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Bulletin 71

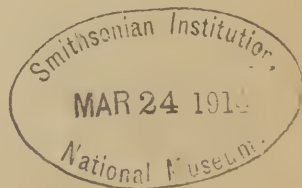
A MONOGRAPH OF THE FORAMINIFERA
OF THE NORTH PACIFIC OCEAN

PART IV. CHILOSTOMELLIDÆ, GLOBIGERINIDÆ
NUMMULITIDÆ

BY

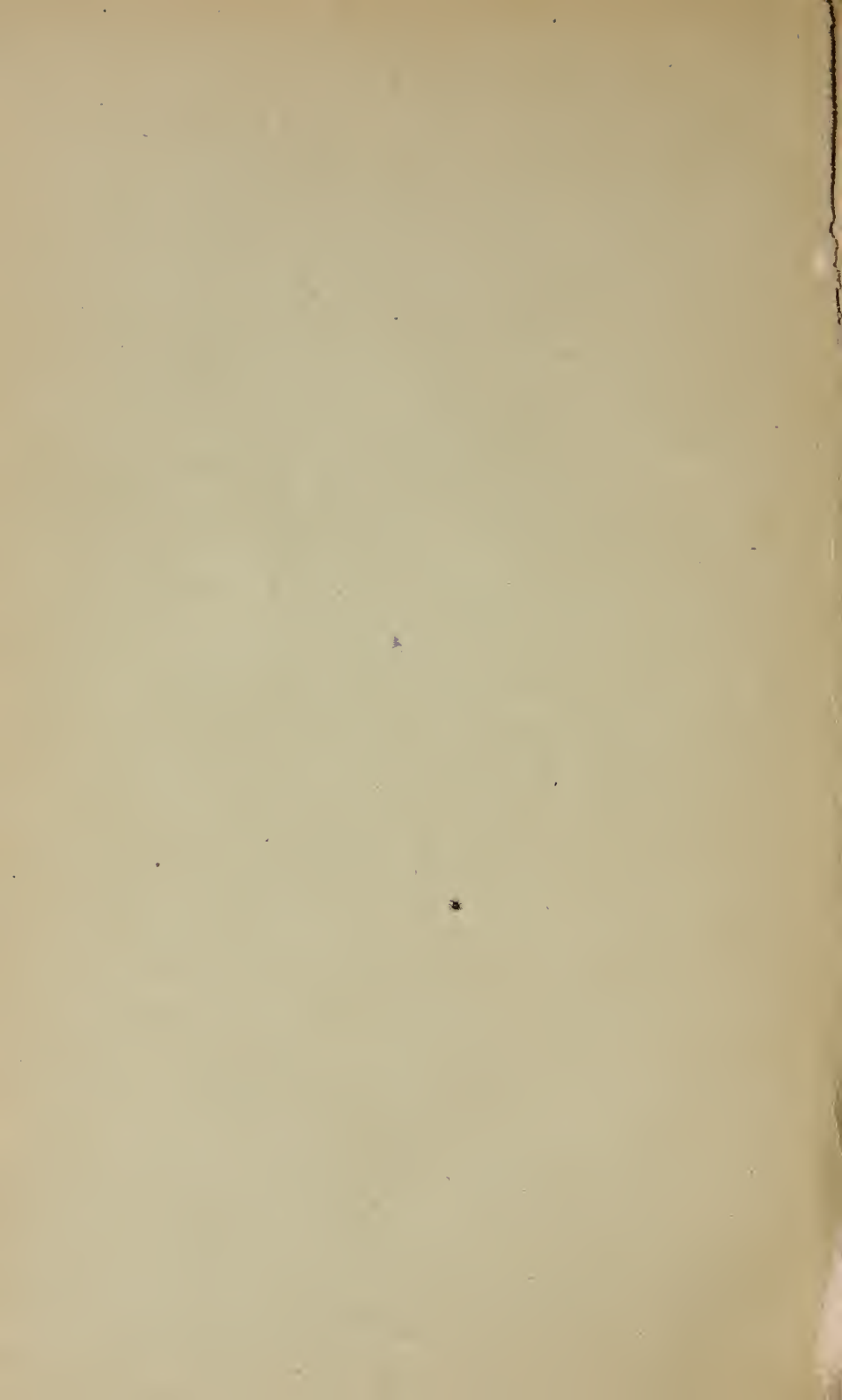
JOSEPH AUGUSTINE CUSHMAN

Of the Boston Society of Natural History



WASHINGTON
GOVERNMENT PRINTING OFFICE

1914



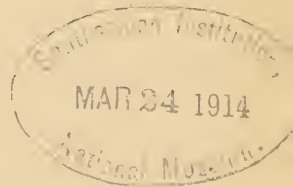
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ISSUED FEBRUARY 28, 1914.

INTRODUCTION.

The present volume is the fourth of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the families Chilostomellidæ, Globigerinidæ and Nummulitidæ. The last family while not appearing in its usual place above the Rotalidæ is included here simply for the better balancing of the present part, the other two included families being comparatively small. The first part, issued in 1910, included the families Astrorhizidæ and Lituolidæ; the second part, issued in 1911, included the family Textulariidæ; and the third part, issued in 1913, included the family Lagenidæ. Part five will be devoted to the Rotalidæ and part six, the last, will be given to the Miliolidæ.

JOSEPH AUGUSTINE CUSHMAN.

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A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

CHILOSTOMELLIDÆ, GLOBIGERINIDÆ, NUMMULITIDÆ.

By JOSEPH AUGUSTINE CUSHMAN,
Of the Boston Society of Natural History.

INTRODUCTION.

This fourth part of the work on the North Pacific Foraminifera deals with three comparatively small families. In the natural order of sequence the family Nummulitidæ should follow the Rotalidæ, but it is here included so that the next part may be devoted entirely to the Rotalidæ and the final part to the Miliolidæ.

As these families have been long worked on and especially the Globigerinidæ are of world-wide distribution it has been unnecessary to describe new species. Although the North Pacific as a whole is an area of red clay owing to the great depth, nevertheless in many parts it has immense deposits of typical Globigerina ooze, and these with certain restrictions which will be noted are very similar to those of the North Atlantic.

The Nummulitidæ are rather poorly represented in the material, largely due to the fact that most of the North Pacific material which has been at my disposal has come from deep water and for the most part outside the Tropics. The Nummulitidæ, especially the larger forms, are characteristic of shallow tropical regions, especially abundant about coral reefs. Such habitats occur about the Hawaiian Islands and the Philippines, and here they are abundant, especially in the latter archipelago, but unfortunately the material from this region available for the present work is very limited. One interesting feature is the occurrence of these tropical forms up to the southern coast of Japan, where, as has already been several times noted, the southern East Indian fauna seems to reach its northern limits in this region.

Certain of the Globigerinidæ have been illustrated by photographs taken at the United States National Museum from mounted specimens. While these are too small to give minute detail they show in a general way the actual appearance of the specimens better than drawings.

SYSTEMATIC TREATMENT.

A systematic presentation of the three families follows, the arrangement of the data being the same as in preceding parts of this monograph.

Family 6. CHILOSTOMELLIDÆ.

Test calcareous, conspicuously punctate, chambers inflated, ovate, coiled, the chambers in various genera making up a greater or less proportion of the volution; aperture a curved opening between the base of the chamber and its predecessor.

This family in the present oceans is represented by two genera, *Chilostomella*, in which the chamber takes up 180° of the periphery as added, and *Allomorphina*, in which it takes up typically 120°.

Instead of being related closely to the Textulariidae this family seems more closely related to the Globigerinidae in many ways.

Genus CHILOSTOMELLA Reuss, 1850.

Chilostomella REUSS (type, *C. ovoidea* Reuss), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 379.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 436.

Description.—Test composed of a series of chambers in a coil, each chamber making a half coil of 180° and embracing so that but a small part of the preceding chamber is visible; wall smooth, finely perforate; aperture at the inner margin of the ventral face of the chamber, curved.

This genus is unlike any others of the perforate type in its having but two visible chambers, in its translucent perforate walls, and in the peculiar arched aperture. It has been described as an alternating series of chambers but seems to be really a coiled test in which each chamber takes up 180° of the volution.

CHILOSTOMELLA OVOIDEA Reuss.

Plate 1, figs. 1-5.

Chilostomella ovoidea REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380, pl. 48, fig. 12.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 280, pl. 8, figs. 11, 12; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 436, pl. 55, figs. 12-23.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 485, pl. 11, fig. 12.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 305, pl. 9, figs. 1, 2.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 53, pl. 9, figs. 512-516; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 50.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 14.

Description.—Test composed of several chambers, ovoid, but two visible from the exterior, increasing in size rapidly as added, but a small portion of the second chamber visible; wall smooth, translucent, very thin, finely punctate; aperture a curved, somewhat

arched opening between the base of the chamber and the preceding one, often with a slightly thickened somewhat flaring lip.

Length up to 1 mm.

Distribution.—Brady records this species from six *Challenger* stations in the North Pacific at depths ranging from 95 to 3,125 fathoms. Goës records it from eight *Albatross* stations in the western Pacific at depths ranging from 770 to 1,832 fathoms. I have had it from several *Albatross* and *Nero* stations off the Galapagos Islands, off the Hawaiian Islands, off Guam and Japan, depths ranging from 323 to 2,256 fathoms. It has occurred usually as single specimens.

There is some considerable variation in the amount of overlapping of the chambers and a coincident variation in the form of the aperture and its lip.

Genus ALLOMORPHINA Reuss, 1850.

Allomorphina REUSS (type, *A. trigona* Reuss), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 437.

Description.—Test made up of a few ovate chambers, in a coil, each chamber making up 120° of the volution so that but three chambers are visible from the exterior; wall thin, translucent, punctate; aperture a narrow slit at the base of the chamber.

This genus is very similar to *Chilostomella* in its general characters of the wall, but differs mainly in the arrangement of the chambers in the coil, which in *Allomorphina* each make up 120° of the volution, whereas in *Chilostomella* they take up 180° .

ALLOMORPHINA TRIGONA Reuss.

Plate 1, figs. 6-8.

Allomorphina trigona REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380, pl. 48, figs. 14a-e.—SCHWAGER, Boll. Com. Geol. Italia, vol. 8, 1877, p. 26, pl. 71.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 67, pl. 8, figs. 13, 14; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 438, pl. 55, figs. 24-26.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 305, pl. 9, figs. 3, 4.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 53, pl. 9, figs. 517-519.

Description.—Test composed of several ovate chambers, coiled each chamber making 120° of the volution and embracing so that but three chambers are visible from the exterior, chambers longer than wide, inflated, sutures somewhat depressed; wall smooth, conspicuously punctate, usually thin and translucent; aperture a narrow curved opening at the base of the ventral margin of the chamber between it and the previously formed adjacent chamber.

Length about 0.40-0.60 mm.

Distribution.—Brady reports this species from the Pacific. It has not appeared in the material which I have examined. The figures are from Brady.

Family 7. GLOBIGERINIDÆ.

Test composed of numerous chambers, usually much inflated, arranged in a trochoid or planospiral coil, often umbilicate, calcareous and perforate walls; aperture either large and single or with numerous accessory apertural openings.

This family, while not consisting of a large number of species or genera, is nevertheless one of the most numerous of the present ocean in regard to numbers of individuals and in the deposits of the present ocean bottom. Making up as it does the great proportion of the enormous amount of pelagic foraminifera and composing the great proportion of the mass of the *Globigerina* ooze which makes up the most of the ocean bottom between 500 and 2,000 fathoms, its importance may be realized.

Among the fossils it makes up the mass of the various chalk deposits and has a long geological history. At the present time, however, perhaps its greatest interest is in the modifications of the test for pelagic life.

In order that the greatest amount of surface may be allowed for the bulk of the test, there is a tendency, in the pelagic forms of the family at least, to assume as nearly as possible a spherical form. The chambers individually assume a spherical contour, and even when made of several chambers the whole test in the various genera tends to take on a subspherical outline. This is carried to perfection in *Orbulina*, where the final chamber is a perfect sphere. In the pelagic forms the protoplasm is protruded from the test and forms a vesicular mass about the exterior. This is probably aided somewhat by the long radiating spines which are usually present in fresh pelagic specimens. In order that the protoplasm may have free access to the exterior, the apertures in this family are as a rule large, especially in pelagic species; where they are not large they are often numerous, as in *Candeina*. In *Globigerina* the apertures from several chambers may enter upon a common umbilical cavity, or in the higher development, as in *G. conglobata*, *sacculifera*, etc., there are numerous accessory apertural openings so that there is a large amount of space allowing perfectly free communication with the exterior.

The surface of the wall of the test is very characteristic in many species, consisting of a reticulated pattern with the pores at the base of the depressions.

The distribution, especially of the pelagic species, is world-wide, but seems to reach its greatest development in the warmer waters of the oceans.

Genus *GLOBIGERINA* d'Orbigny, 1826.

Globigerina D'ORBIGNY (type, *G. bulloides* d'Orbigny) Ann. Sci. Nat., vol. 7, 1826, p. 277.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 589.

Description.—Test composed of subglobular, inflated chambers, variously arranged, in the early stages at least in a coiled form either planospiral or trochoid; wall typically coarsely perforate, reticulate; aperture large, arched, at the base of the inner margin of the chamber, in some species more than one aperture.

This genus, comprising numerous well distinguished species, makes up the large proportion of the pelagic group of the Foraminifera and is the great constituent of *Globigerina* ooze. The range of structure and method of development of the test is remarkable and under the microscope the reticulated surface, combined with the curves of the sutures and the spherical chambers, make the various members of this genus very beautiful and interesting. It is remarkable that several of the largest and now best known and most abundant of the species should not have been known until the *Challenger* expedition, but it is all the more to the credit of that pioneer work in the deep water of the oceans. The form and surface structure of *Globigerina* is so distinctive that its members are easily distinguished from any other genus, unless perhaps it may be *Candeina* or *Hastigerina*, but these have their own distinctive characters, as will be noted.

The larger part of the figures illustrating the various species of *Globigerina* are from photographs taken at the United States National Museum and for the most part having a magnification of $\times 35$ unless otherwise noted. These show well the general characters of the species.

GLOBIGERINA BULLOIDES d'Orbigny.

Plate 2, figs. 7-9; plate 9.

Globigerina bulloides D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 277, No. 1; Modèles, No. 17 and No. 76; Foram. Voy. Amér. Mérid., 1839, p. 37; in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, 1839, pt. 2, Foraminifères, p. 132, pl. 2, figs. 1-3, 28; Foram. Foss. Bass. Tert. Vienne, 1846, p. 163, pl. 9, figs. 4-6.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 291, pl. 11, figs. 11, 12.—WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 56, pl. 5, figs. 116-118.—STACHE, *Novara-Exped.*, Geol. Theil, vol. 1, 1864, p. 286, pl. 24, figs. 35a-d.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 21, pl. 2, fig. 56; p. 31, pl. 2, fig. 55.—TERQUEM, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 85, pl. 9 (17), figs. 2a, b.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 90, pl. 6, figs. 195-207.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 172, pl. 3, fig. 3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 593, pl. 77; pl. 79, figs. 3-7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225, pl. 45, fig. 15.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 561, pl. 11, fig. 17.—WOODWARD and THOMAS, Geol. Nat.

Hist. Survey Minnesota, vol. 3, 1893, p. 40, pl. D, figs. 14-17.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 362, pl. 13, figs. 1-3.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 83, pl. 14, figs. 754-760.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 245, pl. 4, figs. 7-9.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 579, pl. 1, fig. 4.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 321, pl. 69, fig. 2.—RHUMBLER, in Brandt, Nordisches Plankton, Heft. 14, 1900, p. 21, figs. 24-26.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 685.—BAGG, Bull. U. S. Geol. Surv., No. 268, 1905, p. 41, pl. 7, fig. 7; Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 3; vol. 54, No. 16, 1910, p. 23.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 77, pl. 23, figs. 2-8.

Description.—Test subglobose, spiral, composed of few chambers, inflated, subspherical, all visible from above, three to four visible from below, umbilicate, sutures deep; surface reticulate, with spines when in a perfect state of preservation; aperture from each chamber, large, opening into a central umbilical depression.

Diameter, 0.30-0.80 mm.

Distribution.—Brady speaks of this species in the *Challenger* Report as found "wherever Foraminifera have been collected." Bagg records it at each of the nineteen stations from which he had material, off the Hawaiian Islands. I have records of its occurrence at more than a hundred *Nero* stations between Guam and Yokohama and then stopped recording as it was found at nearly every station where any *Globigerina* types occurred. Some of the records are as shallow as 55 fathoms, near the Hawaiian Islands and from that it occurred at stations down to 2,543 fathoms.

The variety *triloba* Reuss occurs with the typical nearly everywhere but seems much less common.

GLOBIGERINA DUBIA Egger.

Plate 4, figs. 1-3.

Globigerina dubia EGGER, Neues Jahrb. für Min., 1857, p. 281, pl. 9, figs. 7-9.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 71; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 595, pl. 79, figs. 17a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 366, pl. 13, figs. 36-38, 77.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 4.—RHUMBLER, in Brandt, Nordisches Plankton, Heft. 14, 1900, p. 19, fig. 20.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 686.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 154; Bull. U. S. Geol. Surv., No. 513, 1912, p. 79, pl. 22, figs. 4a-d.

Description.—Test composed of numerous inflated chambers arranged in a nautiloid spiral, chambers all visible from above, umbilicate below, with only the chambers of the last volution visible, usually 5 to 6 in number; wall reticulate; apertures of the chambers opening into the umbilical cavity.

Diameter, 0.50-0.80 mm.

Distribution.—Like the foregoing species this is found almost always when *Globigerina* types are found. It is recorded by Brady in the *Challenger* Report from the North Pacific; by Bagg from eight *Albatross* stations off the Hawaiian Islands. I have had material from a great number of stations wherever *Globigerina* ooze material has occurred.

This species, while related to *G. bulloides*, has a much more definite form and the coiling is very even; the outline from above or below is nearly circular.

GLOBIGERINA CRETACEA d'Orbigny.

Globigerina cretacea D'ORBIGNY, Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 34, pl. 3, figs. 12-14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 596, pl. 82, figs. 10a-c (?).—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.

Description.—Test similar in general characters to *G. dubia* but more compressed, number of chambers larger in each coil, smaller in size.

Diameter about 0.5 mm.

Distribution.—In the North Pacific Bagg records this species from three *Albatross* stations off the Hawaiian Islands, in 572-1,343 fathoms.

While the fossil forms described by d'Orbigny seem to be distinctive, in the recent material there seems to me to be little to separate these two forms.

GLOBIGERINA DIGITATA H. B. Brady.

Plate 14, figs. 1-3.

Globigerina digitata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 599, pl. 80, figs. 6-10; pl. 82, figs. 6, 7.—TERRIGI, Mem. Accad. Nuovi Lincei, ser. 4, vol. 6, 1889, p. 113, pl. 6, fig. 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 369, pl. 13, figs. 25, 60, 61.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 323, pl. 70, fig. 2.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.

Description.—Test spiral, regular, consisting of two or three volutions, early chambers inflated, subspherical, later chambers much elongated, pointed or otherwise modified at the tip, spreading radially; wall reticulate; aperture opening into the central umbilical opening, or in the elongate chambers making up the larger part of the base of the chamber, the area of attachment being very much reduced.

Diameter in adults up to 2 mm.

Distribution.—Bagg records this species from seven stations of the *Albatross* in the vicinity of the Hawaiian Islands, depths ranging from 384 to 1,259 fathoms. I have had material from about the Hawaiian Islands, *Nero* station 2037 in 55 fathoms, the shallowest, and from

about Guam at several *Nero* stations, 891 to 1,143 fathoms. It occurs usually in but small numbers.

This is a pelagic species and in the adult with the very large apertures it is easily possible for the sarcode to extend out to form the usual vesicles. The tips of the long chambers are pointed, flattened, fimbriate or even sometimes show a tendency toward branching.

**GLOBIGERINA DUTERTREI* d'Orbigny.

Globigerina dutertrei D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 95, pl. 4, figs. 19-21.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 601, pl. 81, figs. 1a-c.

Description.—"Test Rotaliform, suborbicular, both faces convex, margin thick and rounded; composed of about three convolutions, the last of which consists of five segments; segments gradually increasing in size from the commencement, somewhat inflated, especially the later ones; aperture a single arched orifice at the inferior umbilical margin of the final segment.

"Diameter, $\frac{1}{30}$ th inch (0.5 mm.) or less."

Distribution.—The only record for this species in the North Pacific is that of Picaglia, who records it from a single station of the *Vettor Pisani*, long. 109° 58' W.; lat. 0° 47' N., depth 4,670 m.

I have found no material which seems referable to this rather doubtful species. The description is from Brady.

GLOBIGERINA INFLATA d'Orbigny.

Plate 4, figs. 4-8.

Globigerina inflata D'ORBIGNY, in Barker, Webb and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, 1839, Foraminifères, p. 134, pl. 2, figs. 7-9.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 601, pl. 79, figs. 8-10.—BALKWILL and MILLETT, Journ. Micr., vol. 3, 1884, p. 84, pl. 4, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 369, pl. 13, figs. 45-47.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 85, pl. 14, figs. 763-765.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 3.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 577, pl. 1, fig. 3.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 19, fig. 19.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 687.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 23.

Globigerina bulloides, var. *inflata* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 367, pl. 16, figs. 16, 17.

Description.—Test composed of numerous inflated chambers, usually arranged in a spiral test of about three volutions, the last one composed of four chambers, upper side of test flattened, lower end of chambers prolonged so that in side view the test is about as high as broad; surface reticulate, but usually less conspicuously so than most of the other species of the genus; aperture a long arched opening at the base of the inner face of the chamber.

Diameter 0.40-0.80 mm.

Distribution.—Brady notes the occurrence of this species in the North Pacific at five *Challenger* stations, depths ranging from 345 to 3,125 fathoms. Bagg does not record it. I have found the species at a very large number of *Nero* stations, depths ranging from 264 to 2,543 fathoms, well scattered over the area. It has also occurred at various *Albatross* and *Tuscarora* stations.

GLOBIGERINA RUBRA d'Orbigny.

Plate 3, figs. 6-9.

Globigerina rubra D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 94, pl. 4, figs. 12-14.—BAILEY, Smiths. Contr., vol. 2, 1851, p. 11, pl., figs. 23, 24.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 602, pl. 79, figs. 11-16.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225, pl. 45, fig. 12.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 360, pl. 13, figs. 42-44.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 85, pl. 14, fig. 766.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 262, pl. 5, fig. 4.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 5.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 580, pl. 2, fig. 11.—MILLET, Journ. Roy. Micr. Soc., 1903, p. 687.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 154.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 4; vol. 54, No. 16, 1910, p. 23.

Description.—Test composed of several inflated chambers arranged in an elongate trochoid spire of about three volutions each with three chambers; walls reticulate, with spines in pelagic specimens; aperture an arched opening at the umbilical border of the chamber and in the later chambers this is supplemented by two or more nearly circular openings on the upper border of the chamber near its connection with the preceding chambers; color of the early chambers, sometimes of all the chambers, pink.

Length about 0.75 mm.; diameter about 0.50 mm.

Distribution.—This species is not nearly so abundant in the North Pacific as are most of the others of the genus. Brady records it from the Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. Bagg records it from thirteen *Albatross* stations also in the vicinity of the Hawaiian Islands, depths ranging from 275 to 1,544 fathoms. I have records of its occurrence at 26 *Nero* stations well scattered from the Hawaiian Islands to Guam and Yokohama but it has usually occurred in small numbers.

This is a beautiful species when its delicate coloring is well preserved, but in the material I have seen there is but a small amount of this species compared to what is found in material from the West Indian region.

The high spire of this species with its peculiar accessory apertural openings will at once distinguish this species, even though the color may be lacking, as is often the case.

GLOBIGERINA CONGLOBATA H. B. Brady.

Plate 3, figs. 3-5; plate 10, figs. 1, 6.

Globigerina conglobata H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 603, pl. 80, figs. 1-5; pl. 82, fig. 5.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225, pl. 45, fig. 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 368, pl. 13, figs. 55, 56.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 86, pl. 14, figs. 768, 769; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 66.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 6.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 582, pl. 2, figs. 12-15; pl. 3, figs. 1-5.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 688.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 153.

Description.—Test subglobular, early chambers arranged in a compact spiral; in the adult the last three chambers form the last volution taking up nearly the whole surface of the test; wall strongly reticulate; in pelagic specimens with delicate spines; aperture at the inner margin of the chamber with several rounded accessory apertures along the sutures between the chamber and the previous ones to which it is adjacent.

Diameter up to 1 mm.

Distribution.—Brady records this as found in the North Pacific in the *Challenger* surface tows as well as at two bottom stations, 214 in 500 fathoms and 224 in 1,850 fathoms. Bagg records it from 15 out of 19 *Albatross* stations near the Hawaiian Islands in 275 to 1,544 fathoms.

I have found the species to be abundant in material dredged by the *Albatross* between San Francisco and the Hawaiian Islands and at a great number of *Nero* stations wherever *Globigerina* ooze conditions were encountered. It also occurs frequently in the *Alert* and *Tuscarora* material.

This is a very characteristic species and it is singular that it was not found previous to the *Challenger* expedition. The globose form, with the three chambers making up practically all the visible test and the peculiar accessory apertural openings, will distinguish this species from any others.

Evidently this is one of the highest of the species of the genus. It is often almost globose, the accessory apertural openings numerous and large, especially in adult specimens. It is apparently a rare species outside of the recent oceans, its occurrence as a fossil being practically unknown.

In the north Pacific material this is often the characteristic species of the genus.

GLOBIGERINA SACCULIFERA H. B. Brady.

Plate 2, figs. 4-6; plate 5; plate 10, fig. 4.

Globigerina helicina CARPENTER, (not *G. helicina* d'Orbigny), *Intr. Foram.*, 1862, pl. 12, fig. 11.

Globigerina sacculifera H. B. BRADY, *Geol. Mag.*, Dec. 2, vol. 4, 1877, p. 535; *Quart. Journ. Micr. Sci.*, vol. 19, 1879, p. 73; *Rep. Voy. Challenger, Zoology*, vol. 9, 1884, p. 604, pl. 80, figs. 11-17; pl. 82, fig. 4.—EGGER, *Abh. kön. bay. Akad. Wiss. München*, Cl. II, vol. 18, 1893, p. 369, pl. 13, figs. 50, 51.—GoËs, *Bull. Mus. Comp. Zoöl.*, vol. 29, 1896, p. 66.—SILVESTRI, *Mem. Pont. Accad. Nuovi Lincei*, vol. 15, 1899, p. 263, pl. 5, fig. 5.—FLINT, *Ann. Rep. U. S. Nat. Mus.*, 1897 (1899), p. 322, pl. 70, fig. 1.—MILLET, *Journ. Roy. Micr. Soc.*, 1903, p. 688.—BAGG, *Proc. U. S. Nat. Mus.*, vol. 34, 1908, p. 154.

Description.—Test composed of numerous chambers, in its early stages very similar to *G. bulloides* but later developing a more oblong form, the chambers extended, somewhat compressed and with accessory apertural openings, the final chamber often flattened and irregularly formed toward the outer end; wall strongly reticulated in all but the final chamber which is much smoother than the others; aperture large, arched with other accessory openings in the chambers of adult specimens.

Diameter up to and sometimes slightly exceeding 1 mm.

Distribution.—Brady records this species from three North Pacific *Challenger* stations, ranging in depth from 345 to 1,850 fathoms. Bagg records it from all but one of the nineteen *Albatross* stations in the vicinity of the Hawaiian Islands from which he examined material. I have found this species present and often in considerable numbers in material from a very large number of North Pacific stations in the *Albatross*, *Nero*, *Alert*, and *Tuscarora* material. These stations range in depth from 268 to 2,552 fathoms.

This species is easily distinguished, especially in its adult form. In some specimens where the accessory apertures are large it is possible to look through the opening between the last chambers and those of the previous whorl. The figured specimen shows the general character of the last chamber, its smoother surface and the accessory apertural openings.

As noted in regard to the preceding species this species seems to be practically unknown as a fossil form. By its large openings it is one of the highest developed species of the genus.

The last-formed chamber in adults is often very variable in shape, especially the outer border, which is often deeply lobed and irregularly extended.

GLOBIGERINA HELICINA d'Orbigny.

Plate 3, figs. 1, 2.

Globigerina helicina d'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 277, No. 5.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 175, pl. 11, fig. 113.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 287; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 605, pl. 81, figs. 4, 5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 370, pl. 13, fig. 52.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 264, pl. 5, fig. 6.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 583, pl. 3, figs. 11, 12.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 688, pl. 7, fig. 1.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 154.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 4, pl. 1, fig. 9.

Description.—Test oblong or ovate, composed of several chambers more or less irregularly arranged, inflated, the later chambers being added on the periphery of the test without regard to the spiral arrangement of the earlier ones; wall reticulate; aperture on the basal side of the inner margin of the chamber but also are added one or more accessory apertural openings on the upper side of the test, especially in the added last chambers.

Diameter up to 1 mm.

Distribution.—Bagg records this species as rare at *Albatross* station H 4696 in 367 fathoms off the Hawaiian Islands. I have it also from the same region, *Albatross* station H 2923 in 392 fathoms where it occurred with several specimens here figured.

It may be a question as noted by Brady whether this may not be an abnormal development of some other species, as it seems to occur but rarely and always shows an irregular form.

GLOBIGERINA ÆQUILATERALIS H. B. Brady.

Plate 2, figs. 1-3; plate 10, fig. 5.

Cassidulina globulosa (part) EGGER, Neues Jahrb. für Min., 1857, p. 296, pl. 11, fig. 4.

Globigerina æquilateralis H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 71; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 605, pl. 80, figs. 18-21.—WRIGHT, Proc. Belfast Nat. Field Club, 1884-85, App. 9, 1886, p. 332, pl. 27, fig. 9.—CHAPMAN, Quart. Journ. Geol. Soc., vol. 48, 1892, p. 517, pl. 15, fig. 14.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 364, pl. 13, figs. 5-8.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 86, pl. 14, fig. 767.—CHAPMAN, Journ. Roy. Micr. Soc., 1896, p. 589, pl. 13, fig. 7.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 66.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 265, pl. 5, fig. 8.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 580, pl. 4, figs. 3, 4.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 323, pl. 70, fig. 3.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 20, figs. 21-23.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 689.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 152.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 4, pl. 1, fig. 10.

Description.—Test composed of numerous inflated chambers arranged in a bilaterally symmetrical, planospiral coil of one and a

half to two volutions; chambers increasing rapidly in size as added, usually 5 to 6 visible in side view, sutures much depressed giving a lobulated contour; wall reticulate, often with broken spines; aperture large, an arched opening at the base of the chamber.

Diameter up to 1 mm.

Distribution.—Brady records this species in the North Pacific from the following *Challenger* stations, Honolulu coral reefs, 40 fathoms; station 206 in 2,100 fathoms, 214 in 500 fathoms, and 224 in 1,850 fathoms. Bagg records it from 18 *Albatross* stations off the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms. I have had material from numerous *Albatross* stations between San Francisco and the Hawaiian Islands, depths ranging from 323 to 2,615 fathoms. It has occurred at a great number of stations of the *Nero* wherever those soundings were below 2,000 fathoms across the Pacific and especially between Yokohama and Guam where I have record of its occurrence at 40 stations. It has also occurred in the material from the soundings of the *Alert* and *Tuscarora* and off Japan in the *Albatross* work as well as off the Galapagos Islands. Altogether it seems to be well distributed in the North Pacific and to occur abundantly at many stations.

The planospiral arrangement of the chambers in this species will distinguish it from the others of the genus. There is some considerable variation in the closeness of the coiling in various specimens. In old-age specimens there is a tendency to reduce the size of the last-formed chamber and to make it less high and of smaller diameter than the preceding one.

Genus ORBULINA d'Orbigny, 1839.

Orbulina d'ORBIGNY (type, *O. universa* d'Orbigny), in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 606.

Description.—Test composed of several *Globigerina*-like chambers, rapidly increasing in size as added, finally entirely surrounded by the adult chamber which is spherical, with numerous small pores and one large circular orifice, or occasionally more than one; wall reticulated, in living condition with long, fine spines.

There has been much discussion in the past in regard to the position of *Orbulina* and its relation to *Globigerina*. It seems best now that something is known of the development to recognize *Orbulina* as a genus derived from *Globigerina* ancestry, the adult final chamber inclosing the earlier ones being a good generic character. It is comparable to certain of the Miliolidæ where a similar inclosing of the earlier developed chambers takes place.

In *Orbulina* there seems to be a process of resorption by which the interior chambers disappear in the adult specimens, the smaller, thinner specimens having such included chambers, whereas they almost never are found in large well-developed specimens.

ORBULINA UNIVERSA d'Orbigny.

Plate 6; plate 7; plate 11, fig. 3.

"Polymorpha sphaerulae vitreae," SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, p. 116, pl. 119, figs. I-N.

Orbulina universa D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 3, pl. 1, fig. 1; in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, Foraminifères, 1839, p. 122, pl. 1, fig. 1; Foram. Foss. Bass. Tert. Vienne, 1846, p. 22, pl. 1, fig. 1.—BAILEY, Smiths. Contr., vol. 2, 1851, p. 9, pl., fig. 1.—WILLIAMSON, Rec. For. Great Britain, 1858, p. 2, pl. 1, fig. 4.—CARPENTER, PARKER, and JONES, Intr. Foram., 1862, p. 176, pl. 12, fig. 8.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 364, pl. 16, figs. 13, 14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 608, pl. 78; pl. 81, figs. 8-26; pl. 82, figs. 1-3.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 174, pl. 4, figs. 25-31.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 9.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 225, pl. 45, figs. 7, 8, 14.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 374, pl. 14, figs. 7-9, 11, 12, 39, 40.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 3, 1893, p. 430, pl. 2, fig. 12.—LISTER, Philos. Trans., vol. 186, 1895, p. 408, figs. a-e.—RHUMBLER, Abh. deuts. Zool. Ges., 1897, p. 174, fig. 21.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 266, pl. 5, figs. 11-16, 19-22.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 69, fig. 1.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 27, figs. 27-30.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 690.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 5; vol. 54, No. 16, 1910, p. 24.—BAGG, Bull. 513, U. S. Geol. Surv., 1912, p. 79, pl. 23, fig. 1.

Description.—Test composed of a series of *Globigerina*-like chambers followed by and inclosed by a globular chamber, surface reticulate with a pit at the bottom of each reticulation and one larger, circular aperture; surface with long spines in the living condition.

Diameter up to 1 mm.

Distribution.—Little need be said of the distribution of this species which seems to be found nearly always in any sample of typical *Globigerina* ooze. Brady simply speaks of it as cosmopolitan. Bagg records it from all 19 of the *Albatross* stations from which he examined material from off the Hawaiian Islands. Picaglia notes it from two stations of the *Vettor Pisani* in the North Pacific. Flint notes it from various *Nero* stations.¹

I have found it common in material from the *Albatross*, *Nero*, *Tuscarora*, and *Alert* soundings wherever such soundings came into the regions of *Globigerina* ooze.

There is a tendency in specimens to show many layers in the wall of the final chamber, and it may be that the test increases by addition of material from without and resorption from within. At least

¹ Bull. U. S. Nat. Mus., No. 55, 1905, pp. 16, etc.

various sizes are found in the material, suggesting that there must be some increase in size.

This is one of the commonest of the pelagic species and has the sarcode extended in a living condition into the bubblelike form already referred to here. Various double forms and some with a second chamber showing are occasionally found, and these seem to simply show specimens in which the last formed chamber has not entirely inclosed the preceding ones, similar to *Biloculina sphaera*. One such specimen is figured on plate 7 as fig. 2.

Genus *HASTIGERINA* Wyville Thomson, 1876.

Plate 8.

Nonionina (part) D'ORBIGNY, Foram. Amér. Mérid., 1839, p. 27.

Lituola (part) JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 302, table No. 181.

Globigerina (part) PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 366.

Hastigerina WYVILLE THOMSON (type, *Hastigerina pelagica* (d'Orbigny)), Proc. Roy. Soc., vol. 24, 1876, p. 534.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 612.

Description.—Test composed of numerous chambers arranged in planospiral manner, inflated; surface with numerous spines, aperture large, broad oval at the inner margin of the chamber. This genus represented by the following species is essentially pelagic.

HASTIGERINA PELAGICA (d'Orbigny).

Plate 8.

Nonionina pelagica D'ORBIGNY, Foram. Amér. Mérid., 1839, p. 27, pl. 3, figs. 13, 14.

Lituola pelagica JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 302, table, No. 181.

Globigerina pelagica PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 366.

Hastigerina pelagica H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 77; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 613, pl. 83, figs. 1-8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 372, pl. 13, figs. 53, 54.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 324, pl. 70, fig. 4.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 273, pl. 5, fig. 9.—RHUMBLER, in Brandt, Nordisches Plankton, 1900, p. 29, fig. 31.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 691.

Hastigerina murrayi WYVILLE THOMSON, Proc. Roy. Soc., vol. 24, 1876, p. 534, pls. 22, 23.

Description.—Test composed of numerous inflated, subglobular chambers in a spiral form, umbilicate, chambers increasing in size progressively as added, sutures much depressed; wall very thin and transparent, clothed with long slender spines which are serrate, especially toward the base; aperture a large, arched, oval opening at the inner border of the chamber.

Diameter of test without spines up to 1.3 mm.

Distribution.—Brady records this species from 12 *Challenger* stations in the North Pacific. Flint¹ records the species or at least the genus from *Nero* station 11 in 1,983 fathoms between the Hawaiian Islands and Midway Island and 166–174, 1,593–2,111 fathoms between Midway Island and Guam. Bagg does not record it from the region of the Hawaiian Islands; and in all the material I have examined I have failed to find specimens, whether from lack of care in searching the material or too rough handling in washing the material, or what, I do not know.

The species may be distinguished from *Globigerina æquilateralis* which it somewhat resembles in contour by the thinner wall and the peculiar spinose character of the surface.

Hastigerina pelagica is truly pelagic, and in the specimens obtained in a living condition by the *Challenger* the sarcode was expanded in the bubblelike form seen in different members of the pelagic group of Foraminifera.

Genus CANDEINA d'Orbigny, 1839.

Candeina D'ORBIGNY (type, *Candeina nitida* d'Orbigny), in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 107.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 622.

Description.—Test usually in the form of an elevated spire, but may be more or less compressed, chambers several, increasing in size as added, globular or subglobular; wall usually clear, finely perforate, translucent; apertures numerous, elliptical in form along the sutural lines between the chambers.

This genus is unique in the family in the manner of its development of numerous apertural openings along the border of the last formed chamber where it comes in contact with the preceding chambers. It is represented in the North Pacific material by the following species:

CANDEINA NITIDA d'Orbigny.

Plate 11, fig. 1.

Candeina nitida D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, Foraminifères, p. 108, pl. 2, figs. 27, 28; Foram. Foss. Bass. Tert. Vienne, 1846, p. 193, pl. 21, fig. 28.—GoëS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 89, pl. 6, figs. 187–189.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 622, pl. 82, figs. 13–20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 373, pl. 13, fig. 57.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 3.—RHUMBLER, in Brandt, Nordisches Plankton, vol. 14, 1900, p. 31, fig. 33.—MILLET, Journ. Roy. Micr. Soc., 1903, p. 692, pl. 7, fig. 2a-c.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 156.

Description.—Test composed of numerous chambers, progressively increasing in size as added, globular or subglobular, arranged in a

¹ Bull. U. S. Nat. Mus., No. 55, 1905, pp. 15, 17.

spire or variously compressed; wall smooth, sutures depressed, punctate; aperture consisting of a series of rounded or elliptical pores at the junction of the last formed chamber with the next preceding chambers.

Diameter of test averaging about 0.75 mm.

Distribution.—Brady records this species from a single North Pacific station in the *Challenger* Report, the depth given being 214–500 fathoms. Bagg records it off the Hawaiian Islands at seventeen *Albatross* stations, the depths ranging from 104–1,544 fathoms. I have had numerous specimens of this species from a large number of stations about the Hawaiian Islands, off Guam, between Guam and Yokohama, and between Guam and Midway Island. It has never occurred in any great numbers. The depths range from 392–2,615 fathoms with the average at about a thousand fathoms.

This species is easily distinguished by its *Globigerina*-like form and its very characteristic apertural openings. It was found by Millett in material from the Malay Archipelago and by Brady in the South Pacific and the regions of the West Indies and various parts of the Atlantic. D'Orbigny's original specimens came from the shore sands of the West Indies, Cuba, and Jamaica.

This species is one of the small number that occur as pelagic forms. The *Challenger* obtained specimens from tow nets in the North Pacific and also in the South Atlantic.

Genus SPHÆROIDINA d'Orbigny, 1826.

Sphæroidina D'ORBIGNY (type, *S. bulboides* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 267.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 619.

Description.—Test composed of a small number of chambers arranged in a short spire, the chambers inflated and increasing rapidly in size and embracing, few only visible from the exterior; wall perforate; aperture an arched opening at or near the inner margin of the chamber, often with a calcareous tooth-like process partially closing the opening.

One of the species, *S. dehiscens*, occurs in the pelagic condition and is especially modified in various ways as are a number of pelagic species.

This genus is found in some numbers in the later Tertiary, but earlier than this does not seem to be at all common.

Various synonyms appear, such as *Sexloculina* Czjzek, and *Grammobotrys*, and *Bolbodium* of Ehrenberg.

SPHÆROIDINA BULLOIDES d'Orbigny.

Plate 10, fig. 7; plate 12, fig. 1.

Sphæroidina bulloides D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267, No. 1; Modèles, No. 65.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 58.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 89, pl. 60, figs. 190-193.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 620, pl. 84, figs. 1-7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 45, figs. 9-11.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 562, pl. 11, figs. 20, 21.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 3, 1893, p. 430, pl. 2, fig. 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 375, pl. 13, figs. 48, 49.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 87, pl. 14, fig. 770; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 67.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 692.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 5, pl. 1, fig. 11.

Description.—Test nearly spherical, composed of a few much inflated chambers, arranged in a spire of but about two revolutions, only those of the last formed revolution being visible from the exterior in most specimens; wall smooth and polished, thick, minutely perforate; aperture an arched, semicircular opening, usually nearly closed by a broad flat semicircular tooth.

Diameter on an average about 1 mm.

Distribution.—Brady records this species from four *Challenger* stations in the North Pacific in from 1,850 to 2,300 fathoms. Goës records it from the western Pacific, *Albatross* D 3407 in 885 fathoms and D 3376 in 1,132 fathoms. Bagg records it from four *Albatross* stations off the Hawaiian Islands, with depths ranging from 572 to 1,398 fathoms.

In the North Pacific material I have examined the species has occurred at many stations, in the region about the Hawaiian Islands and through the various *Nero* soundings as well as off Japan. The depths of the stations have as a rule been more than 1,000 fathoms, the shallowest being 859 and the deepest 2,067 fathoms.

Occasionally specimens are met with which in the final revolution have failed to entirely cover the earlier chambers and the beginning of the spiral development is visible. At first glance this species appears like an imperforate foraminifer the perforations being very fine and indistinct and the wall white and highly polished. In almost all its characters it is in great contrast with the species following.

SPHÆROIDINA DEHISCENS Parker and Jones.

Plate 10, fig. 2; plate 13, fig. 1.

Sphæroidina dehiscens PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 369, pl. 19, fig. 5, *a*, *b*.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 295; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 621, pl. 84, figs. 8–11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 376, pl. 13, figs. 58, 59.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 67.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 325, pl. 71, fig. 2.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.

Globigerina seminulina SCHWAGER, *Novara* Exped., Geol. Theil, vol. 2, 1866, p. 256, pl. 7, fig. 112.

Description.—Test subglobular, composed of a few chambers arranged as in *S. bulloides* but distinguished even in early stages by the large perforations and translucent test; chambers in later development separated by deep fissure-like sutures, often in adult specimens nearly closed by the fimbriated edges of the chamber; wall thick, conspicuously perforate, somewhat reticulate, rough; aperture an arched opening into the chamber from the deep fissure near its base.

Diameter up to 1.5 mm.

Distribution.—Brady records this species from four *Challenger* stations in the North Pacific, depths ranging from 500 to 2,100 fathoms. Picaglia records it from two North Pacific stations of the *Vettor Pisani*. Goës records it from two *Albatross* stations in the western Pacific, D 3371 in 770 fathoms and D 3400 in 1,322 fathoms. Bagg records it from a number of *Albatross* stations near the Hawaiian Islands at depths ranging from 305 to 1,544 fathoms. I have found specimens from a great number of stations in all parts of the North Pacific where *Globigerina* ooze material has been available. In depth these range from 323 to 2,175 fathoms. Often the specimens have been abundant and excellent for showing the developmental stages.

In the young of *S. dehiscens* the test is comparatively smooth but is conspicuously perforate with comparatively large pores. At this time there is almost no trace of the deep sutures and except for the pores and the translucent test the resemblance to a specimen of *S. bulloides* is close. As chambers are added usually a triangular area is left, at first very small and inconspicuous, later becoming more marked, similar to the specimen figured by Schwager noted above. By degrees as chambers are added the sutures become wider and finally in adult specimens they are at the bottom of deep fissures which are wide open, but which in old-age specimens are partially closed near the exterior by the growing in of the side walls near the surface. In such specimens the walls at the edge of these fissures are often considerably raised and fimbriate and the remainder of the wall becomes rough and somewhat reticulate. In the old-age specimens the wall is very thick and the pores are conspicuous in section.

The large pores are similar to what is seen in many other pelagic species. Although usually found as a bottom form this species occurs sparingly as a pelagic form in tow-net gatherings.

Genus PULLENIA Parker and Jones, 1862.

Nonionina (part) D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 293.

Pullenia PARKER and JONES (type, *P. sphæroides* (d'Orbigny)), in Carpenter, Parker, and Jones, Intr. Foram., 1862, p. 184.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 614.

Description.—Test composed of several chambers arranged in a planospiral or oblique nautiloid more or less involute spiral, sutures not greatly inflated, only those of the last volution visible; wall smooth, perforations small and indistinct; aperture a curved opening at the base of the inner face of the chamber.

Certain of the characters of this genus make it seem related to such genera as *Nonionina* or *Polystomella*, especially the former, but no complicated structures have been demonstrated here as occur in *Polystomella*. Of the three species *P. obliquiloculata* is most clearly related in form and apertural characters to the Globigerinidæ.

PULLENIA SPHÆROIDES (d'Orbigny).

Plate 11, fig. 2.

Nonionina sphæroides D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 293, No. 1; Modèles, No. 43.

Pullenia sphæroides PARKER and JONES, in Carpenter, Parker and Jones, Intr. Foram., 1862, p. 184, pl. 12, fig. 12; Philos. Trans., vol. 155, 1865, p. 368, pl. 14, figs. 43 *a*, *b*; pl. 17, fig. 53.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 615, pl. 84, figs. 12, 13, text fig. 18, p. 616.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 348, pl. 12, figs. 28*a*, *b*.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 10.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 43, figs. 21, 24.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 372, pl. 19, figs. 30, 31.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 87, pl. 14, figs. 771, 772.—CHAPMAN, Proc. California Acad. Sci., ser. 3 (Geol.), vol. 1, 1900, p. 252, pl. 30, fig. 6.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 691.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.

Nonionina bulloides D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 293, No. 2; Foram. Foss. Bass. Tert. Vienne, 1846, p. 107, pl. 5, figs. 8–10.

Pullenia bulloides REUSS, Denkschr. Akad. Wiss. Wien, vol. 25, 1866, p. 150.

Description.—Test subglobular, somewhat laterally compressed, composed of numerous chambers making three to four volutions, each consisting of four chambers, embracing so that the last volution only is visible from the exterior; surface of the test smooth, the wall very finely but indistinctly perforate; aperture a narrow curved slit between the base of the inner face of the chamber and the previously formed whorl.

Diameter 0.17–0.40 mm.

Distribution.—Brady in the *Challenger* Report records this species from five stations in the North Pacific, the depths ranging from 345 to 2,750 fathoms. Picaglia records it from two stations of the *Vettor Pisani* and Bagg records it from seven *Albatross* stations in the vicinity of the Hawaiian Islands at depths ranging from 495 to 1,398 fathoms.

I have had numerous specimens of this species, notably from the *Nero* soundings from off the Hawaiian Islands and especially along the line of *Nero* soundings between Guam and Yokohama. These stations average about 1,500 fathoms, the shallowest being 392 and the deepest 1,660 fathoms, but two stations however were less than a thousand fathoms in depth. As a rule but very few specimens were present in the material from any one station in contrast to *P. obliquiloculata* which is often present in great numbers.

This species is one of the smallest of the family and one which may be overlooked on account of its size, but its other characters are such as to easily distinguish it.

PULLENIA QUINQUELOBA (Reuss).

Plate 13, fig. 2.

Nonionina quinqueloba REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 47, pl. 5, figs. 31a, b.

Pullenia quinqueloba H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 712; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 617, pl. 84, figs. 14, 15.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 348, pl. 12, figs. 29a, b.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 43, figs. 22, 23.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 487, pl. 11, fig. 29.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 373, pl. 19, figs. 28, 29.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 87, pl. 14, fig. 773; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 68.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 324, pl. 70, fig. 5.

Pullenia spheroides (part) PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 368, pl. 17, fig. 53.

Description.—Test bilaterally symmetrical, biconvex, composed of numerous chambers arranged in an involute coil, five chambers usually being present in each coil, compressed laterally, peripheral edge broadly rounded; surface smooth, sutures somewhat compressed; aperture a long, narrow, curved slit at the base of the inner face of the chamber.

Diameter, 0.50–0.75 mm.

Distribution.—This species seems to be the least common of the three. Brady records it from two *Challenger* stations in the North Pacific, 224 in 1,850 fathoms and 241 in 2,300 fathoms. Goës records it from the western Pacific in 1,100–1,200 fathoms. I have had it from several stations, off the Galapagos Islands, in 1,379 fathoms, off

the Hawaiian Islands, and from several *Nero* soundings, especially between Guam and Yokohama, but never in any considerable numbers.

PULLENIA OBLIQUILOCULATA Parker and Jones.

Plate 10, fig. 3; plate 12, figs. 2, 3.

Pullenia obliquiloculata PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 368, pl. 19, figs. 4a, b.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 294; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 618, pl. 84, figs. 16–20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 372, pl. 13, figs. 62–64.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 68.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 324, pl. 70, fig. 6.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 692.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 155.

Description.—Test obliquely nautiloid, subglobular, inequilateral, outer volution only visible, consisting of about five chambers, chambers inflated, sutures somewhat depressed; wall smooth; aperture a long, narrow, curved slit at the inner margin of the chamber.

Diameter, 0.50–0.90 mm.

Distribution.—This has proved to be one of the most common and widely distributed species of the North Pacific. Brady recorded it from four *Challenger* stations in the North Pacific ranging in depth from 345 to 2,100 fathoms. Goës records its occurrence in the western Pacific and Bagg found it in material from ten *Albatross* stations off the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms.

I have records of the occurrence of this species at seventy-five *Nero* stations between Guam and Yokohama and it has occurred also at numerous *Albatross*, *Nero*, and *Tuscarora* stations well scattered over the area. The depths have a range from 268 to 2,175 fathoms.

This species is the only one of the genus which has been found as a pelagic form. It is noteworthy that the pores of this species are much larger than those of the other two.

Family 9. NUMMULITIDAE.

Test calcareous, perforate, the chambers usually numerous, arranged in a spiral, either umbilicate or completely involute, surface variously ornamented; chamber walls in the higher forms with secondary canal system.

This family includes some of the largest and most complex of the Foraminifera and also from a paleontological viewpoint some of the most important rock builders. As a rule the largest species are characteristic of shallow tropical waters, especially of coral reefs. As such they are not common in the material which I have had available for this paper. However certain isolated regions as the Hawaiian Islands, Guam, and the southern tip of Japan have given records for most of the tropical species and the smaller colder water species of *Nonionina* and *Polystomella* have often been found in considerable numbers.

The higher genera of this family have been made the objects of critical researches by many writers and students of the Foraminifera, and their structure, although often complicated, is well known and abundantly illustrated.

Genus *NONIONINA* d'Orbigny, 1826.

Nautilus (part) WALKER and JACOB, Adam's Essays, Kanmacher's Ed., 1798, p. 641.

Polystomella (part) DEFRANCE, Dict. Sci. Nat., vol. 32, 1824, p. 183.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 403.

Nonionina D'ORBIGNY (type, *N. umbilicatula* d'Orbigny=*N. pompilioides* (Fichtel and Moll)), Ann. Sci. Nat., vol. 7, 1826, p. 293.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 724.

Description.—Test composed of numerous chambers arranged to form a bilateral, nautiloid coil, the last formed volution usually embracing all the preceding ones; walls usually smooth, sometimes pitted, very finely perforated; aperture a narrow opening or row of openings at the base of the apertural face, between it and the preceding volution.

In *Nonionina* the skeleton of the test is simple with little trace of the supplementary test being developed. The aperture is usually simple but in some species shows a tendency to become a series of openings as in some of the higher forms. Usually the last formed coil completely embraces the previously formed ones, but the test may be umbilicate, exposing the earlier coils at the umbilicus. In some species there is a tendency more or less marked to form a star-shaped thickening at the umbilical region, extending outward along the sutures between the chambers.

NONIONINA DEPRESSULA (Walker and Jacob).

Plate 17, fig. 3.

"*Nautilus spiralis utrinque subumbilicatus*" WALKER and BOYS, Test. Min., 1784, p. 19, pl. 3, fig. 68.

Nautilus depressulus WALKER and JACOB, Adam's Essays, Kanmacher's Ed., 1798, p. 641, pl. 14, fig. 33.

Nonionina depressula PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 4, 1859, pp. 339, 341.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 725, pl. 109, figs. 6, 7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 229, pl. 43, fig. 25.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 427, pl. 19, figs. 38, 39.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 103, pl. 17, figs. 825, 826.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 121, pl. 1, fig. 20.—WRIGHT, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 23.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, 1904, p. 12, pl. 3, fig. 6.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 599.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 12, pl. 4, fig. 8; vol. 54, No. 16, 1910, p. 29.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 88, pl. 26, figs. 16a-c; pl. 28, figs. 7, 8.

Nonionina asterizans, var. *depressula* PARKER and JONES, Intr. Foram., Appendix, 1862, p. 310.

Polystomella crista, var. (*Nonionina*) *depressula* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 403, pl. 14, fig. 39a, b.

Description.—Test rounded in side view, ten to twelve chambers visible in the last-formed volution, in apertural view with parallel sides and broadly rounded angles, narrow, about $3\frac{1}{2}$ times as long as broad; very slightly if at all depressed at the umbilicus; chambers somewhat inflated and the sutures correspondingly depressed giving a lobulated periphery; umbilical region with a slight tendency toward filling in of shell tissue and a slight trace of stellate extension of this material outward along the sutures; aperture a narrow, arched slit.

Diameter, 0.40–0.50 mm.

Distribution.—The only previous records of this species in the North Pacific are those given by Bagg, *Albatross* stations D 4025 in 275–368 fathoms, H 4430 in 1,544 fathoms, H 4440 in 1,259 fathoms, and H 4566 in 572 fathoms, all off the Hawaiian Islands. I have had material from *Albatross* station D 4974 in 905 fathoms, bottom temperature 36.6° F. off Japan, and from the following *Nero* stations between Japan and Guam, 1081 in 1,900 fathoms, 1184 in 1,542 fathoms, 1191 in 1,551 fathoms, 1295 in 1,415 fathoms, and 1,302 in 1,331 fathoms.

NONIONINA UMBILICATULA (Montagu).

Plate 17, fig. 1.

Nautilus umbilicatus MONTAGU, Test. Brit., 1803, p. 191; Suppl., p. 78, pl. 18, fig. 1.

Nonionina umbilicatus PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 242, pl. 12, fig. 157.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 203, pl. 4, fig. 48.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 726, pl. 109, figs. 8, 9.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 19.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 426, pl. 19, figs. 36, 37.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 103, pl. 17, fig. 823.—CHAPMAN, Proc. California Acad. Sci., ser. 3 (Geol.), vol. 1, 1900, p. 256, pl. 30, fig. 15.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 600.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 15.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 90, pl. 27, figs. 4–6.

Nonionina umbilicata TERQUEM, Mém. Soc. géol. France, ser. 3, vol. 2, mem. III, 1882, p. 42, pl. 2, fig. 7.

Description.—Test composed of numerous chambers, deeply umbilicate, in face view slightly tapering, broadest at the latest formed portion of the coil, about twice as long as broad, the periphery broadly rounded; surface deeply and prominently pitted, sutures tending to become limbate; aperture a very narrow curved opening at the base of the apertural wall of the chamber.

Diameter, 0.50–0.70 mm.

Distribution.—This species is recorded by Brady in the *Challenger* Report at four stations 214 in 500 fathoms, 224 in 1,850 fathoms, 241 in 2,300 fathoms, and 253 in 3,125 fathoms. Goës records it from two *Albatross* stations in the western Pacific, D 3431 in 995 fathoms and D 3375 in 1,201 fathoms, one specimen at each station. Bagg records it from two *Albatross* stations, H 4508 in 495 fathoms and H 4555 in 1,398 fathoms off the Hawaiian Islands.

In the material I have examined this has proved to be the most common species of the genus. It has occurred at *Albatross* stations D 3603 in 1,771 fathoms in Bering Sea, H 4878 in 84 fathoms and D 4970 in 500 fathoms, bottom temperature 39.1° F., both off Japan. It was taken at *Alert* station 1169 in 2,113 fathoms, lat. 21° 00' 30" N.; long. 142° 34' 00" E. Near Guam it was found at two *Nero* stations 990 in 859 fathoms and 1464 in 891 fathoms. Between Yokohama and Guam it occurred at a large number of stations ranging in depth from 901 to 2,250 fathoms.

This is the commonest umbilicate species as far as the North Pacific records show. It may be distinguished from the following species most easily in face view, which in this species is narrow and in *N. pompilioides* is broad.

NONIONINA POMPILIOIDES (Fichtel and Moll).

Plate 17, fig. 2.

"*Nautilus Melo*" SOLDANI, Testaceographia, vol. 2, 1798, p. 38, pl. 8, figs. ZZ. A, B, C.

Nautilus pompilioides FICHEL and MOLL, Test. Micr., 1803, p. 31, pl. 2, figs. a-e, ser. 3, vol. 16, 1865, p. 18, pl. 3, fig. 98; ser. 4, vol. 8, 1871, p. 246, pl. 12, fig. 158.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 204, pl. 4, fig. 49.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 727, pl. 109, figs. 10, 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 426, pl. 19, figs. 32, 33.—CHAPMAN, Proc. California Acad. Sci., ser. 3 (Geol.), vol. 1, 1900, p. 256, pl. 30, fig. 16.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 601.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.

Description.—Test composed of numerous chambers, slightly umbilicate, last volution of about seven chambers, in face view slightly tapering, broadest at the latest formed portion of the coil, slightly longer than broad, the periphery very broadly rounded; surface prominently pitted, sutures slightly limbate; aperture a narrow, curved opening at the base of the apertural face of the chamber forming nearly a semicircle, with a definite lip thickening.

Diameter, 0.50–0.80 mm.

Distribution.—Brady records this species from two *Challenger* stations in the North Pacific in 1,850 and 2,250 fathoms. Bagg records it from *Albatross* station H 4567 in 1,307 fathoms off the Hawaiian Islands. I have had specimens from Holothurian stomachs taken at

Albatross station D 3603 in 1,771 fathoms in Bering Sea and D 4822 in 130 fathoms off Japan. It occurred at *Nero* stations 12 in 1,924 fathoms, 166 in 1,850 fathoms, and 189 in 1,813 fathoms between the Hawaiian and Midway Islands and at a large number of *Nero* stations between Guam and Japan at depths ranging from 1,321 to 2,250 fathoms.

This species is easily distinguished from *N. umbilicatula* by its much broader test in face view.

NONIONINA ORBICULARIS H. B. Brady.

Plate 15, fig. 2.

Nonionina orbicularis H. B. BRADY, Denkschr. Akad. Wiss. Wien, vol. 43, 1881, p. 105, pl. 2, figs. 5a, b; Ann. Mag. Nat. Hist., ser. 5, vol. 8, 1881, p. 415, pl. 21, figs. 5a, b; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 727, pl. 109, figs. 20, 21.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 600, pl. 11, fig. 1.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.

Nonionina depressula, var. *orbicularis* MADSEN, Medd. Dansk. Geol. Forening, No. 2, 1895, p. 217, pl., fig. 7.

Description.—Test subglobular with ten or more chambers in the final volution, in face view broad, periphery very broadly rounded, almost flattened, umbilical region filled with shell material granular as is also the material of the umbilical portion of the slightly limbate sutures; wall fairly smooth, the periphery lobulated slightly; aperture a narrow slit at the base of the apertural face of the chamber, the lateral portions tending toward division by downwardly projecting tooth-like portions.

Diameter, 0.75–1.00 mm.

Distribution.—The only record for this species in the North Pacific is that of Bagg, *Albatross* station D 4566 in 572 fathoms off the Hawaiian Islands.

NONIONINA ASTERIZANS (Fichtel and Moll).

Plate 14, fig. 5.

Nautilus asterizans FICHEL and MOLL, Test. Micr., 1803, p. 37, pl. 3, figs. e-h.

Pulvinulus asterizans LAMARCK, Tab. Encycl. et Méthod., pt. 23, 1816, pl. 466, figs. 10a-d.

Placentula asterizans LAMARCK, Anim. sans Vert., 1822, p. 621, No. 2.

Nonionina asterizans PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 287, pl. 11, figs. 20, 21; ser. 3, vol. 5, 1860, p. 101, No. 1.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 217, pl. 4, fig. 78.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 728, pl. 109, figs. 1, 2.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 425, pl. 19, figs. 47, 48.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 14.

Polystomella crispa, var. (*Nonionina*) *asterizans* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 403, pl. 14, fig. 35; pl. 17, fig. 54.

Description.—Test with twelve or more chambers in the final volution, in face view narrow, periphery broadly rounded, about $2\frac{1}{2}$ to 3

times as long as wide, surface pitted, umbilical region slightly excavated at the center, the rest filled with shell tissue of considerable extent as a central mass, thence extending outward along the sutures in a star-like mass, making up nearly one-third the diameter of the test; aperture simple, narrow, with a slightly thickened lip.

Diameter up to 1 mm.

Distribution.—This species has not previously been recorded from the North Pacific. The only material I have had came from *Albatross* station H 4857 in 324 fathoms, in Bering Sea. The specimens are not typical, but are here figured.

NONIONINA STELLIGERA d'Orbigny.

Plate 14, fig. 4; plate 15, fig. 4; plate 16, fig. 2.

Nonionina stelligera D'ORBIGNY, in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, Foraminifères, 1839, p. 128, pl. 3, figs. 1, 2.—H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 471, pl. 48, fig. 19; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 728, pl. 109, figs. 3-5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 425, pl. 19, fig. 44.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 104, pl. 17, figs. 827, 828.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 121, pl. 1, fig. 18.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, 1899, p. 654, fig. 5.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 600.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 13, pl. 4, fig. 9; vol. 54, No. 16, 1910, p. 29.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1910, p. 89, pl. 27, figs. 7, 8.

Polystomella crispa, var. (*Nonionina*) *stelligera* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 404, pl. 14, figs. 40, 41.

Description.—Test with usually ten to twelve chambers in the last formed volution, in face view narrow, 3 to 3½ times as long as broad, sides nearly parallel, periphery broadly rounded, slightly lobulated, surface punctate, umbilical portion with a filling of shell tissue in radiating rays from the umbilical portion toward the periphery along the sutures, each ray widest near the middle and distinct from the others, almost no umbilical depression; aperture a semicircular, very narrow opening at the base of the apertural face of the chamber, simple.

Diameter 0.50-0.70 mm.

Distribution.—This species has not previously been recorded from the North Pacific. It has occurred at *Albatross* D 2806 in 1,379 fathoms off the Galapagos Islands.

There is considerable variation in this species as will be seen by referring to the various figures of the synonymy given above. It is perhaps most easily confused with *N. asterizans*.

NONIONINA BOUEANA d'Orbigny.

Plate 16, fig. 1.

Nonionina boueana D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 108, pl. 5, figs. 11, 12.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 729, pl. 109, figs. 12, 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 426, pl. 19, figs. 34, 35.—GoëS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 104, pl. 17, fig. 829.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 337, pl. 79, fig. 5.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 5, vol. 8, 1900, p. 400, fig. 49; ser. 6, vol. 1, 1904, p. 13, pl. 3, fig. 11.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 602.

Description.—Test compressed, composed of twelve to fifteen chambers in the last formed volution, chambers much longer than broad, sutures much curved, in face view test about $2\frac{1}{2}$ times as long as wide, periphery subacute, scarcely if at all lobulated; umbilical area filled with shell tissue, sutures limbate; surface nearly smooth, wall very finely punctate; aperture a narrow curved slit at the base of the apertural face of the chamber, simple.

Diameter 0.50–0.75 mm.

Distribution.—The only *Challenger* record which Brady gives is Hongkong harbor in 7 fathoms. Flint records it from the Gulf of Tokyo in 9 fathoms. I have had it from off the Hawaiian Islands, *Albatross* H 2917 in 2,615 fathoms. It has also occurred at D 4964 in 37 fathoms, bottom temperature 66.6° F. off Japan. From the *Nero* material it occurred at station 1237 in 613 fathoms off Yokohama, Japan, and 1444 in 2,175 fathoms between Yokohama and Guam.

This is a rather characteristic species with its numerous chambers in a rapidly increasing width of volution and peculiar umbilical region.

NONIONINA SCAPHA (Fichtel and Moll).

Plate 15, fig. 1; plate 16, figs. 3, 4.

Nautilus scapha FICHTEL and MOLL, Test. Micr., 1803, p. 105, pl. 19, figs. *d-f*.
Nonionina scapha PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 102, No. 4.—H. B. BRADY, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865, p. 106, pl. 12, figs. 10*a*, *b*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 730, pl. 109, figs. 14, 15, and 16?—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 20.—WOODWARD and THOMAS, Geol. Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 48, pl. E, figs. 35, 36.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 424, pl. 19, figs. 43, 44.—GoëS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 104, pl. 17, fig. 830.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 121, pl. 1, fig. 23.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 337, pl. 80, fig. 1.—FORNASINI, Mem. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, 1904, p. 12, pl. 3, fig. 4; pl. 13, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 601.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 164.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 13; vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 13.—BAGG, Bull. U. S. Geol. Surv. No. 513, 1912, p. 88, pl. 27, figs. 1–3.

Polystomella crista, var. (*Nonionina*) *scapha* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 404, pl. 14, figs. 37, 38; pl. 17, figs. 55, 56.

Description.—Test somewhat compressed, composed of about ten chambers in the last formed volution, chambers rapidly increasing in length as added, especially in the adult test; chambers in front view broadest near the proximal end gradually tapering to the rounded periphery, earlier half of coil much narrower, whole test in face view a little more than twice as long as wide; surface smooth, punctate; aperture a narrow slit at the base of the apertural face, simple.

Diameter about 0.50 mm.

Distribution.—Brady records this species from three North Pacific stations in from 7–345 fathoms, the last being off Japan on the *Hyalonema*-ground. Flint records it from *Albatross* station D 2805 in 51 fathoms in Panama Bay and from the Gulf of Tokyo in 9 fathoms. Bagg records it from five *Albatross* stations off the Hawaiian Islands, D 4000 in 104–213 fathoms, D 4025 in 275–368 fathoms, H 4440 in 1,259 fathoms, H 4567 in 1,307 fathoms and H 4696 in 367 fathoms.

From the *Nero* material I have this species from station 1160 in 1,907 fathoms and 1237 in 613 fathoms. From the *Albatross* material I have had it from D 3603 in 1,771 fathoms in Bering Sea and from material from Holothurian stomachs, D 3608 in 276 fathoms. It also occurred off the Galapagos Islands, D 2806 in 1,379 fathoms. Off Japan it occurred at *Albatross* H 4878 in 84 fathoms, bottom temperature 51.9° F., D 5054 in 282 fathoms, bottom temperature 45.3° F., D 5056 in 258 fathoms, bottom temperature 46° F. and D 5085 in 622 fathoms, bottom temperature 37.8° F.

There seems to be either considerable variation in this species or else a number of forms included under a single name. The amount of material is not sufficient to determine the limits of variation.

NONIONINA TURGIDA (Williamson).

Plate 15, fig. 3.

Rotalina turgida WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 50, pl. 4, figs. 95–97.

Nonionina turgida H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 474, No. 91; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 731, pl. 109, fig. 17–19.—TERQUEM, Bull. Soc. Zool. France, vol. 11, 1886, p. 331, pl. 11, figs. 7, 8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 425, pl. 19, figs. 45, 46.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 602.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 13; vol. 54, No. 16, 1910, p. 29.

Polystomella crista, var. (*Nonionina*) *turgida* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 405, pl. 17, figs. 57a–c.

Description.—Test composed of about ten chambers in the last formed volution, very rapidly increasing in size as added, the last

formed chamber in the adult often making up nearly one-half the visible test and often at one side instead of bilaterally placed, in face view about twice as long as wide, the last formed chamber making up the larger part of the test, broadest at its base and thence gradually tapering to the subacute periphery, very slightly lobulated; wall smooth, punctate; aperture a narrow curved opening at the base of the apertural face, simple.

Length 0.40–0.55 mm.

Distribution.—The only North Pacific record for this species is that of Brady in the *Challenger* Report, off the coast of Japan on the *Hyalonema*-ground in 345 fathoms.

Genus POLYSTOMELLA Lamarck, 1822.

Nautilus (part) LINNÆUS, Syst. Nat., ed. 12, 1767, p. 1162.

Polystomella LAMARCK (type, *Polystomella crispa* (Linnæus)), Anim. sans Vert., vol. 7, 1822, p. 625.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 731.

Description.—Test composed of numerous chambers, arranged in a regular, bilaterally symmetrical, nautiloid spire, the chambers extending back to the umbilical region so that only the last formed chamber is visible, chambers either inflated with depressed sutures bridged across at regular intervals or the sutures may be limbate and the processes form a regular series of elevated ridges connecting the sutures; aperture either a simple opening at the base of the apertural face of the chamber or subdivided into a series of openings.

There is a considerable range of development seen in the various species of this genus from the simple species such as *P. striatopunctata* to the more complex *P. crispa*. In the higher species there is a supplemental skeleton to the test which is provided with a rather complex system of internal canals. Of these there are two spiral canals, one at either side of the test connecting with the meridional canals which lie in the septal depressions between the chambers and connect with the exterior by short tubes opening upon the septal lines. These are best seen in *P. arctica* and *P. sibirica*, the latter of which is here figured. Where the umbilical portion is filled with a secondary shell material as in *P. craticulata* this portion is filled with straight canals leading to the interior. The best figures of the internal structure are those given by Carpenter.

There is an interesting development in the species of this genus and corresponding distribution. The arctic species are decidedly different in many ways from the species which are so characteristic of tropical coral reefs.

POLYSTOMELLA STRIATO-PUNCTATA (Fichtel and Moll).

Plate 18, fig. 2.

Nautilus striato-punctatus FICHEL and MOLL, Test. Micr., 1803, p. 61, pl. 9, figs. a-c.

Polystomella striato-punctata PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 103, No. 6.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, ann. 33, 1880, p. 216, pl. 4, figs. 73, 74.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 733, pl. 109, figs. 22, 23.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 17.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 433, pl. 19, figs. 49, 50.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 101, pl. 17, figs. 815 (part) 822.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 122, pl. 1, fig. 19.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899) p. 337, pl. 80, fig. 2.—WRIGHT, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 24.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 602.—RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24, 1906, p. 73, pl. 5, figs. 61, 62.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1905, p. 31, pl. 5, fig. 4.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 14, pl. 4, fig. 10; pl. 5, figs. 1, 2; vol. 54, No. 16, 1910, p. 29, pl. 3, fig. 16.—BAGG, Bull. U. S. Geol. Surv., No. 513, p. 92, pl. 27, figs. 10-12.

Description.—Test composed of about 10 chambers in the last formed volution, in face view about $2\frac{1}{2}$ times as long as wide, periphery broadly rounded, usually slightly depressed at the umbilicus: periphery slightly lobulated, chambers somewhat inflated, septal lines with regular bridging: aperture a nearly semicircular, narrow opening, sometimes showing traces of division into a series of openings.

Diameter, 0.50-0.70 mm.

Distribution.—In the North Pacific Brady records this species from a single *Challenger* station, Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. Bagg records it from one *Albatross* station D 4174 in 735-865 fathoms. Rhumbler records it from Chatham Island and Laysan. I have material from Hongkong; from *Nero* station 1311 in 1,503 fathoms; from off Alaska; from *Albatross* station 3603 in 1,771 fathoms in Bering Sea, abundant. It also occurred in material taken from Holothurian stomachs at *Albatross* D 3608 in 276 fathoms in Bering Sea.

There seems to be a number of forms which are included under this species and a critical study of a large amount of material would doubtless show some definite forms. I have not had sufficient material of this species to make any such comparisons.

POLYSTOMELLA SUBNODOSA (Münster).

Plate 14, fig. 8.

- Robulina subnodosa* MÜNSTER, Neues Jahrb. für Min., 1838, p. 391, pl. 3, fig. 61.
Polystomella subnodosa REUSS, Sitz. Akad. Wiss. Wien, vol. 18, 1855, p. 240, pl. 4, fig. 51a, b.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 734, pl. 110, fig. 1a, b.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 102, pl. 17, figs. 817-819.—FORNASINI, Rend. Accad. Sci. Ist. Bologna, vol. 2, 1897, pl. 1, fig. 12.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 604.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 16, pl. 5, fig. 6; vol. 54, No. 16, 1910, p. 30.—BAGG, Bull. U. S. Geol. Survey, No. 513, 1912, p. 92, pl. 28, figs. 12a, b.

Description.—Test composed of about 12 chambers in the last formed volution, in face view about $2\frac{1}{2}$ times as long as wide, the periphery angled with a blunt keel, periphery very slightly if at all lobulated, umbilical region umbonate, septal lines depressed and evenly bridged: aperture an arched narrow opening at the base of the apertural face.

Diameter about 0.60 mm.

Distribution.—The only previously recorded station for this species is that given by Bagg, *Albatross* H 4508 in 495 fathoms. I have had specimens collected in the Inland Sea of Japan, and from *Albatross* D 4875 in 59 fathoms off Japan in the eastern channel of Korea Strait. It also occurred at D 3501 in 688 fathoms in Bering Sea.

This makes a rather peculiar distribution for this species.

POLYSTOMELLA CRISPA (Linnaeus).

Plate 18, fig. 1.

- “Cornu Hammonis orbiculatum” PLANCUS, Conch. Min., 1739, p. 10, pl. 1, fig. 2.
Nautilus crispus LINNÆUS, Syst. Nat., ed. 12, 1767, p. 1162.
Polystomella crispa LAMARCK, Anim. sans Vert., vol. 7, 1822, p. 625, No. 1.—D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 125, pl. 6, figs. 9-14.—WILLIAMSON, Trans. Micr. Soc. London, vol. 2, 1849, p. 159, pl. 28; Rec. Foram. Great Britain, 1858, p. 40, pl. 3, figs. 78-80.—CARPENTER, Intr. Foram., 1862, p. 278, pl. 16, figs. 4-6.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 399, pl. 14, fig. 24; pl. 17, figs. 61a, b.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 736, pl. 110, figs. 6, 7.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 9, 1893, p. 216, pl. 4, fig. 3.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 432, pl. 20, figs. 20, 21.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894, p. 102, pl. 17, figs. 820, 821.—LISTER, Philos. Trans., vol. 186, 1895, p. 414, pl. 6, figs. 1-3, 5-12; pl. 7, figs. 13-27; pl. 8, figs. 28-32.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 338, pl. 80, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 603, pl. 11, fig. 2.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 15; vol. 54, No. 16, 1910, p. 30.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 90, pl. 27, figs. 13-20; pl. 28, figs. 1-6.

Description.—Test composed of twenty or more chambers in the last formed volution, in face view about twice as long as wide, len-

ticular, widest at the middle, keeled with sharp angled periphery, not at all lobulated; surface with the reticulated portion larger than the septal lines; umbilical region umbonate, filled with clear shell material, usually with a few pores: aperture an angled narrow opening, V-shaped, divided into several secondary openings.

Diameter up to 1 mm.

Distribution.—Brady in the *Challenger* Report gives this species as found "as far north as Japan". I have found it a number of times in the material I have examined. It occurred in material collected in Gaspar Straits by Captain Rodgers of the U. S. Exploring Expedition, from Hongkong, 9 fathoms: from Cagayan, Philippine Islands, collected by Dr. E. A. Mearns. In the *Nero* material it occurred at station 990 in 859 fathoms off Guam and station 1237 in 613 fathoms off Yokohama, Japan. In the *Albatross* material it occurred at station D 4922 in 60 fathoms, D 4916 in 361 fathoms, D 4891 in 181 fathoms and D 4970 in 500 fathoms.

POLYSTOMELLA MACELLA (Fichtel and Moll).

Plate 18, fig. 3.

Nautilus macellus, var. α , FICHEL and MOLL, Test. Micr., 1803, p. 66, pl. 10, figs. e-g.

Polystomella macella PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 104, No. 8.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 737, pl. 110, figs. 8, 9, 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 432, pl. 20, figs. 22, 23.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 15, pl. 5, fig. 4; vol. 54, No. 16, 1910, p. 30.

Description.—Test compressed, with about twenty chambers in the last-formed volution, in face view 3 to 5 times as long as wide, keeled with a sharp-angled periphery, sometimes slightly lobulated at the periphery, surface with the reticulated portion making up most of the area, the septal lines narrow, umbilical region slightly depressed, porous, aperture divided into a number of smaller openings.

Diameter up to 0.85 mm.

Distribution.—Bagg records this species from two *Albatross* stations off the Hawaiian Islands, D 4000 in 104–213 fathoms and H 4430 in 1,544 fathoms. I have seen it in the material I have examined from the Gulf of Tokyo, in 9 fathoms, *Albatross* stations D 4825 in 120 fathoms and D 4970 in 500 fathoms both off Japan and at *Nero* station 1306 in 1,208 fathoms between Yokohama and Guam.

POLYSTOMELLA CRATICULATA (Fichtel and Moll).

Plate 19, fig. 4.

Nautilus craticulatus FICHEL and MOLL, Test. Micr., 1803, p. 51, pl. 5, figs. h-k.

Polystomella craticulata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 284, No. 3.—
CARPENTER, Intr. Foram., 1862, p. 279, pl. 16, figs. 1, 2.—H. B. BRADY,
Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 739, pl. 110, figs. 16, 17.—
EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 433,
pl. 20, figs. 24, 25.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 604.

Description.—Test subglobose, composed of as many as fifty chambers in the last formed coil; in face view broadly lenticular about $1\frac{1}{2}$ times as long as wide, periphery bluntly rounded; umbilical region umbonate, filled with clear shell material for one-third or more of the diameter of the test, with large pores; remainder of surface reticulate; aperture a long, narrow opening subdivided into a number of pores.

Diameter up to 3.5 mm.

Distribution.—Brady records this species from three North Pacific *Challenger* stations, Chinese Sea, Hongkong Harbor in 7 fathoms and Honolulu coral reefs, Hawaiian Islands, in 40 fathoms. The only material I have had was collected by Dr. E. A. Mearns from shore sands, Cebu, Philippine Islands.

This is distinctly a tropical shallow-water species, and a large and beautiful one. Very probably it is widely distributed in the shallow waters about the islands of the southern portion of the North Pacific, although material is not available.

POLYSTOMELLA SIBIRICA Goës.

Plate 19, fig. 1.

Polystomella sibirica Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, 1894,
p. 100, pl. 17, fig. 814.

Description.—Test broad, complanate, much compressed, made up of about 25 chambers in the last-formed volution; in face view about $3\frac{1}{2}$ to 5 times as long as wide, sutural lines showing a double line of pores, umbilical region filled with clear shell material, porous; aperture a series of small pores in a V-shaped arrangement.

Diameter up to 4 mm.

Distribution.—This species was found at but one station, *Albatross* D 3600 in 156 fathoms in Bering Sea. At this station it was abundant and it probably has a general distribution in this region from which comparatively little material is available. It is a large and striking species.

Genus AMPHISTEGINA d'Orbigny, 1826.

Amphistegina D'ORBIGNY (type, *A. lessonii* d'Orbigny) Ann. Sci. Nat., vol. 7, 1826, p. 304.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 739.

Description.—Test spiral, lenticular, more convex on one side than the other, the last-formed volution usually covering the others, chambers with the alar projections on one side simple, divided on the other side by deep constrictions to form supplementary lobes; wall thickened near the umbilicus, usually smooth except near the aperture on the ventral side where it is usually papillose, no true secondary canal system developed; aperture on the ventral side at the base of the chamber, simple.

There are various forms of this genus but by the foregoing characters they may be distinguished. Occasionally there is some surface ornamentation but usually the wall is smooth. It is often very abundant in the shallow waters of the Tropics.

AMPHISTEGINA LESSONII d'Orbigny.

Plate 19, fig. 2.

Amphistegina lessonii D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 304, No. 3, pl. 17, figs. 1-4; Modèles, No. 98.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 34, pl. 3, fig. 92.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 740, pl. 111, figs. 1-7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 230, pl. 43, fig. 15.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 431, pl. 20, figs. 18, 19.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 338, pl. 82, fig. 4.—FORNASINI, Rend. Accad. Sci. Ist. Bologna, vol. 7, 1903, pl. 2, fig. 1.—SHERLOCK, Bull. Mus. Comp. Zool., vol. 38, 1903, p. 356, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 605.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 165.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, pt. 2, 1910, p. 294, pl. 53, fig. 6.

Description.—Test lenticular or more convex on one side than the other, surface smooth, composed of about 25 chambers in the last-formed volution which embraces the preceding ones, chambers on the dorsal side with the alar projections simple, on the ventral side divided by deep constrictions usually into two lobes, especially in the thicker varieties the test is papillose about the ventral margin of the aperture, aperture Rotaliform, simple.

Diameter up to 3 mm.

Distribution.—Brady does not record this species from the *Challenger* material of the North Pacific. Bagg records it from eleven *Albatross* stations in the vicinity of the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms.

Among the various lots of material I have had this species was very common in that from Gaspar Straits, from Cagayan, Philippines, collected by Dr. E. A. Mearns, *Alert* station 1177 in 23-118 fathoms

and in Hongkong Harbor. It occurred at *Nero* station 201 in 1,033 fathoms and 209 in 82 fathoms off Midway Islands, station 990 in 859 fathoms off Guam, and stations 2031 in 1,624 fathoms, 2036 in 82 fathoms, and 2074 in 22 fathoms off the Hawaiian Islands. In the *Albatross* material it has occurred at H 2922 in 268 fathoms also off the Hawaiian Islands and D 4922 in 60 fathoms and H 4882 in 248 fathoms both off Blake Reef, Colnett or Vincennes Strait off southern Japan. This region from other species already recorded here has proved to be southern in its relations and a region at which many southern species seem to approach their northern limits on this coast.

This species is used at the present time to include various forms which may be distinct. Brady notes the fact that various forms occur and Bagg also found them. A study of recent tropical material should show something definite in regard to these specific or varietal forms.

Genus OPERCULINA d'Orbigny, 1826.

Nautilus (part) GRONOVIVS, Zooph. Gron., 1781, p. 282.

Lenticulites (part) DEFRANCE, Dict. Sci. Nat., vol. 25, 1822, p. 453.

Operculina D'ORBIGNY (Type, *O. complanata* Defrance), Ann. Sci. Nat., vol. 7, 1826, p. 281.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 742.

Description.—Test coiled, compressed, consisting of numerous chambers in three or four volutions, bilaterally symmetrical, and all visible from either side, not embracing, except in the early whorls, in face view very thin, usually thickest at the umbonal region; surface smooth or ornamented with bosses; aperture single at the base of the apertural wall of the chamber.

Carpenter¹ has given a very detailed account of the structure of this genus. The genus is characteristic, at least in the larger forms, of the warmer shallow seas. It is a characteristic genus of the earlier Tertiaries.

OPERCULINA COMPLANATA (Defrance).

Lenticulites complanata DEFRANCE, Dict. Sci. Nat., vol. 25, 1822, p. 453.

Operculina complanata D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 281, pl. 14, figs. 7-10; Modèles, No. 80.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 8, 1861, p. 229.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 743, pl. 112, figs. 3, 4, 5, 8.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 175, pl. 4, fig. 35; vol. 3, 1893, p. 45, pl. E, fig. 37.—[?] EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 435, pl. 20, figs. 40-42.—NEWTON and HOLLAND, Journ. Coll. Sci. Imp. Univ. Tokyo, 1902, p. 13, pl. 1, fig. 3, 5; pl. 3, fig. 3.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 605.

Description.—Test much compressed, the early volutions somewhat embracing, later ones nonembracing, bilaterally symmetrical, cham-

¹ Introd. Foram., 1862.

bers in the last formed whorl very numerous, periphery very thin, sometimes slightly keeled, sutures usually angled and sharply directed backward near the periphery, surface smooth; aperture a single opening at the base of the apertural face in addition to which there are numerous secondary openings in the chambers of the last whorl, appearing as large pores on the exterior.

Diameter up to 8 or 10 mm.

Distribution.—The only record from the North Pacific for this typical form of the species has been that of Brady in the *Challenger* Report, coral reefs of Honolulu, 40 fathoms. I have found it in material collected in Gaspar Straits by Captain Rodgers of the North Pacific Exploring Expedition. The smooth form seems to be much less common than the following variety.

OPERCULINA COMPLANATA (Defrance), var. GRANULOSA Leymerie.

Plate 19, fig. 3.

Operculina granulosa LEYMERIE, Mém. Soc. Géol. France, ser. 2, vol. 1, 1846, p. 359, pl. 13, figs. 12a, b.—[?] EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 435, pl. 20, figs. 36, 37, 43.

Operculina complanata (DEFRANCE), var. *granulosa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 743, pl. 112, figs. 6, 7, 9, 10.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 176, pl. 4, fig. 36.—NEWTON and HOLLAND, Journ. Coll. Sci. Imp. Univ. Tokyo, vol. 17, 1902, p. 14, pl. 2, fig. 4; pl. 3, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 606.

Description.—Differing from the typical form in the character of the surface which is granular or papillose, especially on the earlier whorls, the papillæ being most frequent along the suture lines.

The varietal form seems to be much more common than the typical smooth form. Brady in the *Challenger* Report records it from the coral reefs of Honolulu in 40 fathoms. In the material I have examined it was common in Gaspar Straits; in 13 fathoms off Singapore, from *Alert* station 1177 in 23–118 fathoms and from *Albatross* station D 4922 in 60 fathoms. This last is the station from which *Heterostegina* was also found showing the southern character of the fauna at that station.

OPERCULINA AMMONOIDES (Gronovius).

Plate 14, fig. 7.

Nautilus ammonoides GRONOVIVS, Zooph. Gron., 1781, p. 282, No. 1220.

Operculina ammonoides PARKER and JONES, Intr. Foram., 1862, Appendix, p. 810.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 745, pl. 112, figs. 1, 2.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 434, pl. 20, figs. 38, 39.

Description.—Test small, somewhat embracing, the last formed whorl making up the greater part of the visible test with about twelve

chambers in the whorl, sutures limbate, the intermediate portions of the surface depressed, the inner margin of the whorl often granulose, in face view about five times as long as wide; aperture simple.

Diameter about 0.5 mm.

Distribution.—The only North Pacific stations from which this species has been recorded are given by Brady in the *Challenger* Report, off the Philippines in 95 fathoms, Hongkong Harbor in 7 fathoms, south of Japan on the *Hyalonema* ground in 345 fathoms.

I have the species from *Albatross* station D 4970 in 500 fathoms off Japan.

Genus HETEROSTEGINA d'Orbigny, 1826.

Heterostegina D'ORBIGNY (type, *H. depressa* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 305.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 745.

Description.—Test compressed, especially the last-formed whorl, the early whorls often embracing and fairly thick, lenticular in side view; chambers numerous, subdivided into chamberlets by transverse partitions and visible from the exterior; secondary canal system developed and comparable to *Operculina*; aperture consisting of a row of pores on the outer face of the chamber, one pore for each of the chamberlets.

The chamberlets are not directly connected with one another in the same chamber but are connected by the previously formed apertures with the adjacent chamberlet of the previous chamber. Often the central portion of the test is decidedly thickened while the last-formed whorl is extremely thin.

The genus is characteristic of shallow water of the Tropics.

HETEROSTEGINA DEPRESSA d'Orbigny.

Plate 19, fig. 5.

Heterostegina depressa D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 305, No. 2, pl. 17, figs. 5-7; Modèles, No. 99.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 34, pl. 3, fig. 100.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 746, pl. 112, figs. 14-20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 433, pl. 20, figs. 34, 35.—CHAPMAN, Journ. Linn. Soc., Zool., vol. 28, 1900, p. 18, pl. 3, figs. 6, 7.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 606.—RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24, 1906, p. 74.

Description.—Test in section lenticular, early chambers embracing and thickened, later whorls thin, periphery with a thin keel, chambers subdivided into chamberlets by transverse partitions, the chamberlets near the interior border of the whorl being much larger than those of the peripheral portion, division apparent from the exterior.

Diameter up to 5 mm. or more.

Distribution.—The *Challenger* expedition obtained this species in the North Pacific from the Chinese Sea and from the Honolulu coral reefs in 40 fathoms. Bagg records it from one *Albatross* station near the Hawaiian Islands, H 4566 in 572 fathoms. Rhumbler records it from Laysan Island.

The only station at which I have had the species is *Albatross* D 4922 in Colnett or Vincennes Strait in 60 fathoms, bottom temperature 79.2° F. The bottom is given as coral in the records. This and the adjoining stations are those from which many southern species were found and where they apparently approach their northern limits in this particular region.

Genus NUMMULITES Lamarck, 1801.

Nummulites LAMARCK (type, *N. laevigata* Lamarck), Anim. sans Vert., vol. 9, 1801, p. 101.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 747.

Description.—Test coiled, biconvex, usually bilaterally symmetrical, composed of numerous volutions. The chambers numerous and extending to the umbro, each volution completely inclosing the preceding ones, the periphery often keeled, aperture a simple V-shaped opening at the base of the apertural face of the chamber.

The genus *Nummulites* is almost entirely represented by fossil species but the genus still persists in the warmer seas of the Pacific in comparatively shallow water. Our recent species are much less complicated in their structure and smaller in size than the fossil ones.

NUMMULITES CUMINGII (Carpenter).

Plate 14, fig. 6.

Amphistegina cumingii CARPENTER, Philos. Trans., 1859, p. 32, pl. 5, figs. 13-17.

Nummulites cumingii H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 749, pl. 112, figs. 11-13; woodcut, fig. 22.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 166.

Nummulites radiata BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 167.

Description.—Test composed of several whorls, with about 20 chambers in the last-formed whorl, lenticular in cross section, about 2½ times as long as wide, surface smooth, umbonal portion with sutures showing thickened bands at the surface, abruptly curved backward near the periphery, surface between the sutures often with conspicuous pores; aperture simple, V-shaped.

Diameter about 3 mm.

Distribution.—Brady records this species from the Chinese Sea and off the Philippine Islands in 95 fathoms. Bagg records it from four *Albatross* stations off the Hawaiian Islands, D 4000 in 104-213

fathoms, H 4476 in 438 fathoms, H 4566 in 572 fathoms, and H 4590 in 978 fathoms.

So far as I have observed in the material I have examined this species has occurred but once, *Nero* station 190 in 864 fathoms near Midway Islands. It should be noted, however, that most of the material I have had has come from deep water and little of it from shallow water in the Tropics where this species is mostly found.

There seems to be but one living species of this genus.

EXPLANATION OF PLATES.

PLATE 1.

- Fig. 1. *Chilostomella ovoidea*. × 40. Partial side view.
2. *Chilostomella ovoidea*. × 40. *a*, front view; *b*, apertural view.
3. *Chilostomella ovoidea*. × 50. Broken specimen showing relative size of chambers (after Brady).
4, 5. *Chilostomella ovoidea*. × 70. By transmitted light showing relations of interior chambers (after Brady).
6. *Allomorphina trigona*. × 60. (After Brady.)
7. *Allomorphina trigona*. × 60. (After Brady.)
8. *Allomorphina trigona*. × 100. Viewed by transmitted light (after Brady).

PLATE 2.

Figures from photographs. × 30.

- Fig. 1. *Globigerina æquilateralis*, apertural view.
2. *Globigerina æquilateralis*, front view.
3. *Globigerina æquilateralis*, side view.
4. *Globigerina sacculifera*, from above.
5. *Globigerina sacculifera*, from below.
6. *Globigerina sacculifera*, from side.
7. *Globigerina bulloides*, from above.
8. *Globigerina bulloides*, from side.
9. *Globigerina bulloides*, from below.

PLATE 3.

Figures from photographs. × 30.

- Fig. 1. *Globigerina helicina*, from below.
2. *Globigerina helicina*, from above.
3. *Globigerina conglobata*, from below.
4. *Globigerina conglobata*, from side.
5. *Globigerina conglobata*, from above.
6. *Globigerina rubra*, from above.
7. *Globigerina rubra*, from side.
8. *Globigerina rubra*, from side.
9. *Globigerina rubra*, from below.

PLATE 4.

Figures from photographs. × 30.

- Fig. 1. *Globigerina dubia*, from above.
2. *Globigerina dubia*, from side.
3. *Globigerina dubia*, from below.
4. *Globigerina inflata*, from above.
5. *Globigerina inflata*, from below.
6. *Globigerina inflata*, from side.
7. *Globigerina inflata*, from side.
8. *Globigerina inflata*, from side.

PLATE 5.

Globigerina sacculifera. $\times 75$. 1a, from above; 1b, same from below.

PLATE 6.

Orbulina universa. $\times 50$. (After Brady.)

- Fig. 1. Specimen with spines;
 2-4. Specimens viewed by transmitted light showing *Globigerina*-like young within.
 5. Thick-walled specimen showing various layers of wall.

PLATE 7.

Orbulina universa.

- Fig. 1. Broken specimen showing early *Globigerina*-like chambers. $\times 75$.
 2. Slightly irregular specimen showing large aperture and smaller pores, previously formed chamber still visible from the exterior. $\times 90$.

PLATE 8.

Hastigerina pelagica (after Brady).

- Fig. 1. Living specimen. $\times 30$.
 2. Specimen showing spines complete and sarcod. $\times 33$.
 3, 4. Specimens from glycerine mounts. $\times 38$.
 5-8. Dead and empty tests with broken spines. $\times 38$.

PLATE 9.

Living specimen of *Globigerina bulloides* with spines (after Brady).

PLATE 10.

- Fig. 1. *Globigerina conglobata*, in section. $\times 50$. (After Brady.)
 2. *Sphaeroidina dehiscens*, in section. $\times 50$. (After Brady.)
 3. *Pullenia obliquiloculata*, in section. $\times 50$. (After Brady.)
 4. *Globigerina sacculifera*, in section. $\times 50$. (After Brady.)
 5. *Globigerina xquilateralis*, in section. $\times 50$. (After Brady.)
 6. *Globigerina conglobata*, in section. $\times 50$. (After Brady.)
 7. *Sphaeroidina bulloides*, in section. $\times 50$. (After Brady.)

PLATE 11.

- Fig. 1. *Candeina nitida*. $\times 75$. a, from side; b, from above; c, from below.
 2. *Pullenia sphaeroides*. $\times 75$. a, from side; b, apertural view.
 3. *Orbulina universa*. $\times 180$. Portion of surface.

PLATE 12.

- Fig. 1. *Sphaeroidina bulloides*. $\times 66$. a, apertural view; b, from above.
 2. *Pullenia obliquiloculata*. $\times 66$. a, from above; b, apertural view.
 3. *Pullenia obliquiloculata*. $\times 66$. a, from above; b, apertural view.

PLATE 13.

- Fig. 1. *Sphaeroidina dehiscens*. $\times 55$. a, from below; b, from above; c, from side.
 2. *Pullenia quinqueloba*. $\times 66$. a, apertural view; b, side view.

PLATE 14.

- Fig. 1. *Globigerina digitata*. $\times 50$. Adult specimen.
 2. *Globigerina digitata*. $\times 50$. Adult specimen.
 3. *Globigerina digitata*. $\times 50$. Young specimen.
 4. *Nonionina stelligera*. $\times 66$. *a*, from side; *b*, apertural view.
 5. *Nonionina asterizans*. $\times 66$. *a*, from side; *b*, apertural view.
 6. *Nummulites cumingii*. $\times 13$. *a*, side view; *b*, apertural view.
 7. *Operculina ammonoides*. $\times 33$.
 8. *Polystomella subnodosa*. $\times 133$. *a*, front view; *b*, apertural view.

PLATE 15.

- Fig. 1. *Nonionina scapha*. $\times 100$. *a*, side view; *b*, front view.
 2. *Nonionina orbicularis*. $\times 50$. (After Brady).
 3. *Nonionina turgida*. $\times 50$. *a*, side view; *b*, front view. (After Brady).
 4. *Nonionina stelligera*. $\times 100$. *a*, side view; *b*, front view.

PLATE 16.

1. *Nonionina boueana*. $\times 130$. *a*, side view; *b*, face view.
 2. *Nonionina stelligera*. $\times 130$. *a*, side view; *b*, face view.
 3. *Nonionina scapha*, slightly umbilicate form. $\times 75$. *a*, side view; *b*, face view.
 4. *Nonionina scapha*, more typical form. $\times 75$. *a*, side view; *b*, face view.

PLATE 17.

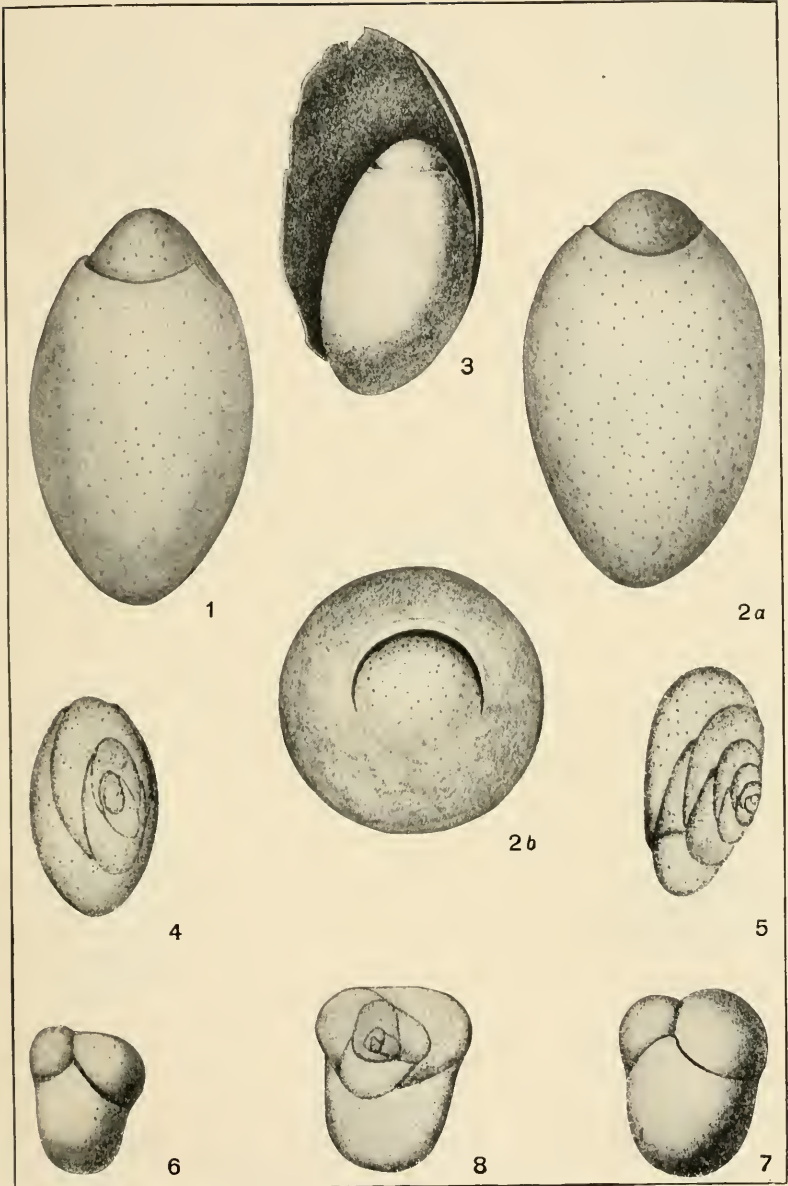
1. *Nonionina umbilicatula*. $\times 75$. *a*, side view; *b*, face view.
 2. *Nonionina pompilioides*. $\times 75$. *a*, side view; *b*, face view.
 3. *Nonionina depressula*. $\times 130$. *a*, side view; *b*, face view.

PLATE 18.

- Fig. 1. *Polystomella crispa*. $\times 30$. *a*, side view; *b*, face view.
 2. *Polystomella striato-punctata*. $\times 66$. *a*, side view; *b*, face view.
 3. *Polystomella macella*. $\times 66$. *a*, side view; *b*, face view.

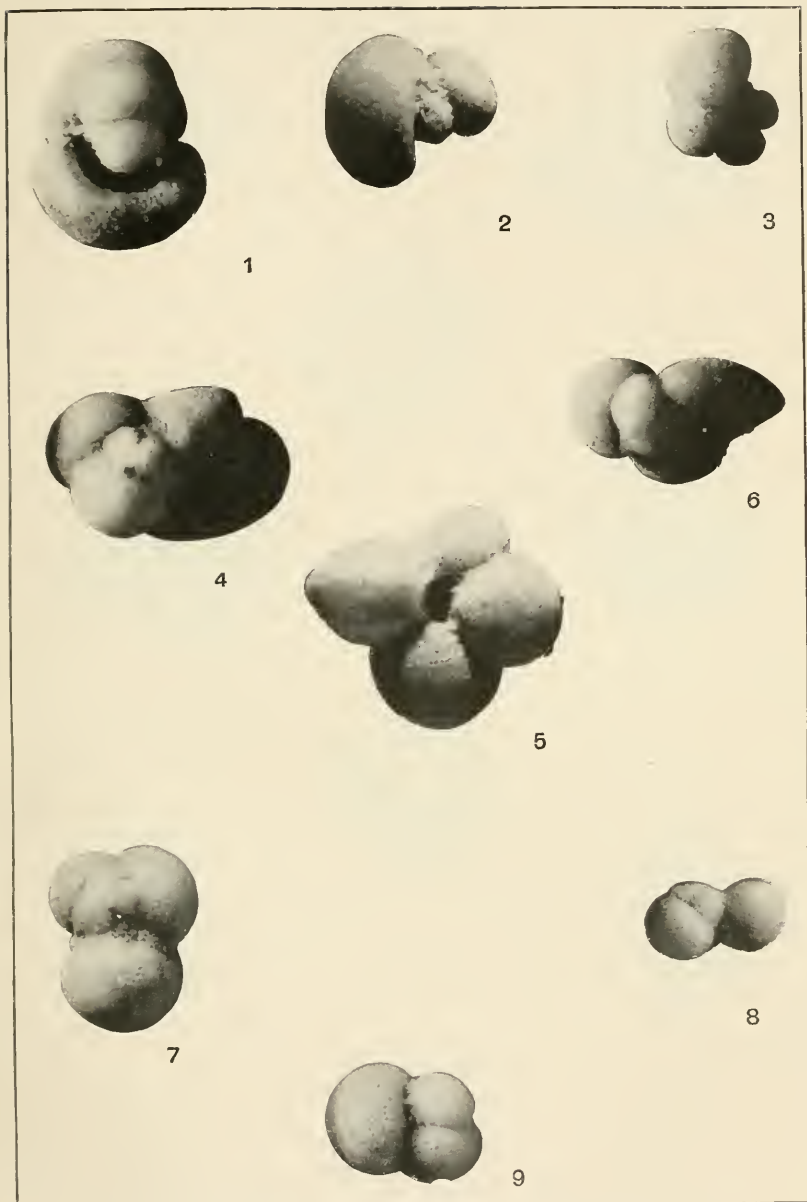
PLATE 19.

- Fig. 1. *Polystomella sibirica*. $\times 30$. *a*, side view; *b*, face view.
 2. *Anphistegina lessonii*. $\times 30$.
 3. *Operculina complanata*, var. *granulosa*. $\times 18$.
 4. *Polystomella craticulata*. $\times 35$. *a*, side view; *b*, face view.
 5. *Heterostegina depressa*, young specimen. $\times 35$.



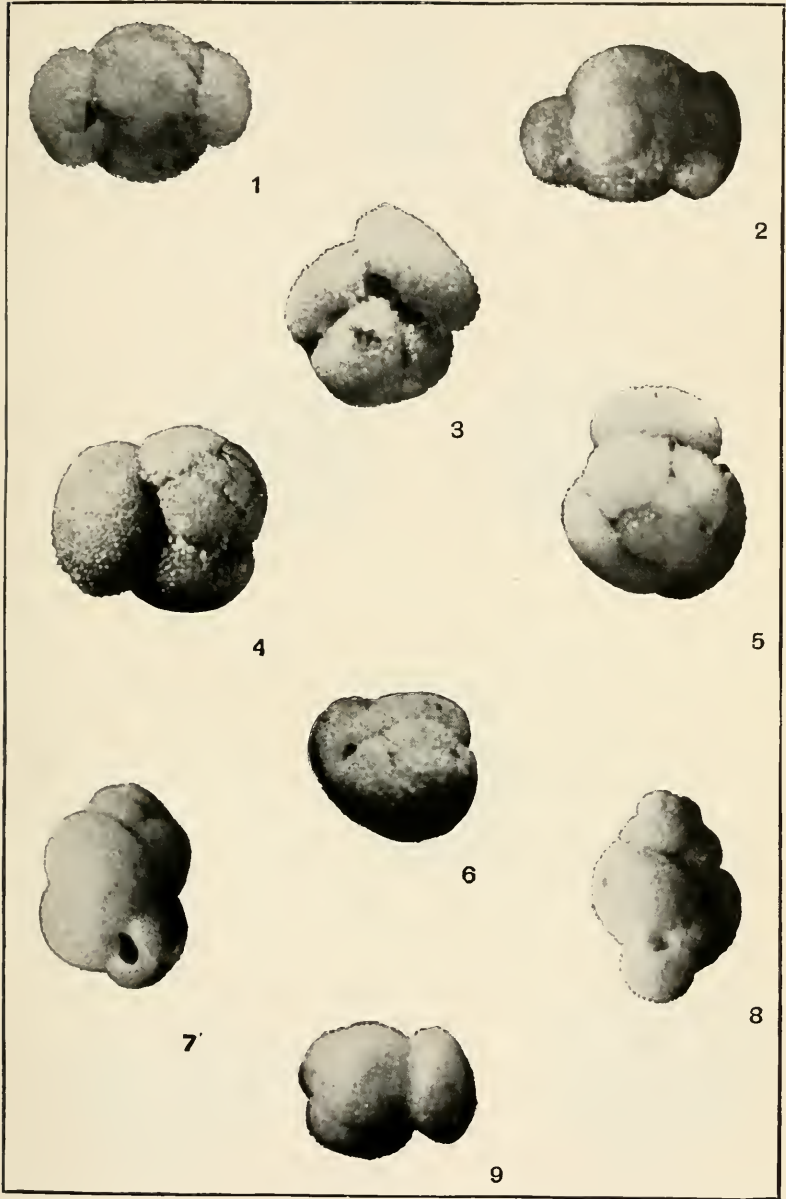
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FOR EXPLANATION OF PLATE SEE PAGE 41.



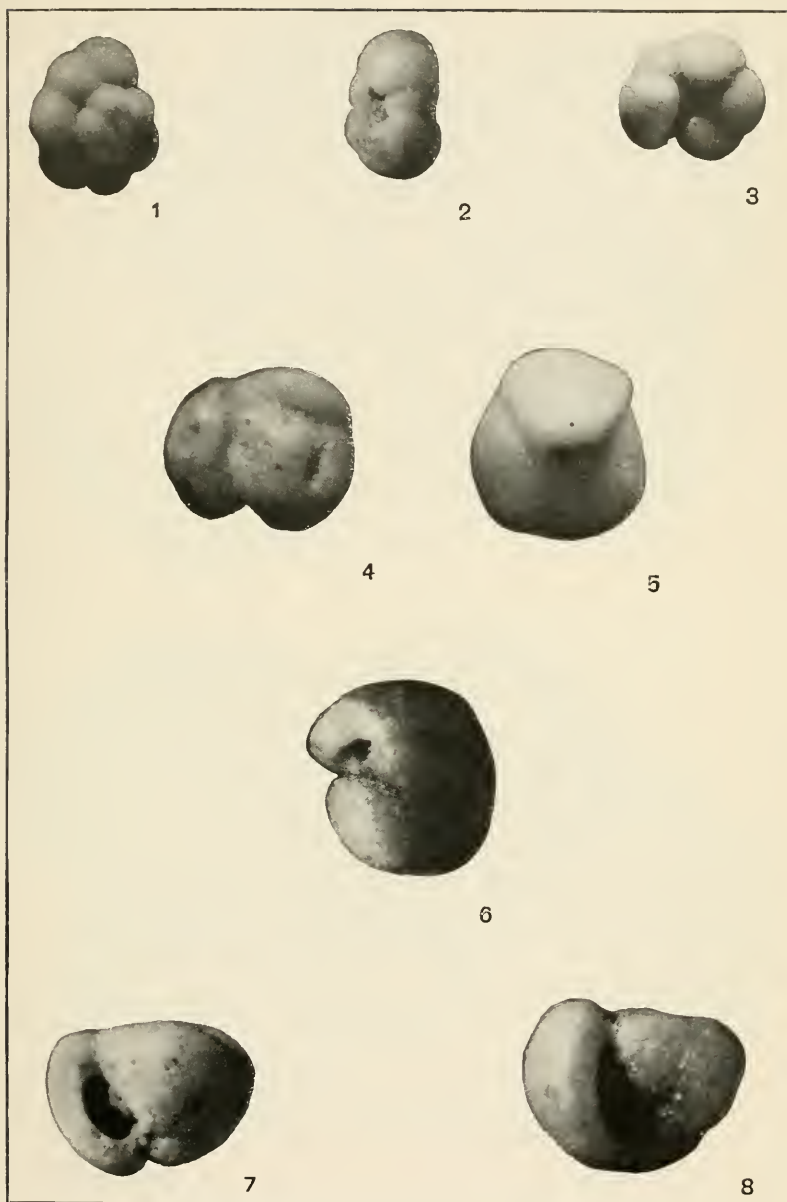
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FOR EXPLANATION OF PLATE SEE PAGE 41.



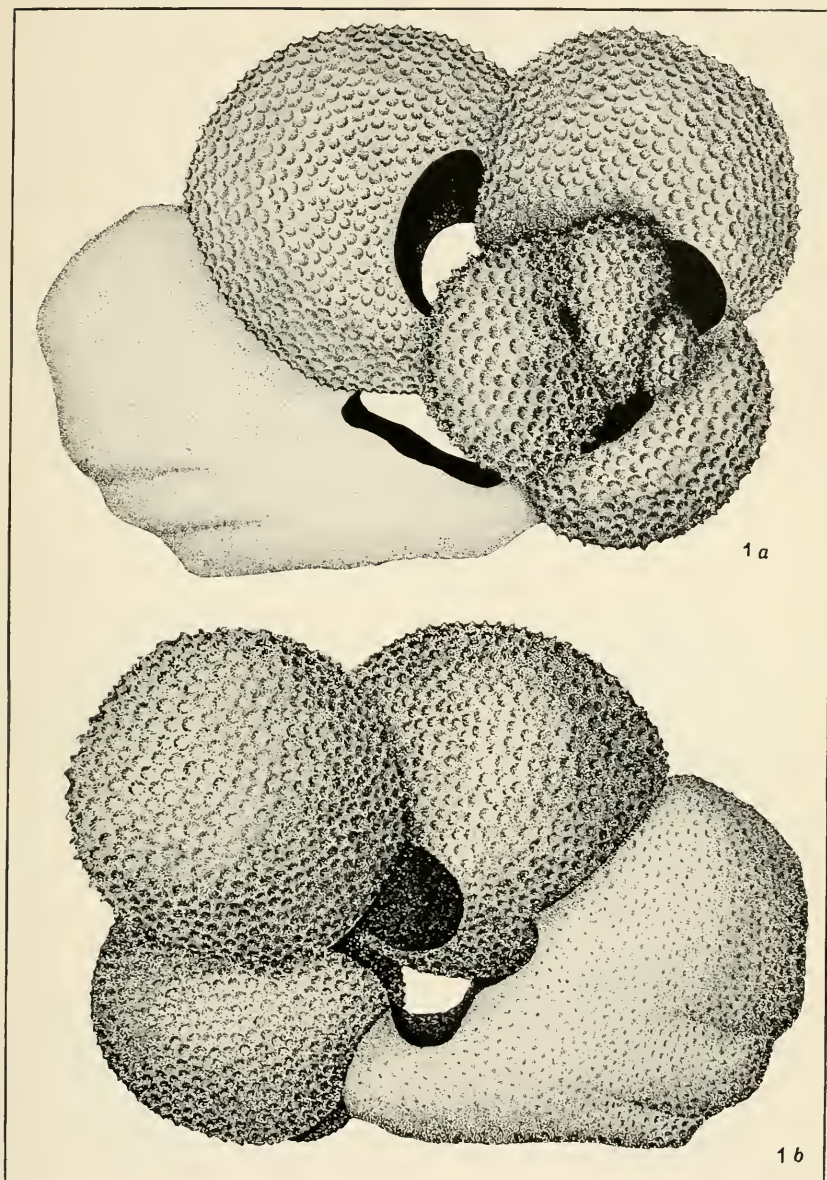
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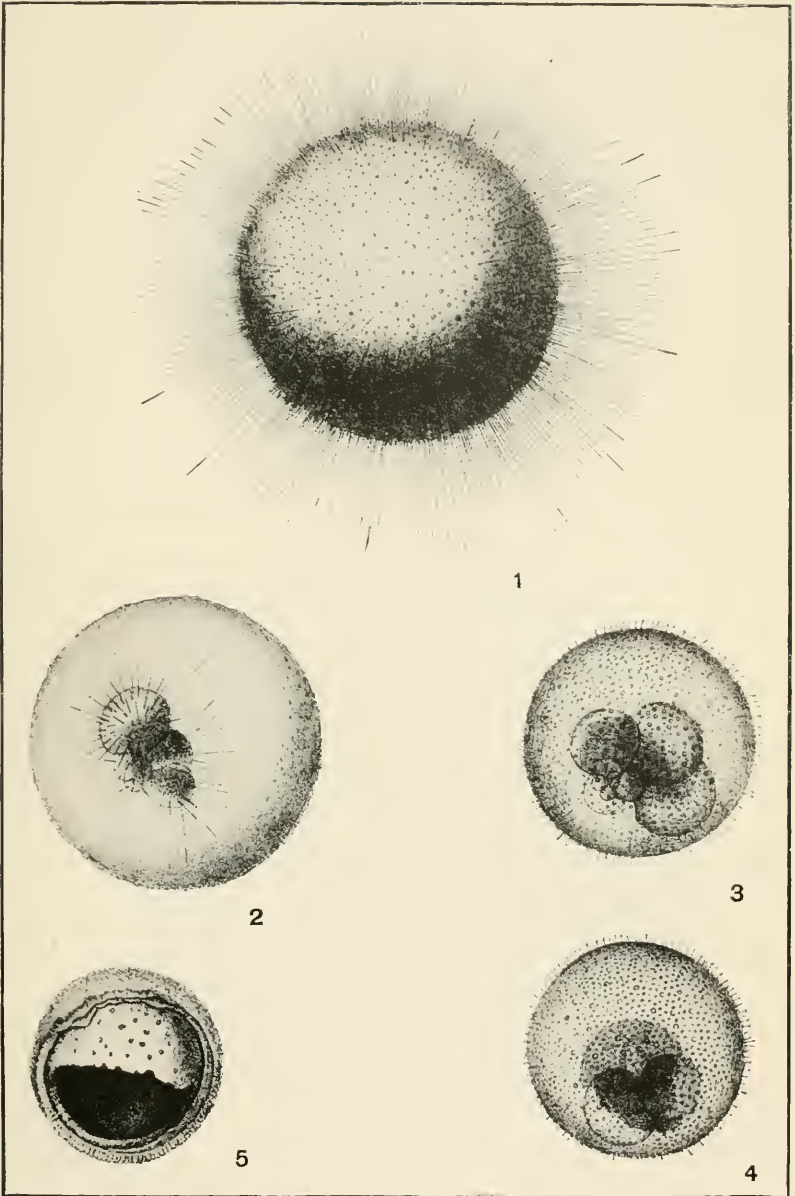
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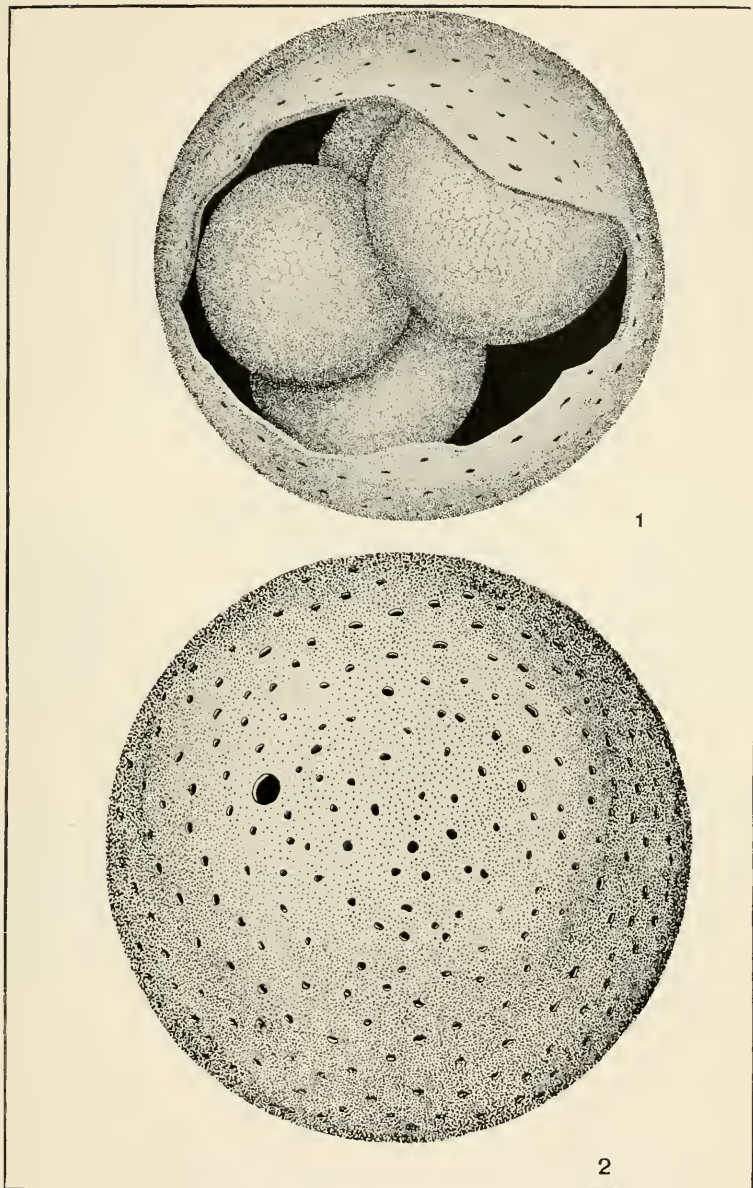
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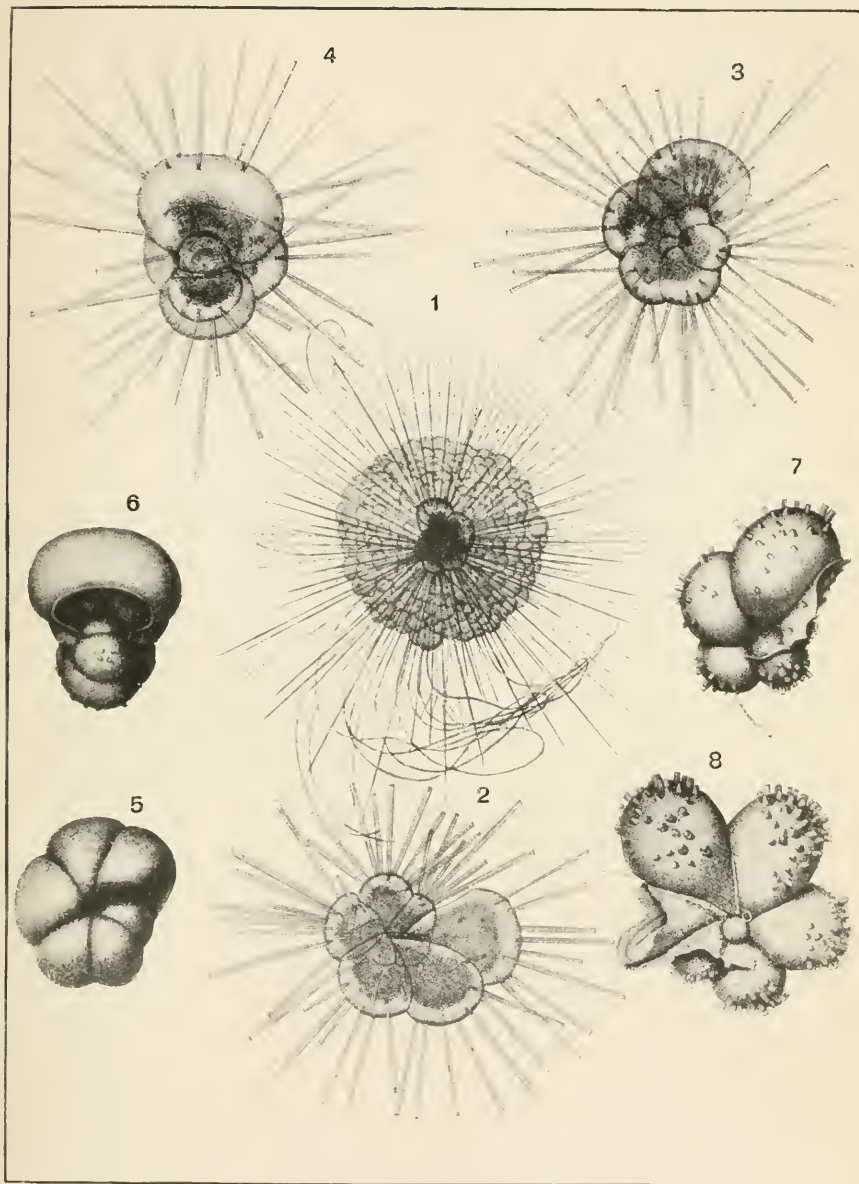
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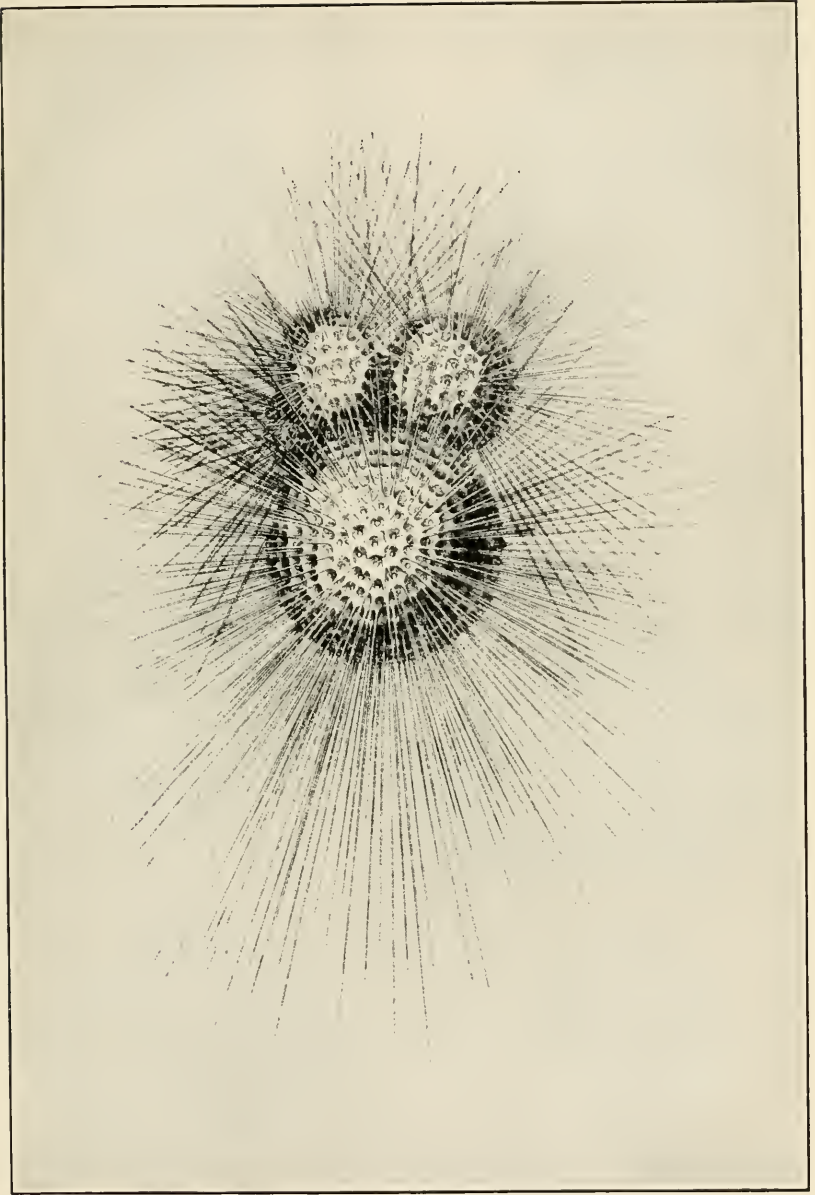
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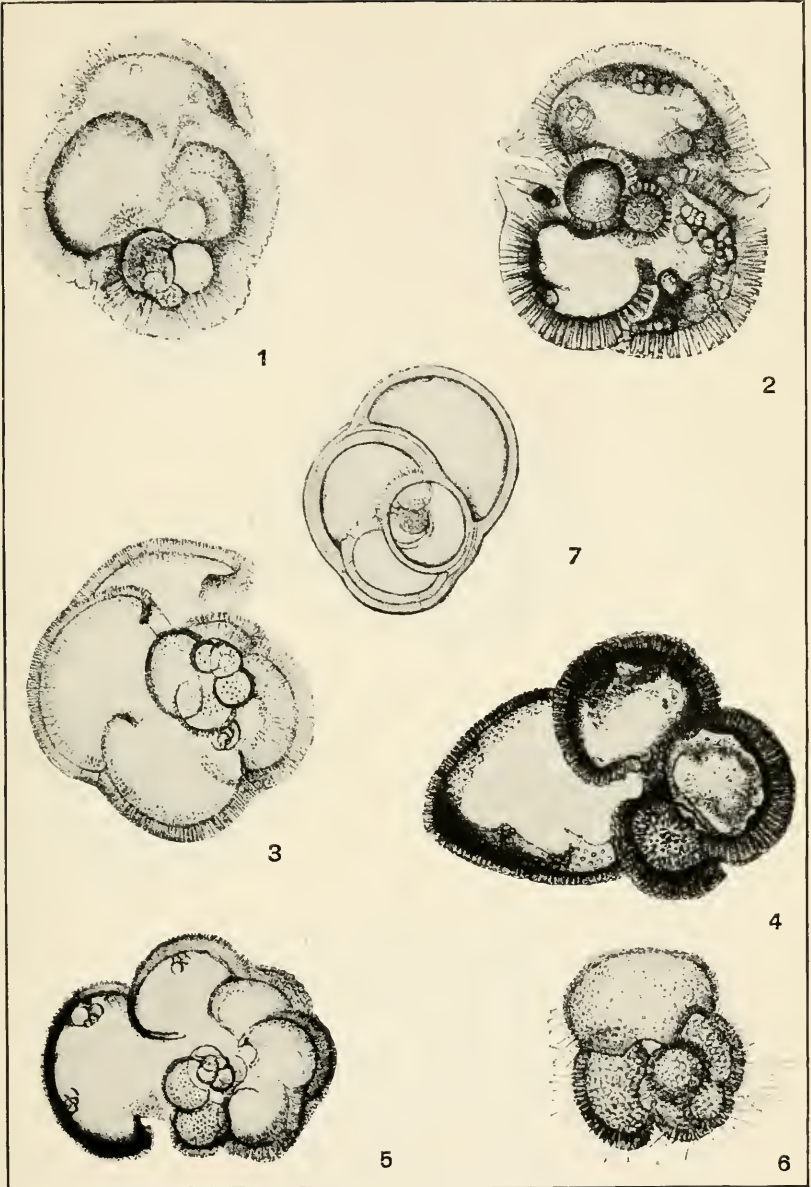
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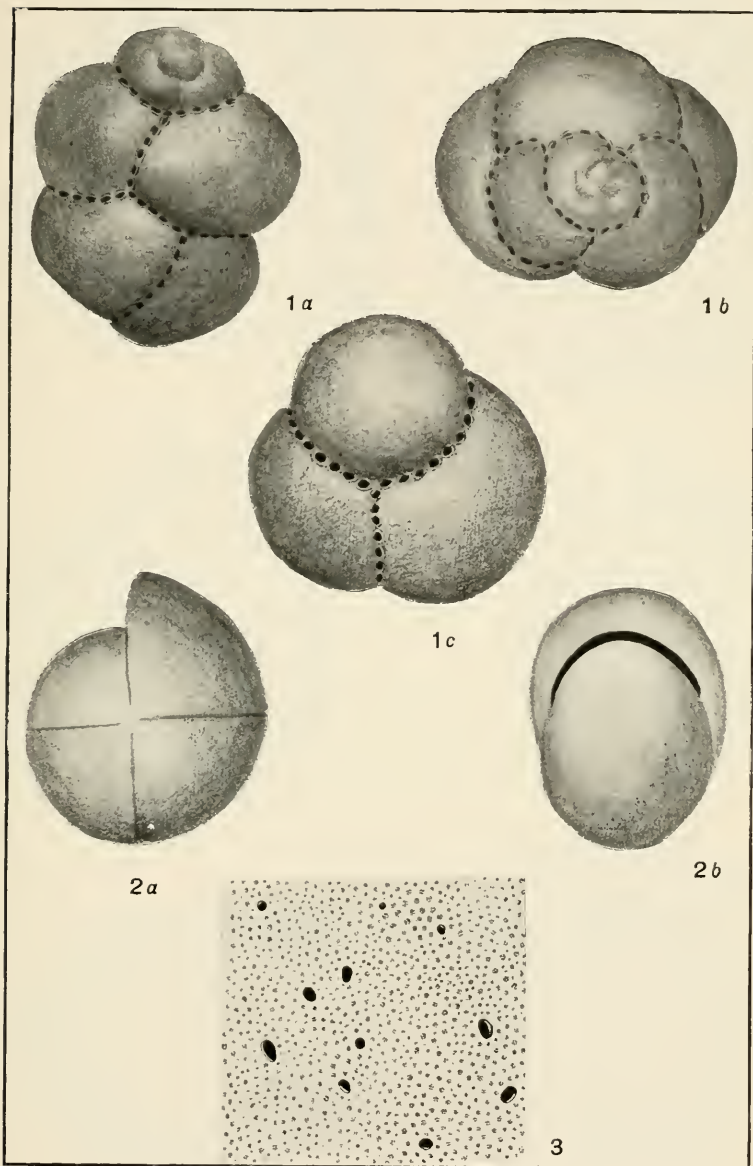
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GLOBIGERINIDÆ OF NORTH PACIFIC OCEAN.

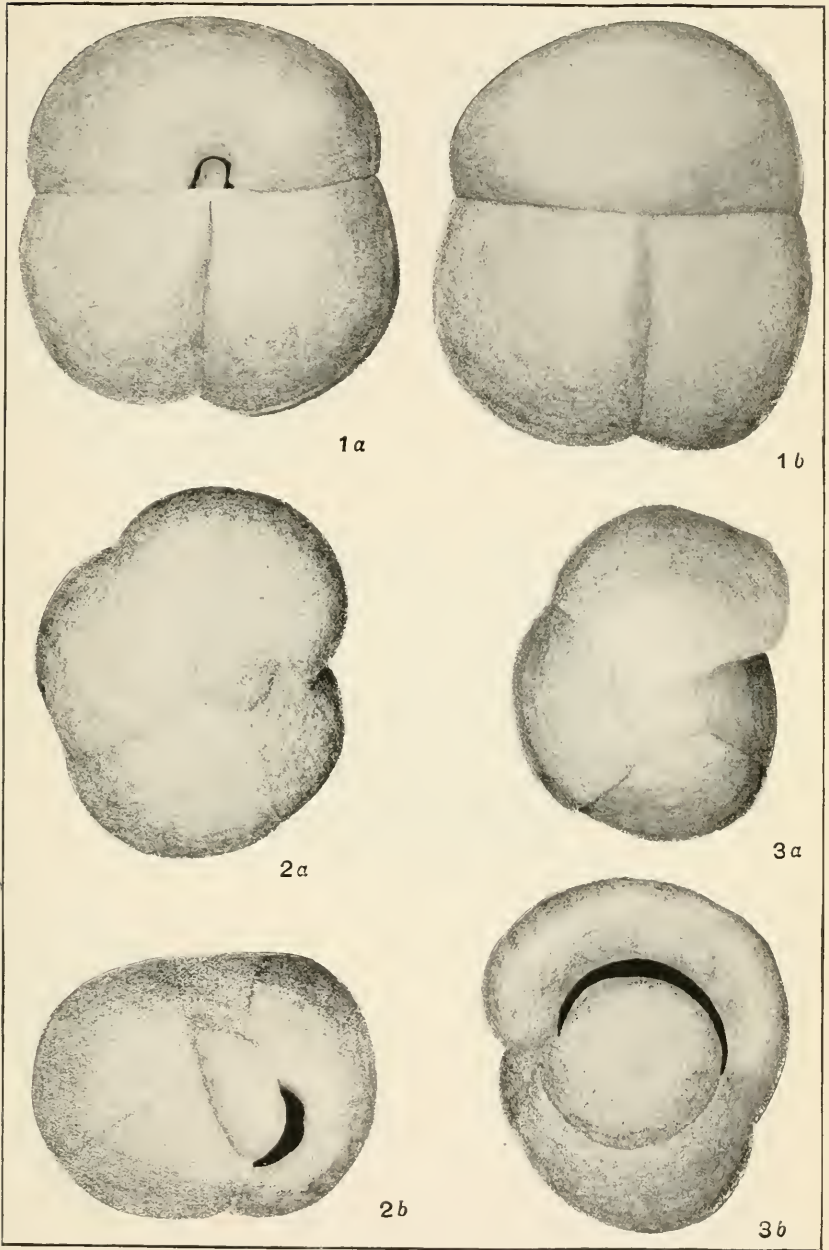
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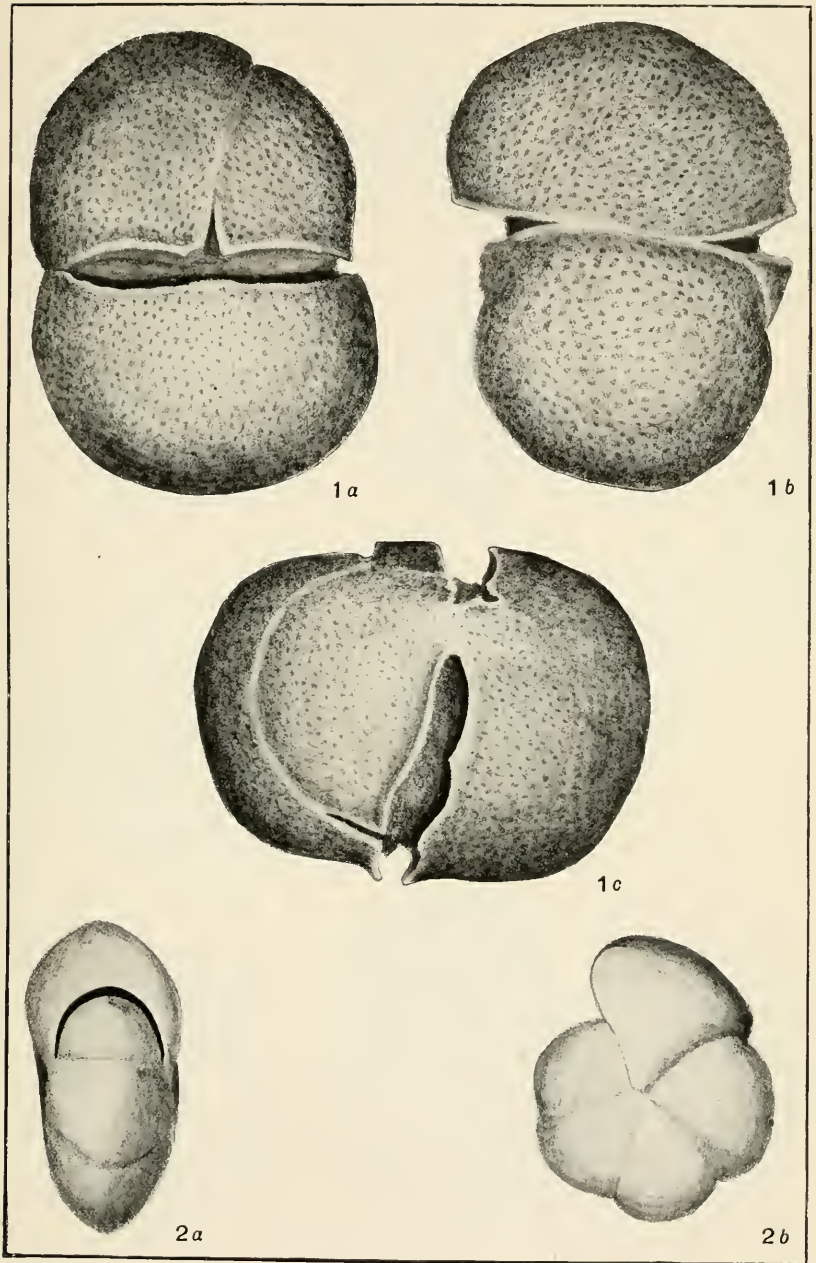
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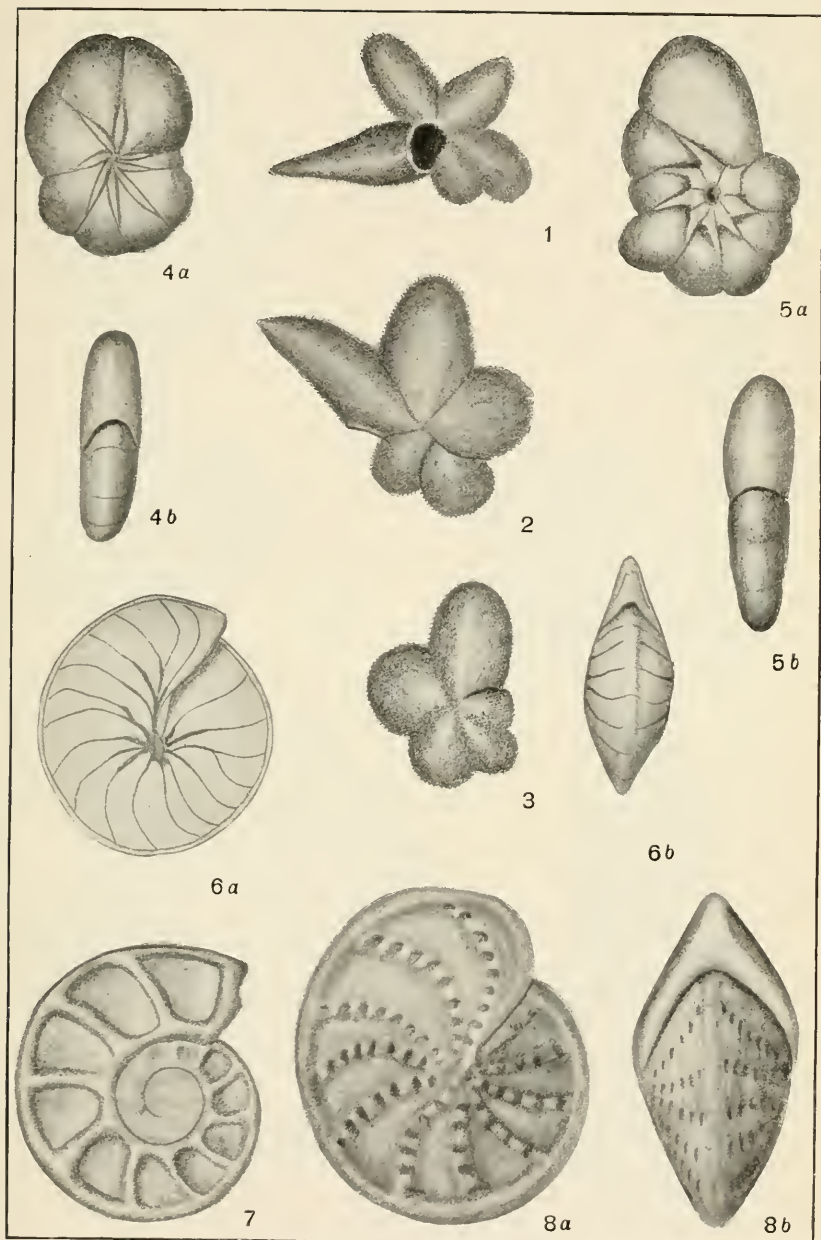
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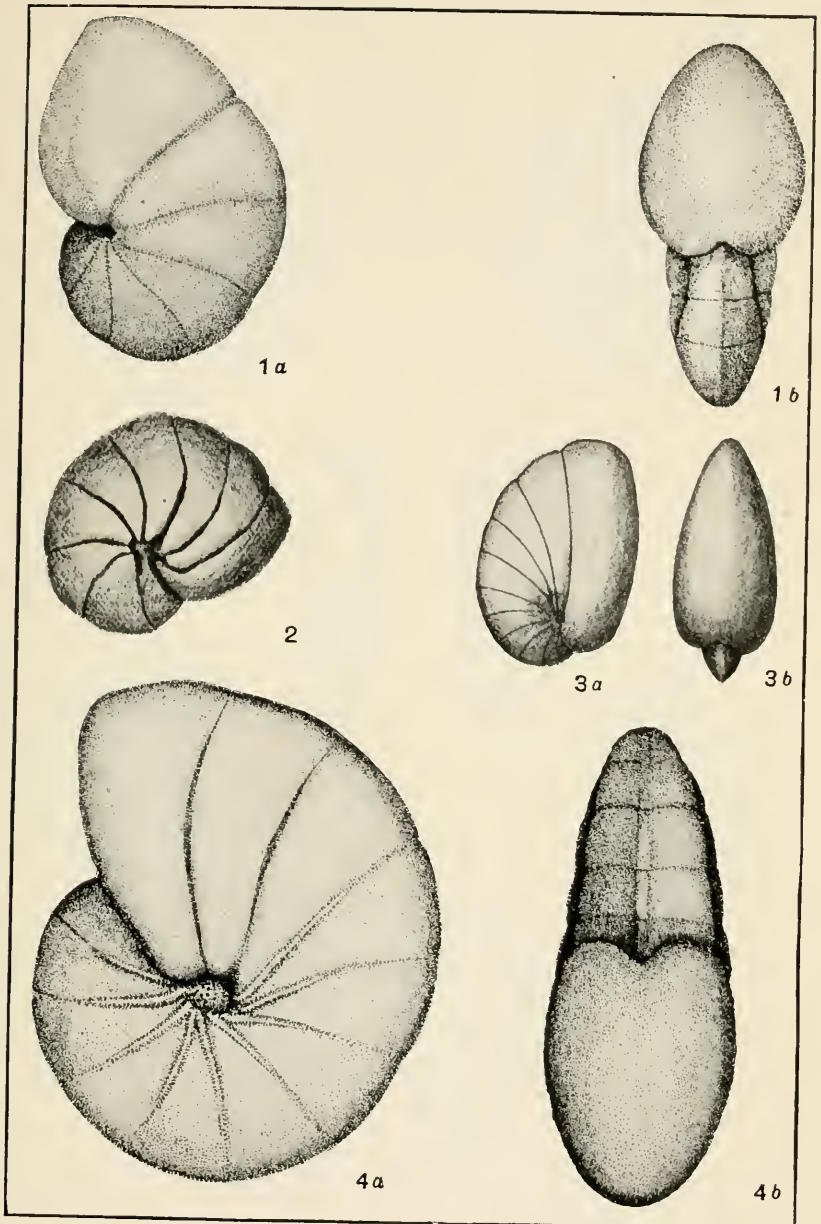
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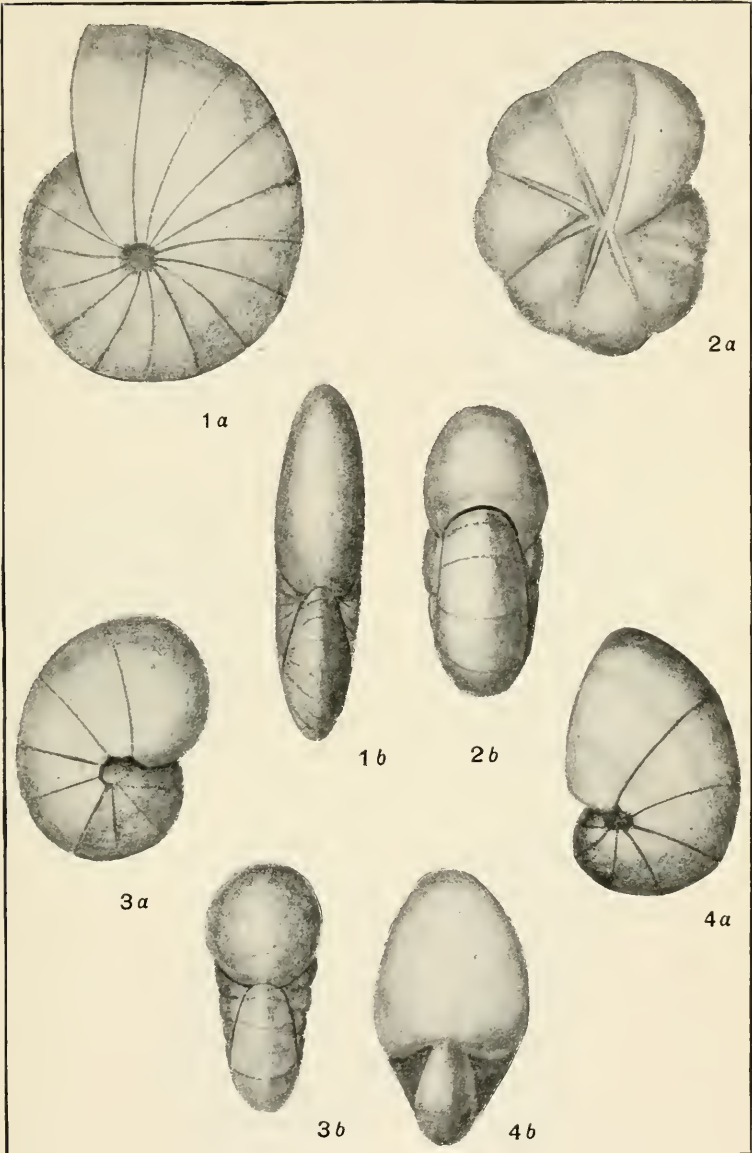
GLOBIGERINIDÆ AND NUMMULITIDÆ OF NORTH PACIFIC OCEAN.

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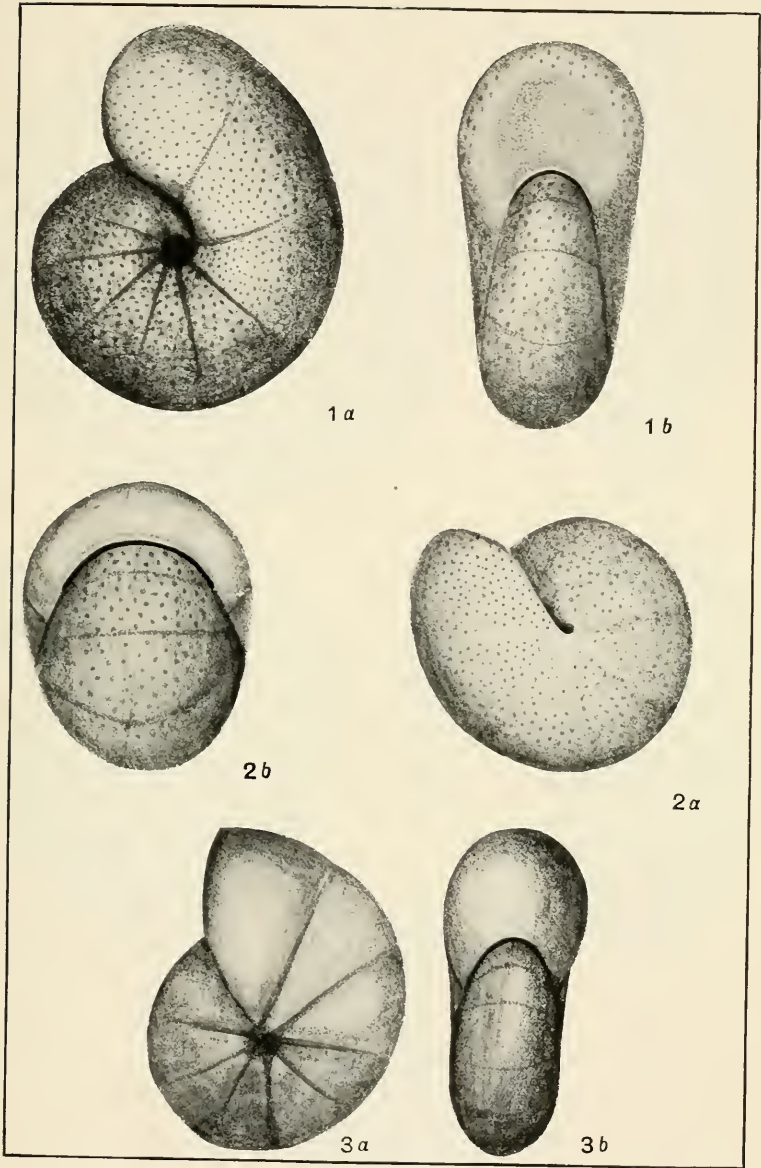
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FOR EXPLANATION OF PLATE SEE PAGE 43.



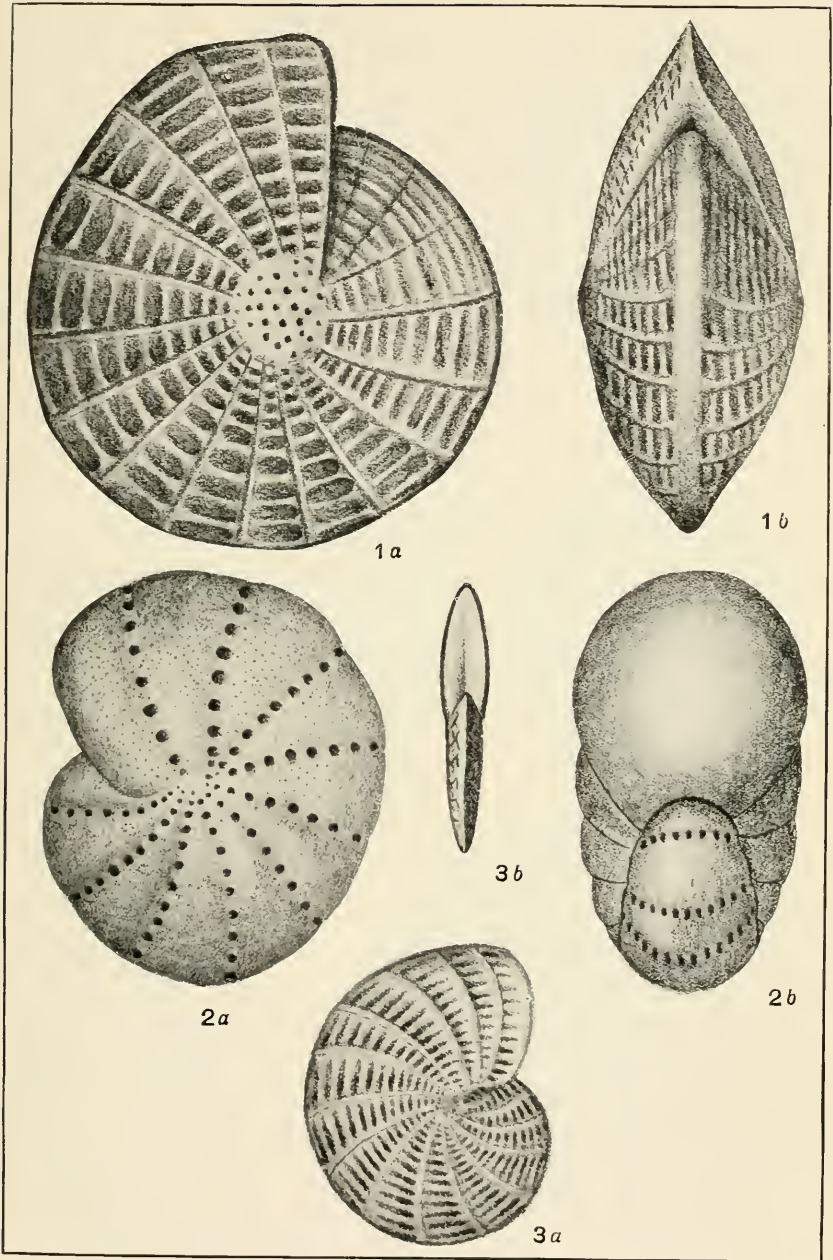
NUMMULITIDÆ OF NORTH PACIFIC OCEAN.

FOR EXPLANATION OF PLATE SEE PAGE 43.



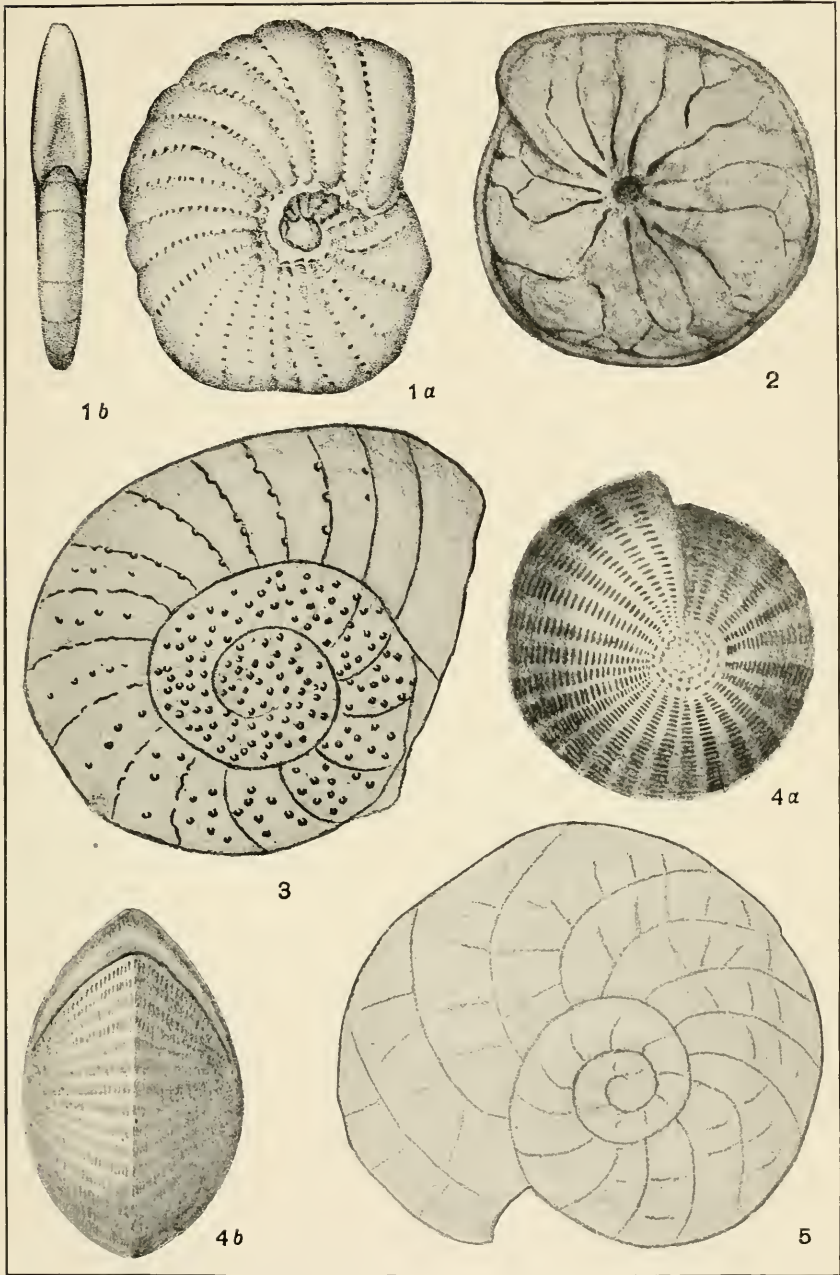
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