," upon which oil-field correlations are based, would be completely ignored.

The wide use of micropaleontology by the oil industry in the identification of strata demonstrates the completely different approach of the present day to the study of fossil faunas. Yet these living Arctic species are still being referred to species described originally from beds as old as the Cretaceous, and from environments as different as the tropical Pacific, the Red Sea, and the West Indies. Even a cursory examination of the literature shows the great variation in character of forms all referred to the same "classic living species." Even more surprises result from the examination of type specimens in the various collections, where sometimes representatives of three or four *genera* have been included under a single specific name. There are many more instances where a number of quite distinct species have been labeled with the same name. In some of the more recent literature authors have remarked that certain "species" seem to include a variety of forms, but in all too many instances no attempt has been made to rectify the situation, and the old all-inclusive names are used again and again. As one example we might cite the species herein

made the type for the new genus *Pateoris*. Although possessing characters that would exclude it from these genera, it has nevertheless been frequently referred in the literature to the *genotype species* of three different genera, *Quinqueloculina, Miliolinella,* and *Massilina.* Although differing from those three species in nearly every character of generic importance, only after about 80 years had passed was it finally given a separate name. Even then it was considered a *forma* of one of these earlier genotype species, and not given even varietal or subspecific rank.

One recent work on Arctic faunas to which these remarks do not apply is that of Höglund (1947), for he made an extremely detailed taxonomic study and revised a number of the old "species." However, he could not include all the Arctic species and many problems remain.

In general, the careless identification of Arctic forms with tropical species, fossil species, etc., no matter how distinct they might appear, has made it impossible to learn much about the actual present-day distribution of species. A compilation of the depths, temperature, bottom conditions, etc., at which a single species has been recorded in the literature would imply that almost no Foraminifera are even moderately affected by their environment. Even a glance at assemblages from different regions or varying depths will show how false is this impression.

Correlations previously made on the basis of "species," in large part are based on occurrences of a number of misidentified forms, and identical published lists of names will, upon examination of the specimens themselves, prove to refer to astonishingly distinct faunas. It is comparable to basing correlations on the presence of all quadrupeds with black eyes, for example, although that would include not only many different species, but also representatives of different genera and families. Such are the identifications upon which foraminiferal ecologic studies have been based, specimens which belong to quite distinct genera, and even different families as well, having been referred to one specific name.

This is not to say, however, that no comparisons can be made. An examination of publications that have described and illustrated the specimens they obtained (regardless of the names assigned to them), and a study of the types when available, shows a marked similarity among all the Arctic faunas. A few distinct species occur, which are limited to a small geographic area or to certain ocean depths, but on the whole, the Arctic fauna is a circumpolar one. Identical forms are

found in the Arctic Ocean and adjoining regions, i.e., Alaska, the Greenland area, Canadian Arctic, north of the British Isles, the coasts of Sweden and northern Germany, and from off the Russian and Siberian coasts.

Unfortunately, this method of interpretation of the earlier works upon the basis of their figures and descriptions is greatly hampered by the fact that all too many authors have not adequately described their material. Many references make use of faunal lists (obviously questionable in view of the wide variation in the concept of the different species by the various writers). Many other references have recorded a species, but in place of figures and descriptions of the material at hand, the original figures and descriptions have been copied (to save time and effort). A comparison of the type specimens of these later authors with the meager descriptions given by them (and either quoted verbatim from the original author or paraphrased in some way) shows the descriptions often to be at considerable variance with the specimens actually found.

In some cases species have been recorded and important characters described as present, under the erroneous supposition that the specimens at hand were like those from other areas, seen in the literature. Closer examination of the types shows that the true characters are quite different, sometimes even requiring transfer of the species to another genus.

We have therefore changed the point of emphasis for our present study, so that it is largely a taxonomic one, and we have tried to straighten out some of the tangled problems that have been uncovered. Admittedly, other problems still exist, some of which require a first-hand examination of the original types of Brady, Parker and Jones, and other European workers for solution, but as this was impossible for the present, these problems are stated as such under the appropriate specific descriptions.

A redescription of all genotype species of the smaller Foraminifera is in progress by the writers and a proposed study of the original types in Europe will undoubtedly settle many more of these taxonomic problems. Only then will a detailed ecologic study be possible.

The present study is not intended as a monographic treatment, and not all species that were obtained have been included. A few of the lagenids, some of the polymorphinids and rotalids, and a few of the arenaceous species have been left for later study because of the questions arising as to their correct identification. It is hoped that future studies will allow us to complete the descriptions of the Arctic faunas.

LIST OF STATIONS

Station

1. 3.2 miles off Point Barrow, northern Alaska, at a depth of 48.6 m. Bottom: mud, gravel, stones, small rocks. Dredged February 18, 1950, through ice with a dog team.
2. 7.0 miles offshore at Point Barrow, northern Alaska, at a depth of 126 m. Bottom: stones and gravel. Dredged August 9, 1949.
3. 12.1 miles off Point Barrow, northern Alaska, at a depth of 223.2 m. Bottom: worm tubes. Dredged August 8, 1949.
4. 4.0 miles off Point Barrow Base Camp, northern Alaska, at a depth of 52.2 m. Bottom: gravel and small stones, sea urchins. Dredged October 14, 1949.
5. 5.0 miles off Point Barrow, northern Alaska, at a depth of 55.8 m. Bottom: stones, *Psolus,* and many sea urchins. Dredged August 30, 1949.
6. 8.0 miles off Point Barrow, northern Alaska, at a depth of 136.8 m. Bottom: rocks and small amount of gravel, and *Psolus.* Dredged October 11, 1949.
7. 4.0 miles off Point Barrow, northern Alaska, at a depth of 64.8 m. Bottom: gravel and mud. Dredged October 6, 1949.
8. 16.0 miles off Point Barrow, northern Alaska, at a depth of 144 m. Bottom: worm tubes and few rocks. Dredged September 6, 1949.
9. 5.0 miles off Point Barrow, northern Alaska, at a depth of 84.2 m. Bottom: rocks, stones, gravel, and *Psolus.* Dredged October 6, 1949.
10. 6.0 miles off Point Barrow, northern Alaska, at a depth of 104.4 m. Bottom: few rocks, stones, gravel, and sea urchins. Dredged October 11, 1949.
11. 150 yards offshore at Point Barrow, northern Alaska. Plankton haul touching bottom at a depth of 9.1 m. Collected July 13, 1950.
12. 4.0 miles off Point Barrow Base Camp, northern Alaska, at a depth of 64.8 m. Bottom: gravel and mud. Dredged October 6, 1949.
13. 1.75 miles off Point Barrow, northern Alaska, at a depth of 21.6 m. Bottom: mud, clams, worms, hermit crabs, and a few gastropods. Collected July 21, 1950.
14. Along shore opposite Point Barrow Base Camp, northern Alaska, at a depth of 3.2 m. Collected October 11, 1949.
15. 3.0 miles off Point Barrow Base Camp, northern Alaska, at a depth of 43.2 m. Bottom: mud. Collected July 22, 1950.
16. 2.6 miles off Point Barrow Base Camp, northern Alaska, at a depth of 39.6 m. Bottom: mud. Collected July 22, 1950.
17. 3.5 miles off Point Barrow Base Camp, northern Alaska, at a depth of 42 m. Bottom: mud, sand, gravel, cobbles, octocorals, sponges, pelecypods, gastropods, and isopods. Collected August 1, 1950.
18. 3.0 miles offshore between Point Barrow Base Camp and Barrow village, northern Alaska, at a depth of 37 m. Bottom: mud, sand, gravel, cobbles, and shells. Collected August 1, 1950.

Station

19. 5.5 miles off Point Barrow Base Camp, northern Alaska, at a depth of 61.2 m. Collected August 5, 1950.
20. Lat. 63°25'N., long. 68°19'W. (approximate), about 2.0 miles east of Cape Rammelsburg, west side of Frobisher Bay, Baffin Land, at a depth of 100.5 m. Collected August 23, 1943. Bartlett Collection.
21. Lat. 63°10'N., long. 67°45'W. (approximate), close to the south end of Gletcher Island, east end of Cincinnati Press Channel, Frobisher Bay, at a depth of 54.9 m. Collected August 22, 1943. Bartlett Collection.
22. Just to the southwest of the first island within Kneeland Bay, west shore of Frobisher Bay, at a depth of 31.1 m. Collected August 26, 1942. Bartlett Collection.
23. Off North Wolstenholme Island, northwest Greenland, in 23.8 to 45.7 m. Bartlett Collection.
24. Winter Harbor, Lyon Inlet, Melville Peninsula, Fox Channel. Collected August 27, 1933. Bartlett Collection.
25. North shore of Lyon Inlet, Melville Peninsula, Fox Channel. Collected August 24, 1933. Bartlett Collection.
26. North Omenolu, near North Star Bay, north Greenland, at a depth of 31.1 m. Collected July 28, 1932. Bartlett Collection.
27. Disko Island, Vaigat, west Greenland. Muddy bottom. Collected August 16, 1937. Bartlett Collection.
28. Off Akpatok Island, Ungava Bay, at a depth of 47.6 m. Collected August 9, 1943. Bartlett Collection.
29. 20.0 miles off Akpatok Island, Ungava Bay, at a depth of 65.9 m. Collected August 9, 1943. Bartlett Collection.
30. Off Akpatok Island, Ungava Bay, lat. 60°8'N., long. 67°47'W., at a depth of 73.2 m. Collected August 9, 1943. Bartlett Collection.
31. Between Parker Snow Bay and Conical Rocks, northwest Greenland, at a depth of 45.7 to 82.3 m. Collected July 22, 1940. Bartlett Collection.
32. Lat. 63°34'N., long., 68°14'W. (approximate), about 1.0 mile off An Island, mouth of Porter Inlet, east side of Frobisher Bay, Baffin Land, at a depth of 142.6 m. Collected August 23, 1943. Bartlett Collection.
33. Cape Stosch, Gotthaob Island, Hudson Land, northeast Greenland, at a depth of 12.8 m. Collected 1931. Bartlett Collection.
34. Lat. 66°43'N., long. 80°07'W., Fox Basin. Collected August 1927. Bartlett Collection.
35. Between Shannon and Hochstetter Islands, northeast Greenland. Collected August 13, 1931. Bartlett Collection.
36. Lat. 74°21'N., long. 16°30'W., at a depth of 201.2 m. Bartlett Collection.
37. 5.0 miles off Cape Borlase Warren, northeast Greenland, at a depth of 12.8 m. Collected August 13, 1931. Bartlett Collection.
38. Murray Harbor, Lyon Inlet, Melville Peninsula, Fox Channel. Collected August 27, 1933. Bartlett Collection.
39. Off north shore of an island in harbor of Crystal 2 Base, Frobisher Bay, at a depth of 23.8 m. Collected July 28, 1942. Bartlett Collection.
40. Lat. 54°15'N., long. 57°45'W., Hamilton Inlet, Labrador, at a depth of 54.9 m. Bottom: mud and stones. D. C. Nutt Collection.
41. North Gabriola Island, east side of Vancouver Island, British Columbia, at a depth of 91.4 m. Collected October 1900 by J. W. Taylor.

Station

42. Lat. 63°11'N., long. 67°50'W., near a small island at the east end of Cincinnati Press Channel, at a depth of 146.3 m. Collected August 22, 1943. Bartlett Collection.
43. *Albatross* station D. 2859, lat. 55°20'00"N., long. 136°20'00"W., at a depth of 2869.7 m. Bottom: gray ooze. Collected August 29, 1888.
44. *Albatross* station D. 3600, lat. 55°06'00"N., long. 163°28'00"W., at a depth of 16.5 m. Bottom: fine dark volcanic sand. Collected June 26, 1895.
45. Off Village Pingilkalik, Fury and Hecla Straits, northeast Melville Island. Collected September 6, 1933. Bartlett Collection.
46. Lat. 63°18'N., long. 68°05'W., Bartlett Collection.
47. *Blue Dolphin* station 51-2, Nain Bay, Labrador, at a depth of 82.3 m. Bottom: mud. D. C. Nutt Collection.
48. *Blue Dolphin* station 51-1, Nain Bay, Labrador, at a depth of 65 m. Bottom: mud. D. C. Nutt Collection.
49. Lat. 71°29.4'N., long. 156°53.4'W., at a depth of 148.1 m. Collected August 13, 1951.
50. 3.0 miles off Point Barrow Base Camp, northern Alaska, at a depth of 36.6 m. Bottom: gravel, large stones, and mud. Collected August 8, 1949.
51. Off Clavering Island, northeast Greenland, at a depth of 91.4 to 104.2 m. Collected August 13, 1931. Bartlett Collection.
52. Off south end of the Humboldt Glacier, northwest Greenland, at a depth of 201.2 m. Bottom: mud and sand. Collected August 3, 1940. Bartlett Collection.
53. Off Kushiro, Hokkaido, Japan, at a depth of 200 m. Collected by Hiroshi Niino.
54. Off Clavering Island, northeast Greenland, at a depth of 18.3 to 65 m. Bartlett Collection.
55. *Albatross* station D. 2251, lat. 40°22'17"N., long. 69°51'30"W., at a depth of 78.7 m. Bottom: green mud and fine sand. Collected September 27, 1884.
56. *Albatross* station D. 2453, lat. 47°10'00"N., long. 51°02'00"W., at a depth of 150 m. Bottom: green mud and fine sand. Collected June 26, 1885.
57. *Albatross* station D. 2242, lat. 40°15'30"N., long. 70°27'00"W., at a depth of 106 m. Bottom: green mud. Collected September 26, 1884.
58. *Albatross* station D. 2465, lat. 45°35'00"N., long. 55°01'00"W., at a depth of 122.5 m. Bottom: black, gray sand. Collected July 3, 1885.
59. *Albatross* station D. 2240, lat. 40°27'30"N., long. 70°29'00"W., at a depth of 80.5 m. Bottom: green mud. Collected September 26, 1884.
60. *Albatross* station D. 2253, lat. 40°34'30"N., long. 69°50'45"W., at a depth of 58.6 m. Bottom: gray sand, black specks. Collected September 27, 1884.
61. Hudson Bay, Richmond Gulf (about 3.0 miles from entrance), at a depth of 27.4 to 36.6 m. Bottom: sand and stones. Collected August 23, 1920, by Frits Johansen.
62. Bay at (north of) southeast point of South Twin Island, James Bay, at a depth of 7.3 to 9.1 m. Bottom: sand, gravel, and stones. Collected July 27, 1920 by Frits Johansen.

Station

63. Off Camp David Gray, Shannon Island, northeastern Greenland, at a depth of 122.5 m. Collected by Capt. Robert A. Bartlett.
64. Bay inside boat opening, Manitouk Sound, east coast of Hudson Bay, at a depth of 9.1 to 12.8 m. Bottom: clay with sand and stones. Collected August 27, 1920, by Frits Johansen.
65. Bay between Black Whale and Olaska Harbors, east coast of Hudson Bay (about lat. 55°N.), at a depth of 18.3 m. Bottom: sandy mud with many loose algae. Collected August 28, 1920, by Frits Johansen.
66. Between Clavering Island and Holmes Foreland, near glacier, northeastern Greenland, at a depth of 12.8 m. Collected by Capt. Robert A. Bartlett.
67. Off Shannon Island, northeastern Greenland, at a depth of 18.3 to 65 m. Collected by Capt. Robert A. Bartlett.
68. *Albatross* station D. 3604, lat. 54°54′00″N., long. 168°59′00″W., at a depth of 2562.4 m. Bottom: green ooze.
69. *Albatross* station D. 3608, lat. 55°19′00″N., long. 168°11′00″W., at a depth of 504.8 m. Bottom: gray sand.
70. *Discoverer* station 27-N, lat. 36°41.5′N., long. 122°05′W., at a depth of 1494.3 m.
71. *Guide* station 22 (24), lat. 43°12′N., long. 125°01′W., at a depth of 1086.4 m.
72. *Guide* station 13 (24), lat. 43°15′N., long. 124°53′W., at a depth of 415.2 m.
73. *Guide* station 13 (25), lat. 33°17′N., long. 117°55′W., at a depth of 724.3 m.
74. Off Clavering Island, near glacier, northeastern Greenland. Collected by Capt. Robert A. Bartlett.
75. Between Shannon Island and Hochstetter Foreland, northeastern Greenland. Collected by Capt. Robert A. Bartlett.
76. Off Shannon Island, northeastern Greenland, at a depth of 12.8 m. Collected by Capt. Robert A. Bartlett.
77. Southeast corner of the Fox Basin, lat. 66°46′ N., long. 79°15′W., at a depth of 62.2 to 67.7 m. Collected by Capt. Robert A. Bartlett.
78. Bight of Shannon Island, northeastern Greenland. Collected by Capt. Robert A. Bartlett.

ACKNOWLEDGMENTS

The field work for the present project was sponsored by a contract (ONR 02200) between the Office of Naval Research, Department of the Navy, and the Smithsonian Institution. The writers are indebted to both of these agencies for their splendid cooperation during the course of this work.

Dr. G. E. MacGinitie, former director of the Arctic Research Laboratory, Point Barrow, Alaska, aided in collecting samples and in providing material collected prior to 1950. Jacob Stalker and Miles Itta, Eskimo guides employed by the Arctic Laboratory, gave valuable assistance in collecting the material. Dr. Ira L. Wiggins, present

director of the Arctic Research Laboratory, supplied one sample collected during the 1951 season.

Mrs. Sally D. Lee, scientific illustrator, Smithsonian Institution, prepared the camera-lucida drawings of Foraminifera.

THE FORAMINIFERAL FAUNA

GENERAL STATEMENT

In the present report, 110 species of Foraminifera from the Arctic and sub-Arctic regions, representing 20 families and 56 genera, are described and illustrated. There are 6 new genera, 21 new species, and 1 new specific name proposed for a homonym. Many of the previously described species are placed in genera other than that under which they were originally described or have since been recorded.

The genus *Alveolophragmium* Stschedrina is redefined, and the name *Labrospira* Höglund is suppressed as a synonym. The new genus *Ammotium* is separated from *Ammobaculites* Cushman on the basis of chamber arrangement. The genus *Miliolinella* Wiesner is discussed, and because of the congeneric genotype species the generic name *Triloculinella* Riccio is suppressed as a synonym. A study of apertural characters and plan of chamber arrangement has led to the naming of the new genera *Scutuloris* and *Pateoris,* both belonging to the family Miliolidae.

In the Polymorphinidae, two new genera, *Laryngosigma* and *Esosyrinx,* are proposed because of their distinctive apertural characters, which separate them respectively from *Sigmomorphina* Cushman and Ozawa and *Polymorphina* d'Orbigny.

Because of the apertural characters of the genotype species of *Elphidium* Montfort, the generic name *Cribroelphidium* Cushman and Bronnimann is suppressed as a synonym. An examination of the genotype species of *Discorinopsis* Cole has shown that genus to be an agglutinated form, and not a representative of the calcareous Rotaliidae. Hyaline, calcareous species formerly placed in *Discorinopsis* are now placed in the new genus *Trichohyalus.*

THE BARROW AREA

CHARACTER OF THE BARROW FAUNA

In all, 74 species were found in the Barrow area, representing 40 genera. Only 14 of the species are agglutinated forms, and 10 are calcareous imperforate. The remaining 50 species are calcareous ones, belonging mainly to the Lagenidae, Polymorphinidae, Nonionidae,

Elphidiidae, Buliminidae, and Cassidulinidae. These forms were also most abundant in number of individuals, especially *Oolina costata* and *O. melo,* and the 3 species representative of the Nonionidae, as well as *Elphidium* and *Cassidulina.*

Of the agglutinated forms *Eggerella, Spiroplectammina, Alveolophragmium,* and *Ammotium* were often abundant in individuals, although represented by only a few species.

Quinqueloculina agglutinata, Pyrgo williamsoni, and *Pateoris hauerinoides* also were abundant in most of the samples.

LOCAL LIMITING FACTORS IN THE FORAMINIFERAL DISTRIBUTION

A total of 74 species of Foraminifera are here recorded from the 21 dredge samples taken from the vicinity of Point Barrow, Alaska. A range table has been prepared, showing the samples in order of increasing distance from shore. The depths in meters are also given, for in general the depths increase steadily with greater distance from shore. Station 3, from a distance of 12.1 miles offshore and a depth of 223 meters does not represent a normal depth, however, as it was taken from one of the submarine canyons.

Depth and distance offshore.—These must be treated as one in this discussion, as with increased distance, the depths also increase. Therefore, only depth is mentioned here, and the range in distance can be easily determined from the table. Among these 21 samples, there is a range from a minimum of 3 species to a maximum of 55 species in a single sample. The samples range in depth from 3 to 223 meters and from a dredging made along shore to a distance of 16 miles offshore.

As can be readily seen from the chart, the extremely shallow samples are less populated, but a total of 69 of the 74 species are found in the dredgings between the depths of 20 and 50 meters. Some of the species occur throughout the entire depth and distance range, but others are more restricted.

In particular, the Miliolidae, some of the species of *Oolina* and *Fissurina,* the Nonionidae, Elphidiidae, and Rotaliidae all tend to occur at all depths sampled. In a single genus there may be variation also, for *Cassidulina islandica* and *C. teretis* are both widespread, but *C. norcrossi* was found only in three samples, between 40 and 50 meters in depth.

Species found only in depths less than 50 meters include *Reophax scorpiurus, Adercotryma glomeratum* (only in one sample at 48 meters), *Quinqueloculina stalkeri, Gordiospira arctica, Trochammina*

TABLE 1.—*Distribution of Foraminifera off Point Barrow, Alaska*

Station	14	11	13	50	18	16	17	15	1	4	5	19	7	12	9	10	2	6	8	49	3
Distance offshore in miles	0	.08	1.75	3	3	2.6	3.5	3	3.2	4	5	5.5	4	4	5	6	7	8	16	11	12
Depth in meters	3	9	21	36	37	39	42	43	48	52	55	61	64	64	84	104	126	136	144	148	223
Reophax scorpiurus	X	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Spiroplectammina biformis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	..	X	X	X	..	..
Eggerella advena	X	..	X	X	X	X	..	X	X	X	X	X	X	X	X	X	X	X	X	..	..
Astrononion gallowayi	X	..	X	X	X	X	..	X	X	X	X	X	X	X	X	X	X	X	X	..	X
Elphidium bartletti	X	..	..	X	X	X	X	X	X	X	X	X	X	X	X	..	..	..	..	..	X
E. clavatum	X	X	X	X	X	X	X	X	X	X	X	X	..	X	..	..	X	X	X	..	X
E. orbiculare	X	X	..	X	X	..	X	..	X	X	X	X	X	X	X	..	X	..	X	..	X
Buccella inusitata	X	..	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	..	X
Cassidulina islandica	X	..	X	X	X	X	..	..	X	X	X	X	X	X	X	..	X	X	..	..	X
Reophax arctica	..	..	X	..	X	X	..	X	X	..	..	..	..	X	..	..	X	..	X	..	..
Alveolophragmium jeffreysi	..	..	X	X	X	..	X	X	X	X	X	X	X	X	X	X	..	X	X	X	X
Ammotium cassis	..	..	X	X	X	..	X	X	X	X	..	..	..	X	X	X	X	..	X	..	X
Textularia torquata	..	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..
Quinqueloculina agglutinata	..	..	X	X	X	..	..	X	X	X	X	X	X	..	X	X	X	X	X	X	..
Q. arctica	..	..	X	X	X	..	..	..	..	X	X	X	X	..	X	..	X	..	..	..	..
Q. stalkeri	..	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Triloculina trihedra	..	..	X	X	X	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	X
Pyrgo williamsoni	..	..	X	X	X	X	..	..	X	..	X	..	X	X	..	..	X	X	X	..	X
Dentalina ittai	..	..	X	..	X	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Lagena flatulenta	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
L. gracillima	..	..	X	..	X	..	X	X	..	..	..	..	..	..	..	..	..	..	..	..	..
L. mollis	..	..	X	..	X	X	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..
L. semilineata	..	..	X	..	X	..	X	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Oolina caudigera	..	..	X	X	X	..	..	..	X	X	X	X	..	X	X	X	..	X	X	..	X
O. hexagona	..	..	X	..	X	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Fissurina serrata	..	..	X	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X

TABLE 1.—(*Continued*)

Station	14	11	13	50	18	16	17	15	1	4	5	19	7	12	9	10	2	6	8	49	3
Distance offshore in miles	0	.08	1.75	3	3	2.6	3.5	3	3.2	4	5	5.5	4	4	5	6	7	8	16	11	12
Depth in meters	3	9	21	36	37	39	42	43	48	52	55	61	64	64	84	104	126	136	144	148	223
Fissurina ventricosa	..	..	×	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..	×
Nonion labradoricum	..	..	×	×	×	..	×	×	×	×	×	×	×	×	×	×	..	×	×	..	×
Nonionella auricula	..	..	×	×	×	×	..	×	×	×	×	×	×	×	×	×	..	×	×	..	×
Robertinoides? charlottensis	..	..	×	×	×	..	..	..	×	×	..	×	..	×	..	..	..	×	..	..	×
Bulimina exilis	..	..	×	..	×	×	..	×	..	..	×	..	..	×	..	..	..	..	..	..	..
Buccella frigida	..	..	×	..	×	×	×	..	..	..	×	..	×	×	×	..	..	×	..	..	..
Cassidulina teretis	..	..	×	×	..	×	×	×	×	×	×	×	×	×	×	×	..	..	..	..	×
Reophax curtus	..	..	..	×	×	×	..	..	×	..	..	..	..	×	..	..	×	..	..	..	..
Alveolophragmium crassimargo	..	..	..	×	..	..	..	..	..	..	..	×	×	×	×	×	×	×	×	×	×
Scutuloris tegminis	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	×
Pateoris hauerinoides	..	..	..	×	×	×	×	×	..	×	×	×	×	×	×	..	×	×	×	..	×
Astacolus hyalacrulus	..	..	..	×	×	..	..	..	×	..	..	..	..	×	..	..	..	..	..	..	×
Oolina costata	..	..	..	×	×	..	..	..	×	×	×	×	×	×	×	×	×	×	×	..	×
O. melo	..	..	..	×	×	×	..	..	×	×	×	×	×	×	×	×	..	×	..	..	..
Fissurina marginata	..	..	..	×	×	..	..	..	×	×	×	×	×	×	×	×	×	×	..	..	×
Parafissurina himatiostoma	..	..	..	×	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×
Elphidium frigidum	..	..	..	×	×	..	×	..	×	×	×	..	×	×	×	×	..	×	×	×	×
E. subarcticum	..	..	..	×	×	..	×	×	×	×	×	×	×	×	×	×	..	×	×	..	×
Elphidiella arctica	..	..	..	×	×	..	..	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Patellina corrugata	..	..	..	×	×	..	..	..	×	×	×	×	×	×	×	×	×	×	×	..	×
Miliolinella chukchiensis	..	..	..	..	×	..	×	..	..	..	..	..	..	..	×	..	..	×	..	..	×
Cornuspira involvens	..	..	×	..	×	×	..	..	..	×	×	×	×	..	..	..	×	..	..	..	×
Astacolus sp.	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dentalina baggi	..	..	..	..	×	..	..	..	..	×	..	..	..	×	..	..	..	..	..	×	×
D. frobisherensis	..	..	..	..	×	..	..	..	..	×	×	..	..	..	..	..	..	..	..	..	×
Nodosaria emphysaocyta	..	..	..	..	×	..	..	..	×	..	×	..	..	..	..	..	..	..	..	×	×

TABLE 1.—(*Continued*)

Station	14	11	13	50	18	16	17	15	1	4	5	19	7	12	9	10	2	6	8	49	3
Distance offshore in miles	0	.08	1.75	3	3	2.6	3.5	3	3.2	4	5	5.5	4	4	5	6	7	8	16	11	12
Depth in meters	3	9	21	36	37	39	42	43	48	52	55	61	64	64	84	104	126	136	144	148	223
Lagena apiopleura	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
L. laevis	..	..	..	..	×	..	..	..	..	..	×	..	..	×	..	..	..	..	..	..	×
L. setigera	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oolina squamosa	..	..	..	..	×	..	..	..	×	..	..	..	..	×	..	..	..	..	..	..	..
O. striatopunctata	..	..	..	..	×	..	..	..	×	×	×	..	..	..	..	..	..	..	..	..	×
Laryngosigma williamsoni	..	..	..	..	×	..	..	×	..	..	..	..	×	..	..	..	..	..	..	..	..
Elphidiella groenlandica	..	..	..	..	×	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Globobulimina auriculata	..	..	..	..	×	..	..	..	×	..	..	..	..	..	..	..	..	..	..	×	×
Angulogerina fluens	..	..	..	..	×	..	..	..	×	..	×	..	..	×	..	..	..	..	..	..	×
Gordiospira arctica	..	..	..	..	..	..	×	×	..	..	..	..	..	..	..	..	..	..	..	..	..
Trochammina rotaliformis	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Recurvoides turbinatus	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	×	..	×
Cassidulina norcrossi	..	..	..	..	..	..	..	..	×	..	×	..	..	..	..	..	..	..	..	..	..
Adercotryma glomeratum	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Oolina lineato-punctata	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Glandulina laevigata	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..
Laryngosigma hyalascidia	..	..	..	..	..	..	..	..	×	..	×	..	×	..	..	..	..	..	..	..	×
Fissurina semimarginata	..	..	..	..	..	..	..	..	..	..	..	×	..	..	×	..	..	..	..	..	..
Protoschista findens	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	×	..	..	×
Hippocrepina indivisa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×
Fissurina cucurbitasema	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×
F. lucida	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×

rotaliformis, Astacolus sp., *Dentalina ittai, Lagena apiopleura, L. flatulenta, L. gracillima, L. mollis, L. semilineata, L. setigera, Oolina hexagona, O. lineato-punctata, Glandulina laevigata,* and *Elphidiella groenlandica.*

In addition, *Bulimina exilis* is found only at depths of less than 65 meters, *Fissurina semimarginata* from a single sample at 61 meters, and *Laryngosigma williamsoni* from three samples ranging from 37 to 64 meters in depth. Three species were found only in the deepest sample, at 223 meters, namely, *Hippocrepina indivisa, Fissurina cucurbitasema,* and *Fissurina lucida.*

Thus the factor of depth is of some importance, the extremely shallow samples being comparatively barren and some species being restricted to certain depths, although no very marked change is evident.

Temperature.—Although of regional importance, in that all faunas studied are Arctic faunas, the temperature is definitely not a local factor here, as the bottom temperature varies only between −1.8°C. and −2.9°C. throughout the year, within the Barrow area.

Light.—The amount of light also has little effect on the foraminiferal populations as, with the single exception of station 3, from a submarine canyon, all stations are less than 150 meters in depth, and thus well within the littoral zone (the lighted zone of the benthal). Possibly the light fluctuation in the Arctic from summer to winter would have an effect, but no samples were available to determine the seasonal variation, if any, in the faunas.

Character of the bottom.—Probably the most important factor in the distribution of Foraminifera is the character of the bottom. Adjacent to the shore line is a narrow zone of sand (the beach) which is very sparsely populated. This zone is represented by stations 11 and 14. Beyond this narrow sandy zone is a mud zone, and farther out is a zone of coarse gravel. In the offshore gravel zone is found the most diversified invertebrate fauna, and a varied foraminiferal fauna, whereas the mud zone has fewer species.

The character of the bottom is very important to these benthonic forms, for there is no vegetation in the near-shore zone to offer protection for the minute benthonic forms, and the movement of the sand and gravel by wave or current action destroys all life.

The mud zone also contains fewer Foraminifera, probably because of a lack of oxygen, for the decaying organic matter consumes the supply of oxygen. Where the mud is mixed with gravel and cobbles

the population increases, for here the heterogeneous bottom allows a better supply of oxygen so that many benthonic invertebrates are present.

The boundaries of these zones are not static in the Barrow area. Records of earlier dredgings show that the gravel zone extended much farther inshore in previous years, and even in 1949 gravel and stones with associated invertebrates (clams, gastropods, worms, and echinoids) were found as close as 4 miles from shore. However, heavy storms during the winter of 1949-50 carried large quantities of mud out over the shell banks and gravel zones of earlier years. Dredgings showed a mixture of mud and gravel or mud, sand, and cobbles, as far offshore as collections were made that year (5.5 miles), and a single sample obtained in 1951 contained mud at a depth of 148 meters, approximately 11 miles offshore. This extension of the mud zone made a considerable change in the character of the fauna. In large part only dead shells of the invertebrates were obtained in collections made in 1950 from the former gravel zones, for all the animals were killed by the influx of mud to which they were not accustomed.

There was also a considerable effect on the foraminiferal populations. Station 5 (1949) at a distance of 5 miles offshore and a depth of 55 meters contained 34 species of Foraminifera along with echinoids and *Psolus*. Station 19 (1950) from 5.5 miles offshore at a depth of 61 meters contained only 26 species. In general, the species that dropped out belonged to the Lagenidae and Buliminidae, although a single species each of *Pyrgo, Elphidium, Buccella,* and *Cassidulina* also were present in station 5 and absent from station 19.

Records of the foraminiferal population have not been made for a sufficient length of time to determine in detail the effect of the changing environment. It is probable that a much greater change would eventually take place, providing the mud zone continued to extend farther offshore. Very little is known of the degree of tolerance of Foraminifera of a temporarily unfavorable environment. It is also possible that some mixing of assemblages also was caused by the same strong currents that carried the muds out over the gravel zone.

About the only conclusion that can be reached on the basis of the limited amount of material and the short time interval represented is that the temperature, light, and depth all seem of minor importance in the local Arctic area in the vicinity of Point Barrow, and the character of the ocean bottom itself is the most effective limiting influence on the foraminiferal assemblage.

SYSTEMATIC DESCRIPTIONS

Family Rhizamminidae

Genus BATHYSIPHON M. Sars, 1872

BATHYSIPHON RUFUS de Folin

Plate 1, figure 1

Bathysiphon rufum de Folin, 1886, Act. Soc. Linn. Bordeaux, vol. 40 (ser. 4, vol. 10), p. 283, pl. 6, figs. 8a-c.—Goës, 1896, Bull. Mus. Comp. Zool., vol. 29, p. 23, pl. 1, fig. 10.—Flint, 1899, Ann. Rep. U. S. Nat. Mus. for 1897, p. 267, pl. 7.

Bathysiphon rufus de Folin, Cushman, 1910, U S. Nat. Mus. Bull. 71, pt. 1, p. 32, text fig. 22; 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 29.

Test free, large, consisting of an extremely elongate and somewhat tapering hollow tube, occasionally somewhat arcuate, with irregular constrictions at varying intervals, possibly representing growth stages; wall fairly thick, finely arenaceous, with siliceous cement, surface smooth and polished, color white, yellow, or reddish brown; aperture at the open end of the tube.

Length of figured hypotype 8.66 mm., greatest breadth of tube 0.42 mm., least diameter at early portion of tube 0.16 mm. Other specimens range in length from 2.86 to 7.05 mm., and in width from 0.29 to 0.49 mm.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2146) and unfigured hypotypes from station 43.

Family Saccamminidae

Genus PELOSINELLA Parr, 1950

PELOSINELLA DIDERA Loeblich and Tappan, new species

Plate 1, figure 2

Test free, unilocular, with a single ovate chamber, and two elongate necks at opposite ends of the test; wall arenaceous, of medium-sized to coarse grains, with a chitinous base; apertures at the open ends of the two tubular necks.

Length of holotype 1.35 mm., length of chamber 0.60 mm., greatest breadth of chamber 0.44 mm., diameter of neck 0.10 mm. Length of paratype 0.60 mm.

Remarks.—The genus *Pelosphaera* was described by Heron-Allen and Earland, 1932, from the Antarctic, as consisting of a spherical test usually with two hollow conical projecting processes, which do not possess external openings at their ends. *Pelosinella,* 1950, also

from the Antarctic, was defined as having definite apertures at the ends of the tubes. It seems very probable that the two may be congeneric and either the latter has broken ends rather than true apertures, or apertures may be present on *Pelosphaera* but concealed by sediment. However, as it is impossible to determine this definitely without examination of the types, the present species is placed in *Pelosinella,* as it appears to have definite apertures.

The present species is very similar in appearance to *Pelosinella bicaudata* Parr, the genotype species from the Antarctic. It differs in being about one-fourth as large and in having somewhat more elongate necks.

Types and occurrence.—Holotype (U.S.N.M. No. P2062) and unfigured paratype from station 43.

Genus THURAMMINA Brady, 1879

THURAMMINA ALBICANS Brady

Plate 1, figure 3

Thurammina albicans Brady, 1879, Quart. Journ. Micr. Soc., vol. 19, p. 46; 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 323, pl. 37, figs. 2-7.—Cushman, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 58, text figs. 67-72; 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 71, pl. 28, figs. 4-8.

Test free, unilocular, nearly globular; wall thin, finely arenaceous, surface smoothly finished; about 5 to 6 apertures, nearly equidistant, and situated upon mammillate protuberances.

Greatest diameter of figured hypotype 0.73 mm.

Remarks.—*T. albicans* Brady differs from *Thurammina papillata* Brady in being smaller in size and in having much more infrequent apertures. Typical *T. papillata* is covered with numerous protruding orifices. An atypical specimen of *Thurammina papillata* Brady (1884, pl. 36, fig. 7) is very similar in the relatively smooth appearance and few apertures, but is larger than the usual specimens of *T. albicans.*

Type and occurrence.—Figured hypotype (U.S.N.M. No. P2063) from station 43.

Genus THOLOSINA Rhumbler, 1895

THOLOSINA BULLA (Brady)

Plate 1, figure 4

Placopsilina bulla Brady, 1881, Quart. Journ. Micr. Soc., vol. 21, p. 51; 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 315, pl. 35, figs. 16, 17.

Tholosina bulla (Brady) CUSHMAN, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 49, text fig. 55; 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 63, pl. 25, fig. 6; 1920, Rep. Canadian Arctic Exped. 1913-1918, vol. 9, pt. M, p. 5, pl. 1, figs. 1, 2.—CUSHMAN and MCCULLOCH, 1939, Allan Hancock Pacific Exped., vol. 6, No. 1, p. 49, pl. 2, fig. 6.—CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 15, pl. 1, fig. 13.

Pseudoplacopsilina bulla (Brady) EIMER and FICKERT, 1899, Zeitschr. wiss. Zool., vol. 65, No. 4, p. 672.

Test attached, a hemispherical undivided chamber; wall finely arenaceous, whitish in color, surface smooth, but granular in appearance; aperture small, rounded, adjacent to the substratum.

Greatest diameter of figured hypotype 0.65 mm., height of test 0.29 mm. Other specimens range from 0.96 to 1.77 mm. in diameter.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1099) from station 3; unfigured hypotype recorded from station 30.

Genus AMMOPEMPHIX Loeblich, 1952

AMMOPEMPHIX ARCTICA (Cushman)

Plate 1, figure 5

Urnula arctica CUSHMAN, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 1, pl. 1, figs. 1, 2; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 17, pl. 2, figs. 1, 2.

Test attached, but generally loosened from the attachment, nearly circular in outline, flat on the attached side, convex above; consisting of four or more chambers, usually symmetrically arranged, with a few chambers (4 or 5) in a single whorl, occasionally with a second outer ring of chambers surrounding the first, chambers of nearly equal size; sutures distinct, depressed, the septa visible from the base on unattached specimens, straight, of a thickness nearly equal to that of the outer wall; outer wall finely arenaceous, white to yellowish in color, wall adjacent to the attachment very thin, delicate and translucent, and may be broken off when loosened from the attachment, leaving the chambers open ventrally; a rounded aperture at the center of each chamber.

Greatest breadth of figured hypotype 0.36 mm., height of test from attachment 0.08 mm.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1061) from station 50; unfigured hypotypes are recorded from stations 51 and 67.

Family HYPERAMMINIDAE

Genus HYPERAMMINA Brady, 1878

HYPERAMMINA ELONGATA Brady

Plate 1, figure 6

Hyperammina elongata BRADY, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 433, pl. 20, figs. 2a,b.—CUSHMAN, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 60, text fig. 73 (74?); 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 74, pl. 29, fig. 4.—HÖGLUND, 1947, Zool. Bidrag Uppsala, vol. 26, p. 66, text figs. 22-25.—CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 18.—F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 395, pl. 1, fig. 10.

Test free, narrow, elongate, cylindrical; consisting of a bulbous proloculus and long, slender, tubular second chamber of diameter somewhat less than that of the proloculus; wall rather coarsely arenaceous, of many angular quartz fragments with a small amount of ferruginous stained cement, surface rough; aperture terminal, but broken from the single specimen found.

Length of figured hypotype 1.59 mm., greatest breadth of proloculus 0.26 mm., greatest breadth of tubular chamber 0.18 mm.

Remarks.—Only a single specimen was observed and its terminal portion was broken. According to Höglund (1947, p. 66), "round the aperture, which is constricted to half or a third of the diameter of the tubular chamber, a circular, crater-like vallum is constructed of only fine-grained mortar-mass, without intermixture of larger grains of sand. . . . The ring encircling the aperture loosens very readily from the rest of the test, which explains the erroneous statement of Cushman and other authors: Aperture at the distal end of the tube, circular without a lip or other modification."

Type and occurrence.—Figured hypotype (U.S.N.M. No. P2033) from station 51.

HYPERAMMINA SUBNODOSA Brady

Plate 1, figures 7-12

Hyperammina subnodosa BRADY, 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 259, pl. 23, figs. 11-14.—GOËS, 1894, Svenska Vet.-Akad. Handl., vol. 25, No. 9, p. 16, pl. 3, fig. 42-53 (not fig. 54).—CUSHMAN, 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 76, pl. 29, figs. 7, 8; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 19, pl. 2, fig. 7.

Test very large, elongate and narrow, subcylindrical; proloculus large and rounded to elongate, later tubular chamber may be of slightly less diameter with somewhat irregular constrictions, and rarely (about 2 percent of the specimens examined) bifurcating (fig.

9); wall thick and fairly coarsely arenaceous, but containing clear quartz grains well sorted as to size, which give the surface a sugary appearance because of the relatively small amount of cement, color yellowish, because of the ferruginous stained cement; aperture circular, at the somewhat constricted distal end of the tube.

Length of hypotype of figure 8, 9.0 mm., breadth of proloculus 1.46 mm., greatest breadth of tubular chamber 1.38 mm., least breadth of tubular chamber 0.86 mm. Length of hypotype of figure 10, 3.17 mm., breadth 1.90 mm.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1069a-f) from station 40; unfigured hypotypes are recorded from stations 40, 47, and 48.

Genus HIPPOCREPINA Parker, 1870

HIPPOCREPINA INDIVISA Parker

Plate 1, figure 13

Hippocrepina indivisa Parker, 1870, *in* Dawson, Can. Nat., n. s., vol. 5, p. 176, fig. 2.—Cushman, 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 57, pl. 23, figs. 3-7; 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 6, pl. 1, fig. 5; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 21, pl. 2, figs. 4, 5.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 394, pl. 1, fig. 5.

Test free, consisting of a single elongate, tapering chamber which is contracted and broadly rounded at the top; wall finely arenaceous, reddish to yellowish in color, the apertural portion somewhat lighter in color, smoothly finished, but with occasional slight transverse constrictions, which are not related to any structural features as there are no internal divisions into chambers; aperture small, terminal, central, usually circular, sometimes surrounded by a slightly raised lip.

Length of figured hypotype 0.91 mm., greatest breadth 0.39 mm. Other specimens range from 0.47 to 1.04 mm. in length.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1045) from station 3; unfigured hypotypes are recorded from stations 27, 29, 30, and 47.

Genus SACCORHIZA Eimer and Fickert, 1899

SACCORHIZA RAMOSA (Brady)

Plate 1, figures 14, 15

Hyperammina ramosa Brady, 1879, Quart. Journ. Micr. Soc., vol. 19, p. 33, pl. 3, figs. 14, 15; 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 261, pl. 23, figs. 15-19.—Flint, 1899, Ann. Rep. U. S. Nat. Mus. for 1897, p. 270, pl. 11, fig. 1.

Saccorhiza ramosa (Brady) Eimer and Fickert, 1899, Zeitschr. wiss. Zool., vol. 65, No. 4, p. 670.—Cushman, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 65, text fig. 81; 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 81, pl. 30, figs. 3, 4.

Test free, with a subglobular proloculus and long dichotomously branching tubular undivided chamber of nearly uniform diameter throughout; wall thick, agglutinated, consisting of medium to fine sand grains, with an abundance of sponge spicules fastened almost at right angles to the outer surface, giving a very spinose and bristling appearance, color white or yellowish, with frequent dark mineral grains sometimes giving a very speckled appearance; apertures formed by the open ends of the tubes.

Length of hypotype of figure 15, 5.77 mm., breadth of tube varying from 0.44 to 0.65 mm. Length of hypotype of figure 14, 3.93 mm.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2067a,b) and unfigured hypotypes from station 43.

Family Reophacidae

Genus REOPHAX Montfort, 1808

REOPHAX ARCTICA Brady

Plate 1, figures 19, 20

Reophax arctica Brady, 1881, Ann. Mag. Nat. Hist., ser. 5, vol. 8, p. 405, pl. 21, figs. 2a,b; 1882, Denkschr. Akad. Wiss. Wien, math.-nat. Kl., vol. 43, p. 99, pl. 2, figs. 2a,b.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 395, pl. 1, figs. 6, 7.

Bigenerina arctica (Brady) Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 31, pl. 3, fig. 9 (not figs. 10, 11).

Test free, small, elongate, somewhat compressed and slightly tapering at the base, later portion with nearly parallel margins; chambers numerous, uniserially arranged throughout, early ones low and broad, increasing in relative height as added, final chambers of nearly equal breadth and height, last chamber somewhat produced toward the aperture; sutures distinct, slightly depressed, later ones somewhat constricted so that the margin is somewhat lobulate in appearance; wall finely arenaceous, with occasional larger grains, white to gray in color, rather smoothly finished; aperture terminal, rounded.

Length of hypotype of figure 20, 0.55 mm., breadth 0.13 mm. Length of hypotype of figure 19, 0.39 mm.

Remarks.—Cushman (1948b, p. 31) mixed specimens of this species with those of *Textularia torquata* Parker, considering the present form as the megalospheric generation with a much-reduced biserial

stage and indistinct early chambers. He stated that the microspheric stage was biserial for a considerable portion of the test and that young specimens may not reach the uniserial stages. However, the associated *Textularia torquata* is not related to this species and never reaches a uniserial stage. Cushman's figure (1948b, pl. 3, fig. 9) is definitely misinterpreted and the test is actually uniserial down to the base rather than biserial as drawn. Cushman also stated that the size and color of the wall show the two forms to be the same. However, the *Textularia* which is often but not always associated with *R. arctica* is characteristically reddish in color as are so many of these Arctic agglutinated forms. Furthermore, the uniserial form is more slender and elongate, and the biserial form shorter and more flaring. After this separation had been made in manuscript by the present writers, Parker's paper (1952a) appeared in which she also separated the two forms and described the biserial form as a distinct species.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1054) from station 1; figured hypotype (U.S.N.M. No. P1055) from station 12; unfigured hypotypes are also recorded from the following stations: 1, 2, 8, 12, 13, 15, 16, 18, 20, 21, 22, 23, 26, 27, 29, 30, 31, 32, 33, 37, 38, 40, 42, 46, 47, 48, 51, 52, and 72.

REOPHAX CURTUS Cushman

Plate 2, figures 1-4

Reophax curtus Cushman, 1920, U. S. Nat. Mus. Bull. 104, pt. 2, p. 8, pl. 2, figs. 2, 3; 1922, Contr. Can. Biol., No. 9 (1921), p. 139.—Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., vol. 6, No. 1, p. 58, pl. 2, fig. 12.—Cushman, 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 10, pl. 1, figs. 15, 16; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 24, pl. 2, figs. 13, 14.—F. Parker, 1942, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 395.

Reophax subfusiformis Earland, Höglund, 1947 (part), Zool. Bidrag Uppsala, vol. 26, p. 82, pl. 9, figs. 1, 2, 4 (not 3), pl. 26, figs. 1-36, pl. 27, figs. 1-19, text figs. 43-50.

Test free, large, elongate, usually slightly arcuate, tapering at the base; consisting of 3 to 4 chambers, increasing rapidly in size, slightly inflated, final chamber pyriform in outline, tapering to form a neck; sutures obscured, later ones somewhat constricted, horizontal; wall coarsely arenaceous, with occasional black or dark green mineral grains among the usual clear quartz ones, little cement, mostly white or light in color, except for the occasional dark grains; aperture rounded, terminal, upon the slightly produced last chamber.

Length of specimen of figure 4, 2.05 mm., breadth 0.68 mm. Length

of specimen of figure 2, 2.34 mm., breadth 0.65 mm. Length of specimen of figure 3, 1.66 mm., breadth 0.60 mm. Other specimens range from 0.81 to 2.78 mm. in length.

Remarks.—The specimens figured by Höglund (1947) as *R. subfusiformis* Earland are apparently identical with the present species. However, Earland's types were from the Antarctic and thus may be distinct, hence we have not placed this species in the above synonymy. Höglund stated that *R. curtus* was described as lacking a neck and that *R. subfusiformis* had a definite neck. As Parker (1952a) noted, *R. curtus* may have a definite neck, but this may be broken because of its fragile character. Specimens we have found bear out this conclusion.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1046a-d) from station 35; unfigured hypotypes are recorded from the following stations: 1, 2, 12, 16, 18, 20, 22, 26, 29, 30, 31, 35, 36, 40, 50, and 51.

REOPHAX PILULIFERA Brady

Plate 2, figure 6

Reophax pilulifera Brady, 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 292, pl. 30, figs. 18-20.—Flint, 1899, Ann. Rep. U. S. Nat. Mus. for 1897, p. 273, pl. 18, fig. 1.

Reophax pilulifer Brady, Cushman, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 85, figs. 117, 118; 1920, U. S. Nat. Mus. Bull. 104, pt. 2, pp. 7-8, pl. 2, fig. 1.—Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., vol. 6, No. 1, p. 68, pl. 4, fig. 6.

Reophax sufusiformis Earland, Höglund, 1947 (part), Zool. Bidrag Uppsala, vol. 26, p. 82, pl. 9, fig. 3 only.

Test free, straight and somewhat elongate, consisting of a series of rounded or globular chambers with each additional chamber much larger than the preceding, the final chamber may be somewhat elongate and produced into a neck: sutures distinctly constricted between the nearly separated chambers; wall arenaceous, of medium-sized clear quartz grains, and occasional dark mineral grains, color white, surface fairly smooth; aperture terminal, rounded, on a slight necklike elongation of the final chamber.

Length of figured hypotype 1.09 mm., greatest breadth of first chamber 0.13 mm., greatest breadth of second chamber 0.23 mm., greatest breadth of final chamber 0.42 mm.

Remarks.—The specimen figured by Cushman (1944) from the New England coast seems closer to *R. curtus* than to the present species. The specimen shown by Höglund (1947, pl. 9, fig. 3) and one or

two of his text figures (not numbered) are apparently this species. They differ from *R. curtus* Cushman in having more regular and more globular chambers, and are more constricted between chambers. Höglund commented concerning these specimens which he referred to as "extreme variant No. 2" of *Reophax subfusiformis* Earland: "Individuals can be met with that I think show quite as much similarity to the original figures of *R. pilulifer*. . . . In saying this, however, I do not mean to assert that there is identity. An opinion on that problem can only be formed by someone having access to a sufficiently large material from Brady's original localities." Nevertheless, these figured specimens seem much closer to Brady's types than to the types of *R. subfusiformis,* which is an Antarctic species, or of *R. curtus* Cushman, to which the majority of Höglund's specimens of "*R. subfusiformis*" most probably belong.

Type and occurrence.—Figured hypotype (U.S.N.M. No. P1058) from station 43.

REOPHAX SCORPIURUS Montfort

Plate 2, figures 7-10

Reophax scorpiurus Montfort, 1808, Conchyliologie systematique . . . , vol. 1, p. 330.—Cushman, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 83, figs. 114-116; 1920, U. S. Nat. Mus. Bull. 104, p. 6, pl. 1, figs. 5-7; 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 10, pl. 1, fig. 19.— (?) Höglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 81, pl. 9, figs. 9, 10, pl. 26, figs. 52-55, text figs. 51, 52.

Test free, small, narrow, elongate, nearly straight or arcuate; consisting of a few chambers which increase rapidly in height as added, but less rapidly in breadth; sutures nearly horizontal, obscure to moderately constricted; wall agglutinated, largely composed of medium-sized clear quartz grains with a few scattered dark mineral grains and comparatively little cement, surface rough; aperture terminal, rounded, at the end of a distinct tubular neck.

Length of specimen of figure 10, 1.14 mm., breadth 0.39 mm. Other specimens range from 0.52 to 1.09 mm. in length.

Remarks.—This species is similar in appearance to *R. curtus* Cushman, but differs in being much smaller, more slender, with less-incised sutures, and is less coarsely arenaceous.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1043a-c) from station 14; figured hypotype (U.S.N.M. No. P1044) from station 43; unfigured hypotypes are recorded from stations 14, 17, 33, 35, and 51.

Genus PROTOSCHISTA Eimer and Fickert, 1899

PROTOSCHISTA FINDENS (Parker)

Plate 1, figures 16-18

Lituola findens Parker, 1870, *in* Dawson, Can. Nat., n. s., vol. 5, p. 176, pl. fig. 1.
Reophax findens (Parker) Siddall, 1879, Catalogue of British Recent Foraminifera, p. 4.—Cushman, 1921, U. S. Nat. Mus. Bull. 100, vol. 4, p. 71, pl. 13, fig. 4.
Protoschista findens (Parker) Eimer and Fickert, 1899, Zeitschr. wiss. Zool., vol. 65, No. 4, p. 677.—Galloway, 1933, Manual of the Foraminifera, p. 176, pl. 15, fig. 19.
Dendrophrya? findens (Parker) Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 22, pl. 3, figs. 1, 2.

Test free, consisting of a series of chambers which are usually regularly uniserial, occasionally branching and forming 2 or 3 uniserial series of chambers from the proloculus; chambers somewhat broader than high, slightly inflated, of nearly equal size throughout; wall arenaceous, with comparatively little cement, surface rough, color yellowish to white; aperture circular at the ends of the series of chambers.

Length of hypotype of figure 16, 1.04 mm., breadth 0.23 mm.; length of hypotype of figure 18, 0.49 mm., breadth 0.18 mm.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1041a,b) from station 3; figured hypotype (U.S.N.M. No. P1042) from station 12; unfigured hypotypes are also recorded from stations 3, 6, 26, 52, 54, and 66.

Family Ammodiscidae

Genus TURRITELLELLA Rhumbler, 1903

TURRITELLELLA SHONEANA (Siddall)

Plate 2, figure 5

Trochammina shoneana Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. 2, p. 46, figs. 1, 2.
Ammodiscus shoneanus Siddall, Siddall, 1879, Catalogue of British Recent Foraminifera, p. 5.—Balkwill and Wright, 1882, Proc. Roy. Irish Acad., vol. 3, p. 546; 1884, Journ. Micr., vol. 3, p. 25, pl. 1, fig. 4.—Brady, 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 335, pl. 38, figs. 17-19.—Heron-Allen and Earland, 1913, Proc. Roy. Irish Acad., vol. 31, No. 64, p. 49, pl. 3, fig. 6; 1916, Trans. Linn. Soc. London, vol. 11, pt. 13, p. 227.
Turritellopsis shoneanus Siddall, Rhumbler, 1895, Nachr. Ges. Wiss. Göttingen, p. 85; 1902, Zeitschr. allg. Phys., vol. 2, p. 284, fig. 103.
Turritellella shoneana (Siddall) Rhumbler, 1903, Arch. Prot., vol. 3, p. 283, fig. 135—Cushman, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 79, figs. 107-109; 1918, U. S. Nat. Mus. Bull. 104, pt. 1, p. 102, pl. 38, figs. 5-7.—Höglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 129, text fig. 102.

Test free, elongate, narrow, consisting of a proloculus and long, undivided tubular second chamber increasing very slowly in diameter and coiled in a very high close spire, of approximately 10 volutions; spiral suture slightly depressed; wall finely arenaceous, of a reddish or yellowish color, grading from a more deeply colored proloculus to a lighter terminal portion; aperture consists of the open end of the tube.

Length of figured hypotype 0.31 mm., greatest breadth 0.10 mm. Length of unfigured hypotypes ranges from 0.23 to 0.26 mm.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1059) from station 20; unfigured hypotypes (U.S.N.M. No. P1060) are recorded from station 26.

Family Lituolidae

Genus ADERCOTRYMA Loeblich and Tappan, 1952

ADERCOTRYMA GLOMERATUM (Brady)

Plate 8, figures 1-4

Lituola glomerata Brady, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 433, pl. 20, figs. 1a-c.

Haplophragmium glomeratum (Brady) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. 25, No. 9, p. 23, pl. 5, figs. 134-139.

Haplophragmoides glomeratum (Brady) Cushman, 1910, U. S. Nat. Mus. Bull. 71, pt. 1, p. 104, figs. 158-161; 1920, U. S. Nat. Mus. Bull. 104, pt. 2, p. 47, pl. 9, fig. 6.—Höglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 135, pl. 10, figs. 3, 4, text fig. 112.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 28, pl. 2, fig. 16.

Adercotryma glomeratum (Brady) Loeblich and Tappan, 1952, Journ. Washington Acad. Sci. vol. 42, p. 141, figs. 1-4.

Test free, subglobular to slightly ovate, planispiral but somewhat asymmetrical, with about two whorls present, greatest dimension in the axis of coiling, periphery broadly rounded; chambers few in number, only the four of the final whorl visible, very broad and low, slightly inflated, somewhat wedge-shaped with the narrower portion on the side with the aperture; sutures distinct, rather straight, slightly constricted; wall rather coarsely arenaceous, with considerable cement between the grains; aperture may be indistinct or lacking, or consist of a short slit or low arch at the inner margin of the final chamber, about one-half to two-thirds the distance from the periphery to the umbilicus, on the narrower side of the test.

Greatest diameter of hypotype of figure 2, 0.26 mm., thickness 0.26 mm. Other specimens range in diameter from 0.13 to 0.36 mm.

Remarks.—In describing this species, Brady (1878, p. 433) stated: "Aperture at the inner margin of the terminal chamber, near the exterior of the corresponding segment of the previous convolution, simple, often obscure." Cushman (1948b, p. 28) stated that the aperture is "a short slit at the base of the chamber, often obscured by sand grains." It remained for Höglund (1947, p. 135, pl. 10, fig. 4) to clearly demonstrate the position of this aperture, and he described it as "interio-marginal, forming a short slit at the margin of the last chamber, near the narrow end of the oviform test, most frequently indistinct or even lacking." In any large series of specimens, apertures are occasionally seen. These may be either of two types, a low arch about halfway between the periphery and the umbilicus (figs. 2, 3, 4b), or a slit which extends along the inner margin of the final chamber to the umbilicus (fig. 1b). Höglund suggested that specimens lacking an aperture might be in a growth stage in which it had not yet been developed. It is possible that different stages of growth may account for the two variations of apertures here mentioned.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P829a-c) from station 52; figured hypotype (U.S.N.M. No. P831) from station 51; unfigured hypotypes are recorded from stations 1, 22, 23, 26, 31, 32, 35, 36, 51, 52, and 53.

Genus RECURVOIDES Earland, 1934

RECURVOIDES TURBINATUS (Brady)

Plate 2, figure 11

Haplophragmium turbinatum Brady, 1881, Quart. Journ. Micr. Soc., n. s., vol. 21, p. 50; 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 312, figs. 9a-c.
Trochammina turbinata (Brady) Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 43, pl. 5, figs. 2a,b.
Recurvoides turbinatus (Brady) F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 402, pl. 2, figs. 23, 24.

Test free, streptospiral, with the later portion coiled in a different plane than the early portion, periphery broadly rounded; chambers numerous, increasing gradually in size as added, 5 to 8 in the final whorl, the majority with 6 chambers, later ones slightly inflated; sutures distinct, slightly depressed, nearly straight; wall finely arenaceous, with occasional larger quartz grains, smoothly finished, color yellowish to reddish brown; aperture interio-areal, ovate to somewhat elongate.

Remarks.—Cushman (1948b, p. 44) describes this species as having an aperture at the base of the ventral side of the chamber, but in

reality the aperture is interio-areal. Brady (1884, p. 312) stated the chambers in the final whorl numbered about 6. Cushman states (1948b, p. 44) there are 5 to 8 in the final whorl and Parker (1952a, p. 402) says her specimens have 6 in the final whorl and considered that Cushman might have confused another species with this form. The Arctic specimens examined by the writers have 5 to 8 chambers in the final whorl, with the majority having 6, however.

Types and occurrence.—Cushman (1948b) stated that this species occurred in a single station off Greenland, and that "as this seems to be the only record for it in this cold water, it is probaly not to be included among typical Arctic species." However, we have it at four stations off Point Barrow, Alaska, as well as other Arctic locations.

Figured hypotype (U.S.N.M. No. P2023) from station 23; unfigured hypotypes are recorded from stations 3, 8, 12, 15, 22, 23, 26, 27, 31, 35, 36, 51, and 52.

Genus ALVEOLOPHRAGMIUM Stschedrina, 1936

The nomenclature involving this genus is somewhat complicated and perplexing and involves several generic names including *Labrospira, Cribrostomoides,* and *Haplophragmoides.* Norman (1892, p. 17) describes the species *Haplophragmium crassimargo,* which later became the genotype species of the genus *Labrospira* Höglund. Höglund (1947, p. 144) in his discussion of *Labrospira* includes the species *L. subglobosa* (G. O. Sars) but in addition placed in the synonymy of this latter species *Cribrostomoides bradyi* Cushman. *Cribrostomoides bradyi* is the genotype species of the genus *Cribrostomoides* and if a new generic name were needed to distinguish such forms as *Labrospira,* certainly *Cribrostomoides* Cushman was available and should not have been placed in synonymy. The writers therefor agree with Frizzell and Schwartz (1950, pp. 1, 4) in rejecting *Labrospira* as a synonym, although not of *Cribrostomoides* Cushman. The writers feel that, in spite of the criticism of Earland (1935, p. 89), Höglund (1947, p. 145), Frizzell and Schwartz (1950, p. 3), and Mayne (1952, p. 44), *Cribrostomoides* is a valid genus based on the generic characters enumerated by Cushman (1910, p. 108) and is distinct from forms called *Labrospira* by Höglund.

Höglund's *Labrospira* is a synonym of *Alveolophragmium* Stschedrina and in reality is based on the same species. In describing *Alveolophragmium,* Stschedrina based it on the new species *A. orbiculatum* from the Russian Arctic and sub-Arctic waters, and differentiated it from *Haplophragmoides* as possessing an alveolar wall structure.

However, this species is without doubt the same as the common Arctic species *Haplophragmium crassimargo* Norman. The original description of the latter makes no mention of an interio-areal aperture and to be sure many specimens do not clearly show this feature (Höglund, 1947, p. 144). However, Stschedrina's illustrations of *A. orbiculatum* var. *typica* (1936, p. 315) show a well-developed upper lip, and the figures of *A. orbiculatum* var. *caraensis* (p. 318) show both upper and lower lips, so that it is identical in this character with *H. crassimargo* Norman. The writers do not regard the alveoles in the wall as true alveolar structures, but merely the gaps left between the coarse fragments used in constructing the test. Specimens of *H. crassimargo* Norman from the American Arctic show this identical pseudoalveolar structure. Thus the writers are suppressing the name *Labrospira* as a junior synonym of *Alveolophragmium.*

ALVEOLOPHRAGMIUM CRASSIMARGO (Norman)

Plate 3, figures 1-3

Haplophragmium crassimargo Norman, 1892, Museum Normanianum, pt. 8, p. 17.

Haplophragmium canariense (d'Orbigny) Brady (part), 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 310, pl. 35, fig. 4 (not figs. 1-3, 5).

Haplophragmoides major Cushman, 1920, U. S. Nat. Mus. Bull. 104, pt. 2, p. 39, pl. 8, fig. 6; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 27, pl. 2, fig. 17.

Alveolophragmium orbiculatum var. *typica* Stschedrina, 1936, Zool. Anz., vol. 114, Heft 11/12, p. 315, text figs. 2a,b.

Alveolophragmium orbiculatum var. *ochotonensis* Stschedrina, 1936, ibid., p. 316, text figs. 2a,b.

Alveolophragmium orbiculatum var. *caraensis* Stschedrina, 1936, ibid., p. 318, text figs. 3a,b.

Labrospira crassimargo (Norman) Höglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 141, pl. 11, fig. 1, text figs. 121-125.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 400, pl. 2, figs. 16a,b.

Test free, planispiral, but slightly asymmetrical, biumbilicate, varying from completely involute to slightly evolute, so that a portion of the earlier whorls are visible around the umbilicus, robust, of medium to large size, the very large specimens being rather rare, periphery broadly rounded; chambers numerous, increasing gradually in size as added, later chambers somewhat inflated and occasionally somewhat off center, 7 to 10 in the last whorl, but most commonly 8 or 9; sutures distinct, radial, slightly depressed or constricted in the later portion; wall arenaceous, consisting of many clear quartz grains in a somewhat

granular and fine-grained matrix, smoothly finished, yellowish to reddish in color, sometimes nearly white; aperture in the face of the last formed chamber, interio-areal in position, forming an arched linear slit which parallels the base of the chamber face, but is completely surrounded by a distinct raised lip in well-preserved specimens.

Greatest diameter of hypotype of figure 3, 1.17 mm., thickness 0.65 mm. Greatest diameter of hypotype of figure 1, 2.65 mm., thickness 1.74 mm.

Remarks.—This species has been given three different specific names, and referred to four separate genera, being considered the genotype species of two of the genera.

Cushman described *H. major* as a typical *Haplophragmoides,* stating (1920b, p. 39), "aperture an elongate semicircular slit at the base of the final chamber, the upper portion forming a thin lip." Examination of Cushman's original material shows that his species has an elongate semicircular aperture extending across the apertural face and nearly to the umbilicus, the upper portion forming a thin lip and the lower portion also forming a thin but prominent lip, so that the aperture is interio-areal and not interio-marginal as described. Höglund (1947, p. 143) stated that he could not determine the character of the aperture from Cushman's indistinct figure of this species, but hypothesized that if the aperture were proved to be interio-areal the name should be a synonym of *Labrospira crassimargo* (Norman). Cushman stated in his original description that *Haplophragmoides major* was very similar to the specimen figured by Brady in the *Challenger* report (pl. 35, fig. 4), but he did not state how they agreed or differed. This figure of Brady's was also referred to by Norman (1892, p. 17) in describing *Haplophragmium crassimargo.*

Alveolophragmium was described as having alveoles in the wall; broken fragments were pictured showing these "pores." Fragments of typical specimens of *Haplophragmoides major* Cushman show an identical appearance, but the majority of these so-called alveoles are merely the cavities left between some of the larger grains on the rough interior surface of the wall. The different "varieties" of *Alveolophragmium* are probably entirely due to minor fluctuations in the character of the sea bottom, the coarsely arenaceous and thick-walled tests being built in sandy areas, while along the silty mud bottoms the same species has a finer-grained and thinner wall. This is not so much due to a selective habit which would be of varietal importance, as it is to mere utilization of whatever material was available for building the test.

The type specimens differ slightly in some features, the type of *Haplophragmoides major* having a more semicircular aperture which extends across the face of the last chamber nearly to the umbilicus. The type of *Alveolophragmium orbiculatum* is almost identical with Cushman's types of *H. major* in apertural characters and external appearance. The type of *Haplophragmium crassimargo* has a shorter aperture extending only across the terminal face. These seem merely to be variations, however, and all gradations in extent of aperture occur between them.

The types of *Alveolophragmium* were from the Arctic and sub-Arctic, in the Sea of Okhotsk, the Kara Sea, and the Sea of Japan. The types of *Haplophragmium crassimargo* Norman were from East Finmark and Greenland, the types of *Haplophragmoides major* Cushman were from the Gulf of St. Lawrence, and Höglund, in describing the genus *Labrospira,* also recorded it from Sweden. Thus this species has been reported from the seas adjacent to three continents, but all lie within the circumpolar region, and the Arctic fauna of which this is a representative is the same within this region regardless of the longitude.

As the genotype species of *Alveolophragmium* is thus conspecific with the genotype species of *Labrospira,* the latter name is a junior synonym and must be suppressed. However, the specific name *crassimargo* was the first to be described for the species and thus takes precedence over *orbiculatum* and *major.* The species thus is now referred to *Alveolophragmium crassimargo* (Norman).

Types and occurrence.—Figured hypotype (U.S.N.M. No. 10673, paratype of *Haplophragmoides major* Cushman) from station 56; figured hypotype (U.S.N.M. No. P1038) from station 49; figured hypotype (U.S.N.M. No. P1039) from station 22; unfigured hypotypes are recorded from the following stations: 2, 3, 6, 7, 8, 9, 10, 12, 19, 20, 21, 22, 23, 26, 27, 29, 30, 31, 32, 35, 36, 37, 40, 41, 49, 50, 51, 52, 54, 55, 56, 57, 58, 59, and 60.

ALVEOLOPHRAGMIUM JEFFREYSI (Williamson)

Plate 3, figures 4-7

Nonionina jeffreysii Williamson, 1858, Recent Foraminifera of Great Britain, p. 34, figs. 72-73.

Haplophragmoides canariense (d'Orbigny) Cushman, 1920, Rep. Canadian Arctic Exped., 1913-1918, vol. 9, pt. M, p. 6; 1922, Contr. Can. Biol., No. 9 (1921), p. 140; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 26, pl. 2, fig. 15.

Labrospira jeffreysi (Williamson) Höglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 146, pl. 11, fig. 3, text figs. 128, 129.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 401, pl. 2, figs. 15, 17-20.

Test free, planispiral, and involute, but occasionally somewhat trochoid so that earlier whorls may be visible in the umbilical region on one side, somewhat compressed, biumbilicate, margin lobulate, periphery rounded; 6 or 7 chambers in the final whorl, increasing rapidly in size, the final chamber occasionally somewhat more inflated or tending to uncoil slightly; sutures distinct, slightly depressed; wall very thin and fragile, arenaceous, with many glassy-appearing grains in a finer ground mass, surface smoothly finished; aperture oval, interioareal, usually very near the base of the final chamber, but may be slightly above the base (fig. 6) with a definite lower lip visible on well-preserved specimens or on the earlier chambers when broken or sectioned; color usually reddish or yellowish in the early portion, with the final chambers lighter in color and frequently white.

Greatest diameter of hypotype of figure 7, 0.91 mm., thickness of test 0.36 mm. Other specimens range in diameter from 0.29 to 1.04 mm.

Remarks.—Cushman consistently identified this species as *Haplophragmoides canariense* which he had designated as the genotype species of *Haplophragmoides.* However, the well-defined interio-areal aperture places the present form in the genus *Alveolophragmium* Stschedrina. As no worker has subsequently studied the types of *Haplophragmoides canariense,* it may be found that it also possesses an interio-areal aperture and then the genus *Alveolophragmium* would become a synonym of *Haplophragmoides* Cushman. This case clearly emphasizes the fact that writers should designate as types specimens at hand, and should not rely on figures of so-called classical species, for these invariably become items of doubt to later students. As new structures and internal characters are observed, different criteria are used for differentiating species and genera, and often in the past such features were erroneously assumed to be lacking on early species merely because they had not been mentioned in the original description, and no further study of the types was made.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1040a-d) from station 3; unfigured hypotypes are recorded from stations 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 37, 44, 49, 50, 51, and 52.

AMMOTIUM[1] **Loeblich and Tappan, new genus**

Synonym: *Ammobaculites* (part) of authors.

Genotype (type species): *Lituola cassis* Parker.

Test free, compressed, ovate in outline, chambers planispirally coiled and evolute with later chambers tending to uncoil, but reaching backward toward the coil at the inner margin; wall agglutinated; aperture simple, rounded and terminal, at the dorsal angle of the final chamber.

Remarks.—This genus is erected for species that differ considerably from the genotype species of *Ammobaculites* Cushman, in that they do not become completely uncoiled. It differs from *Ammobaculites* in the same way that *Astacolus* differs from *Marginulina* or *Marginulinopsis,* the later portion being flattened rather than rounded in section, and the chambers reaching far back toward the coil at the inner margin. Other species that can be placed here include *Ammobaculites auricularis* Loeblich and Tappan (Kiowa formation, Lower Cretaceous of Kansas), *A. braunsteini* Cushman and Applin ("marine shale of the Tuscaloosa," Upper Cretaceous of Mississippi), *A. pseudocassis* Cushman and Bronnimann (Recent of Trinidad), *A. salsus* Cushman and Bronnimann (Recent of Trinidad), and *A. salsus* var. *distinctus* Cushman and Bronnimann (Recent of Trinidad).

Range.—Lower Cretaceous to Recent.

AMMOTIUM CASSIS (Parker)

Plate 2, figures 12-18

Lituola cassis Parker, 1870, *in* Dawson, Can. Nat., n. s., vol. 5, pp. 177, 180, fig. 3.

Ammobaculites cassis (Parker) Cushman, 1920, U. S. Nat. Mus. Bull. 104, pt. 2, p. 63, pl. 12, fig. 5.—Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., vol. 6, No. 1, p. 83, pl. 7, figs. 7, 8.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 29, pl. 3, figs. 4-6.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 398, pl. 2, figs. 8-10.

Test free, large, robust, somewhat flattened, early portion planispiral, later uncoiling and flattened, extremely variable in degree of coiling and breadth of uncoiled portion, periphery broadly rounded; chambers numerous, low and broad, increasing gradually in the size as added and increasing in relative breadth in most specimens, with uncoiled chambers reaching back at the inner margin, thickest at the ventral margin, and flattened out toward the dorsal margin, final chamber somewhat higher and may be nearly circular in section, somewhat produced to form a slight neck; sutures obscure in the early por-

[1] From Gr. *ammos,* sand; *otion,* dim. of *ous,* ear.

tion and moderately depressed and distinct between the uncoiled chambers; wall medium to coarsely arenaceous, later portion with progressively larger grains incorporated; aperture terminal at the dorsal angle, large, rounded to oval in shape.

Length of hypotype of figure 17, 1.82 mm., greatest breadth 0.94 mm.; length of hypotype of figure 15, 1.51 mm., greatest breadth 0.57 mm.; length of hypotype of figure 13, 0.88 mm., greatest breadth 0.29 mm.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1047 a-f) from station 3; figured hypotype (U.S.N.M. No. P1048) from station 18; unfigured hypotypes are recorded from stations 1, 2, 3, 4, 8, 9, 10, 12, 13, 15, 17, 18, 22, 26, 27, 30, 50, and 51.

Family TEXTULARIIDAE

Genus SPIROPLECTAMMINA Cushman, 1927

SPIROPLECTAMMINA BIFORMIS (Parker and Jones)

Plate 4, figures 1-6

Textularia agglutinans d'Orbigny var. *biformis* PARKER and JONES, 1865, Philos. Trans. Roy. Soc. London, vol. 155, p. 370, pl. 15, figs. 23, 24.

Textularia biformis Parker and Jones, BRADY, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 436, pl. 20, fig. 8.

Spiroplecta biformis (Parker and Jones) BRADY, 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 376, pl. 45, figs. 25-27.

Spiroplectammina biformis (Parker and Jones) CUSHMAN, 1927, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, p. 23, pl. 5, fig. 1.—HÖGLUND, 1947, Zool. Bidrag Uppsala, vol. 26, p. 163, pl. 12, fig. 1, text figs. 140, 141.—CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 30, pl. 3, figs. 7, 8.—F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 402, pl. 3, figs. 1, 2.

Test free, small, narrow, elongate, parallel-sided, early planispiral coil of 5 to 6 chambers with the later biserial portion of a breadth approximately equal to that of the coil, periphery rounded; chambers numerous, 5 to 6 in the coil, followed by as many as 8 pairs of biserially arranged chambers of nearly equal size, slightly inflated; sutures distinct, straight and radial in the coil, slightly oblique, highest at the midline in the biserial portion; wall finely arenaceous, but granular in appearance, with grains of nearly equal size, surface smoothly finished; aperture a low arch at the inner margin of the last-formed chamber.

Length of hypotype of figure 1, 0.44 mm., breadth of coil 0.10 mm., breadth of biserial portion 0.16 mm., thickness 0.09 mm. Length of hypotype of figure 3, 0.70 mm., breadth of coil 0.21 mm., breadth of

biserial portion 0.21 mm. Other hypotypes range from 0.16 to 0.75 mm. in length.

Remarks.—It seems probable that two species are included here, one considerably smaller than the other, although otherwise very similar. The small form is here shown in figure 1, the larger type in figures 2 to 6. However, the original description of Parker and Jones gave no measurements for their specimens, hence it is uncertain with which of the two forms they dealt. The magnification given by Parker and Jones for their illustrations would seem to suggest that they were concerned with the larger form. However, F. Parker (1952a) has referred the larger form to *S. typica* Lacroix, and the smaller form to *S. biformis*. Only an examination of the types can settle this problem, and we have been unable to determine this satisfactorily through correspondence. Therefore, the two forms are here described as one species with the reservation that one will probably later be removed.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2103 a-e) from station 13; figured hypotype (U.S.N.M. No. P2104) from station 52; unfigured hypotypes are recorded from stations 1, 2, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 26, 27, 29, 30, 31, 32, 33, 42, 46, 50, 51, and 52.

Genus TEXTULARIA Defrance, 1824

TEXTULARIA TORQUATA F. Parker

Plate 2, figures 19-21

Textularia torquata F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 403, pl. 3, figs. 9-11.

Test free, tiny, flattened, flaring from a pointed or bluntly rounded base, early portion occasionally somewhat twisted, biserial throughout; chambers increasing rapidly in size as added, low and broad over most of the test, the final pair comparatively higher, slightly inflated, somewhat overlapping earlier chambers at the periphery; sutures straight, somewhat oblique, slightly depressed in the later portion; wall finely arenaceous, but of rather large grains for the size of the test, roughly finished; aperture narrow, slitlike, extending up into the apertural face.

Length of hypotype of figure 21, 0.34 mm., breadth 0.18 mm. Other figured hypotypes are 0.29 and 0.34 mm. in length.

Remarks.—A comment seems necessary as to the wall texture. The original description stated that the species was "coarsely arenaceous." However, as can be seen from the measurements, the entire test is nowhere near as large as a single grain found in the wall of certain larger

species. The terms "finely" or "coarsely" arenaceous as commonly used may thus be quite misleading. Actually the grains in this species are very small, but seem rather larger as compared to the size of the minute test.

Types and occurrence.—This species was originally described from off Portsmouth, N. H., and was also recorded from near Greenland, in samples from Baffin Bay and the Kane Basin. Figured hypotypes (U.S.N.M. Nos. P1051a-c) from station 23; unfigured hypotypes are recorded from the following stations: 8, 13, 16, 18, 21, 22, 23, 26, 29, 30, 31, 32, 35, 36, 37, 38, 46, 47, 48, and 52.

Family VALVULINIDAE

Genus EGGERELLA Cushman, 1933

EGGERELLA ADVENA (Cushman)

Plate 3, figures 8-10

Verneuilina advena CUSHMAN, 1922, Contr. Can. Biol., No. 9 (1921), p. 141.
Eggerella advena (Cushman) CUSHMAN, 1937, Cushman Lab. Foram. Res. Spec. Publ. No. 8, p. 51, pl. 5, figs. 12-15; 1948, Cushman Lab. Foram. Res. Spec. Publ. No. 23, p. 32, pl. 3, fig. 12.
Eggerella arctica HÖGLUND, 1947, Zool. Bidrag Uppsala, vol. 26, p. 193, pl. 16, fig. 4, text figs. 166-168.
not *Verneuilina advena* Cushman, HÖGLUND, 1947, ibid., p. 185, pl. 13, fig. 11, text fig. 169.

Test free, elongate, somewhat tapering, early portion with 4 to 5 chambers to a whorl, later portion triserial; chambers numerous, low and broad in the early portion, increasing in relative height as added, those of the final whorl being approximately equal in height and breadth; sutures distinct, depressed; wall finely arenaceous, with occasional larger grains, rather smoothly finished, reddish to yellowish in color, with the final whorl much lighter in color and nearly white; aperture small, central, a low arch at the base of the final chamber.

Length of hypotype of figure 10, 0.68 mm., breadth 0.21 mm. Length of hypotype of figure 8, 0.39 mm., breadth 0.21 mm.

Remarks.—This species was originally described by Cushman from the Hudson Bay Expedition, but no figures were given then or later of the types. Furthermore, the original description of the species stated, in part, "Test minute, elongate, triserial, tapering," which would imply that it was a true *Verneuilina*. To add to the confusion, Cushman stated that he had recorded the same species as *V. polystropha* from the Canadian Arctic (1920a, p. 8m, pl. 1, fig. 5) and that

Heron-Allen and Earland recorded it as a dwarfed *V. polystropha.* The first illustrations given by Cushman under the name *V. advena* were those in the Atlantic Foraminifera monograph (1922a, pl. 9, figs. 7-9), which were copies of the figures of Heron-Allen and Earland.

In 1933 Cushman defined the genus *Eggerella* for the species which began with more than three chambers to a whorl, and in 1937 placed his species *Verneuilina advena* in the genus *Eggerella,* for the first time illustrating the typical Arctic forms.

An examination of the original types in the Cushman collection from the four localities where it was first recorded shows them to be true *Eggerella,* and despite Cushman's original description, references to the British forms and copies of the British figures, *Verneuilina advena* Cushman is a true *Eggerella,* and the British triserial form which is a typical *Verneuilina* is not only a distinct species, but belongs to a different genus and family.

Höglund (1947) noted that Cushman (1937) had included under *E. advena* typical *Eggerella* with an early whorl of 4 to 5 chambers, but also placed in his synonymy the British form of Heron-Allen and Earland. As he had no opportunity to examine Cushman's types, Höglund based his interpretation of Cushman's species on the incorrect original description and the first illustrations published by Cushman (the copies of the British figures), and thus erroneously assumed that the typical *V. advena* was a true *Verneuilina,* and that the specimens of *Eggerella* figured later by Cushman (1937) should be given a distinct specific name. He therefore proposed that *Verneuilina advena* be restricted to the forms with a triserial base (the Swedish and British forms) and gave the name *Eggerella arctica* to Cushman's Arctic species illustrated in the 1937 monograph. Unfortunately, Cushman's type specimens from the Arctic are all true *Eggerella* and according to the rules of nomenclature the specific name *advena* must be restricted to those forms like the original types. Thus the name *Eggerella arctica* Höglund must be suppressed as a synonym of *E. advena* Cushman, and the European form is in need of a new name.

Types and occurrence.—Lectotype (here designated) (Cushman Coll. No. 1138), the specimen figured by Cushman (1937, pl. 5, figs. 13a,b) from station 65; figured hypotypes (U.S.N.M. Nos. P1053a-c) from station 2; unfigured hypotypes are also recorded from stations 1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 38, 39, 42, 44, 46, 50, 51, 52, 61, 62, 64, and 65.

Family Silicinidae

Genus SILICOSIGMOILINA Cushman and Church, 1929

SILICOSIGMOILINA GROENLANDICA (Cushman)

Plate 4, figures 7-9

Quinqueloculina fusca Brady var. *groenlandica* Cushman, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 2, pl. 1, fig. 4.

? *Quinqueloculina groenlandica* Cushman, Nørvang, 1945, Zoology of Iceland, vol. 2, pt. 2, p. 6.

Quinqueloculina groenlandica Cushman, Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 34, pl. 3, fig. 18.

not *Quinqueloculina fusa* Brady, Cushman, 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 14, pl. 2, fig. 21.

Test free, oblong, length about twice the width, sigmoiline in plan, with chambers a half a coil in length, added slightly more than 180° apart rather than in a single plane so that in cross section the chambers are aligned in a sigmoid curve of two continuously revolving spirals; chambers elongate, inflated, somewhat thicker at the base and narrower toward the aperture; early sutures somewhat obscure, later ones distinct and slightly depressed; wall insoluble in acid, finely arenaceous, with a large proportion of siliceous cement, surface smoothly finished, and almost porcelaneous in appearance; aperture terminal, a curved slit, due to the infolding of a portion of the inner edge of the chamber wall so that it forms a broad flap.

Length of hypotype of figure 9, 0.75 mm., greatest breadth 0.44 mm., thickness 0.26 mm. Other hypotypes range from 0.29 to 0.70 mm. in length.

Remarks.—This species has never been completely described. The complete original definition of this form as a variety of *Q. fusca* stated only, "Variety differing from the typical in the much smoother test with a much larger proportion of cement of a light gray color, and the test usually more compressed." Nørvang (1945, p. 6) separated the variety as a distinct species of *Quinqueloculina,* but as he neither figured nor described the species it is impossible to be certain whether or not he actually had the same form as was described by Cushman.

Parker (1952a, p. 405) stated "In connection with the study of *M. fusca* at the Cushman Laboratory, specimens of *'Quinqueloculina groenlandica'* Cushman were examined and found to belong to the genus *Miliammina.*"

The present species is insoluble in acid, showing that it should be placed in the Silicinidae, but a section of the test (fig. 8) shows that it

is not triloculine or quinqueloculine in plan, as is *Miliammina,* but has the successive chambers added on opposite sides in continuously revolving spirals, as in *Silicosigmoilina.*

Thus, this species was described as a variety of an existing species, later separated as a distinct species, and still later removed to a different genus, without a complete description of its characters ever being published. Finally, the actual description of this species necessitates its being placed in a third genus, *Silicosigmoilina.*

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1052 a-c) from station 35; unfigured hypotypes are recorded from stations 32, 35, 36, 40, 52, and 75.

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA AGGLUTINATA Cushman

Plate 5, figures 1-4

Quinqueloculina agglutinata CUSHMAN, 1917, U. S. Nat. Mus. Bull. 71, pt. 6, p. 43, pl. 9, fig. 2.—CUSHMAN and TODD, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 1, p. 61, pl. 14, figs. 12, 13.—CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 33, pl. 3, fig. 13.

Test free, ovate in outline, of medium to large size and robust appearance; 5 chambers visible in the adult, chambers elongate and somewhat angular, but with the angles rounded, broadest at the base, narrowing toward the aperture; sutures distinct, depressed; wall finely arenaceous, smoothly finished, although surface is granular in appearance, yellowish to reddish in color, the chambers being progressively lighter in color as added; aperture terminal, circular to oval, with a small but broad flattened tooth projecting from the inner margin.

Length of hypotype of figure 2, 1.04 mm., breadth 0.73 mm., thickness 0.55 mm. Length of larger hypotype of figure 1, 1.40 mm., breadth 1.04 mm. Length of hypotypes of figures 4 and 3, 0.99 mm. and 0.83 mm.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1049a,b) from station 4; figured hypotypes (U.S.N.M. Nos. P1050a,b) from station 26; unfigured hypotypes are also recorded from stations 1, 2, 4, 5, 6, 7, 8, 9, 10, 13, 15, 18, 19, 22, 23, 26, 29, 31, 32, 35, 39, 40, 42, 45, 49, and 50.

QUINQUELOCULINA ARCTICA Cushman

Plate 5, figures 11, 12

Quinqueloculina arctica CUSHMAN, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 2, pl. 1, figs. 3a-c; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 35, pl. 4, figs. 2a-c.—F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 405, pl. 3, figs. 19a,b.

Test free, of medium size, robust, ovate in outline, subtriangular in section, periphery truncate; chambers typically quinqueloculine in plan and distinctly angled; sutures distinct, slightly depressed; wall calcareous, imperforate, surface smooth; aperture large, semicircular, at the end of the final chamber, no projecting neck present, a thin and delicate bifid tooth projecting into the aperture from the margin adjacent to the preceding chamber.

Length of hypotype of figure 11, 1.33 mm., breadth 1.04 mm., thickness 0.83 mm. Length of hypotype of figure 12, 0.94 mm., breadth 0.73 mm. Other specimens range from 0.39 to 1.25 mm. in length.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2035a,b) from station 4; unfigured hypotypes are recorded from stations 2, 4, 5, 7, 9, 13, 18, 19, 21, 22, 23, 26, 27, 35, 40, 50, 51, 63, 66, 67, 75, 76, and 78.

QUINQUELOCULINA STALKERI Loeblich and Tappan, new species

Plate 5, figures 5-9

Quinqueloculina fusca Brady, CUSHMAN, 1948 (not Brady, 1870), Cushman Lab Foram. Res. Spec. Publ. 23, p. 33, pl. 3, figs. 16, 17.

Test free, small, ovate in outline, rounded in section, periphery rounded; chambers quinqueloculine in plan, of nearly equal diameter throughout; sutures distinct, depressed; wall calcareous, imperforate, soluble in hydrochloric acid, with a very finely grained agglutinated surface; aperture ovate to rounded, somewhat elevated on a short neck and surrounded by a distinct lip, a small bifid tooth based on the margin adjacent to the preceding chamber.

Length of holotype 0.57 mm., breadth 0.31 mm., thickness 0.23 mm. Length of paratype of figure 8, 0.44 mm., breadth 0.23 mm. Length of paratype of figure 6, 0.34 mm., breadth 0.16 mm. Length of paratype of figure 5, 0.36 mm., breadth 0.18 mm. Other paratypes range from 0.26 to 0.52 mm. in length.

Remarks.—This Arctic species was referred to *Quinqueloculina fusca* Brady by Cushman, but it differs in having a higher percentage of the wall calcareous, with a smaller amount of agglutinated material,

and in possessing a small bifid tooth. *Q. fusca* was described as being a characteristic brackish-water form and the writers doubt that the same species would be found in the more or less normal marine Arctic waters. *Q. stalkeri,* new species, resembles *Q. nitida* Nørvang, but has a more prominent lip around the aperture and differs in possessing a small bifid tooth, which is lacking in *Q. nitida* Nørvang. This species is named in honor of Jake Stalker, Eskimo guide employed by the Naval Arctic Research Laboratory, Point Barrow, Alaska.

Types and occurrence.—Holotype (U.S.N.M. No. P2036) from station 33; figured paratypes (U.S.N.M. Nos. P2037a,b) from station 13; figured paratypes (U.S.N.M. Nos. P2038a,b) from station 18; unfigured paratypes are recorded from stations 16, 18, 23, 27, 33, and 78.

SCUTULORIS [2] Loeblich and Tappan, new genus

Synonyms: *Miliolinella* (part) Wiesner, 1931; Cushman, 1933.
Quinqueloculina (part) of authors (not d'Orbigny, 1826).

Genotype (type species); *Scutuloris tegminis* Loeblich and Tappan, new species.

Test free, chambers in a quinqueloculine arrangement; wall calcareous, imperforate; aperture at the end of the chamber and nearly filled by a broad, low flap.

Remarks.—Species of this genus have been previously referred to *Miliolinella* Wiesner because of the erroneous subsequent designation of *Quinqueloculina lamellidens* Reuss as the genotype species for *Miliolinella.* As *Vermiculum subrotundum* Montagu was selected as the genotype by original designation by Wiesner, no later change is permissible. *Scutuloris* differs from *Miliolinella* in having a quinqueloculine chamber arrangement, and from *Quinqueloculina* in having a broad flap filling the aperture, in place of the bifid tooth characteristic of the latter.

SCUTULORIS TEGMINIS Loeblich and Tappan, new species

Plate 5, figure 10

Test free, robust, ovate in section, with rounded periphery; chambers in a quinqueloculine arrangement, increasing rapidly in size as added, inflated; sutures distinct, slightly depressed; wall calcareous, imperforate, white and porcelaneous in appearance, surface smooth; aperture at the end of the chamber, semicircular, and nearly filled by a broad flap, which leaves open only a slitlike crescent.

[2] From L. *scutum,* dim. *scutulum,* an oblong shield; *oris,* mouth, oral.

Length of holotype 0.75 mm., breadth 0.55 mm., thickness 0.34 mm. Paratypes range from 0.31 to 0.60 mm. in length.

Remarks.—This species differs from *Quinqueloculina lamellidens* Reuss in being somewhat more compressed and ovate rather than subtriangular in section; and in the final chambers being more inflated and occupying a larger proportion of the test.

Types and occurrence.—Holotype (U.S.N.M. No. P2101) from station 3; unfigured paratypes from stations 6, 26, 28, 33, and 50.

PATEORIS [3] Loeblich and Tappan, new genus

Synonyms: *Massilina* (part) of authors (not Schlumberger, 1893).
Miliola (part) of authors (not Lamarck, 1804).
Miliolina (part) of authors (not Williamson, 1858).
Quinqueloculina (part) of authors (not d'Orbigny, 1826).
Sigmoilina Martinotti, 1921 (not Schlumberger, 1887).

Genotype (type species): *Quinqueloculina subrotunda* (Montagu) forma *hauerinoides* Rhumbler.

Test quinqueloculine in the early portion, later chambers added in a single plane, usually two to a coil, but as many as three to a coil in the later stages; wall calcareous, imperforate; aperture at the open end of the chamber, without a tooth or flap.

Remarks.—This genus differs from *Massilina* Schlumberger and *Quinqueloculina* d'Orbigny in lacking an apertural tooth, and in the later stage having more than two chambers to a coil. It differs from *Quinqueloculina* and *Miliola* Lamarck also in having the later chambers in a single plane. It differs from *Sigmoilina* Schlumberger in having the later chambers in a single plane and more than two to a coil, and in lacking the apertural tooth, and differs from *Hauerina* and *Miliola* in lacking the cribrate aperture.

The following species, in addition to the genotype species, apparently belong in *Pateoris: Massilina agglutinans* Keijzer, *M. australis* Cushman, *M. obliquestriata* Cushman and Valentine, *M. pacificensis* Cushman, and *Sigmoilina sidebottomi* Martinotti.

PATEORIS HAUERINOIDES (Rhumbler)

Plate 6, figures 8-12; text figures 1A, B

Miliolina seminulum (Linné) var. *disciformis* (Macgillivray) Williamson, 1858 (not *Vermiculum disciforme* Macgillivray, 1843), Recent Foraminifera of Great Britain, p. 86, pl. 7, figs. 188, 189.

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[3] From L. *pateo,* to lie open; *os, oris,* mouth, opening.

Miliola (*Quinqueloculina*) *subrotunda* (Montagu) PARKER and JONES, 1865 (not *Vermiculum subrotundum* Montagu, 1803), Philos. Trans. Roy. Soc. London, vol. 155, p. 411, pl. 15, figs. 38a,b (erroneously numbered 28a,b on the plate).

? *Massilina secans* (d'Orbigny) CUSHMAN, 1929, U. S. Nat. Mus. Bull. 104, pt. 6, p. 37, pl. 7, figs. 3, 4.

Quinqueloculina subrotunda (Montagu) forma *haucrinoides* RHUMBLER, 1936, Foram. der Kieler Bucht, Teil II-Ammodisculinidae bis Textulinidae, vol. 1, No. 1, pp. 206, 217, 226, text figs. 167 (p. 205), 208-212 (p. 225).

Quinqueloculina subrotunda (Montagu)? CUSHMAN, 1948 (not *Vermiculum subrotundum* Montagu, 1803), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 35, pl. 3, figs. 20, 21, pl. 4, fig. 1.

Quinqueloculina subrotunda (Montagu) F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 406, pl. 4, figs. 4a,b.

Test free, ovate to subcircular in outline, somewhat compressed, with a rounded periphery; chambers quinqueloculine in arrangement in the early portion, later chambers added in a single plane and becoming more embracing although shorter in length so that in the later portion there may be $2\frac{1}{2}$ to 3 chambers to a coil; wall calcareous, imperforate, porcelaneous surface smooth and polished, the later chambers sometimes with transverse wrinkles; aperture at the open end of the chamber, consisting of a low arch on the periphery in the early stages, later opening slightly to one side of the periphery and developing a slight reentrant, the gerontic form having an elongate, almost slitlike extension of the aperture (fig. 11c).

Greatest diameter of hypotype of figure 11, 0.49 mm., thickness 0.29 mm. Greatest diameter of hypotype of figure 8, 0.65 mm., thickness 0.42 mm. Greatest diameter of hypotype of figure 10, 0.68 mm., thickness 0.34 mm. Greatest diameter of hypotype of figure 12, 0.75 mm., thickness 0.39 mm. Greatest diameter of hypotype of figure 9, 0.96 mm., thickness 0.42 mm. Other hypotypes range from 0.18 to 0.91 mm. in diameter.

Remarks.—Although recorded under many names, this species has been most often confused with *Vermiculum subrotundum* Montagu, the genotype species of *Miliolinella,* and *Quinqueloculina secans* d'Orbigny, the genotype species of *Massilina.* It seems difficult to believe that they could have been so confused, for *V. subrotundum* is triloculine, rather than quinqueloculine, does not become massiline or hauerine in the later stages, and it has a broad flap partially covering the aperture, rather than a completely open aperture.

Quinqueloculina secans is a larger species, and, in addition to having an elongate, strongly bifid tooth, is much more compressed, distinctly keeled and with oblique transverse ribs.

Williamson referred the present species to *Miliolina seminulum* (Linné) var. *disciformis* (Macgillivray), thus referring it to a variety of the genotype species of *Quinqueloculina,* but Macgillivray defined his form as having a "medial, erect tooth, extending to more than half the height of mouth," and in being carinate.

The first time the present form was recognized as distinct was when Rhumbler described it as the forma *hauerinoides* of *subrotunda.* As *V. subrotundum* is the genotype species of *Miliolinella,* the present form cannot be its "forma," and hence is here raised to specific rank, and placed in the new genus *Pateoris.* Rhumbler described this species from the Kieler Bucht, north of Germany, and it occurs through-

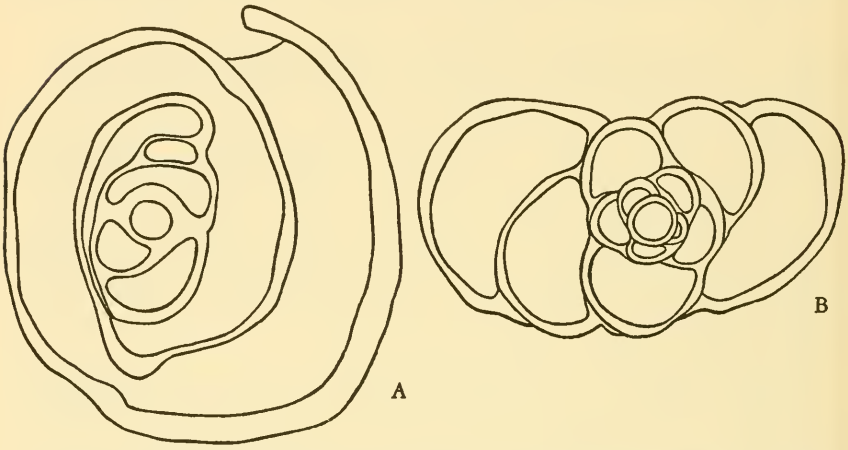

FIG. 1.—*Pateoris hauerinoides* (Rhumbler). A, Longitudinal section cut in plane of adult coiling. B, Transverse section showing early quinqueloculine stage and *Massilina*-like arrangement of the later chambers. × 100.

out the Arctic regions from Alaska, Canada, and Greenland, and also is found on the coasts of Great Britain.

Massilina agglutinans Keijzer is similar in having more than 2 chambers to a coil in the later stages, but has an agglutinated wall, and is more compressed. *Massilina australis* Cushman is similar in the character of coiling, and in lacking a tooth, but is much more compressed. *Massilina pacificensis* Cushman is also similar, but more compressed and with a subacute periphery, and has prominent, obliquely transverse crenulations on the chambers. *Massilina obliquestriata* Cushman and Valentine is more ovate in outline and ornamented by longitudinal, slightly oblique ribs.

It differs from *Sigmoilina sidebottomi* Martinotti in being more evolute so that the earlier chambers are visible in the center and more

compressed, and Martinotti's species lacks the transverse ridges of *P. hauerinoides*.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2105a-e) and thin-sectioned hypotypes (U.S.N.M. Nos. P2106a,b) from station 17; unfigured hypotypes are recorded from stations 2, 3, 4, 5, 6, 7, 8, 9, 12, 15, 16, 17, 18, 19, 22, 23, 24, 25, 26, 28, 29, 30, 31, 33, 34, 35, 37, 38, 40, 45, 47, 48, 50, and 51.

Genus TRILOCULINA d'Orbigny, 1826

TRILOCULINA TRIHEDRA Loeblich and Tappan, new species

Plate 4, figure 10

Test free, small, triangular in section with subacute angles and nearly flat to slightly convex sides; chambers triloculine in plan, slightly inflated; wall calcareous, imperforate, vitreous, surface smooth and polished; aperture terminal, ovate, with a short and broad bifid tooth.

Length of holotype 0.60 mm., breadth 0.49 mm., thickness 0.47 mm. Other paratypes range from 0.23 to 1.04 mm. in length.

Remarks.—This species differs from *Triloculina tricarinata* d'Orbigny, from the Red Sea, in having less-excavated sides, more-rounded angles and in the chambers being more enveloping. *Miliolites trigonula* Lamarck, from the Paris Basin, France, differs in being almost circular in section, and more ovate in side view. *Triloculina gibba* d'Orbigny from the Pliocene and Recent of Italy is more elongate-ovate in side view and with more-inflated chambers.

It is probable that the majority of Arctic and other northern references to the Mediterranean species of d'Orbigny and Lamarck should be included in the present species, but as many of the references show no figures, or only copy the original figures, this can be determined only from a study of the types.

Types and occurrence.—Holotype (U.S.N.M. No. P2110) from station 3; unfigured paratypes are recorded from stations 13, 15, 18, 21, 22, 23, 26, 39, 45, and 50.

Genus MILIOLINELLA Wiesner, 1931

Genotype (type species): *Vermiculum subrotundum* Montagu. Original designation by Wiesner (1931, p. 63).

Miliolinella, as described by Wiesner (1931, p. 107), included biloculine, triloculine, and quinqueloculine forms—in most cases those forms characterized by large flaplike extensions covering the aperture.

Cushman (1933b, p. 148) designated *Quinqueloculina lamellidens* Reuss as a genotype and most later authors have apparently followed Cushman in this type designation. However, this was in error as Wiesner (1931, p. 63) by original designation had made *Vermiculum subrotundum* Montagu the type species.

The species *Vermiculum subrotundum* as figured by Montagu has a triloculine test, but unfortunately the aperture was not figured and it would be difficult now to determine what species Montagu originally had. Wiesner evidently based his concept of *V. subrotundum* on Brady's figures (1884, pl. 5, figs. 10, 11), of which one specimen was quinqueloculine (?) and one specimen shows five chambers in a lateral view and the apertural view shows a large flap which nearly covers the aperture. Incidentally, this is not the same type of test as illustrated by Cushman (1948b, pl. 3, figs. 20, 21) as *Quinqueloculina subrotunda* (Montagu)(?). Thus neither Brady's nor Cushman's figured specimens of *V. subrotundum* are conspecific, or even congeneric with those of Montagu. The genus *Miliolinella* can only include species agreeing in character with the genotype species and as Montagu's illustration shows a distinctly triloculine test, the biloculine and quinqueloculine species should be excluded.

Parr subdivided Wiesner's genus in 1950, describing the new genus *Planispirinoides* (1950, p. 287) with the genotype *Miliolina bucculenta* Brady having an adult "triloculine" stage and possessing a broad lip. This species of Brady's had been included in *Miliolinella* by Wiesner (1931, p. 107), but placed in the synonymy of *Miliolinella subrotunda* var. *trigonina* Wiesner. This latter was erroneous as noted by Parr, for if it were to be classed only as a variety, Brady's name would nevertheless have been available, and the varietal name *trigonina* is thus suppressed as a synonym. Parr placed the genus *Planispirinoides* in the Ophthalmidiidae as it had an early *Cornuspira* stage, and is thus distinct from *Miliolinella,* although both genera have a triloculine adult.

Riccio (1950, p. 90) named another triloculine genus and, following Cushman's genotype designation, he stated that his new genus *Triloculinella* (genotype *T. obliquinodus* Riccio) differed from *Miliolinella* in being triloculine rather than quinqueloculine. *Triloculinella* Riccio is here suppressed as a junior synonym of *Miliolinella* Wiesner, as both genera have triloculine genotype species.

It is unfortunate that Montagu's species was selected as the genotype for it was neither well figured nor described in the original publication, and various distinct species have since been referred to it. The main character differentiating these forms from *Triloculina* is

the apertural flap, and as the apertural characters are not shown by Montagu this genotype species is thus somewhat doubtful. It would have caused much less confusion if Wiesner had selected a species from his own material as the genotype rather than a so-called classic species. This practice of using "classic" species as genotypes whenever possible has been followed by many authors, but time after time has proved to be an unfortunate choice, for almost invariably these classic species are incompletely known, from the too brief descriptions and small and generalized original figures. Furthermore, many of the type specimens were in private collections and have since been lost or destroyed, and as geologic age and type localities are not always exactly known it is sometimes impossible to obtain a reliable specimen on which to base a redefinition of the species.

MILIOLINELLA CHUKCHIENSIS Loeblich and Tappan, new species

Plate 6, figure 7

Test free, ovate in outline, triloculine in chamber arrangement, periphery rounded; chambers inflated, increasing rather rapidly in size as added, final chamber somewhat wider at the base and tapering toward the aperture on the side where three chambers are visible; sutures distinct, depressed, slightly oblique; wall calcareous, imperforate, white and porcelaneous in appearance, surface smooth; aperture at the open end of the chamber, partially covered by a broad, low flap which leaves only a crescentic opening.

Length of holotype 0.75 mm., breadth 0.55 mm., thickness 0.42 mm.; paratypes range in length from 0.34 to 0.83 mm.

Remarks.—This species differs from *Triloculina valvularis* Reuss in being about one-fourth as large, more ovate in outline, and with slightly inclined sutures. It differs from *Triloculina circularis* Bornemann in being ovate rather than circular in outline.

Types and occurrence.—Holotype (U.S.N.M. No. P2098) from station 6; unfigured paratypes are recorded from stations 3, 6, 9, 17, 18, 21, 26, 45, and 47.

Genus PYRGO Defrance, 1824

PYRGO ROTALARIA Loeblich and Tappan, new species

Plate 6, figures 5, 6

Biloculina murrhyna Schwager, CUSHMAN (part), 1917 (not Schwager, 1886), U. S. Nat. Mus. Bull. 71, pt. 6, p. 75, pl. 29, figs. 1a-c (not pl. 28, figs. 3a,b.)

Test free, circular in outline, much inflated, but with a distinctly carinate border, slightly produced at the aboral end; chamber devel-

opment typically biloculine; wall calcareous, imperforate, surface smooth; aperture nearly circular, with a broad tooth that is slightly notched to give a bifid appearance.

Length of holotype 0.55 mm., greatest breadth 0.52 mm., thickness 0.31 mm. Length of figured paratype 0.57 mm., breadth 0.52 mm. Other specimens range from 0.47 to 0.86 mm. in length.

Remarks.—This species resembles *Pyrgo murrhyna* (Schwager) of some authors, but the type specimen of Schwager has two strong spines on either side of an indentation on the basal margin, and the peripheral margin of the test is grooved.

It resembles *Biloculina bradyi* Fornasini, 1886, in general appearance, but is more inflated, and has a slight elongation of the basal margin, rather than an indentation. Furthermore, the tooth is broader in *P. rotalaria,* new species, and not as strongly bifurcate.

Types and occurrence.—Holotype (U.S.N.M. No. P2064), figured paratype (U.S.N.M. No. P2065), and unfigured paratypes all from station 43.

PYRGO WILLIAMSONI (Silvestri)

Plate 6, figures 1-4

Biloculina ringens (Lamarck) *typica* Williamson, 1858 (not *Miliolites ringens* Lamarck, 1804), Recent Foraminifera of Great Britain, p. 79, pl. 6, figs. 169, 170, pl. 7, fig. 171.

Biloculina williamsoni Silvestri, 1923, Atti Accad. Pont. Romana Nuovi Lincei, vol. 76 (1922-23), p. 73.

Pyrgo elongata (d'Orbigny) Cushman, 1948 (not *Biloculina elongata* d'Orbigny, 1826), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 39, pl. 4, figs. 7, 8.

Test oval in outline, inflated; chambers oval in outline, the last extending beyond the previous one on all margins, the young specimens somewhat more elongate, the larger ones nearly circular; sutures distinct, depressed; wall calcareous, white, imperforate and vitreous in appearance, surface smooth; aperture ovate with a small, broad, and bifid tooth projecting from the inner and lower margin of the aperture, the tooth more strongly bifid in the older specimens.

Length of hypotype of figure 1, 0.57 mm., breadth 0.44 mm., thickness 0.42 mm. Length of hypotype of figure 2, 0.29 mm., breadth 0.18 mm., thickness 0.21 mm. Length of hypotype of figure 3, 0.83 mm., breadth 0.78 mm., thickness 0.65 mm. Length of hypotype of figure 4, 0.44 mm., breadth 0.34 mm., thickness 0.31 mm.

Remarks.—This species varies somewhat in outline with age, the young forms being more narrow and elongate with a nearly circular aperture and spatulate tooth, and the tests gradually become more

rounded in outline with increase in size, the aperture becoming more ovate and the tooth more distinctly bifid. This species has been recorded from the Arctic as *P. elongata* (d'Orbigny), but d'Orbigny's species does not have the last chamber surrounding the penultimate one on all sides and is not as broad.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2114a-d) from station 50; unfigured hypotypes are recorded from stations 1, 2, 3, 5, 6, 7, 8, 12, 13, 16, 18, 22, 23, 26, 28, 29, 30, 33, 35, 47, and 50.

Family Ophthalmidiidae

Genus CORNUSPIRA Schultze, 1854

CORNUSPIRA INVOLVENS (Reuss)

Plate 7, figures 4, 5

Operculina involvens Reuss, 1850, Denkschr. Akad. Wiss. Wien, vol. 1, p. 370, pl. 46, fig. 30.

Cornuspira involvens (Reuss) Brady, 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 200, pl. 11, figs. 1-3.—Flint, 1899, Ann. Rep. U. S. Nat. Mus. 1897, p. 303, pl. 48, fig. 3.—Cushman, 1917, U. S. Nat. Mus. Bull. 71, pt. 6, pp. 5, 25, pl. 1, fig. 2, pl. 2, fig. 2, text figs. 2-3; 1929, U. S. Nat. Mus. Bull. 104, pt. 6, p. 80, pl. 20, figs. 6-8.—Wiesner, 1931, Deutsche Südpolar-Exped., 1901-1903, vol. 20 (Zoology, vol. 12), p. 101, pl. 14, figs. 161, 162.

Test free, planispiral, evolute, periphery rounded; consisting of a globular proloculus and long undivided tubular second chamber which increases steadily in size as added; spiral suture distinct; wall calcareous, porcelaneous, surface smooth, except for various transverse growth lines; aperture at the open end of the tube.

Greatest diameter of hypotype of figure 5, 1.59 mm., thickness 0.29 mm. Greatest diameter of hypotype of figure 4, 1.48 mm., thickness 0.31 mm. Other hypotypes range from 0.21 to 2.05 mm. in diameter.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2091) from station 2; figured hypotype (U.S.N.M. No. P2092) from station 23; unfigured hypotypes are recorded from stations 3, 4, 5, 7, 13, 16, 17, 18, 19; 20, 21, 22, 23, 26, 27, 30, 31, 33, 34, 35, 37, 38, 42, and 51.

Genus GORDIOSPIRA Heron-Allen and Earland, 1932

GORDIOSPIRA ARCTICA Cushman

Plate 7, figures 1-3

Gordiospira arctica Cushman, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 3, pl. 1, figs. 5-7; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 41, pl. 4, figs. 11-13.

Test free, nearly planispiral, partially evolute so that previous coils are visible in the umbilical region, as many as 3½ whorls may be present; proloculus globular, followed by long undivided tubular second chamber, which is somewhat irregular in coiling in the early portion; wall calcareous, imperforate, surface marked by numerous ridges of growth; aperture large, formed by the open end of the tube.

Greatest diameter of hypotype of figure 1, 0.88 mm., greatest thickness 0.36 mm. Greatest diameter of hypotype of figure 2, 0.34 mm. Greatest diameter of hypotype of figure 3, 0.39 mm.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1072) from station 23; figured hypotype (U.S.N.M. No. P1073) from station 15; figured hypotype (U.S.N.M. No. P1074) from station 22; unfigured hypotypes are recorded from stations 15, 17, 20, 22, 23, 26, 33, and 34.

Family TROCHAMMINIDAE

Genus TROCHAMMINA Parker and Jones, 1859

TROCHAMMINA NANA (Brady)

Plate 8, figure 5

Haplophragmium nana BRADY, 1881, Quart. Journ. Micr. Soc., vol. 21, p. 50; 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 311, pl. 35, figs. 6-8.

Trochammina nana (Brady) CUSHMAN, 1920, U. S. Nat. Mus. Bull. 104, pt. 2, p. 80, pl. 17, fig. 1; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 42, pl. 5, fig. 1.—PHLEGER, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 86, pl. 13, figs. 31, 32.

Test free, small, trochoid, biconvex, ventrally umbilicate, margin lobulate; chambers numerous, increasing rapidly in size as added, later ones inflated, particularly on the ventral side, the complete 2½ whorls visible dorsally, only the 6 or 7 chambers of the final whorl visible ventrally; sutures distinct, nearly straight and radiate ventrally, curving backward to the periphery on the dorsal side; wall arenaceous, of medium-sized grains, with some larger clear quartz grains, surface rather smoothly finished; color yellowish to reddish brown, the early portion usually darker in color; aperture at the base of the apertural face on the ventral side.

Greatest diameter of hypotype of figure 5, 0.35 mm., thickness 0.16 mm. Other hypotypes range from 0.18 to 0.31 mm. in greatest diameter.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2013) from station 51; unfigured hypotypes are recorded from stations 35, 36, 51, and 52.

TROCHAMMINA QUADRILOBA Höglund

Plate 7, figure 8

Trochammina pusilla Höglund, 1947 (not *Serpula pusilla* Geinitz, 1848), Zool. Bidrag Uppsala, vol. 26, p. 201, pl. 17, figs. 4a-c, text figs. 183, 184.
Trochammina quadriloba Höglund, 1948, Contr. Cushman Lab. Foram. Res., vol. 24, pt. 2, p. 46.

Test free, small, trochoid, high-spired, periphery rounded, margin lobulate; chambers increasing rapidly in size as added, strongly inflated, four in the final whorl; sutures fairly distinct, constricted; wall thin, finely arenaceous with medium-sized grains as well, surface usually rather smoothly finished, but occasional specimens have a rough exterior, color white to reddish brown, later chambers of lighter color than the early ones; aperture small, interio-marginal, an arched slit at the base of the last chamber.

Greatest diameter of figured hypotype 0.26 mm., height of spire 0.26 mm. Other hypotypes range from 0.16 to 0.23 mm. in maximum diameter.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2021) and unfigured hypotypes from station 36.

TROCHAMMINA ROTALIFORMIS Wright

Plate 8, figures 6-9

Trochammina rotaliformis Wright, *in* Heron-Allen and Earland, 1911, Journ. Roy. Micr. Soc., p. 309.—Cushman, 1920, U. S. Nat. Mus. Bull. 104, pt. 2, p. 77, pl. 16, figs. 1, 2; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 42, pl. 4, figs. 16a-c.

Test free, small to medium-sized, trochoid, concavo-convex, with low dorsal spire and excavated and umbilicate ventral side, periphery broadly rounded; chambers numerous, up to 3½ volutions visible dorsally, only the 5 to 6 of the last whorl visible ventrally with the final chamber occupying about one-third of the ventral side; sutures distinct, slightly depressed, radial and nearly straight ventrally, gently curved backward on the periphery on the dorsal side; wall finely arenaceous, with occasional larger grains, smoothly finished, white to reddish brown in color, the later chambers progressively lighter in color on each specimen; aperture an elongate ventral slit, at the base of the final chamber, extending from near the periphery into the umbilicus, partially covered by a flaplike covering from the final chamber.

Greatest diameter of hypotype of figure 8, 0.86 mm., height of spire 0.44 mm. Greatest diameter of hypotype of figure 6, 0.70 mm., height of spire 0.34 mm. Greatest diameter of hypotype of figure 9, 0.68

mm., and of hypotype of figure 7, 0.23 mm. Other hypotypes range from 0.44 to 0.81 mm. in maximum diameter.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2121a,b) from station 17; figured hypotype (U.S.N.M. No. P2122) from station 27; figured hypotype (U.S.N.M. No. P2123) from station 35; unfigured hypotypes are recorded from stations 17 and 35.

Genus TROCHAMMINELLA Cushman, 1943

TROCHAMMINELLA ATLANTICA F. Parker

Plate 7, figures 6, 7

Trochamminella atlantica F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 409, pl. 4, figs. 17-19.—Phleger, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 87, figs. 2, 4.

Test free, small, trochoid, ventrally umbilicate, periphery rounded, peripheral margin lobulate; chambers numerous, slightly inflated, increasing rapidly in size as added, 5-6 in the last whorl; sutures distinct, depressed, radial, nearly straight; wall thin, finely arenaceous, with occasional larger grains, smoothly finished, color yellowish to reddish brown, the later chambers progressively lighter in color; aperture ovate, interio-areal, slightly ventral in position with a distinct lip.

Greatest diameter of hypotype of figure 7, 0.34 mm., thickness 0.18 mm. Greatest diameter of hypotype of figure 6, 0.31 mm., thickness 0.18 mm. Other hypotypes range from 0.16 to 0.39 mm. in maximum diameter.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2022a,b) from station 26; unfigured hypotypes are recorded from stations 26, 31, 35, 36, 51, and 52.

Family Lagenidae

Genus ASTACOLUS Montfort, 1808

ASTACOLUS HYALACRULUS Loeblich and Tappan, new species

Plate 9, figures 1-4

Test free, large, robust, somewhat compressed, early portion close-coiled about the large globular proloculus, later portion uncoiling, but with chambers reaching back toward the coil on the inner margin, final chambers may become completely uniserial, periphery subacute; chambers numerous, about 7 surrounding the proloculus, followed by 3 or 4 which do not reach the coil in well-developed specimens, sutures distinct, visible through the somewhat translucent wall, gently

curved, oblique in uncoiled portion; wall calcareous, finely perforate, radiate, surface smooth; aperture radiate, at the dorsal angle.

Length of holotype 1.40 mm., greatest diameter of coil 0.52 mm., greatest breadth of uncoiled portion 0.49 mm., thickness 0.31 mm. Length of paratypes of figure 3, 0.34 mm., of figure 4, 0.70 mm., and of figure 1, 1.04 mm., breadth 0.52 mm. Other specimens range from 0.31 to 1.43 mm. in length.

Remarks.—This species resembles *Cristellaria berthelotiana* d'Orbigny, from the Canary Isles, in size and general proportions, but the present species is more enrolled at the base, and the later sutures are more nearly horizontal and the test is narrower in the uncoiled portion, but much less compressed.

Cristellaria crepidula (Fichtel and Moll) of Parker and Jones (1865, pl. 13, figs. 15, 16) is very similar, although the magnification given by Parker and Jones suggests that it is much larger than the present species. *A. hyalacrulus,* new species, is quite distinct from Fichtel and Moll's type figure however, as it is less compressed and less enrolled, and the later chambers do not extend as far back on the inner margin, but are higher and narrower and more nearly rectilinear.

Types and occurrence.—Holotype (U.S.N.M. No. P2039) from station 18; figured paratypes (U.S.N.M. Nos. P2040a-c) from station 3; unfigured paratypes are recorded from stations 1, 3, 12, 18, 20, 21, 23, 24, 29, 30, 31, 32, 38, 39, 42, 45, and 50.

ASTACOLUS species

Plate 9, figures 5, 6

Test free, small, ovate in outline, slightly compressed, periphery rounded; chambers few in number, in a somewhat evolute spiral, later chambers extending back toward the base on the inner margin, increasing more rapidly in breadth than in height; sutures distinct, but not depressed; wall calcareous, finely perforate, translucent, surface smooth; aperture radiate, at the somewhat produced dorsal angle.

Length of specimen of figure 5, 0.62 mm., breadth 0.29 mm., thickness 0.23 mm. Length of specimen of figure 6, 0.52 mm., breadth 0.26 mm., thickness 0.17 mm.

Remarks.—This species is similar to *Astacolus etigoensis* Asano from the Pliocene of Japan, but is less enrolled at the base, has a more elongate proloculus, and a narrower test with higher chambers. It differs from *A. planulatus* Galloway and Wissler from the Pleisto-

cene of California in being less enrolled, less compressed, and with a more-produced aperture.

This species somewhat resembles *Cristellaria tenuissima* Heron-Allen and Earland, from the region of the Falkland Islands, but is larger, less compressed, and more ovate in outline, with fewer chambers, and these higher and narrower and not extending as far back on the inner margin of the coil. It closely resembles the early portion of *Astacolus crepidulus* (Fichtel and Moll) in size and proportions but that species is from the Mediterranean, and it seems unlikely that the identical form would be found in the Arctic.

The present form is represented by only two specimens, and as it is not possible to determine if these are adults or juveniles (the small number of chambers suggesting the latter), it is not here specifically identified.

Types and occurrence.—Figured specimens (U.S.N.M. Nos. P2034a,b) from station 18.

Genus DENTALINA d'Orbigny, 1826

DENTALINA BAGGI Galloway and Wissler

Plate 9, figures 10-15

Nodosaria pauperata Bagg, 1912 (not *Dentalina pauperata* d'Orbigny, 1846), U. S. Geol. Surv. Bull. 513, p. 57, pl. 16, figs. 2a-f.

Nodosaria calomorpha Bagg, 1912 (not Reuss, 1866), ibid., p. 53, pl. 15, fig. 3.

Dentalina baggi Galloway and Wissler, 1927, Journ. Paleontol., vol. 1, p. 49, pl. 8, figs. 14, 15.—Cushman and Gray, 1946, Cushman Lab. Foram. Res. Spec. Publ. 19, p. 13, pl. 2, figs. 26, 27.—Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., vol. 6, No. 6, p. 313, pl. 41, figs. 13, 14.

Test free, very large, robust, base rounded and smooth; chambers up to 7 or 8 in number in the Arctic specimens, of nearly equal size throughout, sometimes slightly increasing in size as added, inflated centrally, lower than broad except for the final chamber which is of greater height than breadth; sutures distinct, nearly horizontal, slightly constricted; wall calcareous, finely perforate, opaque, smooth; aperture terminal, radiate, eccentric, slightly produced.

Length of hypotype of figure 10, 3.54 mm., breadth 0.70 mm. Length of hypotype of figure 11, 2.63 mm., breadth 0.62 mm. Length of hypotype of figure 12, 3.17 mm., breadth 0.81 mm. Length of hypotype of figure 13, 3.90 mm., breadth 0.91 mm. Length of hypotype of figure 14, 1.35 mm., breadth 0.68 mm. Length of hypotype of figure 15, 5.72 mm., breadth 0.88 mm. Other hypotypes up to 4.84 mm. in length.

Remarks.—The specimen figured by Bagg as *N. calomorpha* was a juvenile form similar to that shown in figure 14. The types of *D. baggi* were extremely long and well-developed specimens, those of Cushman and Gray were similar to the larger specimens here figured. It is also very similar to *D. pauperata* d'Orbigny, differing in the smooth, rounded base and absence of the apical spine of d'Orbigny's species.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2005) from station 3; figured hypotype (U.S.N.M. No. P2006) from station 4; figured hypotypes (U.S.N.M. Nos. P2007a-c) from station 21; figured hypotype (U.S.N.M. No. P2008) from station 31; unfigured hypotypes are recorded from stations 3, 12, 18, 21, 22, 26, 29, 31, 32, 39, 42, 49, and 56.

DENTALINA FROBISHERENSIS Loeblich and Tappan, new species

Plate 10, figures 1-9

Nodosaria mucronata (Neugeboren) CUSHMAN (part), 1923 (not *Dentalina mucronata* Neugeboren, 1856), U. S. Nat. Mus. Bull. 104, pt. 4, p. 80, pl. 12, figs. 5-7, pl. 13, figs. 7-9.

Dentalina sp. CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 45, pl. 5, fig. 6.

Test free, usually quite large, although small specimens occur which are similar in all other respects and may be megalospheric, straight to slightly arcuate, rounded in section; chambers numerous, up to about 15 in number, early ones very low and broad, increasing in proportionate height as added, later ones of equal height and breadth and slightly inflated and final chamber somewhat elongate, produced at the aperture; sutures distinct, horizontal to very slightly oblique, later ones slightly constricted; wall calcareous, perforate, smooth and translucent; aperture terminal, radiate, slightly eccentric, and toward the inner margin of the curved test.

Length of holotype of figure 9, 3.51 mm., breadth 0.65 mm. Length of paratype of figure 1, 1.87 mm., breadth 0.42 mm. Length of paratype of figure 6, 1.04 mm., breadth 0.23 mm. Length of paratype of figure 7, 0.81 mm., breadth 0.21 mm. Length of paratype of figure 8, 0.47 mm., breadth 0.13 mm. Length of paratype of figure 4, 2.25 mm., breadth 0.62 mm. Length of paratype of figure 3, 1.98 mm., breadth 0.44 mm. Length of paratype of figure 5, 1.43 mm., breadth 0.36 mm. Length of paratype of figure 2, 0.52 mm., breadth 0.13 mm. Other paratypes range from 0.81 to 4.73 mm. in length.

Remarks.—This species was recorded as *N. mucronata* (Neugeboren) by Cushman, 1923, but is more robust, with less-tapered base,

and a straight to slightly arcuate test rather than the sinuate one of Neugeboren's species from the Rumanian Tertiary. The chambers are lower and broader and the sutures horizontal in the present species rather than strongly oblique, and the apertural end is much less produced. Other Recent references to Neugeboren's species by Cushman, Brady, and Flint are apparently not the present species.

Types and occurrence.—Holotype (U.S.N.M. No. P2016) and figured paratypes (U.S.N.M. Nos. P2017a-d) from station 20; figured paratypes (U.S.N.M. Nos. P2018a,b) from station 3; figured paratype (U.S.N.M. No. P2019) from station 5; figured paratype (U.S.N.M. No. P2020) from station 21; unfigured paratypes are recorded from stations 4, 18, 20, 22, 26, 29, 32, 35, 39, and 42.

DENTALINA ITTAI Loeblich and Tappan, new species

Plate 10, figures 10-12

Dentalina cf. *calomorpha* (Reuss) CUSHMAN, 1948 (not *Nodosaria* (*Nodosaria*) *calomorpha* Reuss, 1866), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 44, pl. 5, figs. 4, 5.

Test free, narrow, elongate, arcuate; consisting of 2 to 6 elliptical chambers, of nearly equal diameter, slightly overlapping; sutures distinct, constricted, straight; wall calcareous, finely perforate, translucent, so that the neck and aperture of earlier chambers may sometimes be seen through the wall of that following, surface smooth and unornamented; aperture radiate, terminal and central in position, very slightly produced.

Length of holotype of figure 11, 0.91 mm., greatest breadth 0.16 mm. Length of paratype of figure 10, 1.01 mm., greatest breadth 0.18 mm. Length of paratype of figure 12, 0.68 mm., greatest breadth 0.18 mm.

Remarks.—Brady (1884) and Cushman (1913) recorded *Nodosaria calomorpha* Reuss from the western Pacific, and later Cushman (1948b) recorded the present Arctic form as *Dentalina* cf. *calomorpha* (Reuss). The present species is smaller than the Pacific deep-water form and the Pacific form has a few hispid spines. Both Recent species are arcuate, however, and rounded at both ends, with no basal spine or apertural neck. Reuss's species from the German middle Oligocene is a true *Nodosaria,* rectilinear in growth, with an apical spine, more inflated chambers, more constricted sutures, and a pyriform final chamber tapering to a small neck.

D. ittai, new species, also is similar to *Dentalina baggi* Galloway and Wissler, in general appearance, but is very much smaller than

the 4 to 7 mm. length of *D. baggi* and the chambers are more elongate. The present species is apparently restricted to the Arctic.

This species is named in honor of Miles Itta, Eskimo guide employed by the Naval Arctic Research Laboratory, Point Barrow, Alaska.

Types and occurrence.—Holotype (U.S.N.M. No. P1096) from station 22; figured paratype (U.S.N.M. No. P1097) from station 1; figured paratype (U.S.N.M. No. P1098) from station 18; unfigured paratypes are recorded from stations 13, 18, 20, 21, 22, 23, 26, 27, 29, 30, 31, 33, 35, 38, and 39.

DENTALINA MELVILLENSIS Loeblich and Tappan, new species

Plate 10, figure 13

Test free, tiny, elongate, circular in section; chambers low and subcylindrical, very slightly inflated, 3 to 6 in number, closely appressed; sutures distinct, straight, very slightly constricted; wall calcareous, finely perforate, translucent, surface smooth; aperture terminal, central, round.

Length of holotype 0.47 mm., breadth 0.10 mm. Other specimens range from 0.29 to 0.39 mm. in length.

Remarks.—This species somewhat resembles *D. ittai,* new species, with which it is associated, but chambers of the present form have about one-half the diameter of those of *D. ittai,* and they are lower and more closely appressed. It is similar to *D. baggi* Galloway and Wissler in appearance, but has a less-produced aperture, more horizontal sutures, lower and less inflated chambers, and is very minute in size.

Types and occurrence.—Holotype (U.S.N.M. No. P2032) from station 30; unfigured paratypes are recorded from stations 20, 21, and 26.

DENTALINA PAUPERATA d'Orbigny

Plate 9, figures 7-9

Dentalina pauperata d'Orbigny, 1846, Foraminifères fossiles du bassin tertiare . . . Vienne . . . , p. 46, pl. 1, figs. 57-58.

Nodosaria (D.) pauperata (d'Orbigny) Brady, 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 500, text fig. 14.

Nodosaria pauperata (d'Orbigny) Cushman, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 72, pl. 14, fig. 13.

Dentalina cf. *roemeri* Neugeboren, Cushman and Gray, 1946 (not Neugeboren, 1856), Cushman Lab. Foram. Res. Spec. Publ. 19, p. 13, pl. 2, figs. 19-22.

Dentalina sp. Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 45, pl. 5, fig. 7.

Test free, large and robust, nearly cylindrical, but slightly curved; chambers of about equal breadth and height, inflated at the midline, proloculus with a distinct basal spine, final chamber somewhat produced to the aperture; sutures distinct, slightly constricted, nearly horizontal; wall calcareous, finely perforate, surface smooth; aperture terminal, radiate, eccentric.

Length of hypotype of figure 9, 4.16 mm., breadth 0.60 mm. Length of hypotype of figure 7, 1.17 mm., breadth 0.36 mm. Length of hypotype of figure 8, 0.60 mm., breadth 0.23 mm. Other hypotypes range from 0.86 to 3.12 mm. in length.

Remarks.—The present specimens are apparently identical with the Recent ones figured by Brady and Cushman and no distinction can be made between these and the Miocene type of d'Orbigny.

This species differs from *Dentalina roemeri* Neugeboren from the Tertiary in being larger and much more robust, subcylindrical rather than tapering, with horizontal rather than oblique sutures and with an apiculate instead of a smoothly rounded base. The specimen figured by Cushman (1948b) appears to be symmetrical, like a *Nodosaria,* in his illustration, but this is because the drawing was made from the front instead of from the side which would have shown its eccentric aperture.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2009a,b) from station 20; figured hypotype (U.S.N.M. No. P2010) from station 35; unfigured hypotypes are recorded from stations 20, 21, 22, 26, 29, and 35.

Genus NODOSARIA Lamarck, 1812

NODOSARIA EMPHYSAOCYTA Loeblich and Tappan, new species

Plate 9, figures 16, 17

Test free, large and robust; proloculus rounded, followed by one or two additional subglobular chambers, all of nearly equal size, early chambers fairly closely appressed, third chamber of longer specimens frequently more distinctly separated, final chamber slightly produced at the aperture; sutures distinct, straight, that between second and third chambers much constricted; wall calcareous, finely perforate, surface smooth; aperture terminal, central, radiate.

Length of holotype 1.25 mm., breadth 0.39 mm. Length of figured paratype 0.78 mm., breadth 0.39 mm. Other paratypes range from 0.75 to 1.07 mm. in length.

Remarks.—This species is similar in appearance to *Dentalina subsoluta* (Cushman) but is rectilinear and not curved, the sutures are less

constricted, the basal spine is lacking and the neck less narrowed and produced. No specimens have been seen with more than three chambers and those with only two are more common.

Types and occurrence.—Holotype (U.S.N.M. No. P2011) from station 1; figured paratype (U.S.N.M. No. P2012) from station 3; unfigured paratypes are recorded from stations 1, 3, 5, 18, and 49.

Genus LAGENA Walker and Jacob, 1798

LAGENA APIOPLEURA Loeblich and Tappan, new species

Plate 10, figures 14, 15

Lagena sulcata (Walker and Jacob) Parker and Jones (part), 1865 (not *Serpula* (*Lagena*) *sulcata* Walker and Jacob, 1798), Philos. Trans. Roy. Soc. London, vol. 155, p. 351, pl. 13, figs. 28-31.

Lagena acuticosta Reuss, Brady (part), 1884 (not Reuss, 1862), Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 464, pl. 58, fig. 2 (not pl. 57, figs. 31, 32, and not pl. 58, fig. 20).—Cushman, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 23, pl. 8, fig. 9 (not fig. 10), pl. 23, fig. 2; 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 5, pl. 1, figs. 1-3.—Wiesner, 1931, Deutsche Südpolar Exped., 1901-1903, vol. 20 (Zoology, vol. 12), p. 117, pl. 18, figs. 208-210.—Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., vol. 6, No. 6, p. 329, pl. 43, figs. 9, 10.

Test free, unilocular (but occasional freak twins occur), ovate to pear-shaped in outline, with a rounded base, circular in section; wall calcareous, hyaline, finely perforate, translucent, surface ornamented with a few longitudinal rounded ribs extending upward from a tiny ring at the base, and merging into a smooth collar a short distance below the apertural neck; aperture at the end of the short smooth neck, rounded.

Length of holotype 0.47 mm., width 0.29 mm. Length of two-chambered paratype of figure 15, 0.62 mm., breadth of basal chamber 0.27 mm., breadth of second chamber 0.16 mm. Other paratypes range from 0.31 to 0.47 mm. in length.

Remarks.—This species has often been referred to other ribbed lagenids, but is distinct. It differs from *Serpula (Lagena) sulcata* Walker and Jacob, 1798, in having fewer ribs and a more pear-shaped outline with a shorter neck. *Lagena acuticosta* Reuss is a Cretaceous species with a flattened base and subglobular form and does not have the pyriform appearance of the present species. Wiesner (1931, pl. 18, fig. 210) showed a two-chambered form similar to that here figured.

Types and occurrence.—Holotype (U.S.N.M. No. P2116) from station 18; figured paratype (U.S.N.M. No. P2117) from station 18; unfigured paratypes are recorded from stations 18, 23, and 30.

LAGENA FLATULENTA Loeblich and Tappan, new species

Plate 11, figures 9, 10

Lagena laevis (Montagu) CUSHMAN, 1913 (not Montagu, 1803), U. S. Nat. Mus. Bull. 71, pt. 3, p. 5, pl. 38, fig. 5 (pl. 1, fig. 3 ?); 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 47, pl. 5, fig. 11.—CUSHMAN and MCCULLOCH, 1950 (part), Allan Hancock Pacific Exped., vol. 6, No. 6, p. 341, pl. 45, fig. 15 (not figs. 14, 16).

Lagena laevis (Montagu) var. CUSHMAN and GRAY, 1946, Cushman Lab. Foram. Res. Spec. Publ. 19, p. 18, pl. 3, figs. 24, 25.

Test free, unilocular, flask-shaped, with an elongate, narrow and delicate neck; wall calcareous, hyaline, surface smooth; aperture terminal, rounded, surrounded by a slight lip.

Length of holotype 0.65 mm., breadth 0.31 mm. Length of paratype 0.55 mm., breadth 0.29 mm. Other specimens range in length from 0.49 to 0.68 mm.

Remarks.—This species has often been confused with *L. laevis* (Montagu), but has a nearly globular inflated chamber. Montagu's type is elongate and slender, almost fusiform in outline, and merges gradually into the neck. *Lagena flatulenta,* new species, has an almost globular chamber from which the long, slender neck is quite distinct.

The specimen figured by Cushman (1913, pl. 1, fig. 3) is similar, but shows only a short neck.

Types and occurrence.—Holotype (U.S.N.M. No. P2052) and figured paratype (U.S.N.M. No. P2053) from station 22; unfigured paratypes are recorded from stations 13, 20, 22, 23, 26, 39, and 45.

LAGENA GRACILLIMA (Seguenza)

Plate 11, figures 1-4

Amphorina gracillima SEGUENZA, 1862, Descrizione dei foraminiferi monotalamici Marne mioceniche . . . Messina . . . , Diss. 2, p. 51, pl. 1, fig. 37.

Amphorina distorta SEGUENZA, 1862, ibid., p. 52, pl. 1, fig. 38.

Lagena gracillima (Seguenza) BRADY, 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 456, pl. 56, figs. 19-28.—CUSHMAN, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 11, pl. 1, fig. 4; 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 23, pl. 4, fig. 5.

Test free, unilocular, narrow, elongate, fusiform, straight to slightly arcuate, with a long, apiculate base and a long, narrow neck at the opposite extremity; wall calcareous, hyaline, finely perforate, surface smooth; aperture terminal, rounded, at the end of the smooth, narrow, tubular neck and surrounded by a slight lip.

Length of hypotype of figure 1, 0.78 mm., breadth 0.18 mm. Length of hypotype of figure 4, 0.60 mm., breadth 0.21 mm. Length of hypo-

type of figure 2, 0.81 mm., breadth 0.26 mm. Length of hypotype of figure 3, 1.04 mm., breadth 0.29 mm. Unfigured hypotypes range from 0.52 to 1.01 mm. in length.

Remarks.—Seguenza described the symmetrical form as *Amphorina gracillima,* and an asymmetrical one (like fig. 1) as *A. distorta.* Both were from the same horizon and locality (upper Miocene of Sicily), the former described as common, the latter rare.

Brady placed two asymmetrical specimens with the symmetrical ones in *Lagena gracillima* (Seguenza). We have numerous asymmetrical specimens and they seem to grade imperceptibly into the symmetrical forms.

Lagena distoma-polita Parker and Jones is also similar, but has straighter sides and a more rhomboid side view. The present species is about one-third smaller.

This species resembles *Lagena laevis* (Montagu) var. *amphora* Williamson, 1848, but differs in having a more prominent basal spine. *Lagena clavata* (d'Orbigny) is also similar, but has a more inflated chamber and less extended basal spine.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2094) from station 20; figured hypotype (U.S.N.M. No. P2095) from station 32; figured hypotype (U.S.N.M. No. P2096) from station 46; figured hypotype (U.S.N.M. No. P2097) from station 50; unfigured hypotypes are recorded from stations 13, 15, 17, 18, 20, 21, 22, 23, 26, 30, 32, and 42.

LAGENA LAEVIS (Montagu)

Plate 11, figures 5-8

Vermiculum laeve Montagu, 1803, Testacea Britannica, p. 524.

Lagena vulgaris Williamson, 1858, Recent Foraminifera of Great Britain, p. 3, pl. 1, figs. 5, 5a.—Cushman and Gray, 1946, Cushman Lab. Foram. Res. Spec. Publ. 19, p. 18, pl. 3, figs. 28-30.

Lagena sulcata Walker and Jacob var. *laevis* (Montagu) Parker and Jones, 1865, Philos. Trans. Roy. Soc. London, vol. 155, p. 349, pl. 13, fig. 22 (called *Lagena laevis* on plate description).

Lagena laevis (Montagu) Cushman and Gray, 1946, Cushman Lab. Foram. Res. Spec. Publ. 19, p. 18, pl. 3, figs. 21-23.—Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., vol. 6, No. 6, p. 341, pl. 45, figs. 14, 16 (not fig. 15).

Test free, unilocular, flask-shaped, somewhat elongate, widest slightly below the midportion of the test, base rounded; wall calcareous, hyaline, finely perforate, surface smooth except occasionally very slightly and finely hispid at the base, but without distinct spines;

upper portion of the test tapering gradually to the very elongate and slender neck upon which is situated the rounded aperture.

Length of hypotype of figure 6, 0.83 mm., breadth 0.23 mm. Length of hypotype of figure 8, 0.65 mm., breadth 0.26 mm. Length of hypotype of figure 5, 0.70 mm., breadth 0.34 mm. Length of hypotype of figure 7, 0.86 mm., breadth 0.31 mm.

Remarks.—This species is more slender than *L. flatulenta,* new species, with which it is sometimes associated, and with which it has sometimes been confused in the past. *Lagena vulgaris* is an objective synonym of *L. laevis,* Williamson having proposed changing the name to *vulgaris* so as to include variously ornamented forms in the same species.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2077) from station 20; figured hypotype (U.S.N.M. No. P2078) from station 30; figured hypotypes (U.S.N.M. Nos. P2079a,b) from station 51; unfigured hypotypes are recorded from stations 3, 5, 12, 18, 20, 22, 29, 30, 38, 39, and 44.

LAGENA MERIDIONALIS Wiesner

Plate 12, figure 1

Lagena caudata (d'Orbigny) Parker and Jones, 1865 (part) (not *Oolina caudata* d'Orbigny, 1839), Philos. Trans. Roy. Soc. London, vol. 155, p. 352, pl. 16, fig. 7.

Lagena gracilis Williamson, Brady, 1884 (part), Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 464, pl. 58, fig. 19 (not figs. 22-24).

Lagena gracilis Williamson var. Cushman, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 25, pl. 8, fig. 7.

Lagena gracilis Williamson var. *meridionalis* Wiesner, 1931, Deutsche Südpolar-Exped. 1901-1903, vol. 20 (Zoology, vol. 12), p. 117, pl. 18, fig. 211.

Test free, unilocular, elongate-ovate, with rounded base, sometimes slightly bent and asymmetrical, lower three-fourths is regularly ovate, followed by a slight constriction, and then a somewhat narrowed upper one-fourth just below the short apertural neck; wall calcareous, hyaline, finely perforate, surface ornamented with numerous fine longitudinal costae, about 16 to 20, of which every second one is shorter, stopping at the constriction in the upper portion of the test, the remaining half continuing across the narrower upper portion to stop at the base of the smooth neck; aperture simple, terminal, rounded, on a smooth short neck.

Length of figured hypotype 0.44 mm., breadth 0.16 mm. Other hypotypes range from 0.29 to 0.49 mm. in length.

Remarks.—Parker and Jones referred this species to *L. caudata* (d'Orbigny), but the latter is more flask-shaped in outline, has an apical spine and a more elongate and slender neck. Wiesner defined the variety as differing from the species *L. gracilis* in the alternation of long and shorter ribs. As *L. gracilis* is fusiform in outline, with an apiculate base and very elongate neck, the "variety" is here raised to specific rank.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2080) from station 20; unfigured hypotypes are recorded from stations 20, 21, 22, 29, 30, 31, 32, 39, 42, and 45.

LAGENA MOLLIS Cushman

Plate 11, figures 25-27

Lagena gracillima (Seguenza) var. *mollis* CUSHMAN, 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 21, pl. 3, fig. 3.

Test free, unilocular, elongate-fusiform in outline, with a basal spine and an extremely long and slender neck at the opposite end, sides nearly parallel over the central portion of the test; wall calcareous, hyaline, finely perforate, ornamented with numerous very fine longitudinal ribs which die out at the beginning of the neck; aperture terminal, surrounded by a flared lip, at the end of a long, slender and smooth neck.

Length of hypotype of figure 25, 0.55 mm., greatest breadth 0.13 mm. Length of hypotype of figure 26, 0.60 mm., greatest breadth 0.08 mm. Length of hypotype of figure 27, 0.50 mm., greatest breadth 0.10 mm. Other hypotypes range from 0.39 to 0.73 mm. in length.

Remarks.—Cushman's complete description of this form stated, "Variety differing from the typical in the very fine, longitudinal costae on the surface." Cushman's illustrations do not show very clearly the fine striae characteristic of this species.

The writers have separated the present form as a distinct species, however, as it has a Recent Arctic and sub-Arctic range, and *L. gracillima* was from the Miocene of Sicily. It seems much more probable that the similar outline is accidental rather than the identical species being smooth in one environment and geologic period and ribbed at another time and region.

Lagena distoma Parker and Jones, 1864, may be the same as this species, and if so it would take priority. It is of similar size, shape, and ornamentation, but was described as having an aperture at each end. This assumption was undoubtedly due to the fact that the basal

spine and the elongate neck were broken, and a complete specimen might well be identical with *L. mollis*.

Lagena mollis Cushman differs from *L. gracilis* Williamson, 1848, in possessing many more fine ribs and in being less fusiform. *Lagena vulgaris* var. *gracilis* Williamson, 1858, possesses only a few distinct ribs, instead of the many fine ones of *L. mollis*. *Lagena laevis* (Montagu) var. *amphora* Williamson, and *L. elongata* Ehrenberg are similar to *L. mollis* in shape, but they are smooth forms.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2041 a-c) from station 20; unfigured hypotypes are recorded from stations 13, 15, 16, 18, 20, 21, 22, 23, 26, 32, and 39.

LAGENA PARRI Loeblich and Tappan, new species

Plate 11, figures 11-13

Lagena laevis (Montagu) var. *baggi* Cushman and Gray, Cushman and McCulloch, 1950 (not Cushman and Gray, 1946), Allan Hancock Pacific Exped., vol. 6, No. 6, p. 342, pl. 45, fig. 17.

Test free, unilocular, flask-shaped to ovate, widest in the lower half of the test, with a single distinct basal spine, and a long, very slender neck; wall calcareous, hyaline, finely perforate, surface smooth; aperture terminal on the long, delicate neck.

Length of holotype 0.68 mm., breadth 0.26 mm. Length of paratype of figure 12, 0.65 mm., breadth 0.29 mm. Length of paratype of figure 13, 0.68 mm. Other specimens range from 0.65 to 0.75 mm. in length.

Remarks.—Cushman and McCulloch (1950, pl. 45, fig. 17) figured a slender-necked apiculate specimen and referred it to *L. laevis* var. *baggi* Cushman and Gray. The type of the variety has an inconspicuous spine, almost obsolete, and has a short and thicker neck with a definite lip.

Lagena parri, new species, resembles *Oolina clavata* d'Orbigny in possessing the smooth test, elongate neck, and basal spine, but d'Orbigny's species is fusiform in outline rather than globose.

Lagena ? sphaerula Silvestri is similar, but has a more globular test and a more elongate basal spine.

The species is named in honor of the late Walter J. Parr, in recognition of his work on the lagenoid Foraminifera.

Types and occurrence.—Holotype (U.S.N.M. No. P2054) from station 32; figured paratype (U.S.N.M. No. P2055) from station 20; figured paratype (U.S.N.M. No. P2056) from station 21; unfigured paratypes are recorded from stations 20 and 21.

LAGENA SEMILINEATA Wright

Plate 11, figures 14-22

Lagena semilineata Wright, 1886, Proc. Belfast Nat. Field Club, n. s., vol. 1, app. 9, p. 320, pl. 26, fig. 7.—Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., vol. 6, No. 6, p. 345, pl. 46, fig. 11.

Lagena sulcata Walker and Jacob var. *semistriata* Williamson, Parker and Jones, 1865 (not *L. striata* (Montagu) var. *β semistriata* Williamson, 1848), Philos. Trans. Roy. Soc. London, vol. 155, p. 350, pl. 13, fig. 23.

Lagena caudata (d'Orbigny) Cushman, 1948 (not d'Orbigny, 1839), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 46, pl. 5, figs. 8, 9.

Test free, unilocular, flask-shaped, widest near the apiculate base, somewhat tapered at the upper portion and grading into a very long, slender and delicate neck; wall calcareous, hyaline, finely perforate, the upper one-half to two-thirds of the test is smooth, the lower portion ornamented with fine costae, which double in number by intercalation a short distance from the base, but in occasional specimens the intercalary costae apparently did not develop, so that fewer costae are present (fig. 19), a delicate basal spine of about one-half the diameter of the neck is present on well-preserved specimens, but more usually broken off; aperture terminal, surrounded by a slight lip, and at the end of a long, slender neck of a length about two-thirds that of the chamber itself.

Length of hypotype of figure 17, 0.60 mm., breadth 0.23 mm. Length of hypotype of figure 16, 0.62 mm., breadth 0.23 mm. Length of hypotype of figure 14, 0.62 mm., breadth 0.23 mm. Length of hypotype of figure 19, 0.65 mm., breadth 0.24 mm. Length of hypotype of figure 15, 0.68 mm., breadth 0.21 mm. Other hypotypes range from 0.47 to 0.83 mm. in length.

Remarks.—This species was described from the coast of Ireland, and also reported from the coast of Scotland. Cushman recorded this species as *L. caudata* (d'Orbigny) from off Greenland, but d'Orbigny's species from off the Falkland Islands is a much smaller form, about one-sixth the size of the present species.

Parker and Jones (1865, p. 350, pl. 13, fig. 23) figured a very similar specimen, referring it to *L. sulcata* var. *semistriata* Williamson. Williamson defined *L. striata* (Montagu) var. *β semistriata,* but this is a more globose form, and lacks a basal spine. Parker and Jones's figure shows a suggestion of a broken basal spine, but an examination of the actual specimen will be necessary to determine whether it has a spine.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2083 a,b) from station 20; figured hypotypes (U.S.N.M. Nos. P2084a-d)

from station 21; figured hypotypes (U.S.N.M. Nos. P2085a,b) from station 22; figured hypotype (U.S.N.M. No. P2086) from station 23; unfigured hypotypes are recorded from stations 1, 13, 17, 18, 20, 21, 22, 23, 26, 27, 29, 30, 31, 32, 39, and 42.

LAGENA SETIGERA Millett

Plate 11, figures 23, 24

Lagena clavata (d'Orbigny) var. *setigera* Millett, 1901, Journ. Roy. Micr. Soc. London, pt. 11, p. 491, pl. 8, fig. 9.

Lagena perlucida (Montagu) var. Cushman and McCulloch, 1950 (not *Vermiculum perlucidum* Montagu, 1803), Allan Hancock Pacific Exped., vol. 6, No. 6, p. 343, pl. 46, figs. 3, 4.

Test free, unilocular, circular in section, globose to flask-shaped in outline; wall calcareous, hyaline, surface smooth, with a flattened base surrounded by a circlet of very tiny spines, which may easily be overlooked and in some specimens the spines are rudimentary or broken, so that only a ringlike scar marks their position; aperture terminal, surrounded by a thickened lip, at the end of a very elongate, slender and smooth neck.

Length of hypotype of figure 24, 0.52 mm., breadth 0.29 mm. Length of hypotype of figure 23, 0.55 mm., breadth 0.26 mm.

Remarks.—In describing this form as a variety, Millett stated, "Differs from the type in having at the aboral end a cup-shaped indentation surrounded by a circle of setae.

"In *Oolina striaticollis* d'Orbigny, and some of the figures of *Lagena tenuis* Bornemann, as interpreted by Reuss, the free ends of the ribs extend beyond the base of the shell and have a similar appearance; but in the variety under consideration the ribs are entirely wanting." *Oolina striaticollis* also differs from the present species in having a shorter neck, and in the neck being ornamented with spiraling striae.

Lagena tenuis (Bornemann) var. *ornata* Reuss, 1863, has a long smooth neck, but has a more slender and elongate chamber and the basal spines grade into costae on the basal portion of the chamber.

Millett's variety is here raised to specific rank, as d'Orbigny's type of *Oolina clavata* from the Tertiary of the Vienna Basin has a single central basal spine, rather than a depressed or flattened base surrounded by spines.

The specimens referred to *Lagena perlucida* (Montagu) var. by Cushman and McCulloch belong with this species. *Vermiculum perlucidum* Montagu has vertical costae covering the complete test.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2075) from station 18; figured hypotype (U.S.N.M. No. P2076) from station 29; unfigured hypotypes are recorded from stations 20, 21, 29, 30, 31, 32, 35, 39, and 42.

Genus OOLINA d'Orbigny, 1839

OOLINA CAUDIGERA (Wiesner)

Plate 13, figures 1-3

Lagena (*Entosolenia*) *globosa* (Montagu) var. *caudigera* Wiesner, 1931, Deutsche Südpolar-Exped., 1901-1903, vol. 20 (Zoology, vol. 12), p. 119, pl. 18, fig. 214.

Lagena (*Entosolenia*) *ovata* (Terquem) var. *caudigera* Wiesner, 1931, ibid., p. 119, pl. 18, fig. 215.

Entosolenia lineata Williamson, Cushman, 1948 (not Williamson, 1848), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 64, pl. 7, fig. 5.

Test free, unilocular, globular to ovate, with a long, narrow basal spine; wall calcareous, hyaline, finely perforate, surface smooth; aperture terminal, rounded, with radial grooves extending a short distance down the side from the aperture, and with a very long entosolenian tube extending almost through the entire chamber cavity and slightly expanded at its lower extremity.

Length of hypotype of figure 3, 0.36 mm., breadth 0.23 mm. Length of hypotype of figure 1, 0.36 mm., breadth 0.29 mm. Length of hypotype of figure 2, 0.55 mm., breadth 0.39 mm. Other specimens range from 0.23 to 0.55 mm. in length.

Remarks.—Wiesner described a globular form (like that of fig. 1) as *Lagena globosa* var. *caudigera,* and an ovate specimen (like that of fig. 2) as *L. ovata* var. *caudigera,* thus making a homonym of the latter. We believe both to be merely individual variations, and are also raising the variety to specific rank.

Smooth, extremely hyaline specimens of this species were referred to *Entosolenia lineata* Williamson by Cushman (1948b, p. 64), but the latter species as described by Williamson is covered with exceedingly fine parallel longitudinal striae. Cushman's figure shows a smooth test, and this is borne out by his type specimen. *Entosolenia lineata* of Williamson has a straight internal tube that nearly reaches the base of the shell and is described as being slightly patulous at the base of the tube. In the specimen figured by Cushman (1948b, pl. 7, fig. 5) the internal tube is very short, but as the test agrees in form with several other specimens identified as this species by Cushman it is probable that an abnormal or damaged specimen was figured. The

other specimens in Cushman's collection do have long internal tubes running nearly to the base of the test and expanded at the lower extremity.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1093) from station 12; figured hypotype (U.S.N.M. No. P1094) from station 18; figured hypotype (U.S.N.M. P1095) from station 22; unfigured hypotypes are recorded from stations 1, 3, 4, 5, 6, 8, 9, 10, 12, 13, 18, 19, 20, 21, 22, 23, 26, 28, 29, 30, 32, 35, 38, 39, 42, and 50.

OOLINA COSTATA (Williamson)

Plate 13, figures 4-6

Entosolenia costata Williamson, 1858, Recent Foraminifera of Great Britain, p. 9, pl. 1, fig. 18.

Lagena costata (Williamson) Cushman, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 12, pl. 1, fig. 16, pl. 2, figs. 1, 2 (not pl. 3, fig. 8); 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 21, pl. 3, fig. 4.—Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., vol. 6, No. 6, p. 335, pl. 44, fig. 7.

Oolina costata (Williamson) F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 409, pl. 4, figs. 20, 21.

Test free, ovate in outline, somewhat broader at the base; wall calcareous, finely perforate, surface ornamented with about 12 to 17 well-separated, narrow longitudinal ribs which begin near a circular projecting area at the base, and extend up the sides, grading into a smooth area surrounding the aperture; aperture terminal, slightly produced, radiate, with an internal tube.

Length of hypotype of figure 4, 0.88 mm., breadth 0.60 mm. Length of hypotype of figure 6, 0.75 mm., breadth 0.52 mm. Length of bilocular freak 1.12 mm., breadth 0.47 mm. Other hypotypes range from 0.39 to 0.78 mm. in length.

Remarks.—Although originally defined as *Entosolenia costata* this species has been widely recorded as *Lagena*. The presence of an internal tube makes that designation erroneous. The aberrant bilocular form shown in figure 5 is rare, but a similar specimen of this species was figured by Balkwill and Wright (1882), and refigured by Cushman (1923). Occasional bilocular forms are also found in other unilocular species.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2042a,b) from station 26; figured hypotype (U.S.N.M. No. P2043) from station 7; unfigured hypotypes are recorded from stations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 18, 19, 21, 22, 23, 26, 27, 28, 29, 30, 31, 32, 39, 42, and 50

OOLINA HEXAGONA (Williamson)

Plate 14, figures 1, 2

Entosolenia squamosa (Montagu) var. γ *hexagona* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 20, pl. 2, fig. 23; 1858, Recent Foraminifera of Great Britain, p. 13, pl. 1, fig. 32.

Lagena hexagona (Williamson) Brady, 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 472, pl. 58, figs. 32, 33.—Cushman, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 17, pl. 6, figs. 2, 3; 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 24, pl. 4, fig. 6.

Lagena favosa Reuss, 1863, Sitzb. Akad. Wiss. Wien, math.-nat. Kl., vol. 46, Abt. 1 (1862), p. 334, pl. 5, figs. 72, 73.

Test free, unilocular, ovate in outline, with a somewhat produced neck; wall calcareous, hyaline, surface ornamented with many tiny hexagonal reticulations which give a honeycombed appearance; aperture terminal, rounded, small, at the end of a short, smooth, cylindrical neck, and with an internal entosolenian tube.

Length of hypotype of figure 1, 0.37 mm., breadth 0.23 mm. Length of hypotype of figure 2, 0.42 mm., breadth 0.26 mm. Other hypotypes range from 0.29 to 0.44 mm. in length.

Remarks.—Oolina hexagona (Williamson) is similar to *Lagena cellularis* Silvestri, but differs in having the depressions more hexagonal in outline rather than diamond-shaped. The species *Lagena favosa* Reuss was based on specimens from the Shetland Islands, but Reuss's figures of the species were copied from Williamson and thus Reuss's species is here considered a junior synonym of *O. hexagona* (Williamson).

Williamson described this species as a variety of *Entosolenia squamosa* (Montagu) and characterized it as having hexagonal areas "not arranged in well-marked perpendicular rows." It is interesting to note that Cushman (1948b, p. 64, pl. 7, fig. 6) elevates *hexagona* to species rank, but makes the variety named by Williamson (1848, p. 20) as *Entosolenia squamosa* var. *scalariformis* a variety of *Entosolenia hexagona.* The "variety" *scalariformis* of Williamson, with its regularly arranged rows of reticulations, is certainly not closely related to *Oolina hexagona* and should not be associated as a variety of *hexagona.*

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2093a,b) from station 18; unfigured hypotypes are recorded from stations 1, 13, 18, 21, 22, 29, 30, and 32.

OOLINA LINEATA (Williamson)

Plate 13, figures 11-13

Entosolenia lineata Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 18, pl. 2, fig. 18.

Entosolenia globosa (Montagu) var. *lineata* Williamson, Williamson, 1858, Recent Foraminifera of Great Britain, p. 9, pl. 1, fig. 17.

Lagena lineata (Williamson) Brady, 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 461, pl. 57, fig. 13.—Cushman, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 31, pl. 5, fig. 10, pl. 6, figs. 5-8.

not *Entosolenia lineata* Williamson, Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 64, pl. 7, fig. 5.

Test free, unilocular, globose to ovate, with a small basal spine; wall calcareous, hyaline, finely perforate, surface covered with numerous very fine and very closely spaced longitudinal striae; aperture terminal, rounded, surrounded by the more prominent ends of the longitudinal striae, and with an internal entosolenian tube.

Length of hypotype of figure 13, 0.47 mm., breadth 0.37 mm. Length of hypotype of figure 11, 0.29 mm., breadth 0.21 mm. Other specimens range from 0.23 to 0.55 mm. in length.

Remarks.—The specimen referred to this species by Cushman in 1948 is smooth and unornamented, and we consider it to belong to *O. caudigera* (Wiesner). Williamson's type is very finely striate, as are the present figured specimens.

Types and occurrence.—Hypotype of figure 12 (U.S.N.M. No. P2087) from station 7; hypotype of figure 13 (U.S.N.M. No. P2088a) from station 29; hypotype of figure 11 (U.S.N.M. No. P2088b) from station 29; unfigured hypotypes are recorded from stations 29, 30, 31, 39, and 42.

OOLINA LINEATO-PUNCTATA (Heron-Allen and Earland)

Plate 13, figure 8

Lagena globosa (Montagu) var. *lineato-punctata* Heron-Allen and Earland, 1922, British Antarctic Exped., 1910, Nat. Hist. Rep., Zool., vol. 6, No. 2, p. 142, pl. 5, figs. 12-14.

Test free, unilocular, globose to ovate, with broadly rounded base and somewhat protruding neck; wall calcareous, hyaline, with many fine pits in the surface, closely arranged in vertical rows; aperture terminal, rounded, on a slight neck, with an entosolenian tube in the interior of the test.

Length of figured hypotype 0.42 mm., breadth 0.31 mm. Length of unfigured hypotypes range from 0.36 to 0.39 mm., and breadth from 0.31 to 0.34 mm.

Remarks.—Heron-Allen and Earland's type is from off the coast of New Zealand, but the present specimens appear the same in all respects.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2068) from station 1; unfigured hypotypes are recorded from stations 1 and 39.

OOLINA MELO d'Orbigny

Plate 12, figures 8-15

Oolina melo d'Orbigny, 1839, Voyage dans l'Amérique méridionale, Foraminifères, vol. 5, pt. 5, p. 20, pl. 5, fig. 9.

Entosolenia squamosa (Montagu) var. *catenulata* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 19, pl. 2, fig. 20; 1858, Recent Foraminifera of Great Britain, p. 13, pl. 1, fig. 31.

Entosolenia squamosa (Montagu) var. *scalariformis* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 20, figs. 21, 22.

Lagena squamosa (Montagu) Brady, 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 471, pl. 58, figs. 28-31.

Lagena catenulata (Williamson) Cushman, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 9, pl. 1, fig. 11.

Entosolenia hexagona Williamson var. *scalariformis* Williamson, Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 64, pl. 7, fig. 6.

Test free, unilocular, although occasional twinned specimens occur in this as in many similar species, ovate in outline, with a rounded base and slightly produced apertural end; wall calcareous, hyaline, finely perforate, surface ornamented with vertical and horizontal ridges, forming a surface network, the vertical rows of cancellations ranging from 8 to 19 in number, sometimes dividing or combining halfway up the test, and the horizontal divisions range from 4 to 11 in number and usually alternating rather than continuous around the test, so that at times the pits appear hexagonal, although the vertical costae are usually straight and more prominent; aperture terminal, rounded, slightly produced on a short tubular neck, and with an internal entosolenian tube.

Length of hypotype of figure 12, 0.39 mm., breadth 0.29 mm. Length of hypotype of figure 10, 0.36 mm., breadth 0.29 mm. Length of hypotype of figure 13, 0.39 mm., breadth 0.29 mm. Length of hypotype of figure 8, 0.36 mm., breadth 0.29 mm. Length of hypotype of figure 14, 0.44 mm., breadth 0.39 mm. Length of hypotype of figure 9, 0.39 mm., breadth 0.31 mm. Other hypotypes range in length from 0.21 to 0.55 mm.

Remarks.—This species has been much subdivided and variously known, *Lagena squamosa* (Montagu) being used for the forms with

many cancelli, the var. *scalariformis* Williamson for those with large cancelli in a small number of vertical rows, and *Entosolenia catenulata* Williamson [or *Lagena catenulata*] used for those with many vertical rows of small cancelli.

Brady in 1884 (p. 471) noted that the form referred to the species *catenulata* was identical with *Lagena melo* (d'Orbigny), and Heron-Allen and Earland (1922, p. 152) also considered it synonymous. They separated as a distinct species the form referred to *catenulata* of Williamson by Reuss, 1863, and credited the species to *Lagena catenulata* Reuss. This is an erroneous use of the name as Reuss did not use *catenulata* as a new specific name, and it can be used only for the species containing Williamson's type. Chapman and Parr (1937, p. 65) therefore renamed Reuss's species *Lagena pseudocatenulata.*

Brady considered *squamosa* as synonymous with its varieties *catenulata* and *scalariformis,* but he separated the variety *hexagona* as a distinct species. The present writers believe the forms described by Williamson as varieties *catenulata* and *scalariformis* to be merely end members of a gradational series. We have seen specimens with 8, 9, 10, 12, 13, 14, 16, 17, and 19 vertical rows of cancellations, and in some specimens two of the rows may combine into a single row halfway up the test. This evidence of gradation leads us to combine all these forms under the name *Oolina melo* d'Orbigny.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2127a,b) from station 1; figured hypotypes (U.S.N.M. Nos. P2128a-c) from station 6; figured hypotype (U.S.N.M. No. P2129) from station 10; figured hypotype (U.S.N.M. No. P2130) from station 29; figured hypotype (U.S.N.M. No. P2131) from station 31; unfigured hypotypes are recorded from stations 1, 4, 5, 6, 7, 9, 10, 12, 16, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 39, 42, 45, and 50.

OOLINA SCALARIFORME-SULCATA (Wiesner)

Plate 13, figure 7

Lagena (*Entosolenia*) *scalariforme-sulcata* Wiesner, 1931, Deutsche Südpolar-Exped., 1901-1903, vol. 20 (Zoology, vol. 12), p. 120, pl. 18, fig. 219.

Test free, small, unilocular, ovate in outline or rounded at the base, with somewhat truncated sides sloping to the aperture; wall calcareous, hyaline, surface of the lower half of the test ornamented with 8 to 13 longitudinal costae, grading into hexagonal or polygonal reticulations in the upper portion of the test, with larger and more regular polygons near the midline passing into smaller and less regularly arranged reticulations near the aperture; aperture terminal,

rounded, surrounded by a smooth lip, without a distinct neck, but with an internal entosolenian tube.

Length of hypotype 0.36 mm., breadth 0.26 mm.

Remarks.—This species differs from *O. squamoso-sulcata* (Heron-Allen and Earland), in averaging fewer ribs in the lower portion, more truncated sides in the upper portion, and more irregular and smaller reticulations.

Type and occurrence.—Figured hypotype (U.S.N.M. No. P2069) from station 30.

OOLINA SQUAMOSA (Montagu)

Plate 13, figures 9, 10

Vermiculum squamosum MONTAGU, 1893, Testacea Britannica, p. 526, pl. 14, fig. 2.

Entosolenia squamosa (Montagu) WILLIAMSON, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 18, pl. 2, fig. 19.—CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 64.

Lagena squamosa (Montagu) CUSHMAN, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 51, pl. 10, fig. 3 (not fig. 4 = *Oolina hexagona*).

not *Lagena squamosa* (Montagu) CUSHMAN, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 16, pl. 6, fig. 1 [= *Oolina hexagona?*].

not *Entosolenia squamosa* (Montagu) CUSHMAN, 1941, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 36, pl. 9, fig. 13.—CUSHMAN and GRAY, 1946, Cushman Lab. Foram. Res. Spec. Publ. 19, p. 31, pl. 5, figs. 37-39 [all = *Oolina melo*].

not *Entosolenia squamosa* (Montagu) CUSHMAN and TODD, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 66, pl. 15, fig. 27 [= *Oolina hexagona*].

Test free, unilocular, ovate, with rounded base and slightly produced apertural end; wall calcareous, hyaline, ornamented with numerous fine cancelli, only slightly depressed, and with the pits rounded; aperture terminal, rounded, only slightly produced, with an internal entosolenian tube.

Length of hypotype of figure 10, 0.29 mm., breadth 0.23 mm. Length of hypotype of figure 9, 0.36 mm., breadth 0.31 mm. Other hypotypes range in length from 0.26 to 0.42 mm.

Remarks.—This species has often been confused with *Oolina melo* and *Oolina hexagona,* but differs in having less regularly arranged cancelli, and in having rounded pits rather than rectangular or hexagonal ones, and the pits are usually of much smaller size in the present species.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2132) from station 18; figured hypotype (U.S.N.M. No. P2133) from

station 20; unfigured hypotypes are recorded from stations 1, 12, 18, 20, 21, 29, 30, 32, 35, 39, and 42.

OOLINA SQUAMOSO-SULCATA (Heron-Allen and Earland)

Plate 12, figures 6, 7

Lagena melo (d'Orbigny) (intermediate var.) Brady, Parker and Jones, 1888, Trans. Zool. Soc. London, vol. 12, p. 237, pl. 44, fig. 25.

Lagena squamoso-sulcata Heron-Allen and Earland, 1922, British Antarctic Exped., 1910, Nat. Hist. Rep., Zool., vol. 6, No. 2, p. 151, pl. 5, figs. 15, 19.

Test free, unilocular, inflated, ovate in outline, widest at the base and tapering somewhat toward the aperture, circular in section; wall calcareous, hyaline, finely perforate, the lower one-half ornamented by about 12 to 20 longitudinal ribs, which are connected in the upper half of the test by many slightly arched transverse costae, so that the upper portion of the test is reticulate in appearance; aperture terminal, rounded, surrounded by a slight lip, and a short, smooth collar, but without a distinct neck, an entosolenian tube occurs in the center of the chamber cavity and can be seen through the wall of some of the translucent specimens.

Length of hypotype of figure 7, 0.44 mm., breadth 0.34 mm. Length of hypotype of figure 6, 0.44 mm., breadth 0.34 mm.

Remarks.—Lagena (*Entosolenia*) *scalariforme-sulcata* Wiesner, 1931, is a similar form, with costae in the lower half and reticulations in the upper half. It differs in being more acuminate at the oral end, and in having hexagonal reticulations, whereas in the present species there are continuous vertical ribs, which are joined by arched transverse ribs in the upper portion.

The present species is here placed in *Oolina,* as a distinct entosolenian tube can be seen on some of the more translucent specimens.

One of the specimens has 12 vertical ribs, another 13. Heron-Allen and Earland's type also had 13. The specimen here shown in figure 7 has 20 ribs which is considerably more, but as the number of ribs is variable, this specimen is considered to belong to the same species.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2070) from station 29; figured hypotype (U.S.N.M. P2071) from station 45; unfigured hypotype from station 42.

OOLINA STRIATOPUNCTATA (Parker and Jones)

Plate 12, figures 2-5

Lagena sulcata (Walker and Jacob) var. *striatopunctata* Parker and Jones, 1865, Philos. Trans. Roy. Soc. London, vol. 155, p. 350, pl. 13, figs. 25-27.

Entosolenia striatopunctata (Parker and Jones) Dawson, 1870, Can. Nat., n.s., vol. 5, p. 178, fig. 11.

Lagena striatopunctata Parker and Jones, Brady, 1878, Ann. Mag. Nat. Hist., ser. 5, vol. 1, p. 434, pl. 20, fig. 3; 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 468, pl. 58, figs. 37, 40.—Cushman, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 30, pl. 14, fig. 10; 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 55, pl. 10, fig. 10; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 47, pl. 5, fig. 10.

Test free, unilocular, flask-shaped, somewhat elongate, rounded in section, occasionally with a thick, blunt, spinelike projection at the base (fig. 4), the opposite end produced into a long and delicate neck; wall calcareous, perforate, surface ornamented with 12 to 14 narrow longitudinal ribs, of which only one-half begin at the base of the test, the remainder being intercalated a short distance above the base where the chamber is wider, ribs ornamented by a row of pores on each side which extend into the central cavity of the test, the ribs dying out at the upper end of the test, and the test becoming smooth for a short distance, passing into the somewhat elongate neck; aperture terminal, radial, surrounded by a slight lip which is petaloid in appearance because of the radial grooves, and with a long and delicate entosolenian tube in the interior of the chamber (fig. 5).

Length of hypotype of figure 2, 0.55 mm., breadth 0.26 mm. Length of hypotype of figure 3, 0.60 mm., breadth 0.23 mm. Length of hypotype of figure 4, 0.47 mm., breadth 0.26 mm. Other hypotypes range from 0.39 to 0.65 mm. in length.

Remarks.—This species was originally defined as a variety of *Lagena sulcata,* but was placed in *Entosolenia* by Dawson (1870). All other authors have apparently referred it to *Lagena.* As it has a distinct internal tube (fig. 5), it is here placed in *Oolina.*

Cushman and McCulloch (1950, p. 352) described *L. striatopunctata* var. *excentricitas,* stating that it differed from the typical form in the axis of the test being bent at the apertural end and the costae fewer and more prominent. In our material a large proportion of the specimens are more or less irregular, and it seems probable that this irregularity is due to the form of the material upon which the specimen grew, rather than an inherited characteristic.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2044) from station 1; figured hypotype (U.S.N.M. No. P2045) from station 3; figured hypotype (U.S.N.M. No. P2046) from station 29; figured hypotype (U.S.N.M. P2047) from station 30; unfigured hypotypes are recorded from stations 1, 3, 4, 5, 18, 21, 22, 23, 24, 26, 29, 30, 31, 32, 36, 39, 42, and 45.

Genus FISSURINA Reuss, 1850

FISSURINA CUCURBITASEMA Loeblich and Tappan, new species

Plate 14, figures 10, 11

Test free, ovate, flattened with an outline like that of a melon seed, occasionally very slightly produced at the base; wall calcareous, translucent, finely perforate, with a thin marginal keel, surface smooth; aperture terminal, ovate, with a slight lip, and with an entosolenian tube extending about one-half the length of the test.

Length of holotype 0.26 mm., breadth 0.16 mm., thickness 0.10 mm. Length of paratype of figure 10, 0.23 mm., breadth 0.13 mm., thickness 0.13 mm. Other paratypes range from 0.18 to 0.42 mm. in length.

Remarks.—This species differs from *F. marginata* (Montagu) in the more elongate test, less-produced aperture and mucronate base.

Types and occurrence.—Holotype (U.S.N.M. No. P2119) from station 29; figured paratype (U.S.N.M. No. P2120) from station 25; unfigured paratypes are recorded from stations 3, 20, 21, 26, 29, 30, 32, 42, and 51.

FISSURINA LUCIDA (Williamson)

Plate 14, figure 4

Entosolenia marginata (Montagu) var. *lucida* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 17, pl. 2, fig. 17.

Entosolenia lucida (Williamson) Cushman and Gray, 1946, Cushman Lab. Foram. Res. Spec. Publ. 19, p. 30, pl. 5, figs. 16-18.—Cushman and Todd, 1947, Cushman Lab. Foram. Res. Spec. Publ. 21, p. 20, pl. 3, fig. 11; 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 65, pl. 15, fig. 22.

not *Entosolenia lucida* (Williamson) Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 63, pl. 7, fig. 2.

Test free, unilocular, somewhat compressed, ovate in outline, base smooth and rounded; wall calcareous, hyaline, with a horseshoe-shaped opaque border on the lower margin and up the sides, around the clear central area of the test; aperture terminal, ovate, with a short entosolenian tube.

Length of figured hypotype 0.27 mm., breadth 0.22 mm., thickness 0.16 mm. Length of unfigured hypotype 0.24 mm.

Remarks.—This species is characterized by the horseshoe-shaped opaque area near the outer margin, and the clear central portion of the shell. This specimen figured from Greenland by Cushman (1948b, pl. 7, fig. 2) does not have this surface character.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2118) and unfigured hypotype from station 3.

FISSURINA MARGINATA (Montagu)

Plate 14, figures 6-9

Vermiculum marginatum Montagu, 1803, Testacea Britannica, p. 524.

Lagena sulcata Walker and Jacob var. (*Entosolenia*) *marginata* (Montagu) Parker and Jones, 1865 (part), Philos. Trans. Roy. Soc. London, vol. 155, p. 355, pl. 13, figs. 42, 43 (not fig. 44 and not pl. 16, fig. 12).

Lagena marginata (Walker and Boys) Brady, 1884 (part), Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 476, pl. 59, fig. 22 (not figs. 21, 23).—Cushman, 1913, U. S. Nat. Mus. Bull. 71, pt. 3, p. 37, pl. 22, figs. 1-7.

Entosolenia marginata (Montagu) var. Cushman and Gray, 1946 (part), Cushman Lab. Foram. Res. Spec. Publ. 19, p. 30, pl. 5, figs. 19-21 (not figs. 22-24.—Cushman and Todd, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 65, pl. 15, figs. 23, 24.

Entosolenia marginata (Montagu)? Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 65, pl. 7, fig. 7.

Test free, unilocular, somewhat compressed, rounded to ovate in outline, with a slightly produced apertural end; wall calcareous, finely perforate, translucent, with a narrow marginal keel, surface otherwise smooth; aperture terminal, varying from an elongate slit to ovate, with a clear collarlike portion surrounding it and with a short to elongate entosolenian tube which is free for one-third to one-half the length of the test and is then attached to the wall at its lower end, where it is somewhat flared.

Length of hypotype of figure 6, 0.31 mm., breadth 0.26 mm., thickness 0.18 mm. Other hypotypes range from 0.16 to 0.42 mm. in length.

Remarks.—This species is one of the commonest in the Arctic and is quite variable, particularly in the character of the internal tube. Some have a straight tube, in others the tube bends to one side. The tube may be attached to one wall at the lower end, but in many specimens the attached tube extends to the base and up the opposite wall. We also have two "freak" specimens with double apertures. In these two specimens both apertures are ovate in the plane of the peripheral keel, and only one aperture of each has an internal tube.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2136) from station 3; figured hypotype (U.S.N.M. No. P2137) from station 18; figured hypotypes (U.S.N.M. Nos. P2138a-b) from station 36; unfigured hypotypes are recorded from stations 1, 2, 3, 4, 5, 6, 7, 9, 10, 12, 18, 19, 20, 21, 22, 24, 28, 29, 30, 31, 35, 36, 39, 42, 45, and 50.

FISSURINA SEMIMARGINATA (Reuss)

Plate 14, figure 3

Lagena sp. (Nos. 64-65) von Schlicт, 1870, Die Foraminiferen Septarienthones Pielzpuhl, p. 11, pl. 4, figs. 4-6, 10-12.

Lagena marginata Williamson var. *semimarginata* Reuss, 1870, Sitzb. Akad. Wiss. Wien, vol. 62, pt. 1, p. 468.—Brady, 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 446, pl. 59, figs. 17, 19.

Lagena (*Entosolenia*) *marginata* var. *semimarginata* Reuss, Wiesner, 1931, Deutsche Südpolar-Exped., 1901-1903, vol. 20 (Zoology, vol. 12), p. 120, pl. 19, fig. 224.

Test free, unilocular, compressed, ovate in outline, with rounded base; wall calcareous, finely and distinctly perforate, translucent to opaque, surface smooth, but with a slight marginal keel in the upper part; aperture elongate, produced on a clear necklike extension of the chamber, and with a long entosolenian tube attached to the wall.

Length of figured hypotype 0.34 mm., breadth 0.21 mm., thickness 0.13 mm. Length of unfigured hypotype 0.23 mm.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2090) from station 30; unfigured hypotype from station 19.

FISSURINA SERRATA (Schlumberger)

Plate 14, figure 5

Lagena serrata Schlumberger, 1894, Mém. Soc. Zool. France, vol. 7, p. 258, pl. 3, fig. 7.

Entosolenia serrata (Schlumberger) Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 63, pl. 7, fig. 3.

Test free, unilocular, compressed, of a shape like a melon seed, ovate in outline, bluntly rounded at the base, widening rapidly and then narrowing to the short, thick neck; wall calcareous, hyaline, finely perforate, surface smooth, except for a marginal keel, which has radial tubules passing through it and presenting a serrated or almost fimbriate appearance; aperture terminal, radial, at the end of the blunt neck, and with an internal entosolenian tube.

Length of figured hypotype 0.34 mm., breadth 0.18 mm., thickness 0.10 mm. Other hypotypes range from 0.29 to 0.44 mm. in length.

Remarks.—This species was originally described from the Arctic Ocean off Russia and was recorded by Cushman from northeastern Greenland. It is similar to *Entosolenia marginata* var. *lagenoides* Williamson, but differs in having a much less elongate neck. This is the second species of the genus having a radiate aperture.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2108) from station 3; unfigured hypotypes are recorded from stations 3, 13, 18, 20, 21, 22, 23, 32, 39, 45, and 51.

FISSURINA VENTRICOSA (Wiesner)

Plate 14, figure 15

Lagena (*Entosolenia*) *marginata* var. *ventricosa* Wiesner, 1931, Deutsche Südpolar-Exped., 1901-1903, vol. 20 (Zoology, vol. 12), p. 120, pl. 19, fig. 222.

Test free, unilocular, small, ovate in outline, inflated and nearly circular in section; wall calcareous, hyaline, surface smooth; aperture ovate, terminal, with an internal tube extending about one-half to two-thirds the length of the test, free in the upper portion, then curving downward to become attached to one wall for a short distance and flaring slightly at its extremity.

Length of figured hypotype 0.29 mm., breadth 0.23 mm., thickness 0.21 mm. Other hypotypes range from 0.18 to 0.23 mm. in length.

Remarks.—This species is one of the most nearly globular in the genus, and lacks the marginal keel of *Fissurina marginata* (Montagu).

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2089) from station 43; unfigured hypotypes are recorded from stations 3, 12, and 13.

Genus PARAFISSURINA Parr, 1947

PARAFISSURINA FOLLICULA Loeblich and Tappan, new species

Plate 14, figure 16

Test free, unilocular, ovate in outline, inflated, widest near the base; hyaline, surface smooth, with occasional large perforations giving a spotted appearance to the surface; aperture an arched slit covered over by a flap from the aboral side, with an entosolenian tube on the inside against the aboral wall.

Length of holotype 0.29 mm., breadth 0.16 mm.

Remarks.—This species resembles *P. tectulostoma*, new species, in the small size and occasional large perforations, but the present species differs in being more robust, in having a broader and lower aperture, and a rounded rather than apiculate base.

Type and occurrence.—Holotype (U.S.N.M. No. P2066) from station 20.

PARAFISSURINA FUSULIFORMIS Loeblich and Tappan, new species

Plate 14, figures 18, 19

Test free, narrow, elongate, slightly curved, acute to subrounded at the base, tapering to an acutely angled upper extremity; wall calcareous, hyaline, finely perforate, surface smooth; aperture eccentric, a small rounded opening, partially covered by a flap from the

aboral side and connected to an entosolenian tube which is attached to the interior of the aboral side, extending about two-fifths the length of the test and visible through the translucent wall.

Length of holotype 0.29 mm., breadth 0.10 mm. Length of paratype 0.31 mm., breadth 0.08 mm. Other specimens range from 0.26 to 0.36 mm. in length.

Remarks.—This species differs from *Parafissurina tectulostoma,* new species, in being smaller and narrower and slightly curved, with a less apiculate base. The aperture is smaller, and rounded, rather than arched, and the entosolenian tube is not as long as in *P. tectulostoma.*

Types and occurrence.—Holotype (U.S.N.M. No. P2048) and figured paratype (U.S.N.M. No. P2049) from station 20; unfigured paratypes are recorded from stations 20, 32, and 39.

PARAFISSURINA HIMATIOSTOMA Loeblich and Tappan, new species

Plate 14, figures 12-14

Test free, unilocular, ovate in outline, with a wide but pointed base and narrowing somewhat toward the oral extremity; wall calcareous, hyaline, finely perforate, with scattered large pores that give a rather speckled appearance to the otherwise smooth surface; aperture ovate, eccentric, partially covered by an extension of the aboral side of the test, which forms a semicircular hood, and with an internal entosolenian tube adjacent to the aboral side.

Length of holotype 0.31 mm., breadth 0.16 mm. Length of paratype of figure 13, 0.29 mm., breadth 0.13 mm. Length of paratype of figure 12, 0.31 mm., breadth 0.16 mm. Other unfigured paratypes range from 0.26 to 0.39 mm. in length.

Remarks.—This species differs from *P. fusuliformis,* new species, in being more robust, and in having a pointed rather than rounded base, and a rounded rather than narrow and pointed oral extremity. The characteristic spotty appearance of the present species due to the perforations is also distinct.

From *P. tectulostoma,* new species, the present form may be distinguished by its shorter and broader form, and the rounded aperture, instead of the arched slit of *P. tectulostoma,* and a much shorter entosolenian tube in the interior of the chamber.

Types and occurrence.—Holotype (U.S.N.M. No. P2072) and figured paratype (U.S.N.M. No. P2073) from station 20; figured paratype (U.S.N.M. No. P2074) from station 18; unfigured paratypes are recorded from stations 3, 18, 20, 21, 29, 30, 32, 39, and 50.

PARAFISSURINA TECTULOSTOMA Loeblich and Tappan, new species

Plate 14, figure 17

Test free, unilocular, elongate-ovate, with a pointed base, widest across the lower portion, narrowing somewhat to the aperture; wall calcareous, hyaline, finely perforate, surface smooth; aperture eccentric, appearing as a crescent and covered by a hood, with a long, narrow entosolenian tube extending from the orifice down the side opposite the opening, attached to this aboral wall, and of a length slightly greater than one-half the length of the test.

Length of holotype 0.42 mm., greatest breadth 0.18 mm., greatest thickness 0.16 mm. Length of unfigured paratype 0.31 mm., breadth 0.16 mm.

Remarks.—This species resembles some of the forms referred to *Lagena felsinea* Fornasini by Cushman (1923, p. 17). However, under this name Cushman mixed species belonging to two genera, one (U.S.N.M. No. 19136) being closer to *Oolina* than to *Parafissurina* in that it has a collar at the apertural end, and a stellate aperture, and lacks the hooded aperture. The second form includes the remainder of Cushman's Atlantic specimens referred to Fornasini's species, but belong to the genus *Parafissurina,* showing a well-developed hooded aperture. However, neither of these species appears to be that illustrated and described by Fornasini from the Pliocene of Italy, as the latter species had neither a hooded nor radiate aperture, but had a simple eccentric aperture, and an entosolenian tube attached to the aboral wall on the side opposite the apertural opening. Furthermore, Fornasini's species is rounded at the base rather than apiculate.

The present form has a broader aperture than Cushman's specimens or Fornasini's species, and has a long tube attached to the aboral wall and a pointed base.

Types and occurrence.—Holotype (U.S.N.M. No. P2050) and unfigured paratype (U.S.N.M. No. P2051) from station 20.

Family POLYMORPHINIDAE

Genus GLANDULINA d'Orbigny, 1826

GLANDULINA LAEVIGATA d'Orbigny

Plate 16, figures 2-5

Nodosaria (*Glandulina*) *laevigata* D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 252, pl. 10, figs. 1-3.

Glandulina laevigata d'Orbigny, 1846, Foraminifères fossiles du bassin tertiare Vienne . . . , p. 29, pl. 1, figs. 4, 5.—Cushman and Ozawa, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 143, pl. 40, figs. 1a,b.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 52, pl. 5, figs. 20, 21, pl. 6, fig. 1.—van Voorthuysen, 1950, Meded. Geol. Sticht., n. s., No. 4, p. 37, text fig. 4 (1-5b).

Pseudoglandulina laevigata (d'Orbigny) Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., vol. 6, No. 6, p. 325, pl. 42, fig. 4.

Test free, ovate to fusiform in outline, circular in section, pointed at the base, early portion biserial, later becoming uniserial; as many as 3 pairs of biserially arranged chambers, and usually one or two uniserial ones, chambers increasing rapidly in size as added, final chamber occupying from one-half to two-thirds the length of the test; sutures distinct, not depressed; wall calcareous, thin and sometimes translucent, especially near the aperture, surface smooth; aperture terminal, central, radiate, with an internal tube.

Length of hypotype of figure 3, 1.17 mm., breadth 0.52 mm. Length of hypotype of figure 4, 0.94 mm., breadth 0.52 mm. Length of hypotype of figure 5, 0.73 mm., breadth 0.39 mm.

Remarks.—Cushman and McCulloch (1950, p. 325) placed *Glandulina laevigata* d'Orbigny under the generic designation of *Pseudoglandulina* Cushman, 1929. If it were congeneric with *Glandulina,* d'Orbigny's name has more than a hundred years' priority over *Pseudoglandulina* Cushman. The latter was defined as differing from *Glandulina* in being uniserial throughout, rather than biserial in the early portion. An internal tube has also been noted by Selli (1947) in *Glandulina glans* and *G. silvestrii.* It was recorded in *Glandulina laevigata* by Van Voorthuysen (1950a). Furthermore, the internal tube is apparent in figures (and specimens) from the Arctic (Cushman, 1948b, pl. 5, fig. 21), but as this character was never mentioned by Cushman in descriptions of specimens from this area it must be assumed it was interpreted as a highlight on the drawings. Galloway (1933, p. 244) implied the presence of a tube in stating, "aperture terminal, central, round, protruding, sometimes with entosolenian collar."

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1070a-c) from station 26; figured hypotype (U.S.N.M. No. P1071) from station 22; unfigured hypotypes are recorded from stations 1, 20, 22, 26, 29, 30, 39, and 40.

LARYNGOSIGMA[4] **Loeblich and Tappan, new genus**

Synonyms: *Sigmomorphina* of authors (not Cushman and Ozawa, 1928).
Polymorphina of authors (not d'Orbigny, 1826).

Genotype (type species): *Laryngosigma hyalascidia* Loeblich and Tappan, new species.

Test free, somewhat compressed, chambers added in planes slightly less than 180°, forming a sigmoid series, each succeeding chamber farther removed from the base; wall calcareous, finely perforate; aperture terminal, radiate, with an internal tube.

Remarks.—Laryngosigma differs from *Sigmomorphina* Cushman and Ozawa in possessing an "entosolenian" tube within the aperture, and from *Esosyrinx,* new genus, in having a sigmoid chamber arrangement rather than a biserial arrangement in a single plane. It differs from *Siphoglobulina* Parr in having a sigmoid rather than triloculine chamber arrangement, and in the entosolenian tube being free rather than attached to the wall interior.

Other species that belong here include *Sigmomorphina subulata* Chapman and Parr and *Polymorphina williamsoni* Terquem. In addition *Sigmomorphina pearceyi* Cushman and Ozawa was described as having an internal tube, but this was apparently done on the basis of the tube shown by Pearcey in his species *Polymorphina inflata* (not *P. inflata* Zittel) which Cushman and Ozawa placed in the synonomy of their species. However, the holotype selected by Cushman and Ozawa from Dry Tortugas, Fla., does not show such an internal tube, and Chapman and Parr (1937, p. 77) stated that Cushman and Ozawa's species was distinct from that of Pearcey. Chapman and Parr therefore proposed the new name *Sigmomorphina subulata* for the species with the internal tube described by Pearcey from the south Atlantic, and *Sigmomorphina pearceyi* remains in that genus, the specific description being here emended to delete mention of an "entosolenian" tube.

LARYNGOSIGMA HYALASCIDIA Loeblich and Tappan, new species

Plate 15, figures 6-8

Test free, ovate to elongate-ovate in outline, slightly compressed; chambers numerous, biserially arranged but not in a plane, a line through the center of the chambers forming a sigmoid curve, each chamber farther removed from the base, but extending far back on the sides; sutures distinct, strongly oblique, slightly depressed; wall

[4] From Gr. *laryngos,* gullet; *sigma,* s (shape).

calcareous, finely perforate, translucent, surface smooth; aperture terminal, radiate, with a short and narrow, tubular, slightly curved "entosolenian" tube.

Length of holotype 0.68 mm., breadth 0.31 mm., thickness 0.21 mm. Length of paratype of figure 6, 0.53 mm., breadth 0.36 mm. Length of paratype of figure 8, 0.44 mm. Other paratypes range from 0.31 to 0.65 mm. in length.

Remarks.—This species is closest in appearance to *Sigmomorphina lamarcki* Cushman and Ozawa, but is more rounded in outline and less compressed, lacks the surface striae and has an "entosolenian" tube. It differs from *Sigmomorphina pearceyi* Cushman and Ozawa and *Sigmomorphina subulata* Chapman and Parr in being widest near the base rather than tapered at the base. *Polymorphina williamsoni* Terquem differs in having parallel sides and nearly vertical sutures.

Types and occurrence.—Holotype (U.S.N.M. No. P2139) from station 1; figured paratypes (U.S.N.M. Nos. P2140a,b) from station 35; unfigured paratypes are recorded from stations 3, 5, 7, 9, 20, 26, 29, 30, 31, and 51.

LARYNGOSIGMA WILLIAMSONI (Terquem)

Plate 16, figure 1

Polymorphina lactea (Walker and Jacob) var. *oblonga* Williamson, 1858 (not *Polymorphina* (*Globulinen*) *oblonga* Roemer, 1838, and not *Polymorphina oblonga* d'Orbigny, 1846), Recent Foraminifera of Great Britain, p. 71, pl. 6, figs. 149, 149a.—Cushman, 1923, U. S. Nat. Mus. Bull. 104, pt. 4, p. 147, pl. 40, figs. 7, 8.

Polymorphina williamsoni Terquem, 1878, Mém. Soc. Géol. France, ser. 3, vol. 1, p. 37.—Heron-Allen and Earland, 1932, *Discovery* Rep., vol. 4, p. 393, pl. 12, figs. 26-28.

Sigmomorphina williamsoni (Terquem) Cushman and Ozawa, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 138, pl. 38, figs. 3, 4.—Cushman, 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 23, pl. 3, fig. 21.

Test free, subquadrate in outline, with somewhat rounded extremities, compressed; chambers biserially sigmoid in arrangement, increasing gradually in size as added successively farther from the base, but very much overlapping at the sides; sutures distinct, depressed, and so strongly oblique as to be nearly vertical; wall calcareous, finely perforate, hyaline and translucent, surface smooth; aperture terminal, radiate, with a short tubular "entosolenian" neck.

Length of hypotype of figure 1, 0.47 mm., greatest breadth 0.21 mm., thickness 0.18 mm.

Remarks.—This species differs from *L. hyalascidia,* new species, in

being subquadrate rather than ovate in outline, with parallel margins, and very strongly oblique to nearly vertical sutures.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2141) from station 15; unfigured hypotypes are recorded from stations 7, 18, 20, 21, 30, and 35.

ESOSYRINX[5] Loeblich and Tappan, new genus

Synonym: *Pseudopolymorphina* Cushman and Ozawa, 1930 (not 1928).

Genotype (type species): *Pseudopolymorphina curta* Cushman and Ozawa, 1930.

Test free, chambers biserially arranged throughout; wall calcareous, perforate; aperture terminal, radiate, with a distinct internal tube.

Remarks.—This genus differs from *Pseudopolymorphina* Cushman and Ozawa in being biserial throughout and in having an "entosolenian" tube. It differs from *Polymorphina* d'Orbigny, 1826, and *Polymorphinoides* Marie, 1941, in the possession of the internal tube.

ESOSYRINX CURTA (Cushman and Ozawa)

Plate 15, figures 1-5

Pseudopolymorphina curta CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 105, pl. 27, figs. 3a,b.—CUSHMAN, 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 23, pl. 3, fig. 16; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 52, pl. 5, fig. 18 (not figs. 17, 19).

not *Pseudopolymorphina* sp. CUSHMAN and OZAWA, 1929, Japanese Journ. Geol. and Geogr., vol. 6, Nos. 3-4, p. 71, pl. 15, fig. 7.

not *Pseudopolymorphina curta* Cushman and Ozawa, CUSHMAN and TODD, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 63, pl. 15, fig. 14.

Test free, ovate in outline, slightly compressed, robust with rounded margins; chambers few in number, biserially arranged, but overlapping previous chambers; sutures oblique, very slightly depressed, sometimes obscure; wall calcareous, thin and translucent, surface smooth; aperture terminal, radiate, with a prominent internal tube.

Length of holotype 0.56 mm., breadth 0.42 mm., thickness 0.29 mm. Length of hypotype of figure 5, 0.55 mm., breadth 0.39 mm. Length of hypotype of figure 3, 0.81 mm., breadth 0.44 mm. Length of hypotype of figure 1, 0.94 mm., breadth 0.62 mm. Length of hypotype of figure 2, 0.86 mm., breadth 0.57 mm. Other hypotypes range from 0.31 to 0.83 mm. in length.

Remarks.—The genus *Pseudopolymorphina* Cushman and Ozawa was described (1928, p. 15) as having the chambers "in a closed

[5] From Gr. *esō*, within; *syrinx*, tube.

sigmoid series in the earlier stages, becoming biserial in the adult." The figures of the type species of *Pseudopolymorphina* show the early plan to be quinqueloculine, however, and the genus is so described by Cushman (1948a, p. 229). No "entosolenian" or internal tube was described in the genotype species, or for that matter in any species of *Pseudopolymorphina.* All specimens of this species encountered in Arctic or sub-Arctic waters show a test with relatively thin walls, biserial chambers with no trace of an early "closed sigmoid series" or quinqueloculine stage, and all possessing prominent internal tubes. The original drawings of the holotype of this species (Cushman and Ozawa, 1930, pl. 27, figs. 3a,b) are inaccurate. The type shows a test of only four biserial chambers (fig. 4), not five as originally drawn, and shows a radiate aperture with a prominent internal tube visible when the test is dampened.

Two of the specimens figured by Cushman in 1948 (pl. 5, figs. 17 and 19) do not agree with the types of this species. These specimens have more chambers, a test of a different outline, and lack the internal tube. However, the specimen of figure 18 (1948b, pl. 5) is a true *Esosyrinx curta* and shows the internal tube. On the drawing this is shown as a light area running downward to the right from the aperture. As no mention was made of the tube in any description it must be assumed that these were interpreted as "highlights" on the drawing of the specimen. The specimen figured from New England (Cushman, 1944, pl. 3, fig. 16) shows the internal tube characteristic of this species. The specimen figured by Cushman and Todd (1947a, pl. 15, fig. 14) from the Pliocene? of Amchitka Island has a large, thick-walled, robust test with numerous chambers bearing little resemblance to *E. curta* (Cushman and Ozawa).

Types and occurrence.—Holotype (Cushman Coll. No. 2254) from Recent deposits at 32 fathoms, 0.5 mile northwest of Eagle Island, Casco Bay, Maine; figured hypotype (U.S.N.M. No. P2000) from station 29; figured hypotypes (U.S.N.M. Nos. P2001a-c) from station 30; unfigured hypotypes are recorded from stations 20, 23, 28, 29, 30, and 61.

Family NONIONIDAE

Genus NONION Montfort, 1808

NONION LABRADORICUM (Dawson)

Plate 17, figures 1, 2

Nonionina labradorica DAWSON, 1860, Can. Nat., vol. 5, p. 191, fig. 4.
Nonionina scapha (Fichtel and Moll) var. *labradorica* DAWSON, 1870, Can. Nat., n. s., vol. 5, p. 177, fig. 5.

Nonion labradorica (Dawson) CUSHMAN, 1927, Bull. Scripps Inst. Oceanography, techn. ser., vol. 1, p. 148, pl. 2, figs. 7, 8; 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 11, pl. 4, figs 6-12.

Nonion labradoricum (Dawson) CUSHMAN, 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 23, pl. 6, figs. 13-16.—PHLEGER, 1939, Bull. Geol. Soc. Amer., vol. 50, p. 1403, pl. 2, figs. 13, 14.—CUSHMAN, 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 24, pl. 3, fig. 23; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 52, pl. 6, fig. 2.—F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 413, pl. 5, fig. 12.

Test free, medium in size, ovate to auriculate in outline, planispiral, completely involute and bilaterally symmetrical, biconvex, and biumbilicate, periphery subacute, margin slightly lobulate, apertural face broad and subtriangular; chambers numerous, 8 to 10 in the final whorl, increasing gradually in size as added, but the final chamber is nearly twice as high as the preceding; sutures distinct, gently curved, very slightly depressed except near the umbilicus, where they are distinctly incised; wall calcareous, hyaline, finely perforate, thin and translucent, so that the outline of the preceding chamber may be discerned within the final chamber; aperture a low, arched slit at the base of the apertural face.

Greatest diameter of hypotype of figure 1, 0.81 mm., least diameter 0.60 mm., greatest breadth of apertural face 0.47 mm. Other specimens range from 0.23 to 0.86 mm. in greatest diameter.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1063a,b) from station 18; unfigured hypotypes are recorded from stations 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 38, 39, 40, 42, 45, 46, 50, and 51.

NONION ZAANDAMAE (van Voorthuysen)

Plate 16, figures 11, 12

Nonion pompilioides (Fichtel and Moll) CUSHMAN, 1930 (not *Nautilus pompiloides* Fichtel and Moll, 1798), U. S. Nat. Mus. Bull. 104, pt. 7, p. 4, pl. 2, figs. 1, 2 (not pl. 1, figs. 7-11).

Nonion barleeanum (Williamson) CUSHMAN and HENBEST, 1940 (not *Nonionina barleeana* Williamson, 1858), U. S. Geol. Surv. Prof. Pap. 196-A, pl. 9, fig. 13.—CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 54, pl. 6, fig. 4.

not *Nonion barleeanum* (Williamson) CUSHMAN, 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 11, pl. 4, fig. 5; 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 23, pl. 6, fig. 11.

Nonion barleeanum (Williamson) var. *inflatum* VAN VOORTHUYSEN, 1950 (not *Nonionina inflata* Alth, 1850), Meded. Geol. Sticht., n. s., No. 4, p. 41, text fig. 7, pl. 3, figs. 6a,b.

not *Anomalinoides barleeanum* (Williamson) var. *inflatum* (van Voorthuysen) VAN VOORTHUYSEN, 1950, ibid., p. 66, pl. 4, figs. 3a,b.

Anomalinoides barleeanum (Williamson) var. *zaandamae* (van Voorthuysen) VAN VOORTHUYSEN, 1952, Journ. Paleontol., vol. 26, No. 4, p. 681.

Test free, of medium size, planispiral and involute, biumbilicate, periphery broadly rounded; chambers increasing gradually in size as added, 9 to 11 in the final whorl surrounding the open umbilicus; sutures distinct, much thickened, gently curved; wall calcareous, hyaline, coarsely perforate, but otherwise smooth; aperture an elongate curved slit, at the base of the apertural face of the final chamber, extending nearly to the umbilicus on each side, and bordered above by a slight lip.

Greatest diameter of hypotype of fig. 11, 0.49 mm., least diameter 0.44 mm., greatest thickness 0.23 mm. Greatest diameter of hypotype of fig. 12, 0.43 mm., thickness 0.18 mm. Other hypotypes range from 0.26 to 0.70 mm. in greatest diameter.

Remarks.—Some of the specimens figured by Cushman (1930, pl. 2, figs. 1-2) as *N. pompilioides* belong to the present species, but they are much more compressed than the species of Fichtel and Moll, and like the present form are characterized by limbate sutures and a coarsely perforate wall.

In 1930, Cushman described *Nonion barleeanum* (Williamson), but listed no types or occurrences. His figures were copied from Williamson and the description was apparently modified after Williamson. In the monograph on the Nonionidae (Cushman, 1939), the same description and figures were given. However, in 1940, Cushman and Henbest figured as *N. barleeanum* a specimen from a deep-sea core from the north Atlantic. This specimen has only 9 chambers visible, and has somewhat limbate sutures, thus differing from the types of Williamson's species which had 12 chambers in the final whorl and depressed sutures. No specific description was given in this article.

In 1948, in his publication on the Arctic Foraminifera, Cushman again gave the identical specific description of *Nonion barleeanum* as was given in his 1930 and 1939 papers. However, the specimen then figured was of the type shown by Cushman and Henbest (1940), and here referred to as a distinct species. Thus the description stated in part (Cushman, 1948b, p. 54), "chambers numerous, 12 or more in the last formed coil." Examination of all specimens in the Cushman collection shows no specimens having more than 10 chambers, and that figured by Cushman (1948b, pl. 6, fig. 4) had only 9. Williamson's type of *N. barleeana* shows about 13 chambers as well as a higher aperture, at the periphery. In addition, his species had more

strongly curved sutures and they do not appear limbate as in the present species.

Numerous specimens of the present species observed by the writers show that by far the greatest number have 10 chambers in the final whorl, a few have only 9, and a single specimen was found with 11 chambers.

Van Voorthuysen (1950a) described *Nonion barleeanum* (Williamson) var. *inflatum* van Voorthuysen, stating that it differed from the typical form of the species in that "specimens are less compressed and of smaller proportions than the recent species of the British Isles. The number of chambers in the youngest whorl is not 12 or more, but 10-12, mostly 11. A transverse section shows the thickened extremities of the septa, corresponding with the thickened apertural edge. The test is typically coarsely perforate."

Later (1950b) he placed the species and variety in the genus *Anomalinoides* Brotzen, 1942, stating that "the aperture is composed of a peripheric one extending onto the umbilical side with a distinct lip, visible on the three or four youngest chambers. This fact has convinced us that this form is not a *Nonion,* but belongs to the genus *Anomalinoides* Brotzen, 1942."

In this latter paper, however, he figured a form which he described as differing from those of his previous paper, in being "nearly twice as large with about 15 chambers.... The main characters are the same however, so we consider these larger ones only as having lived in exceptionally favorable conditions."

As the smaller size and fewer chambers were the original basis for separating van Voorthuysen's form from that of Williamson, it would seem that placing both forms together would remove the distinction from Williamson's species and therefore invalidate the variety of van Voorthuysen. In any case, van Voorthuysen's varietal name was a homonym, being preoccupied by *Nonionina inflata* Alth, 1850, and he renamed it var. *zaandamae* in 1952.

The large specimen figured by van Voorthuysen (1950b) is more compressed, has much more numerous chambers, and does not seem to have the thickened sutures characteristic of the present species. Furthermore, the aperture shown for his type of *N. barleeanum* var. *inflatum* is like that here shown (fig. 11) and does not have the high arch on the periphery shown in Williamson's figures. We therefore believe van Voorthuysen's original type of *N. barleeanum* var. *inflatum* to be identical with the present species, but distinct from that of Williamson and also distinct from the larger specimens referred to the variety in his later paper (1950b).

The present species we believe should remain in the genus *Nonion,* and not in *Anomalinoides* where it was placed by van Voorthuysen (1950b, p. 66). A study of topotype specimens of *Anomalinoides plummerae* Brotzen shows a distinctly trochoid coil, and the much more coarsely perforate test typical of the Anomalinidae. Furthermore, the aperture extends over onto the dorsal side in *Anomalinoides* and in the present species the aperture extends equally onto the two sides, much as in the genotype species of *Nonion.* Incidentally, an examination of the wall structure of the type species of *Anomalinoides* shows it to be perforate granular, as were *Anomalinella* and *Cibicides* (Wood, 1949, p. 252), although the majority of the genera of this family have perforate radiate walls. The present species also has perforate granular walls, as do all species of true *Nonion* examined by Wood.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2027) from station 36; figured hypotype (U.S.N.M. No. P2028) from station 52; unfigured hypotypes are recorded from stations 26, 43, 51, and 52.

Genus ASTRONONION Cushman and Edwards, 1937

ASTRONONION GALLOWAYI Loeblich and Tappan, new name

Plate 17, figures 4-7

Astrononion stellatum Cushman and Edwards, 1937 (not *Nonionina stellata* Terquem, 1882), Contr. Cushman Lab. Foram. Res., vol. 13, p. 32, pl. 3, figs. 9-11.—Cushman, 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 36, pl. 10, figs. 3-5.—Cushman and McCulloch, 1940, Allan Hancock Pacific Exped., vol. 6, No. 3, p. 168, pl. 18, fig. 11.—Cushman and Todd, 1947, Cushman Lab. Foram. Res. Spec. Publ. 21, p. 13, pl. 2, fig. 15.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 56.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 410, pl. 5, figs. 2, 3.

Astrononion stelligerum (d'Orbigny) Cushman, 1948 (not *Nonionina stelligera* d'Orbigny, 1839), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 55, pl. 6, fig. 6.

Test free, planispiral and involute, compressed, umbilical region somewhat concave, periphery rounded; chambers increasing in size as added, larger chambers 8 to 10 in number, strongly inflated, smaller wedge-shaped supplementary chambers surround the umbilicus on each side, tapering outward to the suture about one-half the distance to the periphery; sutures distinct, gently to strongly curved, depressed; wall calcareous, hyaline, larger chambers fairly coarsely perforate, the supplementary chambers less coarsely perforate; aperture a low arch at the base of the final chamber, extending on each

side toward the umbilicus, with a supplementary opening at the outer posterior margin of each of the supplementary chambers.

Greatest diameter of hypotype of figure 7, 0.49 mm., thickness 0.18 mm. Greatest diameter of hypotype of figure 5, 0.49 mm. Greatest diameter of hypotype of figure 6, 0.42 mm. Greatest diameter of hypotype of figure 4, 0.42 mm.

Remarks.—Astrononion stellatum Cushman and Edwards is preoccupied by *Nonionina stellata* Terquem, 1882, which is a distinct *Astrononion*, and the former is here renamed *A. gallowayi*, new name. In the monograph on the Nonionidae, Cushman (1939, p. 4) referred to Terquem's species as *Nonion? stellatum* (Terquem), stating, "No specimens were found in any of the collections from the Paris Basin which I studied. The exact generic position of this species must be left in some doubt until actual specimens can be studied."

However, the original figure of Terquem shows a distinct stellate arrangement in the center of the test, and the original description (1882, p. 43) stated in part, "sutures couvertes par une étoile à cinq rayons inégaux et creusés en sillon."

Furthermore, Terquem compared his species to two others, *N. stelligera* d'Orbigny (which Cushman and Edwards selected as the genotype for *Astrononion*) and *N. asterizans* Brady (which Cushman and Edwards described (1937, p. 35) as *Astrononion fijiense*, as it was distinct from *N. asterizans* Fichtel and Moll).

Terquem's species was from the Eocene of France, and in the original description of *Astrononion*, Cushman and Edwards (1937, p. 30) stated, "Stellate forms referred to '*Nonionina*' have been recorded as early as the Eocene of Europe. We have found specimens in our material from the Eocene of Biarritz, France, the locality from which Halkyard recorded the species (*N. stelligera*), which probably belong to this genus."

Although hesitating to refer Terquem's species to *Astrononion* without an examination of the specimens, Cushman and Edwards selected as genotype of their genus the Recent species of d'Orbigny from the Canary Isles, for which the type repository is unknown, and of which they stated, "There have been many records referred to this species. . . . A study of these figures seems to show that none of them are identical with the species figured and described by d'Orbigny. We have been unable to study any material from the type locality."

Therefore, although the genus was based on a species unknown to them, another species was considered questionable until the types were examined, and the identical specific name was proposed for a new species.

Parker (1952a, p. 410) considered *A. stelligerum* Cushman, 1948 (not d'Orbigny, 1839) as conspecific with this species. An examination of all types in the Cushman collection and U. S. National Museum collections shows that these are conspecific. However, all these types are from the Arctic or from cold waters and none were from the warm water of the type area of *A. stelligera*. The Arctic species is thicker, the periphery more lobulate, and the supplementary chambers broader and more wedge-shaped, while those of d'Orbigny's species were narrower and distinctly angled at a short distance from the umbilicus.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2031a-d) from station 6; unfigured hypotypes are recorded from the following stations: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39, 40, 42, 45, 46, 48, 50, 51, 52, 54, 66, 67, 74, 75, and 77.

Genus NONIONELLA Cushman, 1926

NONIONELLA AURICULA Heron-Allen and Earland

Plate 16, figures 6-10

Nonionella auricula Heron-Allen and Earland, 1930, Journ. Roy. Micr. Soc., vol. 50, p. 192, pl. 5, figs. 68-70.—Cushman, 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 33, pl. 9, figs. 7-9; 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 25, pl. 3, figs. 26, 27.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 413, pl. 5, figs. 13a-14b.

Test free, ovate in outline and compressed, coiled and slightly trochoid, periphery rounded; chambers slightly inflated, increasing rapidly in size as added, the 5 or 6 of the previous whorl visible dorsally where the test is partially evolute, only the 9 to 10 chambers of the final whorl visible ventrally, final chamber somewhat inflated and comparatively higher than the preceding chambers, extending farther over the ventral side when seen in edge view; sutures distinct, gently curved or even slightly sinuate, moderately depressed; wall calcareous, thin, hyaline, finely perforate and smooth; aperture at the base of the apertural face extending from the periphery a short distance on the ventral side.

Greatest diameter of hypotype of figure 10, 0.73 mm., least diameter 0.52 mm., greatest thickness 0.29 mm. Greatest diameter of hypotype of figure 7, 0.70 mm., least diameter 0.55 mm., thickness 0.23 mm. Greatest diameter of hypotype of figure 8, 0.65 mm., of figure 6, 0.49 mm., of figure 9, 0.75 mm.

Remarks.—This species was described from off Plymouth, England, and has been recorded off the coast of New England (Rhode Island, Massachusetts, and New Hampshire).

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1067 a-d) from station 18; figured hypotype (U.S.N.M. No. P1068) from station 30; unfigured hypotypes are recorded from the following stations: 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 18, 19, 20, 21, 22, 23, 27, 29, 30, 31, 32, 34, 39, 42, and 50.

Genus CHILOSTOMELLINA Cushman, 1926

CHILOSTOMELLINA FIMBRIATA Cushman

Plate 17, figure 3

Chilostomellina fimbriata CUSHMAN, 1926, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 4, p. 78, pl. 11, figs. 22a-c.

Test free, robust, nearly globular, planispiral and involute; chambers few in number, increasing very rapidly in size as added, final chamber nearly completely enveloping the test, and overlapping far down over the umbilical region on each side, with a fimbriate margin at the sides and base of the apertural face, so that only the 6 preceding chambers are visible; sutures distinct, gently curved, not depressed; wall calcareous, thin and fragile, finely perforate, smooth; aperture low, crescentiform, on the periphery at the base of the final chamber, with additional supplementary apertures at the reentrants between the fingerlike projections of the final chamber.

Height of test of figured hypotype 0.60 mm., thickness 0.55 mm.

Remarks.—Cushman (1926, p. 78) described the genus *Chilostomellina* and placed it in the family Chilostomellidae, stating, "Test composed of a few inflated chambers, the last-formed one almost completely enveloping the preceding ones. . . . This is a peculiar genus in some characters related to *Chilostomella* especially in the apparent alternation of chambers and the embracing character of each newly added chamber." Cushman's diagnosis of the genus and species describes little except the gross form, but says nothing of the early chamber arrangement.

Galloway (1933, p. 268) correctly interpreted the structure of the genus as planispiral, but placed this genus, as well as *Allomorphinella,* which Cushman and Galloway both considered its ancestor, and the planispiral *Pullenia* all in the Nonionidae. These three genera Cushman (1940, p. 283; 1948a, p. 316) again placed in the Chilostomellidae and stated, "These genera have sometimes been placed with

the Nonionidae, but a study of their microspheric forms in the early stages will show that they do not belong there, but have been derived from *Chilostomella*."

Dissection of specimens of *Chilostomellina* by the writers show a planispiral development throughout, and not the early trochoid or biserial development characteristic of *Allomorphina* and *Chilostomella*. It is very similar to *Allomorphinella* however, which also is completely planispiral.

An interesting sidelight is the fact that Wood (1949), in examining the wall structure of various genera, found among the so-called Chilostomellidae that the genotype species of *Allomorphina, Chilostomella,* and *Pullenia* have a perforate granulate structure, and the types of *Seabrookia* and *Sphaeroidina* are perforate radiate. *Nonion* also is perforate and granulate and Wood suggested that it should be placed with the similar "Chilostomellidae" such as *Pullenia* rather than in a family with *Elphidium,* which is radiate in wall structure. He thus upholds Galloway's suggestion as to the relationship of *Nonion* to various members of the Chilostomellidae. Wood's original study of the wall structure did not cover the monotypic genus *Chilostomellina*. The present writers have examined the wall structure of this form, and find it to be granular in structure, so that although more closely related to *Allomorphinella* and *Pullenia* in its planispiral character, it nevertheless should probably be kept in the same family as *Chilostomella*. Galloway associated *Pullenia, Nonion,* and *Chilostomellina,* but placed them in the Nonionidae and separated *Chilostomella* and allied genera in the Chilostomellidae. As these are so similar in wall character as well as other features, it would seem better to place *Nonion* and its related genera with the entire family of the Chilostomellidae. In this event the family name Nonionidae Reuss, 1860, would take precedence over the Chilostomellidae of Brady, 1881. In any event, *Elphidium* and related radiate walled genera are here placed in a separate family, the Elphidiidae. They may possibly have arisen from a form such as *Globigerinella* which is similarly planispiral with radiate perforate walls, and an aperture at the base of the apertural face of the final chamber. It is interesting to note that some of the Globigerinidae (i.e., *Globigerinoides, Globigerinatella, Canorbulina,* and *Candeina*) also have sutural pores as do the Elphidiidae.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1075) from station 68; unfigured hypotypes are recorded from stations 18, 68, 69, 70, 71, 72, and 73.

Family Elphidiidae

Tests free, planispiral, trochoid or uncoiling; wall calcareous, hyaline, perforate radial in structure, with a canal system ending in a single or double row of pores along the sutures, and with retral processess projecting across the sutures; aperture consisting of a single slit or row of pores at the base of the apertural face, or scattered pores on the face.

Remarks.—The following genera are included in the Elphidiidae: *Elphidium* Montfort, *Elphidioides* Cushman, *Elphidiella* Cushman, *Ozawaia* Cushman, *Polystomellina* Yabe and Hanzawa, *Notorotalia* Finlay, and *Faujasina* d'Orbigny.

This group of genera has previously been placed in the Nonionidae, and various authors have considered *Nonion* and *Elphidium* to intergrade. In his monograph on the Nonionidae, Cushman stated (1939, p. 2), "It is evident, however, that the simpler forms of *Elphidium* developed directly from *Nonion* by the addition of the pores along the sutures and the development of retral processes. Species are known in which the characteristics of *Elphidium* are not developed until the last two or three chambers of the adult, and the entire younger stages, if found alone, would unhesitatingly be described as *Nonion.*"

Galloway (1933, p. 265) concurred in this derivation of *Elphidium,* stating "It is difficult to distinguish a simple *Elphidium* from *Nonion,*" but he did separate the four genera known at that time which possess retral processes and the canal and pore systems into the subfamily Elphidiinae.

The first question raised as to the placement of these forms in the family Nonionidae was that of Wood (1949), based on the wall structure. Wood stated (p. 243), "The separation between *Nonion* and *Elphidium* on the character of the test-wall is remarkably sharp. Hitherto the two genera have been considered to be connected by intermediate species, an idea due to Carpenter (1862). Though the resemblance in form between *Nonion* and *Elphidium* may be close, I have never found a type with retral processes and a canal system which did not have radially built walls. . . . These facts suggest that *Nonion* may be more correctly placed in the Chilostomellidae, with *Pullenia,* whose structure so closely resembles it in other respects." [6]

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[6] *Nonion* could not be placed in the Chilostomellidae, for the family Nonionidae Reuss, 1860, clearly preoccupies the Chilostomellidae of Brady, 1881. If a close relationship exists, *Pullenia* should be placed in the Nonionidae, and this was in fact done by Galloway, 1933, p. 267. The placement of these additional genera is not within the scope of the present paper, however.

We have also found the wall characters to afford a sharp distinction, and to supply an easy method of separating the "simple" species of *Elphidium* and *Nonion*, so difficult to separate on external features alone. The few species that seemed to show transitional characters were found to be incorrectly placed (i.e., *Nonionina orbicularis* Brady = *Elphidium orbiculare*, discussed here in more detail on pp. 102-103). It is also probable that there was another ancestral genus than *Nonion*, for this present family, as Wood's work showed the wall structure to be of considerable importance in classification. All members of the present family have radial perforate walls, and *Nonion*, *Pullenia*, and other members of the Nonionidae are perforate granular in structure.

The family Elphidiidae is therefore considered to include those genera characterized by a radial perforate wall, and possessing sutural pores, retral processes, and an internal canal system.

Genus ELPHIDIUM Montfort, 1808

ELPHIDIUM BARTLETTI Cushman

Plate 18, figures 10-14

Nonionina striatopunctata (Fichtel and Moll) Parker and Jones, 1865 (not *Nautilus striato-punctatus* Fichtel and Moll, 1798), Philos. Trans. Roy. Soc. London, vol. 155, p. 402, pl. 14, figs. 31-34, pl. 17, fig. 60.

Elphidium bartletti Cushman, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 4, pl. 1, fig. 9; 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 64, pl. 18, fig. 10; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 59, pl. 6, fig. 13.

Cribroelphidium arcticum Tappan, 1951, Contr. Cushman Found. Foram. Res., vol. 2, pt. 1, p. 6, pl. 1, figs. 27, 28; 1951, U. S. Geol. Surv., Oil and Gas Invest. Map OM-126, sheet 3, fig. 21 (1a,b).

Elphidium articulatum (d'Orbigny) F. Parker, 1952 (not ?*Polystomella articulata* d'Orbigny, 1839), Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 411, pl. 5, figs. 5-7.

Test free, of medium size, robust, planispiral and involute to very slightly evolute, sides almost flat, with slightly depressed umbilical regions, periphery broadly rounded, peripheral margin moderately lobulate; chambers numerous, from 7 to 12 in the final whorl, most commonly 9 or 10, slightly inflated; sutures distinct, depressed, gently curved, with 8 to 12 pores visible on each side along each suture, retral processes short and broad; wall calcareous, very finely perforate, surface smooth and glassy, umbilical area filled with granular material which may also have pores similar to those along the septa; aperture consists of a row of small pores at the base of the apertural

face and numerous scattered pores in the apertural face of the final chamber.

Greatest diameter of hypotype of figure 13, 0.73 mm., thickness 0.36 mm. Greatest diameter of hypotype of figure 10, 0.55 mm., thickness 0.29 mm. Greatest diameter of hypotype of figure 12, 1.09 mm., thickness 0.49 mm. Greatest diameter of hypotype of figure 11, 0.68 mm., thickness 0.36 mm. Other hypotypes range from 0.34 to 1.04 mm. in diameter.

Remarks.—The specimens referred to *Nonionina striatopunctata* by Parker and Jones are like the present species, but wholly unlike the species of Fichtel and Moll which has far more numerous chambers and very prominent retral processes which give the appearance of continuous revolving ribs.

Cribroelphidium arcticum was described from the Alaskan Pleistocene and compared to *E. bartletti,* although it was stated (Tappan, 1951, p. 6) to be "of greater thickness, has fewer and more inflated chambers in the final whorl, and possesses the multiple aperture of the genus *Cribroelphidium.*" At the time this description of *Cribroelphidium arcticum* was written, Cushman's types were not available and neither the original nor later descriptions, nor any figures showed the presence of the very prominent multiple aperture in *E. bartletti,* so that it was assumed that the two forms were not even congeneric. Since then, an examination of the holotype of *E. bartletti* shows that it also has a multiple aperture, and paratype specimens are identical with the somewhat thicker, fewer-chambered holotype of *Cribroelphidium arcticum.* Furthermore, a few specimens of the more-compressed type were also found in the Alaskan Pleistocene. As both forms are found together and apparently intergrade, and all have a multiple aperture, they are here considered identical.

Elphidium articulatum d'Orbigny of Parker (1952a, p. 411) is the same as the present species, and she stated that "*E. articulatum* appears to be closely related to *E. bartletti* Cushman. The adult forms of the latter species have a maximum of 12 chambers instead of the 10 or less of the former. The young specimens of *E. bartletti,* however, appear to be identical with *E. articulatum.* It is possible that *E. bartletti* represents the Arctic development of *E. articulatum,* which is not reported from that area." She further stated that "A comparison with specimens from the Falkland Islands, one of the localities from which d'Orbigny described the species, shows the Portsmouth species to be almost identical although slightly less compressed." Cushman (1930, pl. 10, figs. 7-8) illustrated one of these specimens from the Falklands, which is very similar to the present

species. However, d'Orbigny's type figure shows a sharp, acutely angled periphery, rather than the broadly rounded periphery of all other specimens referred to his species, and present also in *E. bartletti*. Until d'Orbigny's types can be examined, it seems advisable to consider the present form as a distinct species, and if future study proves them to be conspecific, d'Orbigny's specific name would then take priority.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2124a,b) from station 16; figured hypotype (U.S.N.M. No. P2125) from station 17; figured hypotypes (U.S.N.M. Nos. P2126a, b) from station 23; unfigured hypotypes are recorded from stations 1, 3, 4, 5, 7, 9, 12, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25, 26, 27, 28, 30, 31, 33, 34, 35, 39, 40, 42, 45, 50, and 51.

ELPHIDIUM CLAVATUM Cushman

Plate 19, figures 8-10

Elphidium incertum (Williamson) var. *clavatum* Cushman, 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 20, pl. 7, fig. 10.—Cushman and Cole, 1930, Contr. Cushman Lab. Foram. Res., vol. 6, p. 96, pl. 13, figs. 8, 9.—Cushman, 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 57, pl. 16, figs. 1, 2; 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 25, pl. 3, figs. 32, 33; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 57, pl. 6, fig. 8.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 412, pl. 5, figs. 10, 11.—Phleger, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 83, pl. 14, fig. 7.

Test free, of medium size, planispiral, involute, biumbonate, periphery subacute; 9 to 13 chambers in the final whorl, increasing gradually in size as added; sutures distinct, gently curved, thickened, may be slightly depressed with a single row of sutural pores, and short, distinct retral processes; wall calcareous, very distinctly perforate, thin and translucent, umbilical region with a somewhat elevated boss; aperture a single row of small pores at the base of the apertural face of the final chamber.

Greatest diameter of hypotype of figure 9, 0.60 mm., thickness 0.26 mm. Greatest diameter of hypotype of figure 8, 0.55 mm., thickness 0.31 mm. Greatest diameter of hypotype of figure 10, 0.57 mm., thickness 0.31 mm. Other hypotypes range from 0.23 to 0.70 mm. in maximum diameter.

Remarks.—We have raised this form to specific rank, as a restudy based on the holotype of Cushman's variety shows it to differ from *E. incertum* (Williamson) in many more important features than "in the ornamentation of the test, the umbilical portions being oc-

cupied by several large irregular bosses, very distinct but not forming a distinct umbonate mass" which was the varietal description of Cushman (1930, p. 20).

An examination of all Arctic specimens in the Cushman collection and the U. S. National Museum collections which have been referred to *E. incertum* shows not a single specimen that is similar to Williamson's type (see discussion here under that species), but *E. clavatum* differs in being thickest through the umbonal region, with an elevated central boss, which may be subdivided into more than one irregular knob, and the test of *E. clavatum* is much more coarsely perforate. Furthermore, basing the size on the figures of Macfadyen, *E. incertum* is a considerably larger species. Williamson gave no measurements for *E. incertum* and no magnification was given for the illustration.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2024a,b) from station 13; figured hypotype (U.S.N.M. No. P2025) from station 14; unfigured hypotypes are recorded from stations 1, 2, 3, 4, 5, 6, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 36, 37, 38, 39, 40, 42, 44, 45, and 50.

ELPHIDIUM FRIGIDUM Cushman

Plate 18, figures 4-9

Elphidium frigidum CUSHMAN, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 5, pl. 1, fig. 8; 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 64, pl. 18, fig. 8; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 57, pl. 6, figs. 9-11.

Test free, planispiral and involute, discoidal, sides nearly flat, umbilical area slightly depressed, periphery broadly rounded; 8 to 9 slightly inflated chambers in the final whorl, the later chambers being more inflated, and the final chamber sometimes higher and extending away from the general outline of the test; sutures distinct, slightly depressed, curved, with a row of sutural pores from which about 10 grooves extend in both directions, parallel to the peripheral margin, extending over the lower portion of the next succeeding chamber and over the upper portion of the preceding chamber, these grooves usually dying out over the most-inflated central portion of each chamber; wall calcareous, rather coarsely perforate, ornamented by the sutural pores and above-mentioned spiraling striae; aperture consisting of a row of pores at the base of the apertural face and numerous scattered pores in the face of the final chamber.

Greatest diameter of hypotype of figure 8, 0.94 mm., thickness 0.34 mm. Greatest diameter of hypotype of figure 4, 0.44 mm., thickness 0.18 mm. Greatest diameter of hypotype of figure 6, 0.57 mm.,

thickness 0.18 mm. Greatest diameter of hypotype of figure 9, 0.62 mm., thickness 0.21 mm. Other hypotypes range from 0.31 to 1.01 mm. in diameter.

Remarks.—Although defined as an *Elphidium* and retained in that genus by Cushman (1948b) after the genus *Cribroelphidium* was erected by Cushman and Bronnimann the previous month, this species has a distinct multiple aperture. We have found numerous other species, originally described as *Elphidium,* to have a similar cribrate aperture, although not always as distinct. These pores may be filled in the apertural face of some specimens, but visible in that of the penultimate chamber when the last chamber is broken away. However, the original figure of the genotype species of *Elphidium* (*Nautilus macellus* Fichtel and Moll, 1798) shows pores in the apertural face and these were noted in the description as "quinque foraminula per medium." It therefore seems that *Cribroelphidium* should be considered a synonym of *Elphidium,* and the present species is here retained in the genus *Elphidium.*

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2059) from station 3; figured hypotypes (U.S.N.M. Nos. P2060a-c) from station 10; figured hypotypes (U.S.N.M. Nos. P2061a,b) from station 19; unfigured hypotypes are recorded from stations 1, 4, 5, 6, 7, 8, 9, 10, 12, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 37, 38, 39, 42, 45, 46, 49, 50, 51, and 52.

ELPHIDIUM INCERTUM (Williamson)

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

Elphidium incertum (Williamson) Macfadyen, 1932, Geol. Mag., vol. 69, No. 821, pl. 35, figs. 6a,b.— ? Phleger, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 83, pl. 14, fig. 7.

Williamson's complete original description stated, "This variety differs from the typical form in the smaller number of the transverse crenulations along the septal lines, in their less uniform aspect, and more unequal size. Sometimes they form long radiating grooves, especially near the umbilicus; at others they appear as small oval pits, the long axes of which are also parallel with the septal line; and not unfrequently they are so slight as to be scarcely visible. In such examples it is exceedingly difficult to distinguish this shell from *Nonionina umbilicatula,* except by preparing a transverse section of the specimen, and mounting it in Canada balsam, so as to bring the septal apertures into view. I have met with single specimens of this

variety in several localities, but I have only found it to be the prevalent form at Scarborough."

Remarks.—This species has apparently been misidentified with abandon throughout the American literature. An examination of all Arctic specimens in the Cushman and U. S. National Museum collections shows not a single specimen like that figured by Williamson. Probably no other species has been so thoroughly confused. On slides referred to *E. incertum* in the Cushman collection are a mixture of specimens of *E. bartletti* Cushman, *E. clavatum* Cushman, and *E. orbiculare* (Brady), showing the wide, inflated test and cribrate aperture like the holotype of *bartletti,* the coarsely perforate specimens with umbonal boss like the holotype of *clavatum,* and other inflated specimens with the very slight sutural pores of *orbiculare.*

To add to the confusion, in the monograph on Atlantic Foraminifera, Cushman figured Williamson's illustrations, but the side view figured by Williamson (1858, fig. 81) Cushman referred to *E. excavatum* (Terquem) (Cushman, 1930, pl. 8, fig. 7), whereas Williamson's edge view of this same specimen (1858, fig. 82) Cushman reillustrated and identified as *E. incertum* (Cushman, 1930, pl. 7, fig. 4b), and considered it the edge view of Williamson's figure 82a, the holotype of *E. incertum* (Williamson). Williamson's plate description and the text also show his true intent, and a comparison of the illustrations shows the obvious discrepancy, particularly as to the number and distribution of the sutural pores (the character on which Williamson separated these forms). This same mistake was copied again by Cushman in this monograph on the Nonionidae (1939), where Williamson's figures of *"Polystomella umbilicatula"* again are separated, the side view referred to *E. excavatum* (Cushman, 1939, pl. 16, fig. 10) and the edge view referred to *E. incertum* (Cushman, 1939, pl. 15, fig. 21b).

Cushman (1930, pl. 7, fig. 5) also refigured as *E. incertum* a drawing "after H. B. Brady," although nowhere did Brady describe or figure any specimens referred either to *incertum* or to *umbilicatula.* An examination of the plates of the *Challenger* report shows that the illustration copied from Brady by Cushman was one referred by Brady to *Polystomella striatopunctata* (1884, pl. 109, fig. 23). Cushman did not list this reference of Brady's under the synonymy of *E. incertum,* however, nor did he refer to it in the discussion.

A later British reference to *E. incertum* is that of Macfadyen (1932, pl. 35, figs. 16a,b). This figure shows a form much like the type figures of Williamson, with radial slits at the inner portion of the sutures joining at the depressed umbilicus. American Arctic speci-

mens referred to *E. incertum* (other than those obviously belonging to *E. bartletti, clavatum,* or *orbiculare*) almost invariably have an umbonal boss, as well as straighter sutures and more numerous chambers.

The only American Arctic reference to *incertum* which possibly may be correctly identified is that of Phleger (1952, pl. 14, fig. 7), as it has the sutural slits converging at the umbilical depression. Phleger's specimen does have more-numerous chambers, however—11 in the final whorl—whereas Williamson's and Macfadyen's figures show only 9. Unfortunately neither of these later authors give a complete description in their text, so it is impossible to say whether this number is an unchangeable character or an upper or lower limit. In this connection it might be noted that all too often similar misidentifications occur because of the failure of authors to give complete descriptions of new varieties.

Williamson's description of his variety *incertum* discussed important features (the very ones ignored by later authors, in fact), but failed to give such pertinent features as measurements, number of chambers, etc., and only a side view was figured (in spite of Cushman's later inclusion of Williamson's edge view of *umbilicatula* along with the side view of *incertum*). Thus, until 1932 (almost 75 years later) there were no reliable figures showing both side and edge views, and as yet still no adequate description of the typical *incertum.* Cushman's various descriptions of *incertum* are based on the specimens he had from Greenland, Hudson Bay, the coast of Maine, Massachusetts, etc., which are not *incertum.* Thus his descriptions refer to an umbilical knob, not present in the English specimens, and he differentiated his "variety" *clavatum* of *E. incertum* as differing from the typical form only in possessing several bosses in the umbilical region. Among specimens he referred to var. *clavatum* in the Cushman collection are many specimens with a single central boss, however.

ELPHIDIUM ORBICULARE (Brady)

Plate 19, figures 1-4

Nonionina orbicularis Brady, 1881, Ann. Mag. Nat. Hist., ser. 5, vol. 8, p. 415, pl. 21, figs. 5a,b; 1882, Denkschr. Akad. Wiss. Wien, math.-nat. Kl., vol. 43, p. 17, pl. 2, figs. 5a,b; 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 727, pl. 109, figs. 20-21.—Cushman, 1922, Contr. Canadian Biol., No. 9 (1921), p. 13 (145).

Nonion orbiculare (Brady) Cushman, 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 12, pl. 5, figs. 1-3; 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 23, pl. 6, figs. 17-19; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 53, pl. 6, fig. 3.

Test free, of medium size, robust, planispirally coiled and involute, sides flat or gently convex, periphery broadly rounded; 9 to 11 chambers in the last whorl, increasing very gradually in size as added; sutures gently curved, distinct, slightly depressed, somewhat thickened and granular in appearance near the umbilical region, or may have a few rather indistinct pores; wall calcareous, hyaline, finely perforate, surface smooth, umbilical area with a granular surface which grades into the sutural granulation; aperture a linear series of pores at the base of the final chamber.

Greatest diameter of hypotype of figure 2, 1.01 mm., greatest thickness 0.62 mm. Greatest diameter of hypotype of figure 3, 0.55 mm., thickness 0.29 mm.

Remarks.—This species was placed in the genus *Nonion* by Cushman, although he stated (1939, p. 24), "aperture a long, very narrow slit at the base of the apertural face, sometimes divided into several openings. . . . The aperture tends toward that of *Elphidium,* and some specimens show what may be slight traces of retral processes."

Inasmuch as the different apertural characters, sutural pores and retral processes were the main basis for separation of these genera, it seems that this species would better have been placed in *Elphidium.* This placement is further corroborated by the character of the wall structure. According to Wood (1949), all species of *Nonion* have perforate granular walls, and *Elphidium* has a distinctly perforate radiate wall structure. The writers have examined the wall of the present species and find it to be radiate, and we therefore place the species in *Elphidium.*

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2026a-d) from station 18; unfigured hypotypes are recorded from the following stations: 1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 14, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 32, 33, 34, 35, 37, 38, 39, 42, 45, and 50.

ELPHIDIUM OREGONENSE Cushman and Grant

Plate 18, figures 1-3

Polystomella siberica Goës, CUSHMAN, 1914 (not Goës, 1894), U. S. Nat. Mus. Bull. 71, pt. 4, p. 34, pl. 19, fig. 1.

Elphidium oregonense CUSHMAN and GRANT, 1927, Trans. San Diego Soc. Nat. Hist., vol. 5, p. 79, pl. 8, fig. 3.—CUSHMAN, 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 50, pl. 18, figs. 14-16.—VAN VOORTHUYSEN, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 1, p. 22, pl. 5, fig. 5, text fig. 1.

Elphidiella oregonense (Cushman and Grant) CUSHMAN, 1941 (part), Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 34, pl. 9, figs. 8, 9 (not fig. 7).

Elphidiella oregonensis (Cushman and Grant) BANDY, 1950, Journ. Paleontol., vol. 24, No. 3, p. 277, pl. 41, figs. 13a,b.

Test free, extremely large, somewhat compressed, biumbonate, the umbilical boss being progressively more prominent with age, the larger specimens having a distinctly projecting boss of clear shell material with occasional pores; chambers numerous, varying from 12 in the last whorl of juvenile specimens to as many as 23 in the larger specimens, all of approximately equal height; sutures distinct, curved, flush to slightly depressed in the later portion of the test, with a large number of sutural pores, and prominent and elongate retral processes; wall calcareous, finely perforate, surface smooth in the later portion, the elongate retral processes often giving a cancellate appearance to the earlier part of the final whorl, the umbonal boss projecting above the remainder of the test; aperture consisting of numerous scattered pores in the apertural face of the final chamber.

Greatest diameter of hypotype of figure 3, 0.75 mm., thickness through umbo 0.34 mm. Greatest diameter of hypotype of figure 2, 1.12 mm., thickness through umbo 0.34 mm. Greatest diameter of hypotype of figure 1, 2.42 mm., thickness through umbo 0.75 mm. Other hypotypes up to 2.26 mm. in diameter.

Remarks.—Described originally as an *Elphidium,* this species was placed in *Elphidiella* by Cushman (1941, p. 34) on the basis of specimens with double rows of pores. However, closer examination of these double-pored specimens shows them to actually belong to *Elphidiella groenlandica* (Cushman). One of these was illustrated by Cushman (1941, pl. 9, fig. 7). Later Bandy (1950, p. 277) concurred in placing the species in *Elphidiella,* stating "sutural pores varying from an irregular single row to a double row," although his illustrated specimen shows only a single row. Van Voorthuysen (1952a, p. 23) stated, "Wax-preparations made for the study of the canal system . . . indicate that our form possesses a single row of openings narrowly beginning and broadly ending. . . . Since our *Elphidium oregonense* specimens do not show forking canals they are considered to belong to *Elphidium.*"

The specimen figured by Cushman (1914, pl. 19, fig. 1) and referred to *Polystomella siberica* Goës from a dredging at *Albatross* station D 3600 at 9 fathoms (16.5 m.) (erroneously recorded by Cushman as 156 fathoms) in the Bering Sea is like the present species. Unfortunately the specimen figured by Cushman has apparently been lost, as it is not to be found in his collections; however, the specimen of figure 1 is very similar to Cushman's illustration and in fact was picked from the same *Albatross* sample by the present writers. The

slightly evolute appearance of the later chambers surrounding the umbonal boss is characteristic of the present species, but distinct from *Elphidiella siberica*. Göes's species has a smooth surface and the umbonal region is not separated in a distinct elevated boss, and there are two distinct rows of pores.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2109a-c) and unfigured hypotypes from station 44.

ELPHIDIUM SUBARCTICUM Cushman

Plate 19, figures 5-7

Elphidium subarcticum CUSHMAN, 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 27, pl. 3, figs. 34, 35; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 58, pl. 6, fig. 12,—F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 412, pl. 5, fig. 9.

Test free, discoidal, planispiral and involute, sides flat, periphery broadly rounded, margin slightly lobulate; 8 to 9 chambers visible, the later ones moderately inflated; sutures distinct, slightly depressed, with a row of small sutural pores and a wide opaque band on either side; wall calcareous, finely perforate, translucent, except for the band along the sutures, surface smooth; aperture consisting of a row of pores at the base of the apertural face of the final chamber and additional accessory pores scattered over the face, although not always prominent.

Greatest diameter of hypotype of figure 6, 0.73 mm., thickness 0.26 mm. Greatest diameter of hypotype of figure 5, 0.86 mm., thickness 0.36 mm. Greatest diameter of figure 7, 0.73 mm., thickness 0.29 mm. Other hypotypes range from 0.29 to 0.86 mm. in diameter.

Remarks.—Like *E. frigidum* Cushman, this species has scattered apertural pores in the apertural face, in addition to the pores at the base of the face. These scattered pores have not been noted in previous descriptions or figures of either of these species. Unless future restudy of the genotype species of *Elphidium* shows that species to have been erroneously described as possessing such pores in the face, the name *Cribroelphidium* should be suppressed as a synonym of *Elphidium*. Thus we have retained the present species in the genus *Elphidium*.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2057a,b) from station 1; figured hypotype (U.S.N.M. No. P2058) from station 10; unfigured hypotypes are recorded from stations 1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 17, 18, 19, 20, 24, 27, 30, 34, 38, 45, 46, and 50.

Genus ELPHIDIELLA Cushman, 1936

ELPHIDIELLA ARCTICA (Parker and Jones)

Plate 20, figures 1-3

Polystomella arctica Parker and Jones, 1864, *in* H. B. Brady, Trans. Linn. Soc. London, Zool., vol. 24, p. 471, pl. 48, fig. 18.

Elphidium arcticum (Parker and Jones) Cushman, 1930, U. S. Nat. Mus. Bull. 104, pt. 7, p. 27, pl. 11, figs. 1-6.

Elphidiella arctica (Parker and Jones) Cushman, 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 65, pl. 18, figs. 11-14.—Cushman and Todd, 1947, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 65, pl. 15, fig. 20.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 59, pl. 6, fig. 15.

Test free, large, planispiral, moderately compressed, with nearly flat sides and broadly rounded periphery; chambers numerous, increasing gradually in size as added, 10 to 13 in the final whorl, later ones slightly inflated; sutures distinct, early ones sometimes thickened and slightly raised, later ones slightly depressed so that the margin is somewhat lobulate, two rows of pores along the sutures, about 11 to 13 pairs along the last suture as seen from a single side; wall calcareous, smooth except for the double row of pores, the sometimes slightly elevated sutures and occasionally shallow parallel grooves extending from the sutural pores across the intervening chambers and paralleling the outer margin; aperture consists of a few pores in the face, only about three in the young stages, later with a row of pores across the face, but somewhat above its base, and scattered pores in the face above this row.

Greatest diameter of hypotype of figure 1, 1.56 mm., thickness 0.49 mm.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1056a,b) from station 6; figured hypotype (U.S.N.M. No. P1057) from station 49; unfigured hypotypes are recorded from the following stations: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 19, 20, 21, 22, 23, 24, 26, 28, 29, 30, 31, 32, 34, 35, 39, 42, 49, 50, 51, and 52.

ELPHIDIELLA GROENLANDICA (Cushman)

Plate 19, figures 13, 14

Elphidium groenlandicum Cushman, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 4, pl. 1, fig. 10.

Elphidiella groenlandica (Cushman) Cushman, 1939, U. S. Geol. Surv. Prof. Pap. 191, p. 66, pl. 19, fig. 3; 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 60, pl. 6, fig. 14.

Elphidiella oregonense (Cushman and Grant) Cushman, 1941 (part), Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 34, pl. 9, fig. 7 (not figs. 8, 9).

Test free, large, planispiral and involute, thickest through the umbilical region, periphery subacute; chambers numerous, low, 14 to 16 in the final whorl; sutures distinct, not depressed, very gently curved, bordered with a double row of sutural pores, which alternate and can be seen extending into the interior of the shell on well-preserved specimens, giving the sutures a characteristic pinnate appearance; wall calcareous, very finely perforate, surface smooth, umbilical region filled with clear shell material; aperture consists of a row of pores along the base of the apertural face of the final chamber.

Remarks.—Cushman (1941, p. 35, pl. 9, fig. 7) discussed and figured a specimen of this species as a possible young stage of *Elphidiella oregonense* (Cushman and Grant). On the basis of this specimen, which in no way resembled *Elphidium oregonense* but is a typical example of *Elphidiella groenlandica* Cushman, he erroneously changed the generic position of *oregonense* to *Elphidiella.*

The types of this species are from Greenland. Specimens of this species, recorded as *Elphidiella oregonense,* were found in the Pleistocene from a submarine beach about 1.0 mile north, 60° west of Nome, Alaska. It is rare off the northern coast of Alaska, occurring only in two samples off Point Barrow. As the specimens found there are dead shells and appear somewhat worn, it is possible that they may actually be fossil shells, as this species is much more abundant in the Pleistocene of this part of northern Alaska than in the present seas.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2134) from station 17; figured hypotype (U.S.N.M. No. P2135) from station 18; unfigured hypotypes are recorded from stations 17, 18, 33, 63, 66, and 74.

ELPHIDIELLA NITIDA Cushman

Plate 19, figures 11, 12

Elphidium hannai CUSHMAN and GRANT, var. 1927, Trans. San Diego Soc. Nat. Hist., vol. 5, p. 78, pl. 8, fig. 2.

Elphidiella hannai (Cushman and Grant) CUSHMAN, 1939 (part), U. S. Geol. Surv. Prof. Pap. 191, p. 66, pl. 19, fig. 2 (not fig. 1).—CUSHMAN and McCULLOCH, 1940, Allan Hancock Pacific Exped., vol. 6, No. 3, p. 177, pl. 20, fig. 11.—CUSHMAN and TODD, 1947, Cushman Lab. Foram. Res. Spec. Publ. 21, p. 15, pl. 2, fig. 22.

Elphidiella nitida CUSHMAN, 1941, Contr. Cushman Lab. Foram. Res., vol. 17, pt. 2, p. 35, pl. 9, fig. 4.

Test free, lenticular, planispiral and involute, periphery rounded; chambers distinct, numerous, 13 to 15 in the last whorl; sutures distinct, thickened but not raised, radial to slightly curved, bordered by a double row of sutural pores extending to the smooth umbilical region;

wall calcareous, finely perforate, surface smooth, except for numerous fine granules on the periphery of the previous whorl for a short distance just in front of the aperture and up the apertural face; aperture consists of a row of pores at the base of the apertural face of the final chamber.

Greatest diameter of hypotype of figure 12, 0.75 mm., thickness 0.34 mm. Greatest diameter of hypotype of figure 11, 0.60 mm., thickness 0.26 mm. Other hypotypes range from 0.31 to 0.81 mm. in diameter.

Remarks.—The fine granules present on the apertural face and on the periphery of the preceding whorl just in front of the aperture have apparently been shown in the illustration of Cushman and McCulloch, but have never been mentioned in any description of this species. Cushman and Grant stated that the aperture consisted of a series of pores at the base of the face and in addition other pores scattered over the apertural face. We have been unable to see these scattered pores on any of the types in the Cushman collection or in our own specimens and suspect that the above-mentioned pustules may have been mistaken for apertural pores.

In 1941 Cushman described the present species as distinct from *E. hannai* (Cushman and Grant), and placed in *E. nitida* the above-listed references of Cushman and Grant, 1927, Cushman, 1939, and Cushman and McCulloch, 1940. However, in 1947 all these references were again listed in the synonymy of *E. hannai* by Cushman and Todd and no mention was made of *E. nitida,* apparently through an oversight. The specimens shown by Cushman and Todd seem also to belong to *E. nitida.*

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2143a,b) and unfigured hypotypes from station 44.

Family Buliminidae

Genus ROBERTINOIDES Höglund, 1947

ROBERTINOIDES (?) CHARLOTTENSIS (Cushman)

Plate 20, figures 6, 7

Cassidulina charlottensis Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, p. 41, pl. 6, figs. 6, 7.

Robertina charlottensis (Cushman) Cushman and F. Parker, 1936, Contr. Cushman Lab. Foram. Res., vol. 12, pt. 4, p. 97, pl. 16, figs. 12a,b.

Robertina californica Cushman and F. Parker, 1936, ibid., figs. 14a,b.

Test free, elongate, spiral, widest at or slightly above the mid-portion; several chambers to a whorl, each subdivided by a vertical

infolding of the wall which gives the external appearance of a suture, but does not completely divide the chamber; sutures distinct, thickened, but not raised; wall calcareous, finely but distinctly perforate, surface smooth; aperture double, consisting of a vertical slit extending into the face of the final chamber from its base, and a second slit almost at right angles to the first, and extending along the base of the chamber, sometimes the two apertural slits are connected and in other specimens the chamber flap is firmly attached between them separating the aperture distinctly.

Length of hypotype of figure 7, 0.49 mm., breadth 0.31 mm. Length of hypotype of figure 6, 0.65 mm., breadth 0.34 mm. Other hypotypes range from 0.29 to 0.83 mm. in length.

Remarks.—A study of the holotype and paratype specimens of *Cassidulina charlottensis* Cushman and *Robertina californica* Cushman and Parker, shows no appreciable difference between them. The slight curvature of the axis described as characteristic of the former seems to be merely an individual variation, hence the two forms are here regarded as conspecific.

There is more doubt as to the generic status than the specific one, however. *Robertina* (genotype *R. arctica* d'Orbigny) was described by d'Orbigny as having a virguline aperture on the side of the last chamber. Höglund, 1947, described *Robertinoides* as having a double aperture and he also stated that the majority of species previously referred to *Robertina* belonged to *Robertinoides* as well. Specimens referred by Höglund to *R. arctica* were like the illustration of d'Orbigny in having a single aperture.

Specimens referred to *Robertina arctica* by Cushman and Parker, 1936, have a double aperture like the present species, and Höglund stated that they were not the same as d'Orbigny's form. In a later paper Parker (1952a, p. 416) stated that Höglund's *Robertina arctica* resembled *R. charlottensis* (Cushman), and commented, "I cannot agree with his interpretation of d'Orbigny's species. . . . The specimens referred to *Robertina arctica* by Cushman and Parker (1947) appear to be identical with d'Orbigny's figured form except that there is a narrow apertural opening along the inner part of the chamber division. I believe that it would have been easy for d'Orbigny to overlook this, merely believing it to be a part of the dividing suture. . . . If my interpretation of d'Orbigny's figures is correct, Höglund's genus *Robertinoides* should be placed in the synonomy under *Robertina* and a new genus erected for the single-apertured forms."

Thus the generic designation rests upon which interpretation of

d'Orbigny's species is correct and can only be solved by an examination of d'Orbigny's type specimens. Meanwhile, as d'Orbigny only showed a single aperture in *Robertina* and Höglund described *Robertinoides* as having a double aperture, we are placing this species in *Robertinoides,* although there is at least a possibility that d'Orbigny's illustration and description may be inaccurate and the two generic names synonymous.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2099) from station 12; figured hypotype (U.S.N.M. No. P2100) from station 18; unfigured hypotypes are recorded from stations 1, 3, 4, 6, 13, 18, 19, 20, 21, 22, 23, 26, 27, 31, 35, 37, 50, and 51.

Genus BULIMINA d'Orbigny, 1826

BULIMINA EXILIS Brady

Plate 20, figures 4, 5

Bulimina elegans d'Orbigny var. *exilis* Brady, 1884, Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 399, pl. 50, figs. 5, 6.—Cushman, 1911, U. S. Nat. Mus. Bull. 71, pt. 2, p. 82, text fig. 135; 1922, U. S. Nat. Mus. Bull. 104, pt. 3, p. 106, pl. 17, figs. 7-12, pl. 19, figs. 2, 3.

Bulimina exilis Brady, Cushman and F. Parker, 1940, Contr. Cushman Lab. Foram. Res., vol. 16, pt. 1, p. 11, pl. 2, figs. 18-21; 1947, U. S. Geol. Surv. Prof. Pap. 210-D, p. 123, pl. 28, figs. 27, 28.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 62, pl. 7, fig. 1.—F. Parker, 1948, Bull. Mus. Comp. Zool., vol. 100, No. 2, pl. 4, fig. 9.

Test elongate, slender, tapering to the sometimes apiculate base; chambers numerous, slightly inflated, elongate; sutures distinct, depressed; wall calcareous, finely perforate, translucent and smooth; aperture loop-shaped, rather broad, but elongate.

Length of hypotype of figure 5, 0.47 mm., breadth 0.18 mm. Other hypotypes range from 0.18 to 0.70 mm. in length.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2111a,b) from station 33; unfigured hypotypes are recorded from stations 5, 12, 13, 15, 16, 18, 21, 22, 23, 27, 29, 30, 32, 33, 35, 38, 42, and 52.

Genus GLOBOBULIMINA Cushman, 1927

GLOBOBULIMINA AURICULATA subsp. ARCTICA Höglund

Plate 20, figures 8, 9

Bulimina ellipsoides Costa, Goës (part), 1894 (not Costa, 1856), Svenska Vet.-Akad. Handl., vol. 25, No. 9, p. 45.

Globobulimina auriculata (Bailey) forma *arctica* Höglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 254, text figs. 266, 267, 270, 271.

Test free, large, ovate in outline with broadly rounded base, circular in section; chambers arranged in an elongate spiral, triserial, slightly inflated, increasing rapidly in size as added; sutures distinct, slightly depressed; wall calcareous, thin, perforate, surface smooth; aperture loop-shaped, with a doubly folded tongue of which one extremity rises above the aperture like a fan, and the other is extended into the chamber cavity like an "entosolenian" tube, connecting with the aperture of the previous chamber.

Length of hypotype of figure 8, 1.38 mm., breadth 0.70 mm. Length of hypotype of figure 9, 0.88 mm., breadth 0.47 mm.

Remarks.—No elaboration need be made on the excellent description of the internal characters of this species given by Höglund, and our specimens seem identical with those referred by Höglund to forma *arctica.*

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2112) from station 1; figured hypotype (U.S.N.M. No. P2113) from station 43; unfigured hypotypes are recorded from stations 3 and 18.

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA PSEUDOPUNCTATA Höglund

Plate 20, figures 13, 14

Bolivina punctata d'Orbigny, Goës (part), 1894 (not d'Orbigny, 1839), Svenska Vet.-Akad. Handl., vol. 25, No. 9, p. 49, pl. 9, figs. 478, 480 (not figs. 475-477).

Bolivina pseudopunctata Höglund, 1947, Zool. Bidrag Uppsala, vol. 26, p. 273, pl. 24, fig. 5, pl. 32, figs. 23, 24, text figs. 280, 281, 287.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 414. pl. 5, figs. 20, 21.—Phleger, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 83, pl. 14, fig. 19.

Test free, small, narrow and elongate, tapering gradually, slightly compressed, periphery rounded; chambers low and broad at first, increasing in relative height as added, later chambers of greater height than breadth; sutures distinct, depressed, strongly oblique; wall calcareous, thin, translucent, surface smooth, the lower portion of each chamber with numerous fine pores, the upper portion imperforate; aperture elongate, with a tongue.

Length of hypotype of figure 13, 0.43 mm., breadth 0.10 mm., thickness 0.08 mm. Length of hypotype of figure 14, 0.44 mm., breadth 0.16 mm.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2145a,b) from station 21; unfigured hypotypes are recorded from stations 20, 21, 22, 23, 26, 29, 30, 31, 32, 39, and 42.

Genus ANGULOGERINA Cushman, 1927

ANGULOGERINA FLUENS Todd

Plate 20, figures 10-12

Angulogerina fluens Todd, 1947, *in* Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 67, pl. 16, figs. 6, 7; 1948, *in* Cushman and McCulloch, Allan Hancock Pacific Exped., vol. 6, No. 5, p. 288, pl. 36, fig. 1.

Angulogerina angulosa (Williamson) Cushman, 1948 (not *Uvigerina angulosa* Williamson, 1858), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 66, pl. 7, fig. 8.

Test free, elongate, slightly flaring to fusiform, triangular in section in the early portion, the angles becoming rounded in the later portion; chambers numerous, triserially arranged, inflated, of nearly equal height and breadth, early chambers closely appressed, and later ones more separated; sutures distinct, constricted, particularly in the later portion; wall calcareous, finely and distinctly perforate, ornamented by numerous low, vertical costae, curving with the chambers, sometimes nearly dying out over the final chamber, so that the surface is smooth and the perforations seem relatively more distinct; aperture terminal, elongate oval, on a very short neck with a thickened rim.

Length of hypotype of figure 11, 0.73 mm., breadth 0.29 mm. Length of hypotype of figure 10, 0.55 mm., breadth 0.26 mm. Length of hypotype of figure 12, 0.42 mm., breadth 0.22 mm. Other hypotypes range from 0.21 to 0.78 mm. in length.

Remarks.—This species is much less angular than *A. angulosa* (Williamson), and the specimen figured by Cushman (1948b) from the Arctic apparently belongs with the present species.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2002) from station 18; figured hypotype (U.S.N.M. No. P2003) from station 20; figured hypotype (U.S.N.M. No. P2004) from station 21; unfigured hypotypes are recorded from stations 1, 3, 5, 12, 18, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 34, 35, 36, 38, 39, 42, 44, and 45.

Family Spirillinidae

Genus SPIRILLINA Ehrenberg, 1843

SPIRILLINA VIVIPARA Ehrenberg

Plate 21, figures 2, 3

Spirillina vivipara Ehrenberg, 1843, Abh. Akad. Wiss. Berlin (Jahrg. 1841), pt. 1, pp. 323, 422, pl. 3, VII, fig. 41.—Parker and Jones, 1865, Philos. Trans. Roy. Soc. London, vol. 155, p. 397, pl. 15, fig. 28.—Brady, 1884, Rep. Voy. *Challenger*, vol. 9 (Zoology), p. 630, pl. 85, figs. 1-5.—Cushman, 1915, U. S. Nat. Mus. Bull. 71, pt. 5, p. 3, text figs. 1a,b, pl. 1, figs. 1, 2; 1931, U. S. Nat. Mus. Bull. 104, pt. 8, p. 3, pl. 1, figs. 1-4.

Spirillina arctica CUSHMAN, 1933 (part), Smithsonian Misc. Coll., vol. 89, No. 9, p. 6, pl. 2, fig. 2 (not fig. 1); 1948 (part), Cushman Lab. Foram. Res. Spec. Publ. 23, p. 66, pl. 7, fig. 10 (not fig. 9).

Test free, small, discoidal, nearly planispiral, consisting of a globular proloculus and long, undivided, spirally coiled tubular second chamber which increases gradually in diameter as added; spiral suture distinct; wall calcareous, hyaline, with fine to medium perforations, occasionally with transverse growth wrinkles in the latter portion, surface otherwise smooth; aperture at the open end of the tubular chamber.

Greatest diameter of hypotype of figure 3, 0.31 mm., thickness 0.05 mm. Greatest diameter of hypotype of figure 2, 0.18 mm. Other hypotypes range from 0.16 to 0.44 mm. in diameter.

Remarks.—The holotype of *Spirillina arctica* Cushman is a *Turrispirillina,* but Cushman's figured paratype is a true *Spirillina* and seems close to *Spirillina vivipara* as figured by Brady. Ehrenberg's original illustration is a drawing of a specimen mounted in balsam and does not show the surface characters. It is most probably the same however.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2081) from station 34; figured hypotype (U.S.N.M. No. P2082) from station 39; unfigured hypotypes are recorded from stations 28 and 29.

Genus TURRISPIRILLINA Cushman, 1927

TURRISPIRILLINA ARCTICA (Cushman)

Plate 21, figure 1

Spirillina arctica CUSHMAN, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 6, pl. 2, fig. 1 (not fig. 2); 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 66, pl. 7, fig. 9 (not fig. 10).

Test free, small, circular in outline, consisting of a globular proloculus and long undivided tubular second chamber, increasing gradually in diameter as added and tightly coiled into a low hollow cone; spiral suture distinct, slightly depressed; wall calcareous, thin, hyaline, translucent and very finely perforate; aperture formed by the open end of the tube, somewhat higher than broad because of the slightly compressed tubular chamber.

Greatest diameter of figured hypotype 0.23 mm., least diameter 0.21 mm., height of spire 0.05 mm.

Remarks.—Cushman (1933a, p. 6) in describing this species states "close coiled, overlapping very slightly on the dorsal side leaving a

depressed hollow cone as it revolves." This character alone distinguishes members of the genus *Turrispirillina* Cushman, 1927, from those belonging to *Spirillina,* which is close-coiled in a single plane. To further complicate the matter Cushman's holotype slide contains two specimens, both typical specimens of the genus *Turrispirillina,* but the figured paratype specimen (1933a, pl. 2, fig. 2; 1948b, pl. 7, fig. 10) is a typical *Spirillina* and bears no close relation to the "holotype" slide. The unfigured paratypes in the Cushman collection are all specimens of *Turrispirillina.*

Types and occurrence.—Figured hypotype (U.S.N.M. No. P1062) from station 29; unfigured hypotypes are recorded from stations 29, 38, and 42.

Genus PATELLINA Williamson, 1858

PATELLINA CORRUGATA Williamson

Plate 21, figures 4, 5

Patellina corrugata Williamson, 1858, Recent Foraminifera of Great Britain, p. 46, pl. 3, figs. 86-89.—Cushman, 1930, Contr. Cushman Lab. Foram. Res., vol. 6, p. 15, pl. 3, figs. 5a-c; 1931, U. S. Nat. Mus. Bull. 104, pt. 8, p. 11, pl. 2, figs. 6, 7; 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 30, pl. 4, fig. 14.—Cushman and Todd, 1947, Cushman Lab. Foram. Res. Spec. Publ. 21, p. 20, pl. 3, fig. 13; 1947, Contr. Cushman Lab. Foram. Res., vol. 23, p. 67, pl. 16, fig. 9.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 67, pl. 7, fig. 11.—F. Parker, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 420, pl. 6, figs. 16, 17.

Test free, low, scalelike, planoconvex or concavoconvex, and ventrally umbilicate, periphery acute, with a slight keel; the globular proloculus is followed by a long, undivided tubular second chamber of approximately 2 to 3 whorls, and then by crescentic-shaped chambers arranged in two alternating series, each covering slightly over one-half the circumference of the preceding whorl, final chamber may be completely annular, many internal secondary septa partially subdividing these later chambers; sutures distinct; wall calcareous, hyaline, very thin and translucent, finely perforate; aperture ventral, elongate, at the base of the final chamber.

Greatest diameter of hypotype of figure 4, 0.44 mm., height of spire 0.18 mm.; greatest diameter of hypotype of figure 5, 0.31 mm., height of spire 0.10 mm. Other hypotypes range from 0.13 to 0.47 mm. in diameter.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2029) from station 34; figured hypotype (U.S.N.M. No. P2030) from station 51; unfigured hypotypes are recorded from the following sta-

tions; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30, 31, 32, 35, 36, 37, 42, 45, 50, and 51.

Family Rotaliidae

Genus BUCCELLA Andersen, 1952

BUCCELLA FRIGIDA (Cushman)

Plate 22, figures 2, 3

Pulvinulina frigida Cushman, 1922, Contr. Can. Biol. No. 9 (1921), p. 12 (144).

Eponides frigida (Cushman) Cushman, 1931, U. S. Nat. Mus. Bull. 104, pt. 8, p. 45.

Eponides frigidus (Cushman) Cushman, 1941, Contr. Cushman. Lab. Foram. Res., vol. 17, pt. 2, p. 37, pl. 9, figs. 16, 17.

Eponides frigida (Cushman) var. *calida* Cushman and Cole, 1930, Contr. Cushman Lab. Foram. Res., vol. 6, No. 4, p. 98, pl. 13, figs. 13a-c.—Cushman, 1931, U. S. Nat. Mus. Bull 104, pt. 8, p. 47; 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 34, pl. 4, figs. 19, 20.

Buccella frigida (Cushman) Andersen, 1952, Journ. Washington Acad. Sci., vol. 42, No. 5, p. 144, figs. 4a-c, 5, 6a-c.

Test free, small, trochoid, biconvex, periphery rounded; all chambers of the 2½ to 3 whorls visible dorsally, only the 5 to 8 of the final whorl visible ventrally, increasing gradually in size as added; sutures distinct, thickened, flush, oblique and curved backward on the periphery on the dorsal side, on the ventral side radial and filled with granular material which continues into the umbilical region; wall calcareous, finely perforate, smooth and polished dorsally, with the sutures, umbilical area, and basal margin of the final chamber granular in appearance on the ventral side; aperture concealed by the pustulose material, but worn specimens show an arched aperture at the basal margin of the final chamber, about midway between the umbilicus and periphery, with supplementary apertures at the outer margin of the sutures near the periphery.

Greatest diameter of lectotype 0.46 mm., thickness 0.20 mm. Hypotypes range from 0.21 to 0.47 mm. in diameter.

Remarks.—The structure and relationships of this species were well described by Andersen and need no elaboration here.

Types and occurrence.—Lectotype (Cushman Coll. No. 3032) from a depth of 18.3 m. in bay on east coast (south of Black Whale Harbor), Canadian Arctic. Figured hypotype (U.S.N.M. No. P2144) from station 17; unfigured hypotypes are recorded from stations 5, 6, 7, 9, 12, 13, 16, 17, 18, 20, 21, 23, 24, 25, 27, 28, 30, and 37.

BUCCELLA INUSITATA Andersen

Plate 22, figure 1

Eponides frigidus (Cushman) Cushman and Todd, 1947 (not *Pulvinulina frigida* Cushman, 1922), Cushman Lab. Foram. Res. Spec. Publ. 21, p. 21.—Cushman, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 71, pl. 8, fig. 7.

Buccella inusitata Andersen, 1952, Journ. Washington Acad. Sci., vol. 42, No. 5, p. 148, figs. 10a-11c.

Test of medium size, trochoid, biconvex to nearly planoconvex, with a relatively high dorsal spire, periphery acute and with a narrow keel, peripheral margin of the later chambers lobulate; all chambers of the 3 to 4 whorls visible dorsally, only the 7 to 9 chambers of the last whorl visible ventrally; sutures distinct, limbate, oblique and curved backward strongly at the periphery on the dorsal side, radial ventrally and covered with granular material; wall calcareous, finely perforate, the dorsal side smooth and polished in appearance, the ventral side more coarsely perforate and with a considerable amount of granular material along the sutures, umbilical area, and back margin of the final chamber; apertures at the outer margin of each suture on the ventral side.

Greatest diameter of figured hypotype 0.52 mm., thickness 0.29 mm. Other hypotypes range from 0.21 to 0.94 mm. in greatest diameter.

Remarks.—This species differs from the associated *B. frigida* in being larger, more sharply keeled and more strongly convex.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2102) from station 18; unfigured hypotypes are recorded from stations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 38, 39, 42, 44, 45, 50, 51, and 52.

TRICHOHYALUS [7] Loeblich and Tappan, new genus

Synonyms: *Discorbis* Cushman, 1933 (part) (not Lamarck, 1804).
Discorinopsis Cushman, 1948 (not Cole, 1941).

Genotype (type species): *Discorbis bartletti* Cushman, 1933.

Test free, trochoid, planoconvex, all whorls visible dorsally, ventral side obscured by a secondary growth of shell material, forming a vesicularlike plate over the umbilical region and extending over the other chambers nearly to the periphery, with pores extending through this vesicular tissue into the cavity beneath, and the exterior ornamented with nodes, ridges, and furrows; wall calcareous, hyaline, coarsely perforate-granular in structure, smooth dorsally, the ventral

[7] From Gr. *thrix, trichos,* hair; *hyalos,* glass.

side ornamented by the grooves, ridges, and nodes of the vesicular secondary growth; aperture absent or obscured by secondary growth on the final chamber, but can be seen on earlier chambers by dissection, as an arch at the base of the chamber, slightly ventral from the periphery.

Occurrence.—Recent.

TRICHOHYALUS BARTLETTI (Cushman)

Plate 23, figures 1-7

Discorbis bartletti CUSHMAN, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 6, pl. 2, figs. 3-6.

Discorinopsis bartletti (Cushman) CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 70, pl. 7, fig. 15, pl. 8, figs. 1-3.

Test free, trochoid, planoconvex, with rounded periphery and slightly lobulate margin; all chambers of the 1½ whorls visible on the strongly convex dorsal side, only those of the last whorl visible ventrally, increasing gradually in size as added, and increasing also in number per whorl from 4 in juvenile specimens to as many as 10 in the adult; sutures distinct, slightly depressed and gently curved on the dorsal side, early sutures obscured ventrally; wall calcareous, hyaline, but granular in structure, coarsely perforate, but smooth on the dorsal side, ornate ventrally with many fine radial ridges on the outer portion of the chambers, some continuous, others broken and giving the outer margin of the test a fimbriatelike edge, the grooves between these ridges tracing into pores toward the umbilical area, the umbilical area being filled with a vesicular secondary growth which covers all the earlier chambers and is externally nodose in appearance, with pores running to the interior of the test and a definite cavity between this growth and the actual chamber walls; no aperture visible on the final chamber, but dissection shows the presence of a low arched opening at the base of the penultimate chamber somewhat ventral from the periphery, which is doubtless obscured on the final chamber by the vesicular tissue.

Greatest diameter of hypotype of figure 1, 1.51 mm., thickness 0.70 mm. Greatest diameter of hypotype of figure 5, 1.22 mm. Greatest diameter of hypotype of figure 7, 0.78 mm. Greatest diameter of hypotype of figure 6, 0.60 mm. Greatest diameter of hypotype of figure 2, 1.48 mm.

Remarks.—This species was originally described as a *Discorbis,* later was referred to *Discorinopsis* Cole, 1941. Thin sections of the genotype species of *Discorinopsis* show that it is an arenaceous form,

hence the present species is quite distinct, and is here made the genotype species of *Trichohyalus,* new genus.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P1065a-d) from station 34; figured hypotypes (U.S.N.M. Nos. P1066a-c) from station 29; unfigured hypotypes are recorded from stations 23, 28, 29, 30, 31, 34, 39, and 45.

TRICHOHYALUS PUSTULATA Loeblich and Tappan, new species

Plate 23, figures 8, 9

Test free, trochoid, biconvex, periphery subacute, margin serrate in appearance due to the ventral pustules extending beyond the edge; chambers numerous, about 7 chambers in the final whorl in the adult, with about 1½ whorls present, all whorls visible dorsally; sutures gently curved backward on the dorsal side, obscure, slightly thickened but not raised, completely obscured by the surface ornamentation on the ventral side; wall calcareous, finely perforate, dorsal surface smooth, ventral surface covered by numerous pustules, larger and more irregular ones toward the umbilical region and smaller and more elevated granules toward the peripheral margin; aperture ventral, at the base of the apertural face of the final chamber, about half the distance from the periphery.

Greatest diameter of holotype 0.88 mm., least diameter 0.73 mm., thickness 0.42 mm. Greatest diameter of juvenile paratype 0.36 mm., thickness 0.16 mm.

Remarks.—This species differs from *T. bartletti* (Cushman) in being smaller, more biconvex, and in the different character of the ventral ornamentation. In *T. bartletti* the central part of the ventral side is pustulose, the outer part is deeply grooved, whereas in *T. pustulata* the outer part is strongly pustulose, and the central part blistered in appearance with large irregular swellings. The sutures are much less distinct dorsally in the present species. Only two specimens of the present species have been found.

Types and occurrence.—Holotype (U.S.N.M. No. P2014) and figured paratype (U.S.N.M. No. P2015) from station 44.

Family CASSIDULINIDAE

Genus CASSIDULINA d'Orbigny, 1826

CASSIDULINA ISLANDICA Nørvang

Plate 24, figure 1

Cassidulina islandica NØRVANG, 1945, Foraminifera, Zoology of Iceland, vol. 2, pt. 2, p. 41, text figs. 7, 8d-f.

Cassidulina islandica Nørvang forma *minuta* NØRVANG, 1945 (not *Cassidulina minuta* Cushman, 1933), Foraminifera, Zoology of Iceland, vol. 2, pt. 2, p. 43, text figs. 8a-c.—F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 421, pl. 6, figs. 22a-23.—PHLEGER, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 83, pl. 14, fig. 30.

Cassidulina islandica Nørvang var. *nørvangi* THALMANN, 1952, *in* Phleger, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 83 (footnote).

Test free, of small to medium size, not much compressed, periphery broadly rounded; chambers inflated, about 4 pair in the last whorl, alternate chambers extending to the umbilicus on one side with only a small triangular portion visible on the opposite side; wall calcareous, translucent, distinctly perforate, surface smooth; aperture an elongate triangular slit, appearing alternately on each side of the periphery, provided with a thin tooth extending upward from the lower margin of the chamber.

Greatest diameter of figured hypotype 0.35 mm., thickness 0.21 mm. Other hypotypes range from 0.16 to 0.39 mm. in diameter.

Remarks.—Although Nørvang divided his species into the typical *C. islandica* and a forma *minuta* (later recognized as a variety and renamed *nørvangi*) he also questioned the validity of this separation, stating (1945, p. 43), "Differs from the typical form in the small size of the test. These are possibly starved specimens of *C. islandica.*" He recorded only two of the small specimens, one each from depths of 28 to 30 meters and 37 meters, off Keflavik, Iceland.

In our material from off Point Barrow, Alaska, this species is abundant, and specimens of all sizes can be found in the assemblage, showing a definite size gradation from *C. islandica* to the variety *nørvangi.* We therefore believe the "variety" to be an artificial separation, and consider all our specimens to belong to *C. islandica.* Many earlier references to *Cassidulina crassa* d'Orbigny are undoubtedly this species, including many of the Cushman types in the National Museum collections. It differs from *C. crassa* in being somewhat smaller and differs particularly in the shape and position of the aperture. *C. crassa* was described from the Falkland Islands and both d'Orbigny's original figures and those of Heron-Allen and Earland (1932) from that area show the aperture to be a curved slit extending from the dorsal angle on the periphery in the direction of the umbilicus. The aperture thus shows on the periphery as a reentrant even when seen from the temporarily aboral side. In the present species the aperture is close against the base of the chamber, paralleling the sutural margin below it, and extending from the suture only about

two-thirds the distance toward the periphery and completely obscured when the test is viewed from the aboral side. It also contains the very distinctive tooth mentioned by Nørvang, which is not found in *C. crassa*.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2115) from station 18; unfigured hypotypes are recorded from stations 1, 2, 3, 4, 5, 6, 7, 9, 12, 13, 14, 16, 18, 19, and 50.

CASSIDULINA NORCROSSI Cushman

Plate 24, figure 2

Cassidulina norcrossi CUSHMAN, 1933, Smithsonian Misc. Coll., vol. 89, No. 9, p. 7, pl. 2, figs. 7a-c; 1944, Cushman Lab. Foram. Res. Spec. Publ. 12, p. 35, pl. 4, fig. 26.—NØRVANG, 1945, Foraminifera, Zoology of Iceland, vol. 2, pt. 2, p. 44, text fig. 10.—CUSHMAN, 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 75, pl. 8, fig. 12.—F. PARKER, 1948, Bull. Mus. Comp. Zool., vol. 100, No. 2, pl. 6, figs. 2a,b; 1952, ibid., vol. 106, No. 9, p. 422, pl. 6, figs. 24, 25.

not *Cassidulina norcrossi* Cushman, PHLEGER, 1952, Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 83, pl. 14, fig. 22 (= *C. teretis* Tappan).

Test free, lenticular, periphery subacute, with a narrow keel; chambers distinct and alternating from one side to the opposite side, although more nearly equal on the two sides than is usual for the genus; sutures distinct, limbate, flush, nearly straight, but oblique, so that chambers appear triangular in side view; wall calcareous, finely perforate, translucent, surface smooth; aperture elongate, paralleling and just adjacent to the peripheral margin of the apertural face and alternately to one side or the other.

Greatest diameter of figured hypotype 0.31 mm., thickness 0.14 mm. Other hypotypes range from 0.21 to 0.44 mm. in diameter.

Remarks.—The specimen figured by Phleger (1952) and referred to this species does not have the chambers overlapping nearly equally on the two sides as is true in typical *C. norcrossi*. Phleger's specimen also has 10 or 11 chambers visible in the final whorl (about 5 pairs) and half of these appear bandlike or ovate on each side rather than triangular, whereas *C. norcrossi* has only 4 pairs (8 chambers) in the final whorl, and all chambers appear triangular in side view on both sides.

Types and occurrence.—Figured hypotype (U.S.N.M. No. P2142) from station 37; unfigured hypotypes are recorded from stations 1, 5, 15, 22, 24, 37, 51, and 52.

CASSIDULINA TERETIS Tappan

Plate 24, figures 3, 4

Cassidulina laevigata d'Orbigny, Brady, 1884 (not d'Orbigny, 1826), Rep. Voy. *Challenger,* vol. 9 (Zoology), p. 428, pl. 54, figs. 1-3.—Cushman (part), 1948, Cushman Lab. Foram. Res. Spec. Publ. 23, p. 73, pl. 8, fig. 8.

Cassidulina teretis Tappan, 1951, Contr. Cushman Found. Foram. Res., vol. 2, pt. 1, p. 7, pl. 1, figs. 30a-c; 1952, *in* Payne et al., U. S. Geol. Surv., Oil and Gas Invest. Map OM-126, sheet 3, fig. 21 (3a-c).

Cassidulina norcrossi Cushman, Phleger, 1952 (not Cushman, 1933), Contr. Cushman Found. Foram. Res., vol. 3, pt. 2, p. 83, pl. 14, fig. 22.

Test free, lenticular, biumbonate, coiled, slightly evolute; chambers biserially arranged and coiled, with 4 to 5 pairs of chambers in the final whorl, chambers extending from the clear umbilical region across the peripheral keel and about halfway to the boss on the opposite side, appearing ovate in outline on the side where they reach the umbo, and only a small subtriangular portion appearing on the opposite side; sutures distinct and thickened, but flush with the surface, gently curved; wall calcareous, perforate, translucent, surface smooth, with a narrow peripheral keel; aperture elongate, narrow and crescentic, extending upward three-fourths the distance from the base of the apertural face to the keel of the final chamber, and paralleling the anterior margin of the chamber.

Greatest diameter of hypotype of figure 3, 0.60 mm., thickness 0.23 mm. Greatest diameter of hypotype of figure 4, 0.60 mm., thickness 0.29 mm. Other hypotypes range from 0.21 to 0.73 mm. in diameter.

Remarks.—Although recorded from the Arctic by Brady and Cushman as *Cassidulina laevigata* d'Orbigny, the present species is quite distinct in having a peripheral keel and a less lobulate periphery, and in being somewhat evolute so that an umbonal boss occurs, through which may be seen the earlier whorls in the translucent living specimens. D'Orbigny's type figure shows the chambers to extend completely over the central portion. Furthermore, the aperture is not as elongate in d'Orbigny's species.

A more similar form is *Cassidulina laticamerata* Voloshinova, from the Pliocene of the Kamchatka Peninsula, U.S.S.R., but it is described as having a rounded periphery and slightly depressed sutures, and is a more-compressed species. It is possibly ancestral to *C. teretis,* however. The present species was originally described from the Pleistocene Gubik formation on the coast of northern Alaska and is found living offshore in the same region.

Types and occurrence.—Figured hypotypes (U.S.N.M. Nos. P2107 a,b) from station 18; unfigured hypotypes are recorded from stations 1, 3, 4, 5, 7, 9, 10, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 45, 46, 50, and 51.

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EXPLANATION OF PLATES

Plate 1. Rhizamminidae, Saccamminidae, Hyperamminidae, Reophacidae

Plate 2. Reophacidae, Ammodiscidae, Lituolidae, Textulariidae

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showing the smaller form occasionally found. 1b, Top view. 2, Side view of hypotype (U.S.N.M. No. P2103a) from station 13, showing unusually large coil and reduced biserial portion. 3a, Side view of large hypotype (U.S.N.M. No. P2103b) from station 13, showing nearly parallel sides. 3b, Top view. 4, 5, 6, Side views of hypotypes (U.S.N.M. Nos. P2103c-e), showing variation in size and occasionally slightly flared test. All × 100.

Figs. 7-9. *Silicosigmoilina groenlandica* (Cushman)..... 38
7a, 7b, Opposite sides of hypotype (U.S.N.M. No. P1052a) from station 35. 7c, Apertural view of same. 8, Sectioned hypotype (U.S.N.M. No. P1052b) showing spiraling development of chambers. 9a,b, Opposite sides of larger hypotype (U.S.N.M. No. P1052c) from station 35, showing four chambers on each side, as in *Silicosigmoilina* rather than *Miliammina*. 9c, Top view, showing curved slitlike aperture. × 100.

Fig. 10. *Triloculina trihedra* Loeblich and Tappan, new species..... 45
10a, Side view of holotype (U.S.N.M. No. P2110) from station 3, showing enveloping chambers and slightly convex sides. 10b, Top view, showing triangular section, subacute angles and flat sides, with ovate aperture and short bifid tooth. × 44.

Plate 5. Miliolidae

Figs. 1-4. *Quinqueloculina agglutinata* Cushman..... 39
1a,b, Opposite sides of large hypotype (U.S.N.M. No. P1050a), from station 26. 2a,b, Opposite sides of hypotype (U.S.N.M. No. P1050b) from station 26. 2c, Top view, showing rounded aperture and small tooth. 3, 4, Side views of hypotypes (U.S.N.M. Nos. P1049a,b) from station 4. All × 27.

Figs. 5-9. *Quinqueloculina stalkeri* Loeblich and Tappan, new species 40
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10a,b, Opposite sides of holotype (U.S.N.M. No. P2101) from station 3. 10c, Top view, showing crescentlike aperture formed by the broad apertural flap. × 44.

Figs. 11, 12. *Quinqueloculina arctica* Cushman..... 40
11a,b, Opposite sides of hypotype (U.S.N.M. No. P2035a), from station 4, showing truncate periphery. 11c, Top view, showing subtriangular section, and large aperture with delicate bifid tooth. 12, Side view of small hypotype (U.S.N.M. No. P2035b) from station 4. All × 27.

Plate 6. Miliolidae

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Figs. 1-4. *Pyrgo williamsoni* (Silvestri)..... 48
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Figs. 5, 6. *Pyrgo rotalaria* Loeblich and Tappan, new species..... 47
5a, Side view of holotype (U.S.N.M. No. P2064), showing nearly circular outline, rounded aperture, and short notched tooth. 5b, Top view, showing carinate border. 6a, Side view of paratype (U.S.N.M. No. P2065). 6b, Top view. Both from station 43. ×44.

Fig. 7. *Miliolinella chukchiensis* Loeblich and Tappan, new species..... 47
7a, Side view of holotype (U.S.N.M. No. P2098), from station 6, showing triloculine chamber arrangement, and the flap which extends partially over the aperture. 7b, Opposite side. 7c, Top view, showing crescentic apertural opening left above the apertural flap. ×44.

Figs. 8-12. *Pateoris hauerinoides* (Rhumbler)..... 42
8a, 8b, Opposite sides of hypotype (U.S.N.M. No. P2105a), showing *Massilina*-like early stages and *Hauerina*-like coiling in the later portion, with three chambers in the final coil. 8c, Top view showing low, open peripheral aperture, without a tooth. 9, Small hypotype (U.S.N.M. No. P2105b). 10a, 10b, Opposite sides of hypotype (U.S.N.M. No. P2105c), which is in the *Massilina* stage, but with the aperture to one side of the periphery. 10c, Top view showing asymmetrical aperture. 11a,b, Opposite sides of gerontic hypotype (U.S.N.M. No. P2105d), showing more embracing final chambers with transverse wrinkling. 11c, Top view, showing slitlike peripheral extension of the aperture. 12, Side view of hypotype (U.S.N.M. No. P2105e), showing more regular *Quinqueloculina*-like young stage. All hypotypes from station 17. All ×44.

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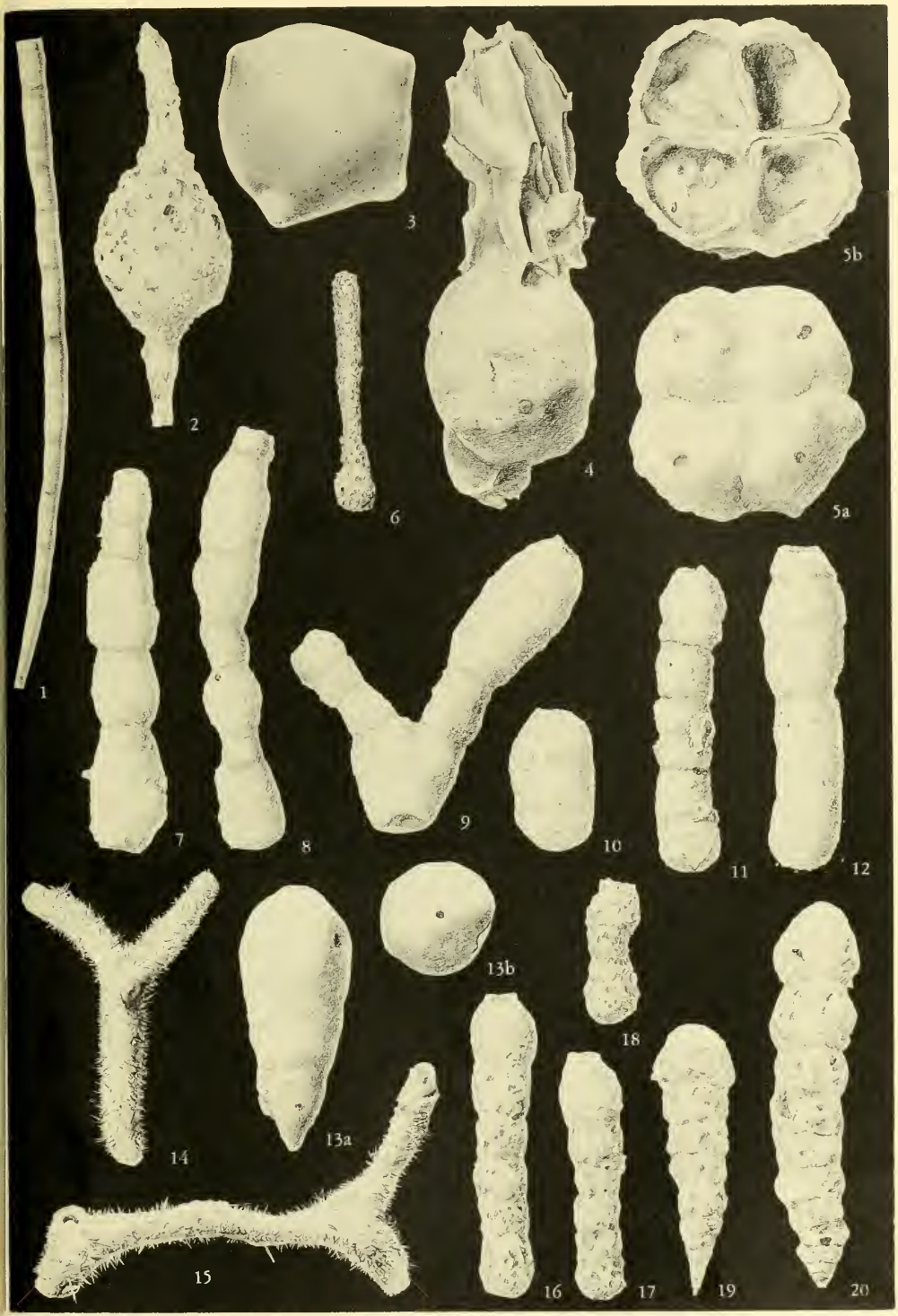

RHIZAMMINIDAE, SACCAMMINIDAE, HYPERAMMINIDAE, REOPHACIDAE

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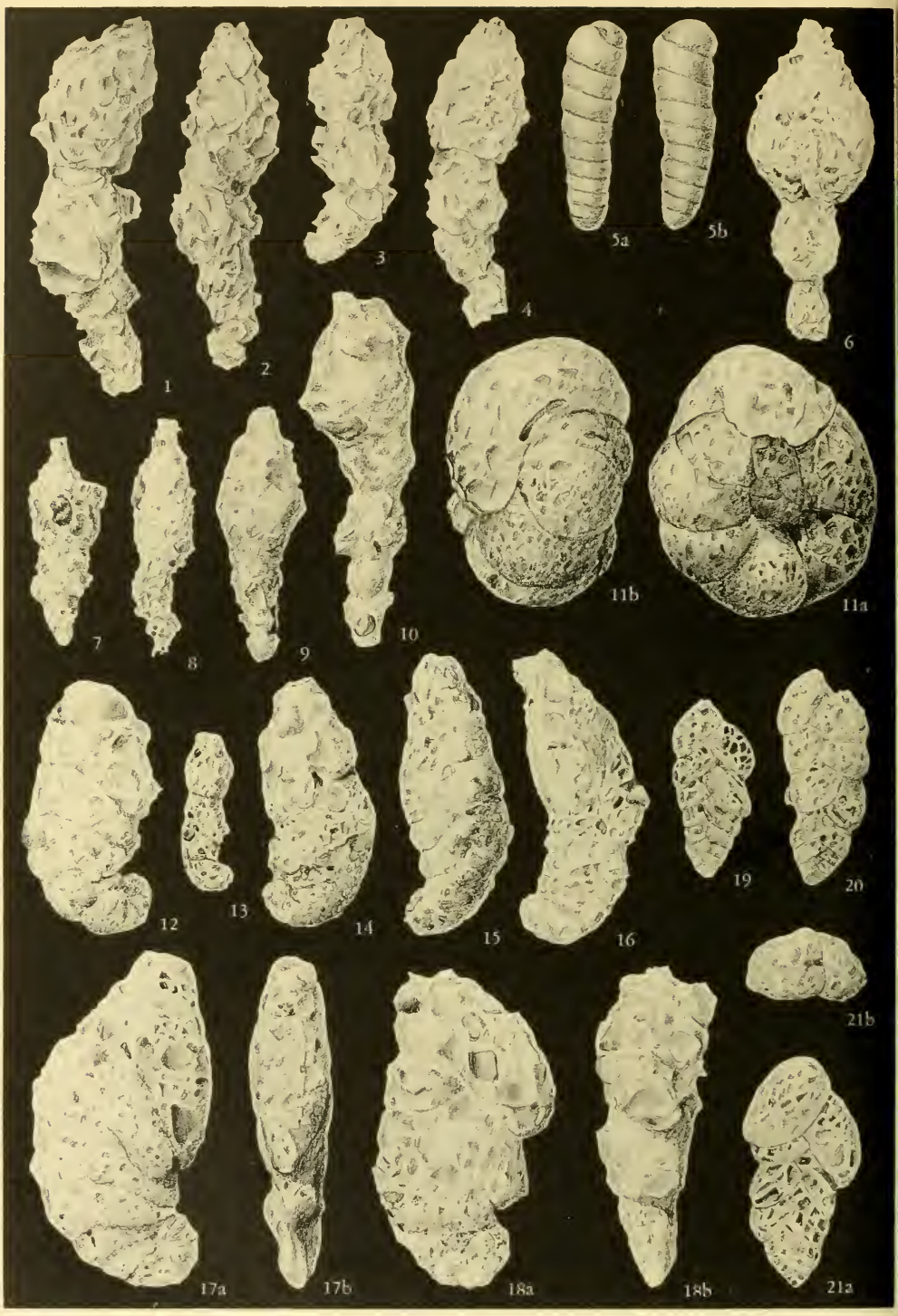

REOPHACIDAE, AMMODISCIDAE, LITUOLIDAE, TEXTULARIIDAE

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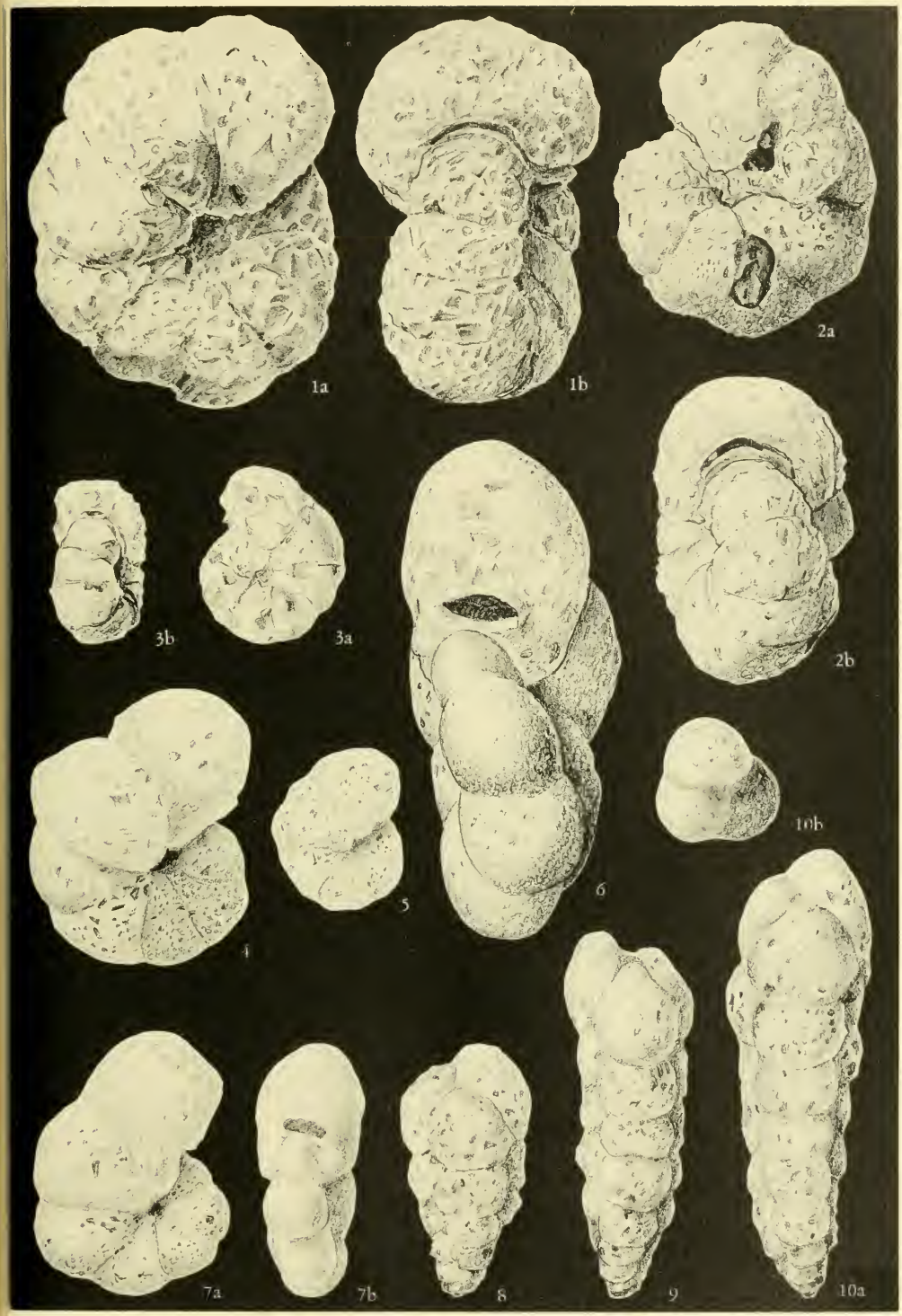

LITUOLIDAE, VALVULINIDAE

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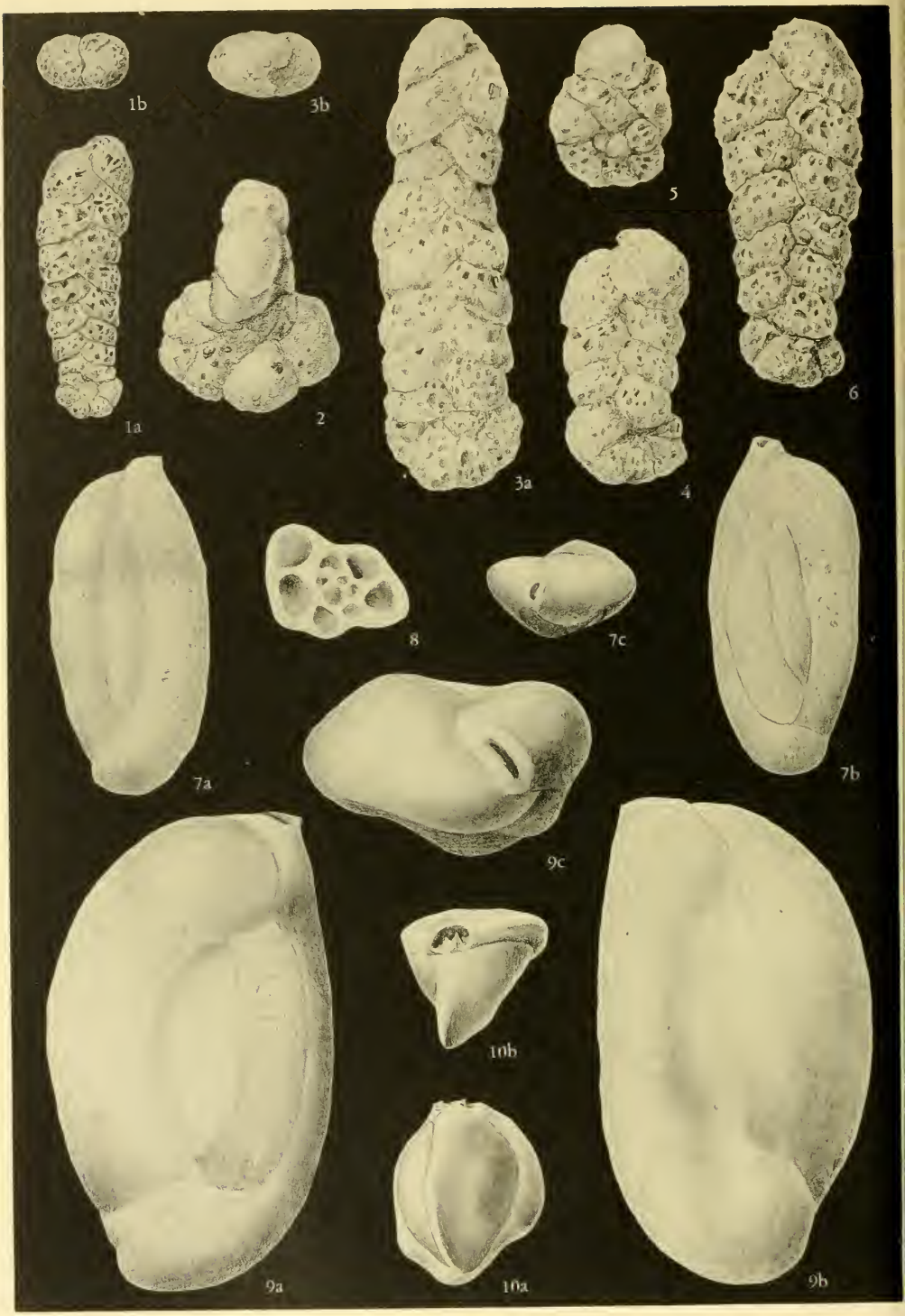

TEXTULARIIDAE, SILICINIDAE, MILIOLIDAE

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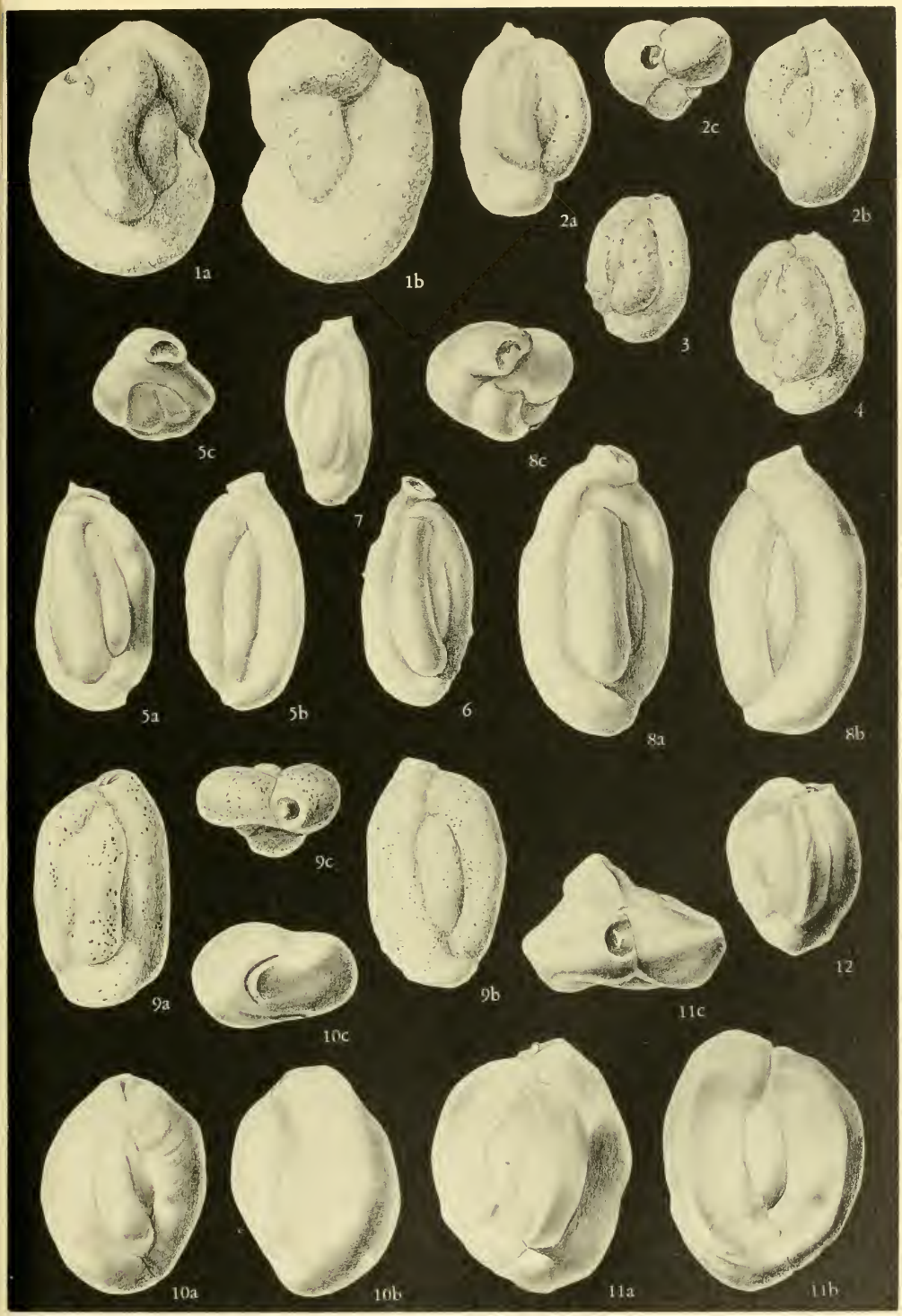

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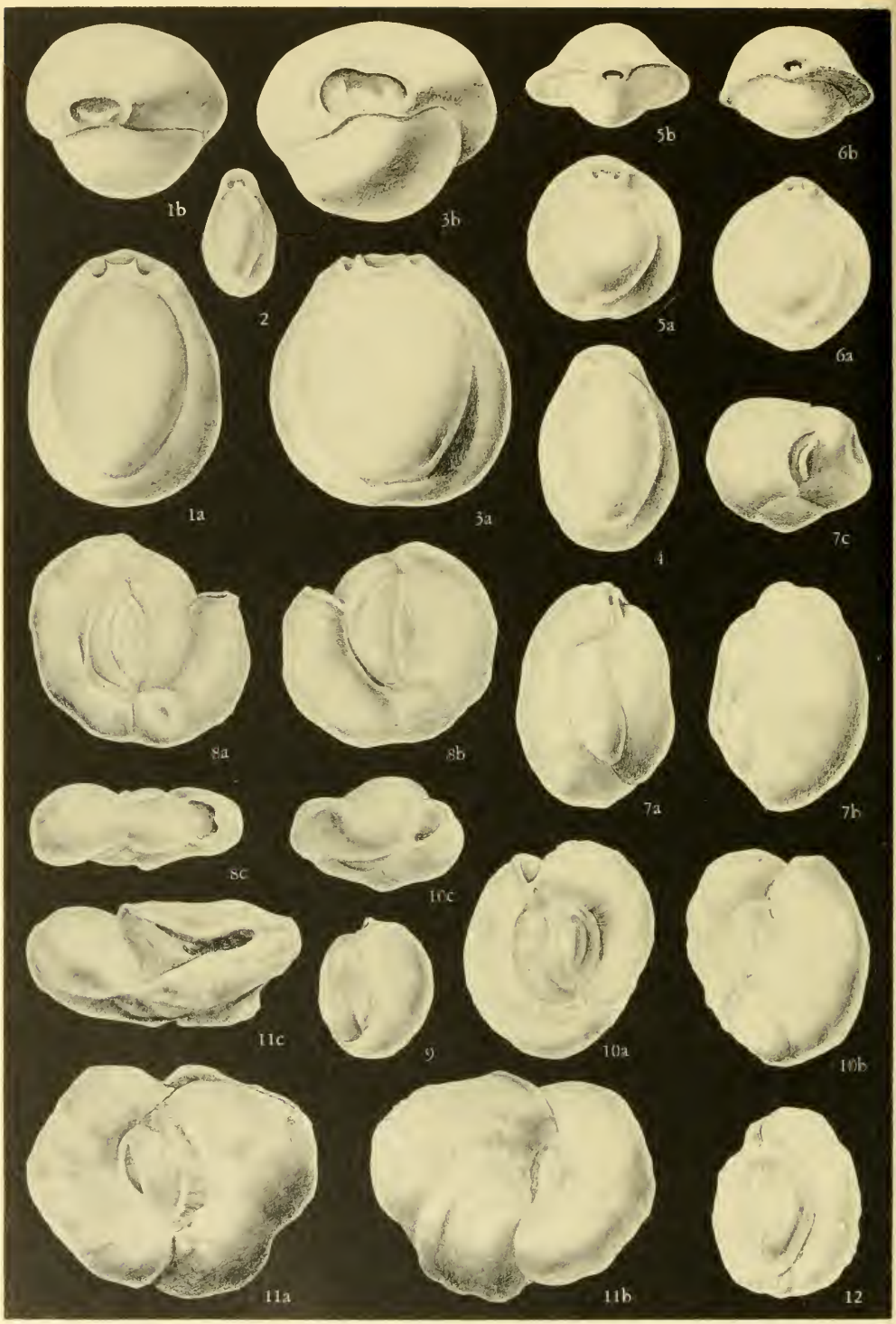

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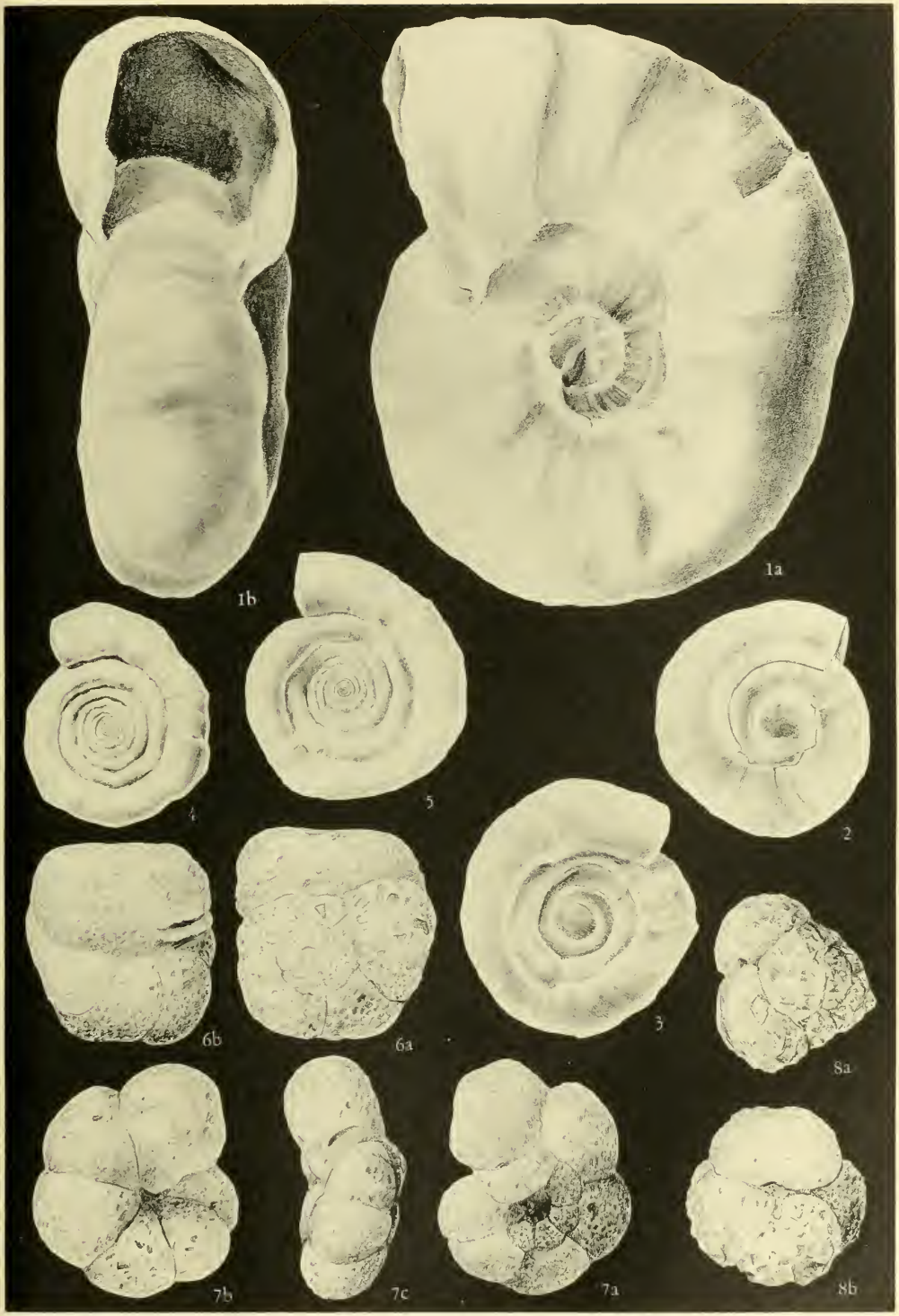

OPHTHALMIDIIDAE, TROCHAMMINIDAE

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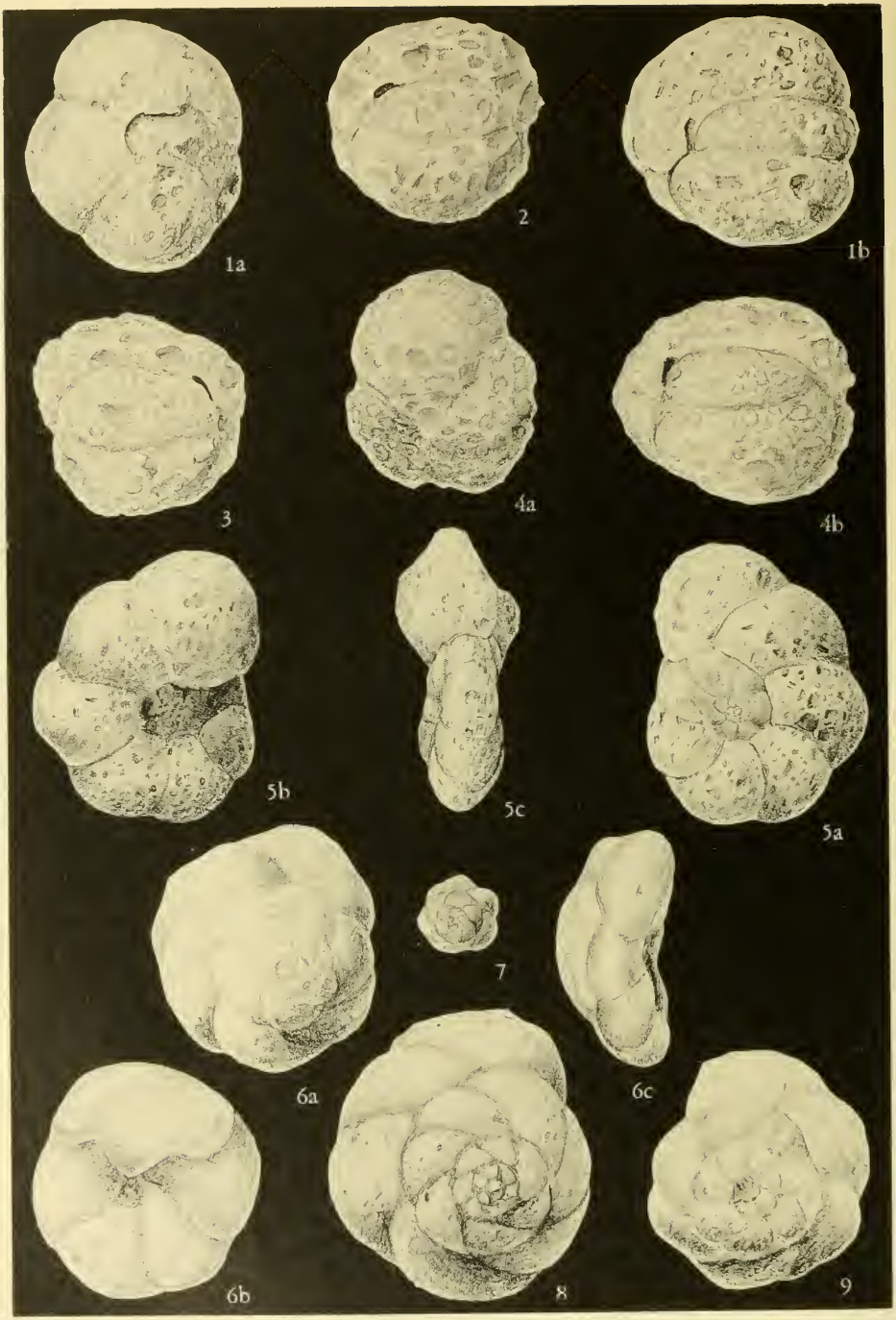

LITUOLIDAE, TROCHAMMINIDAE

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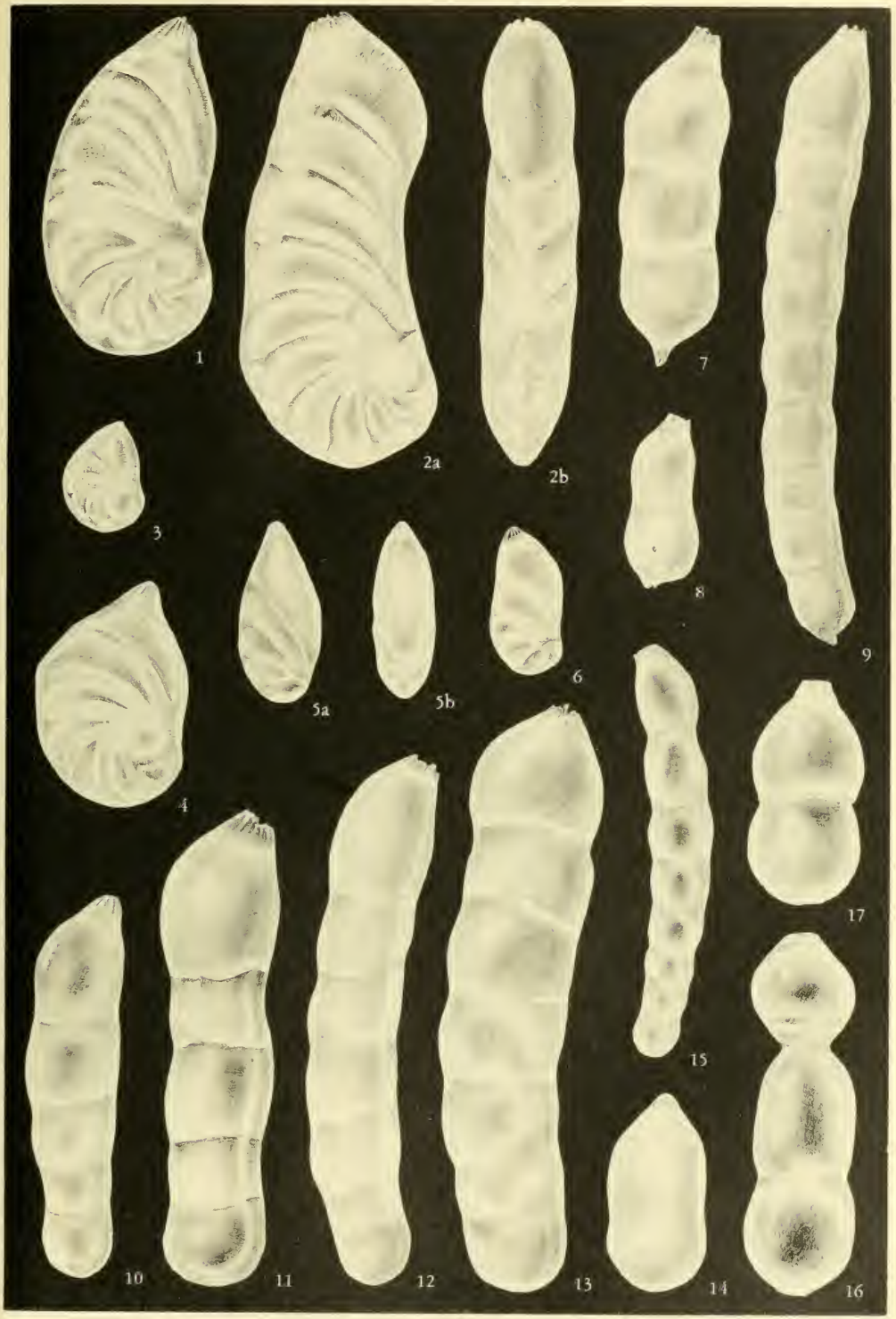

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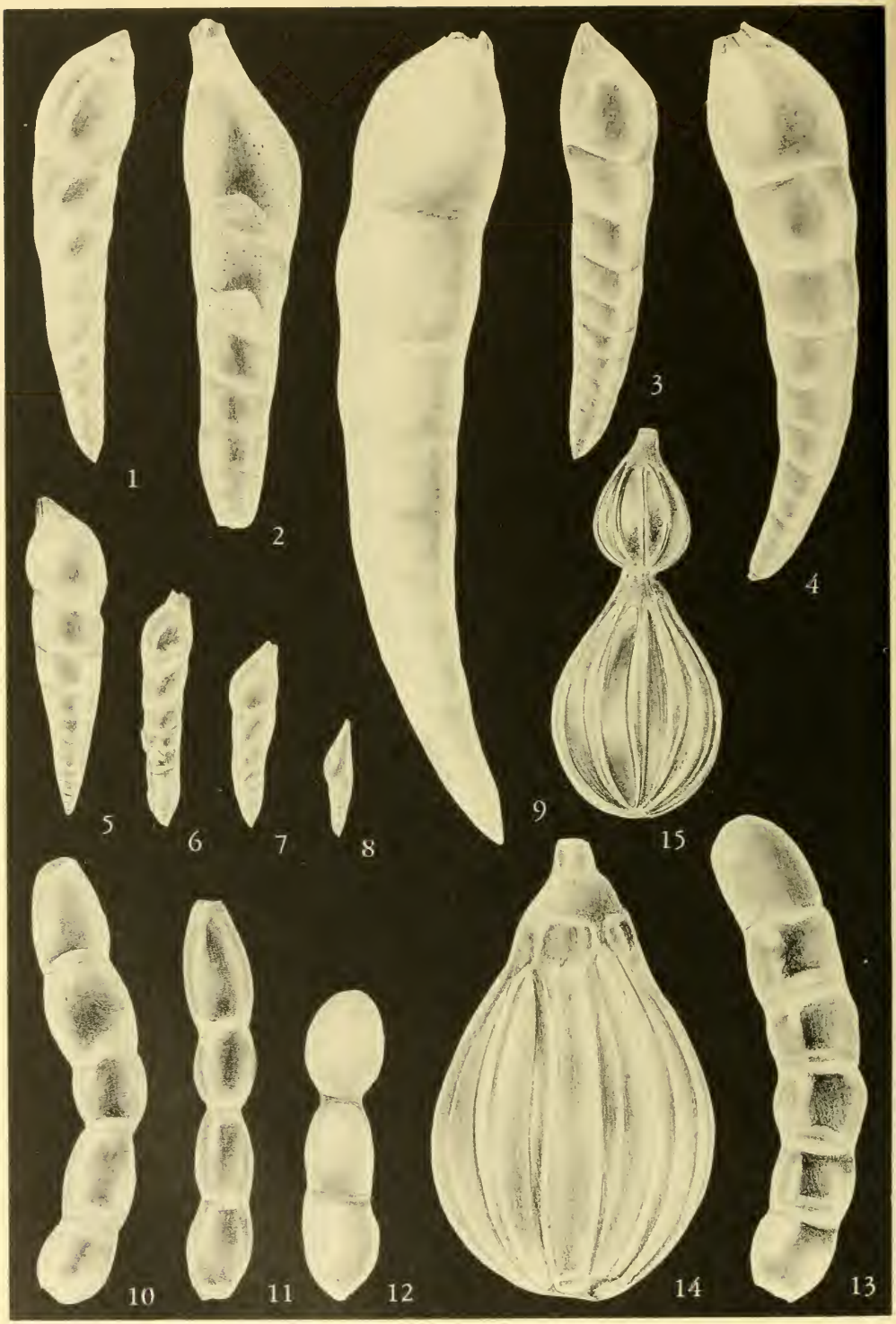

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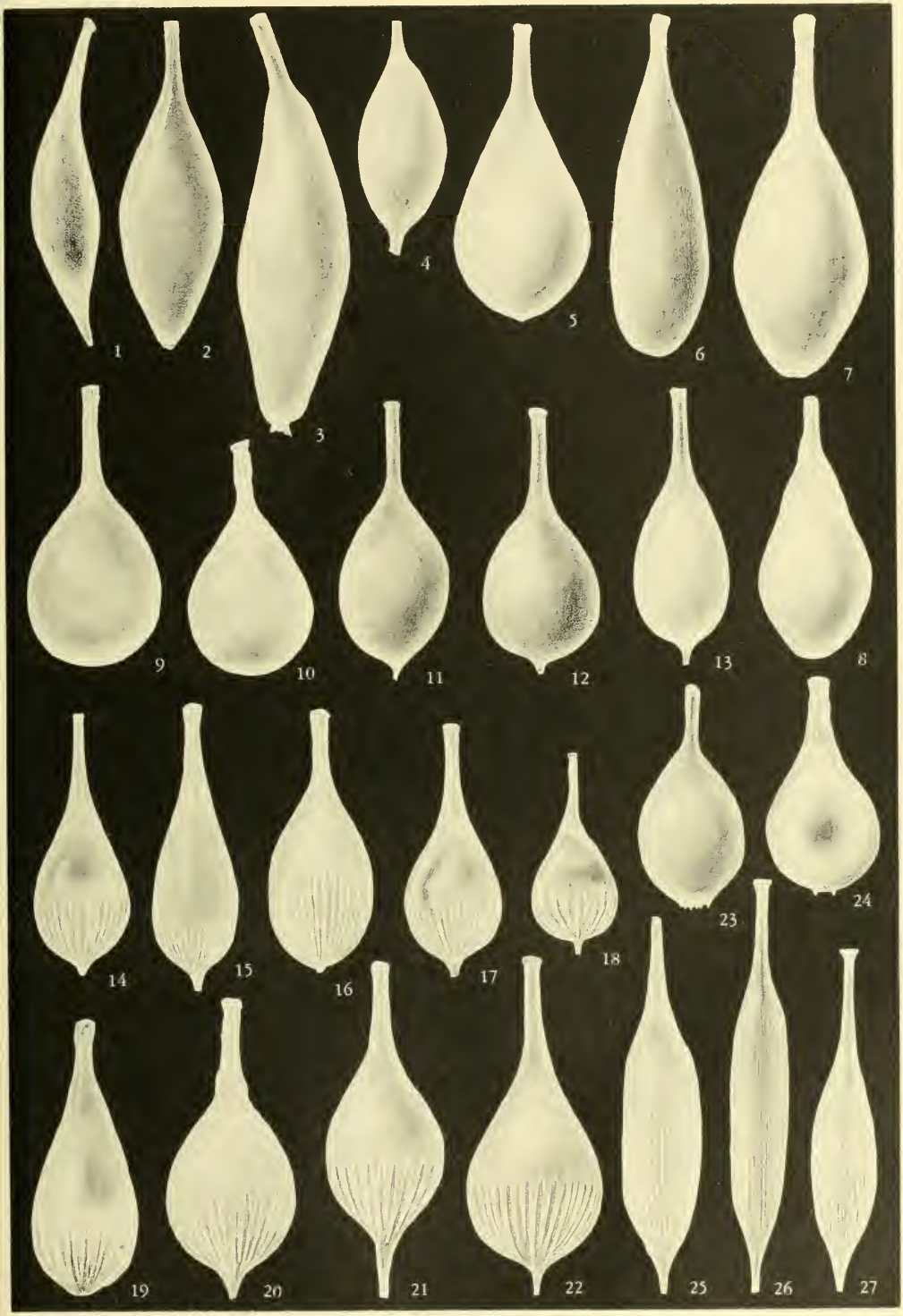

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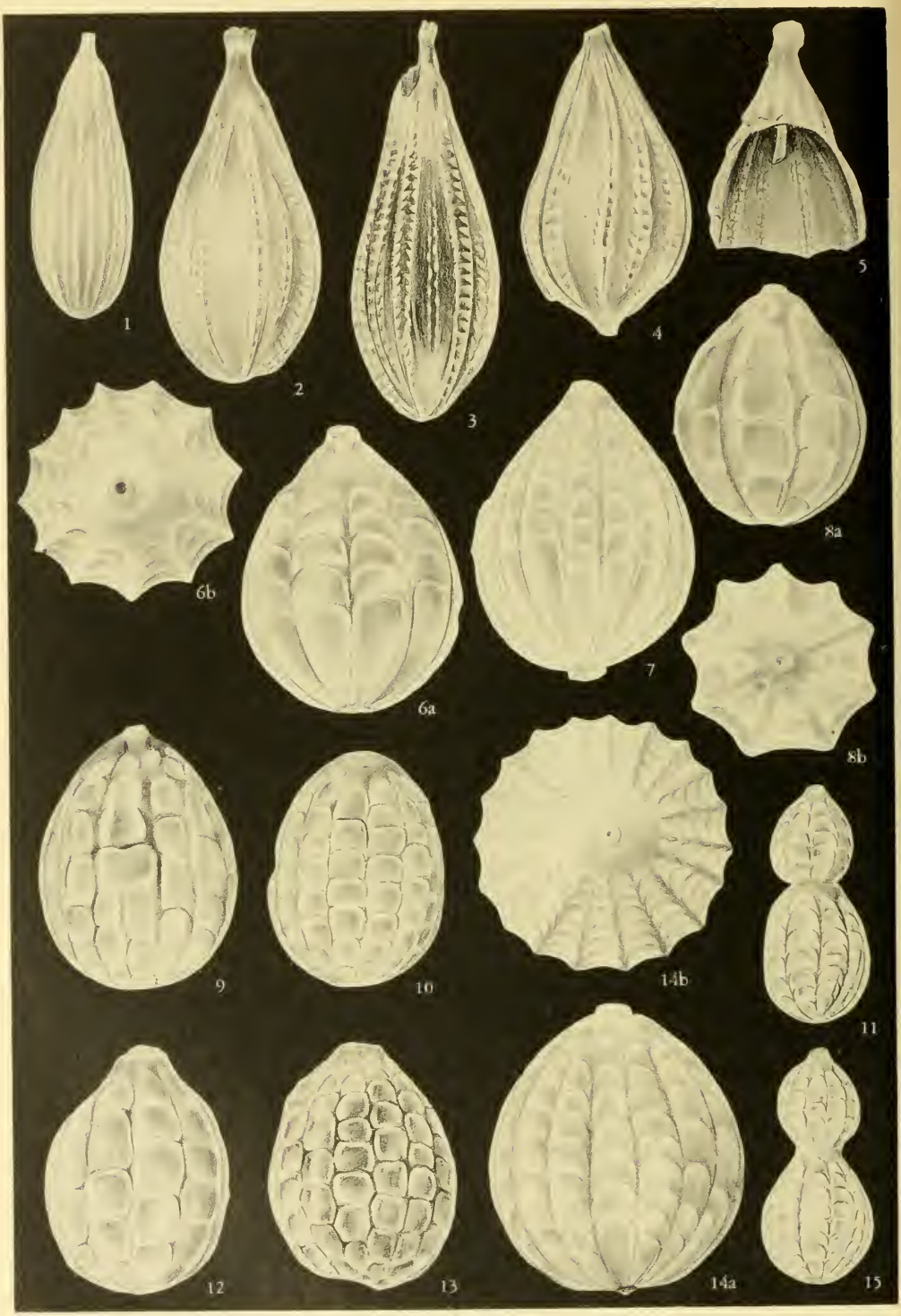

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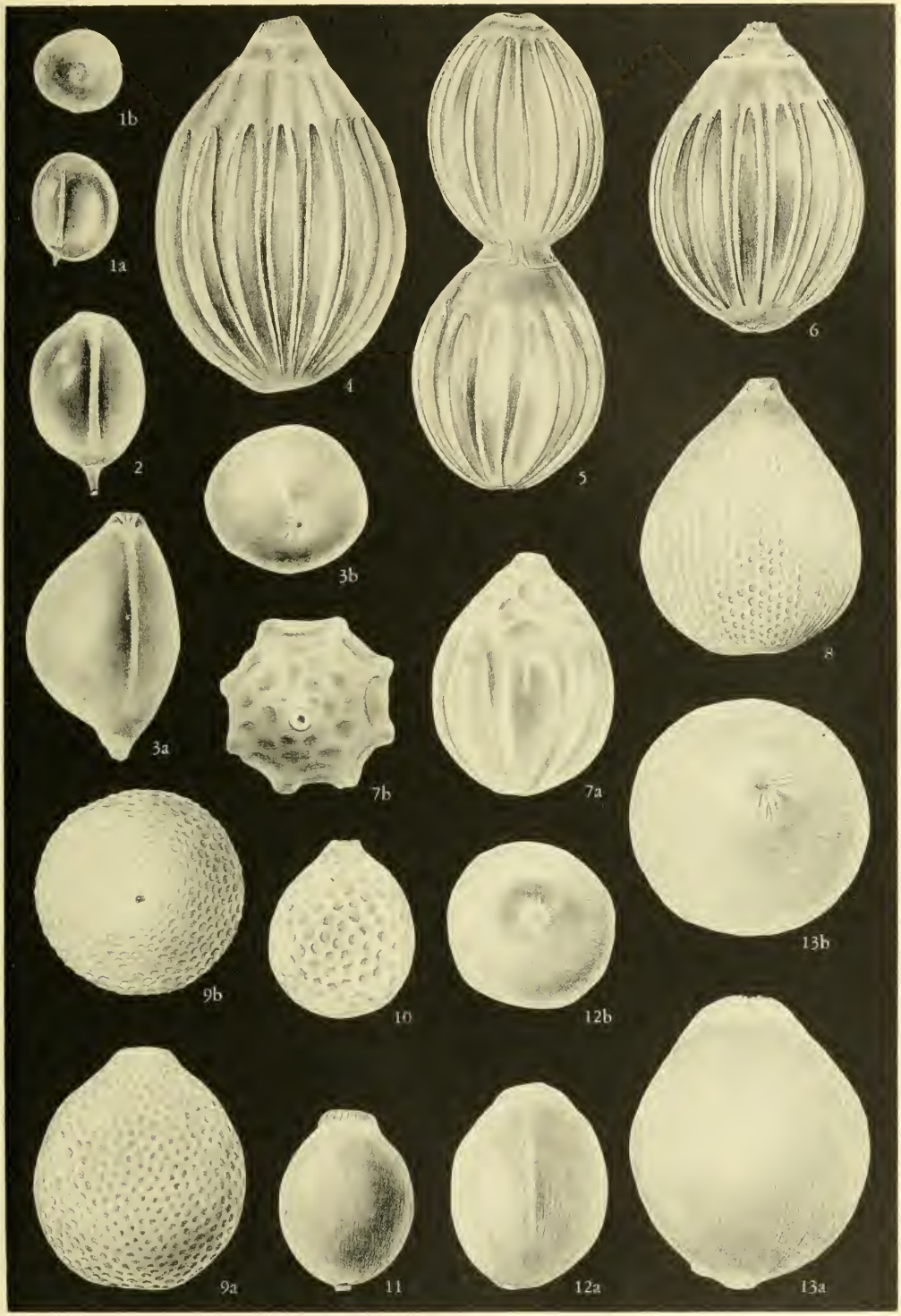

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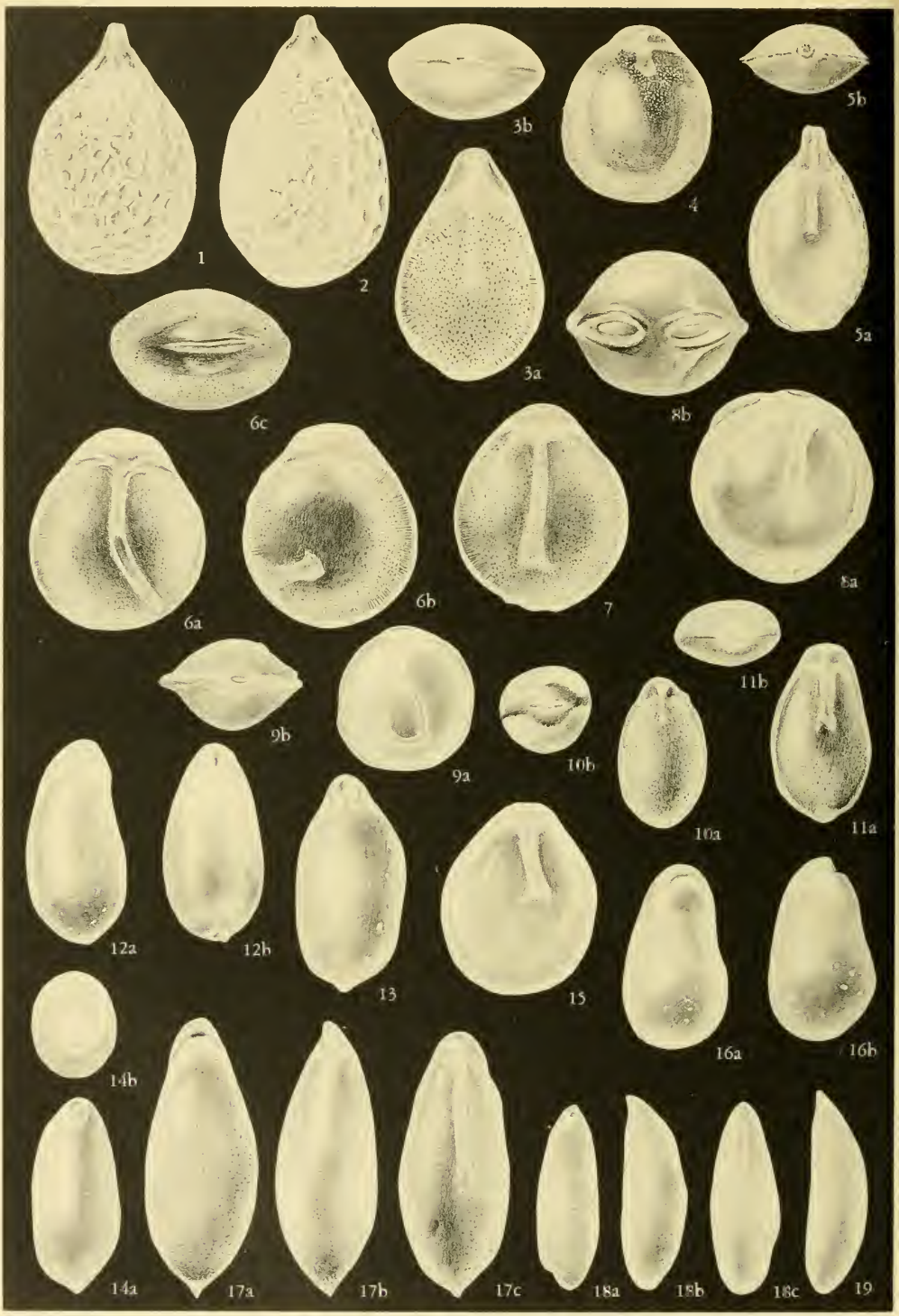

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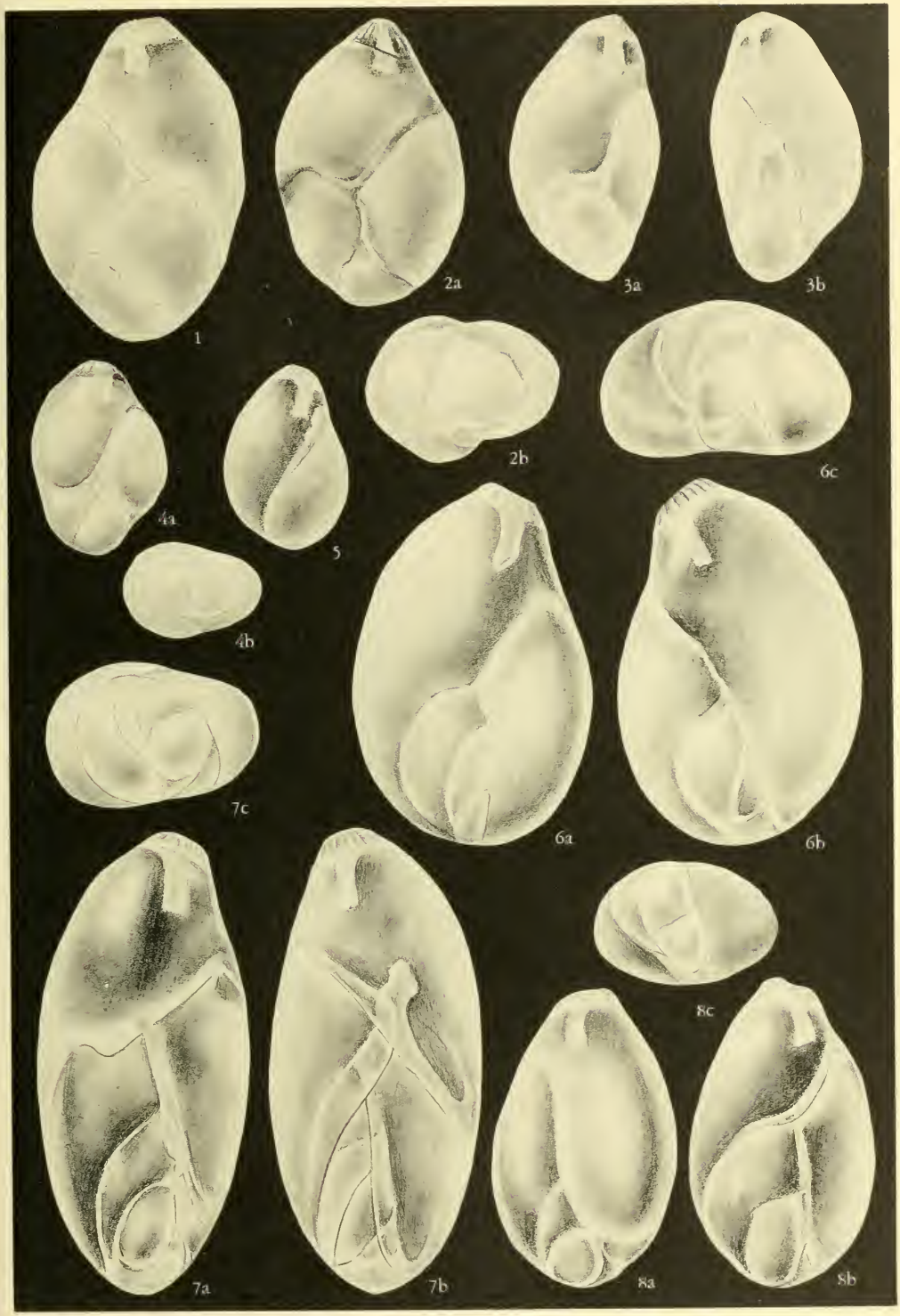

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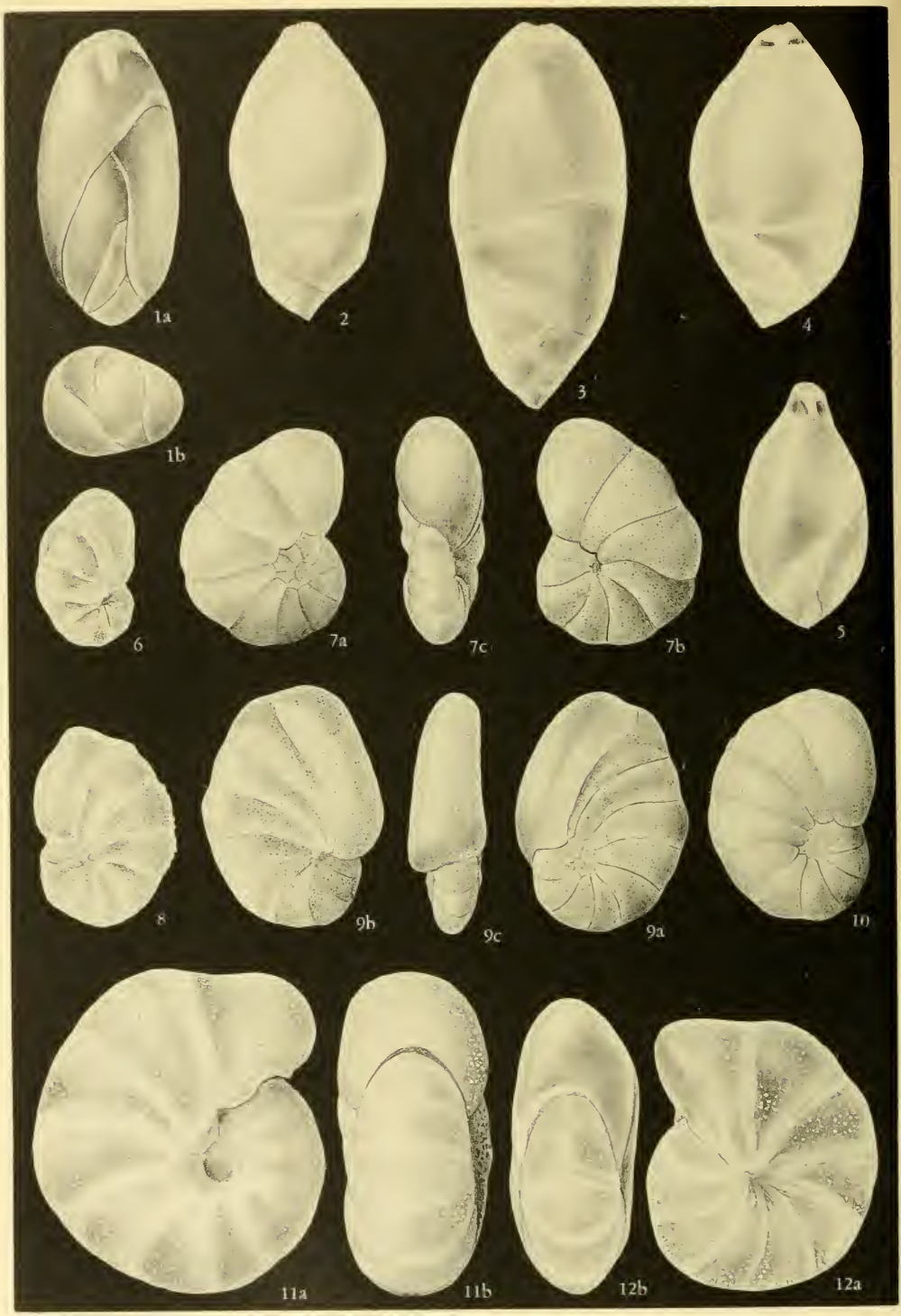

POLYMORPHINIDAE, NONIONIDAE

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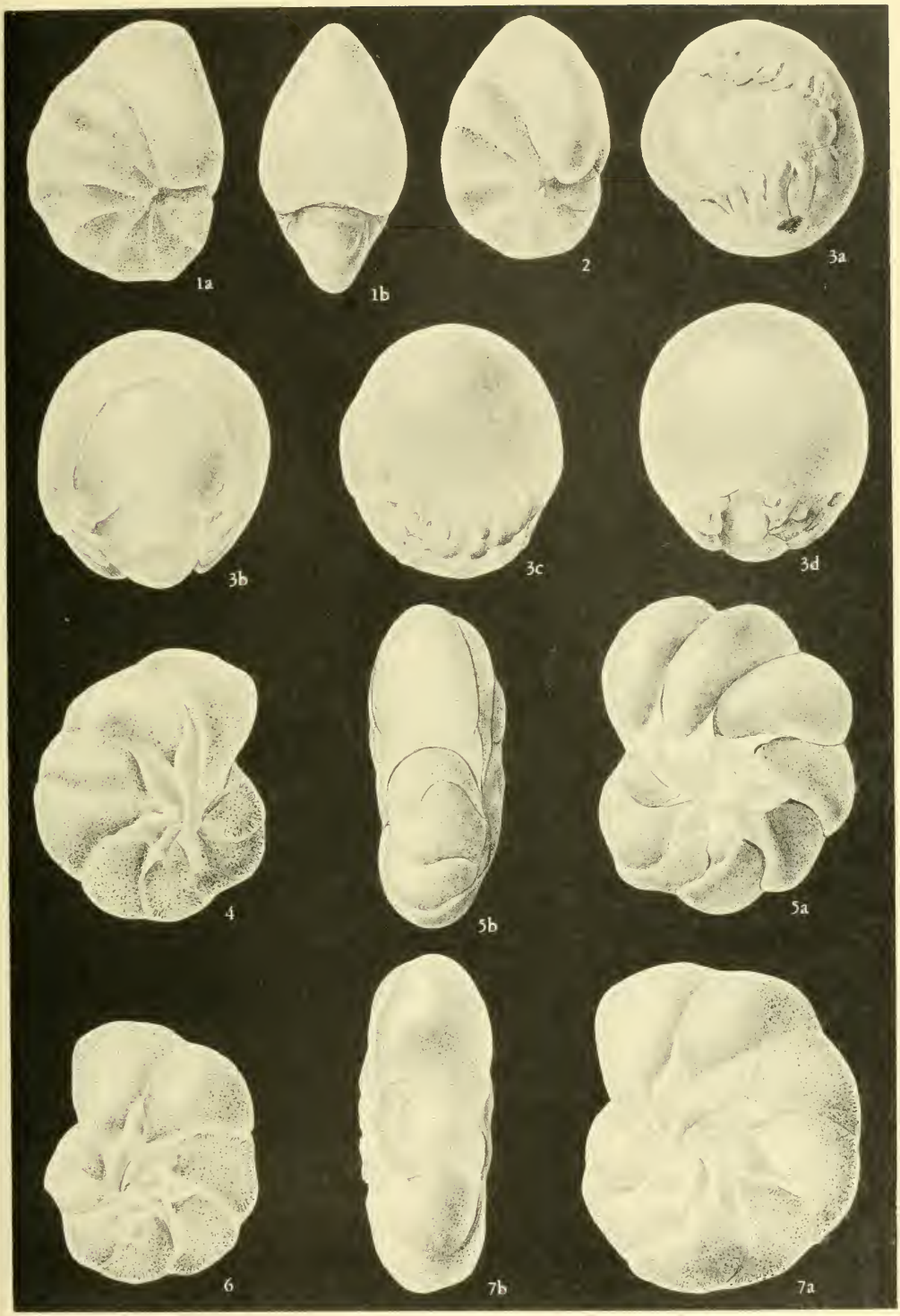

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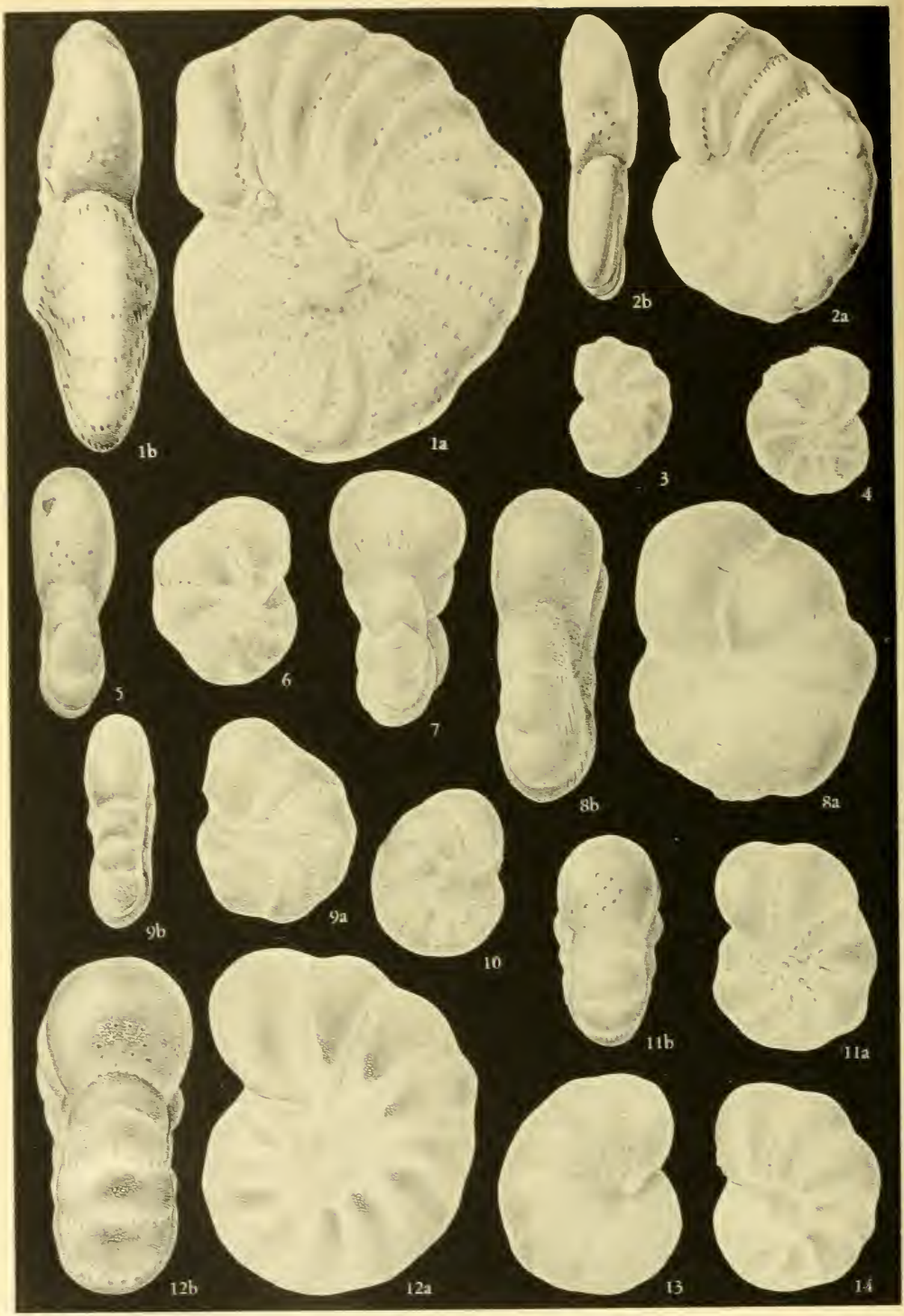

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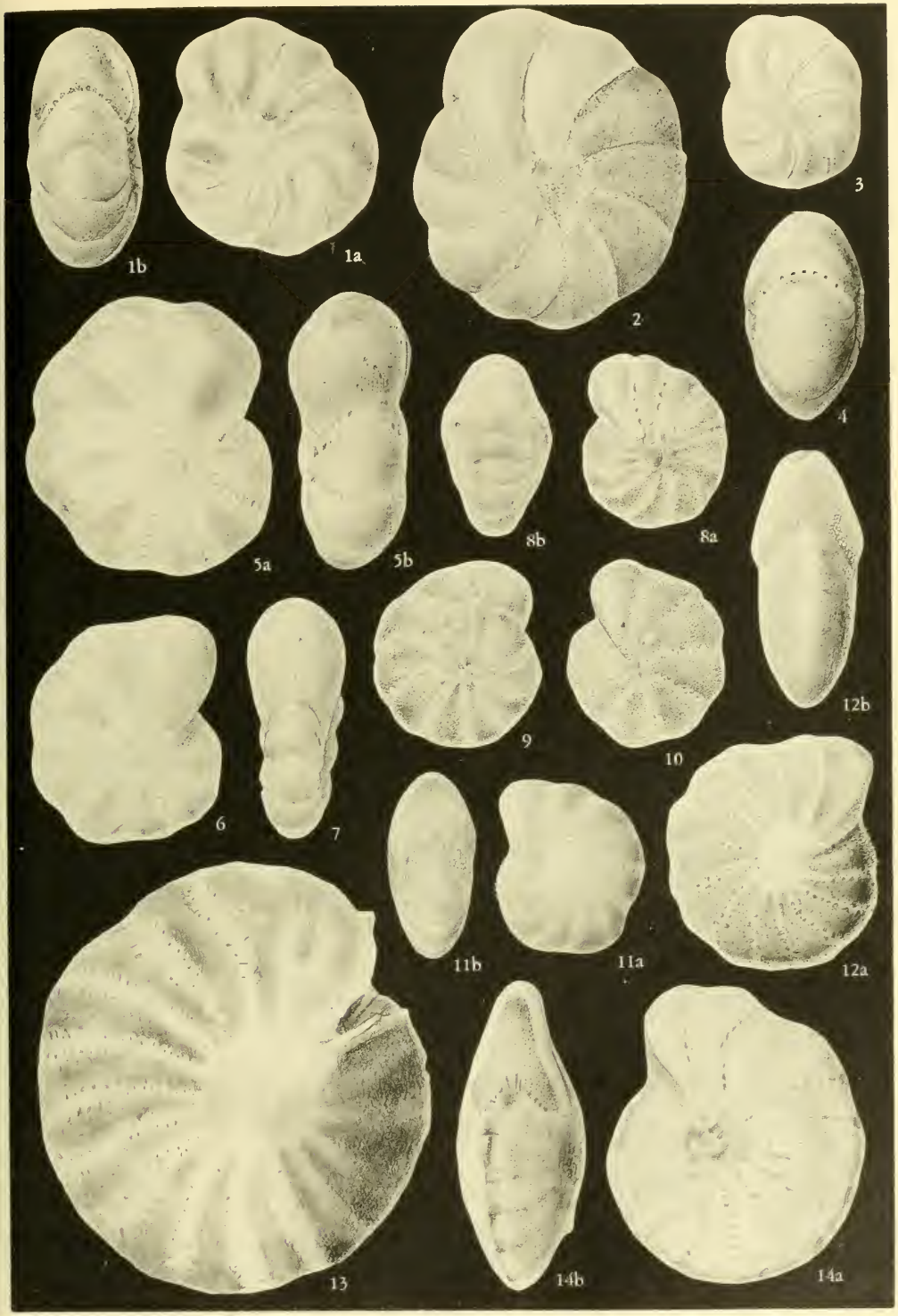

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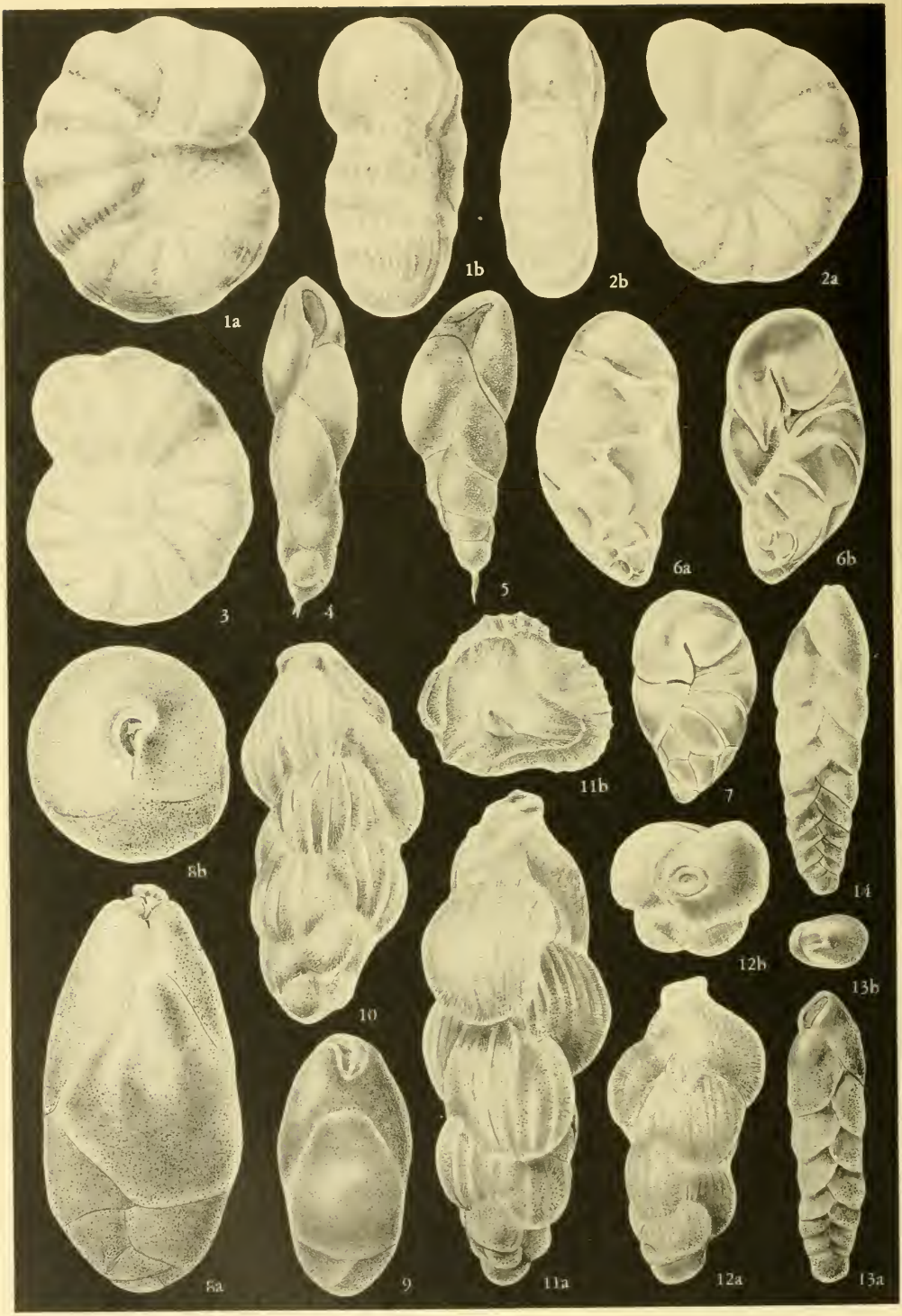

ELPHIDIIDAE, BULIMINIDAE

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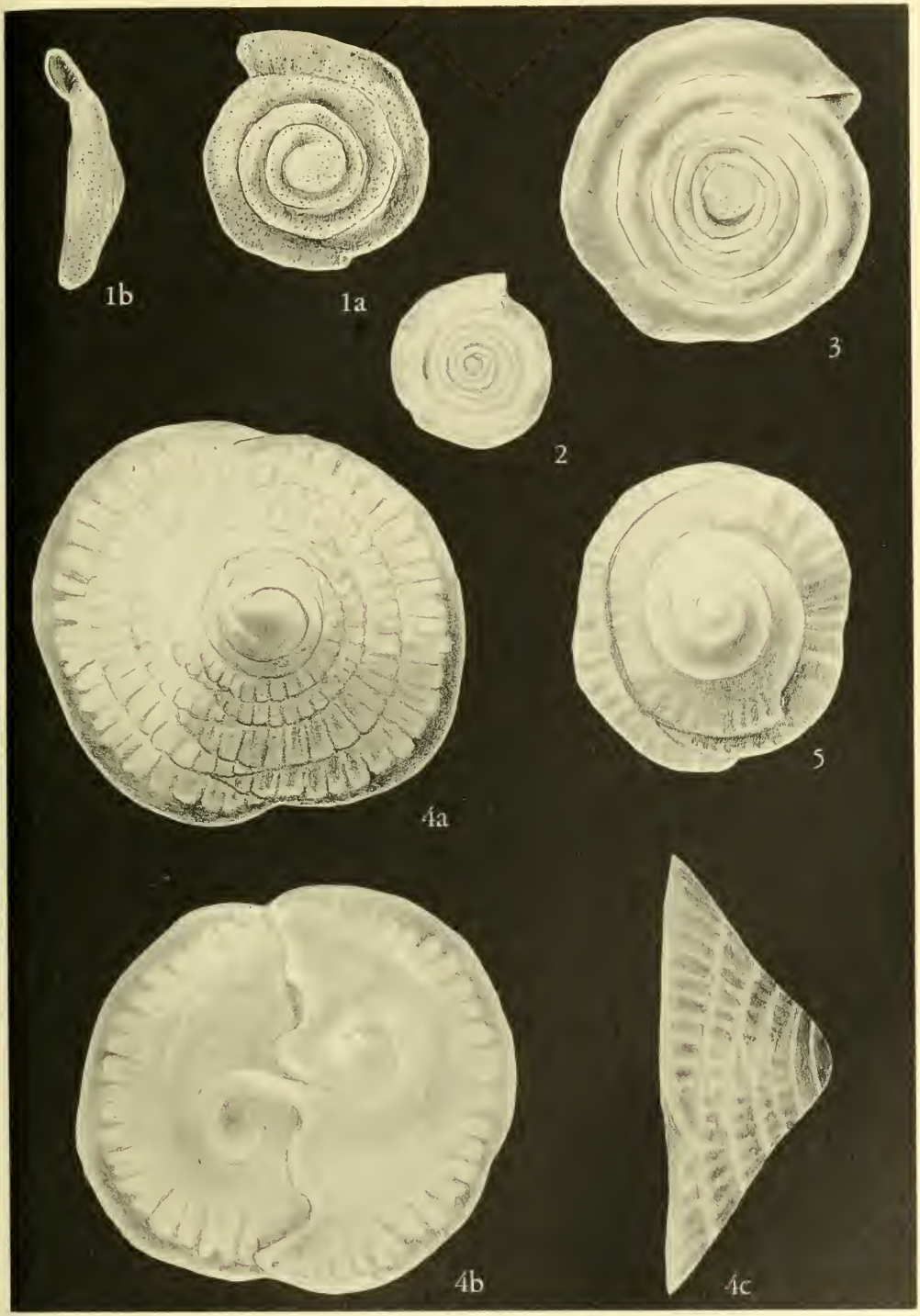

SPIRILLINIDAE

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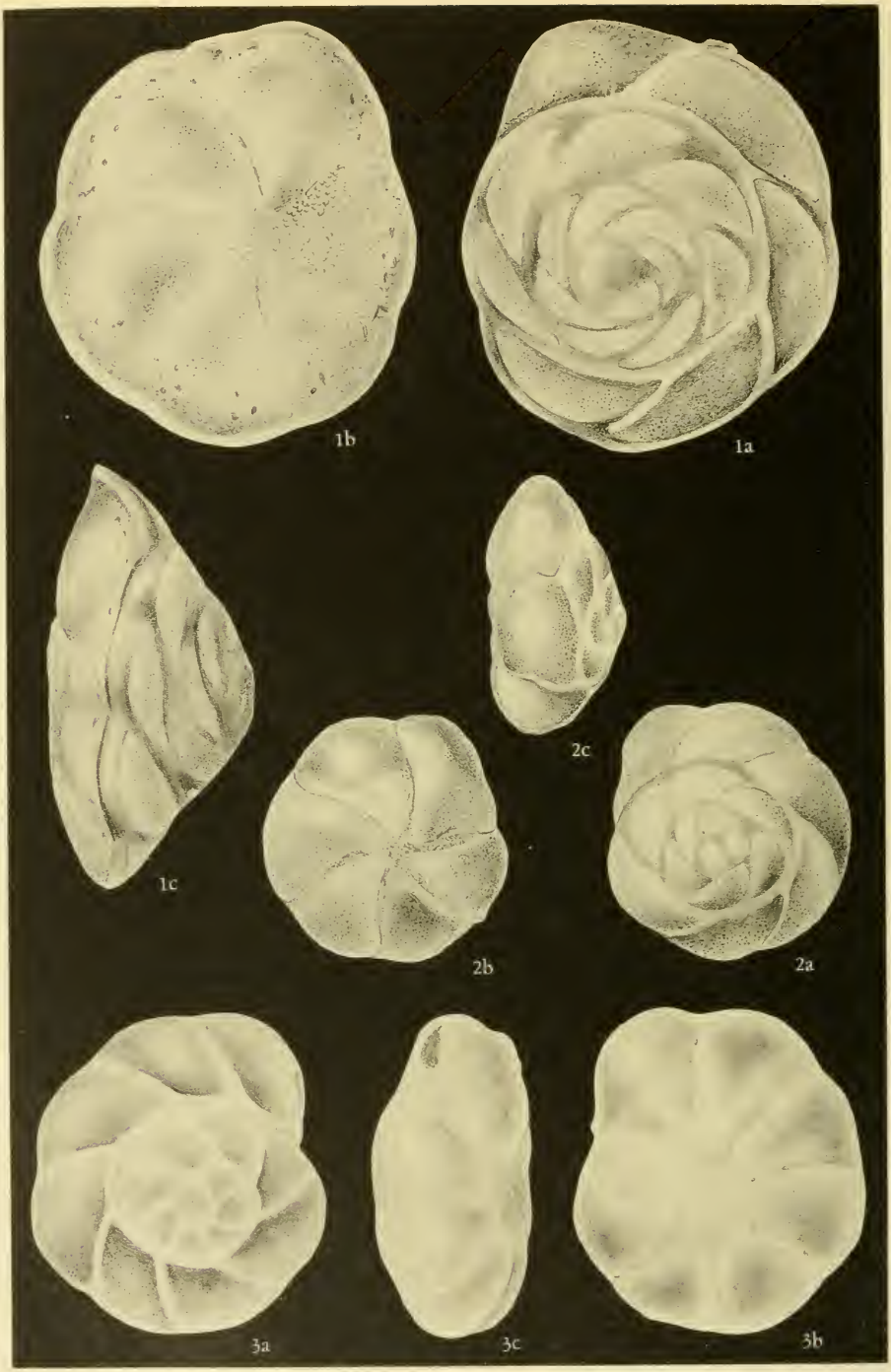

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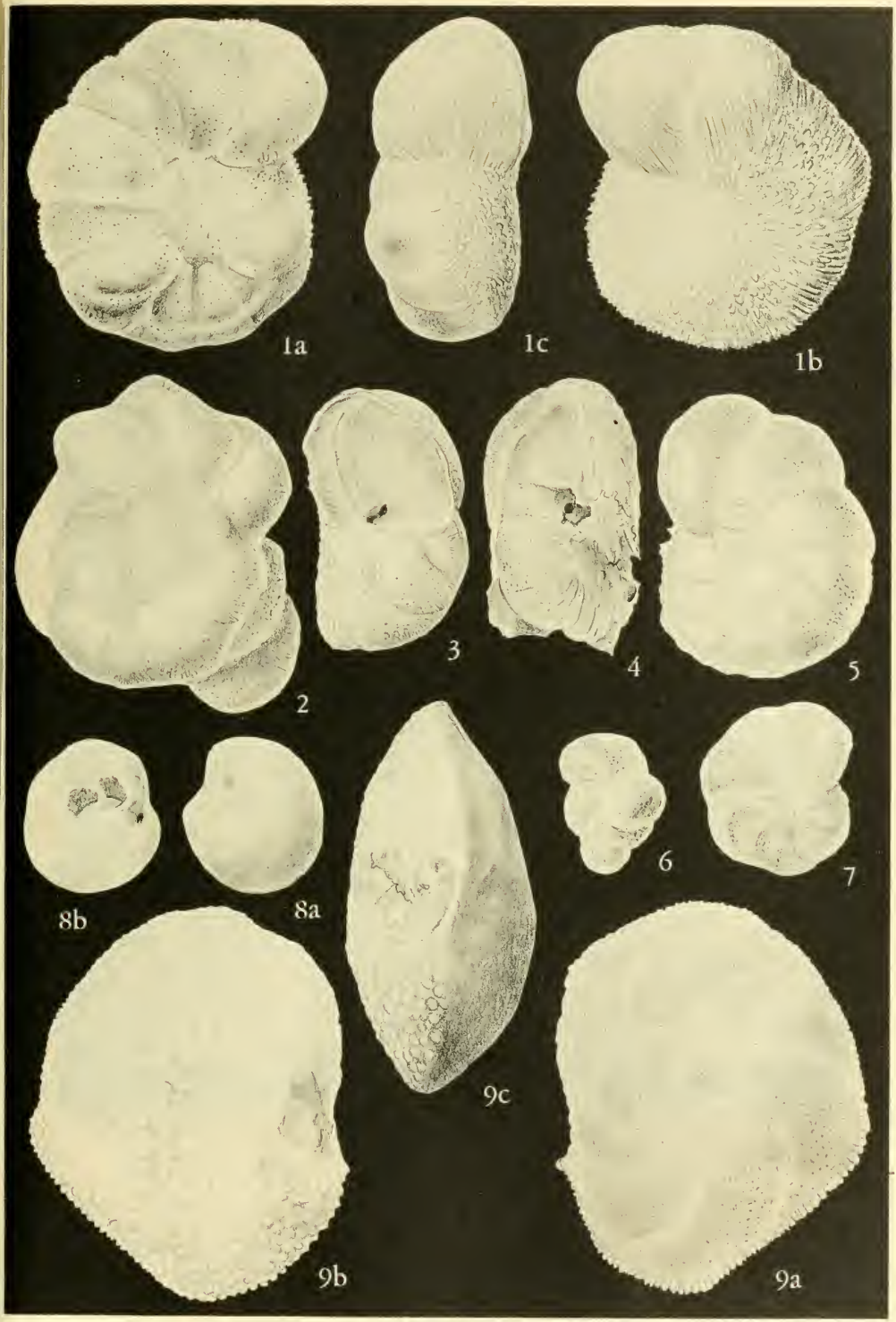

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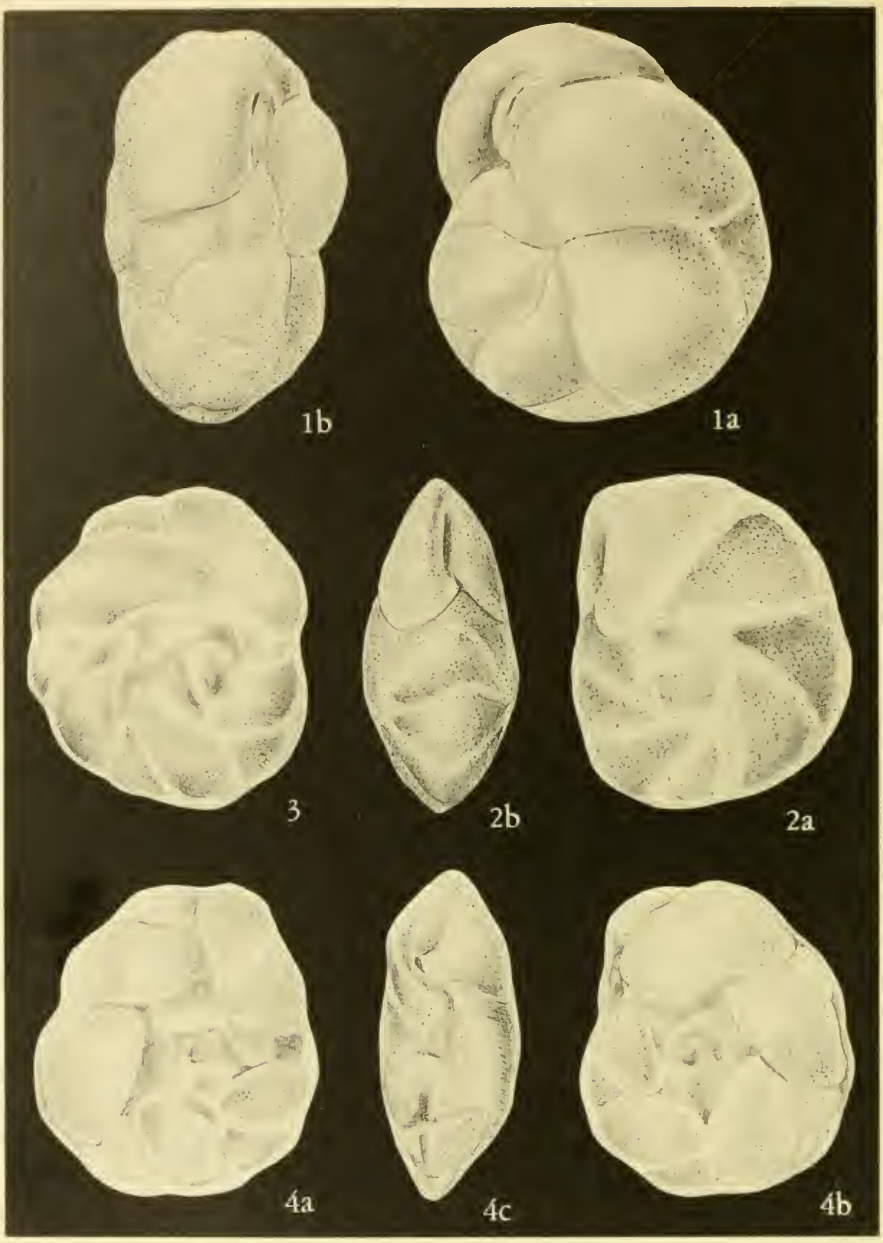

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