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A MONOGRAPH OF THE FORAMINIFERA  
OF THE NORTH PACIFIC OCEAN

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PART V. ROTALIIDÆ

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BY

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ii

## INTRODUCTION.

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The present volume is the fifth of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the family Rotaliidæ. The first part, issued in 1910, included the families Astrorhizidæ and Lituolidæ; the second part, issued in 1911, the family Textulariidæ; the third part, issued in 1913, the family Lagenidæ; and the fourth part, issued in 1914, included the families Chilostomellidæ, Globigerinidæ, and Nummulitidæ. Part six, the last, will be devoted to the Miliolidæ.

JOSEPH AUGUSTINE CUSHMAN.

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# A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

ROTALIIDÆ.

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

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## INTRODUCTION.

This fifth part of the work on the North Pacific Foraminifera deals with the single family Rotaliidæ. In its natural order this family comes before the Nummulitidæ which was the last family treated in the fourth part but which was taken up there in order to better balance the parts, as previously explained.

The members of this family have been widely known and well worked and the new species are not very numerous. However, in some genera the species seem to be more or less localized and often prove to be new. Such genera as *Spirillina* and *Discorbis* are very apt to have new species wherever found.

If the collections which were available for the present paper had included a greater amount of material from shallow water of the tropical portion of the North Pacific, there would undoubtedly have been a larger number of new forms and a greater number of species, as certain genera are especially abundant under such conditions.

It is interesting to note again the occurrence of a considerable number of really tropical species up to the southern coast of Japan, as has been mentioned in previous parts.

In order to have for comparison original figures of many of the species where later authors have included widely differing forms, a series of outline figures has been introduced in the text adapted from the type figure of the species whenever practicable, otherwise from typical figures of subsequent authors.

## SYSTEMATIC TREATMENT.

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



## Family 8. ROTALIIDÆ.

Test calcareous, perforate, composed usually of numerous chambers, except in the subfamily Spirillininæ, early chambers coiled, and later chambers in typical genera spirally coiled so that the chambers are all visible from the dorsal side and only those of the last formed coil from the ventral side, convexity of the two sides varying greatly; later development in specialized genera being columnar or even arborescent.

This family is one with a great variety of form and a wealth of ornamentation especially in tropical species. Some of the genera, such as *Pulvinulina*, make up a considerable percentage of *Globigerina* ooze and as such are very numerous and widely distributed. Others, such as *Tinoporus* often make up a considerable mass of the foraminiferal content of certain tropical shore sands, as in the Philippines and elsewhere.

There is a regular gradational development, although broken here and there from the simple coiled, nonseptate *Spirillina* to *Rotalia*, where there is a tendency to complex form in supplemental skeleton and internal tubular system reminding one of the Nummulitidæ.

## Subfamily 1. SPIRILLININÆ.

Test free or attached, composed of a proloculum and a long coiled tubular second chamber; variously ornamented; aperture at the end of the tube; wall calcareous, perforate.

This subfamily with the single genus *Spirillina* is an excellent parallelism in the Rotaliidæ with the genus *Ammodiscus* in the Lituolidæ and *Cornuspira* in the Miliolidæ. There is a considerable range of form and ornamentation, and most of the species are characteristic of comparatively shallow water especially in the Tropics.

## Genus SPIRILLINA Ehrenberg, 1841.

*Spirillina* EHRENBURG (type, *Spirillina vivipara* Ehrenberg), Abh. Akad. Wiss. Berlin, 1841, p. 422.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 629.

*Operculina* REUSS (part), Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 370 (not *Operculina* d'Orbigny, 1826).

*Cornuspira* SCHULTZE (part), Organ. Polythal., 1854, p. 41.

*Description.*—Test typically free, occasionally attached, spiral, composed of a subcircular or ovoid proloculum and a long undivided tubular second chamber, coiled regularly in one plane; wall hyaline and perforate; surface smooth or variously ornamented; aperture formed by the open end of the tube.

The genus *Spirillina* is composed of few species, most of which are minute. They are found usually in comparatively shallow water and seemingly most often on muddy bottoms. Some species seem to prefer the mud of coral reefs.



In its general simple structure this genus is analogous to *Cornuspira* among the imperforate calcareous forms and to *Ammodiscus* among the arenaceous forms. By some authors these have been classed together but it seems merely a case of parallelism as is found among so many of the various groups of the Foraminifera.

**SPIRILLINA VIVIPARA Ehrenberg.**

Plate 1, figs. 1, 2.

*Spirillina vivipara* EHRENBURG, Abh. Akad. Wiss. Berlin, 1841, p. 442, pl. 3, fig. 41.—WILLIAMSON, Mem. and Proc. Manchester Lit. and Philos. Soc., ser. 2, vol. 8, 1848, p. 45, pl., fig. 34.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 284, pl. 11, fig. 46; Philos. Trans., vol. 155, 1865, p. 397, pl. 15, fig. 28.—MOEBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 88, pl. 8, figs. 1, 2.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 108, pl. 7, fig. 272.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 630, pl. 85, figs. 1-5.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28 (Sci.) 1885, p. 348, pl. 12, fig. 32.—BÜTSCHLI, Morph. Jahrb., vol. 11, 1886, p. 84, pl. 6, fig. 12.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 394, pl. 18, figs. 56-58; vol. 21, 1899, p. 18, pl. 1, figs. 50, 51.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 326, pl. 71, fig. 4.—MILLET, Journ. Roy. Micr. Soc., 1903, p. 693.—RHUMBLER, Zool. Jahrb., Abth. Syst., vol. 24, 1906, p. 32, pl. 2, fig. 7.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 133.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 6, pl. 1, figs. 12-14; pl. 2, figs. 1-3; vol. 54, No. 16, 1910, p. 24.

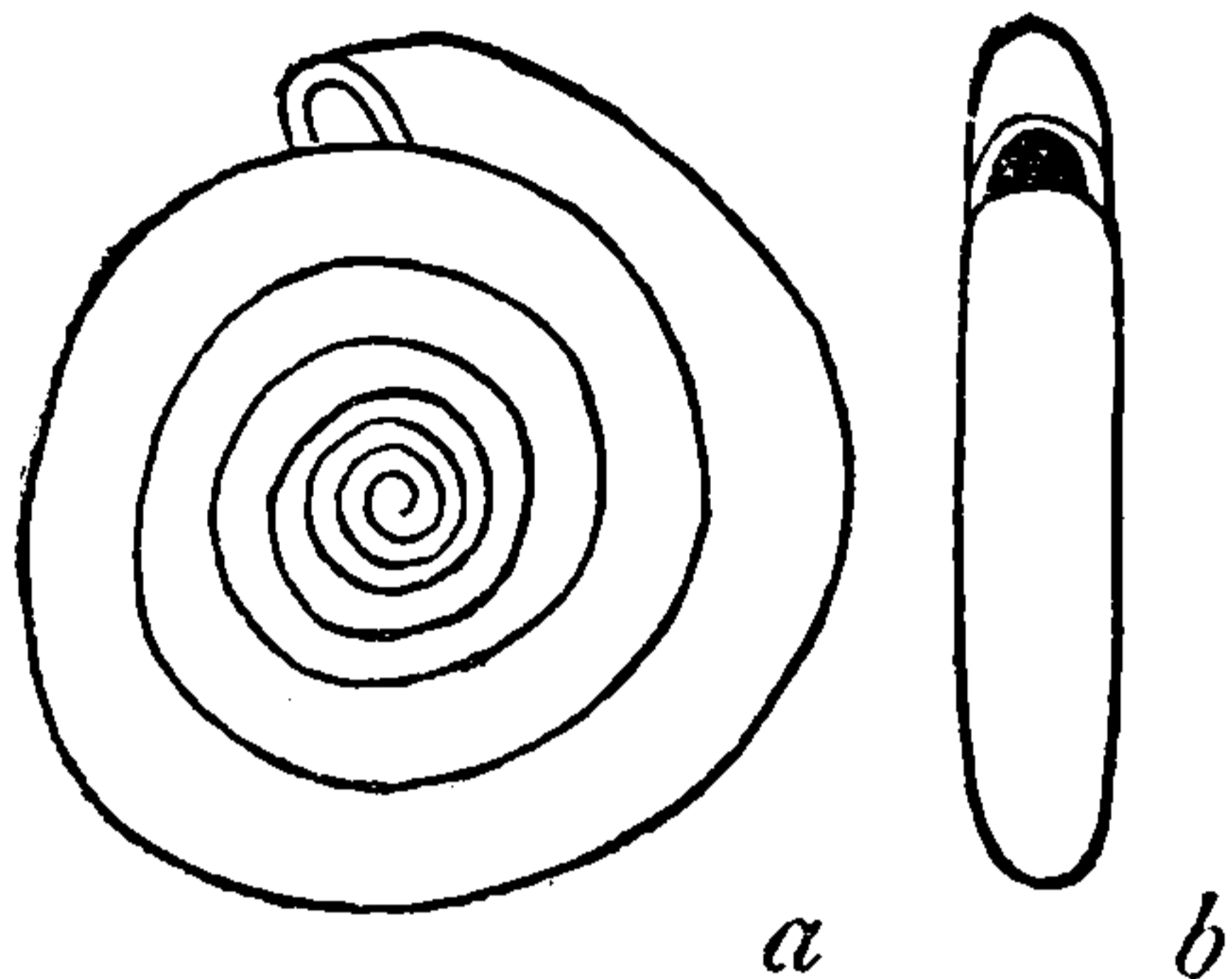


FIG. 1.—SPIRILLINA VIVIPARA EHRENBURG.  $\times 100$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW. (ADAPTED FROM BRADY.)

*Operculina punctata* REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1849, p. 370, pl. 46, fig. 21.

*Cornuspira perforata* SCHULTZE, Organ. Polythal., 1854, p. 41, pl. 2, fig. 22.

*Spirillina perforata* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 92, pl. 7, fig. 202.

*Description*.—Test typically free, rarely adherent, planospiral, coils of early portion in microspheric specimens at least narrow, those of later coils much wider and of nearly uniform width, faces sometimes flattened but more often concave on both sides; sutures usually distinct and often considerably depressed; peripheral border rounded; wall marked by conspicuous perforations, irregularly scattered and most prominent on the last formed volutions; aperture somewhat crescentic.

Diameter 0.4-0.75 mm.

*Distribution*.—Brady records the occurrence of this species in the North Pacific without definite station. Rhumbler records it both from Laysan and the Chatham Islands. I have found the species but a few times in the material at my disposal, largely due, I suppose, to the fact that it was with few exceptions from fairly deep



water. A single specimen occurred at each of two *Albatross* stations D4309 and D4310, and it also occurred off Guam, *Nero* station 1466.

**SPIRILLINA VIVIPARA** Ehrenberg, var. **REVERTENS** Rhumbler.

Plate 1, figs. 3-6.

*Spirillina vivipara* H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 85, fig. 5 (not figs. 1-4).

*Spirillina vivipara*, var. *revertens* RHUMBLER, Zool. Jahrb. Abth. Syst., vol. 24, 1906, p. 32, pl. 2, figs. 8-10.

*Description*.—Test differing from typical *S. vivipara* in the coiling of the test which is regular in the early ones, then the growing end of the test turns under the disk and grows inward so that finally it approaches the middle of the under side.

Diameter 0.07 to 0.15 mm.

*Distribution*.—This variety was found by Rhumbler in material both from Laysan and Chatham Islands. I have had no material referable to this variety.

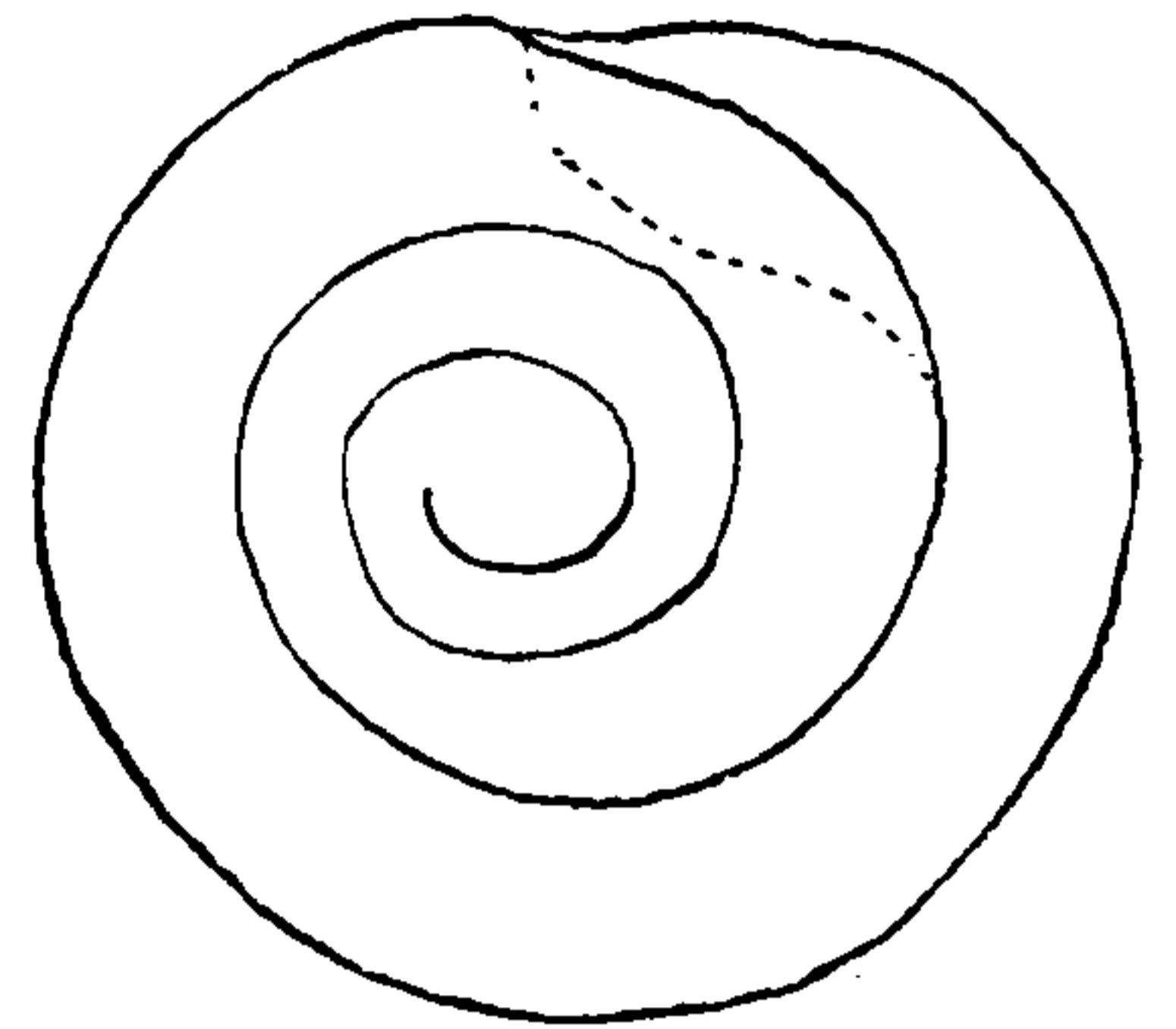
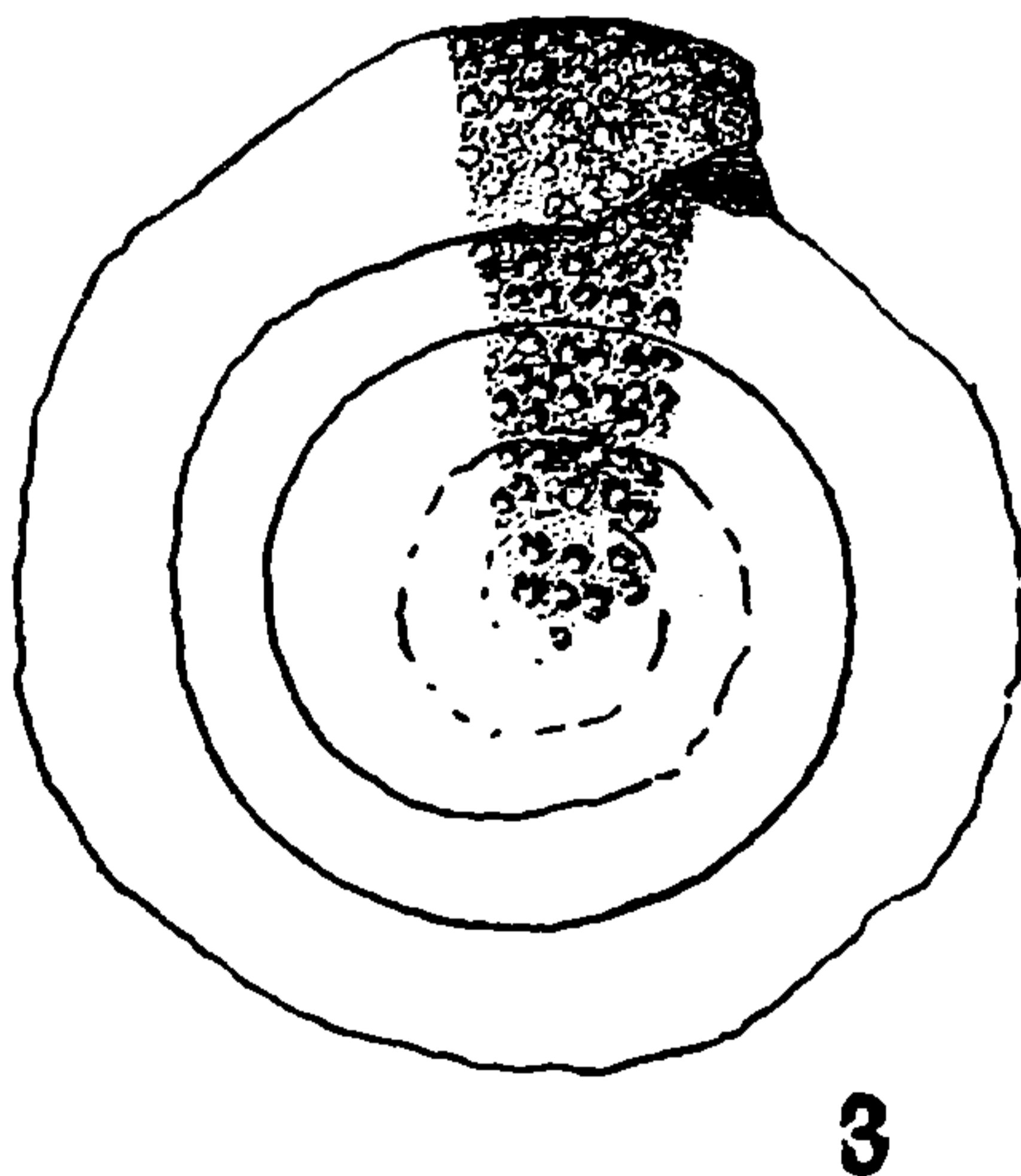


FIG. 2.—SPIRILLINA VIVIPARA, VAR. REVERTENS RHUMBLER.  $\times 250$ . (AFTER TYPE FIGURE OF RHUMBLER.)

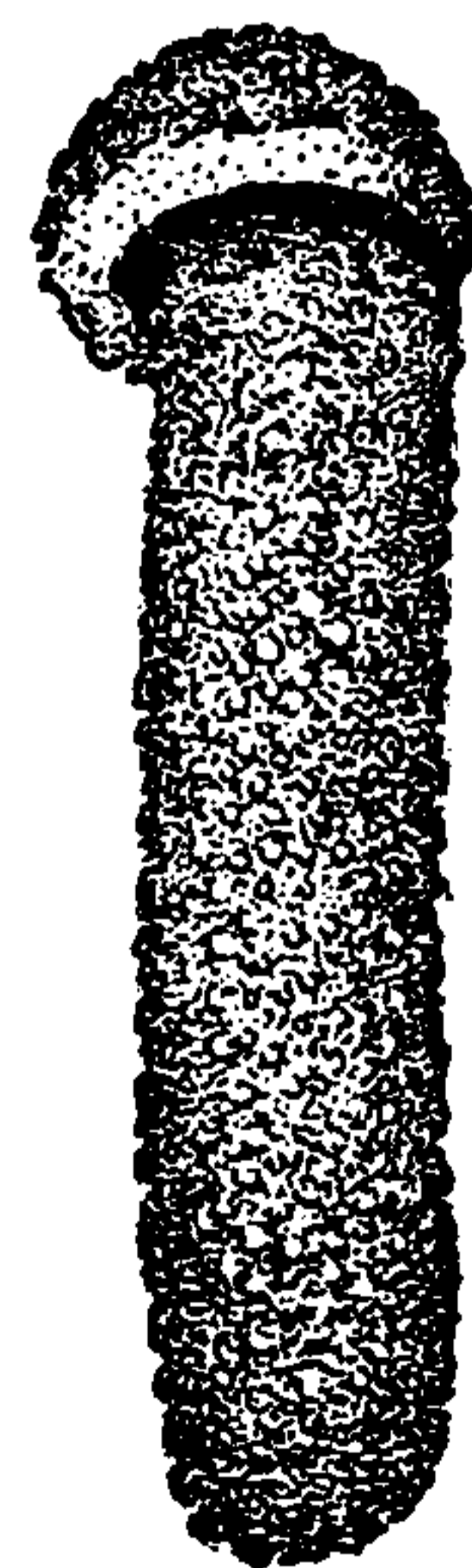
**SPIRILLINA TUBERCULATA** H. B. Brady.

Plate 1, figs. 7-9; plate 2, fig. 3.

*Spirillina tuberculata* H. B. BRADY, in Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 50; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 279, pl. 8, fig. 28a, b; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 631, pl. 85, figs. 12-16.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 395, pl. 18, figs. 62, 63.



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FIGS. 3, 4.—SPIRILLINA TUBERCULATA H. B. BRADY. 3, FRONT VIEW,  $\times 45$ ; 4, APERTURAL VIEW,  $\times 50$ . (FIGURES FROM TYPE FIGURES GIVEN BY BRADY.)

*Description*.—Test free, planospiral, usually slightly asymmetrically coiled, flattened or slightly concave on the dorsal face, slightly excavated at the umbilicus in microspheric specimens; peripheral border



usually rounded; wall covered with a secondary deposit of calcareous material obscuring the sutural depressions of all but the final coil, ornamented over the whole exterior with numerous raised tubercles usually more prominent on the dorsal face; aperture somewhat crescentic.

Diameter 0.5 to 1 mm.

*Distribution.*—Brady gives the only North Pacific record for this species. It was obtained by the *Challenger* off the coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms. Bagg does not record it from this region, but his material, as was that which I have had, came from deeper water. Apparently from Brady's figures of this species he had both microspheric and megalospheric forms of the species.

**SPIRILLINA LIMBATA H. B. Brady.**

Plate 2, figs. 1, 2.

*Spirillina limbata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 278, pl. 8, fig. 26a, b; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 632, pl. 85, figs. 18–21.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 395, pl. 18, figs. 43, 44.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 326, pl. 71, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 694.

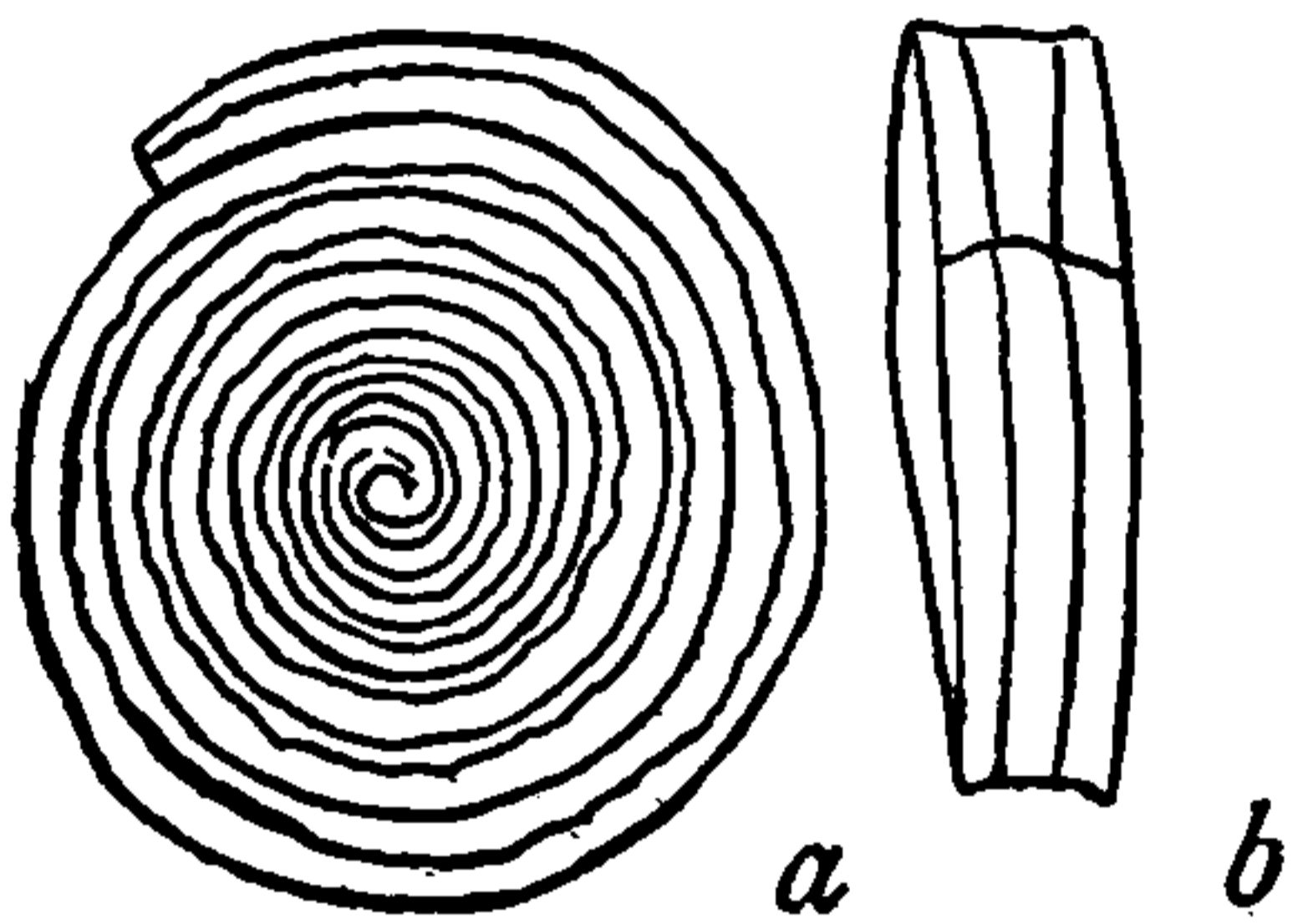


FIG. 5.—SPIRILLINA LIMBATA H. B. BRADY.  $\times 60$ . a, FRONT VIEW; b, APERTURAL VIEW. (ADAPTED FROM BRADY.)

*Description.*—Test planospiral, concave on both sides or merely flattened, composed of numerous regular coils; peripheral border square; wall smooth, the sutural line marked by a raised ridge of calcareous material, perforations small and inconspicuous; aperture somewhat compressed.

Diameter 0.42–0.85 mm.

*Distribution.*—In the *Challenger* report Brady records this species as occurring at one *Challenger* station in the North Pacific, but does not give depth or location.

**SPIRILLINA LIMBATA H. B. Brady, var. DENTICULATA H. B. Brady.**

Plate 3, figs. 1, 2.

*Spirillina limbata* H. B. BRADY, var. *denticulata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 632, pl. 85, fig. 17.

*Description.*—Test very similar in general to that of typical *S. limbata*, but differing in the denticulate character given to the carina of the margin of the chamber by the buttress-like teeth which border it along the inner side.

*Distribution.*—This variety was described from the East Indian region by Brady, but has not previously been recorded from the North Pacific. I have had it from stations which have shown by their



fauna that they are to be considered as belonging to the East Indian fauna to a large extent. They are Gaspar Straits, North Pacific Exploring Expedition, Capt. Rodgers; *Nero* station 1466 off Guam, *Tuscarora* station, 27° 16' N.; 141° 56' E., in 108 fathoms, and *Albatross* H4882 at the station in Colnett or Vincennes Strait, where so many southern species were found.

**SPIRILLINA LIMBATA** H. B. Brady, var. **PAPILLOSA**, new variety.

Plate 2, fig. 4.

*Description.*—Test small, composed of a few coils, dorsal side with the borders of the coil decidedly carinate, and more or less regularly wavy, center depressed; periphery sharply angled at the dorsal margin, rounded at the ventral margin, obliquely sloping to the ventral margin which is of smaller diameter than the dorsal; ventral surface strongly papillose, apertural end of the coil cut back so that the periphery is considerably extended.

Diameter about 0.3 mm.

*Distribution.*—Type-specimen from *Nero* station 2039 in 24 fathoms, near the Hawaiian Islands. (Cat. No. 9023, U.S.N.M.)

This variety differs from the typical in the fewer chambers, more prominent and wavy carina, and the papillose ventral surface which in the typical form is smooth.

Specimens of this variety were later obtained from *Nero* station 1466 in 234 fathoms off Guam, and from *Tuscarora* station 2, lat. 27° 16' N.; long. 141° 56' E., in 108 fathoms.

**SPIRILLINA INÆQUALIS** H. B. Brady.

Plate 3, fig. 3.

*Spirillina inæqualis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 278, pl. 8, fig. 25a, b; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 631, pl. 85,

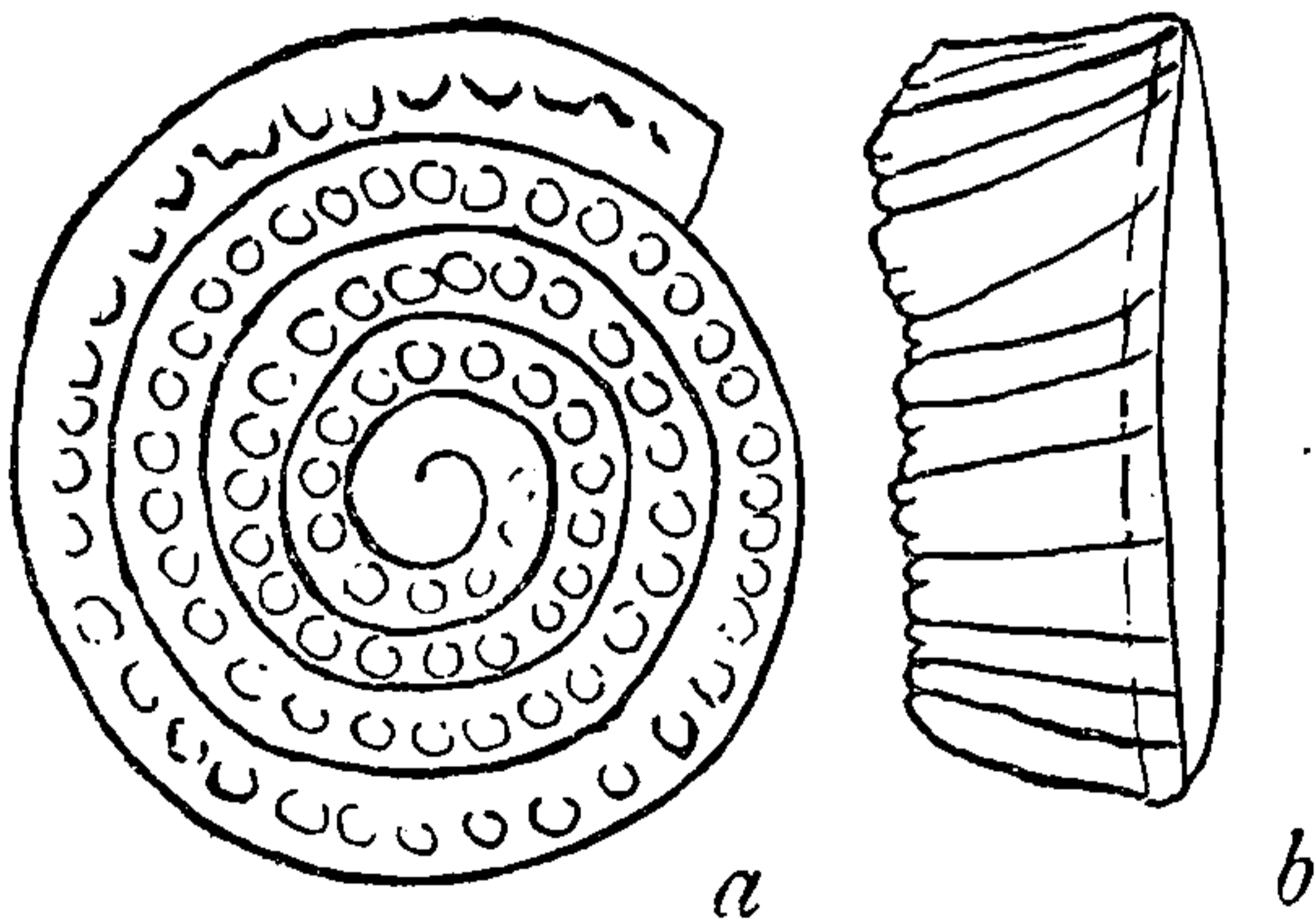


FIG. 6.—*SPIRILLINA INÆQUALIS* H. B. BRADY.  
× 120. *a*, FRONT VIEW; *b*, SIDE VIEW.  
(ADAPTED FROM BRADY.)

figs. 8–11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 394, pl. 18, figs. 40–42.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 693.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 34, pl. 2, fig. 12.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 282.

*Description.*—“Test free or adherent, discoidal, relatively thick; consisting of four or five convolutions; inferior (adherent) surface flat, broader than the superior; superior face concave, or excavated at the umbilicus; periphery oblique, margin acute or subcarinate. Shell-wall coarsely perforated; surface uneven, often decked with slightly raised bosses or tubercles.

“Diameter 1/80th inch (0.3 mm.)”



*Distribution.*—One of the stations from which this species was described by Brady is off the coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms, obtained by the *Challenger*. The only other records for the species in this area are those given by Rhumbler, who found a single specimen from Laysan Island and one from Chatham Island.

The description is from Brady.

**SPIRILLINA DECORATA H. B. Brady.**

Plate 5, figs. 1, 2.

*Spirillina decorata* H. B. BRADY, Rep. Voy. *Challenger* Zoology, vol. 9, 1884, p. 633, pl. 85, figs. 22–25.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 394, pl. 18, figs. 64, 65.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 695.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 33, pl. 2, fig. 11.

*Description.*—“Test free, discoidal, bilaterally symmetrical or nearly so; composed of six or eight convolutions of a somewhat embracing tube. Lateral faces slightly concave, peripheral edge thin and subcarinate; perforations obscure in thick-walled specimens, the surfaces of which become pitted and furrowed; aperture of the adult somewhat contracted and triangular.

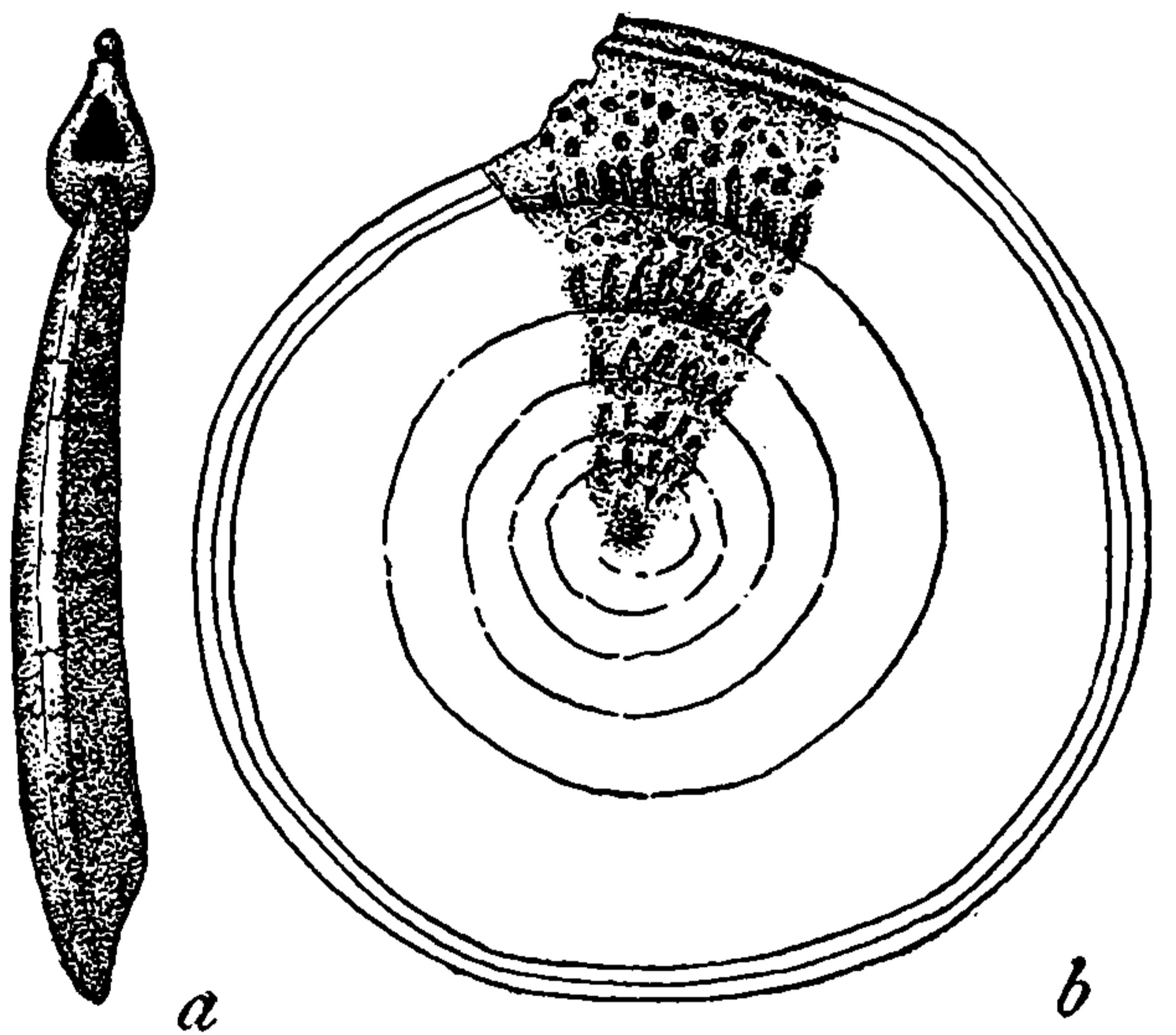


FIG. 7.—SPIRILLINA DECORATA H. B. BRADY.  $\times 50$ . *a*, SIDE VIEW; *b*, FRONT VIEW. (ADAPTED FROM BRADY'S FIGURE OF THE TYPE.)

“Diameter 130th inch (0.84 mm.) or more.”

*Distribution.*—Rhumbler records and figures a single specimen of this species from Laysan Island. This is the only record for the North Pacific.

The description is from Brady.

**SPIRILLINA OPERCULOIDES, new species.**

Plate 4, fig. 2.

*Description.*—Test small, composed of numerous coils, slightly umbonate on the dorsal surface; surface of dorsal side smooth except the outer coil which is longitudinally striate; periphery rather sharply rounded; ventral side slightly concave; the pores of the wall giving the surface a pitted appearance, otherwise smooth.

Diameter 0.3 mm.



*Distribution*.—Type-specimen from Nero station 2038 in 34 fathoms, near the Hawaiian Islands (Cat. No. 9024, U.S.N.M.).

This species in its general form is somewhat similar to *S. obconica* H. B. Brady, but is much less excavated below, its surface ornamentation at once distinguishing it from that species.

**SPIRILLINA GUTTATA, new species.**

Plate 4, fig. 1.

*Description*.—Test spiral, circular in dorsal view, flattened above, very slightly concave below; wall smooth except for the suture and the slight ornamentation consisting of a single row of slight depressions near the inner border of the chamber; suture decidedly depressed, on the under side the central portion filled with a mass of irregular shell material showing the coils indistinctly and having a somewhat radiating appearance.

Diameter about 1 mm.

*Distribution*.—Type-specimen (Cat. No. 9025, U.S.N.M.) from *Albatross* station H4881, off Japan in 316 fathoms.

In much tropical material there are found specimens which seem referable to this genus. Especially when the growing edge is broken and appears as a well defined opening the specimens seem at first sight to belong to *Spirillina*. One such specimen is here figured, plate 4, figure 3. After the specimen was figured others came to hand which were more nearly perfect and which seemed to show convincingly that it was a Gastropod operculum of some sort instead of a *Spirillina*.

**Subfamily 2. ROTALINÆ.**

Test spiral, rotaliform, rarely evolute, very rarely irregular or acervuline; chambers numerous, distinct or in some few species largely obscured by shell growth, early chambers in all distinctly rotaliform.

This subfamily shows a very great range of characters, such genera as *Discorbis* and *Polytrema*, for example, seeming entirely unrelated until the early chambers of each are compared.

**Genus PATELLINA Williamson, 1858.**

*Patellina* WILLIAMSON (type, *P. corrugata* Williamson) Recent British Foraminifera, 1858, p. 46.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 633.

*Description*.—Test conical in form or plano-convex; the early chambers spirally arranged, later ones long and becoming annular or nearly so about the periphery; chambers of living forms usually simple but often partially divided by internal septæ, visible from the exterior; aperture elongate, at the inner border of the chamber.



This genus, represented among the fossils by large, striking and often complicated tests, is, in recent species, represented by small, rather simply constructed tests. In the fossil forms there is usually a central core of deposited material about which are the chambers themselves.

This is evidently a genus which is surviving only by its simplest species, the more complex forms having become extinct in past geological periods.

**PATELLINA CORRUGATA Williamson.**

Plate 7, fig. 1.

*Patellina corrugata* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 46, pl. 3, figs. 86-89.—CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 229,

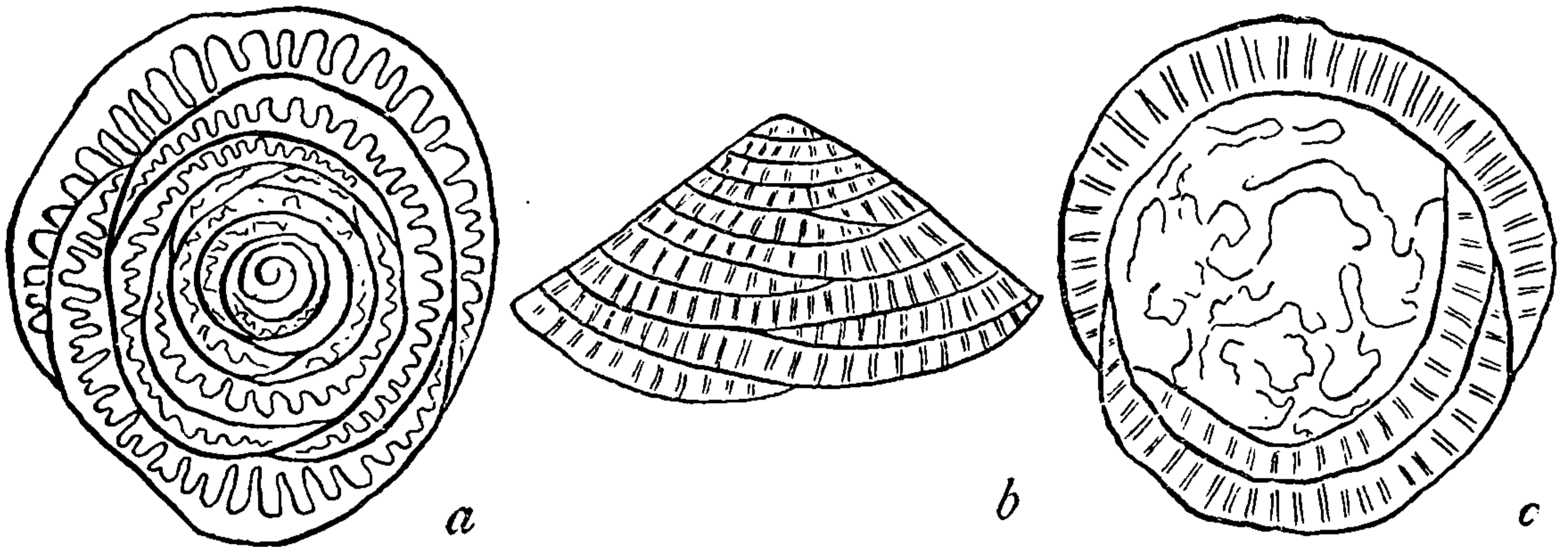


FIG. 8.—*PATELLINA CORRUGATA* WILLIAMSON. (ADAPTED FROM WILLIAMSON'S ORIGINAL FIGURES.)  
a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW.

pl. 13, figs. 16, 17, text-figs. 37, 38.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 398, pl. 15, figs. 29a-c.—SCHWAGER, Boll. Com. geol. Ital., vol. 8, 1887, p. 26, pl., fig. 58.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, 1880, p. 208, pl. 9, fig. 9.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 634, pl. 86, figs. 1-7.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 393, pl. 15, figs. 70-72.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 92.—SCHAUDINN, Sitz. Ges. Nat. Freunde zu Berlin, No. 19, 1895, p. 181, text-fig.—SCHLUMBERGER, Feuille Jeunes Nat., ser. 3, ann. 26, 1896, p. 129, text-fig.—WRIGHT, Geol. Mag., ser. 4, vol. 7, 1900, p. 100, pl. 5, fig. 20.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 696.—RHUMBLER, Zool. Jahrb., Abth. Syst., vol. 24, 1906, p. 35.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 134, pl. 10, fig. 7.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 9.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 29, pl. 5, fig. 3.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 419.

*Description.*—Test usually free, conical, or plano-convex; early portion composed of chambers spirally arranged, later ones elongating and finally becoming annular or nearly so in the last-formed portion of the test; chambers partially divided by internal septæ



which are visible from the exterior, showing clearly in the last-formed chambers from the ventral side; somewhat umbilicate ventrally; walls comparatively thin and translucent; aperture somewhat elongate situated at the inner border of the chamber.

Diameter 0.138–0.636.

*Distribution.*—The only North Pacific records for this species are given by Rhumbler who found it in material from Laysan and from Chatham Island, one specimen from each locality.

#### Genus DISCORBIS Lamarck, 1804.

*Discorbis* LAMARCK (type, *D. vesicularis* Lamarck), Ann. Mus., vol. 5, 1804, p. 183.

*Discorbites* LAMARCK, Ann. Mus., vol. 5, 1804, p. 183.

*Discorbina* CARPENTER, PARKER and JONES, Introd. Foram., 1862, p. 203.—H.

B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 641.

*Description.*—Test free or attached, spiral and rotaliform, plano-convex or biconvex, or modified variously in different species; typically plano-convex with the ventral side flattened and the dorsal convex; all chambers visible from the dorsal side, only those of the last-formed coil visible from the ventral side; test composed of several coils, usually three or four in the adult test; chambers rather numerous; aperture a slit at the umbilical margin of the ventral side of the chamber.

The various species of this genus show a considerable range of characters, some of them such as *D. tabernacularis* being very different from the typical form. As a rule they seem to be most common in comparatively shallow water, and for this reason undoubtedly the number which I have had is comparatively small as most of the *Albatross* and *Nero* material has come from rather deep water.

#### DISCORBIS TURBO (d'Orbigny).

Plate 11, fig. 2.

*Rotalia (Trochulina) turbo* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 274, No. 39; Modèles, No. 73.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 30, pl. 2, fig. 68.—BASSET, Ann. Soc. Sci. Charente Inf., 1884 (1885), p. 162, fig.

*Rotalia turbo* JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 306.

*Discorbina turbo* CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 200.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 206, pl. 9, fig. 10.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 193, pl. 3, figs. 35, 36.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 642, pl. 87, figs. 8a-c.—EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 389, pl. 15, figs. 42–44.—CHAPMAN, Journ. Roy. Micr. Soc., 1896, p. 591, pl. 13, fig. 13.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 697.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 81.

*Description.*—Test plano-convex; dorsal surface conically rounded, ventral side flat or very slightly convex; peripheral margin rather



sharp; chambers numerous, about six or seven in the last-formed whorl, stout; sutures curved backward, slightly if at all depressed above, ventrally somewhat depressed toward the peripheral border, toward the umbilicus broadly limbate, forming a stellate pattern; surface with coarse perforations, on the ventral side the periphery has a bordering carina with radial markings; aperture a narrow slit at the base of the chamber partially covered with a valvular projection.

Diameter 0.50–0.85 mm.

*Distribution*.—Bagg records this species from *Albatross* station H4694 in 865 fathoms, off the Hawaiian Islands, as rare. The only material I have had was from *Albatross* station H4882 off Blake Reef, in Colnett or Vincennes Strait off southern Japan.

**DISCORBIS GLOBULARIS** (d'Orbigny).

Plate 9, fig. 4.

*Rosalina globularis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 271, pl. 13, figs. 1–4; Modèles, No. 69.

*Discorbina globularis* CARPENTER, PARKER, and JONES, Intro. Foramin., 1862, p. 204, pl. 3, fig. 1.—DAWSON, Can. Nat., ser. 2, vol. 7, 1874, p. 253, fig. c.—MOEBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 96, pl. 9, fig. 18.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 643, pl. 86, figs. 8, 13.—H. B. BRADY, PARKER, and JONES, Trans Zool. Soc. London, vol. 12, 1888, p. 226, pl. 46, fig. 6.—TERRIGI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 115, pl. 6, fig. 20.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, pl. 15, figs. 7–9.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 94, pl. 15, fig. 793.—CHAPMAN, Journ. Roy. Micr. Soc., 1896, p. 590, pl. 13, fig. 11.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 120, pl. 1, fig. 22.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 327, pl. 72, fig. 2.—WRIGHT, Geol. Mag., dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 21.—CHAPMAN, Geol. Mag., dec. 4, vol. 7, 1900, pl. 14, fig. 8.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 698.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 68.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 134.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 11, pl. 3, figs. 3–8, pl. 4, figs. 1, 2; vol. 54, No. 16, 1910, p. 25.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, Oct. 1910, p. 419, pl. 55, figs. 14a, b.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 81, pl. 24, fig. 15.

*Discorbina turbo*, var. *vesicularis*, subvar. *globularis* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 386, pl. 14, figs. 22, 23.

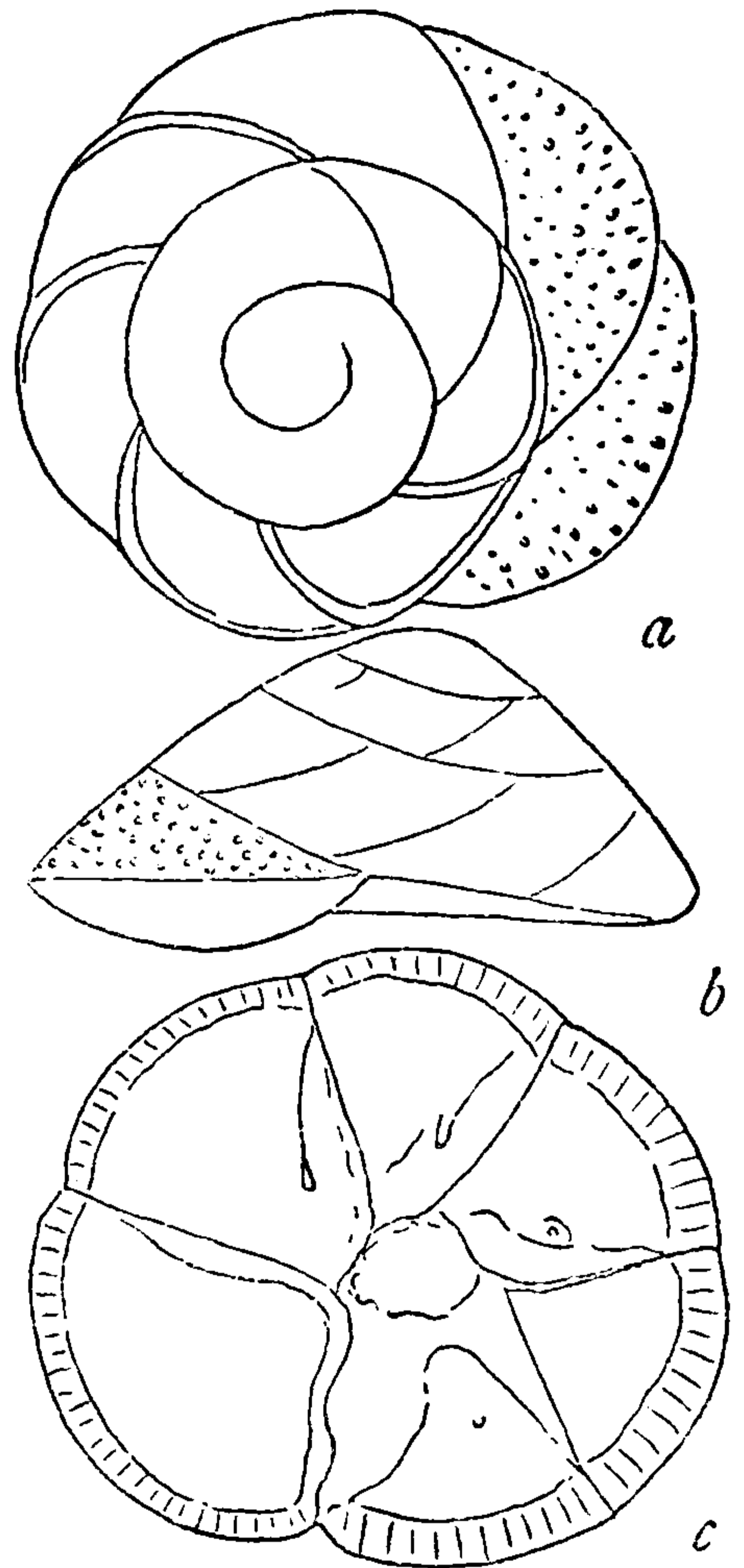
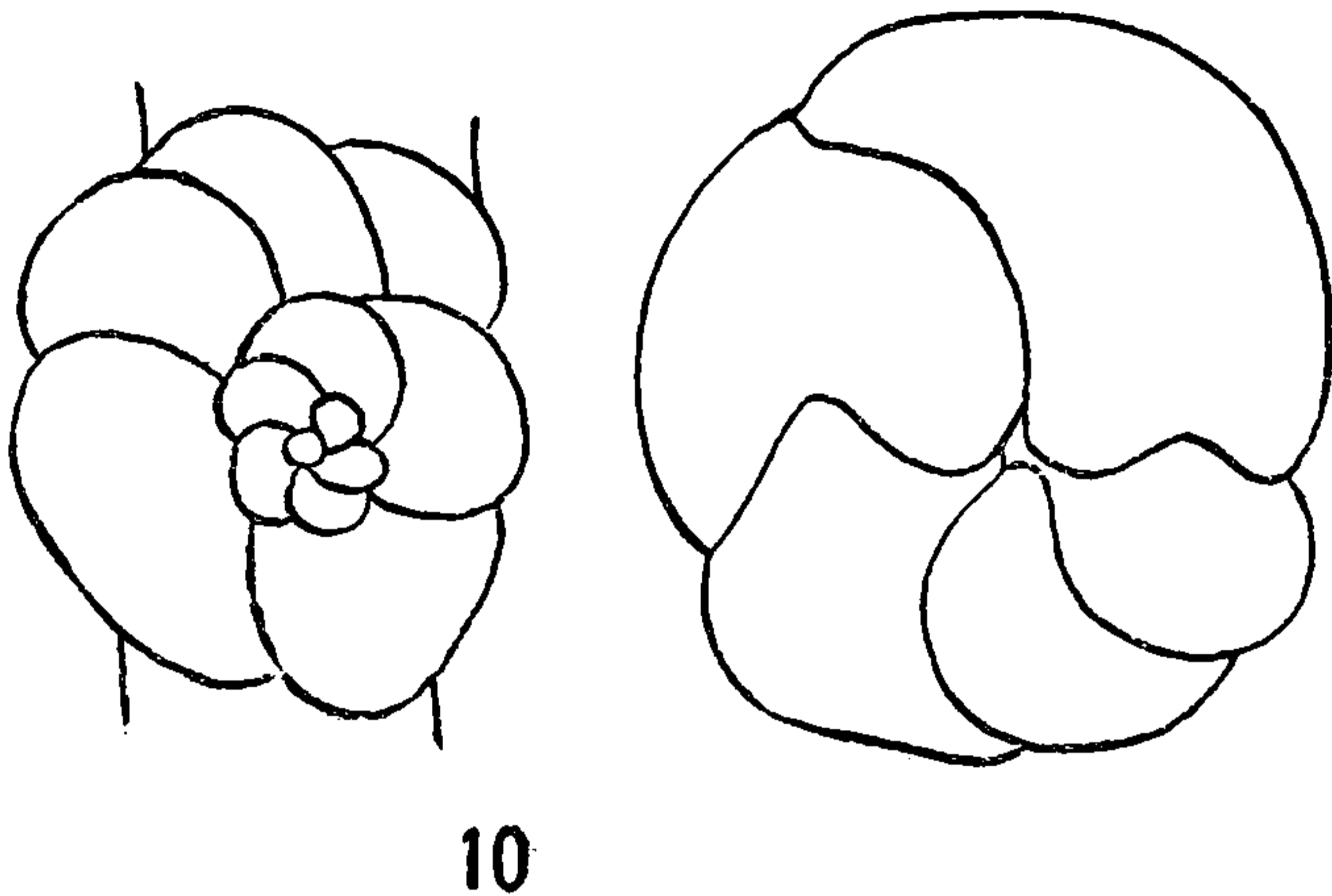


FIG. 9.—DISCORBIS TURBO (D'ORBIGNY).  
× 60. a, DORSAL VIEW; b, SIDE VIEW;  
c, VENTRAL VIEW. (ADAPTED FROM  
BRADY.)



*Description*.—Test plano-convex, the dorsal side convexly rounded the ventral side flattened or slightly concave; peripheral margin rounded, keeled; chambers few in each whorl, usually about five in



10

11

FIGS. 10, 11.—DISCORBIS GLOBULARIS (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S ORIGINAL FIGURES.) 10. DORSAL VIEW. 11. VENTRAL VIEW.

the last-formed whorl; sutures slightly depressed dorsally and limbate with clear shell material as is also the margin except in the last few chambers, finely perforated and hyaline; ventral side with the sutures much depressed, the chambers smooth, the last-formed chamber occupying nearly half the surface, periphery carinate with radiating lines; aper-

ture fairly large, irregular, elongate, at the inner margin of the chamber.

Diameter 0.55–0.85 mm.

*Distribution*.—The only published record for this species is that of Rhumbler, who found it in shallow water material from Laysan Island. I have had the species from *Albatross* station D4875 in 59 fathoms, eastern channel of Korea Strait.

**DISCORBIS GLOBULARIS (d'Orbigny), var. BRADYI, new variety.**

Plate 8, fig. 1.

*Discorbina globularis* H. B. BRADY (not *D. globularis* d'Orbigny), Rep. Voy. Challenger, Zoology, vol. 9, 1884, pl. 86, fig. 8.

*Description*.—Chambers of earlier portion of the test on the dorsal side clearly outlined with limbate sutures; ventral side with a peripheral border with a milled edge, the chambers more or less swollen, the proximal portion separated from the rest, and the last-formed chamber with a peculiar bifid indentation extending inward from the peripheral region; color brownish.

Diameter about 0.80 mm.

*Distribution*.—Type-specimen of variety, from *Albatross* station D4893 in 106 fathoms, bottom temperature 55.9° F. off Japan (U. S. N. M. No. 9027).

This variety seems distinct from the typical *D. globularis* d'Orbigny. The limbations and peculiar conditions of the ventral side seem sufficient to distinguish it.



## DISCORBIS OBTUSA (d'Orbigny).

*Rosalina obtusa* D'ORBIGNY, For. Foss. Bass. Tert. Vienne, 1846, p. 179, pl. 11, figs. 4-6.

*Discorbina obtusa* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 644, pl. 91, fig. 9a-c.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 156.

*Discorbina (Rosalina) obtusa* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 391, pl. 15, figs. 67-69.

*Discorbina turbo*, var. *vesicularis*, subvar. *obtusa* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 386, pl. 14, figs. 18, 19.

*Description*.—Test biconvex, dorsal side slightly more so than the ventral side; peripheral margin rounded; chambers comparatively few, about five in the last-formed whorl; sutures curved, depressed; surface with numerous perforations; aperture an elongate narrow slit extending from the umbilicus nearly to the periphery on the ventral border of the chamber.

Diameter up to 1 mm.

*Distribution*.—Bagg records this species from *Albatross* station H4568 in 1,274 fathoms off the Hawaiian Islands. This seems to be the only North Pacific record for this species.

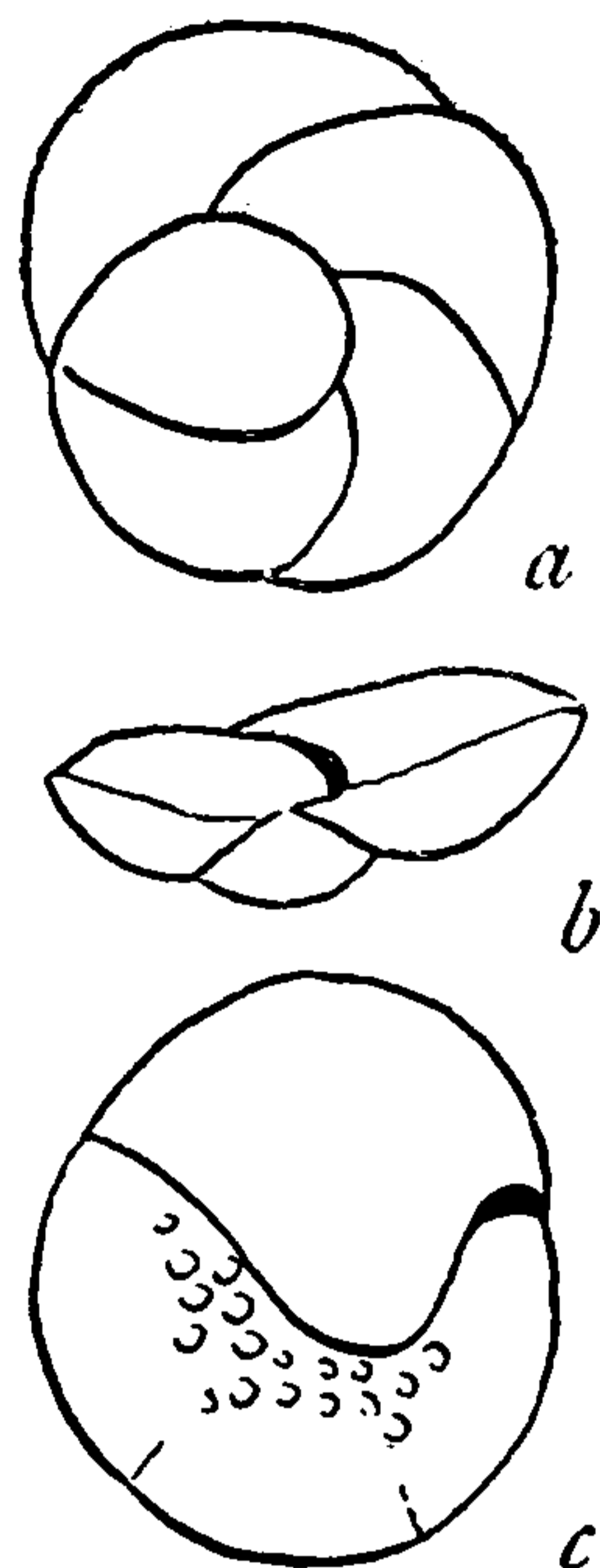


FIG. 12.—DISCORBIS OBTUSA (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S ORIGINAL FIGURE.) a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW.

## DISCORBIS ROSACEA (d'Orbigny).

*Rotalia rosacea* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 273, No. 15; Modèles, No. 39.

*Asterigerina rosacea* D'ORBIGNY, Prod. Pal., vol. 3, 1852, p. 158, No. 2952.

*Discorbina rosacea* H. B. BRADY, Trans. Linn. Soc., vol. 24, 1864, p. 473, No. 69.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 25, pl. 2, fig. 71.—PARKER, JONES, and H. B. BRADY, Pal. Soc. Monograph 19, 1866, pl. 4, fig. 17.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 105, pl. 8, figs. 251-257.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 644, pl. 87, figs. 1, 4.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 385, pl. 15, figs. 39-41.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 94, pl. 15, fig. 792.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 327, pl. 72, fig. 3.—MILLET, Journ. Roy. Micr. Soc., 1903, p. 698.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 135.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 30.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 12, pl. 4, figs. 3-5; vol. 54, No. 16, 1910, p. 25.

*Discorbina turbo*, var. *rosacea* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 385, pl. 16, fig. 28a, b.

*Description*.—Test plano-convex, dorsal side conically convex, ventral side flat or somewhat concave; peripheral margin acute, carinate; chambers numerous, six or seven in the last-formed whorl,



rather broad; sutures slightly curved, either depressed or limbate with clear shell material as is also the peripheral margin; dorsally rather coarsely perforate, and also ventrally, umbilical region either wide open or closed by a stellate callouslike thickening of clear material; aperture a rather large opening, elongate, often with a valvular umbilical end.

Diameter 0.40–1 mm.

*Distribution*.—Flint records *D. rosacea* from a single station in the North Pacific, "coast of Alaska, station unknown." I have had a few typical specimens from *Albatross* station D2932 in 20 fathoms.

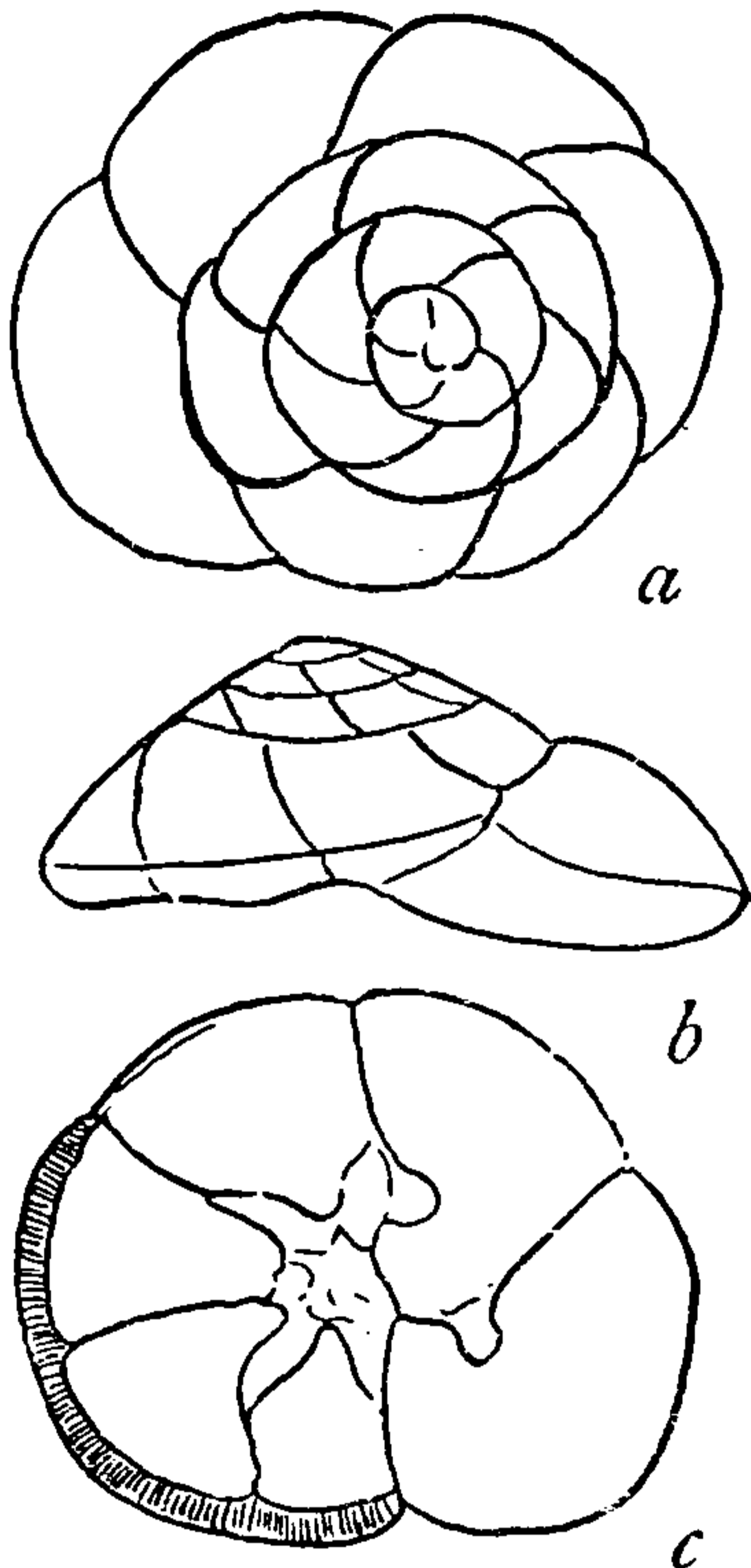


FIG. 13.—DISCORBIS ROSACEA (D'ORBIGNY).  $\times 100$ . a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW. (ADAPTED FROM BRADY.)

DISCORBIS VILARDEBOANA (d'Orbigny).

Plate 9, fig. 2.

*Rosalina vilardeboana* D'ORBIGNY, Voy. Amér. Mérid., 1839, "Foraminifères," p. 44, pl. 6, figs. 13–15.

*Discorbina vilardeboana* PARKER and JONES, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 115.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 645, pl. 86, figs. 9, 12; pl. 88, fig. 2.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 387, pl. 15, figs. 13–15.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol.

25, No. 9, 1894, p. 95, pl. 16, fig. 796.—CHAPMAN, Journ. Roy. Micr. Soc., 1898, p. 15, pl. 2, fig. 16.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 699.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 68.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 12; vol. 54, No. 16, 1910, p. 25.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 82, pl. 28, fig. 9a-c.

*Description*.—Test plano-convex, dorsal side rather evenly rounded, ventral side flattened or slightly concave; peripheral margin rounded; chambers five to seven in the last-formed whorl, the last-formed one, especially on the ventral side, often occupying nearly one-third of the ventral surface; sutures clear, slightly depressed, more so on the ventral side, which is often slightly umbilicate; wall finely punctate; aperture an arched slit running from the umbilicus nearly to the peripheral margin; early chambers often brownish in color.

Diameter 0.40–0.60 mm.

*Distribution*.—Brady records this species with *D. auracana* from the shores of Japan. Bagg had it from two *Albatross* stations in the vicinity of the Hawaiian Islands, H4440 in 1,259 fathoms and H4568 in 1,274 fathoms. Rhumbler records it from Laysan Island.

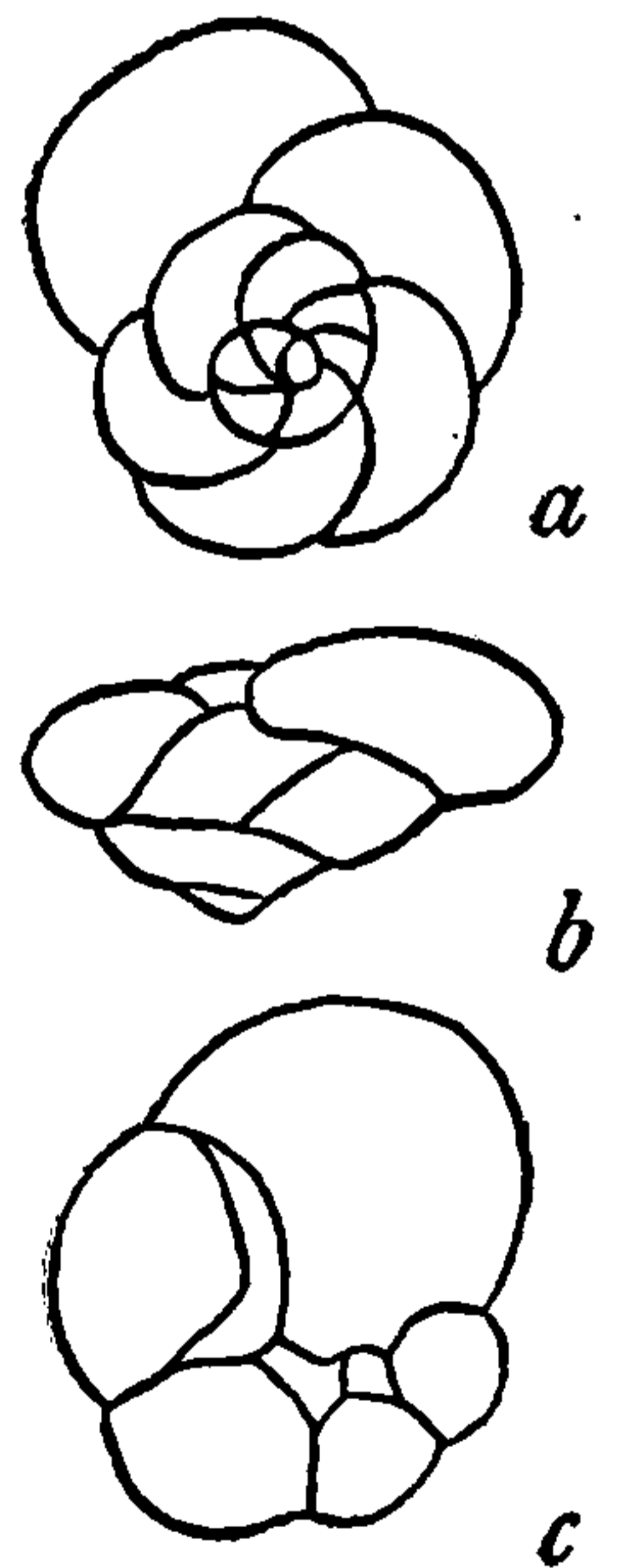


FIG. 14.—DISCORBIS VILARDEBOANA (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S FIGURE OF THE TYPE.) a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW.



I have had specimens from material labelled "off Alaska" and from *Albatross* station D4971 in 649 fathoms, bottom temperature 38.1° F. off Japan.

**DISCORBIS AURACANA** (d'Orbigny).

Plate 9, fig. 3.

*Rosalina auracana* D'ORBIGNY, Voy. Amér. Mérid., 1839, "Foraminifères," p. 44, pl. 6, figs. 16-18.

*Discorbina auracana* PARKER and JONES, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 115.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 645, pl. 86, figs. 10, 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 386, pl. 14, figs. 4-6.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 12; vol. 54, No. 16, 1910, p. 25.

*Description*.—Test small, plano-convex, dorsal side slightly convex, ventral side flat or slightly concave, peripheral margin rather acutely rounded; chambers six to nine in the last-formed whorl, sutures slightly depressed, often limbate with clear shell material, early chambers often carinate with similar material; wall finely punctate; aperture a narrow, curved slit at the margin of the ventral side of the chamber; color brownish, especially the earlier chambers.

Diameter 0.30-0.50 mm.

*Distribution*.—Apparently the only North Pacific record for this species is that of Brady, who records it from the shores of Japan. I have not found well-characterized specimens.

**DISCORBIS ISABELLEANA** (d'Orbigny).

Plate 6, fig. 1.

*Rosalina isabelleana* D'ORBIGNY, Voy. Amér. Mérid., 1839, "Foraminifères," p. 43, pl. 6, figs. 10-12.

*Discorbina isabelleana* PARKER and JONES, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 115.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 646, pl. 88, figs. 1a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 386, pl. 15, figs. 36-38.

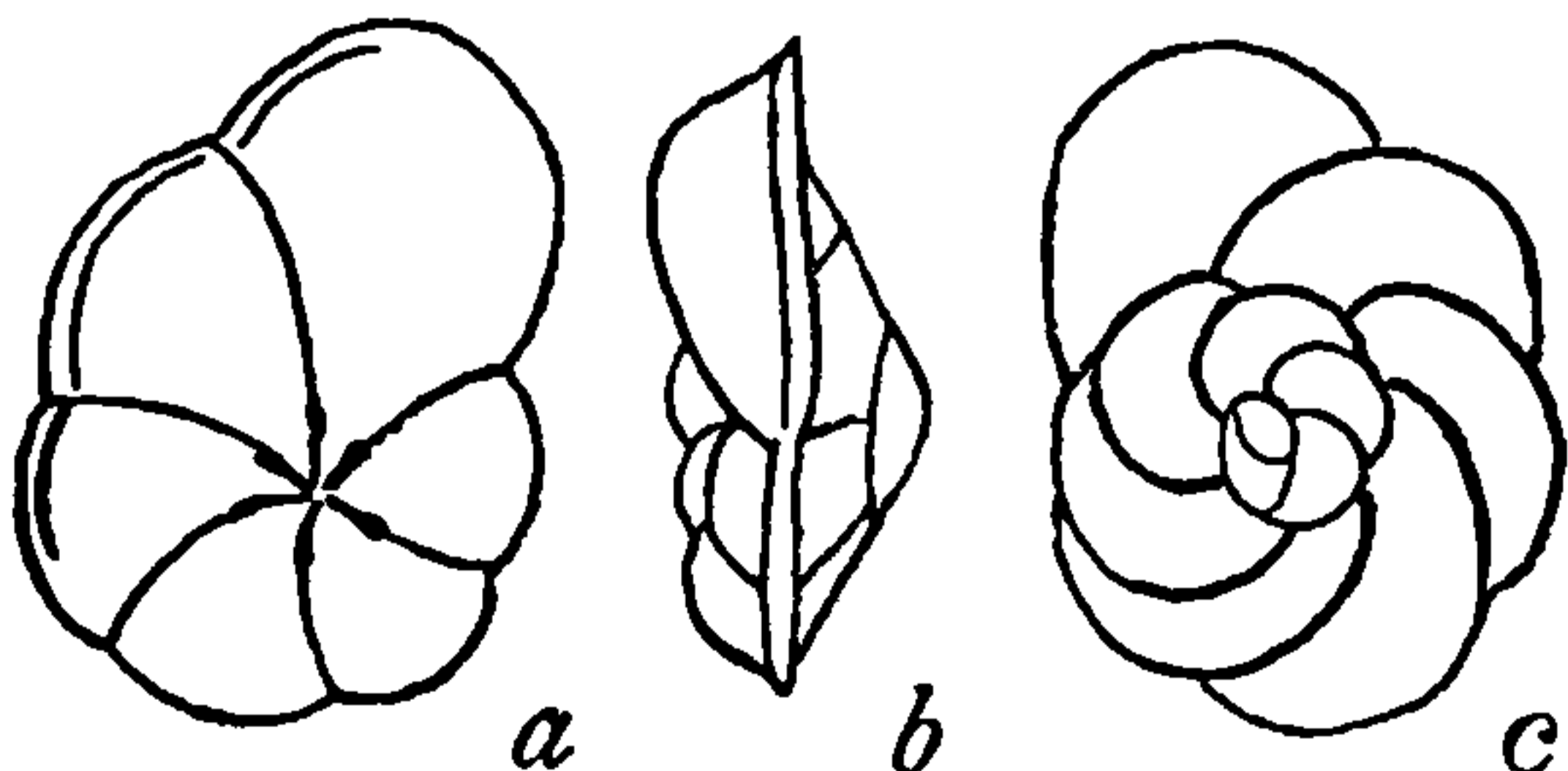


FIG. 16.—DISCORBIS ISABELLEANA (D'ORBIGNY).  
a. VENTRAL VIEW; b, SIDE VIEW; c, DORSAL VIEW. (AFTER D'ORBIGNY'S TYPE FIGURE.)

*Description*.—Test biconvex, smooth, five to six chambers in a coil, limbate dorsally, ventrally the sutures depressed; umbilical region filled and umbonate; peripheral margin acute; aperture a narrow slit extending backward from the margin toward the umbilical region.

Diameter 0.25-0.40 mm.

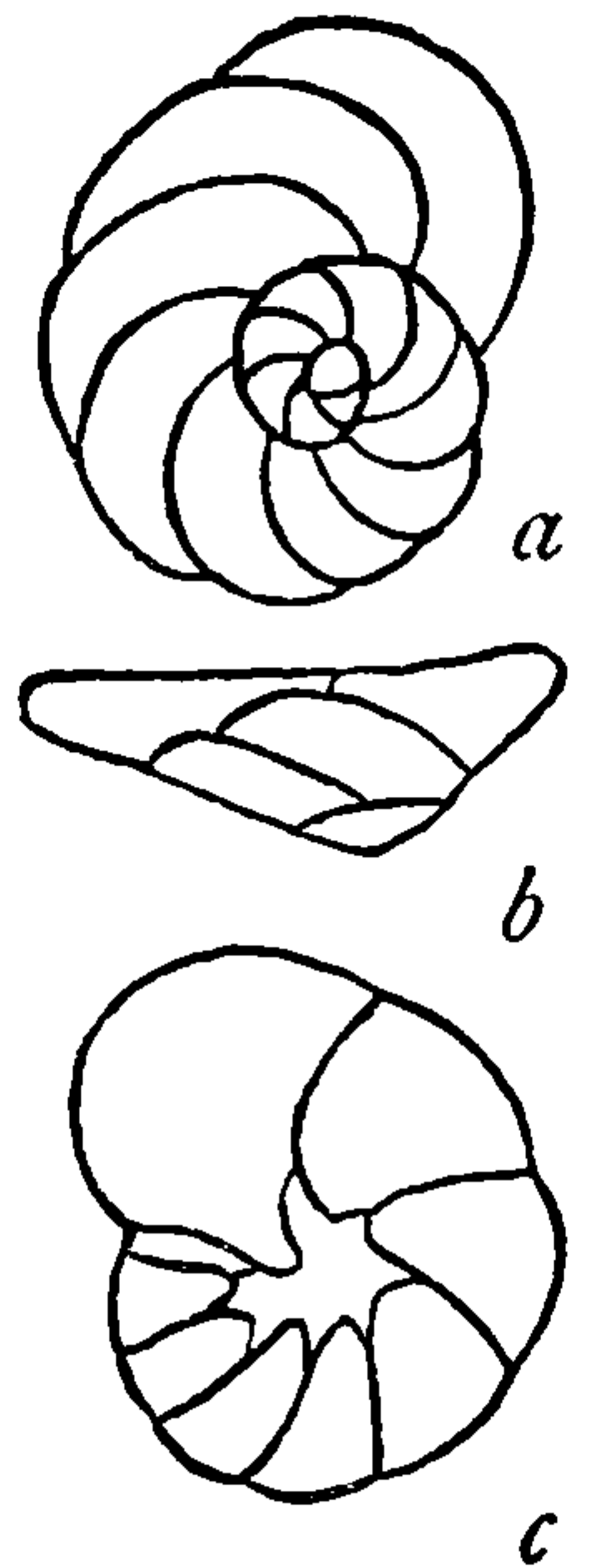


FIG. 15.—DISCORBIS AURACANA (D'ORBIGNY). (ADAPTED FROM TYPE FIGURE OF D'ORBIGNY.)  
a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW.



*Distribution*.—The only station from which I have had this species is *Nero* 991 in 1,143 fathoms off Guam.

**DISCORBIS CONCINNA (H. B. Brady).**

Plate 5, fig. 3.

*Discorbina concinna* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 646, pl. 90, figs. 7, 8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 388, pl. 15, figs. 22–24.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 699.

*Description*.—Test free, outline circular, superior face convex, inferior somewhat concave, peripheral edge angular, composed of some-

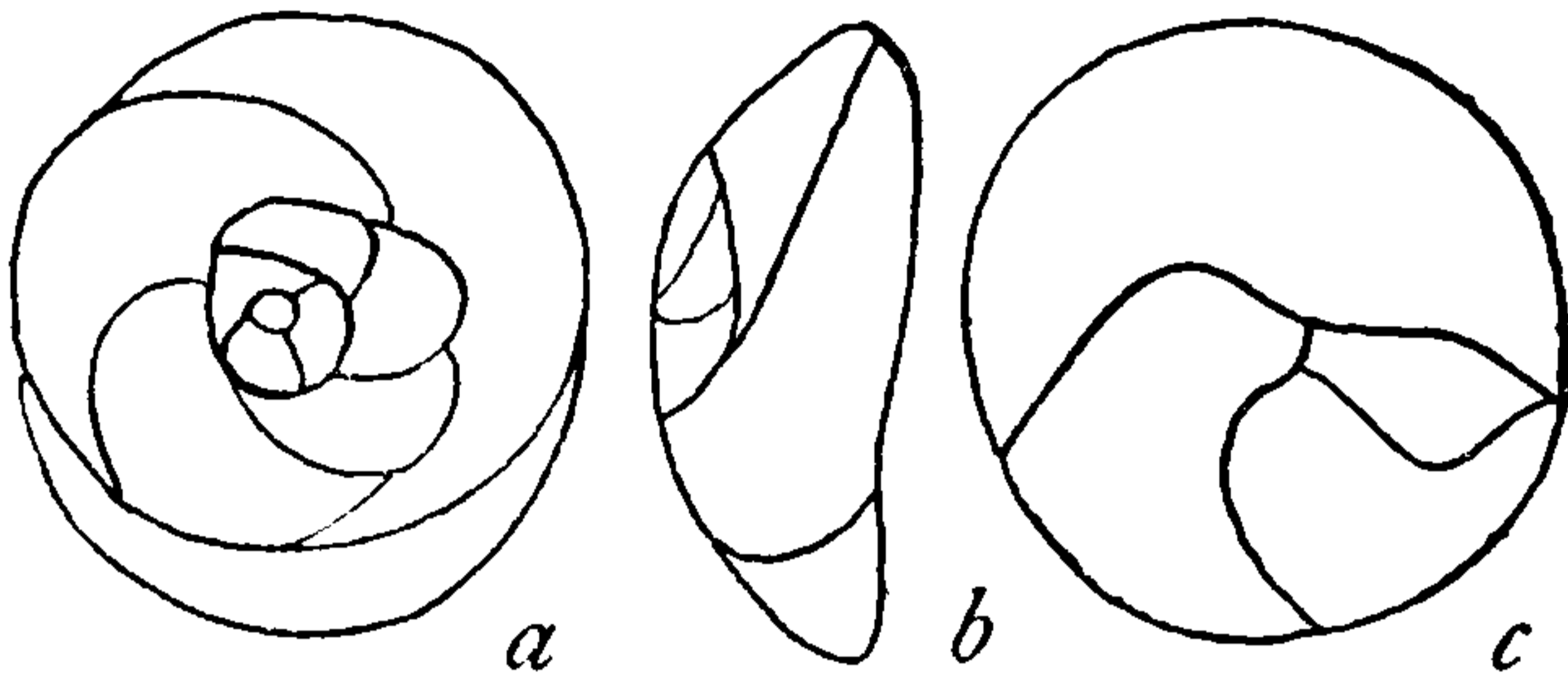


FIG. 17.—DISCORBIS CONCINNA (H. B. BRADY).  $\times 100$ .  
a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW.  
(AFTER BRADY'S FIGURE OF THE TYPE.)

what more than two convolutions, of which the latest consists of from three to four segments. Earlier segments in their superior aspect short and radial, later segments long and crescentiform; on the inferior side the final segment occupying nearly half the entire surface, umbilical flaps distinct but not greatly developed. Walls very thin and conspicuously perforated, sutures marked by fine lines, neither depressed nor limbate externally.

Diameter 1/100th inch (0.25 mm.).

*Distribution*.—The only North Pacific record for this species is that given by Brady in the *Challenger* report, off the Philippines, in 95 fathoms. From the other records given by Brady it seems as though this species should be found in shallow water off southern Japan, but it was not noted in the small amount of material available from this region in the present work. The figure and description are from Brady.

**DISCORBIS ORBICULARIS (Terquem).**

Plate 11, fig. 1.

*Rosalina orbicularis* TERQUEM, Anim. sur la Plage de Dunkerque, 1876, p. 75, pl. 9, figs. 4a, b.

*Discorbis orbicularis* BERTHELIN, Foram. de Borgneuf et Pornichet, 1878, p. 39, No. 63.

*Discorbina orbicularis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 647, pl. 88, figs. 4–8.—BALKWILL and MILLETT, Journ. Micr., vol. 3, 1884, p. 23, pl. 4, fig. 13.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28 (Sci.), 1885, p. 349, pl. 13, figs. 31–33.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 46, fig. 1.—TERRIGI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 115, pl. 17, figs. 2, 3.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 389, pl. 15, figs. 16–18, 76–78.—JONES, Pal. Soc., 1895, p. 295, pl. 7, fig. 31.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 699.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 13, pl. 4, fig. 7.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 282.



*Description.*—Test dorsally convex, concave below; chambers two to four in final whorl, elongate; peripheral border acute, keeled some-

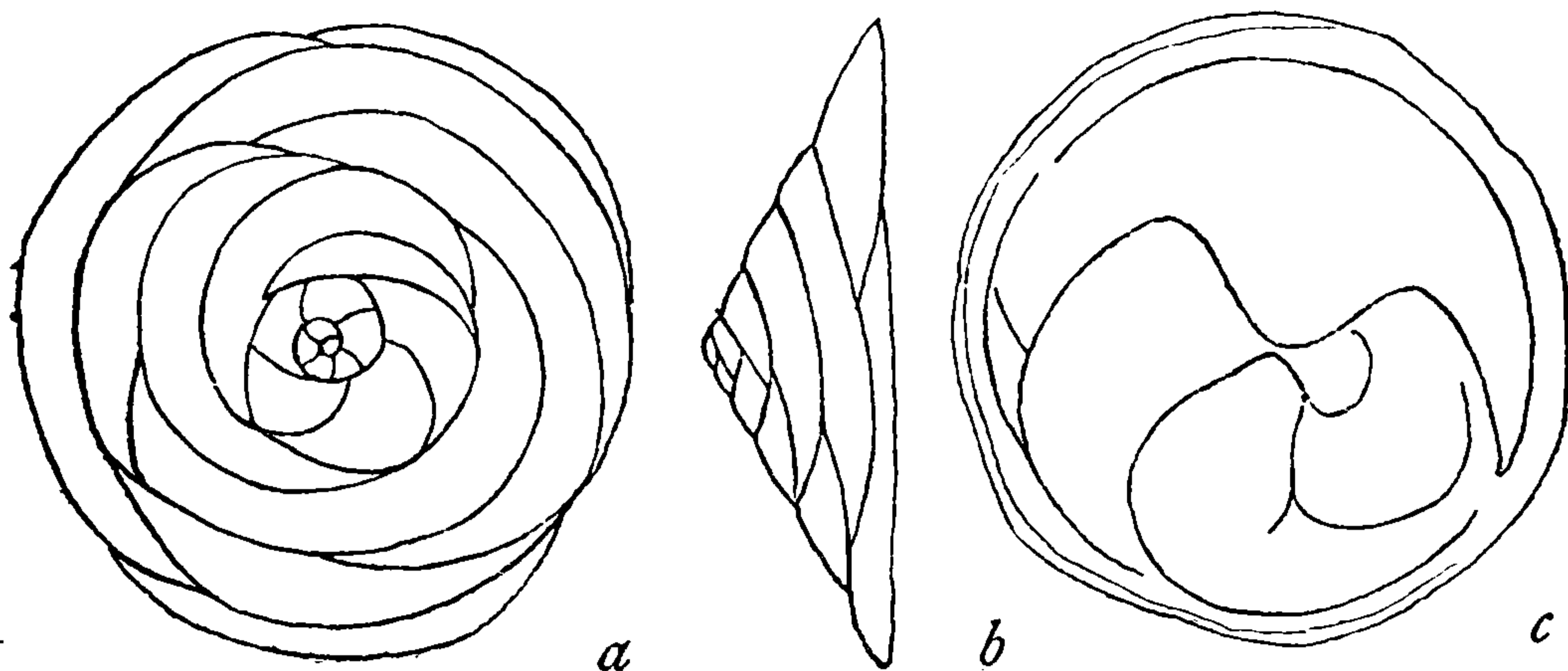


FIG. 18.—DISCORBIS ORBICULARIS (TERQUEM).  $\times 100$ . *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER BRADY.)

times; sutures either marked by fine lines or considerably limbate; ventral side with but three to five chambers visible; wall punctate.

Diameter, 0.50–0.84 mm.

*Distribution.*—I have had specimens of this species from off Hakodate, Japan, and from *Albatross* station D4875 in 59 fathoms, eastern channel of Korea Strait and from D4949 in 110 fathoms off Japan. This species had apparently not previously been recorded from the North Pacific.

**DISCORBIS PATELLIFORMIS (H. B. Brady).**

Plate 5, fig. 5.

*Discorbina patelliformis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 647, pl. 88, figs. 3*a*–*c*; pl. 89, figs. 1*a*–*c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 390, pl. 15, figs. 48–50.—MILLET, Journ. Roy. Micr. Soc., 1903, p. 700.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 68.

*Description.*—Test free; superior side conical, inferior flat, peripheral edge acute; in the adult state composed of fully three convolutions, of which the outermost has from five to seven segments; segments in their superior aspect long and narrow, the sutures and margin marked by broad lines of clear shell substance, but not limbate externally. Superior surface smooth; inferior ornamented either with faint riblets radiating from

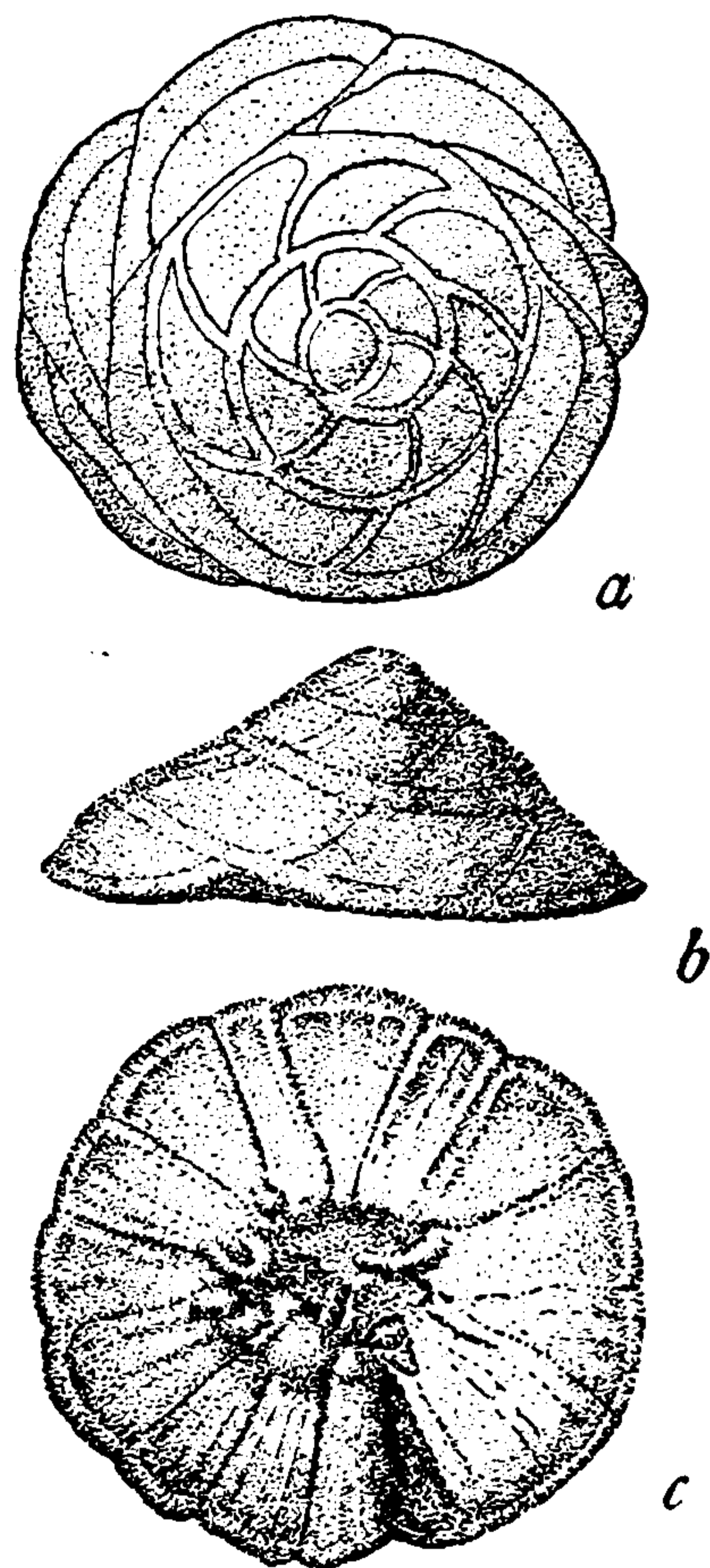


FIG. 19.—DISCORBIS PATELLIFORMIS (H. H. BRADY).  $\times 100$ . *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER BRADY.)



the umbilicus or with lines of closely set granules, sometimes with larger tubercles near the center.

Diameter about 1/70th inch (0.36 mm.).

*Distribution.*—This species was described by Brady from shallow water dredgings among the islands of the South Pacific. The only North Pacific record is that given by Rhumbler, who found it in material from shallow water of Laysan Island.

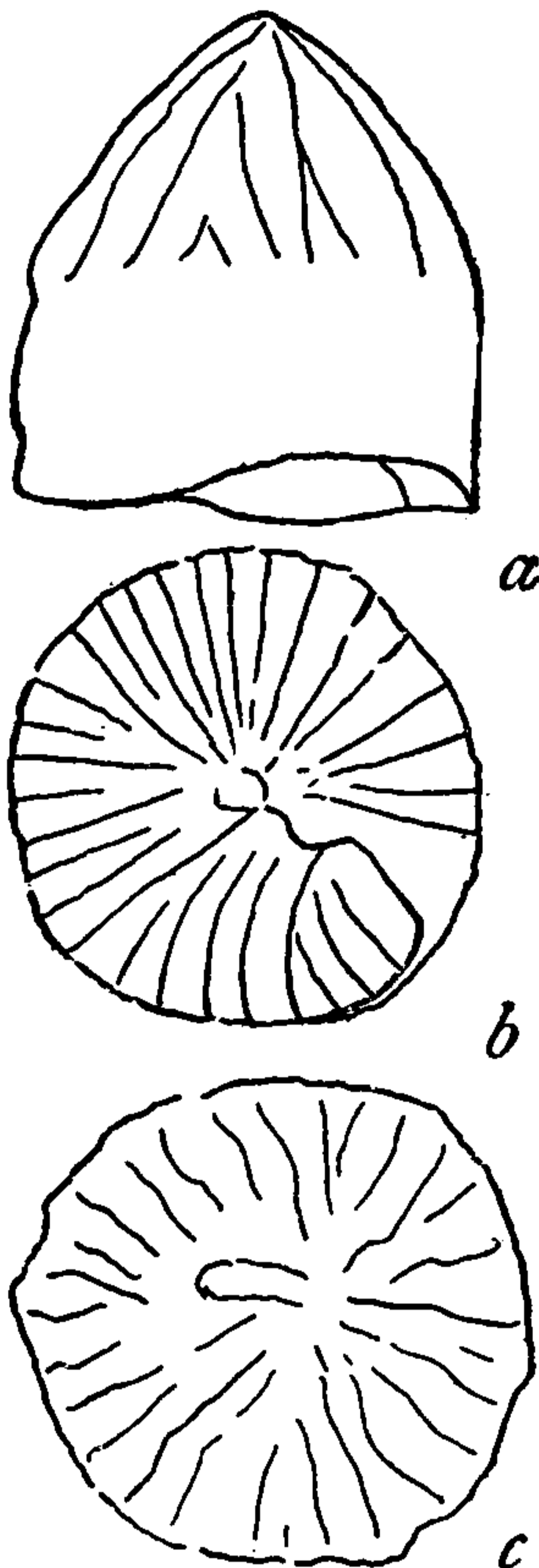


FIG. 20.—DISCORBIS TABERNACULARIS (H. B. BRADY).  $\times 100$ . *a*, SIDE VIEW; *b*, VENTRAL VIEW; *c*, DORSAL VIEW. (ADAPTED FROM BRADY.)

DISCORBIS TABERNACULARIS (H. B. Brady).

Plate 5, fig. 4.

*Discorbina tabernacularis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 65; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 648, pl. 89, figs. 5–7.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 390, pl. 15, figs. 58–60, 79.—MILLET, Journ. Roy. Micr. Soc., 1903, p. 700.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 69.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 15; vol. 54, No. 16, 1910, p. 25, pl. 3, fig. 12.

*Description.*—“Test free; contour that of a tall cone with somewhat convex sides and more or less concave base, often deeply sunken at the umbilicus. Segments long, oblique, arranged in about three convolutions; the septal lines of small or immature specimens limbate externally, those of larger shells concealed by the general thickening of the walls of the test. Inferior surface ornamented with radiating striae or crenulations; superior with striae or irregular costae radiating from the apex.

“Diameter 1/100th inch (0.25 mm.) or less.”

*Distribution.*—This is another species found in the shallow water about tropical islands. Brady records it from the coral reefs off Honolulu, Hawaii, at a depth of 40 fathoms. Rhumbler records it from shallow water material off Laysan Island. I have had no shallow water material which would be apt to contain this species and so have no records for it from this area.

DISCORBIS OPERCULARIS (d'Orbigny).

Plate 11, fig. 3.

*Rosalina opercularis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 271, No. 7; in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, “Foraminifères,” p. 101, pl. 3, figs. 24, 25; pl. 4, fig. 1.



*Discorbina opercularis* PARKER and JONES, Quart. Journ. Geol. Soc., vol. 28, 1872, p. 114.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 650, pl. 89, figs. 8, 9.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 389, pl. 15, figs. 73-75.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 701.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 69.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 135.

*Description*.—Test nearly circular, very much compressed, plano-convex, dorsal side slightly conical, ventral side nearly flat; peripheral margin rather sharp; chambers numerous, about seven to nine in the final whorl, very long and narrow, spirally arranged; sutures distinct but slightly if at all depressed; wall on dorsal side often showing rather prominent granulation; borders of the chambers often slightly carinate; ventral side, especially near the center, with very prominent tubercles somewhat radiately arranged and smaller toward the periphery; aperture a very narrow elongate slit at the ventral border of the chamber.

Diameter 0.40-0.50 mm.

*Distribution*.—The only published record for this species in the North Pacific is that of Rhumbler, who obtained two specimens in material from Chatham Island. I have had the species only from *Albatross* station D4807 in 44 fathoms off Japan.

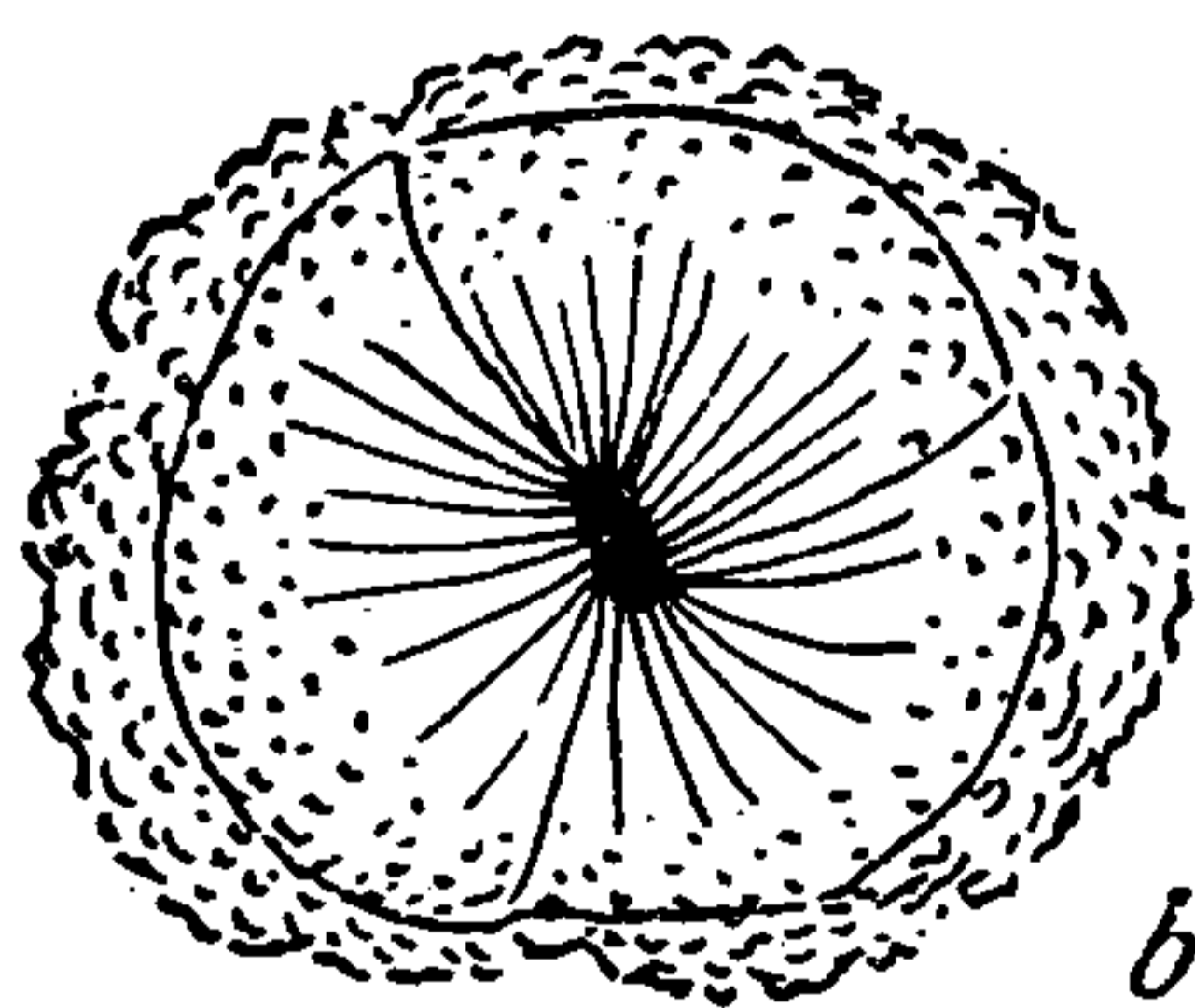
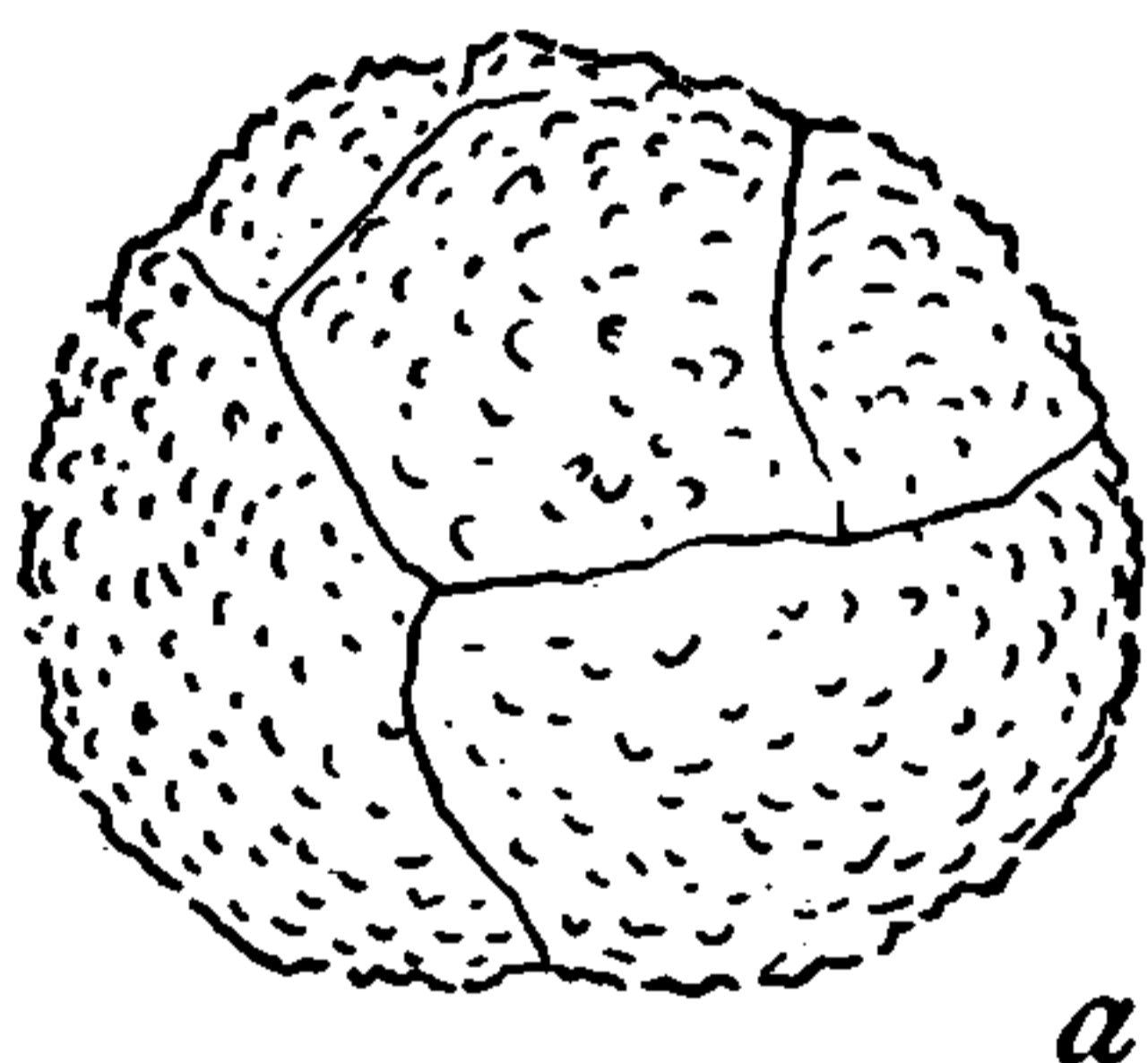


FIG. 22.—DISCORBIS PULVINATA (H. B. BRADY).  $\times$  100. (AFTER BRADY.) *a*, DORSAL VIEW; *b*, VENTRAL VIEW.

*Description*.—“Test broadly ovate or subglobular, somewhat depressed; composed of a few more or less inflated segments, about three in the final convolution; superior face rugose externally; inferior deeply excavated at the umbilicus and ornamented with radiating granulose lines.

“Diameter 1/90th inch (0.28 mm.)”

*Distribution*.—Rhumbler records a single specimen of this species from Laysan. This is the only North Pacific record for the species.

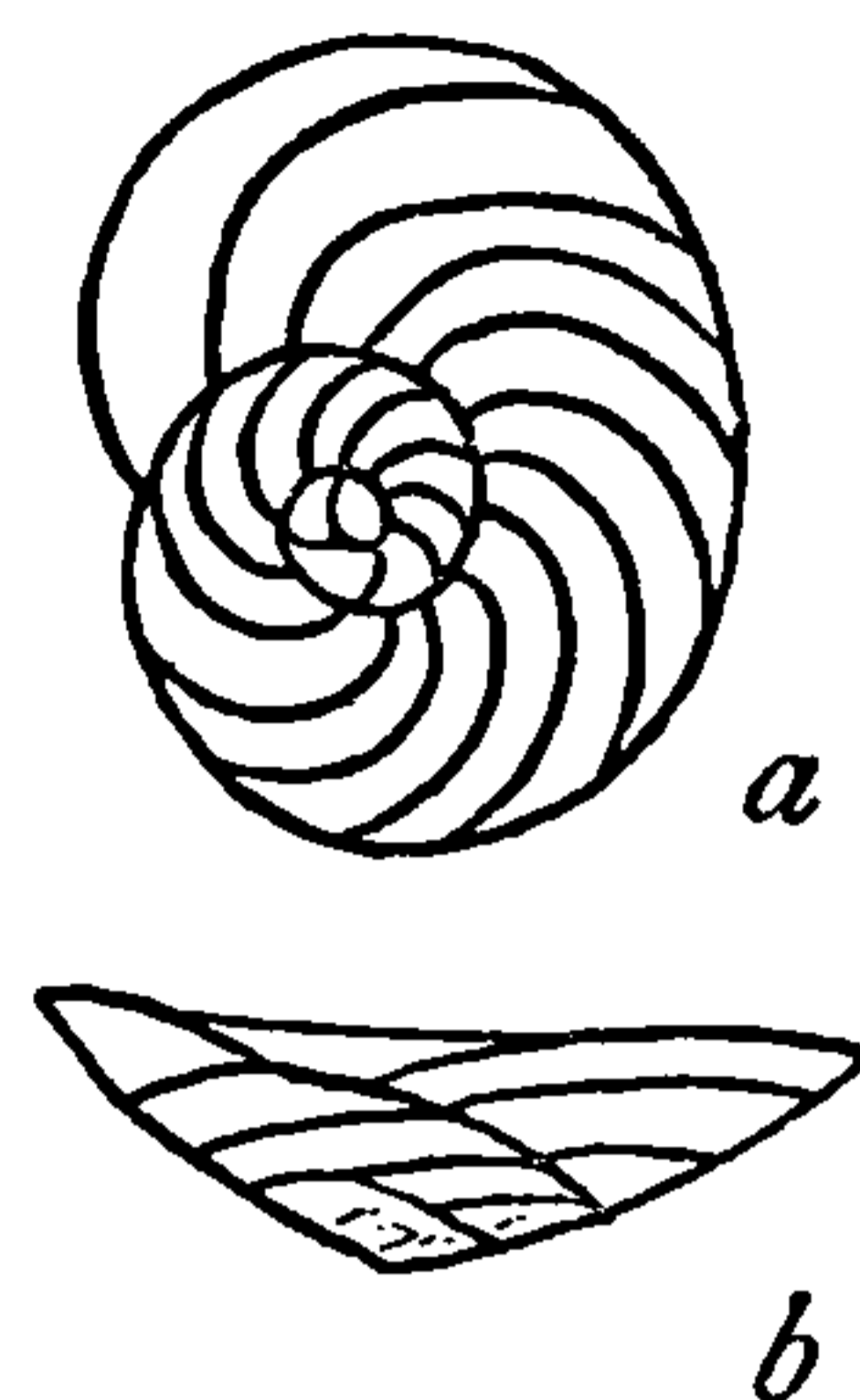


FIG. 21.—DISCORBIS OPERCULARIS (D'ORBIGNY).  $\times$  66. (ADAPTED FROM D'ORBIGNY'S ORIGINAL FIGURE.) *a*, DORSAL VIEW; *b*, SIDE VIEW.

#### DISCORBIS PULVINATA (H. B. Brady).

Plate 7, fig. 2.

*Discorbina pulvinata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 650, pl. 88, fig. 10*a*, *b*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 391, pl. 15, figs. 33-35.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 701.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 70.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 52, No. 13, 1908, p. 14, pl. 5, fig. 4.

*Description*.—“Test broadly ovate or subglobular, somewhat depressed; composed of a few more or less inflated segments, about three in the final convolution; superior face rugose externally; inferior deeply excavated at the umbilicus and ornamented with radiating granulose lines.



Brady described it from shallow water material of the South Sea Islands.

**DISCORBIS BERTHELOTI (d'Orbigny).**

Plate 7, fig. 3.

*Rosalina bertheloti* D'ORBIGNY, in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, "Foraminiferes," 1839, p. 135, pl. 1, figs. 28-30.

*Discorbina bertheloti* H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 469, pl. 48, figs. 10a, b; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 650, pl. 89, figs. 10-12.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 46, figs. 7, 8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 387, pl. 15, figs. 10-12.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 327, pl. 72, fig. 4.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 702.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 70.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 135.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 26.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 80, pl. 28, figs. 10, 11a, b.

*Discorbina berthelotiana* MACDONALD, Ann. Mag. Nat. Hist., ser. 2, vol. 20, 1857, p. 193, pl. 6, fig. 25.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 107, pl. 8, figs. 266-268; vol. 25, No. 9, 1894, p. 93, pl. 15, fig. 790; Bull. Mus. Comp. Zool., vol. 29, 1896, p. 69.

*Discorbina turbo*, var. *parisiensis*, subvar. *berthelotiana* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 387, pl. 16, figs. 26, 27.

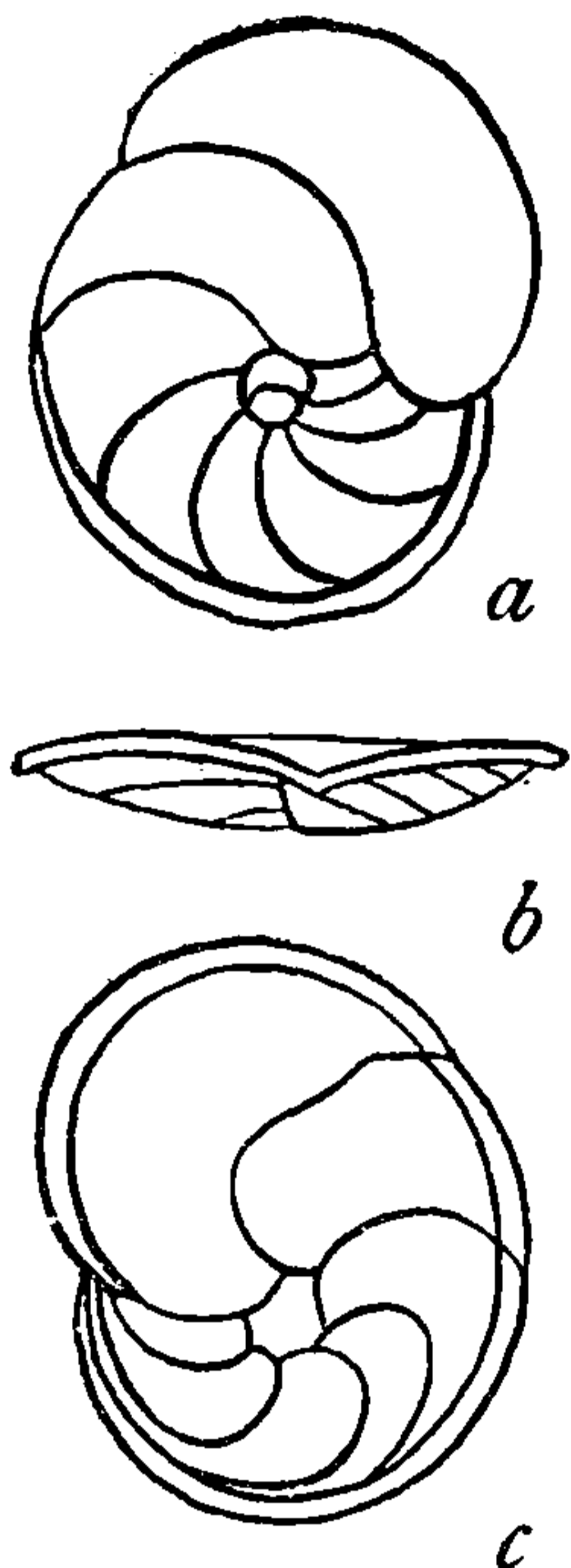


FIG. 23.—DISCORBIS BERTHELOTI (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S FIGURE OF THE TYPE. a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW.

*Description.*—Test oval, plano-convex, much compressed; peripheral margin acute, sometimes slightly carinated; dorsal surface nearly flat, ventral side somewhat convex; chambers five to seven in the final

whorl, often slightly carinate at the border; sutures slightly depressed, distinct; wall smooth, punctate; aperture a narrow slit at the inner margin of the chamber on the ventral side.

Diameter 0.40-0.80 mm.

*Distribution.*—Brady mentions this species as found in the North Pacific but does not give stations. Rhumbler records single specimens both from Chatham Island and Laysan. I have had a few specimens from *Nero* station 990 off Guam in 859 fathoms. It has also occurred at two *Albatross* stations off Japan, D4875 in 59 fathoms and D4946 in 39 fathoms, bottom temperature 68.7° F.

**DISCORBIS RARESCENS (H. B. Brady).**

Plate 7, fig. 4.

*Discorbina rarescens* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 651, pl. 90, figs. 2, 3, and 4.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 388, pl. 15, figs. 45-47.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 136.



*Description.*—“Test free or adherent, plano-convex; peripheral edge extended so as to form a well-defined keel, often of considerable width; the five segments of the outermost whorl alone visible on the

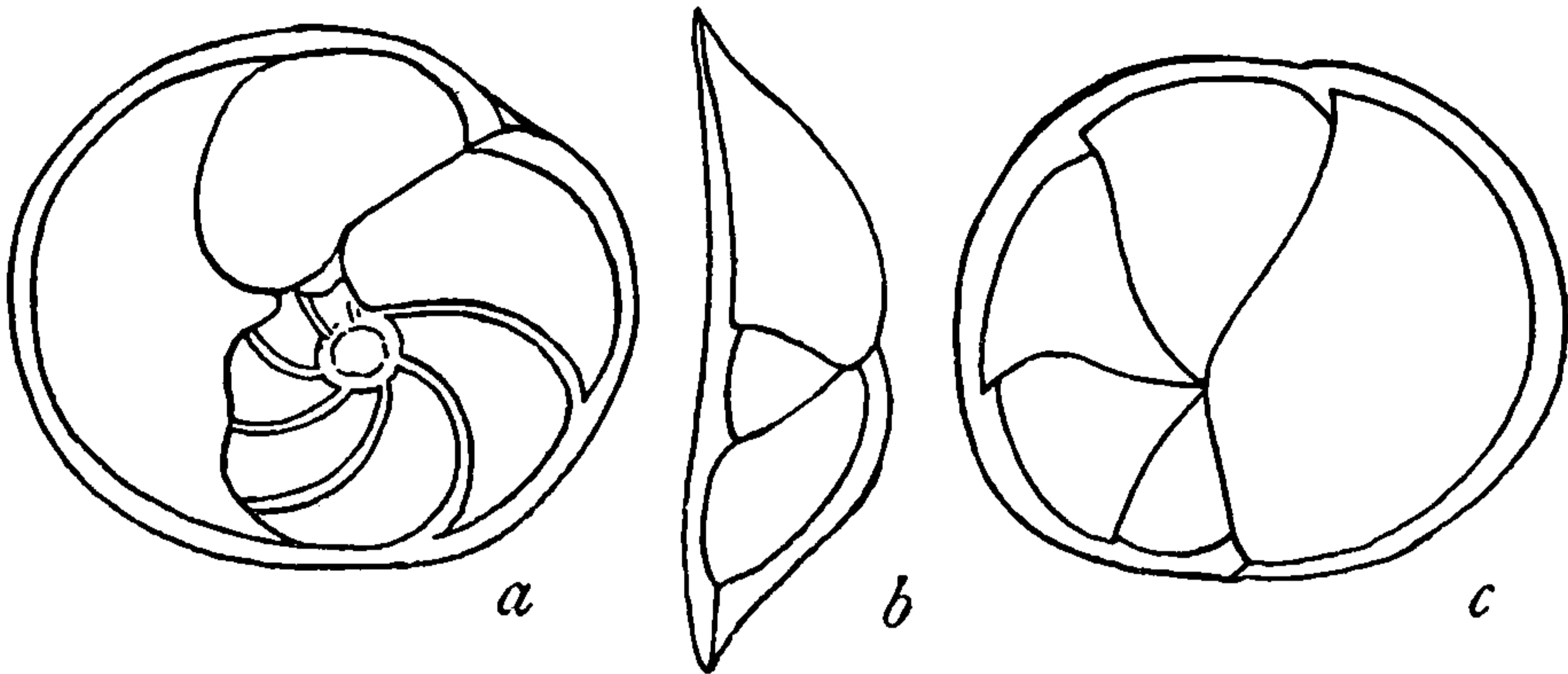


FIG. 24.—DISCORBIS RARESCENS (H. B. BRADY).  $\times 75$ . (AFTER BRADY.) *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW.

convex face, the last chamber being relatively large, and the sutures even and marked only by fine lines; spiral face somewhat depressed at the umbilicus, the valvular lobes of later segments tolerably distinct.

“Diameter  $1/40$ th inch (0.63 mm.)”

*Distribution.*—The only record for this species in the North Pacific seems to be that of Brady, who records it from the *Challenger* stations off the Philippines in 95 fathoms. The figure and description are from Brady.

DISCORBIS ALLOMORPHINOIDES (Reuss).

Plate 9, fig. 1.

*Valvulina allomorphinoides* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 223, pl. 11, fig. 6.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 43, pl. 2, figs. 4, 5.

*Discorbina allomorphinoides* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 654, pl. 91, figs. 5, 8.—CHAPMAN, Proc. California Acad. Sci., ser. 3, Geol., vol. 1, 1900, p. 253, pl. 30, fig. 8.—MILLET, Journ. Roy. Micr. Soc., 1903, p. 703.

*Pulvinulina allomorphinoides* FORNAsINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 8, 1900, p. 394, fig. 44.

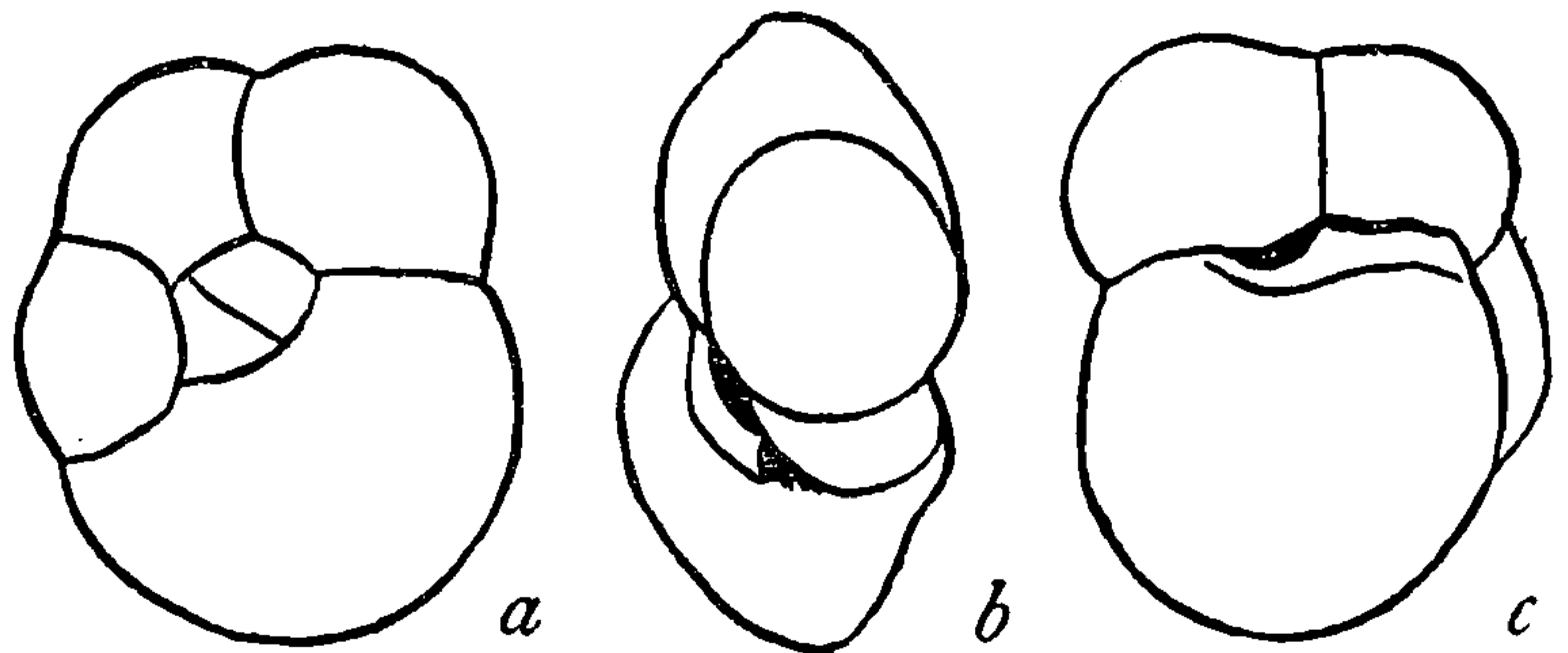


FIG. 25.—DISCORBIS ALLOMORPHINOIDES (REUSS). (ADAPTED FROM REUSS'S FIGURES OF THE TYPE.) *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW.

*Description.*—Test oval, biconvex, ventral side more strongly so; composed of comparatively few chambers, about four in the last formed whorl; peripheral margin broadly rounded; chambers broad;

sutures depressed; wall smooth and finely punctate; aperture an oval opening at the umbilical border of the chamber.

Diameter 0.40–0.85 mm.

*Distribution*.—No other records exist for the North Pacific for this species other than that of Brady, who obtained it from *Challenger* material off the Philippines in 95 fathoms.

**DISCORBIS VENTRICOSA (H. B. Brady).**

Plate 13, fig. 1.

*Discorbina ventricosa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, 654, pl. 91, figs. 7a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 392, pl. 15, figs. 54–57.

*Description*.—“Test free, oblong, rounded, more or less depressed; composed of less than two complete convolutions, the outer whorl

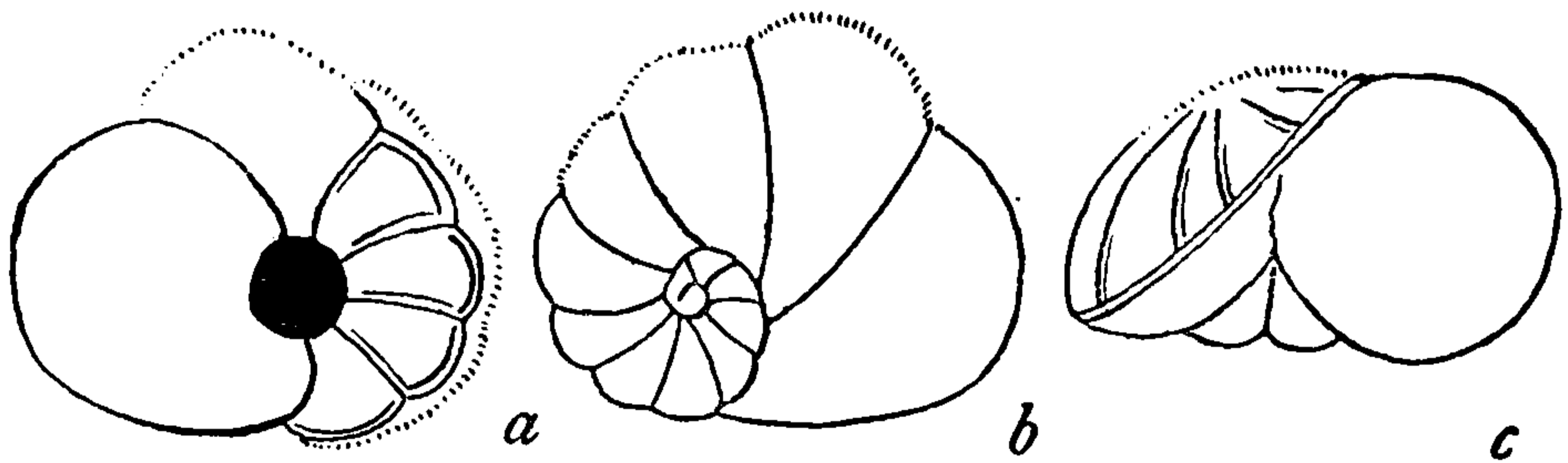


FIG. 26.—DISCORBIS VENTRICOSA (H. B. BRADY).  $\times 50$ . a, VENTRAL VIEW; b, DORSAL VIEW; c, SIDE VIEW. (AFTER TYPE FIGURES BY BRADY.)

consisting of six or seven segments, the successive segments increasing rapidly in length; septal faces ventricose, especially that of the final chamber; sutures excavated. Superior face hispid externally, inferior smooth; umbilicus deeply sunk, valvular flaps but little developed.

“Diameter about 1/50th inch (0.5 mm.)”

*Distribution*.—This species has not previously been recorded from the North Pacific. I have a fine typical specimen from *Albatross* station D4922 in 60 fathoms, off Blake Reef, in Colnett or Vincennes Strait, off southern Japan. This extends considerably the previously known range in this region.

This seems to be a very typical species as far as can be judged by the specimen noted above, which is so near like the figure given by Brady that it might almost have been the original of that figure.

**DISCORBIS IRREGULARIS (Rhumbler).**

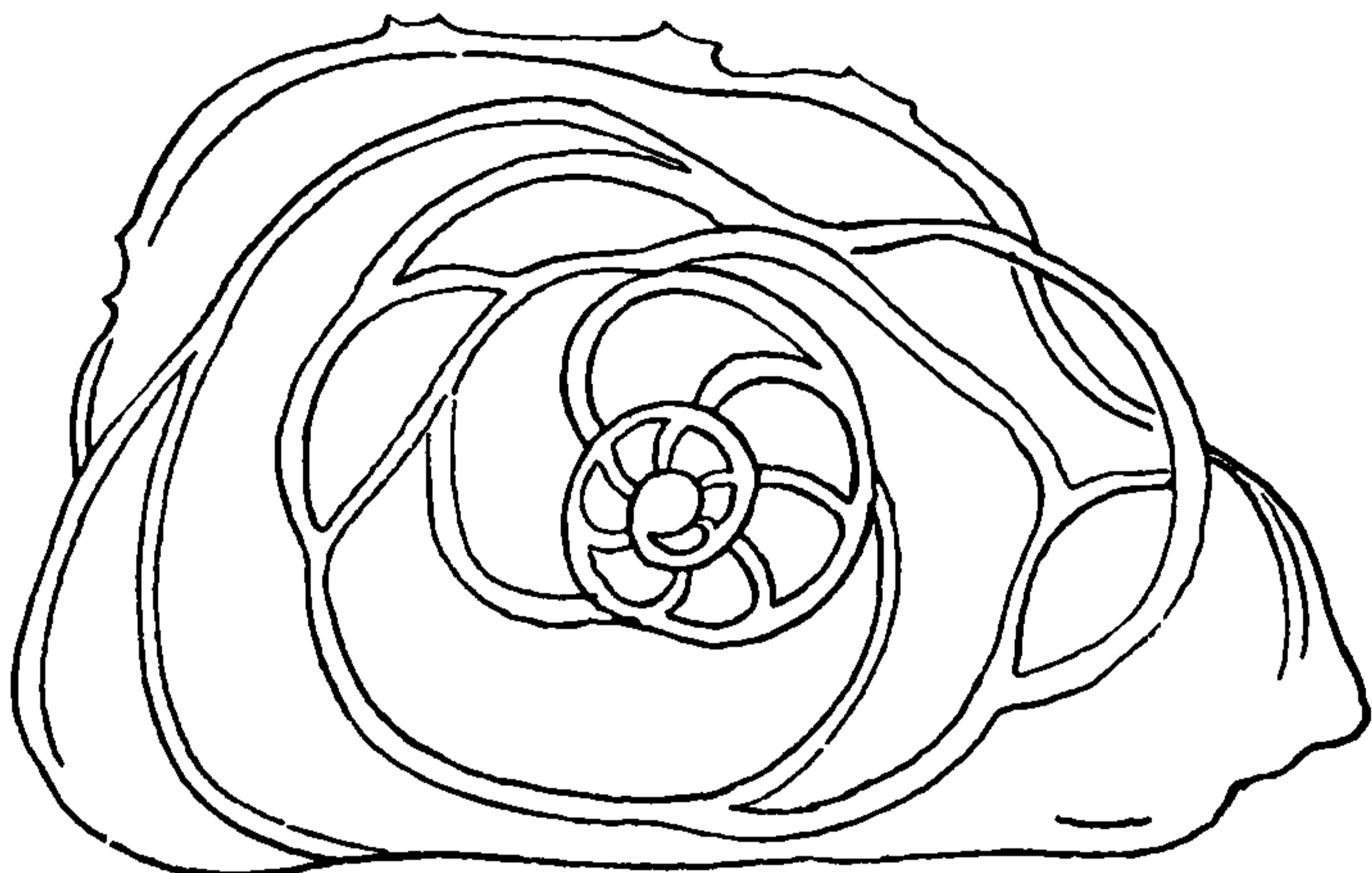
Plate 13, figs. 2, 3.

*Discorbina irregularis* RHUMBLER, Zool. Jahrb. Abt. Syst., vol. 24, 1906, p. 70, pl. 5, figs. 57, 58.

*Description*.—Attached, lower side smooth, flattened, upper side rough, convex, consisting of several coils, the first coil or two regu-



larly spiral with regularly formed chambers, following chambers becoming highly irregular, added finally in concentric rings and losing all trace of a spiral arrangement; aperture of the early chambers typical, a slit between the ventral face of the chamber and the preceding one; in the irregular chambers several apertures on the periphery.



Diameter 0.38 to 0.52 mm.

FIG. 27.—DISCORBIS IRREGULARIS RHUMBLER.  $\times 132$ . (AFTER RHUMBLER'S TYPE FIGURE.)

*Distribution*.—Rhumblér described this species from Chatham Island. I have had no material that can be referred unquestionably to this species, which may be a local one.

**DISCORBIS SUBFILOSA, new species.**

Plate 6, fig. 2.

*Description*.—Test strongly biconvex, less so ventrally, and umbilicate; chambers few in the final coil, rounded; sutures slightly depressed, rather indistinct; wall ornamented by fine tubules extending through the much thickened wall below, with radiating lines from the umbilicus.

Diameter about 1 mm.

*Distribution*.—Type-specimen (Cat. No. 9028, U.S.N.M.) from —.

The surface appearance of this species is very peculiar, arising from the fine tubulation of the wall.

**DISCORBIS PULVINULINOIDES, new species.**

Plate 6, fig. 3.

*Description*.—Test biconvex, somewhat flattened above, ventrally rounded, umbilicate, carinate; chambers several, about seven in the last formed whorl; sutures slightly depressed above, more strongly so below; wall smooth above, ventrally with radiating lines extending in toward the umbilicus.

Diameter about 0.5 mm.

*Distribution*.—Type-specimen (Cat. No. 9029, U.S.N.M.) from Albatross station D4875, in 59 fathoms off Japan.

Dorsally, this species is very much like certain species of *Pulvinulina*, but the ventral view shows it to belong to *Discorbis*.



## Genus CYMBALOPORA Hagenow, 1850.

*Rotalia* (part) D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 272.

*Rosalina* (part) D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 100.

*Cymbalopora* HAGENOW (type, *C. poeyi* (d'Orbigny)) Bryozoen Maastrichter Kreide, 1850, p. 104.—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 635.

*Description*.—Test free; early chambers spirally arranged, later ones annular or irregular; umbilicate; wall finely perforate; chambers often not contiguous, but separated from one another by some distance along the periphery, marked on the ventral side by depressions radiating from the central umbilicus; in the various species the early chambers following the proloculum are usually brownish in color, this being wanting in the later adult chambers.

This genus, together with the following one, *Tretomphalus*, has been placed with the Globigerinidæ by some authors. In the general form of the test, especially in the latter genus, there is a striking resemblance, but it seems merely parallelism. The early chambers are decidedly like *Discorbina* in form, wall, aperture, and even in the peculiar brown coloring so characteristic of *Discorbina* and allied genera of the Rotaliidæ.

There seem to be enough differences in form and structure to keep separate the genus *Cymbalopora* from *Tretomphalus*, as has been done by Moebius.

## CYMBALOPORA POEYI (d'Orbigny).

Plate 10, fig. 1; plate 14, fig. 5.

*Rotalia squamosa* D'ORBIGNY (nomen nudum), Ann. Sci. Nat., vol. 7, 1826, p. 272, No. 8.

*Rosalina poeyi* D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 92, pl. 3, figs. 18-20.

*Cymbalopora poeyi* CARPENTER, PARKER, and JONES, Introd. Foramin., 1862, p. 215, pl. 13, figs. 10-12.—SCHWAGER, Boll. Com. Geol. Ital., vol. 8, 1877, p. 26, pl., fig. 56.—MOEBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 97, pl. 10, figs. 1-5.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, 1880, p. 202, pl. 9, fig. 4.—H. B. BRADY, Rep. Voy.

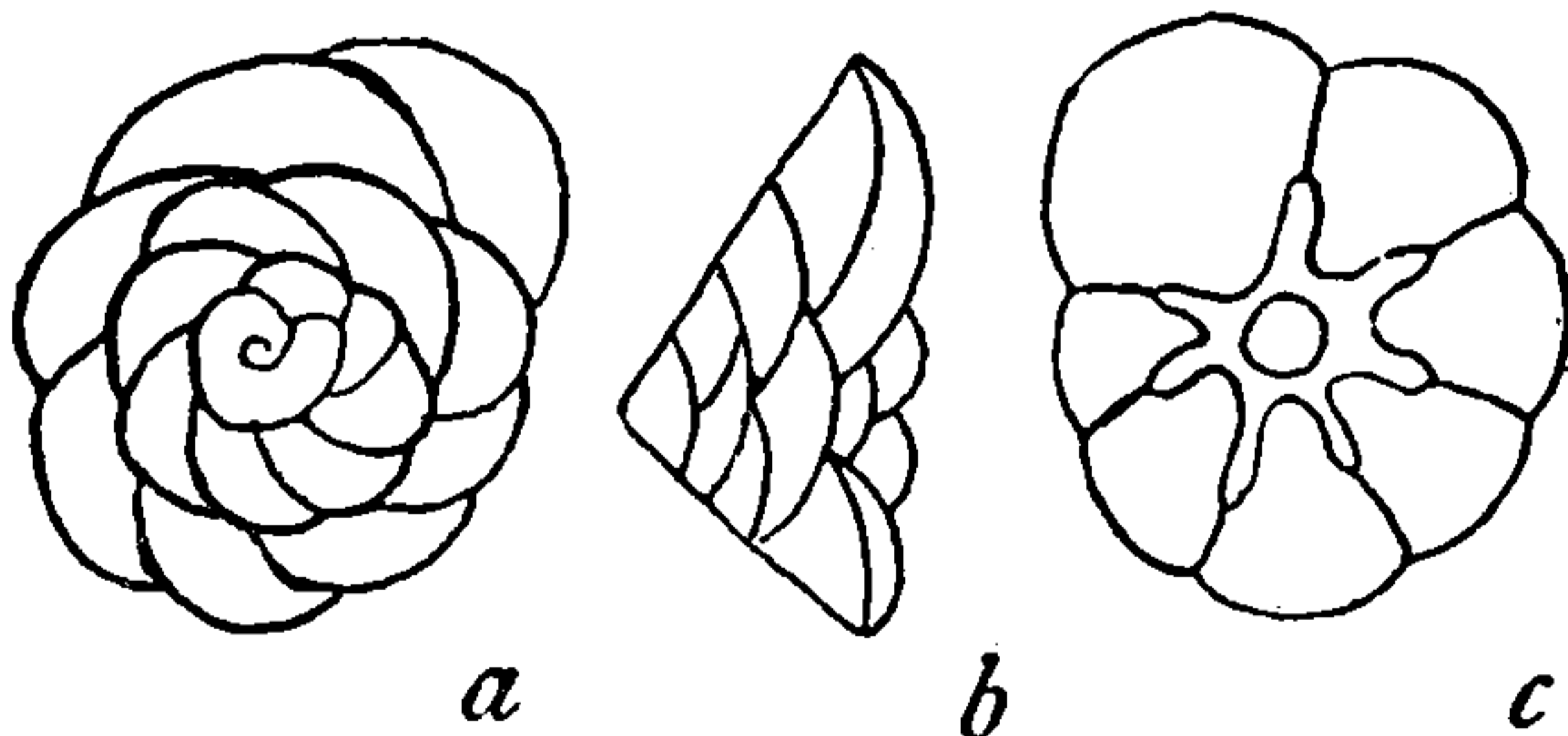


FIG. 28.—CYMBALOPORA POEYI (D'ORBIGNY). *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER D'ORBIGNY.)

*Challenger*, Zoology, vol. 9, 1884, p. 636, pl. 102, figs. 13a-c.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 226, pl. 46, fig. 12.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 381, pl. 18, figs. 51, 52.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 15, 1899, p. 280, pl. 6, fig. 3.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 326, pl. 72, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 696.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 71, pl. 5, fig. 59.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 156.



*Description.*—Test free, subconical, apex rounded, concave below, composed of numerous chambers, early ones in a spiral, later ones in concentric rings about the central umbilical cavity, those of one ring alternating with those of the preceding one, all with rather large perforations; aperture of each chamber on the inner side, opening into the central vestibule.

Diameter 0.50–0.85 millimeters.

*Distribution.*—Brady records the occurrence of this species as from the *Challenger* stations in the North Pacific, depths ranging from 7 to 75 fathoms. Rhumbler records it from Laysan Island. Bagg had the species from five stations in the vicinity of the Hawaiian Islands, depths ranging from 104 to 438 fathoms. I have had material of this species from two stations near the Hawaiian Islands, *Albatross* H3007 in 323 fathoms and *Nero* 2071 in 271 fathoms. Off Japan it occurred at *Albatross* station D4807 in 44 fathoms.

CYMBALOPORA POEYI (d'Orbigny), var. BRADYI, new variety.

Plate 10, fig. 2; plate 14, fig. 2.

*Cymbalopora poeyi* var. H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 637, pl. 102, fig. 14.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 24.

*Description.*—Variety differing from the typical form of the species in its much more compressed form and the much more open arrangement of the chambers on the ventral side.

*Distribution.*—This variety occurred off the Hawaiian Islands, at *Albatross* station H2923 in 392 fathoms.

*Type-specimen.*—Cat. No. 9030, U.S.N.M.

Brady does not definitely state at what localities he found this variety.

CYMBALOPORA TABELLÆFORMIS H. B. Brady.

*Cymbalopora tabellæformis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 637, pl. 102, figs. 15–18.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 382, pl. 18, figs. 54, 55.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 697.

*Description.*—“Test depressed, peripheral outline rounded or oval; superior face complanate, or nearly so, inferior convex, but with an irregular umbilical cavity or recess; peripheral edge obtuse or rounded. Composed of numerous segments, all of which are visible on the superior face; segments inflated inferiorly, sometimes arranged in more or less regular alternating annuli, but more frequently disposed without apparent order. Shell wall coarsely porous; aperture consisting of a number of large perforations along the lines of the inferior sutural depressions. Colour in fresh shell, brown near the center of the superior face, gradually lighter toward the circumference.



“Diameter 1/25th inch (1 mm.).”

*Distribution.*—Brady described this species from various stations, among which were two from the North Pacific off the Philippine Islands, 95 fathoms and the Hawaiian Islands, 40 fathoms. I have had frequent specimens from one *Nero* station, 2071 in 271 fathoms off the Hawaiian Islands.

Genus **TRETOMPHALUS** Moebius, 1880.

*Rosalina* (part) D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, “Foraminifères,” p. 104.

*Cymbalopora* (part) CARPENTER, Introd. Foram., 1862, p. 216.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 638.

*Tretomphalus* MOEBIUS (type, *T. bulloides* (d'Orbigny)), Foram. Mauritius, 1880, p. 98.

*Description.*—Test free, early stages *Discorbina*-like, in a low conical spire; last formed chamber globular, larger than the entire early growth; wall perforate, the last formed chambers with very large ones; aperture in adult chamber rounded with an entosolenian neck.

The genus *Tretomphalus* seems worthy of distinction from *Cymbalopora* as the development of the final chamber is very different. In its adult form it is found in a pelagic condition, especially in the vicinity of coral reefs. The development of the spherical form and the large pores fitting it for a pelagic life are very analogous to those seen in *Orbulina*, *Pulvinulina lateralis*, and other forms.

**TRETOMPHALUS BULLOIDES** (d'Orbigny).

Plate 14, figs. 3, 4.

*Rosalina bulloides* D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, “Foraminifères,” p. 104, pl. 3, figs. 2-5.

*Cymbalopora bulloides* CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 216.—H. B. BRADY, Quart. Journ. Micr. Soc., vol. 19, 1879, p. 80; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 638, pl. 102, figs. 7-12, text-figs. 20 a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 381, pl. 18, fig. 53.—EARLAND, Journ. Quekett Micr. Club, ser. 2, vol. 8, 1902, p. 309, pl. 16, figs 6-9.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 697, pl. 7, fig. 4.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 72.

*Tretomphalus bulloides* MOEBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 98, pl. 10, figs. 6-9.

*Discorbina bulloides* GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 106, pl. 8, figs. 262, 263.

*Description.*—Test free, subglobular; early chambers rotaliform, numerous, finely perforate, final chamber very large, inflated, making up the large portion of the test; aperture in the adult composed of numerous circular openings, usually with a single entosolenian neck from the largest.

Diameter 0.60-1.00 mm.



*Distribution.*—Brady notes the occurrence of this species as pelagic at Zamboanga, Philippine Islands, and at several points in the vicinity of the Hawaiian Islands.

He also notes its occurrence as a bottom form in 40 fathoms off the Honolulu coral reefs, Hawaiian Islands. Rhumbler records the species from Laysan Island.

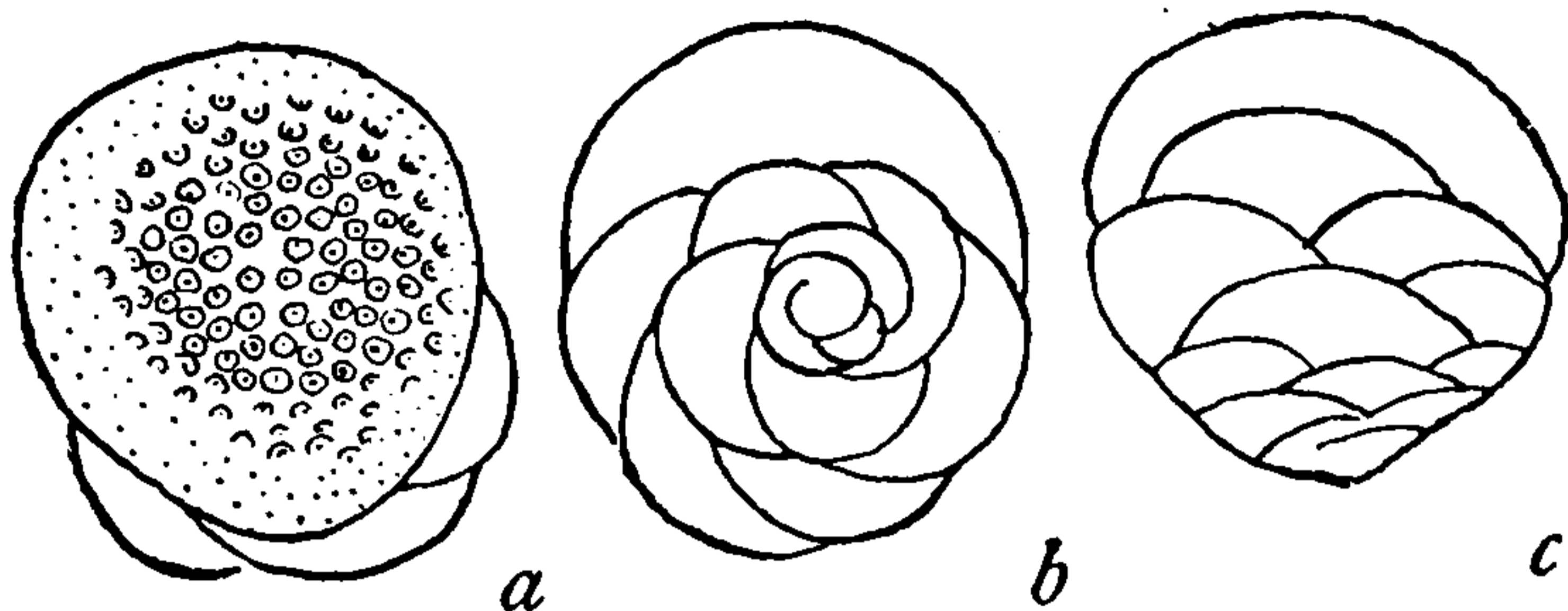


FIG. 29.—TRETOMPHALUS BULLOIDES (D'ORBIGNY). *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW. (AFTER D'ORBIGNY'S TYPE FIGURE.)

I have had material from but one station, *Nero* station 12, also near the Hawaiian Islands.

From Brady's notes in the *Challenger* Report apparently both megalospheric and microspheric forms were taken by the *Challenger*.

#### Genus PLANORBULINA d'Orbigny, 1826.

*Planorbulina* D'ORBIGNY (type, *P. mediterraneensis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 280.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 655.

*Description.*—Test typically adherent; early chambers in a close coil, later chambers surrounding the periphery in an annular arrangement; chambers in a single layer; test attached by its dorsal side, noninvolute; all chambers usually visible from either dorsal or ventral side; wall perforate, often rather coarsely so; aperture in the early chambers single on the inner border of the chamber in the coiled chambers, in those arranged in an annular manner usually two, one at either end of the chamber and near the preceding chambers adjacent and together forming a series of apertures about the periphery of the test; each newly added chamber connects with the two adjacent chambers at either side in the series next previously formed.

This genus in its restricted sense includes only those species which have the peculiar annular arrangement of the chambers in adult growth. The number of species is small, most common in the shallow waters of Temperate and Tropical seas.

#### PLANORBULINA LARVATA Parker and Jones.

Plate 8, fig. 2.

*Planorbulina vulgaris* D'ORBIGNY, var. *larvata* PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 294.

*Planorbulina larvata* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 379, pl. 19, fig. 3*a*, *b*.—CARTER, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 214, pl. 13, fig. 16.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 658, pl. 92, figs. 5, 6.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 381, pl. 14, fig. 31.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 490.

*Description.*—Test typically attached, discoidal; chambers of the central portion hidden by the development of thick granules or



tubercles on the test making the sutures indistinct; peripheral chambers arranged in annular rings, distinct; sutures somewhat depressed; apertures lipped.

Diameter up to 3 mm.

*Distribution.*—Brady records this species from the coral reefs of Honolulu, Hawaiian Islands, at a depth of 40 fathoms, and from the Chinese Sea. I have had specimens from Gaspar Straits, collected by the North Pacific Exploring Expedition, Capt. John Rodgers, and from *Albatross* station H4882 in 248 fathoms, bottom temperature 48.8° F. off Blake Reef, in Colnett or Vincennes Strait, off Southern Japan. This is essentially a species of warm shallow waters and it is interesting to find it in this region where so many species of this same general character have appeared.

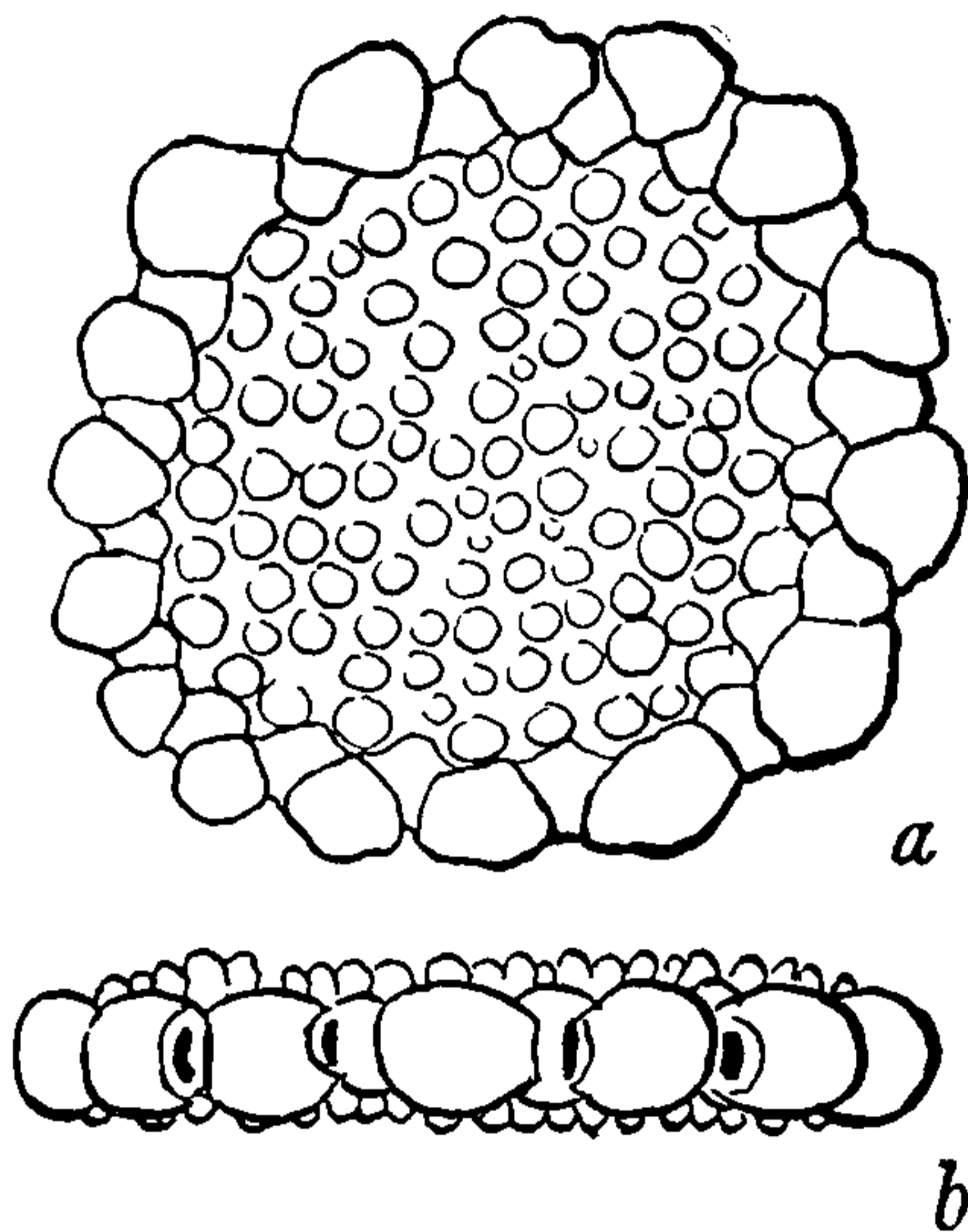


FIG. 30.—*PLANORBULINA LARVATA* PARKER AND JONES.  $\times 15$ . (ADAPTED FROM PARKER AND JONES'S ORIGINAL FIGURE.) *a*, DORSAL VIEW; *b*, SIDE VIEW.

***PLANORBULINA MEDITERRANENSIS* (d'Orbigny).**

Plate 12, fig. 1.

*Planorbulina mediterranensis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 280, pl. 14, figs. 4-6; Modèles, No. 79; Foram. Foss. Bass. Tert. Vienne, 1846, p. 166, pl. 9, figs. 15-17.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 31, pl. 2, fig. 74; ser. 4, vol. 8, 1871, p. 178, pl. 12, figs. 133, 134.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 206, pl. 9, fig. 8.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 656, pl. 92, figs. 1-3.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 45, fig. 18.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 380, pl. 14, figs. 24-26.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 91, pl. 15, fig. 786; Bull. Mus. Comp. Zool., vol. 29, 1896, p. 73.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 328, pl. 72, fig. 6.—SILVESTRI, Mem. Pont. Acad. Nuovi Lincei, vol. 15, 1899, p. 286, pl. 6, figs. 4-7.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 489.—RHUMBLER, Zool. Jahrb., Abt. Syst. vol. 24, 1906.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 137.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, 1909, p. 1, pl. 1, figs. 1-3; vol. 54, No. 16, 1910, p. 26.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 419.

*Planorbulina farcta* (Fichtel and Moll) var. *mediterranensis* PARKER and JONES. Philos. Trans., vol. 155, 1865, p. 383, pl. 16, fig. 21.

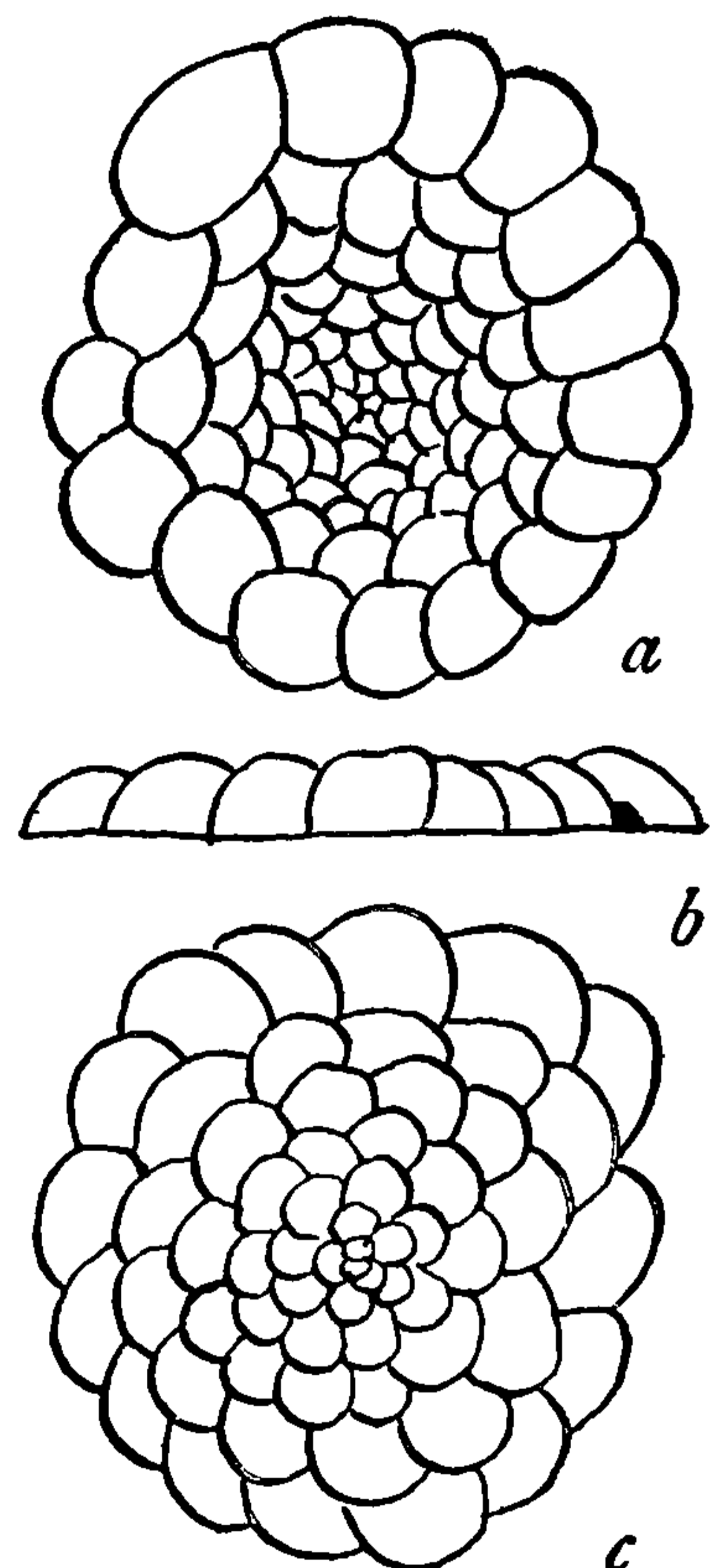


FIG. 31.—*PLANORBULINA MEDITERRANENSIS* (D'ORBIGNY) (ADAPTED FROM D'ORBIGNY'S FIGURE OF THE TYPE.) *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW.



*Description.*—Test adherent, flattened; early chambers distinctly spiral, later ones less so, often irregularly annular in their arrangement, more or less lobulated in the ventral face; periphery irregular, often angular; wall very conspicuously perforated; early chambers usually with a brownish color, later chambers grayish-white; sutures depressed, often clearly marked on the dorsal face by a distinct band of shell material; apertures at either side of the chamber in the adult, simple, each with a raised lip.

Diameter 1–2 mm. or more.

*Distribution.*—Rhumbler has recorded this species from shallow water material from both Chatham Island and Laysan. I have had it only from *Nero* station 990 in 859 fathoms, off Guam.

PLANORBULINA ACERVALIS H. B. Brady.

Plate 14, fig. 1.

*Planorbulina acervalis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 657, pl. 92, fig. 4.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 46, fig. 11.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 328, pl. 72, fig. 7.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 490.—RHUMBLER, Zool. Jahrb., Abteil Syst., vol. 24, 1906, p. 67.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, 1909, p. 2, pl. 1, fig. 4; vol. 54, No. 16, 1910, p. 27.

*Description.*—Test typically adherent, composed of numerous chambers, early ones spiral, later ones irregularly annular, those of the periphery lobulated, the newly added chambers extending outward a considerable distance beyond the preceding ones; ventral surface often covered by a mass of small acervuline chambers; wall conspicuously porous; apertures lipped.

Diameter up to 2.5 mm.

*Distribution.*—Rhumbler records two specimens of this species from Laysan Island. I have had it from *Nero* station 2071 in 271 fathoms off the Hawaiian Islands, *Nero* sta-

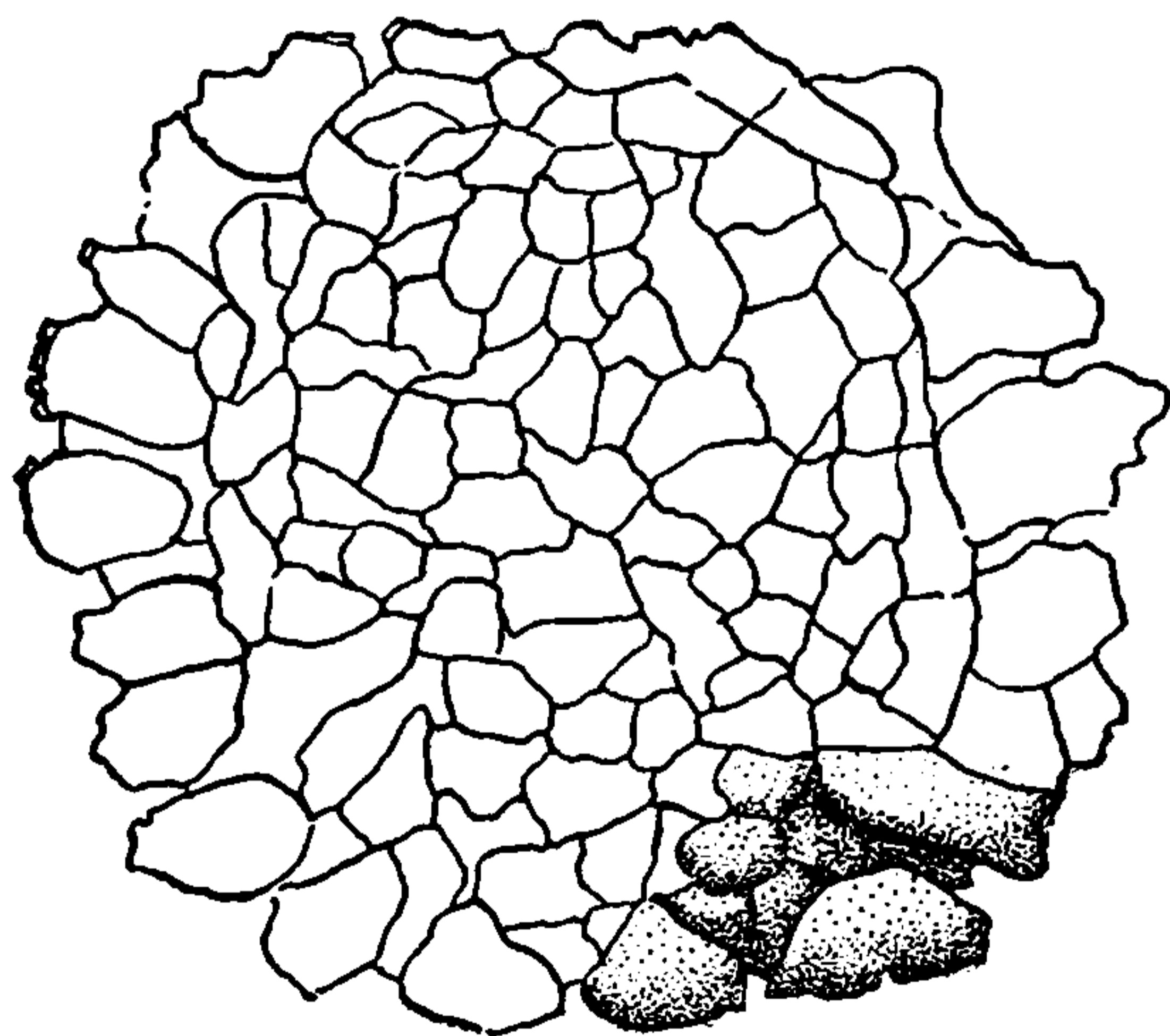


FIG. 32.—PLANORBULINA ACERVALIS H. B. BRADY.  
× 35. (ADAPTED FROM BRADY'S FIGURE OF THE TYPE.)

tion 1466 in 234 fathoms off Guam, and *Albatross* H4882 off Blake Reef in 248 fathoms, bottom temperature 48.8° F. in Colnett or Vincennes Strait, off southern Japan. These are the three areas from which most of the tropical species have occurred in the material I have examined. It is essentially a species of shallow, warm waters.



## Genus TRUNCATULINA d'Orbigny, 1826.

*Nautilus* (part) WALKER and BOYS, Test. Min., 1784, p. 20.—WALKER and JACOB, Adams Essays, Kanmacher's Ed., 1798, p. 642.

*Serpula* (part) MONTAGU, Test Brit., 1803, p. 515.

*Truncatulina* D'ORBIGNY, (type, *T. lobatula* Walker and Jacob) Ann. Sci. Nat., vol. 7, 1826, p. 279.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 658.

*Description*.—Test free or adherent, rotaliform, the ventral face usually the more convex but passing into species which are nearly biconvex; chambers usually visible from both sides, occasionally with limbate sutures; wall either smooth or with raised papillæ, occasionally with limbate margins, coarsely punctate; aperture usually a curved slit at the margin of the inner end of the chamber, often with a definite lip.

This genus includes a considerable variety of species and the extreme forms are somewhat dissimilar but as a whole they form a fairly unified genus. Certain groups have at times been segregated with other generic names but except for two species which are here placed under *Siphonina* it seems best to leave them under the genus *Truncatulina*.

## TRUNCATULINA REFULGENS (Montfort).

Plate 12, fig. 2.

"*Hammonia Balanus* seu *Balanoidea*," SOLDANI, Testaceographia, vol. 1, pt. 1, 1789, p. 58, pl. 46, figs. *nn*, *oo*.

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

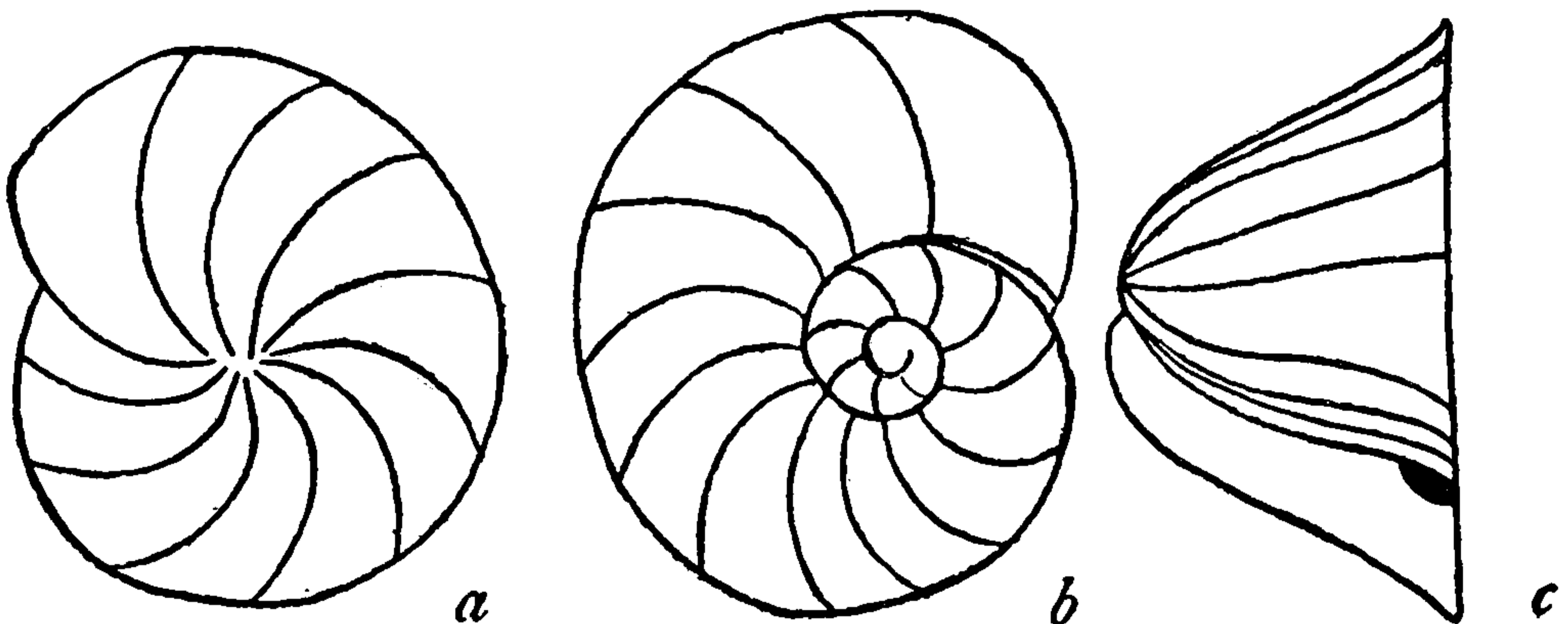


FIG. 33.—TRUNCATULINA REFULGENS (MONTFORT). (ADAPTED FROM D'ORBIGNY, 1826.) *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW.

*Truncatulina refulgens* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 279, pl. 13, fig. 8-11; Modèles, No. 77.—CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 201, fig. 32, *E*.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 31, pl. 2, fig. 76.—H. B. BRADY, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865-1867 (1867), p. 105, pl. 12, fig. 9*a-c*.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 176, pl. 12, fig. 139.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 197, pl. 3, fig. 40.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 659, pl. 92, figs. 7-9.—SHERBORN and CHAPMAN,



Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 13a-c.—TERRIGI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 117, pl. 8, figs. 1-3.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 401, pl. 16, figs. 31-33.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 89, pl. 15, figs. 775, 776.—JONES, Pal. Soc., 1895, p. 302, pl. 5, fig. 31.—CHAPMAN, Journ. Roy. Micr. Soc., 1898, p. 1, pl. 1, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 491.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 137.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 2.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 284; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 420.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 83.

*Description.*—Test usually free, ventral face flattened or concave, dorsal face strongly convex; peripheral margin sharp, keeled; chambers numerous, 7-9 in final whorl, all visible from the ventral face, only those of the last-formed whorl visible from the dorsal face; sutures slightly depressed, somewhat limbate; wall fairly smooth, punctate; aperture a narrow slit at the inner margin of the chamber.

Diameter up to 1.4 mm.

*Distribution.*—Bagg records this species from several *Albatross* stations off the Hawaiian Islands at depths ranging from 104 to 1,544 fathoms. I have had the species from several *Albatross* stations in the same region, depths ranging from 373 to 607 fathoms. At *Albatross* station H2768 in 373 fathoms the species was represented by abundant specimens. It also was noted from *Nero* station 1328 in 871 fathoms between Guam and Yokohama.

#### TRUNCATULINA LOBATULA (Walker and Jacob).

Plate 15, fig. 1.

“*Nautilus spiralis lobatus*, etc.” WALKER and BOYS, Test. Min., 1784, p. 20, pl. 3, fig. 71.

“*Hammonia tuberculata*, etc.” SOLDANI, Testaceographia, vol. 1, pt. 1, 1789, p. 58, pl. 45, figs. *ii*, *kk*, *ll*, *mm*.

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

*Serpula lobatula* MONTAGU, Test. Brit., 1803, p. 515, Suppl., p. 160.

*Truncatulina lobatula* D'ORBIGNY, in Barker, Webb and Berthelot, Hist. Nat. Îsles Canaries, vol. 2, pt. 2, “Foraminifères,” 1839, p. 134, pl. 2, figs. 22-24; Foram. Foss. Bass. Tert. Vienne, 1846, p. 168, pl. 9, figs. 18-23.—EGGER, Neues Jahrb. für Min., 1857, p. 279, pl. 9, figs. 1-3.—PARKER and JONES, Ann. Mag. Nat. Hist. ser. 2, vol. 19, 1857, p. 293, pl. 10, figs. 17-21.—WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 59, pl. 5, figs. 121-123.—JONES, PARKER, and H. B. BRADY, Mon. Foram. Crag, 1866, pl. 2, figs. 4-10, pl. 4, fig. 18.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 176, pl. 12, fig. 136.—SCHWAGER, Boll. R. Com. geol. Ital., vol. 8, 1877, p. 26, pl., fig. 49.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 205, pl. 3, fig. 57.—TERQUEM, Mem. Soc. géol. France, ser. 3, vol. 2, 1882, p. 94, pl. 9, fig. (27), fig. 27a, b.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 660, pl. 92, fig. 10; pl. 93, figs. 1, 4, 5; pl. 95, figs. 4, 5.—SHERBORN and CHAPMAN Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, fig. 12a-c.—MALAGOLI, Atti Soc. Nat. Modena (Rend.), ser. 3, vol. 3, 1887, p. 110, pl. 1, fig. 14.—



H. B. BRADY, PARKER, and JONES, *Trans. Zool. Soc.*, vol. 12, 1888, p. 227, pl. 42, fig. 20; pl. 45, fig. 26.—TERRIGI, *Mem. R. Acad. Lincei*, ser. 4, vol. 6, 1889, p. 116, pl. 7, figs. 5–7.—EGGER, *Abh. kön. bay. Akad. Wiss. München*, Cl. II, vol. 18, 1893, p. 396, pl. 16, figs. 1–3, 10–12.—FORNASINI, *Mem. Accad. Sci. Inst. Bologna*, ser. 5, vol. 3, 1893, p. 435, pl. 2, figs. 15, 16.—GOËS, *Kongl. Svensk. Vet. Akad. Handl.*, vol. 25, No. 9, 1894, p. 88, pl. 15, fig. 774.—BURROWS and HOLLAND, *Proc. Geol. Assoc.*, vol. 15, 1897, p. 47, pl. 2, fig. 24.—MORTON, *Proc. Portland Soc. Nat. Hist.*, vol. 2, 1897, p. 120.—CHAPMAN, *Journ. Roy. Micr. Soc.*, 1898, p. 2, pl. 1, fig. 2.—FLINT, *Rep. U. S. Nat. Mus.*, 1897 (1899), p. 333, pl. 76, fig. 4.—CHAPMAN, *Proc. Roy. Soc. Edinburgh*, vol. 23, 1902, p. 392, pl. 1, figs. 2, 3.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 491.—CHAPMAN, *Trans. New Zealand Inst.*, vol. 38, 1905, p. 103; *Journ. Quekett Micr. Club*, ser. 2, vol. 10, 1907, p. 137.—BAGG, *Proc. U. S. Nat. Mus.*, vol. 34, 1908, p. 158.—CUSHMAN, *Proc. Boston Soc. Nat. Hist.*, vol. 34, 1908, p. 30.—SIDEBOTTOM, *Mem. and Proc. Manchester Lit. and Philos. Soc.*, vol. 53, No. 21, 1909, p. 2.—CHAPMAN, *Proc. Roy. Soc. Victoria*, vol. 22, 1910, p. 284; *Journ. Linn. Soc., Zoology*, vol. 30, 1910, p. 420.—BAGG, *Bull. U. S. Geol. Surv. No. 513*, 1912, p. 82, pl. 24, figs. 9–14.

*Planorbulina farcata*, var. (*Truncatulina*) *lobatula* PARKER and JONES, *Philos. Trans.*, vol. 155, 1865, p. 381, pl. 14, figs. 3–6; pl. 16, figs. 18–20.

*Planorbulina lobatula* GOËS, *Kongl. Svensk. Vet. Akad. Handl.*, vol. 25, No. 9, 1894, p. 88, pl. 15, fig. 774.

*Description.*—Test typically adherent, plano-convex, ventral face flattened, dorsal face moderately convex; peripheral margin rounded;

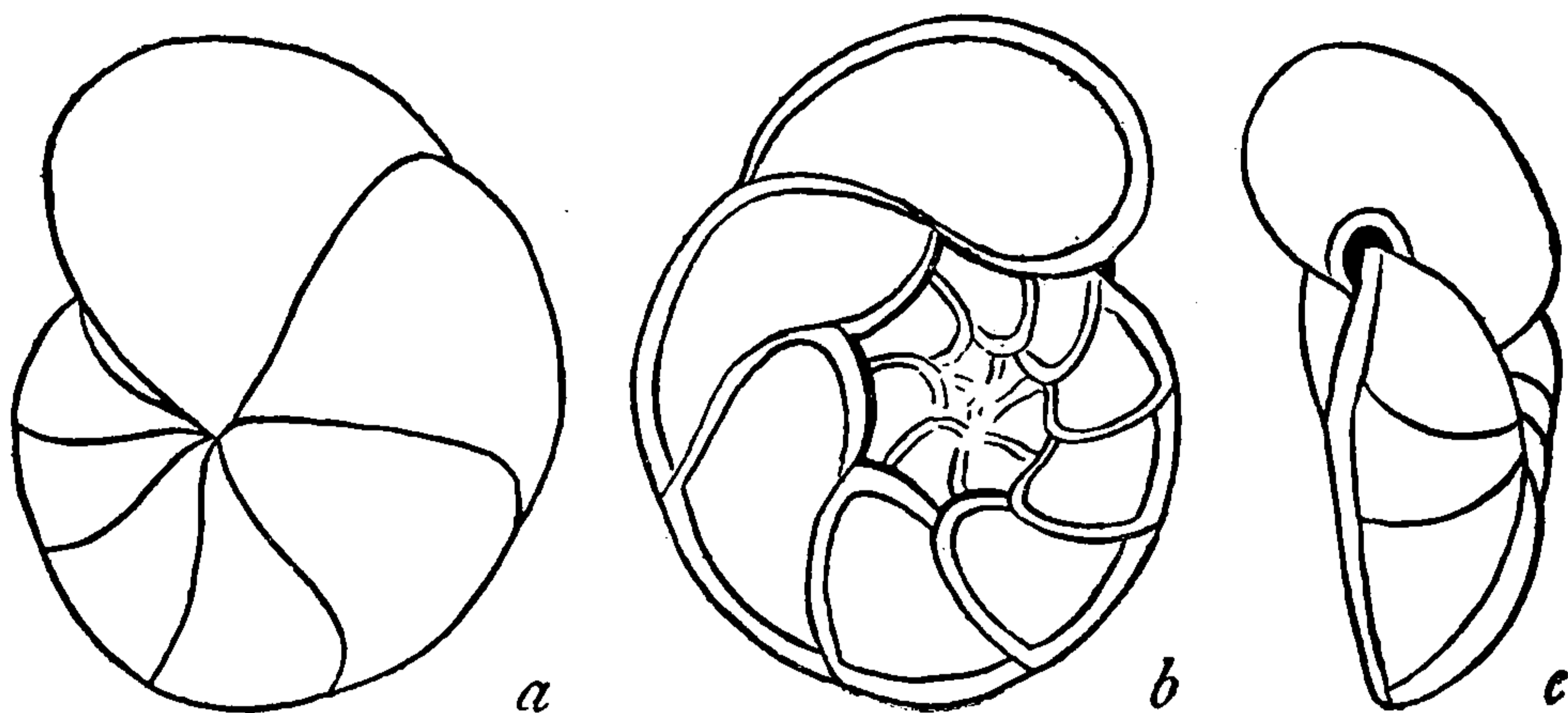


FIG. 34.—TRUNCATULINA LOBATULA (WALKER AND JACOB). (ADAPTED FROM BRADY.) a, VENTRAL VIEW; b, DORSAL VIEW; c, SIDE VIEW.

chambers numerous, usually seven in the last formed coil; sutures somewhat depressed; wall usually fairly smooth, coarsely punctate or sometimes ornamented with ridges or bosses; aperture a narrow slit at the inner margin of the chamber.

Diameter up to 1.2 mm.

*Distribution.*—This species is recorded at *Challenger* station 206 in 2,100 fathoms. Bagg records it from 12 *Albatross* stations off the Hawaiian Islands, depths ranging from 104 to 1,307 fathoms. I have had specimens from the latter region, *Albatross* H2932 in 20 fathoms and H2923 in 392 fathoms. It occurred fairly frequently in material from the stomachs of Holothurians dredged at *Albatross* D3603 in 1,771 fathoms, Bering Sea. At *Nero* station 1464, near Guam in 891



fathoms, a single specimen occurred, and it was found in material from *Nero* stations 1012 in 1,932 fathoms and 1222 in 726 fathoms between Guam and Yokohama. It also occurred in shallow water material off Hakodate, Japan.

This is a very common species in shallow water of the cooler parts of the oceans, but little material from such localities was available in this work.

TRUNCATULINA VARIABILIS d'Orbigny.

"Testæ hammoniformes, plano-cochleatæ, tuberosæ articulatae, etc." SOLDANI, Testaceographia, vol. 1, pt. 1, 1789, pp. 77-80, pls. 70-92.

*Truncatulina variabilis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 279, No. 8; in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 135, pl. 2, fig. 29.—REUSS, Denkschr. Akad. Wiss. Wien, vol. 23, 1864, p. 10, pl. 1, fig. 15.—TERQUEM, Mém. Soc. Géol. France, ser. 3, vol. 1, Mém. 3, 1878, p. 20, pl. 1, fig. 18-25; vol. 2, 1882, p. 92, pl. 9 (17), figs. 22-25.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 661, pl. 93, figs. 6-7.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 227, pl. 45, fig. 17.—TER-RIGI, Mem. R. Accad. Lincei, ser. 4, vol. 6, 1889, p. 116, pl. 7, figs. 8, 9.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 562, pl. 11, fig. 22.—EGGER, Abh. kön. bay. Akad. Wiss.

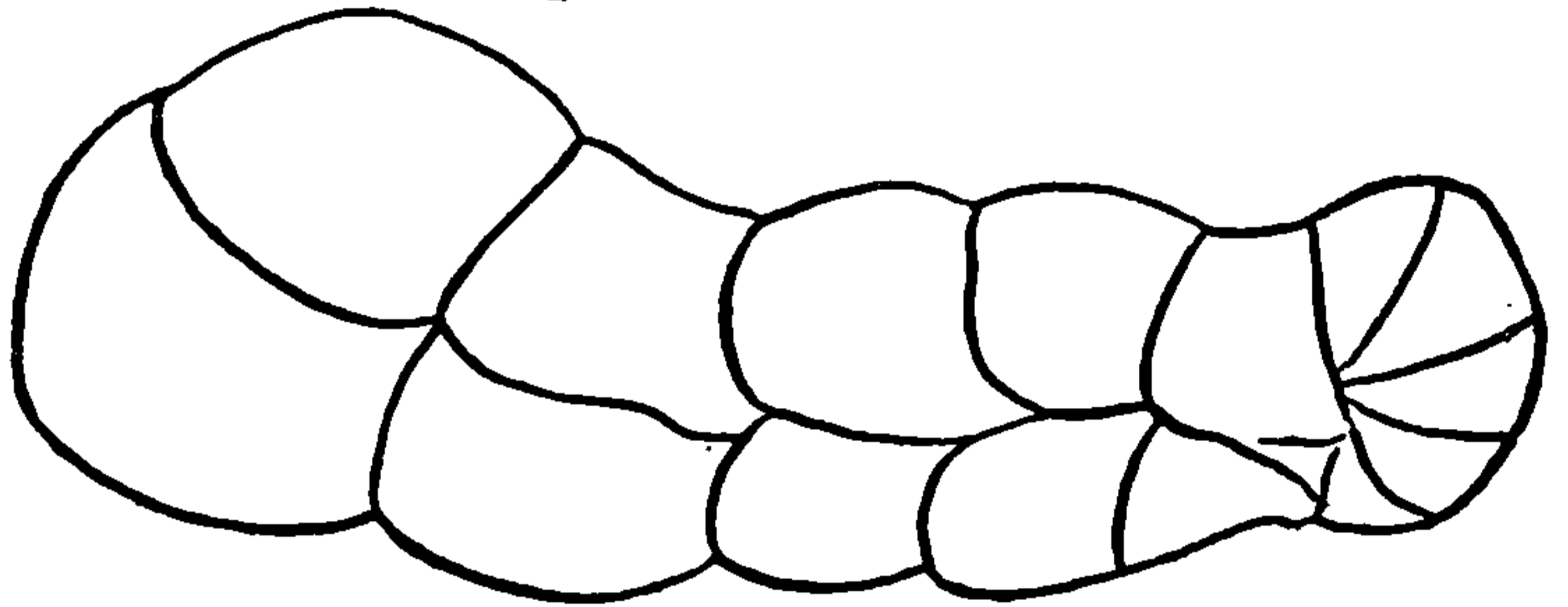


FIG. 35.—TRUNCATULINA VARIABILIS D'ORBIGNY. × 100.

München, Cl. II, vol. 18, 1893, p. 404, pl. 16, figs. 57-59, 63, 64.—JONES, Pal. Soc., 1896, p. 309, pl. 6, fig. 23.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 492.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 103.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 2, pl. 1, figs. 5, 6; pl. 2, figs. 1-3.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 285.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 27.—BAGG, Bull. U. S. Geol. Survey, No. 513, 1912, p. 84, pl. 24, figs. 1-4; pl. 25, figs. 4, 5.

*Planorbulina variabilis* GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 88.

*Description*.—Test adherent, elongated, irregular in shape, dorsal side convex, ventral side in early portion concave, later variously shaped; peripheral margin rounded; chambers numerous, early ones coiled, later ones linear, biserial or irregularly arranged to form an elongate test; sutures somewhat depressed, distinct; wall coarsely punctate.

Length up to 1.75 mm.

*Distribution*.—Apparently this species has not previously been recorded from the North Pacific. I have had material from *Albatross* station H2923 in 392 fathoms off the Hawaiian Islands and from *Nero* station 1310 in 518 fathoms between Guam and Yokohama.

This species presents various modifications of shape in its later growth.



## TRUNCATULINA WUELLERSTORFI (Schwager).

Plate 12, fig. 3.

*Anomalina wuellerstorfi* SCHWAGER, *Novara Exped.*, geol. Theil., vol. 2, 1866, p. 258, pl. 7, figs. 105, 107.

*Truncatulina wuellerstorfi* H. B. BRADY, *Rep. Voy. Challenger*, Zoology, vol. 9, 1884, p. 662, pl. 93, figs. 8, 9.—UHLIG, *Jahrb. k. k. geol. Reichs.*, vol. 36, 1886, p. 174, fig. 3.—EGGER, *Abh. kön. bay. Akad. Wiss. München*, Cl. II, vol. 18,

1893, p. 397, pl. 16, figs. 13–15.—CHAPMAN, *Journ. Roy. Micr. Soc.*, 1893, p. 3, pl. 1, fig. 3.—FLINT, *Rep. U. S. Nat. Mus.*, 1897 (1899), p. 333, pl. 77, fig. 1.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 492.—CHAPMAN, *Trans. New Zealand Inst.*, vol. 38, 1905, p. 102.—BAGG, *Proc. U. S. Nat. Mus.*, vol. 34, 1908, p. 159.—CHAPMAN, *Proc. Roy. Soc. Victoria*, vol. 22, 1910, p. 285; *Journ. Linn. Soc., Zoology*, vol. 30, 1910, p. 420.—BAGG, *Bull. U. S. Geol. Surv.*, No. 513, 1912, p. 84, pl. 25, figs. 10a–c, 11a–c.

*Planorbulina wuellerstorfi* GOËS, *Kongl. Svensk. Vet. Akad. Handl.*, vol. 25, No. 9, 1894, p. 89, pl. 15, fig. 777.

*Description.*—Test usually free, much compressed, dorsal side slightly convex, ventral side flattened; chambers numerous, elongate, curved, 9 or 10 in the last formed coil; sutures limbate; periphery usually bluntly rounded; wall very coarsely punctate; aperture a curved, arched opening at the periphery of the chamber.

Diameter up to 1.40 mm.

*Distribution.*—From the available records this seems to be one of the most common species in the North Pacific. Brady in the *Challenger Report* records it from three North Pacific stations in 345 to 2,050 fathoms. Goës records it from

seven *Albatross* stations in the western tropical Pacific at depths ranging from 660 to 1,201 fathoms. Flint records it from *Albatross* station D2805 in 51 fathoms in Panama Bay. Bagg records it from 14 out of 19 *Albatross* stations off the Hawaiian Islands, depths ranging from 275 to 1,544 fathoms.

I have had material of this species from many stations well scattered over the North Pacific; from off the coast of Washington, *Albatross* D3346 in 786 fathoms, common; off the Galapagos D2806 in 1,379 fathoms, off the Hawaiian Islands between the Hawaiian and Midway Islands and especially at a larger number of stations between Guam and Yokohama. These last stations range in depth from 665 to 2,391 fathoms.

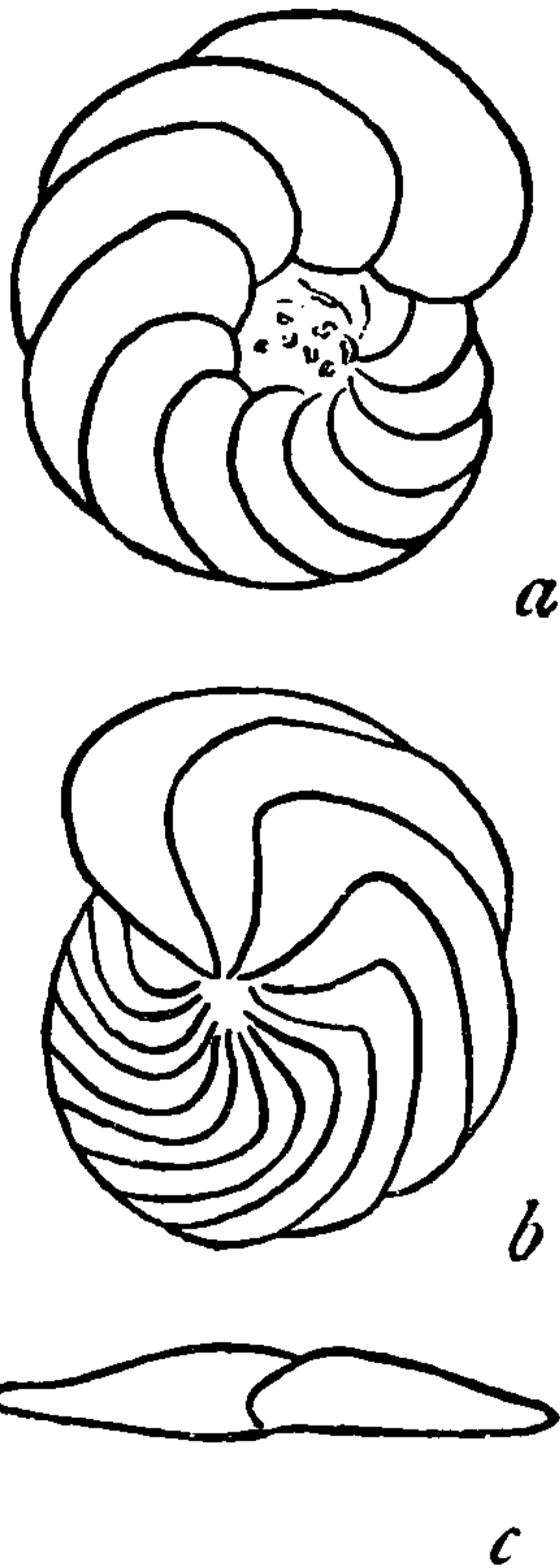


FIG. 36.—TRUNCATULINA WUELLERSTORFI (SCHWAGER). ADAPTED FROM SCHWAGER.) a, DORSAL VIEW; b, VENTRAL VIEW; c, SIDE VIEW.



**TRUNCATULINA HAIDINGERII** (d'Orbigny).

Plate 13, fig. 5; plate 28, fig. 1.

*Rotalina haidingerii* D'ORBIGNY, *Foram. Foss. Bass. Tert. Vienne*, 1846, p. 154, pl. 8, figs. 7-9.

*Planorbulina haidingerii* H. B. BRADY, *Trans. Linn. Soc. London*, vol. 24, 1864, p. 469, pl. 48, fig. 11.

*Truncatulina haidingerii* REUSS, *Sitz. kais. Akad. Wiss. Wien*, vol. 55, 1867, p. 28.—TERRIGI, *Mem. Accad. Lincei*, ser. 4, vol. 6, 1889, p. 118, pl. 8, figs. 7-9.—EGGER, *Abh. kön. bay. Akad. Wiss. Munchen*, Cl. II, vol. 18, 1893, p. 401, pl. 16, figs. 25-27.—LIEBUS, *Jahrb. k. k. geol. Reichs.*, vol. 52, Heft 1, 1902, p. 90, fig. 4.—MILLETT,

*Journ. Roy. Micr.*

*Soc.*, 1904, p. 493.—

CHAPMAN, *Trans.*

*New Zealand Inst.*,

vol. 38, 1905, p. 104;

*Journ. Quekett Micr.*

*Club*, ser. 2, vol. 10,

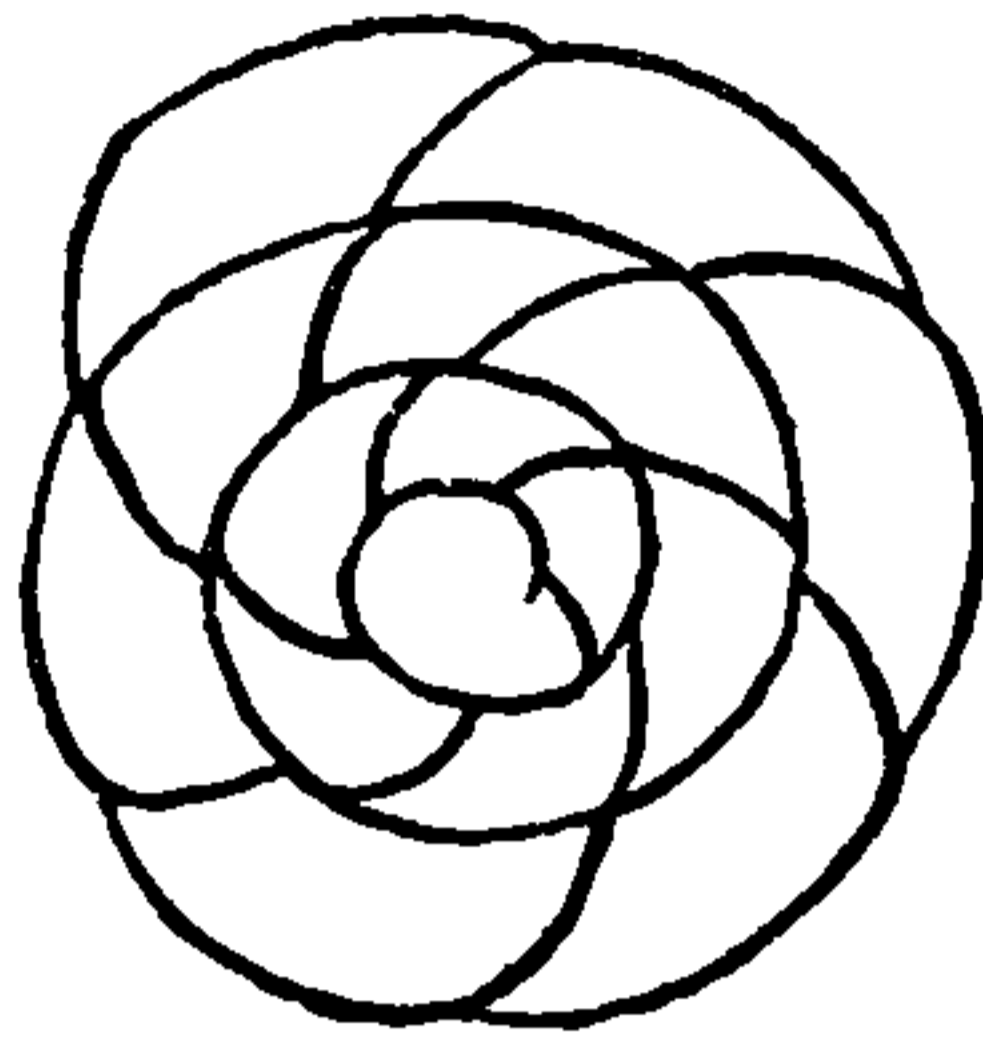
1907, p. 137.—BAGG.

*Proc. U. S. Nat. Mus.*,

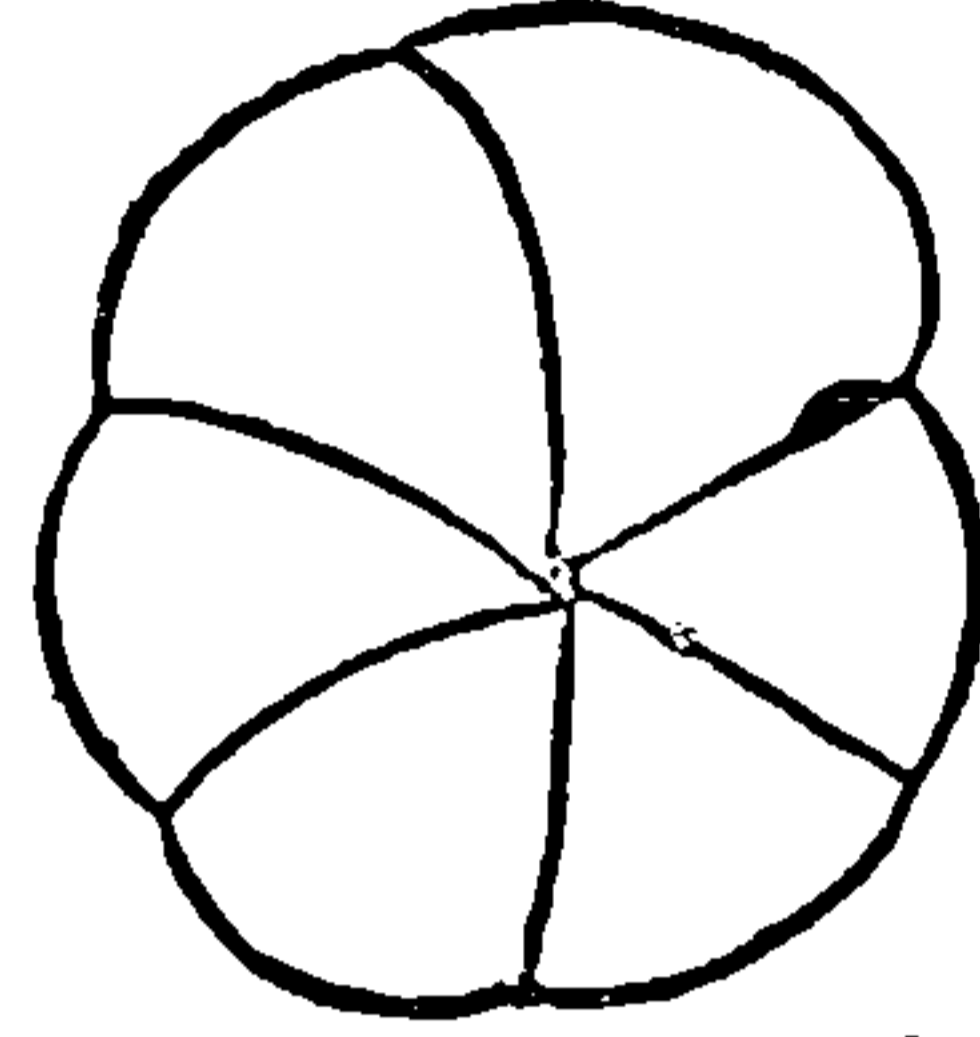
vol. 34, 1908, p. 157.—

CHAPMAN, *Journ.*

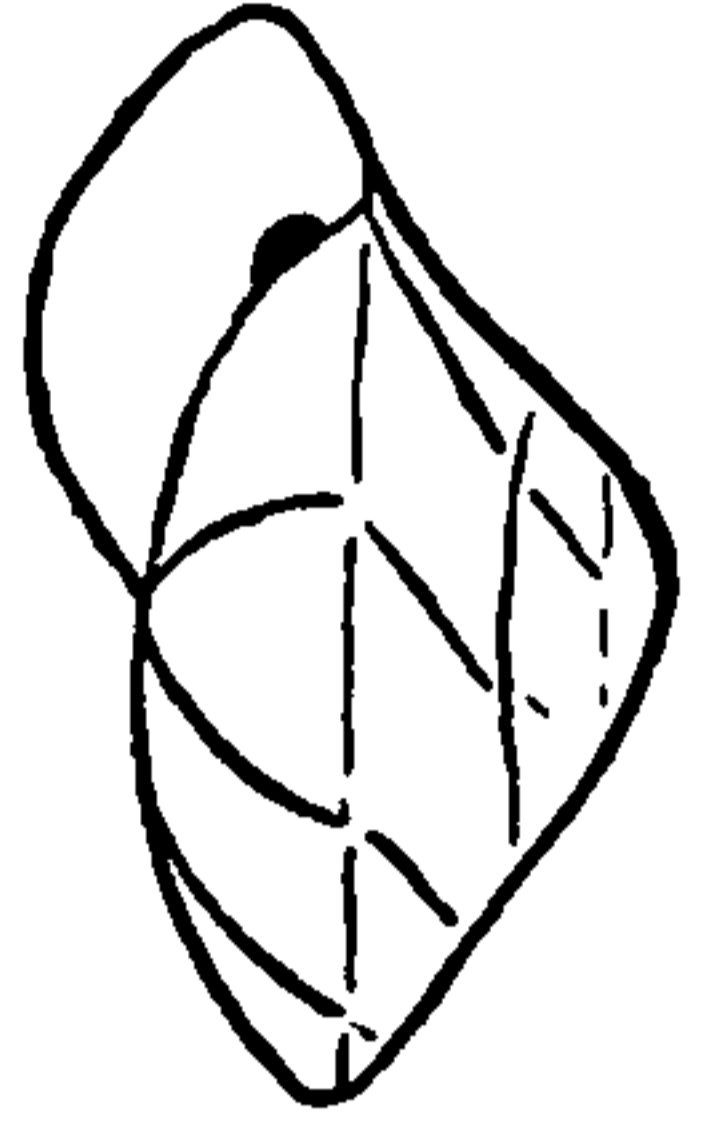
*Linn. Soc., Zoology*, vol. 30, 1910, p. 420.



a



b



c

FIG. 37.—TRUNCATULINA HAIDINGERII (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S TYPE FIGURE.) a, DORSAL VIEW; b, VENTRAL VIEW; c, SIDE VIEW.

*Planorbulina farcata*, var. *haidingerii* PARKER and JONES, *Philos. Trans.*, vol. 155, 1865, p. 382, pl. 16, fig. 22a, b.

*Description*.—Test free, biconvex; peripheral margin rounded; chambers numerous, broad, about nine in the last formed coil; sutures distinct but not depressed; wall smooth, finely punctate; aperture a small opening at the ventral margin of the chamber.

Diameter up to 1.2 mm.

*Distribution*.—The only previously recorded station for this species in the North Pacific is one recorded by Bagg, *Albatross H4508* in 495 fathoms off the Hawaiian Islands. I have had the species from H4878 in 84 fathoms, bottom temperature 51.9° F., D4946 in 39 fathoms, bottom temperature 68.7° F. and also from D4822 in 130 fathoms, bottom temperature 39.4° F., all off Japan.

**TRUNCATULINA AKNERIANA** (d'Orbigny).

Plate 16, fig. 3.

*Rotalina akneriana* D'ORBIGNY, *Foram. Foss. Bass. Tert. Vienne*, 1846, p. 156, pl. 8, figs. 13-15.

*Truncatulina akneriana* REUSS, *Denkschr. kais. Akad. Wiss. Wien*, vol. 25, 1866, p. 160, No. 6.—H. B. BRADY, *Rep. Voy. Challenger*, *Zoology*, vol. 9, 1884, p. 663, pl. 94, fig. 8a-c.—EGGER, *Abh. kön. bay. Akad. Wiss. München*, Cl. II, vol. 18, 1893, p. 400, pl. 16, figs. 60-62.—FLINT, *Rep. U. S. Nat. Mus.*, 1897 (1899), p. 333, pl. 77, fig. 5.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 494.—CHAPMAN, *Trans. New Zealand Inst.*, vol. 38, 1905, p. 103.—BAGG, *Proc. U. S. Nat. Mus.*, vol. 34, 1908, p. 157.—CHAPMAN, *Journ. Linn. Soc., Zoology*, vol. 30, 1910, p. 420.

*Planorbulina akneriana* Goës, *Kongl. Svensk. Vet. Akad. Handl.*, vol. 25, No. 9, 1894, p. 89, pl. 15, figs. 778, 779.

*Description*.—Test free, biconvex; peripheral margin broadly rounded; dorsal surface convex at the margin, depressed or flattened



toward the center, ventral surface convex but less so toward the center; chambers numerous, about 11–13 in the final coil, broad, short; sutures strongly limbate, ventrally depressed, sutures between last few chambers and the previous coil deep and distinct; surface very coarsely punctate; aperture an arched slit at the periphery.

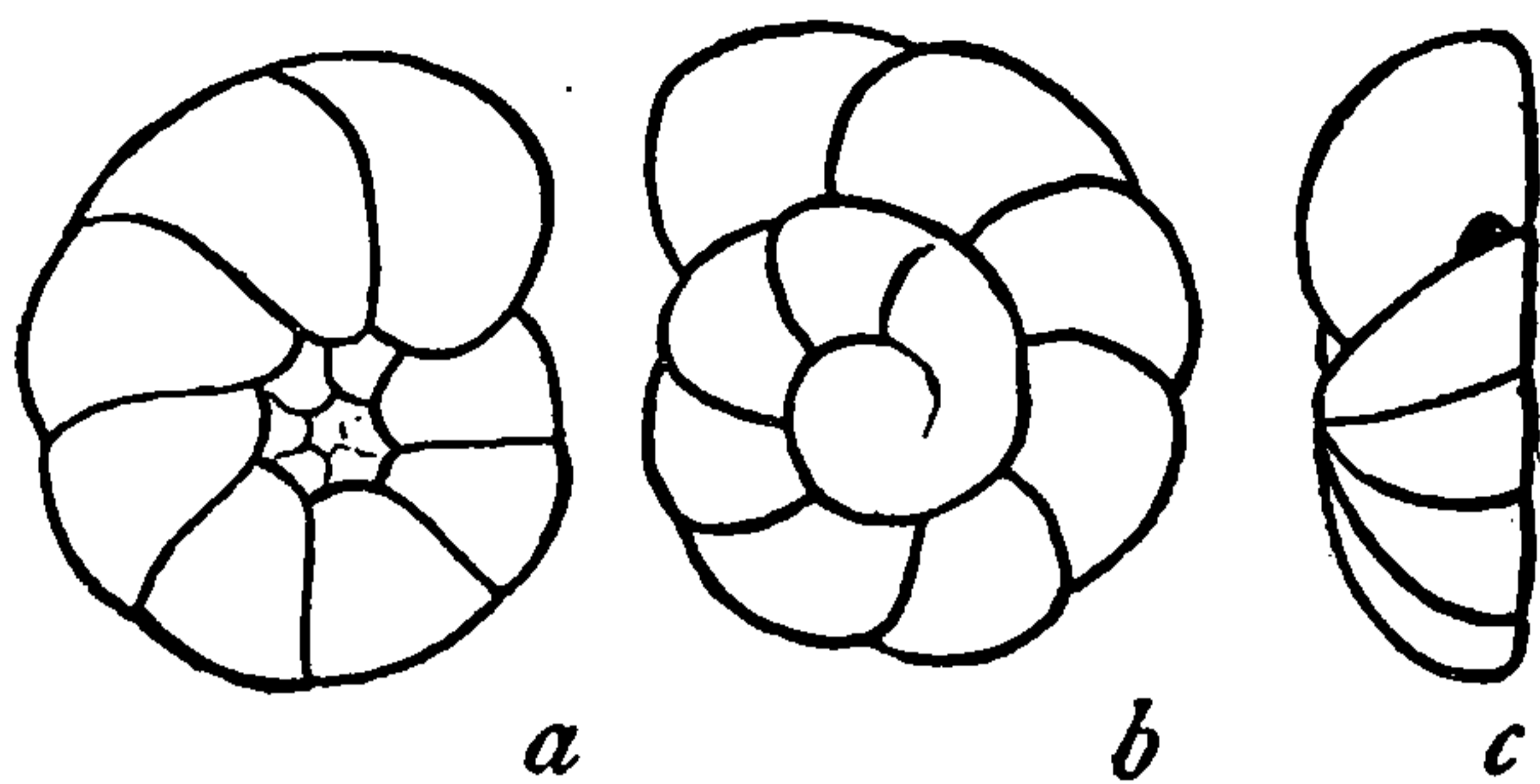


FIG. 38.—TRUNCATULINA AKNERIANA (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S TYPE FIGURE.) *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW.

Diameter up to 1.25 mm.

*Distribution*.—The only North Pacific record for this species is given by Bagg, *Albatross* station H4590 in 978 fathoms off the Hawaiian Islands.

I have had a single specimen from *Albatross* H2922 also off the Hawaiian Islands.

#### TRUNCATULINA UNGERIANA (d'Orbigny).

Plate 17, fig. 2.

*Rotalina ungeriana* D'ORBIGNY, *Foram. Foss. Bass. Tert. Vienne*, 1846, p. 157, pl. 8, figs. 16–18.

*Planorbulina ungeriana* H. B. BRADY, *Trans. Linn. Soc. London*, vol. 24, 1864, p. 469, pl. 48, fig. 12.—SHERBORN and CHAPMAN, *Journ. Roy. Micr. Soc.*, 1886, p. 757, pl. 16, fig. 16.—GÖES, *Kongl. Svensk. Vet. Akad. Handl.*, vol. 25, No. 9, 1894, p. 90, pl. 15, fig. 780.

*Truncatulina ungeriana* REUSS, *Denkschr. Akad. Wiss. Wien*, vol. 25, 1865, p. 161.—H. B. BRADY, *Rep. Voy. Challenger, Zoology*, vol. 9, 1884, p. 664, pl. 94, fig. 9*a-d*.—TERRIGI, *Mem. R. Accad. Lincei*, ser. 4, vol. 6, 1889, p. 117, pl. 8, fig. 4; *Mem. R. Com. geol. d'Italia*, vol. 4, 1891, p. 106, pl. 4, fig. 9.—EGGER, *Abh. kön. bay. Akad. Wiss. München, Cl. II*, vol. 18, 1893, pl. 16, figs. 19–21.—SILVESTRI, *Mem. Pont. Accad. Nuovi Lincei*, vol. 9, 1893, p. 213, pl. 6, fig. 3.—BURROWS and HOLLAND, *Proc. Geol. Ass.*, vol. 15, 1897, p. 47, pl. 2, fig. 23.—FLINT, *Rep. U. S. Nat. Mus.*, 1897 (1899), p. 333, pl. 77, fig. 2.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 493.—CHAPMAN, *Trans. New Zealand Inst.*, vol. 38, 1905, p. 103; *Journ. Quekett Micr. Club*, ser. 2, vol. 10, 1907, p. 138; *Proc. Roy. Soc. Victoria*, vol. 22, 1910, p. 285; *Journ. Linn. Soc., Zoology*, vol. 30, 1910, p. 420.—BAGG, *Bull. U. S. Geol. Surv.*, No. 513, 1912, p. 83, pl. 25, figs. 1–3.

*Planorbulina farcata*, var. *ungeriana* PARKER and JONES, *Philos. Trans.*, vol. 155, 1865, p. 382, pl. 16, figs. 23–25.

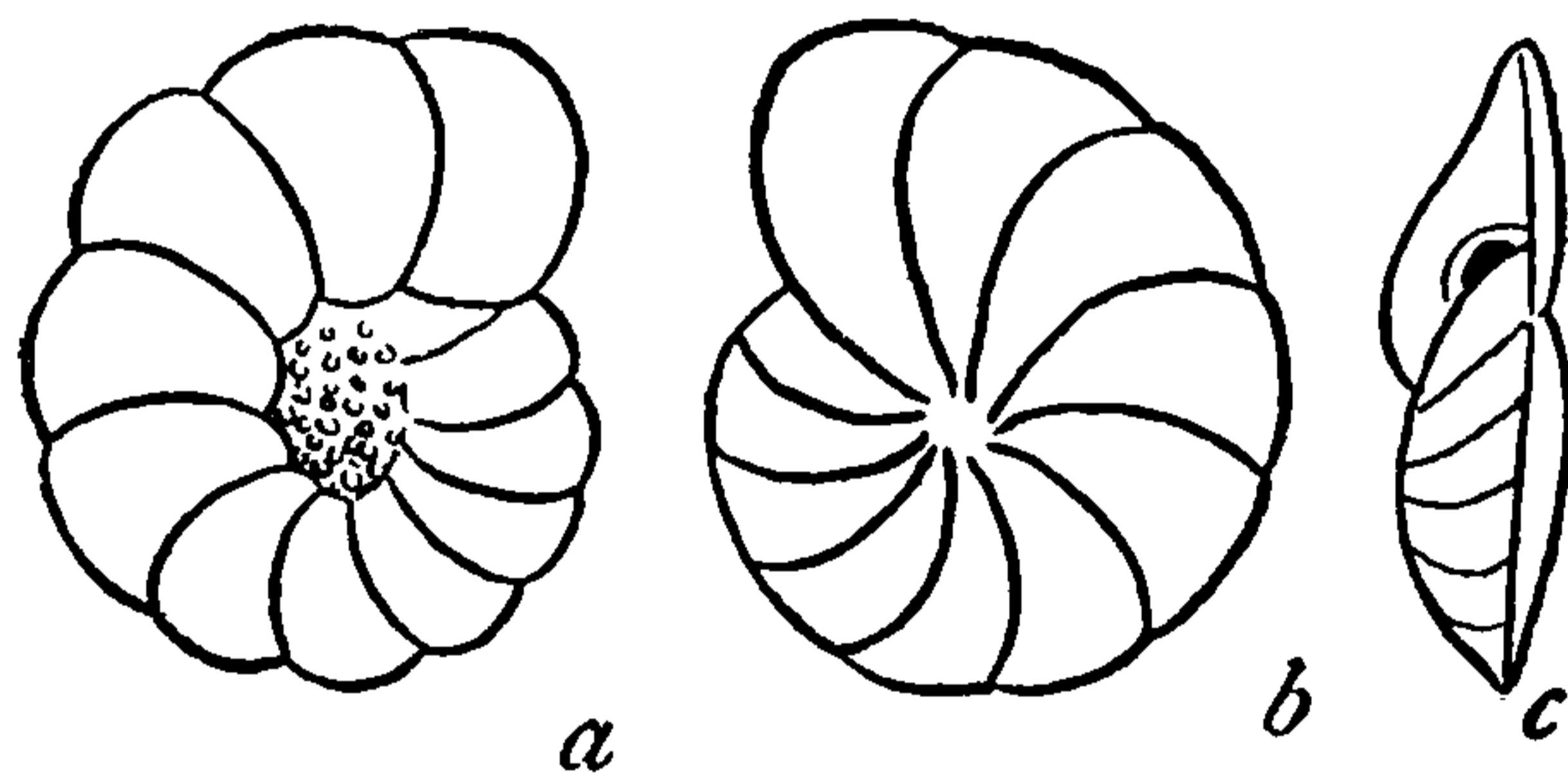


FIG. 39.—TRUNCATULINA UNGERIANA (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S TYPE FIGURE.) *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, SIDE VIEW.

*Description*.—Test free, biconvex but unequally so; peripheral margin acute, subcarinate; chambers numerous, 10 to 12 in the



final whorl, short and broad; sutures distinct, somewhat depressed; wall rather coarsely punctate, especially on the dorsal surface; aperture a narrow arched opening on the periphery of the test.

Diameter up to 1.25 mm.

*Distribution.*—The only previously recorded station for this species in the North Pacific is one given by Brady from the *Challenger* material in 2,300 fathoms. I have had specimens from numerous stations, off the Hawaiian Islands, off Guam and between Guam and Japan, depths ranging from 276 to 1,588 fathoms.

**TRUNCATULINA TENERA H. B. Brady.**

Plate 16, fig. 2; plate 23, fig. 6.

*Truncatulina tenera* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 665, pl. 95, figs. 11a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 402, pl. 16, figs. 45-47.

*Description.*—“Test regularly Rotaliform; both faces convex, peripheral edge acute and lobulated. Consisting of rather more than three convolutions of nearly equal width, the last of which is formed of five or six segments; sutures distinct, slightly depressed, marked on the superior face by nearly straight radial lines; aperture a curved fissure bordered by a thickened lip, situated at the inner margin of the final segment near the periphery.

“Diameter 1/55th inch (0.46 mm.)”

*Distribution.*—Apparently this species has not been previously recorded from the North Pacific. The only material of the species which I have had is from *Albatross* station D4951 in 703 fathoms, bottom temperature 37.7° F., off Japan.

The material is very typical. The above description is from Brady.

**TRUNCATULINA DUTEMPLEI (d'Orbigny).**

Plate 15, fig. 2.

*Rotalina dutemplei* D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 157, pl. 8, figs. 19-21.

*Truncatulina dutemplei* REUSS, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 160, pl. 4, fig. 16.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 665, pl. 95, fig. 5a-c.—TERRIGI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 118, pl. 8, figs. 10, 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 400, pl. 16, figs. 22, 23, 30, 54-56.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 421.

*Description.*—Test free, dorsal surface flattened at the sides, umbonate in the center, ventral surface convex; chambers about six in the last formed coil; peripheral margin broadly rounded; sutures slightly depressed, but very distinct; wall rather coarsely punctate,



especially the last few chambers; aperture a small arched opening ventrally from the periphery of the chamber.

Diameter 0.40–0.75 mm.

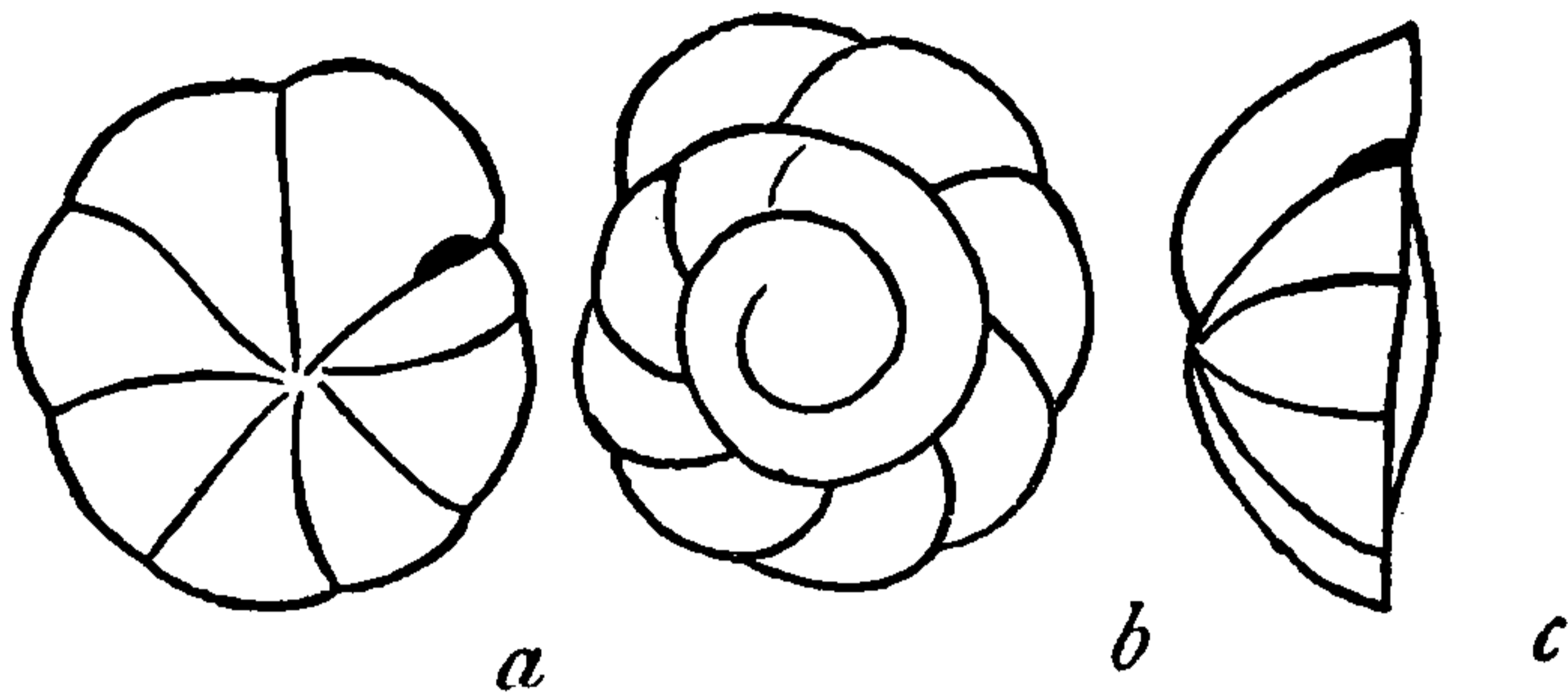


FIG. 40.—TRUNCATULINA DUTEMPLEI (D'ORBIGNY). (ADAPTED FROM D'ORBIGNY'S TYPE FIGURE.) *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW.

*Distribution*.—Bagg records the only previously published station for this species in the North Pacific, *Albatross* H4571 in 384 fathoms off the Hawaiian Islands. I have had specimens referable to this species from two *Nero* stations, 1294 in 1,417 fathoms

and 1,310 in 518 fathoms between Guam and Japan. It has also occurred at *Albatross* station H4882 in 248 fathoms, bottom temperature 48.8° F., off Blake Reef, in Colnett or Vincennes Strait, Southern Japan.

TRUNCATULINA TUMIDULA H. B. Brady.

Plate 15, fig. 3.

*Truncatulina tumidula* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol 9, 1884, p. 666, pl. 95, figs. 8a–d.

*Description*.—"Test trochoid, more or less depressed, consisting of three convolutions, the last of which is composed of about six segments; superior face highly convex; inferior less convex, slightly excavated at the umbilicus; peripheral edge thick and lobulated; segments inflated, especially those of the final convolution. Colour deep brown, except the terminal segment, which is generally of lighter hue.

"Diameter 1/30th inch (0.2 mm.)."

*Distribution*.—Brady described this small species from a *Challenger* station near the Canaries. I have had material from two *Nero* stations between Guam and Japan that very closely resemble the figures of *T. tumidula* and seem to be identical with it. These are *Nero* stations 1160 in 1,907 fathoms and 1294 in 1,417 fathoms.

TRUNCATULINA PYGMEA Hantken.

*Truncatulina pygmaea* HANTKEN, Mitth. Jahrb. ung. geol. Anstalt., vol. 4, 1875, p. 78, pl. 10, fig. 8.

*Truncatulina pygmaea* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 666, pl. 95, figs. 9, 10.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 400, pl. 16, figs. 24, 28, 29.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1906, p. 103.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 421.

*Description*.—Test free, biconvex; peripheral margin bluntly rounded; chambers numerous, angled on the dorsal side, about nine in the last-formed whorl; sutures very distinct, limbate, especially on the dorsal side with clear shell material, most distinct in the last-



formed whorl; aperture an elongate slit at the inner margin of the chamber, ventrally from the periphery.

Diameter 0.30–0.65 mm.

*Distribution.*—In the *Challenger* Report Brady records this species from five stations in the North Pacific ranging in depth from 1,850 to 3,125 fathoms.

Bagg records it from one *Albatross* station, H4502 in 1,342 fathoms off the Hawaiian Islands.

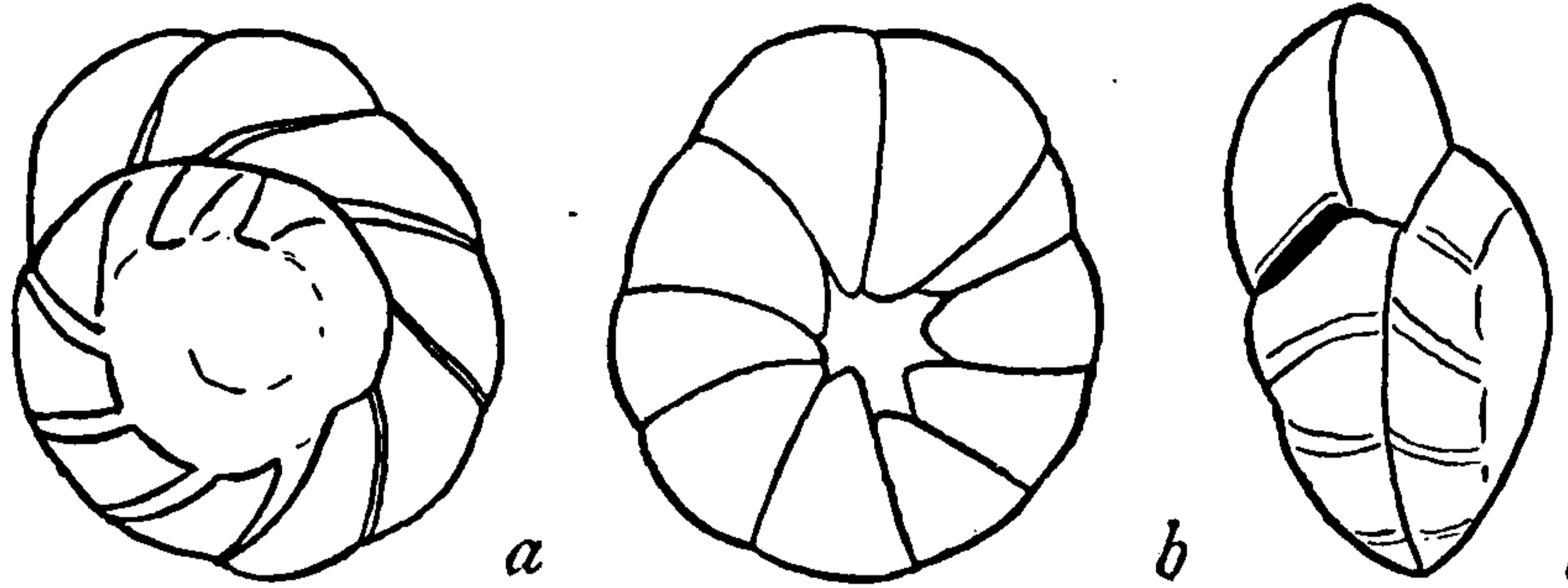


FIG. 41.—TRUNCATULINA PYGMAEA HANTKEN. (ADAPTED FROM BRADY.) *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, SIDE VIEW.

I have had material of this species from several *Nero* stations, 10 in 2,098 fathoms, 124 in 1,726 fathoms, 990 at Guam in 859 fathoms and several stations between Guam and Yokohama, depths ranging from 1,088 to 2,180 fathoms.

From all the North Pacific records this species seems to occur most frequently at depths over 1,500 fathoms.

#### TRUNCATULINA PRÆCINCTA (Karrer).

Plate 26, fig. 2.

*Rotalia præcincta* KARRER, Sitz. Akad. Wiss. Wien, vol. 58, 1868, p. 189, pl. 5, fig. 7.—SEGUENZA, Atti Accad. Lincei, ser. 3, vol. 6, 1897, pp. 56, 64.

*Truncatulina præcincta* H. B. BRADY, Rep. Voy *Challenger*, Zoology, vol. 9, 1884, p. 667, pl. 95, figs. 1–3.—TERRIGI, Mem. Com. geol. Italia, vol. 4, 1891, p. 107, pl. 4, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 403, pl. 16, figs. 51–53.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 5, 1895, p. 12, pl. 4, fig. 36.—FLINT, Rep. U. S. Nat. Mus., 1897

(1899), p. 334, pl. 78, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 494.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 104.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.

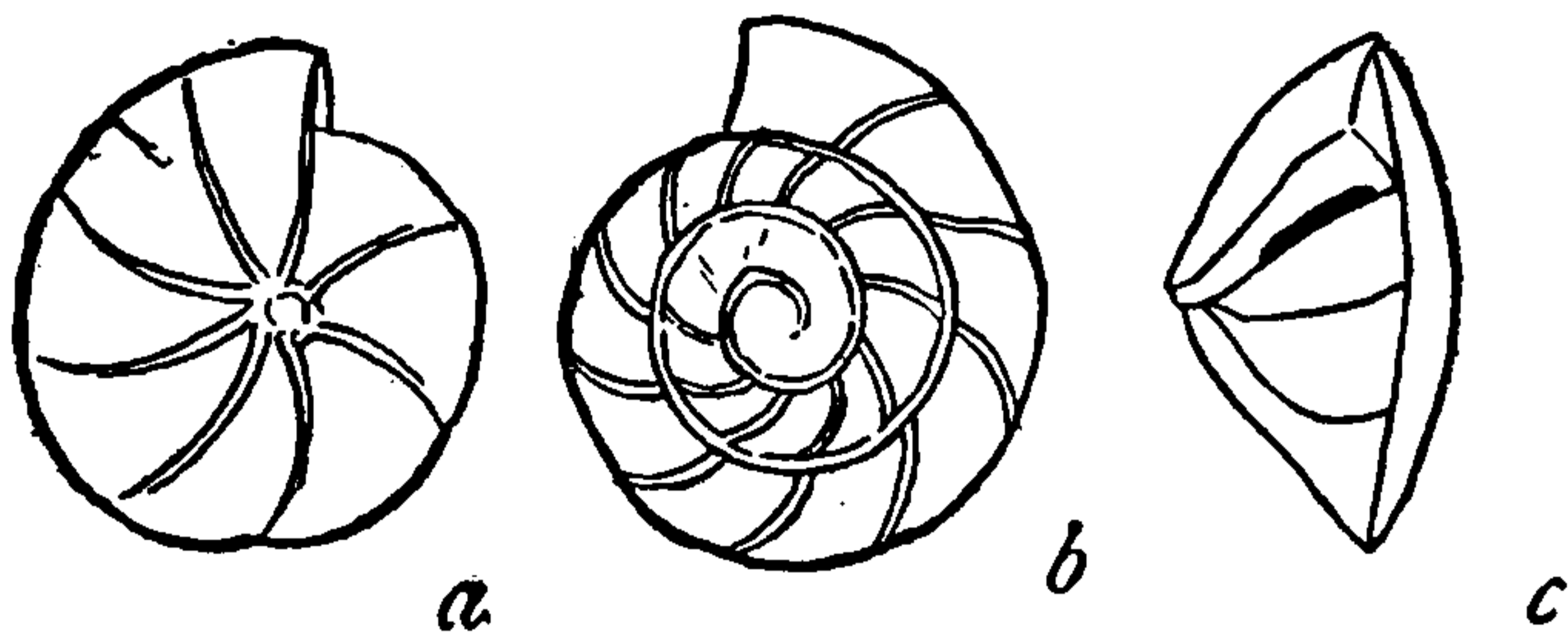


FIG. 42.—TRUNCATULINA PRÆCINCTA (KARRER). (ADAPTED FROM KARRER'S TYPE FIGURE.) *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW.

*Description.*—Test free, ventral side strongly convex, dorsal side but slightly so; comparatively large, peripheral margin bluntly rounded; chambers very numerous, about twelve in the last-formed whorl, short and broad, especially on the dorsal side where four or more whorls may be visible, slightly oblique; sutures and periphery marked by clear shell material often appearing as distinct ridges



most marked toward the umbilicus, remaining portion of surface finely but distinctly punctate; aperture a narrow slit on the inner margin of the chamber ventrally from the peripheral margin.

Diameter up to 1.5 mm.

*Distribution.*—Brady records this from the *Challenger* station off the Philippines in 95 fathoms. Bagg records it from a single *Albatross* station, H4476 in 438 fathoms off the Hawaiian Islands. I have it from a single station in the same region *Albatross* H2683 in 770 fathoms, a few poor specimens, and from *Albatross* D4874 in 66 fathoms off Japan.

TRUNCATULINA MARGARITIFERA H. B. Brady.

Plate 17, fig. 1.

*Truncatulina margaritifera* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 66; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 667, pl. 96, fig. 2 a-c.

*Description.*—"Test Rotaliform; superior face slightly convex or nearly flat, inferior convex; peripheral edge sharp, subcarinate,

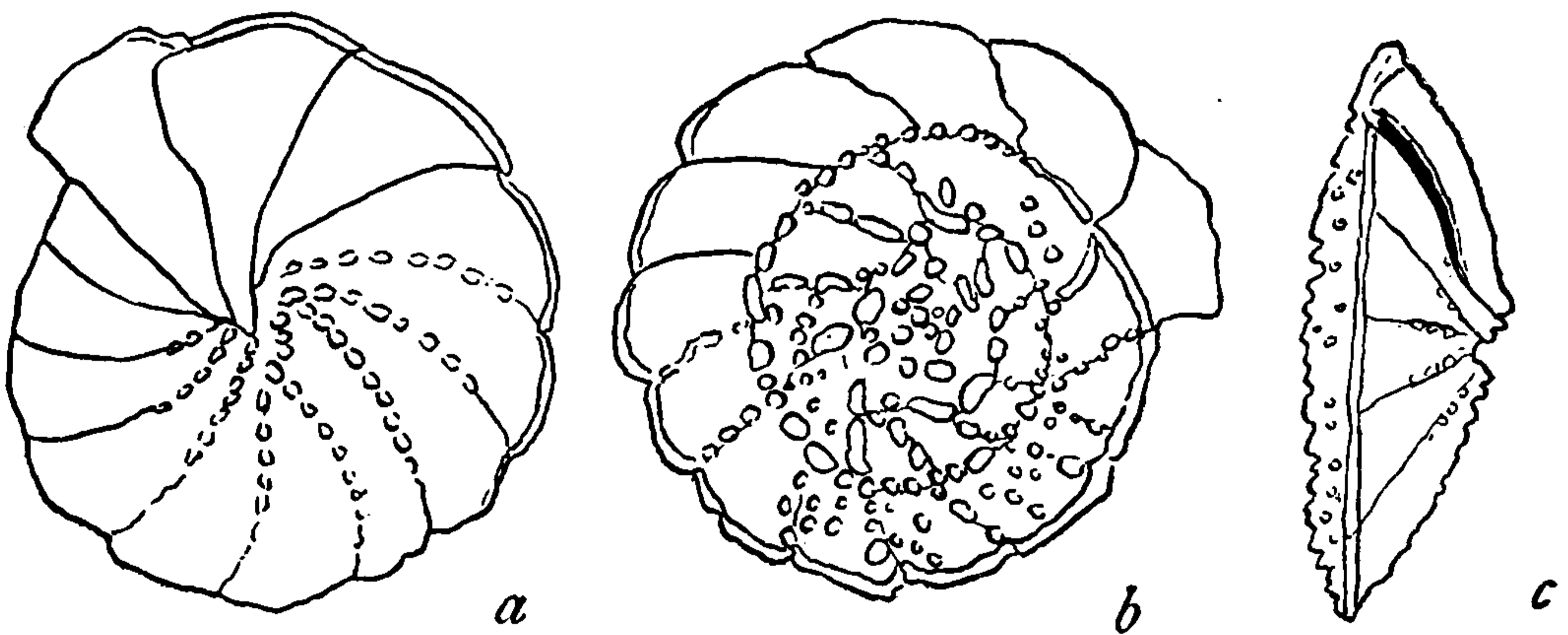


FIG. 43.—TRUNCATULINA MARGARITIFERA H. B. BRADY. (ADAPTED FROM BRADY'S TYPE FIGURE.  $\times 28$ . a, VENTRAL VIEW; b, DORSAL VIEW; c, SIDE VIEW.

more or less lobulated; consisting of three convolutions, of which the last has about twelve segments; segments all visible on the superior face, only those of the final convolution on the inferior. Sutural lines on both faces marked by rows of exogenous beads of clear shell-substance, largest near the center of the test; walls conspicuously foraminated.

"Diameter  $1/20$ th inch (1.27 mm)."

*Distribution.*—The only published North Pacific record for this species is that of Brady from the *Challenger* station off the Philippines in 95 fathoms. Apparently this belongs to the fauna already several times mentioned which in the North Pacific reaches into the Philippine Archipelago from the south and farther north to Japan as it was found at *Albatross* station D4874 in 66 fathoms and D4946 in 39 fathoms, bottom temperature  $68.7^{\circ}$  F.

The Japanese specimens were in every way typical and of good size.



## TRUNCATULINA CULTER (Parker and Jones).

Plate 16, fig. 1.

*Planorbulina culter* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 421, pl. 19, fig. 1 a, b.

*Truncatulina culter* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 668, pl. 96, fig. 3 a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 401, pl. 16, figs. 16-18.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 157.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 421.

*Description*.—Test free, ventrally strongly convex, dorsally flattened or very slightly convex; peripheral margin acute, often carinate, slightly fimbriate; chambers numerous, oblique above, ten or more in the final whorl; sutures limbate, in the earlier whorls becoming very much thickened, in the later ones less so; surface of the test finely punctate; sutures rather indistinct below; aperture an arched or almost comma-shaped opening at the inner margin of the chamber about half way between the peripheral margin and the umbilicus.

Diameter 0.40–0.80 mm.

*Distribution*.—The only North Pacific records for this species are those given by Bagg, *Albatross* H4502 in 1,342 fathoms and H4567 in 1,307 fathoms off the Hawaiian Islands. I have had no material which I could refer to this species.

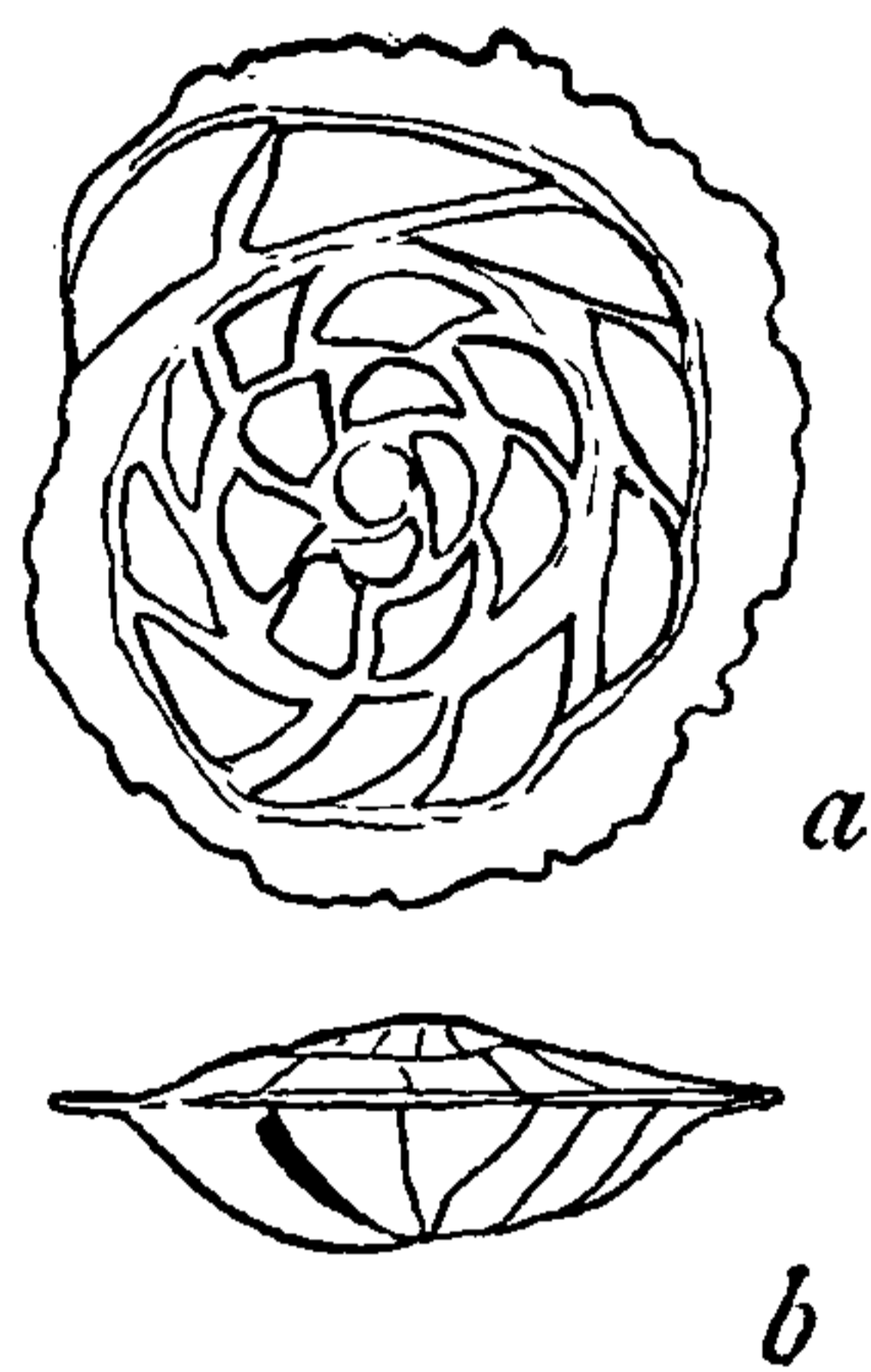


FIG. 44.—TRUNCATULINA CULTER PARKER AND JONES. (ADAPTED FROM PARKER AND JONES'S TYPE FIGURE.)  $\times 25$ . a, DORSAL VIEW; c, SIDE VIEW.

## TRUNCATULINA MUNDULA H. B. Brady, Parker, and Jones.

Plate 13, fig. 4.

*Truncatulina*, sp. H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 95, fig. 6.

*Truncatulina mundula* H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 228, pl. 45, fig. 25.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 158.

*Planorbulina mundula* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 71.

*Description*.—Test free, almost equally biconvex; peripheral margin acutely rounded; chambers numerous, 12 to 14 in the last-formed coil; sutures oblique dorsally; margins of chambers of clear shell material, raised and thickened in the earlier coils, almost hiding the original surface of the chamber and broad even in the last-formed chambers, remainder of the surface distinctly foraminated; ventral side with the sutures indistinct, with little or no trace of thickenings; walls very coarsely foraminated; aperture a narrow slit extending ventrally from the peripheral margin.



Diameter up to 1.0 mm.

*Distribution*.—Goës records this species from two *Albatross* stations, D3353, in 695 fathoms and D3433, in 1,218 fathoms, in the western

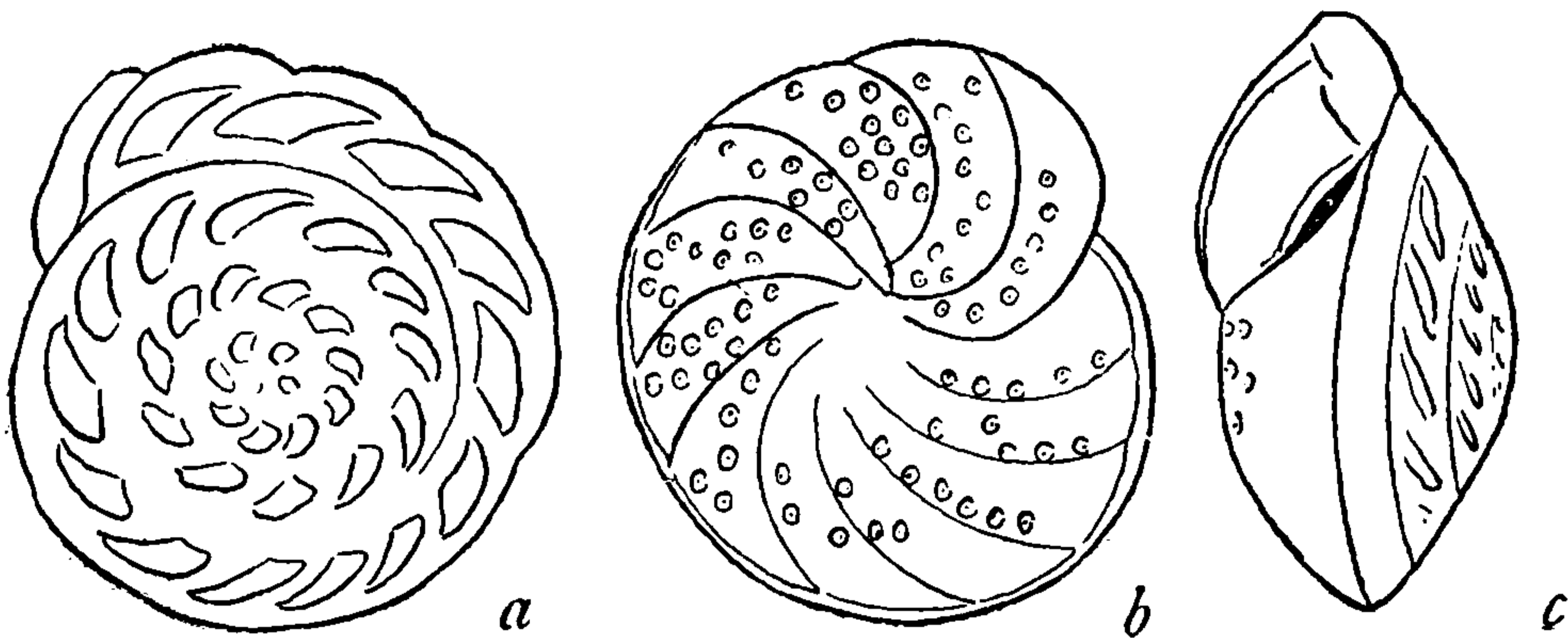


FIG. 45.—TRUNCATULINA MUNDULA H. B. BRADY, PARKER AND JONES. (ADAPTED FROM BRADY'S FIGURE.)  $\times 40$ . *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, SIDE VIEW.

tropical Pacific. Bagg records it from a single *Albatross* station, D4000, in 104–213 fathoms, off the Hawaiian Islands.

#### Genus SIPHONINA Reuss, 1849.

*Rotalia* (part) CZJZEK, Haidinger's Nat. Abh., vol. 2, 1848, p. 145.

*Siphonina*, REUSS (type, *S. reticulata* (Czjzek)), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 372.

*Planorbulina* (part) PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 379.

*Truncatulina* (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 669.

*Description*.—Test free, composed of numerous chambers arranged in a somewhat irregular spiral, rounded or biconvex, perforate; wall smooth or ornamented; aperture rounded, usually with a short neck and phialine lip.

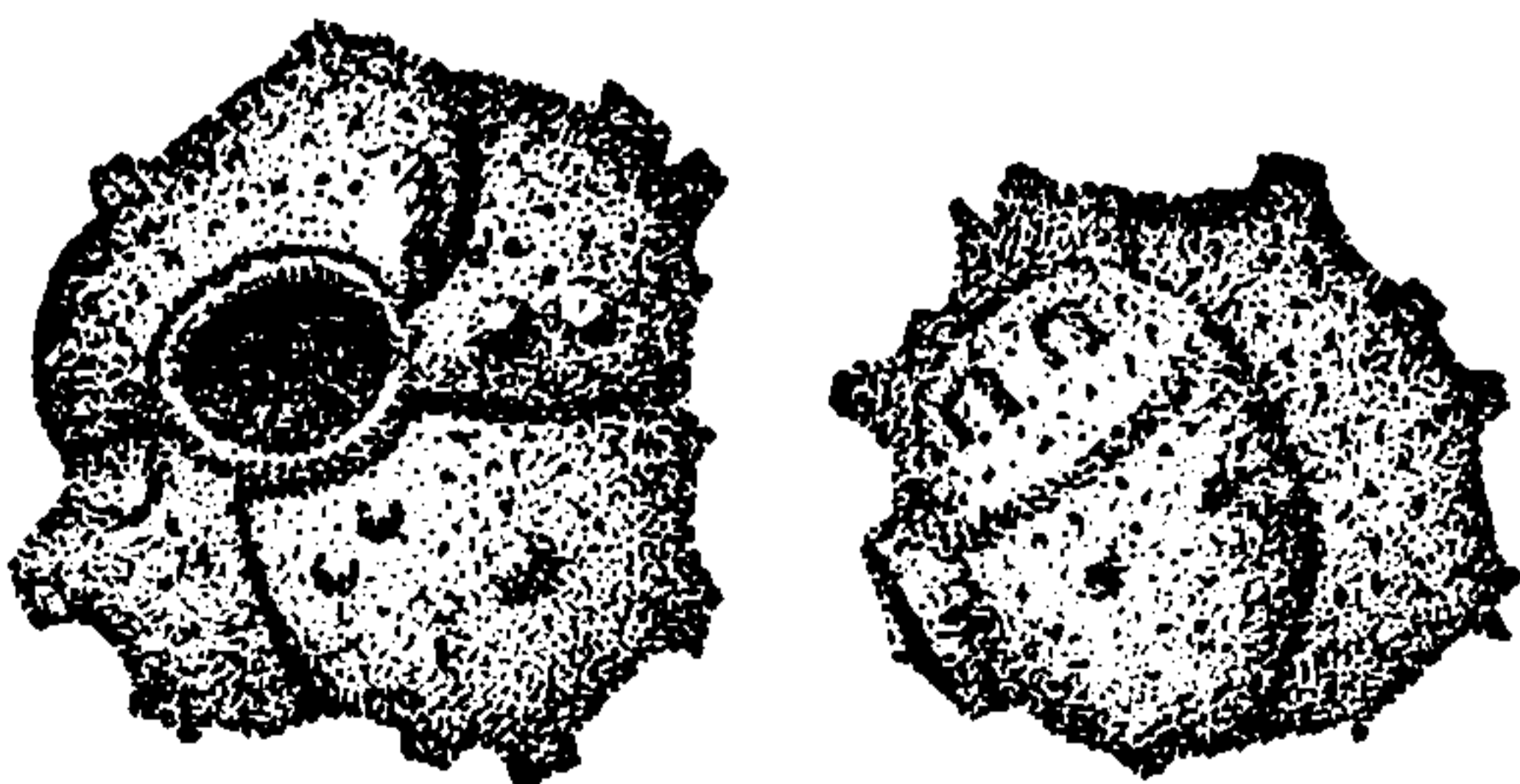
This genus seems to be worthy of separation from *Truncatulina* by its apertural characters alone. There are two North Pacific species which are here described.

#### SIPHONINA ECHINATA (H. B. Brady).

Plate 18, figs. 1–4.

*Planorbulina echinata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 69, pl. 8, fig. 31a–c.

*Truncatulina echinata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 670, pl. 96, figs. 9–14.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 403, pl. 16, figs. 40, 41.



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FIGS. 46, 47.—SIPHONINA ECHINATA (H. B. BRADY).  $\times 100$ . (AFTER BRADY.)

*Description*.—“Test nearly spherical; consisting of about two convolutions, of which the outermost is composed of four segments; segments ventricose, unequally arched, embracing. Shell coarsely



perforated and usually more or less beset with short, blunt spines or tubercles. Aperture large and rounded; bordered by a thickened rim or forming a short, wide neck; often partially closed within by a shelly plate.

“Diameter 1/80th inch (0.32 mm.)”

*Distribution*.—Brady gives the only recorded station for this species in the North Pacific, that of the *Challenger* off the coral reefs of Honolulu, Hawaiian Islands, in 40 fathoms.

**SIPHONINA RETICULATA (Czjzek).**

Plate 16, fig. 4; plate 28, fig. 3.

*Rotalina reticulata* CZJZEK, Haidinger's Nat. Abh., vol. 2, 1848, p. 145, pl. 13, figs. 7-9.

*Siphonina reticulata* BRONN, Lethaea Geognostica, ed. 3, vol. 3, 1853-1856, p. 227, pl. 35(?), figs. 23a-c.

*Truncatulina reticulata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 669, pl. 96, figs. 5-8.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 228, pl. 45, figs. 23, 24.—TERRIGI, Mem. Com. Geol. Italia, vol. 4, 1891, p. 107, pl. 4, fig. 10.—CHASTER, First Rept. Southport Soc. Nat. Sci., 1890-1891 (1892), p. 66, pl. 1, fig. 16.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 402, pl. 16, figs. 42-44.—FLINT, Ann. Rep. U. S. Nat.

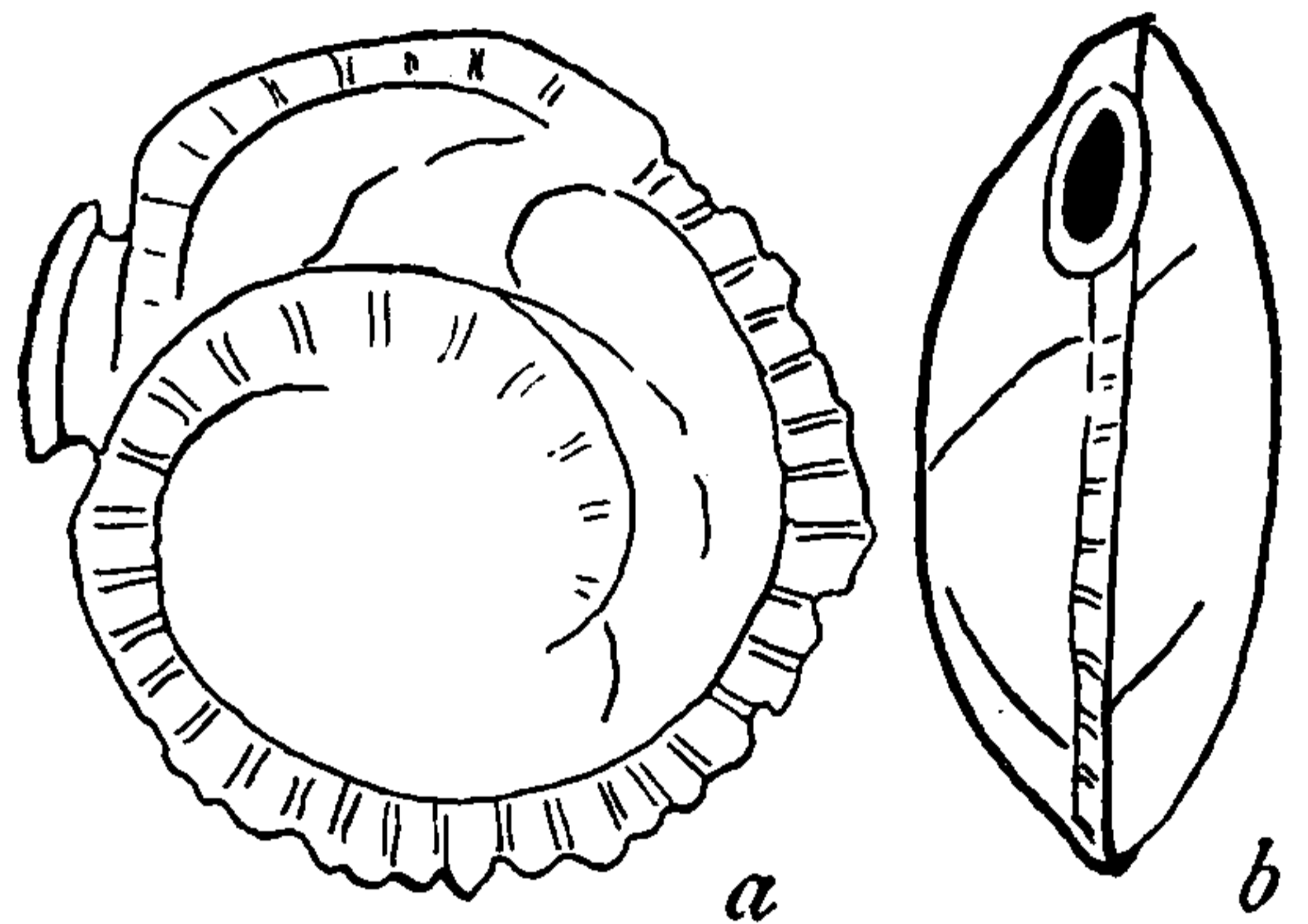


FIG. 48.—SIPHONINA RETICULATA (CZJZEK).  $\times 100$ .  
a, SIDE VIEW; b, APERTURAL VIEW. (ADAPTED FROM BRADY.)

Mus., 1897 (1899), p. 334, pl. 78, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 491.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 102; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 27.

*Siphonina fimbriata* REUSS, Denkschr. Akad. Wiss. Wien, 1849, p. 372, pl. 47, fig. 6.

*Description*.—Test free, nearly circular, biconvex, the two sides about equally so; peripheral margin acute and carinate, in small specimens with large carinal tubuli giving a serrate periphery, less irregular in adult specimens; chambers numerous, arranged in a rotaliform manner, thick-walled, translucent, distinctly punctate; aperture elliptical, with a definite tubular neck and phialine lip.

Diameter 0.50 to 0.75 mm.

*Distribution*.—The only material of this species I have recorded came from two *Albatross* stations off Japan, D4887, in 71 fathoms, bottom temperature 59.7° F., and D4949, in 110 fathoms, bottom temperature 57.8° F.



## Genus ANOMALINA d'Orbigny, 1826.

*Anomalina* D'ORBIGNY (type, *A. punctulata* d'Orbigny), Modèles, 1826, No. 67, p. 282.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 671.

*Description*.—Test nautiloid, composed of numerous chambers, but slightly involute; the two faces usually much alike, biconvex or slightly unsymmetrical; aperture a narrow curved slit at the base of the final chamber.

This genus consists of but few living species. It is distinguished from *Truncatulina*, mainly, by the biconvex character of the test.

## ANOMALINA ARIMINENSIS (d'Orbigny).

Plate 19, fig. 1.

*Planulina ariminensis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 280, pl. 14, fig. 1-3; Modèles, No. 49.

*Anomalina ariminensis* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 674, pl. 93, figs. 10, 11.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 228, pl. 45, figs. 20-22.—TERRIGI, Mem. Com. Geol. Italia, vol. 4, 1891, p. 107, pl. 4, fig. 12.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 5, 1895, p. 13, pl. 4, fig. 37.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 335, pl. 79, fig. 1.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 495.

*Planorbulina ariminensis* G. M. DAWSON, Can. Nat., ser. 2, vol. 7, 1874, p. 253, fig. *d*.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 91, pl. 15, figs. 784, 785.

*Planorbulina tuberosa*, var. *ariminensis* GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 98, pl. 7, figs. 228-233.

*Description*.—Test much compressed laterally, composed of numerous chambers all clearly visible from the dorsal side, and a part from the ventral side besides the last formed coil, nine or ten chambers in the last formed coil, chambers becoming elongate, comma-shaped; the sutures limbate; periphery squarely angled; wall coarsely perforate; aperture somewhat oblique on the ventral half of the chamber in face view.

Diameter about 0.6-1.2 mm.

*Distribution*.—Brady records this species from Hongkong Harbor. Bagg had it from two *Albatross* stations H4430 in 1,544 fathoms and H4567 in 1,307 fathoms off the Hawaiian Islands.

I have had typical specimens from but few stations, *Albatross* D3346 in 786 fathoms off the coast of Oregon and *Nero* 1065 in 1,321 fathoms between Guam and Japan.

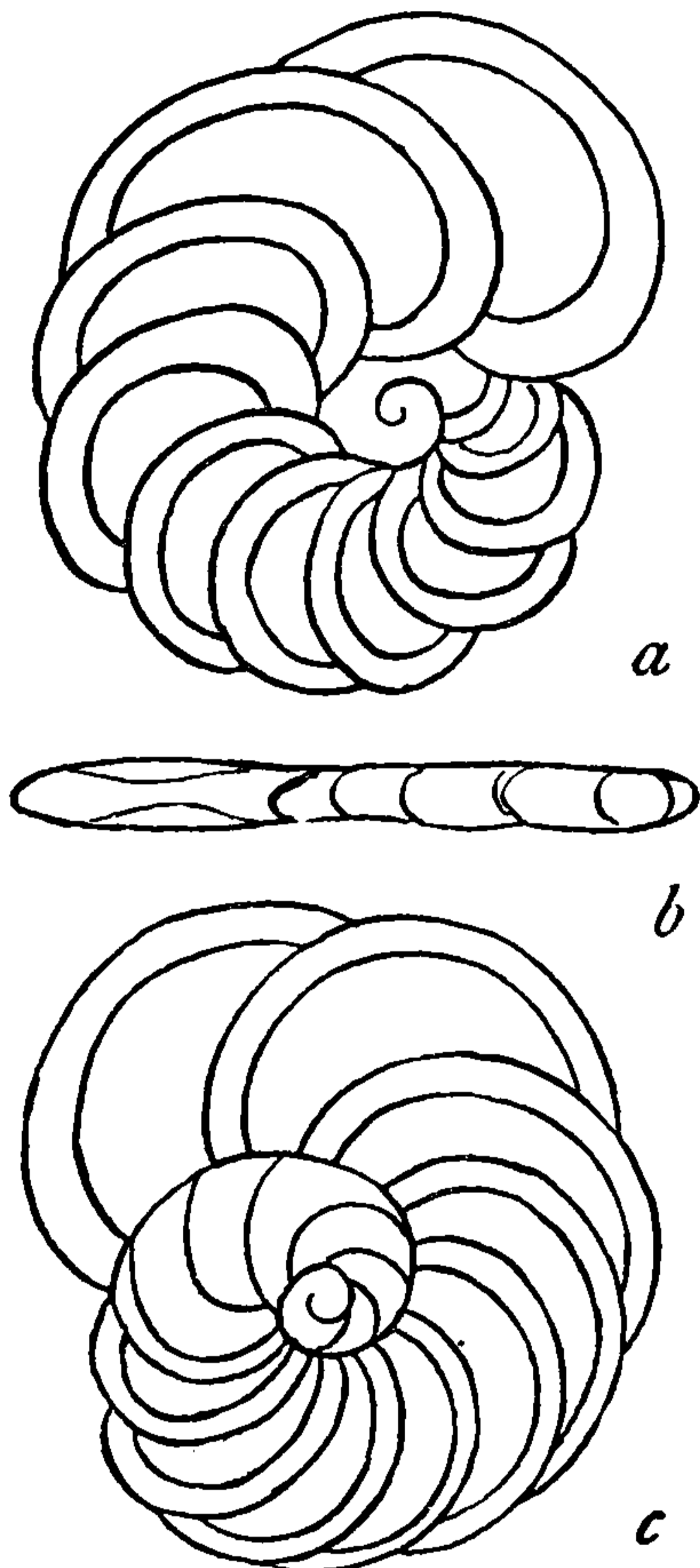


FIG. 49.—ANOMALINA ARIMINENSIS (D'ORBIGNY). (FROM D'ORBIGNY'S TYPE FIGURES OF 1826.) *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW.



## ANOMALINA GROSSERUGOSA (Gümbel).

Plate 20, fig. 1.

*Truncatulina grosserugosa* GÜMBEL, Abh. kais. bay. Akad. Wiss., vol. 10, 1868, p. 660, pl. 2, fig. 104.—TERRIGI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 117, pl. 8, fig. 5.

*Anomalina grosserugosa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 673, pl. 94, figs. 4, 5.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 487, pl. 11, fig. 34.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 563, pl. 11, fig. 25.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 378, pl. 14, fig. 4-6.—BURROWS and HOLLAND, Proc. Geol. Ass., vol. 15, 1897, p. 48, pl. 2, fig. 26.—BAGG, Bull. U. S. Geol. Survey, No. 88, 1898, p. 67, pl. 6, fig. 4.—FLINT, Rep. U. S. Nat. Mus., 1899, p. 335, pl. 78, fig. 5.—CHAPMAN, Proc. California Acad. Sci., ser. 3, Geol., vol. 1, 1900, p. 253, pl. 30, fig. 9.—SCHUBERT, Zeitschr. deutsch. geol. Ges., Jahrg., 1901, p. 21, figs. 5, 6.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 495.—BAGG, Proc. U. S. Nat. Mus. vol. 34, 1908, p. 160.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 421.—BAGG, Bull. U. S. Geol. Survey, No. 513, 1912, p. 85, pl. 26, fig. 1-6.

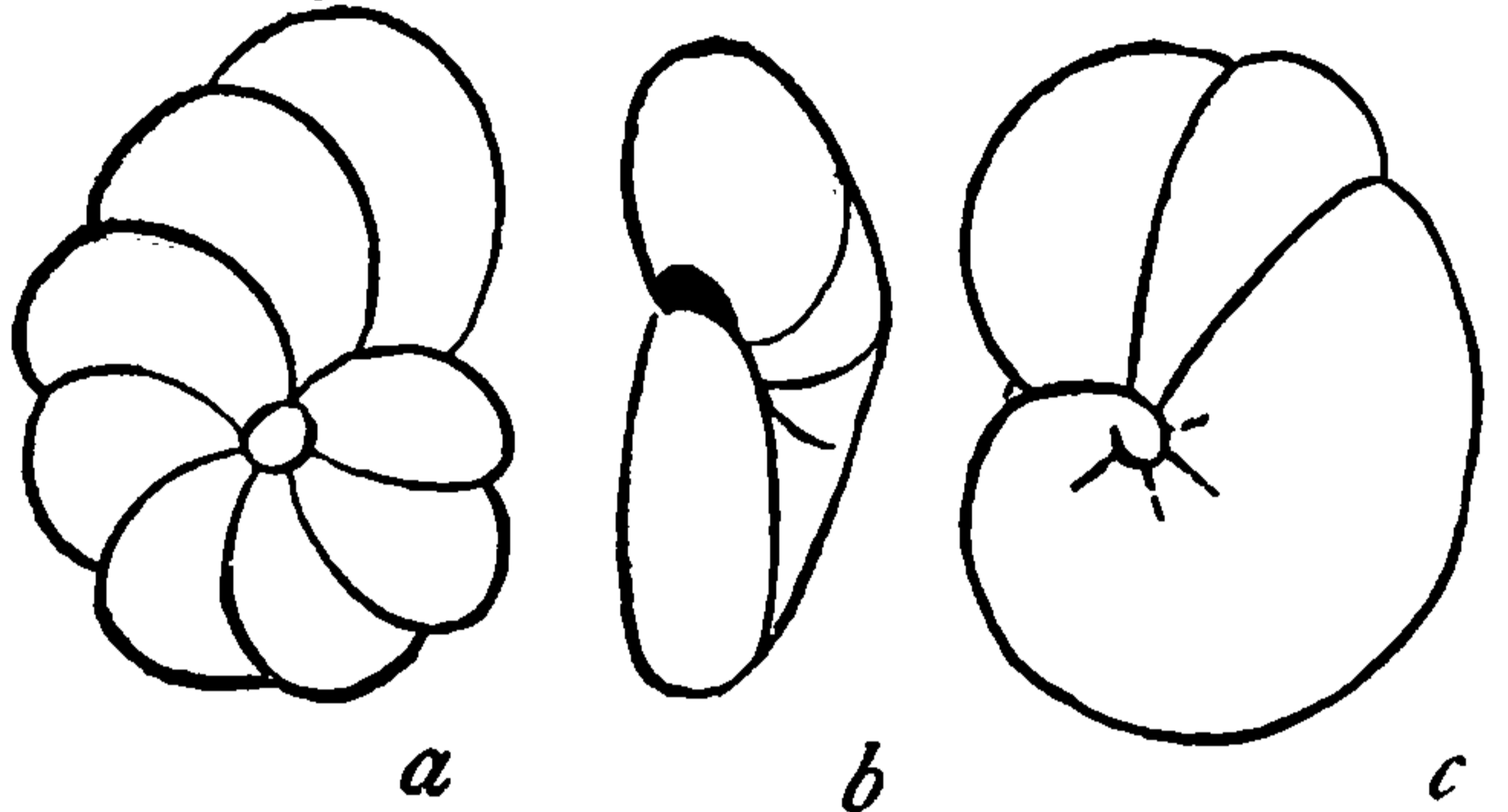


FIG. 50.—ANOMALINA GROSSERUGOSA GÜMBEL. (ADAPTED FROM GÜMBEL'S FIGURE OF THE TYPE.) *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW.

*Description*.—Test nautiloid, dorsal side somewhat concave, ventral side somewhat convex; chambers numerous, in three or more coils, all chambers visible from the dorsal side but only those of the final coil visible on the ventral face, usually seven chambers in the last formed coil; chambers somewhat inflated; sutures depressed, in face view broad; periphery broadly rounded; surface coarsely perforate, usually more so on the ventral side; aperture a narrow curved slit at the base of the chamber.

Diameter 1 mm. or more.

*Distribution*.—Brady gives two *Challenger* stations in the North Pacific for this species in 345 and 2,050 fathoms. Goës records it under the name *Planorbulina rudis* from two *Albatross* stations D3371 in 770 fathoms and D3375 in 1,201 fathoms off the west coast of tropical America. Bagg records it from numerous stations off the Hawaiian Islands at depths ranging from 367 to 1,544 fathoms. I have had it from numerous *Nero* stations between Guam and Japan and in the *Albatross* material from off Japan at depths ranging from 253 to 1,817 fathoms.

As far as the North Pacific material is concerned this is the most common species of the genus in the region.



## ANOMALINA AMMONOIDES (Reuss).

Plate 19, fig. 2.

*Rosalina ammonoides* REUSS, Geogn. Skizze Böhmen, vol. 2, 1844, p. 214; Verstein böhm. Kreide, vol. 1, 1845-6, p. 36, pl. 8, fig. 53; pl. 13, fig. 66; Haidinger's Naturw. Abhandl., vol. 4, 1850, p. 36, pl. 3, fig. 2.

*Planorbulina ammonoides* JONES, Geologist, vol. 6, 1863, p. 294, pl. 15, figs. 7, 8.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 756, pl. 16, figs. 14a-c.

*Discorbina ammonoides* REUSS, Sitz. Akad. Wiss. Wien, vol. 52, 1865, p. 456, No. 5.

*Rotalia ammonoides* GÜMBEL, Sitz. bay. Akad. Wiss., 1870, p. 283.

*Anomalina ammonoides* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 672, pl. 94, figs. 2, 3.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 228, pl. 45, figs. 20-22.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 378, pl. 13, fig. 35; pl. 14, figs. 36, 37.—WOODWARD and THOMAS, Geol. Nat. Hist. Survey, Minnesota, vol. 3, 1893 (1895), p. 44, pl. D, figs. 28, 29.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 7, 1898, p. 205, pl., fig. 24.—CHAPMAN, Journ. Roy. Micr. Soc., 1898, p. 4, pl. 1, fig. 5.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 335, pl. 78, fig. 4.—BAGG, Bull. U. S. Geol. Survey, No. 88, 1890, p. 67, pl. 6, fig. 5.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 494.—RHUMBLER, Zool. Jahrb., Abteil Syst., vol. 24, 1906, p. 67.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 138; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286; Journ. Linn. Soc., Zool., vol. 30, 1910, p. 421.—BAGG, Bull. U. S. Geol. Survey, No. 513, 1912, p. 85, pl. 26, figs. 7-10, b.

*Description.*—Test nearly or quite symmetrical, composed of numerous chambers in three to four coils; umbilici slightly concave,

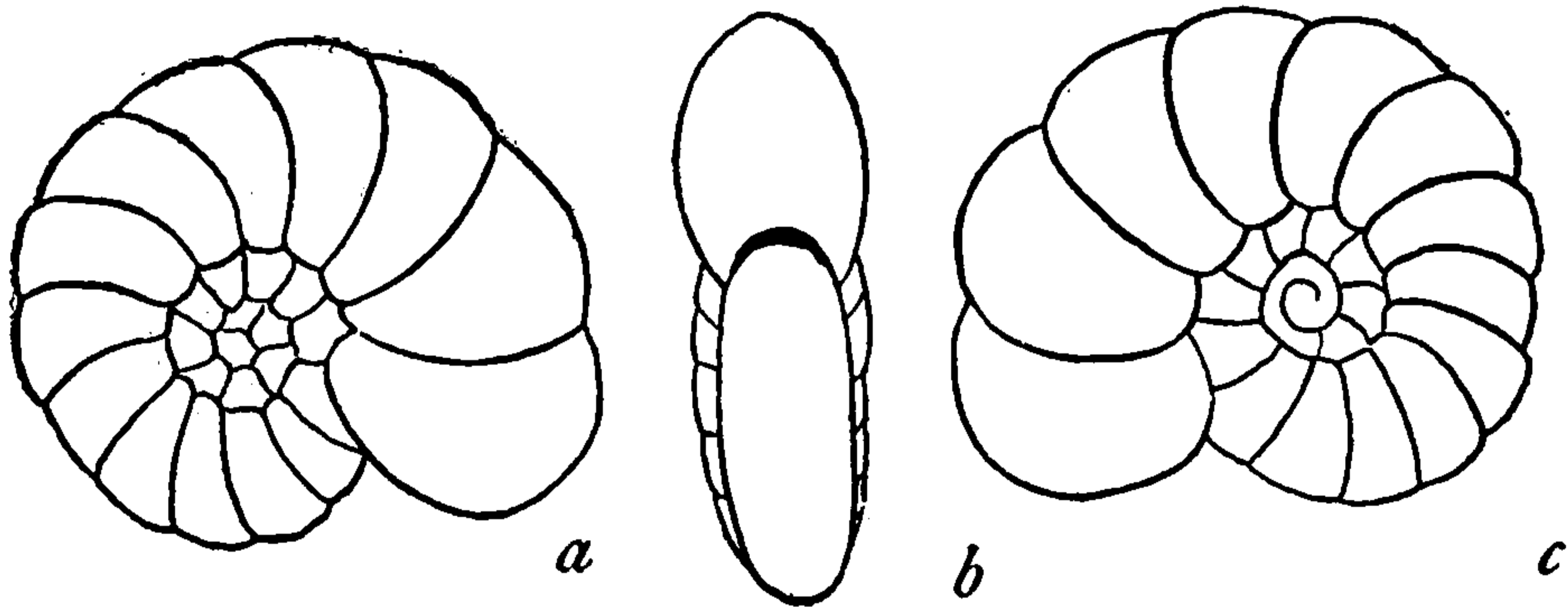


FIG. 51.—ANOMALINA AMMONOIDES (REUSS).  $\times 90$ . a, DORSAL VIEW; b, APERTURAL VIEW; c, VENTRAL VIEW. (ADAPTED FROM BRADY.)

sometimes slightly convex; chambers somewhat inflated; sutures somewhat depressed, about 12 to 16 chambers in the last formed volutions; periphery rounded; wall coarsely perforate, more so on the ventral side; aperture at the middle of the base of the periphery of the chamber.

Diameter 0.8 to 1.25 mm.

*Distribution.*—Brady records this species in anchor mud from Hongkong; Bagg, from 12 out of 19 *Albatross* stations off the Hawaiian Islands from which he had material, depths ranging from 104 to 1,544 fathoms, and Rhumbler records one young specimen from Chatham Island.



In the material at my disposal typical specimens have occurred but few times: At *Nero* station 990 in 859 fathoms off Guam and 1254 in 264 fathoms between Guam and Japan, at *Albatross* station H2986 in 271 fathoms off the Hawaiian Islands, and *Tuscarora* station 1 in 206 fathoms,  $21^{\circ} 10' N.$ ;  $158^{\circ} 04' W.$  From the material I have had this species is not as common in the North Pacific as some of the others of the genus.

**ANOMALINA POLYMORPHA** Costa.

Plate 19, figs. 3, 4.

*Anomalina polymorpha* COSTA, Atti Accad. Pont., vol. 7, 1856, p. 252, pl. 21, figs. 7, 9.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 676, pl. 97, figs. 3-7.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 380, pl. 14, figs. 27, 28, 32-34.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 336, pl. 79, fig. 3.—CHAPMAN, Proc. Roy. Soc. Edinburgh, vol. 23, 1901, p. 392, pl. 1, figs. 4-6; Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 104; Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 138.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 160.—CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1910, p. 421.

*Description*.—Test nautiloid, nearly equally biconvex, ventral side concave, dorsal convex; umbilical region on ventral side depressed; seven to eight chambers in the final coil, in face view broad; periphery broad, angled, some of the chambers with a single large toothlike projection at the periphery; wall coarsely perforate; aperture an elongated arched slit at the base of the chamber.

Diameter up to 1.5 mm.

*Distribution*.—Bagg has recorded this species from several *Albatross* stations in the vicinity of the Hawaiian Islands, depths ranging from 305 to 1,274 fathoms. I have had it from numerous stations off the Hawaiian Islands, off Guam, and off Japan, depths ranging from 271 to 2,067 fathoms.

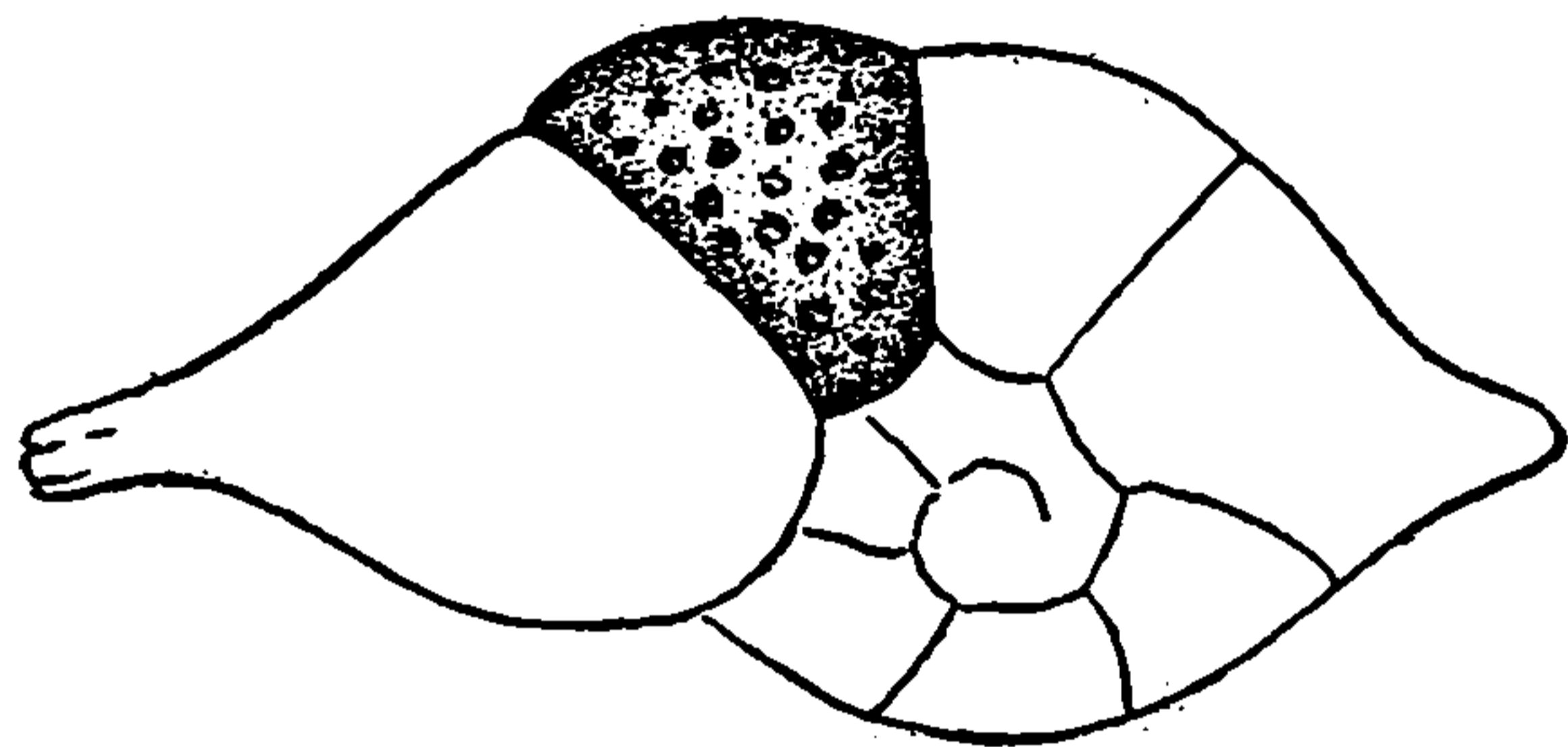


FIG. 52.—ANOMALINA POLYMORPHA COSTA.  $\times 35$ .  
AFTER BRADY.

**ANOMALINA CORONATA** Parker and Jones.

Plate 18, fig. 5.

*Anomalina coronata* PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 294, pl. 10, figs. 15, 16.—H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 469, pl. 48, figs. *a*, *b*; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 675, pl. 97, figs. 1, 2.—FORNASINI, Mem. Acad. Sci. Inst. Bologna, ser. 5, vol. 3, 1893, pl. 2, fig. 17.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 379, pl. 14, figs. 29, 30.—MORTON, Proc. Portland Soc. Nat. Hist., vol. 2, 1897, p. 120, pl. 1, fig. 21.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 159.

*Planorbulina farcata*, var. (*Anomalina*) *coronata* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 383, pl. 14, figs. 7-11.

*Planorbulina coronata* Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 90, pl. 15, figs. 781-783.



*Description*.—Test nautiloid, nearly equally biconvex, the dorsal side more convex than the ventral; the umbilical region concave on both sides, broad, in face view nearly as broad as the diameter; peripheral border nearly flattened in the later chambers which increase rapidly in width, about eight chambers in the final coil; wall coarsely perforate. The inner border of the chambers often of clear shell material; aperture a narrow curved slit at the ventral side of the chamber, oblique.

Diameter up to 1.5 mm.

*Distribution*.—The only North Pacific records for this species seem to be those given by Bagg from four *Albatross* stations off the

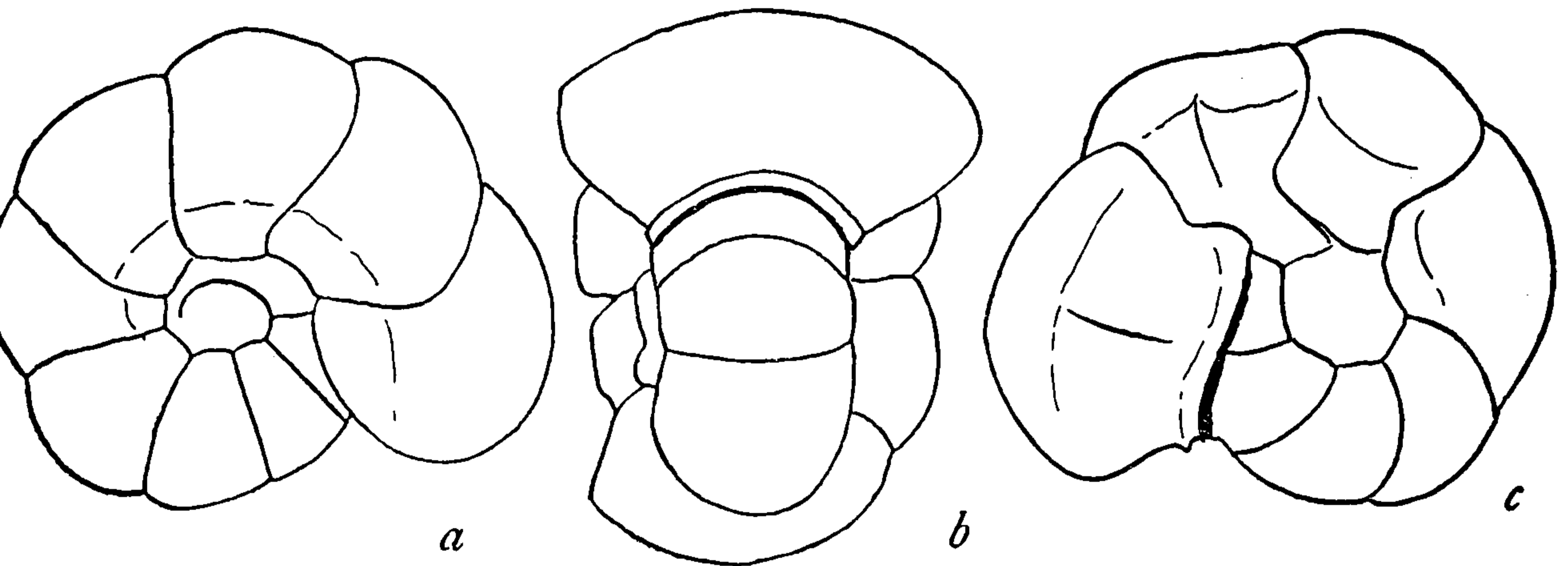


FIG. 53.—ANOMALINA CORONATA PARKER AND JONES.  $\times 40$ . *a*, DORSAL VIEW; *b*, APERTURAL VIEW; *c*, VENTRAL VIEW. (ADAPTED FROM BRADY.)

Hawaiian Islands, D4000, H4566, H4571, H4596, depths ranging from 104 to 572 fathoms. I have failed to find typical specimens of this species.

#### Genus CARPENTERIA Gray, 1858.

*Carpenteria* GRAY (type, *C. balaniformis* Gray), Proc. Zool. Soc., London, vol. 26, 1858, p. 269.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 676.

*Description*.—Test attached, early chambers rotaliform, later ones becoming irregular and inflated, extending upward in an irregular column; chambers few; wall coarsely perforate; aperture in adult specimens usually with a tubular neck.

The species of this genus are apparently most common in the shallow waters of tropical seas. The genus was noted but twice in the North Pacific material examined.

#### CARPENTERIA MONTICULARIS Carter.

Plate 20, fig. 3.

*Carpenteria monticularis* CARTER, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 211, pl. 13, figs. 9–12.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 677, pl. 99, figs. 1–5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 439, pl. 21, fig. 12.—CHAPMAN, Journ. Linn. Soc., Zoology, 1900, p. 14, pl. 2, fig. 5; pl. 4, figs. 5, 6.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 496.

*Description*.—Test attached; early chambers coiled, aperture an elongate slit at the inner margin of the chamber, later chambers



elongate, irregular, piled up irregularly about a central axis; wall smooth; aperture either a rounded opening at the upper end of the test or with a definite tubular neck.

*Distribution.*—Brady figures a fine suite of specimens from off Zamboanga, Philippine Islands, from 102 fathoms. He also found it in material dredged by the *Challenger* off Honolulu, Hawaiian Islands, in 40 fathoms. The only material of this species I have seen in the present collection is from *Nero* station 1328 in 871 fathoms off Japan. This is very much like the figures of the young given by Brady.<sup>1</sup>

CARPENTERIA PROTEIFORMIS Goës.

Plate 20, fig. 2; plate 21, fig. 1.

*Carpenteria balaniformis*, var. *proteiformis* Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, 1882, p. 94, pl. 6, figs. 208–214; pl. 7, figs. 215–219.

*Carpenteria proteiformis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 679, pl. 97, figs. 8–14.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 74, pl. 6, figs. 8–17.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 28, 1900, p. 195, pl. 19, fig. 11.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 496, pl. 10, figs. 1–2.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 286.

*Description.*—Test attached, columnar, basal portion usually somewhat spreading and buttressed; early chambers arranged in a coiled manner but covered by the later ones which become much inflated and are built up into an irregular, subcylindrical column of a few chambers; wall coarsely porous; aperture often with a tubular neck.

Length up to 6 mm.

*Distribution.*—The only specimens from the North Pacific that I have seen came from *Albatross* station D4922, in Colnett or Vincennes Strait in 60 fathoms, bottom temperature 79.2 F. This is essentially a coral-reef species and it adds another to the considerable list of tropical species of foraminifera which have been noted from this and adjoining stations.

Genus RUPERTIA Wallich, 1877.

*Rupertia* WALLICH (type, *R. stabilis* Wallich), Ann Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 502.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 680.

*Description.*—Test attached, columnar; early chambers coiled, later chambers extending up into a coiled column; wall coarsely punctuate; aperture a narrow curved slit at the inner margin of the chamber.

This genus with the single species here given forms a rather unique modification in the Rotaliidæ.

<sup>1</sup> Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 98, figs. 15, 16.



## RUPERTIA STABILIS Wallich.

Plate 21, figs. 2-5.

*Rupertia stabilis* WALLICH, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 501, pl. 20.—SCHLUMBERGER, Feuille des Jeunes Naturalistes, ann. 13, 1883, p. 27, pl. 2, fig. 6-8.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 680, pl. 98, figs. 1-12.—EGGER, Abh. kön. bay. Akad. Wiss, München, Cl. II, vol. 18, 1893, p. 439, pl. 21, figs. 8, 9.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 92, pl. 15, fig. 789; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 74.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 336, pl. 79, fig. 4.

*Description*.—Test attached, with a slightly spreading base, again expanding above into a columnar test, more or less irregular in outline; chambers numerous, arranged in a spiral at the base and then in a spiral manner as the columnar portion is developed; surface smooth but conspicuously punctate; aperture an arched opening near the inner margin of the somewhat concave apertural face; color often yellowish-brown.

Length up to 1.68 mm. or more.

*Distribution*.—The only record for this species in the North Pacific is that given by Goës from the Eastern Tropical Pacific, *Albatross* D 3419, in 772 fathoms.

## Genus PULVINULINA Parker and Jones, 1862.

*Pulvinulina* PARKER and JONES (type *Nautilus repandus* Fichtel and Moll), in Carpenter, Parker, and Jones, *Introd. Foram.*, 1862, p. 201.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 681.

*Description*.—Test usually rotaliform, dorsal side usually convex, ventral side usually flattened; outline typically circular but in some species elongate; wall finely porous, variously ornamented by costæ, bosses, reticulations, or smooth; aperture typically ventral, extending from near the periphery to the umbilicus.

This genus embraces a large number of species which show a wide range of characters, but they seem to be best distinguished by having the dorsal side convex, ventral side flattened, and the aperture elongate from near the periphery to the umbilicus.

There is much confusion in regard to this generic name, but *Pulvinulina* is kept here as there seems to be some difficulty in regard to earlier names.

## PULVINULINA REPANDA (Fichtel and Moll).

Plate 24, fig. 3.

*Nautilus repandus* FICHEL and MOLL, Test. Micr., 1798, p. 35, pl. 3, figs. a-d.

*Rotalia repanda* PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 175, No. 25.

*Pulvinulina repanda* PARKER and JONES, in Carpenter, Parker, and Jones, *Introd. Foram.*, 1862, p. 311.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 206, pl. 3, fig. 61.—Goës, Kongl. Svensk. Vet. Handl., vol. 19, pt. 4, 1882, p. 110, pl. 8, figs. 276-282.—TERRIGI, Atti Accad. Pont. Nuovi



Lincei, vol. 35, 1883, p. 198, pl. 3, fig. 42.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 684, pl. 104, figs. 18a-c.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 757, pl. 16, fig. 18.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 405, pl. 18, figs. 28-30, 34, 35.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 95, pl. 16, fig. 801.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 328, pl. 72, fig. 8.—JONES and CHAPMAN, in A Monograph of Christmas Island, 1900, p. 228, pl. 20, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1903, p. 496.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 138.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 5.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 87, pl. 24, figs. 5-8.

*Description.*—Test almost equally biconvex; peripheral margin acute, slightly lobulated, carinate; chambers seven or eight in the last formed whorl; sutures somewhat curved above, nearly radial below, limbate on both surfaces, on the ventral side running into one another and merging at the umbilical area; wall smooth, finely punctate; aperture a slightly arched opening halfway between the umbilicus and the peripheral margin.

Diameter up to 1.5 mm.

*Distribution.*—Bagg records this species from two *Albatross* stations off the Hawaiian Islands, D4017 in 305 fathoms and H4694 in 865 fathoms. These are the only records for the North Pacific.

**PULVINULINA CONCENTRICA** Parker and Jones.

Plate 28, fig. 4.

*Pulvinulina concentrica* (Parker and Jones, MS.) H. B. BRADY, Trans. Linn. Soc., London, vol. 24, 1864, p. 470, pl. 48, fig. 14.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 393.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 686, pl. 105, fig. 1a-b.—UHLIG, Jahrb. k. geol. Reichs., vol. 36, 1886, p. 190, pl. 3, figs. 3, 4.—GRZYBOWSKI, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej.-Krakowie, vol. 29, 1894, p. 202, pl. 4, fig. 9.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 497.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, 1909, No. 21, p. 7, pl. 3, fig. 5.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 287.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, 1910, No. 16, p. 28.

*Discorbina vestita* SEGUENZA, Mem. Accad. dei Lincei, ser. 3, vol. 6, 1880, p. 148, pl. 13, fig. 39.

*Description.*—Test biconvex, oral; chambers comparatively few, five to seven in the last formed coil, carinate; sutures covered by a clear shell material joining with the carinal border and often covering a large portion of the test, both above and below; aperture near the peripheral border on the ventral side.

Diameter up to 2 mm.

*Distribution.*—Apparently there are no published North Pacific records for this species. I have had specimens from *Albatross* stations D4087 in 44 fathoms and D4922 in 60 fathoms, bottom temperature 79.2° F., both stations off Japan.



## PULVINULINA PUNCTULATA (d'Orbigny).

Plate 24, fig. 1.

*Rotalia punctulata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 273, No. 25; Modèles, No. 12.

*Pulvinulina repanda*, var. *punctulata* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 394, pl. 14, figs. 12, 13.

*Pulvinulina punctulata* PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 20, pl. 3, fig. 82.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 685, pl. 104, fig. 17a-c.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 139.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 287.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 86, pl. 25, figs. 6-9.

*Description*.—Test large, plano-convex, dorsal side somewhat convex, ventral side flattened or even somewhat concave; peripheral

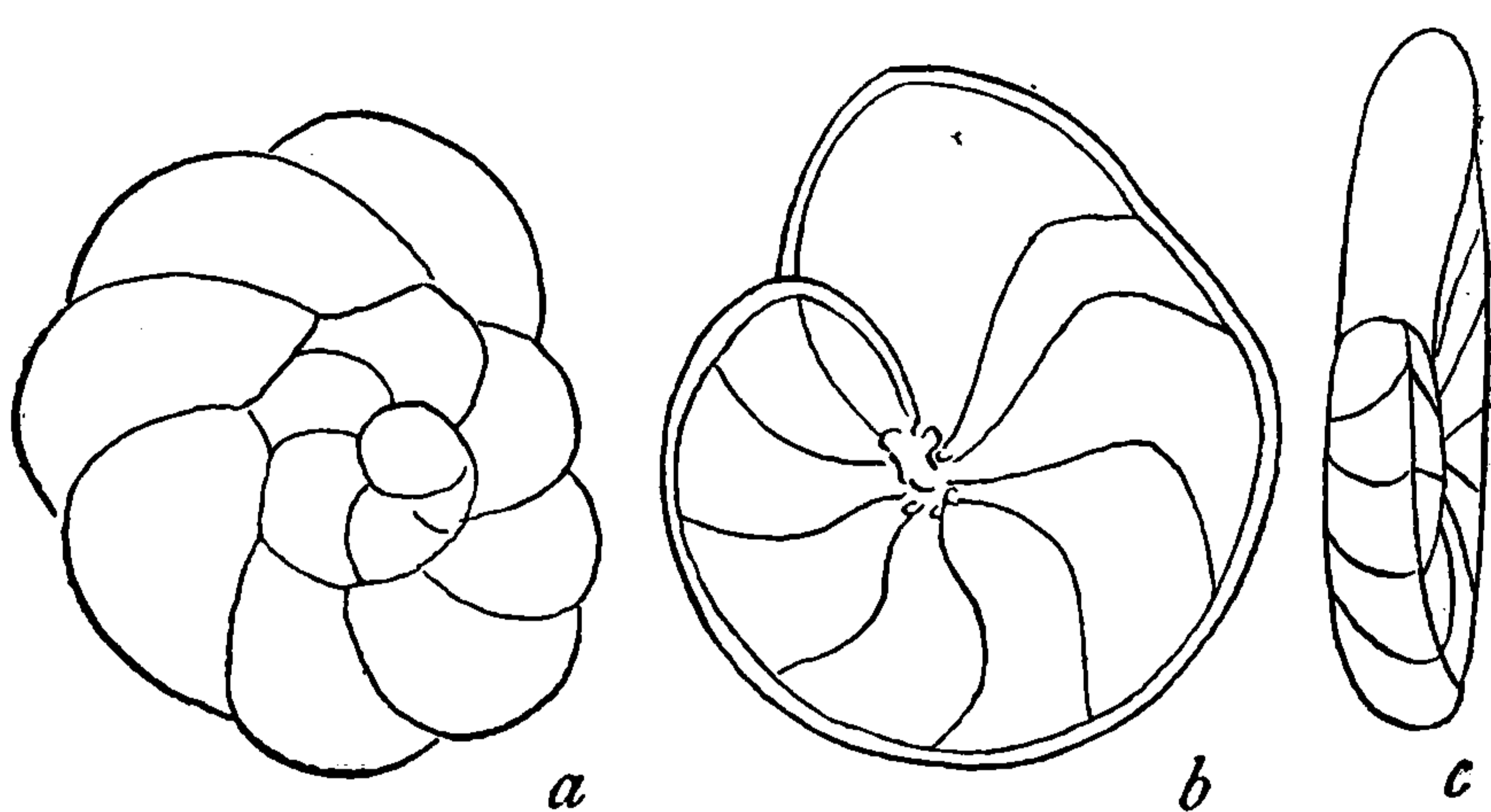


FIG. 54.—PULVINULINA PUNCTULATA (D'ORBIGNY). a, DORSAL VIEW; b, VENTRAL VIEW; c, SIDE VIEW. (AFTER PARKER AND JONES.)

margin rounded; chambers usually seven in the last formed whorl; sutures curved, depressed, on the ventral side the chambers running to a point at the umbilicus; wall smooth except at the um-

bilicus where it is often rugose or granular; aperture a narrow, curved slit at the umbilical end of the chamber.

Diameter up to 3 mm.

*Distribution*.—The only North Pacific record for *Pulvinulina punctulata* is that given by Bagg who records it as rare from *Albatross* D4017 in 305 fathoms, off the Hawaiian Islands. I have failed to find specimens of this species in the material which I have examined from other stations.

## PULVINULINA CONCAMERATA (Montagu).

Plate 25, fig. 1.

*Serpula concamerata* MONTAGU, Test. Brit., Suppl., 1808, p. 160.

*Rotalina concamerata* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 52, pl. 4, figs. 102, 103.

*Pulvinulina repanda* CARPENTER, PARKER and JONES, Introd. Foram., Appendix, 1862, p. 311.

*Pulvinulina repanda*, var. *concamerata* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 685, pl. 104, fig. 19a-c.

*Description*.—Test biconvex, the sides about equally so; chambers six to eight in the last-formed coil, distinct; sutures on the ventral



side simple and depressed, dorsally limbate; peripheral margin carinate, dorsally with a raised margin confluent with that of the sutures; surface smooth below, above with numerous rounded bosses scattered thickly over the area between the raised sutural lines.

Diameter up to 2 mm.

*Distribution*.—This species has apparently not previously been recorded from the North Pacific. It occurred in some considerable numbers at *Albatross* station D4807 in 44 fathoms off Japan.

**PULVINULINA AURICULA (Fichtel and Moll).**

Plate 22, fig. 1.

*Nautilus auricula*, var. *a*, FICHTEL and MOLL, Test. Micr., 1803, p. 108, pl. 20, figs. *a-c*.

*Pulvinulina auricula* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 393.—

PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 173, pl. 12, fig. 143.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33,

1880, p. 206, pl. 3, fig. 58.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19,

pt. 4, 1882, p. 109, pl. 8, figs. 273–275.—H. B. BRADY, Rep. Voy. *Challenger*,

Zoology, vol. 9, 1884, p. 688, pl. 106, figs. 5*a-c*.—CHAPMAN, Trans. New

Zealand Inst., vol. 38, 1905, p. 105.

*Description*.—Test elongate oval, biconvex, the dorsal side slightly convex, the ventral side more strongly so; peripheral margin in later chambers acute, in the early ones rounded; chambers six or seven in the last-formed whorl, rapidly increasing in size and length, the last-formed chamber especially on the ventral side occupying the larger part of the whole area of the test; sutures but very slightly depressed, distinct; wall smooth, thin and translucent, finely perforate; aperture a narrow slit near the umbilicate end of the chamber.

Diameter up to 1 mm.

*Distribution*.—Brady in the *Challenger* Report gives the only North Pacific record for this species in 95 fathoms off the Philippines. From the available records this species does not extend to very great depths, which may account for the fact that I have not found it in the North Pacific material which I have examined.

**PULVINULINA OBLONGA (Williamson), var. SCABRA H. B. Brady.**

Plate 27, fig. 5.

*Pulvinulina oblonga* (Williamson), var. *scabra* H. B. BRADY, Rep. Voy. *Chal-*

*lenger*, Zoology, vol. 9, 1884, p. 689, pl. 106, fig. 8*a-c*.—H. B. BRADY, PARKER,

and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 229, pl. 46, fig. 5.—

SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No.

21, 1909, p. 6, pl. 3, figs. 3, 4; vol. 54, No. 16, 1910, p. 27.

*Description*.—Test biconvex, dorsal side nearly flattened, ventral side more convex; peripheral margin acute, carinate; chambers seven or eight in the final whorl, rapidly increasing in size and length as added, on the ventral side the last formed chamber in the adult



taking up at least one-half the area of the test; sutures slightly depressed, limbate above and below, wall rugose or granular on the dorsal side, smooth below.

Diameter about 0.5 mm.

*Distribution.*—The only published record for this seems to be that of Brady from the *Challenger* station off the Philippines in 95 fathoms. I have questionable specimens from *Nero* station 1073 in 1,208 fathoms.

**PULVINULINA HAUERII (d'Orbigny).**

Plate 22, fig. 4.

*Rotalina hauerii* D'ORBIGNY, *Foram. Foss. Bass. Tert. Vienne*, 1846, p. 151, pl. 7, figs. 22-24.

*Pulvinulina hauerii* PARKER and JONES, *Philos. Trans.*, vol. 155, 1865, p. 393.—H. B. BRADY, *Rep. Voy. Challenger, Zoology*, vol. 9, 1884, p. 690, pl. 106, figs. 6, 7.—EGGER, *Abh. kön. bay. Akad. Wiss. München, Cl. II*, vol. 18, 1893, p. 414, pl. 17, figs. 29-31.—WOODWARD and THOMAS, *Geol. Nat. Hist. Surv. Minnesota*, vol. 3, 1893, p. 44, pl. E, fig. 34.—CHAPMAN, *Journ. Roy. Micr. Soc.*, 1898, p. 5, pl. 1, fig. 7.—EGGER, *Abh. kön. bay. Akad. Wiss. München*, vol. 21, 1899, p. 154, pl. 18, figs. 4-6.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 498.—SIDEBOTTOM, *Mem. and Proc. Manchester Lit. and Philos. Soc.*, vol. 53, 1909, No. 21, p. 7, pl. 3, fig. 6.—CHAPMAN, *Journ. Linn. Soc. Zoology*, vol. 30, 1910, p. 423.

*Description.*—Test biconvex, somewhat elongate, twice as long as wide, composed of few chambers in the last-formed coil; chambers rotund; sutures deeply depressed; wall smooth except for the rather coarse punctæ; aperture on the ventral border of the margin of the chamber.

Length about 1 mm.

*Distribution.*—Apparently this species has not previously been recorded from the North Pacific. I have material from *Albatross* station D4966 in 290 fathoms, bottom temperature 44.1° F., off Japan.

This species may be distinguished from *Pulvinulina auricula* by its much more rounded contour.

**PULVINULINA MENARDII (d'Orbigny).**

Plate 22, fig. 2.

*Rotalia menardii* D'ORBIGNY, *Ann. Sci. Nat.*, vol. 7, 1826, p. 273, No. 26; *Modèles*, No. 10.

*Pulvinulina menardii* OWEN, *Journ. Linn. Soc. London (Zool.)*, vol. 9, 1867, p. 148, pl. 5, fig. 6.—THOMSON, *Proc. Roy. Soc. London*, vol. 23, 1875, p. 37, pl. 3, figs. 1, 2.—GOËS, *Kongl. Svensk. Vet. Akad. Handl.*, vol. 19, pt. 4, 1882, p. 112, pl. 8, figs. 289-295.—H. B. BRADY, *Quart. Journ. Micr. Sci.*, vol. 19, 1879, p. 80; *Rep. Voy. Challenger, Zoology*, vol. 9, 1884, p. 690, pl. 103, figs. 1, 2.—MALAGOLI, *Boll. Soc. Geol. Italia*, vol. 6, 1887, p. 523, pl. 13, fig. 10.—H. B. BRADY, PARKER, and JONES, *Trans. Zool. Soc., London*,



vol. 12, 1888, p. 228, pl. 46, fig. 3.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 19, 1893, p. 411, pl. 17, figs. 1-3, 7-12.—WOODWARD and THOMAS, Geol. Nat. Hist. Survey Minnesota, vol. 3, 1893, p. 45, pl. E, fig. 33.—BURROWS and HOLLAND, Proc. Geol. Ass., vol. 15, 1897, p. 48, pl. 2, fig. 22.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 73, fig. 3.—RHUMBLER, in Brandt, Nordisches Plankton, Heft. 14, 1900, p. 14, figs. 6-8; Zeitschr. für allgem. Phys., vol. 2, 1902, p. 234, fig. 67.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5a, vol. 10, 1902, p. 58, fig. 55.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 499.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 162.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.

*Description.*—Test plano-convex, compressed, dorsal side slightly convex, ventral side flat or somewhat concave, umbilicate; peripheral margin thin, slightly lobulated, carinate; chambers usually six in the last-formed coil; sutures somewhat depressed, especially below, on the dorsal side limbate and curved, ventrally simply depressed, straight, in a radial position; wall usually smooth and punctate but sometimes slightly granular; aperture a rather well-developed opening at the umbilical end of the chamber, with a projecting valvular lip.

Diameter up to 1.27 mm.

*Distribution.*—This species of world-wide distribution is not uncommon in the North Pacific. Goës records its being taken in a pelagic condition. Picaglia records it at three stations of the *Vettor Pisani* just north of the Equator. Bagg records it at 18 out of the 19 *Albatross* stations from which he had material in the vicinity of the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms. I have records of its occurrence at a hundred or more *Albatross*, *Alert*, *Nero*, and *Tuscarora* stations in the area, and this could have been multiplied several times but it was thought not worth while to record further. It is common in the North Pacific wherever conditions of depth and temperature are right for the formation of *Globigerina* ooze.

**PULVINULINA MENARDII (d'Orbigny), var. FIMBRIATA H. B. Brady.**

*Pulvinulina menardii* D'ORBIGNY, var. *fimbriata* H. B. BRADY, Rep. Voy. Challenger, vol. 9, 1884, p. 691, pl. 103, fig. 3a, b.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 412, pl. 17, fig. 19.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 73, fig. 4.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 16, fig. 9.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 162.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.

*Description.*—Variety differing from the typical in the smaller size and spinose character of the peripheral keel.

*Distribution.*—Bagg records this variety from three *Albatross* stations in the vicinity of the Hawaiian Islands, depths from 384 to 1,307 fathoms. I have seen a few rather poorly representative specimens from this same region, but there does not appear to be as good a development of the variety as occurs in the Gulf of Mexico for example.



## PULVINULINA TUMIDA H. B. Brady.

Plate 22, fig. 3.

*Pulvinulina menardii* D'ORBIGNY, var. *tumida* H. B. BRADY, Geog. Mag., vol. 4, 1877 p. 294; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 80.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 163.

*Pulvinulina tumida* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 692, pl. 103, figs. 4-6.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 414, pl. 17, figs. 4-6, 35-37, 44.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 73, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 499.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 31.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 422.

*Description.*—Test biconvex, oval, dorsal surface convex especially in the early portion, ventral side less convex, umbilicate; peripheral margin rounded, becoming more acute in the later formed portion with a rounded carina; chambers fairly numerous, about six in the last-formed whorl; sutures curved, depressed on the ventral side; wall of the early portion of the test granular, later chambers becoming progressively smoother; aperture an arched opening near the umbilical end of the margin of the chamber, often with a slight valvular projection above.

Diameter up to 1.25 mm.

*Distribution.*—Brady records *Pulvinulina tumida* from two Challenger stations in the North Pacific at depths of 500 and 1,850 fathoms. Picaglia records it from three stations of the *Vettor Pisani* in the same area. Bagg records it from 13 out of the 19 stations in the vicinity of the Hawaiian Islands from which he had material, depths ranging from 104 to 1,544 fathoms. I have had specimens from several stations off the Hawaiian Islands at depths varying from 1,265 to 2,615 fathoms, from off the Galapagos Islands D2806 in 1,379 fathoms and from a great number of *Nero* stations, especially between Guam and Yokohama. It seems to be common where *Globigerina* ooze conditions obtain.

## PULVINULINA CANARIENSIS (d'Orbigny).

Plate 23, fig. 1.

*Rotalina canariensis* D'ORBIGNY, in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 130, pl. 1, figs. 34-36.

*Pulvinulina repanda*, var. *menardii*, subvar. *canariensis* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 395, pl. 16, figs. 47-49.

*Pulvinulina canariensis* OWEN, Journ. Linn. Soc. London, vol. 9, Zool., 1867, p. 148, pl. 5, fig. 21.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 80.—TERRIGI, Atti Acad. Pont. Nuovi Lincei, vol. 33, 1880, p. 207, pl. 3, figs. 59, 60.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 692, pl. 103, figs. 8-10.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 413, pl. 17, figs. 20-22.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 16, fig. 10.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 500.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 105.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 160.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.



*Description.*—Test biconvex, dorsal surface somewhat umbonate, ventral low and broadly rounded, umbilicate; peripheral margin acute, conspicuously lobulated with rounded angles, slightly carinate; chambers comparatively few, usually five in the last formed whorl; sutures distinct above, slightly depressed, below much depressed; wall of earlier portion spinosely granular, later chambers becoming progressively smooth, the last formed chamber often very smooth; aperture a narrow curved slit extending from the umbilicus well toward the peripheral margin.

Diameter up to 1.25 mm.

*Distribution.*—In the *Challenger* Report Brady states that this species is much less common in the North Pacific and Indian Ocean than in the other oceans. As far as the North Pacific is concerned this is apparently due to lack of material at his disposal. He recorded it from but one North Pacific station off Japan in 345 fathoms. Bagg records it from 15 out of 19 *Albatross* stations from which he had material off the Hawaiian Islands, depths ranging from 104 to 1,544 fathoms. I have had specimens from *Albatross* H2923 in 392 fathoms off the Hawaiian Islands and D2806 in 1,379 fathoms off the Galapagos Islands. Between Guam and Japan it has occurred at numerous *Nero* stations, depths ranging from 264 to 1,990 fathoms.

Brady also records the species from one surface station in the North Pacific.

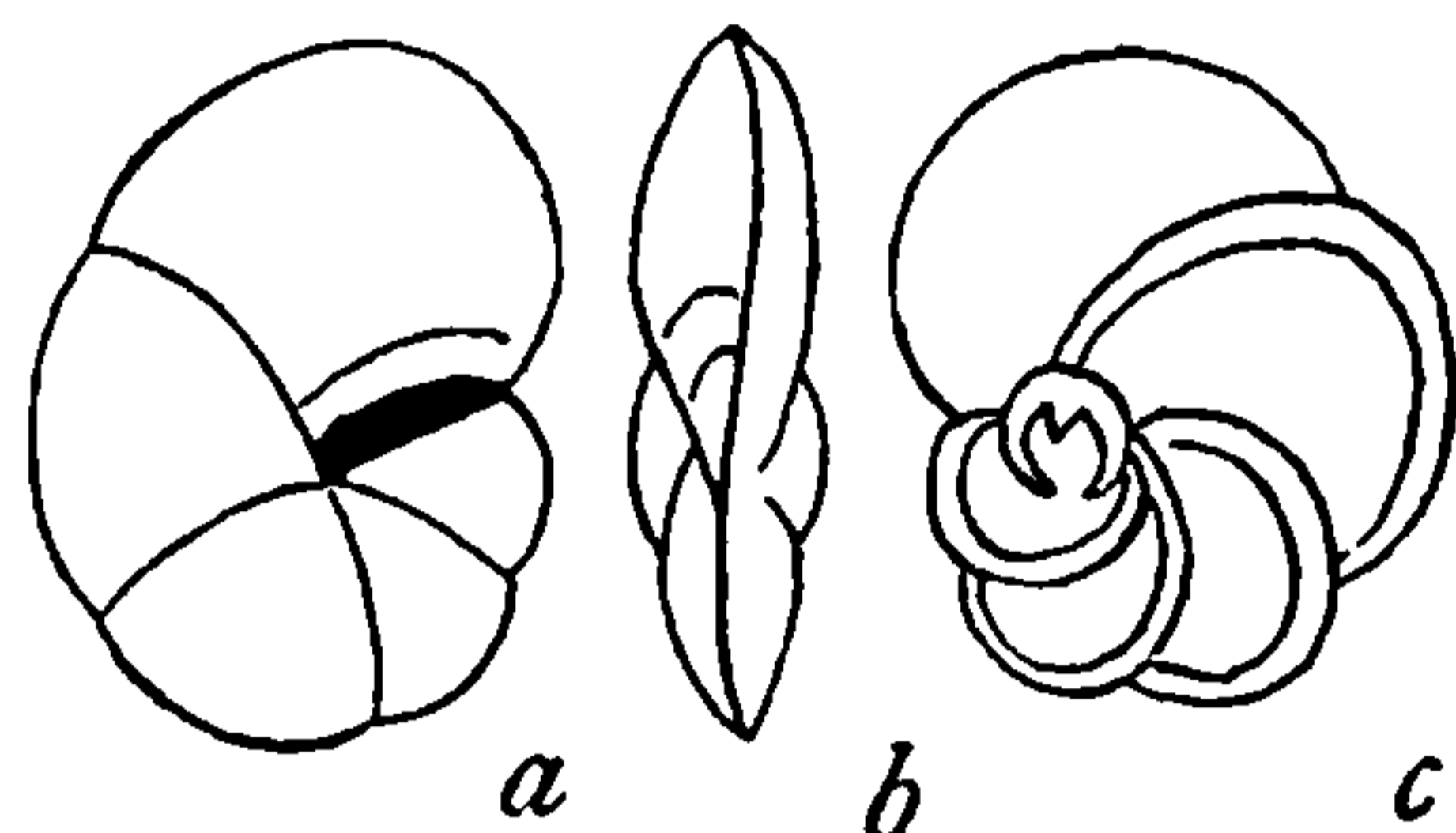


FIG. 55.—PULVINULINA CANARIENSIS (D'ORBIGNY). *a*, VENTRAL VIEW; *b*, SIDE VIEW; *c*, DORSAL VIEW. (AFTER D'ORBIGNY'S TYPE FIGURE.)

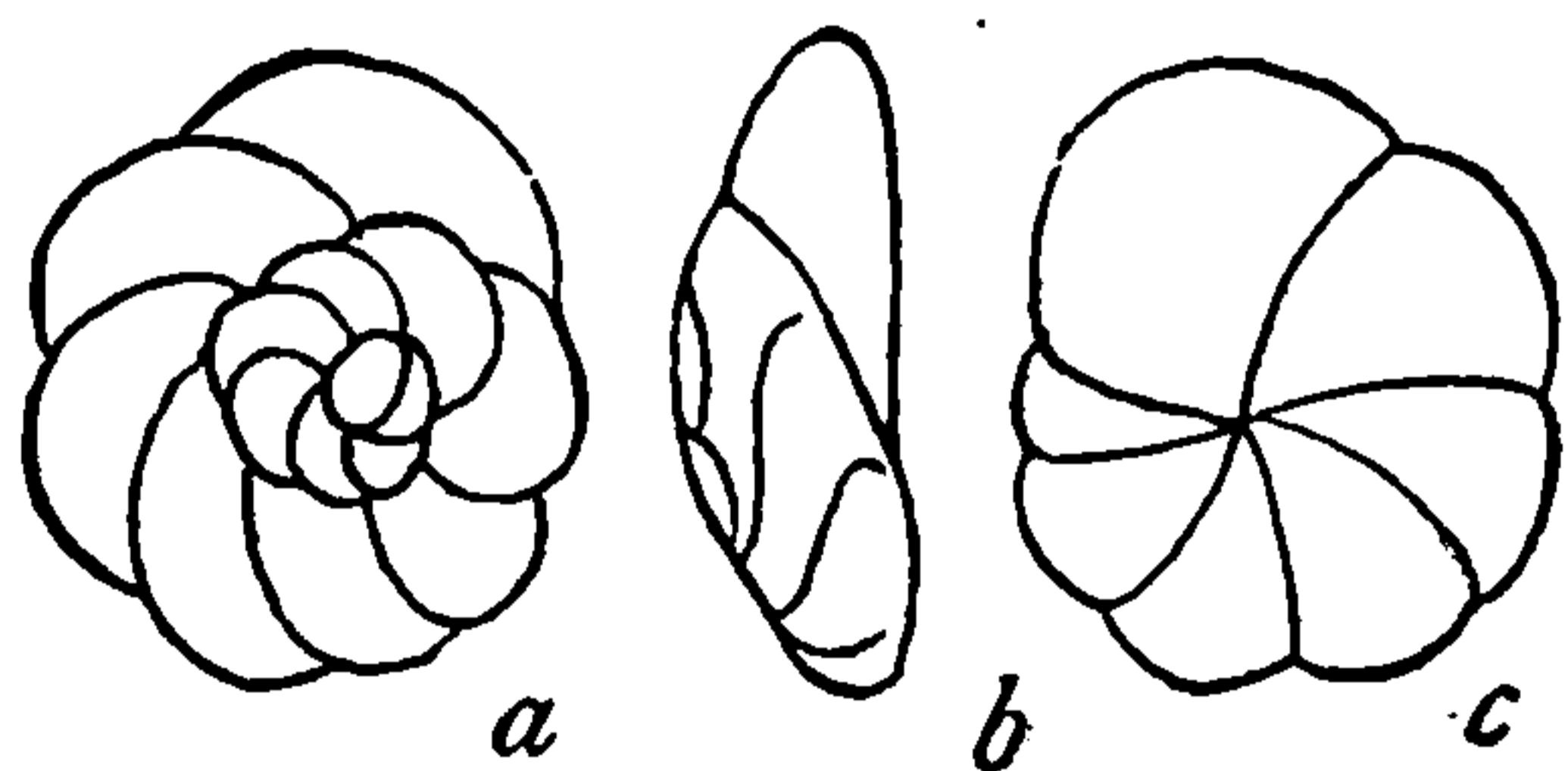


FIG. 56.—PULVINULINA PATAGONICA (D'ORBIGNY). *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER D'ORBIGNY'S TYPE FIGURE.)

PULVINULINA PATAGONICA (d'Orbigny).

*Rotalina patagonica* D'ORBIGNY, Voy Amér. Mérid., 1839, "Foraminifères," p. 36, pl. 2, figs. 6-8.

*Pulvinulina patagonica* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 693, pl. 103, fig. 7a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 413, pl. 17, figs. 16-18.—RHUMBLER, in Brandt, Nordisches Plankton,

Heft 14, 1900, p. 13, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 500.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 162.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 422.

*Description.*—Test small, biconvex, dorsal side more convex than the ventral; peripheral margin rounded, slightly lobulated; chambers few, usually five in the last formed whorl; sutures much curved,



depressed; wall granular roughened; aperture a narrow arched slit extending from the umbilicus well toward the peripheral margin.

Diameter 0.25–0.40 mm.

*Distribution.*—Brady records *Pulvinulina patagonica* from four *Challenger* stations in the North Pacific, the depths ranging from 500 to 2,900 fathoms. Bagg records it from two *Albatross* stations in the vicinity of the Hawaiian Islands H4502 in 1,342 fathoms and H4566 in 572 fathoms.

From the material I have had this species seems to be rather common in the North Pacific. It was frequent at many *Nero* stations between Guam and Yokohama depths ranging from 518 to 2,048 fathoms.

This species somewhat closely resembles *P. canariensis* but may be easily distinguished by the periphery.

PULVINULINA CRASSA (d'Orbigny).

Plate 27, fig. 1.

*Rotalina crassa* D'ORBIGNY, Mém. Soc. Géol. France, vol. 4, 1840, p. 32, pl. 3, figs. 7, 8.

*Pulvinulina crassa* OWEN, Journ. Linn. Soc. Zool. London, vol. 9, 1867, p. 148; pl. 5, fig. 8(?), 9.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 80; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 694, pl. 103, figs. 11, 12.—TERRIGI, Mem. Com. Geol. Ital., vol. 4, 1891, p. 108, pl. 4, fig. 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 416, pl. 18, figs. 7–12.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 329, pl. 74, fig. 1.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 17, figs. 12, 14, 15.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 500.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 105.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 161.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 422.

*Description.*—Test subconical, the dorsal face flat, ventral face convexly rounded, umbilicate; peripheral margin rounded, lobulated, not carinate; chambers comparatively few, usually but four in the last formed whorl, sutures curved; surface granular or subspinose; aperture an arched opening widest at the umbilical end of the chamber and extending nearly to the periphery.

Diameter 0.50–0.60 mm.

*Distribution.*—Brady records *Pulvinulina crassa* from a single *Challenger* station in the North Pacific in 2,250 fathoms. Bagg records it from six *Albatross* stations in the vicinity of the Hawaiian Islands at depths ranging from 384 to 1,544 fathoms. I have failed to find any specimens which I could refer to this species.



## PULVINULINA TRUNCATULINOIDES (d'Orbigny).

Plate 23, fig. 4.

*Rotalina truncatulinoides* D'ORBIGNY, in Barker, Webb, and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 132, pl. 2, figs. 25-27.

*Pulvinulina truncatulinoides* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 398, pl. 16, figs. 41-43.—RHUMBLER, in Brandt, Nordisches Plankton, Heft 14, 1900, p. 17, fig. 16.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 105; Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 423.

*Rotalina micheliniana* D'ORBIGNY, Mém. Soc. Géol. France, vol. 4, 1840, p. 31, pl. 3, figs. 1-3.

*Discorbina micheliniana* REUSS, Sitz. Akad. Wiss. Wien, vol. 52, 1865, p. 455, No. 1.

*Pulvinulina repanda*, var. *menardii*, subvar. *micheliniana* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 396, pl. 14, fig. 16, pl. 16, figs. 41-43.

*Pulvinulina micheliniana* OWEN, Journ. Linn. Soc. London, Zool., vol. 9, 1867, p. 148, pl. 5, fig. 17.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, pt. 4, 1882, p. 114, pl. 8, figs. 296-298.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 694, pl. 104, figs. 1, 2.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 229, pl. 46, figs. 9, 10.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 416, pl. 18, figs. 1-6.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 500.

*Pulvinulina micheliniana* FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 330, pl. 74, fig. 2.

*Description*.—Test subconical, the dorsal surface either flat or more often slightly concave, ventral surface forming a truncate cone, umbilicate; peripheral margin angular, bluntly rounded, often slightly carinate; chambers comparatively few, five or six in the last formed whorl, sutures nearly radial; dorsal surface nearly smooth, punctate or slightly granular, ventral surface very often decidedly granular; aperture a long narrow opening extending from the umbilicus nearly to the peripheral margin.

Diameter 0.60-1 mm.

*Distribution*.—This is one of the most common of the species of the North Pacific, especially at depths which are favorable to the accumulation of *Globigerina* ooze. Brady and Goës record it as pelagic in the North Pacific and Brady records it from five *Challenger* stations with depths ranging from 345 to 2,950 fathoms. Picaglia records it from a single station of the *Vettor Pisani* in the North Pacific and Bagg records its occurrence at 17 out of the 19 *Albatross* stations off the Hawaiian Islands from which he had material, depths ranging from 104 to 1,544 fathoms.

I have had material from various parts of the North Pacific from *Albatross*, *Nero*, *Tuscarora*, and *Alert* stations ranging in depth from

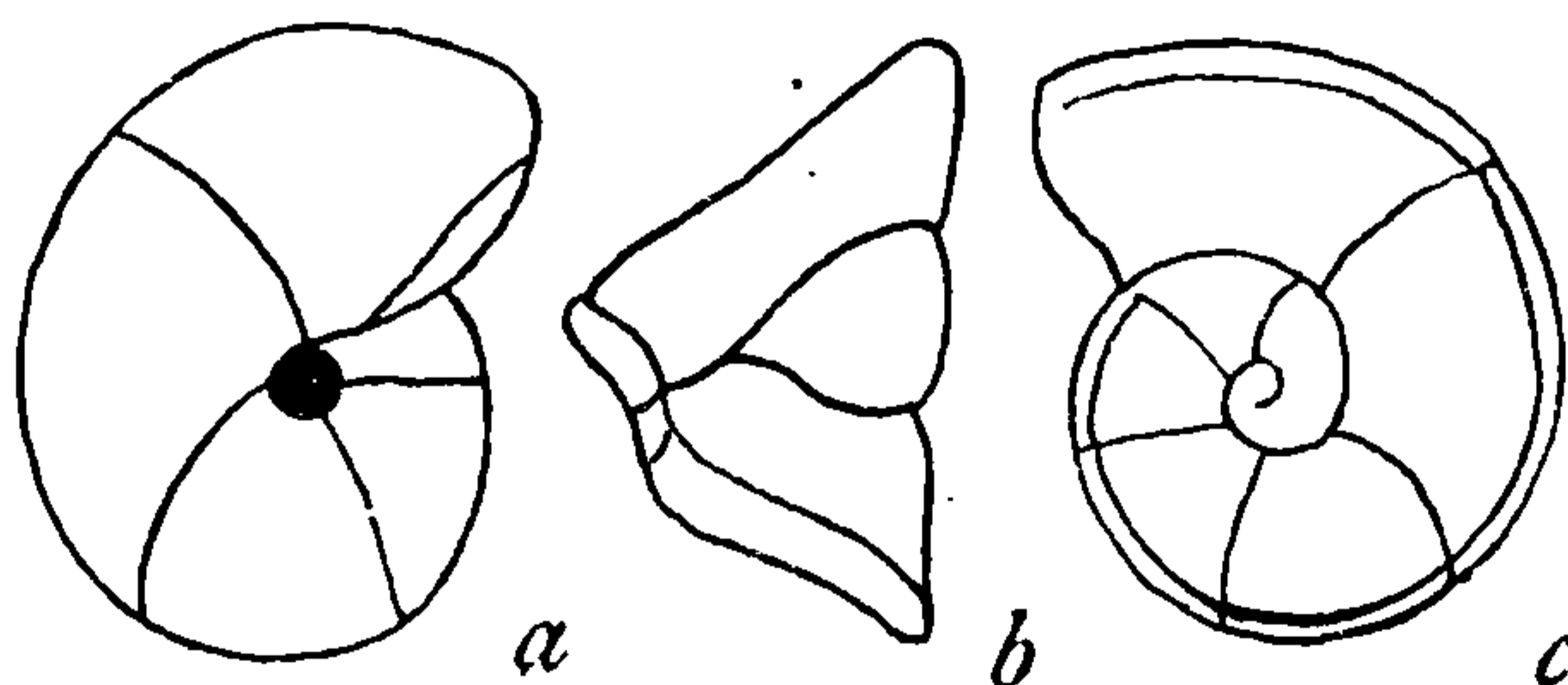


FIG. 57.—PULVINULINA TRUNCATULINOIDES (D'ORBIGNY). a, VENTRAL VIEW; b, SIDE VIEW; c, DORSAL VIEW (AFTER D'ORBIGNY).



264 to 2,615 fathoms. Between Guam and Yokohama at the *Nero* stations where a record was kept it was present at nearly every station.

The specific name *truncatulinoides* antedates *meliniana* and so must be adopted, as has been done by some writers. This is one of the characteristic constituents of the *Globigerina* ooze in the North Pacific as elsewhere.

**PULVINULINA UMBONATA (Reuss).**

Plate 27, fig. 2.

*Rotalina umbonata* REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 75, pl. 5, fig. 35a-c.

*Pulvinulina umbonata* REUSS, Deutsch. Akad. Wiss. Wien, vol. 25, 1866, p. 206.—HANTKEN, Mitth. Jahrb. ung. geol. Anstalt., vol. 4, 1875, p. 77, pl. 9, fig. 8a-c.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 35, 1883, p. 200, pl. 4, figs. 45, 46.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 695, pl. 105, fig. 2a-c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 410, pl. 18, figs. 19-21.—FLINT, Rep. U. S. Nat. Mus. 1897 (1899), p. 330, pl. 74, fig. 4.

*Description*.—Test small, sides unequally convex, the dorsal side much less convex than the ventral; peripheral margin acute; chambers five or six in the last-formed coil; sutures nearly straight, radial, distinct but not depressed; wall smooth, finely punctate; aperture a narrow slit extending from the umbilicus to the peripheral margin

Diameter about 0.50 to 0.75 mm.

*Distribution*.—Brady records this species from three *Challenger* stations in the North Pacific at depths ranging from 345 to 3,125 fathoms. Flint records it from *Albatross* station D3080 in 93 fathoms off the coast of Oregon.

I have seen it only from a *Nero* station, 1207 in 665 fathoms off the coast of Japan.

**PULVINULINA EXIGUA H. B. Brady.**

Plate 23, fig. 5.

*Pulvinulina exigua* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 696, pl. 103, figs. 13, 14.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 75.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 28.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 422.

*Description*.—Test small, almost equally convex on the two sides; peripheral margin bluntly rounded, often lobulated; chambers comparatively few, five or six in the last formed whorl; sutures above as well as the border of the whorl in the early portion marked by clear shell material, on the ventral side depressed and not so marked; wall finely punctate; aperture a narrow slit running from the peripheral margin to the umbilicus.



Diameter 0.3 to 0.5 mm.

*Distribution.*—Brady records *Pulvinulina exigua* from five *Challenger* stations in the North Pacific depths ranging from 15 to 2,300 fathoms. Goës records it from a single *Albatross* station D3433 in 1,218 fathoms, rare. I have had it from *Nero* station 10 between the Hawaiian and Midway Islands and from numerous *Nero* stations between Guam and Yokohama ranging in depth from 859 fathoms off Guam to 2,098 fathoms. As far as noted, it has usually occurred as few specimens at any one station.

**PULVINULINA PAUPERATA Parker and Jones.**

Plate 23, figs. 2, 3.

*Pulvinulina repanda*, var. *menardii*, subvar. *pauperata* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 395, pl. 16, figs. 50, 51.

*Pulvinulina pauperata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 696, pl. 104, figs. 3–11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 412, pl. 17, figs. 32, 34.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 77.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 330, pl. 74, fig. 3.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 423.

*Description.*—Test much flattened, planospiral; peripheral margin extended into a broad, flat, thin, transparent carina, occasionally somewhat thickened at the margin; chambers numerous, ten to fifteen in the last formed coil, all visible from both sides of the test; sutures depressed; chambers inflated; aperture a small opening near the peripheral margin of the test.

Diameter up to 3 mm.

*Distribution.*—This rather unique species seems to be rather well distributed in the North Pacific but does not appear to be common at any particular stations. Brady records it from one *Challenger* station in 1,850 fathoms. Goës notes its occurrence at four *Albatross* stations in the western Tropical Pacific at depths ranging from 770 to 1,201 fathoms. Picaglia records it from a single station just north of the equator. Flint noted its occurrence at *Nero* station 760 in 1,560 fathoms between Midway Islands and Guam. I have had specimens from off the Galapagos Islands *Albatross* D2806 in 1,379 fathoms and from a large number of *Nero* stations from Guam to Yokohama, depths ranging from 1,029 to 2,278 fathoms. This species varies considerably in the width of the marginal wing-like carina. In its remote chambers also it differs from others of the genus.

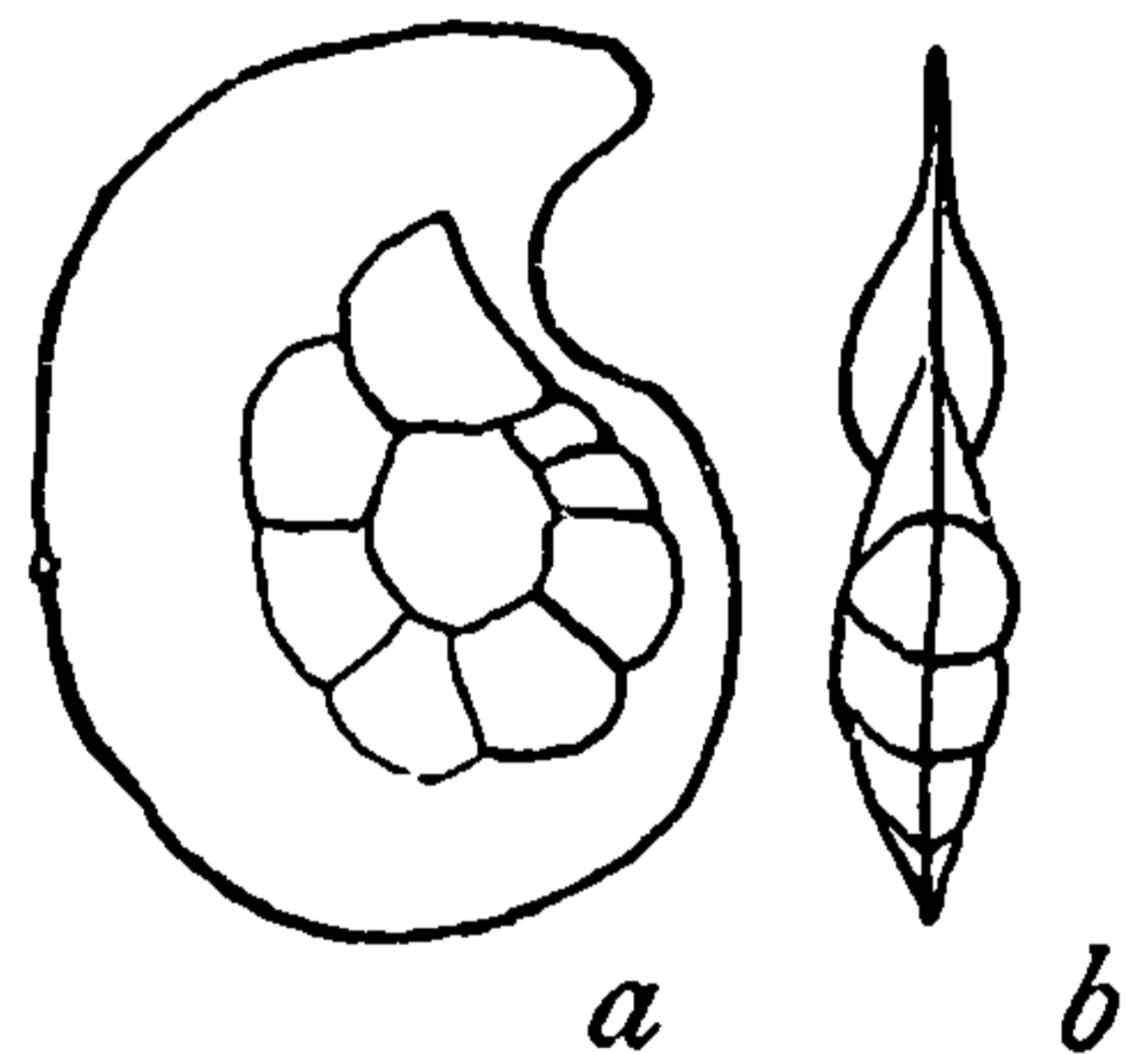


FIG. 58.—PULVINULINA PAUPERATA PARKER AND JONES. *a*, SIDE VIEW; *b*, VIEW FROM PERIPHERY. (AFTER TYPE FIGURE BY PARKER AND JONES.)



## PULVINULINA SCHREIBERSII (d'Orbigny).

*Rotalina schreibersii* D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 154, pl. 8, figs. 4-6.

*Pulvinulina schreibersii* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 393.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 697, pl. 115, fig. 1a-c.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., London, vol. 12, 1888, p. 228, pl. 46, fig. 4.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 409, pl. 18, figs. 31-33, 67-69.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 501.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 106.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 8, pl. 3, fig. 8.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 289.

*Truncatulina schreibersii* SEGUENZA, Atti Accad. Lincei, ser. 3, vol. 6, 1879, p. 149, etc.

*Description.*—Test subconical, dorsal side elevated, apex broadly rounded, ventral side slightly convex; peripheral margin bluntly rounded; chambers numerous, about seven to nine in the last-formed whorl; sutures but slightly depressed above, curved, below more depressed, the umbilical ends filled with secondary material to form a stellate mass; wall finely punctate, smooth; aperture a narrow opening extending from near the peripheral margin wholly or partially to the umbilical end of the chamber.

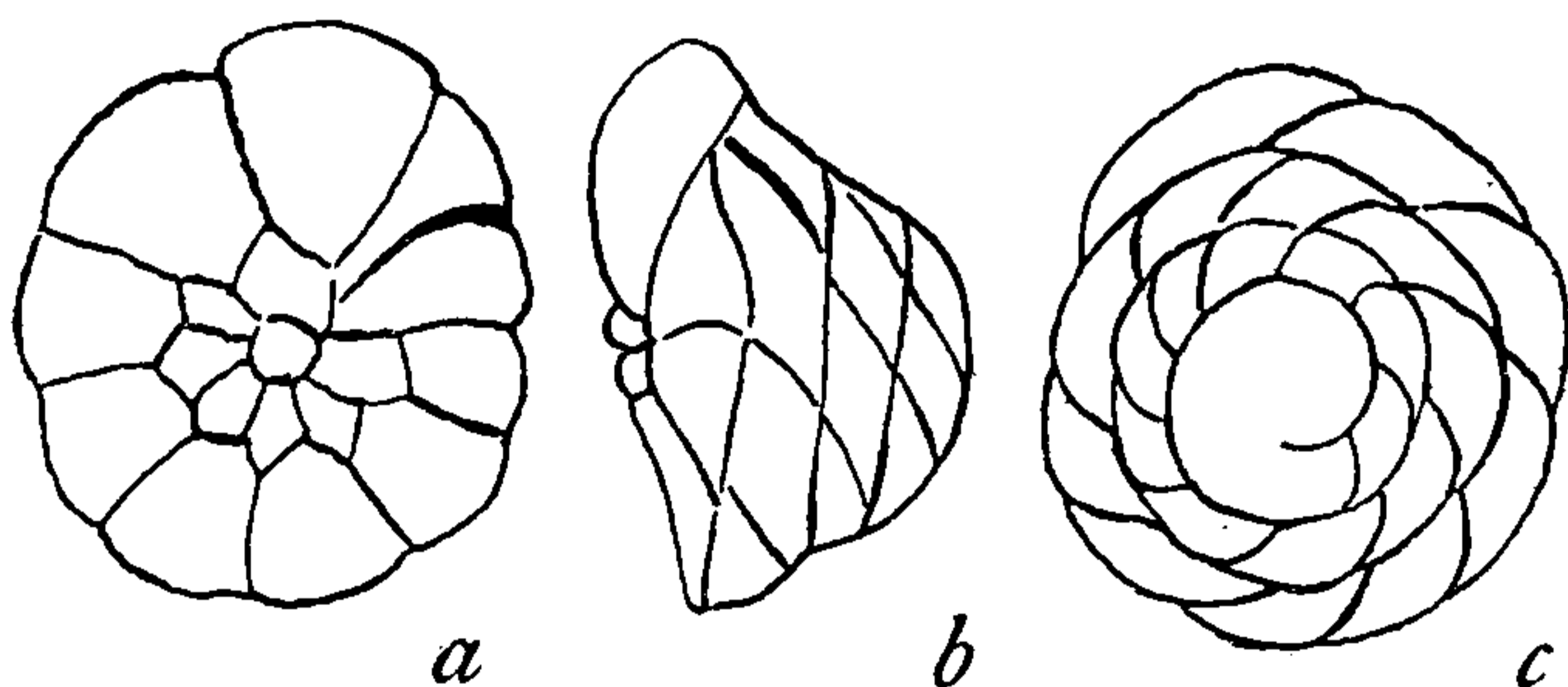


FIG. 59.—PULVINULINA SCHREIBERSII (D'ORBIGNY). a, VENTRAL VIEW; b, SIDE VIEW; c, DORSAL VIEW. (AFTER TYPE FIGURES BY D'ORBIGNY.)

opening extending from near the peripheral margin wholly or partially to the umbilical end of the chamber.

Diameter up to 1.30 mm.

*Distribution.*—The two stations in the vicinity of the Hawaiian Islands recorded by Bagg seem to be the only records for this species in the North Pacific. They are *Albatross* H4476 in 438 fathoms and H4566 in 572 fathoms.

## PULVINULINA PROCERA H. B. Brady.

Plate 24, fig. 2; plate 25, fig. 2.

*Pulvinulina procera* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 66; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 698, pl. 105, fig. 7a-c.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 163.

*Description.*—“Test trochoid, forming an elevated cone with rounded apex and flat or truncate inferior face; composed of numerous convolutions, the last of which consists of about six segments; segmentation very oblique, indistinct on the superior face, especially near the center; sutures and periphery more or less limbate on the inferior side; aperture an arched slit at the margin of the final segment, near the umbilicus.

“Diameter, 1-22 inch (1.1 mm.)”



*Distribution.*—The only definitely recorded station for this species in the North Pacific seems to be that given by Bagg, *Albatross* H4508 in 495 fathoms off the Hawaiian Islands. I have found the species in the material which I have examined only from one station, *Albatross* D4874, in 66 fathoms off Japan. This is the station at which numerous other tropical species occur, such as *Truncatulina præcineta* and *T. margaritifera*.

**PULVINULINA KARSTENI (Reuss).**

Plate 26, fig. 1.

*Rotalia karsteni* REUSS, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 273, pl. 9, fig. 6.

*Pulvinulina karsteni* H. B. BRADY, Trans. Linn. Soc., vol. 24, 1864, p. 470, pl. 48, fig. 15; Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 436, pl. 21, fig. 11a-c; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 698, pl. 105, fig. 8, 9.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 758, pl. 16, fig. 21a-c.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 330, pl. 74, fig. 5.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 7, pl. 3, fig. 7.

*Pulvinulina repanda*, var. *karsteni* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 396, pl. 14, figs. 14, 15, 17; pl. 16, figs. 38-40.

*Description.*—Test almost equally biconvex, the dorsal side slightly more conical, the ventral side rather more broadly rounded; peripheral margin carinate, bluntly rounded; chambers numerous, about five to seven in the last formed whorl; sutures curved, slightly if at all depressed above, below more compressed; wall finely punctate; aperture a narrow slit extending from the umbilical end of the chamber to the peripheral margin.

Diameter 0.3 to 0.6 mm.

*Distribution.*—Apparently this species has not previously been recorded from the North Pacific. I have material from but two stations in western Pacific *Albatross* D4822 in 130 fathoms and *Nero* 1065 in 1,321 fathoms.

**PULVINULINA ELEGANS (d'Orbigny).**

Plate 26, fig. 3.

*Rotalia (Turbinulina) elegans* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 276, No. 54.

*Pulvinulina elegans* JONES and PARKER, Geologist, vol. 7, 1864, p. 88.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 174, pl. 12, fig. 142.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 699, pl. 105, figs. 4-6.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 228, pl. 46, fig. 2.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 489, pl. 11, fig. 30-32.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 410, pl. 18, figs. 37-39.—FORNASINI, Mem. Accad. Sci. Inst. Bologna, ser. 5, vol. 3, 1893, p. 435, pl. 2, fig. 18.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 97, pl. 16, fig. 808; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 76.—CHAPMAN, Journ. Roy. Micr. Soc., 1898, p. 6, pl. 1, fig. 8.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 1.—MILLETT, Journ. Roy.



Micr. Soc., 1904, p. 501.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 139.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 161.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 288; Journ. Linn. Soc. Zoology, vol. 30, 1910, p. 421.—BAGG, Bull. U. S. Geol. Surv., No. 513, 1912, p. 86, pl. 26, figs. 11-15, c.

*Description.*—Test comparatively large, nearly equally convex on the two sides; peripheral margin bluntly rounded; chambers numerous, usually eight or nine in the last-formed whorl; sutures slightly if at all depressed; walls thickened and beautifully marked by clear shell material, the chambers each with an ornamentation of an irregular pattern of dots, lines, and irregular areas of clear shell material on a white opaque background; aperture a narrow opening at the umbilical end of the margin of the chamber with an occasional secondary slit near the peripheral margin.

Diameter up to 1.5 mm.

*Distribution.*—*Pulvinulina elegans* seems to be common in the North Pacific in spite of Brady's note that it is less common than elsewhere. This is again probably due to lack of material. Goës records it from 10 *Albatross* stations in the eastern Tropical Pacific at depths ranging from 660 to 1,832 fathoms. Flint records it from one *Albatross* station D2805 in Panama Bay, depth 51 fathoms. From about the Hawaiian Islands Bagg records it from nine *Albatross* stations, the depths ranging from 367 to 1,544 fathoms. I have had material from several *Albatross* stations off the Hawaiian Islands, depths ranging from 323 to 1,783 fathoms. It occurred at *Albatross* station D2806 off the Galapagos Islands in 1,379 fathoms. In the *Nero* material it has occurred frequently between Guam and Yokohama, the depths ranging from 891 fathoms off Guam to 2,189 fathoms.

PULVINULINA PARTSCHIANA (d'Orbigny).

*Rotalina partschiana* D'ORBIGNY, Foram. Foss. Bass. Tert. Vienne, 1846, p. 153, pl. 7, figs. 28-30, pl. 8, figs. 1-3.

*Pulvinulina partschiana* REUSS, Sitz. Akad. Wiss. Wien, vol. 62, 1870, p. 36.—VON SCHLICHT, Foram. Pietzpuhl, 1870, pl. 20, figs. 23-25, 29-31.—H. B.

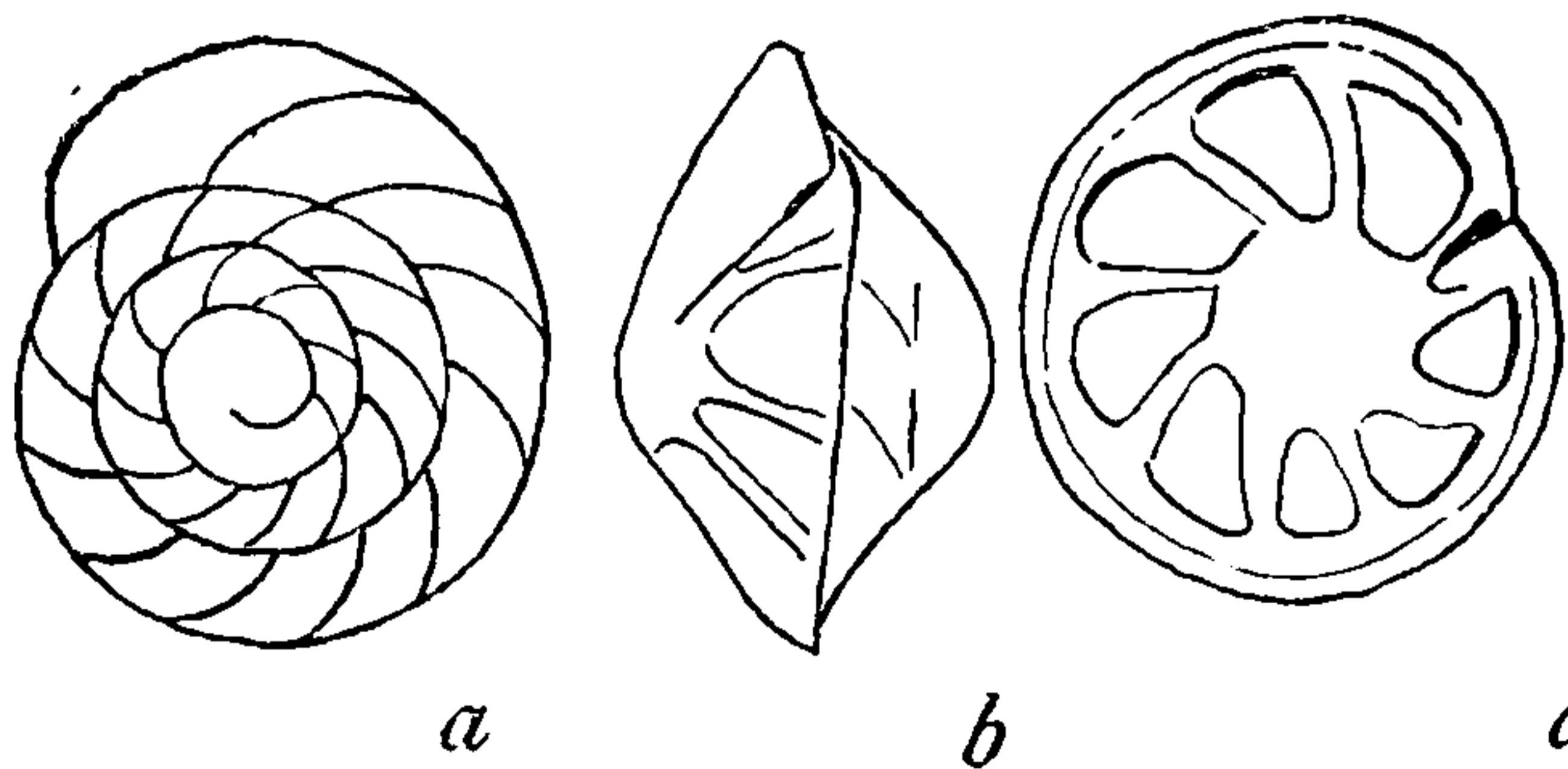


FIG. 60.—PULVINULINA PARTSCHIANA (D'ORBIGNY). *a*, DORSAL VIEW; *b*, SIDE VIEW; *c*, VENTRAL VIEW. (AFTER D'ORBIGNY'S TYPE FIGURE.)

BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 699, pl. 105, fig. 3a-c, woodcut, fig. 21.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, p. 410, pl. 17, fig. 43; pl. 18, figs. 25-27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 502.—BAGG, Bull. U. S. Nat.

Mus., vol. 34, 1908, p. 162.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 287.

*Placentula partschiana* BERTHELIN, Bull. Soc. Geol. France, ser. 3, vol. 11, 1882, p. 16.



*Description.*—Test small, nearly equally convex, dorsal side slightly more conical, ventral side broadly rounded; peripheral margin acute, carinate; chambers numerous, nine or ten in the last-formed coil, short; sutures strongly curved, slightly depressed above, strongly limbate below, the umbilical ends uniting to form an umbonate mass; wall punctate without variegated markings; aperture a short somewhat arched opening on the ventral side toward the peripheral margin.

Diameter 0.40–0.75 mm.

*Distribution.*—Bagg records this species from a single *Albatross* station H4568 in 1,274 fathoms off the Hawaiian Islands. I have had it from several *Albatross* stations also off the Hawaiian Islands, depths ranging from 266 to 618 fathoms.

PULVINULINA FAVUS H. B. Brady.

*Pulvinulina favus* H. B. BRADY, Geol. Mag., dec. 2, vol. 4, 1877, p. 294; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 701, pl. 104, figs. 12–16.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 417, pl. 18, figs. 13–15.

*Description.*—Test biconvex, lenticular, the two faces nearly equally convex; peripheral margin subacute, slightly rounded; chambers numerous, about 12 in the last formed whorl, elongate; sutures oblique, entirely hidden by the surface ornamentation which is composed of a raised reticulated network covering the entire test except that portion of the periphery about the aperture which is usually just ventral to the peripheral margin, slightly oblique, oval.

Diameter 0.75 to 1.25 mm.

*Distribution.*—This species has previously been noted from but one North Pacific station; Brady recording it from *Challenger* station 224 in 1,850 fathoms in lat. 7° 45' N.

I have found it to be very common, especially in the region between Guam and Yokohama, where it was recorded at about 50 stations, after which recording was stopped, as it occurred at nearly every station. The recorded stations range in depth from 847 to 2,250 fathoms, the average depth being about 1,800 fathoms with but one station less than 1,250 fathoms. It also occurred eastward at *Nero* station 124 in 1,726 fathoms and at *Tuscarora* station 221° 07' N; 158° 14' W. in 1,468 fathoms.

It is a striking species with its peculiar type of ornamentation. Apparently it is most common at considerable depths, from 1,500 to 2,000 fathoms, and is widely distributed in the western portion of the Pacific, coming eastward to the central portion.



## PULVINULINA GILBERTI Bagg.

*Pulvinulina gilberti* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 161, pl. 5, figs. 11-15.

*Description.*—"The test is highly vaulted upon the interior side, with deeply sunken septa, which extend from the margin to the umbilicus in an almost straight line, as in *Pulvinulina canariensis* d'Orbigny, which this species somewhat resembles. The segments are, however, more compactly built, and the aperture, a neatly shaped arch, lies midway between the periphery and the umbilicus upon the inferior surface. The superior surface instead of being vaulted as in *P. canariensis*, is almost complanate and the periphery is almost keeled, being quite sharp and distinct, although somewhat lobulated on the last two chambers of the ultimate whorl. There are five segments visible in the last convolution, and they are equally distinct upon both surfaces.

"The shell is very minute and firmly built. It has a slight resemblance to *Truncatulina dutemplei* (d'Orbigny), but the margin is sharp and more angular in the present form, and the septal lines upon the inferior surface are much more depressed and the chambers more inflated. It is somewhat doubtful whether the present form should be considered a distinct species or only a variety of *Pulvinulina menardii*, which it resembles. It is much smaller than *P. menardii*, much more vaulted upon the inferior surface, and a little more closely involute. The septal depressions also are strong, deeply sunken on the lower side and extend straight to the center. Upon the superior side they are strongly curved as in *P. menardii*. There are five of these chambers in the final convolution. The ultimate chamber is largest, and in its outline reminds one of the auriculate type of *Pulvinulinae*, but it is not so extended from the whorl. It is not a young form of *P. menardii*."

*Distribution.*—"Present and rather common at [Albatross] station H4555," in 1,398 fathoms, off the Hawaiian Islands.

In the figures, which are not very distinct, this species seems to me to very greatly resemble *P. menardii*. An examination of the specimens also seems to confirm this. Just what disposal should be made of the form there is not sufficiently well marked material to decide. The descriptive notes are from Bagg.

## Genus ROTALIA Lamarck, 1804.

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

*Rotalia* LAMARCK, (type, *Nautilus beccarii* Linnæus), Ann. Mus., vol. 5, 1804, p. 184.—D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 275.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 702.

*Description.*—Test free, composed of numerous chambers arranged in a flattened spire, the two sides biconvex or varying from flat above



and convex below to convex above and flattened below; all chambers visible from the dorsal side, only those of the last-formed coil visible from below; the umbilical region as usually filled with clear shell material; surface variously ornamented with raised bosses or costæ or smooth and unornamented; aperture a single curved opening toward the periphery on the ventral side of the chamber.

There are several species of this genus presenting a considerable range of form and ornamentation. Certain of the species are abundant in shallow water of the temperate or even subarctic zones, while others are characteristic of shallow waters of the tropics. The largest and most ornate species are these latter.

**ROTALIA BECCARII (Linnæus).**

Plate 30, fig. 3.

“Cornu Hammonis” PLANCUS, *Conch. Min.*, 1739, p. 8, pl. 1, fig. 1 A-c.

“Ammonia unita” GAULTIERI, *Index Test.*, 1742, pl. 19, figs. H, I.

*Nautilus beccarii* LINNÆUS, *Syst. Nat.*, ed. 12, 1767, p. 1162; ed. 13 (Gmelin's), 1788, p. 3370, No. 4.

“Hammoniæ conico-tuberculatæ” SOLDANI, *Testaceographia*, vol. 1, pt. 1, 1789, p. 56, pl. 35, fig. P.

*Rotalia (Turbinulina) beccarii* D'ORBIGNY, *Ann. Sci. Nat.*, vol. 7, 1826, p. 275, No. 40; *Modèles*, No. 74.—PARKER, JONES, and H. B. BRADY, *Ann. Mag. Nat. Hist.*, ser. 3, vol. 16, 1865, p. 30, pl. 3, fig. 83.

*Rotalia beccarii* PARKER and JONES, *Philos. Trans.*, vol. 155, 1865, p. 388, pl. 16, figs. 29, 30.—H. B. BRADY, *Ann. Mag. Nat. Hist.*, ser. 4, vol. 6, 1870, p. 303, pl. 12, figs. 8a-c.—SCHWAGER, *Boll. com. geol. Ital.*, vol. 8, 1877, p. 26, pl., fig. 43.—TERRIGI, *Atti Accad. Pont. Nuovi Lincei*, vol. 33, 1880, p. 208, pl. 3, fig. 62, pl. 4, fig. 63-66.—H. B. BRADY, *Rep. Voy. Challenger, Zoology*, vol. 9, 1884, p. 704, pl. 107, figs. 2, 3.—WRIGHT, *Proc. Belfast Nat. Field Club*, 1884-85, App. 9, 1886, p. 332, pl. 27, fig. 15.—MALAGOLI, *Boll. Soc. geol. Ital.*, vol. 6, 1887, p. 523, pl. 13, fig. 11.—TERRIGI, *Mem. Accad. Lincei*, ser. 4, vol. 6, 1889, p. 119, pl. 9, figs. 4, 5.—EGGER, *Abh. kön. bay. Akad. Wiss. München*, Cl. II, vol. 18, 1893, p. 420, pl. 19, figs. 25-27.—GOËS, *Kongl. Svensk. Vet. Akad. Handl.*, vol. 25, No. 9, 1894, p. 99, pl. 16, fig. 811.—RHUMBLER, *Zeitschr. Wiss. Zool.*, vol. 57, 1894, p. 574, pl. 22, fig. 41.—LISTER, *Philos. Trans.*, vol. 186, 1895, p. 436, pl. 8, figs. 38-40.—FORNASINI, *Mem. Accad. Sci. Inst. Bologna*, 1898, p. 259, figs.—FLINT, *Rep. U. S. Nat. Mus.*, 1897 (1899), p. 331, pl. 75, fig. 2.—WRIGHT, *Geol. Mag.*, dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 22.—FORNASINI, *Mem. Accad. Sci. Inst. Bologna*, ser. 5, vol. 10, 1902, p. 59, figs. 56-58.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 502.—CHAPMAN, *Journ. Quekett Micr. Club*, ser. 2, vol. 10, 1907, p. 139.—CUSHMAN, *Proc. Boston Soc. Nat. Hist.*, vol. 34, 1908, p. 31.—SIDEBOTTOM, *Mem. and Proc. Manchester Lit. and Philos. Soc.*, vol. 53, No. 21, 1909, p. 10, pl. 4, fig. 6; vol. 54, No. 16, 1910, p. 28.

*Description.*—Test with the sides about equally biconvex; chambers numerous, from 8-12 in the last formed whorl; peripheral margin rounded; sutures limbate above, oblique, ventrally much depressed; the sides beaded or irregularly ornamented; umbilical region often filled with a rounded mass of material about which is a



depressed area, wall otherwise smooth; aperture a very narrow slit on the ventral margin of the chamber.

Diameter 0.60–1 mm.

*Distribution*.—This species does not seem to have been definitely recorded from the North Pacific. I have it from Cebu, Philippine Islands, collected by Dr. E. A. Mearns, from *Albatross* H4878 in 84 fathoms, bottom temperature 51.9° F., off Japan and D4968 in 253 fathoms, bottom temperature 45.7°, also off Japan. This is essentially a shallow water species and is probably widely distributed in the region under such conditions but material from shallow water has been very scanty.

**ROTALIA BROECKHIANA** Karrer.

Plate 27, fig. 4; plate 30, fig. 2.

*Rotalia broeckhiana* KARRER, in Drasche, Geol. Insel. Luzon, 1878, p. 98, pl. 5, fig. 26.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 705, pl. 107, figs. 4a–c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 421, pl. 19, figs. 19–21.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 503.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 423.

*Description*.—Test nearly equally biconvex, nearly circular in side view; chambers 7 or 8 in the final whorl, narrow; sutures slightly

depressed, a slight channel between the last formed whorl and the previous one dorsally; umbilical region filled with clear shell material as are also the sutures ventrally; surface smooth; aperture

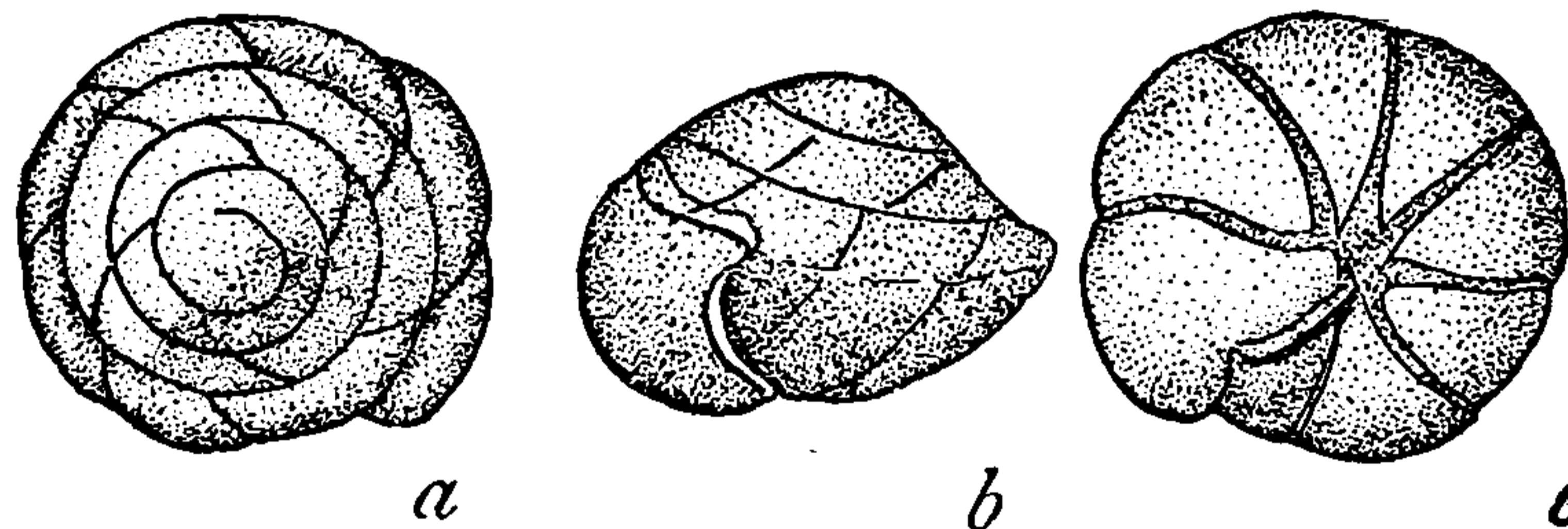


FIG. 61.—*ROTALIA BROECKHIANA* KARRER.  $\times 50$ . a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW. (AFTER BRADY.)

an elongated somewhat arched slit running from near the umbilical region almost to the peripheral margin on the ventral side.

Diameter about 0.75 mm.

*Distribution*.—Apparently this species has not previously been recorded from the North Pacific. The only station from which I have found it is *Nero* 1209 in 660 fathoms, blue mud, off Japan.

**ROTALIA ORBICULARIS** d'Orbigny.

Plate 29, fig. 3.

*Rotalia (Gyroidina) orbicularis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 278, No. 1; Modèles, No. 13.

*Rotalia orbicularis* H. B. BRADY, Trans. Linn. Soc., London, vol. 24, 1864, p. 470, pl. 48, fig. 16.—TERQUEM, Mem. Soc. Géol. France, ser. 3, vol. 2, mem. 3, 1882, p. 60, pl. 4, figs. 1–3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 706, pl. 107, fig. 5; pl. 115, fig. 6.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 421, pl. 19, figs. 22–24.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 331, pl. 75, fig. 5.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 28.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 424.



*Description*.—Test unequally biconvex, dorsal side flattened but unbonate in the middle, somewhat depressed toward the periphery, ventral side strongly convex, umbilicate; peripheral margin rounded; sutures distinct but not depressed; 10–12 chambers in the final whorl; wall smooth; aperture a narrow slit toward the peripheral margin on the ventral side.

Diameter 0.75–1 mm.

*Distribution*.—Brady records this species from the North Pacific in 224 to 1,850 fathoms. Flint records it from *Albatross* station D3080 in 93 fathoms off the coast of Oregon. I have failed to find specimens referable to this species.

**ROTALIA CALCAR (d'Orbigny).**

Plate 28, fig. 2; plate 29, fig. 2.

*Calcarina calcar* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 276, No. 1; Modèles No. 34; in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 93, pl. 5, figs. 22–24.—CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 223, pl. 13, fig. 21.

*Rotalia calcar* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 709, pl. 108, fig. 3, fig. 4?—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 423, pl. 19, figs. 1–3.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 506.—CHAPMAN, Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 140; Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 289, pl. 3, fig. 2.

*Description*.—Test biconvex, composed of numerous chambers with about 10 chambers in the final whorl; sutures limbate both ventrally and dorsally. The peripheral border of each chamber extending out into a spine, central part of the test dorsally with numerous raised tubercles; aperture a narrow, simple slit running ventrally from near the periphery nearly to the umbilicus.

Diameter up to 1.35 mm.

*Distribution*.—This species seems not to have been previously recorded from the North Pacific. I have had a few specimens from Hong Kong Harbor and from Cebu, Philippines, the latter collected by Dr. E. A. Mearns. Its distribution is apparently limited to the shallow waters of tropical and subtropical regions.

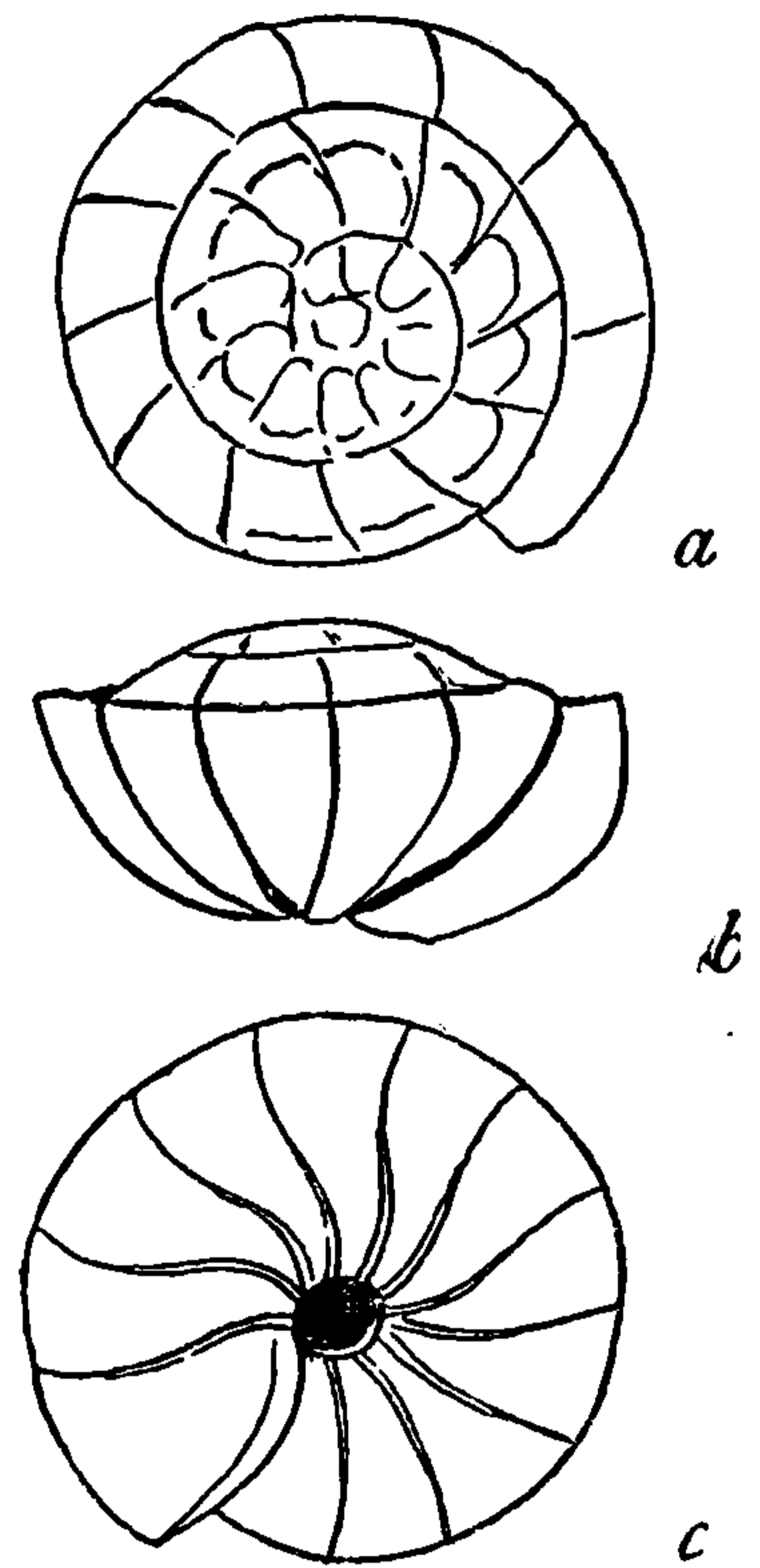


FIG. 62.—*ROTALIA ORBICULARIS* D'ORBIGNY.  $\times 50$ . a, DORSAL VIEW; b, SIDE VIEW; c, VENTRAL VIEW. (ADAPTED FROM BRADY.)



**ROTALIA PAPILOSA H. B. Brady.**

Plate 31, fig. 1.

*Rotalia papillosa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 708, pl. 106, figs. 9a-c.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 322, pl. 76, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 505.

*Description.*—“Test subglobular, slightly compressed; both faces highly convex, periphery obtuse and rounded; composed of three or four convolutions, the last of which has 12 to 14 segments. Sutures limbate; marked externally either by interrupted raised lines, or more frequently by single or double rows of exogenous beads. Umbilical hollow filled with clear shell-substance, the exterior of which is granulated irregularly fissured. Aperture an arched cleft at the inner margin of the inferior face of the final segment, near the periphery.

“Diameter 1/20th inch (1.27 mm.)”

*Distribution.*—Brady records this species from one North Pacific station, Hong Kong harbor in 7 fathoms. I have had several typical specimens from Hong Kong harbor also. It has occurred as numerous fine specimens at *Albatross* station D4874 in 66 fathoms, eastern channel of Korea Strait. Although the bottom temperature is not given for this station that of surrounding stations runs fairly high and numerous southern species occur here.

This is a beautifully ornamented species and very easily identified.

**ROTALIA PAPILOSA H. B. Brady, var. COMPRESSIUSCULA H. B. Brady.**

Plate 30, fig. 1.

*Rotalia papillosa* H. B. Brady, var. *compressiuscula* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 708, pl. 107, figs. 1a-c; pl. 108, figs. 1a-c.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905, p. 106; Journ. Quekett Micr. Club., ser. 2, vol. 10, 1907, p. 139.

*Description.*—“General character similar to those of *Rotalia papillosa*, but the test much more compressed and the periphery sharply angular.

“Diameter 1/25th inch (1 mm.)”

*Distribution.*—Among the original stations for this species Brady records two from the North Pacific, off the Philippines in 95 fathoms and Inland Sea of Japan in 14 fathoms.

I have had specimens from the Inland Sea of Japan collected by Dale and Jouy in 1881 and numerous specimens of the variety with the typical at *Albatross* station D4874 in 66 fathoms, eastern channel of Korea Strait.

At the latter station it was very easy to distinguish between the variety and the typical form especially in size, as well as in the more distinct ornamentation and greater compression of the variety.



## ROTALIA SOLDANII d'Orbigny.

Plate 29, fig. 1; plate 31, fig. 4.

*Rotalia (Gyroidina) soldanii* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 278, No. 5; Modèles, No. 36.

*Rotalia soldanii* HANTKEN, Mitth. Jahrb. ung. geol. Anstalt., 1875, p. 80, pl. 9, figs. 7a-c.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 706, pl. 107, figs. 6, 7.—TERRIGI, Mem. Com. Geol. Italia, vol. 4, 1891, p. 109, pl. 4, fig. 15.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 6, 1899, p. 328, pl. 6, fig. 14.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 332, pl. 75, fig. 4.—MILLETT, Journ. Roy. Micr. Soc., 1904, p. 503.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 106; Journ. Quekett Micr. Club, ser. 2, vol. 10, 1907, p. 140.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 163.

*Rotalia beccarii*, var. *soldani* PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 389, pl. 16, figs. 31-33.

*Rotalia soldanii* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 420, pl. 19, figs. 16-18, 51.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 99, pl. 16, fig. 812.

*Description*.—Test plano-convex, dorsal side flat or even slightly depressed, especially near the peripheral margin, ventral side very convex; chambers numerous, distinct; the sutures but slightly depressed; wall smooth, thick, finely perforate; umbilicus deeply excavated; aperture an elongate slit at the inner margin of the chamber.

Diameter about 1 mm.

*Distribution*.—This is a rather widely distributed species in the North Pacific. Brady records it from two *Challenger* stations 214 and 224 in 500 and 1,850 fathoms respectively. Goës records it from *Albatross* station D3433 in 1,218 fathoms. Flint records it from *Albatross* station D3080 in 93 fathoms off the coast of Oregon and Bagg had it from three *Albatross* stations off the Hawaiian Islands, H4508, H4555, and H4585 in 495, 1,398 and 689 fathoms, respectively. I have had material from about the Hawaiian Islands, off the Galapagos Islands, at numerous *Nero* stations between Guam and Japan and also at *Albatross* stations off Japan. The deepest station is 2,048 fathoms and the shallowest 244 fathoms.

## Genus CALCARINA d'Orbigny, 1826.

*Nautilus* (part) LINNÆUS, Syst. Nat., ed. 13 (Gmelin's), 1788, p. 3371.

*Calcarina* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 276 (type, *Nautilus spengleri* (Linnæus)).

*Description*.—Test composed of numerous chambers, close coiled, biconvex; periphery usually with radiating spines; chambers visible at least on the ventral side, sometimes on the dorsal side as well; aperture typically consisting of a row of small openings along the inner margin of the apertural face; supplemental skeleton and canal system highly developed.



This genus is represented by several recent species, all of which are characteristic of shallow water of the Tropics, although found as far north as the Mediterranean.

**CALCARINA SPENGLERI (Linnæus).**

Plate 31, fig. 2.

“Ammonshorn” SPENGLER, *Danske Skriften*, vol. 1, 1781, p. 379, pl. 2, figs. 9a-c. *Nautilus spengleri* LINNÆUS, *Syst. Nat.*, ed. 13 (Gmelin's), 1788, p. 3371, No. 10. *Calcarina spengleri* D'ORBIGNY, *Ann. Sci. Nat.*, vol. 7, 1826, p. 276, No. 4.—CARPENTER, *Philos. Trans.*, vol. 150, 1860, p. 548, pls. 19, 20, woodcuts.—CARPENTER, PARKER, and JONES, *Introd. Foram.*, 1862, p. 216, pl. 13, fig. 21, pl. 14, figs. 1-10, figs. 33-36 in text.—PARKER, JONES, and H. B. BRADY, *Ann. Mag. Nat. Hist.*, ser. 3, vol. 16, 1865, p. 24, pl. 3, fig. 87.—SCHWAGER, *Boll. Com. Geol. Ital.*, vol. 8, 1877, p. 26, pl., fig. 74.—BÜTSCHLI, in *Bronn, Klassen und Ordnungen Thier-Reichs*, 1880, p. 207, pl. 9, fig. 7.—H. B. BRADY, *Rep. Voy. Challenger, Zoology*, vol. 9, 1884, p. 712, pl. 108, figs. 5, 7.—EGGER, *Abh. kön. bay. Akad. Wiss. München*, Cl. II, vol. 18, 1893, p. 423, pl. 19, figs. 4-6.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 597.

*Description*.—Test lenticular, biconvex; chambers arranged in three or four volutions, each with several chambers, but not distinguishable from the surface except the latter part of the final whorl; wall covered with a thick deposit of calcareous material, the surface with raised tubercles of solid, translucent material; peripheral border typically with large spines, usually simple, subcylindrical; aperture a row of rounded pores along the inner margin of the chamber.

Diameter up to 3 mm. or more.

*Distribution*.—Apparently this species has not previously been recorded from the North Pacific. A few specimens were obtained from material collected by Capt. John Rodgers of the U. S. Exploring Expedition in Gaspar Straits and a few from material collected by Doctor Mearns at Cagayan, Sulu Islands, and Cebu, Philippines.

In some parts of the Tropics this species is very abundant in shore sands. It is an interesting species with its high development of supplemental skeleton and complex canal system.

**CALCARINA HISPIDA H. B. Brady.**

Plate 29, figs. 4, 5; plate 31, fig. 3.

*Calcarina spengleri*, hispid variety CARPENTER, *Philos. Trans.*, vol. 150, 1860, p. 551, pl. 19, figs. 8-11; pl. 20, figs. 6, 8.

*Calcarina hispida* H. B. BRADY, *Proc. Roy. Irish Acad.*, ser. 2, vol. 2, 1876, p. 590; *Rep. Voy. Challenger, Zoology*, vol. 9, 1884, p. 713, pl. 108, figs. 8, 9.—LISTER, *Philos. Trans.*, vol. 186, 1895, p. 437, pl. 8, figs. 34-37.—MILLETT, *Journ. Roy. Micr. Soc.*, 1904, p. 597.

*Calcarina calcar*, var. *hispida* CARTER, *Ann. Mag. Nat. Hist.*, ser. 5, vol. 5, 1880, p. 453.

*Description*.—Test rotaliform, composed of several coils, each of several chambers, little if at all embracing, not visible from the exterior except the few chambers last formed; peripheral margin



with radial spines, short and somewhat flattened; entire surface covered with the supplemental skeleton, ornamented exteriorly with short rather obtuse spines giving the whole test a hispid appearance; aperture a series of pores along the inner margin of the chamber.

Diameter up to 2 mm.

*Distribution*.—From the records this species does not seem to have been definitely recorded from the North Pacific. It occurred with *C. spengleri* in the U. S. Exploring Expedition from Gaspar Straits. Specimens also occurred in Vincennes or Colnett Strait, *Albatross* H4882, in 248 fathoms, bottom temperature 48.8° F. and in the same region D4922, more common, in 60 fathoms, bottom temperature 79.2° F. This is the region from which so many tropical species of Foraminifera were obtained.

### Subfamily 3. TINOPORINÆ.

Test consisting of a close-coiled young followed by chambers irregularly arranged, arborescent, irregular or heaped up into a mass of definite form, either free or attached.

This subfamily consists of three genera as far as the present material is concerned, *Tinoporus*, where the arrangement assumes a regular form, *Gypsina*, where the arrangement in our species is very irregular, and *Polytrema*, where the chambers are arranged in an arborescent form.

Most of the living species seem to be characteristic of shallow water of tropical or subtropical regions.

### Genus TINOPORUS (emend.) Carpenter, 1860.

*Tinoporus* MONTFORT (type, *T. baculatus* Montfort), Conch. Syst., vol. 1, 1808, p. 146.—CARPENTER, (Emend.) Philos. Trans., 1860, p. 557.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 714.

*Description*.—Test free, biconvex, composed of numerous chambers in a mass, the early ones spirally arranged; surface reticulated, with raised tubercles occupying some of the angles of the meshes of the surface; outer walls of the chambers coarsely porous; periphery with several spines.

This genus is an interesting one, only its early chambers showing its real relation to the other members of the Rotaliidæ.

### TINOPORUS BACULATUS [Montfort?] Carpenter.

Plate 27, fig. 3.

*Tinoporus baculatus* (?) MONTFORT, Conch. Syst., vol. 1, 1808, p. 146.

*Tinoporus baculatus* CARPENTER, Philos. Trans., 1860, p. 557, 564, pl. 18, figs. 2-10; pl. 21, figs. 5-11.—CARPENTER, PARKER, and JONES, Int. Foram., 1862, p. 226, pl. 15, figs. 5-12.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, 1880, p. 216, pl. 13, fig. 3.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 716, pl. 101, figs. 4-7.—DERVIEUX, Atti R. Accad. Sci. Torino, vol. 29, 1893, p. 6, pl., figs. 19, 26, 34.—SHERLOCK, Bull. Mus. Comp. Zoöl., vol. 38, 1903, p. 357, fig. 8.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 598.—CHAPMAN, Journ. Linn. Soc., Zoology, vol. 30, 1910, p. 424.



*Description*.—Test free, large, composed of an early coiled portion which is soon inclosed by an irregularly massed group of chambers forming the test; biconvex and with a few very coarse short grooved spines at the periphery; the sutures between the chambers usually marked at their intersections by raised bosses, the whole forming a reticulate network.

Diameter up to 3 mm.

*Distribution*.—In the North Pacific this species has been recorded by Brady, the *Challenger* having obtained it from the shore sands of the Philippines. It is a species of shallow tropical waters.

#### Genus GYPSINA Carter, 1877.

*Gypsina* CARTER (type, *G. vesicularis* (Parker and Jones)), Ann. Mag. Nat. Hist., ser. 4, vol. 20, 1877, p. 173.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 716.

*Description*.—Test free or adherent, when free it may be spherical or compressed, when adherent the test takes the form of the object to which it is attached or becomes a raised mass of chambers more or less symmetrical; early chambers forming a flat spire in the higher species, but in most irregularly arranged throughout; wall coarsely porous.

There has been some question as to whether the species now placed in this genus belonged to the Foraminifera or elsewhere in the animal kingdom. They seem to have sufficient characters, especially in the higher species, to place them with the Rotaliidae.

#### GYPSINA INHÆRENS (Schultze).

Plate 21, figs. 6, 7.

*Acervulina inhærens* SCHULTZE, Organ. der Polythal., 1854, p. 68, pl. 6, fig. 12.

*Gypsina inhærens* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 718, pl. 102, figs. 1-6.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 229, pl. 41, fig. 19.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 91, pl. 15, fig. 787.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 336, pl. 79, fig. 6.—MILLET, Journ. Roy. Micr. Soc., 1904, p. 599.—RHUMBLER, Zool. Jahrb., Abt. Syst., vol. 24, 1906, p. 72, pl. 5, fig. 60.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 53, No. 21, 1909, p. 11.

*Description*.—Test adherent, early portion discoidal, later adapting its shape to the surface to which it is attached, composed of numerous chambers, the earliest ones often showing a spiral arrangement, the later ones irregularly massed; sutures distinct, slightly depressed; surface conspicuously punctate.

Diameter up to 1.50 mm.

*Distribution*.—Rhumbler records this species from shallow water off Laysan Island. There are no other North Pacific records. This is essentially a species of shallow waters of tropical or subtropical seas, although there are records for it in some of the warmer portions of the temperate zone.



Genus **POLYTREMA** Risso, 1826.

*Millepora* (part) LINNÆUS, Syst. Nat., ed. 13 (Gmelin's) vol. 1, 1788, p. 3784.

*Polytrema* RISSO (type, *P. corallina* Risso), Hist. Nat. Europ. Mérid., vol. 5, 1826, p. 340.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 719.

*Pustularia* GRAY, Proc. Zool. Soc. London, vol. 26, 1858, p. 271.

*Description*.—Test adherent; early chambers small, spirally arranged, soon covered by the irregular loosely growing chambers making an irregular spreading mass, later chambers forming an arborescent growth; wall calcareous, areolated, numerous apertures appearing at the surface on papillæ; interior often of loosely arranged chambers with lacunæ between; color red or pink or sometimes white.

This genus was for a long time considered as belonging to the old group of "Zoophytes." Its external appearance is sufficient for an understanding of this error but a study of the structure shows it to be a foraminifer. The early chambers with their spiral growth place it with *Discorbina* and other genera of the Rotaliidae. It is a rather unusual type of the group and is usually found in comparatively shallow water of coral reefs in abundance but ranges out of the tropics both north and south and is found in as great depths as 1,000 fathoms, according to the *Challenger* Report.

**POLYTREMA MINIACEUM** (Linnæus).

Plate 18, fig. 6; plate 20, fig. 4.

*Millepora miniacea* LINNÆUS, Syst. Nat., ed. 13 (Gmelin's), vol. 1, pt. 6, 1788, p. 3784, No. 6.

*Polytrema miniaceum* BLAINVILLE, Dict. Sci. Nat., vol. 42, 1826, Atlas, Zooph., vol. 1, p. 17; ?Actinologie, 1834, pp. 410, 673, pl. 69, figs. 4, 4a.—CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 235, pl. 13, figs. 18-20.—CARTER, Ann. Mag. Nat. Hist., ser. 4, vol. 17, 1876, p. 185, pl. 13, figs. 1-6.—MOEBIUS, Foram. von Mauritius, 1880, p. 85, pl. 7.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 721, pl. 100, figs. 5-9, pl. 101, fig. 1.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 437, pl. 21, figs. 1, 2, 16, 17.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 54, pt. 3, 1910, p. 29.

*Description*.—Test attached, early portion close coiled, consisting of several chambers, later portion consisting of a mass of small chambers arranged in irregular layers, whole more or less arborescent; surface with conspicuous apertural openings; wall areolated; color various shades of red.

Length up to 5 mm or more.

*Distribution*.—This species is apparently not definitely recorded from the North Pacific. The only material I have had was from *Albatross* station D 4922 in Vincennes or Colnett Strait in 60 fathoms bottom temperature 79.2° F.

This is typically a species of warm waters, attached to various objects and does not at all resemble the usual forms of Foraminifera. Only its early chambers, which can not be seen except by breaking away the specimen, show the close coiled, several chambered young, which indicate its relationship to the other members of this family.



## EXPLANATION OF PLATES.

### PLATE 1.

- Fig. 1. *Spirillina vivipara*. × 100. *a*, side view; *b*, peripheral view. (After Brady.)  
2. *Spirillina vivipara*. × 100. (After Brady.)  
3. *Spirillina vivipara*, var. *revertens*. × 250. (After Rhumbler.)  
4. *Spirillina vivipara*, var. *revertens*. × 250. (After Rhumbler.)  
5. *Spirillina vivipara*, var. *revertens*. × 100. (After Brady.)  
6. *Spirillina vivipara*, var. *revertens*. × 250. (After Rhumbler.)  
7. *Spirillina tuberculata*. × 50. (After Brady.)  
8. *Spirillina tuberculata*. × 50. (After Brady.)  
9. *Spirillina tuberculata*. × 50. (After Brady.)

### PLATE 2.

- Fig. 1. *Spirillina limbata*. × 50. *a*, side view; *b*, peripheral view. (After Brady.)  
2. *Spirillina limbata*. × 60. *a*, side view; *b*, peripheral view. (After Brady.)  
3. *Spirillina tuberculata*. × 45. (After Brady.)  
4. *Spirillina limbata*, var. *papillosa*. × 100. *a*, from above; *b*, from below; *c*, from periphery.

### PLATE 3.

- Fig. 1. *Spirillina limbata*, var. *denticulata*. × 100. *a*, from above; *b*, from below; *c*, from periphery. (After Brady.)  
2. *Spirillina limbata*, var. *denticulata*. × 50. *a*, from above; *b*, from below; *c*, from periphery.  
3. *Spirillina inæqualis*. × 120. (After Brady.)

### PLATE 4.

- Fig. 1. *Spirillina guttata*. × 65. *a*, from above; *b*, from below; *c*, from periphery.  
2. *Spirillina operculoides*. × 65. *a*, from above; *b*, from below; *c*, from periphery.  
3. Spirillina-like operculum. × 65. *a*, from above; *b* from below; *c*, from periphery.

### PLATE 5.

- Fig. 1. *Spirillina decorata*. × 50. *a*, from above; *b*, from periphery. (After Brady.)  
2. *Spirillina decorata*. × 50. (After Brady.)  
3. *Discorbis concinna*. × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
4. *Discorbis tabernacularis*. × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
5. *Discorbis patelliformis*. × 100. *a*, from above; *b*, from below; *c*, from side. (After Brady.)

### PLATE 6.

- Fig. 1. *Discorbis isabelleana*. × 75. *a*, from above; *b*, from below; *c*, from side.  
2. *Discorbis subfilosa*. × 75. *a*, from above; *b*, from below; *c*, from side.  
3. *Discorbis pulvinulinoides*. × 75. *a*, from above; *b*, from below.



## PLATE 7.

- Fig. 1. *Patellina corrugata*.  $\times 120$ . *a*, from above; *b*, from below. (After Brady.)  
 2. *Discorbis pulvinata*.  $\times 100$ . *a*, from above; *b*, from side. (After Brady.)  
 3. *Discorbis bertheloti*.  $\times 90$ . *a*, from above; *b*, from below; *c*, from side.  
 (After Brady.)  
 4. *Discorbis rarescens*.  $\times 75$ . *a*, from above; *b*, from below; *c*, from side.  
 (After Brady.)

## PLATE 8.

- Fig. 1. *Discorbis globularis*, var. *bradyi*.  $\times 75$ . *a*, from above; *b*, from below; *c*, from side.  
 2. *Planorbulina larvata*.  $\times 38$ . *a*, from above; *b*, from below; *c*, from side.

## PLATE 9.

- Fig. 1. *Discorbis allomorphinoides*.  $\times 100$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 2. *Discorbis vilardeboana*.  $\times 100$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 3. *Discorbis auracana*.  $\times 75$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 4. *Discorbis globularis*.  $\times 50$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)

## PLATE 10.

- Fig. 1. *Cymbalopora poeyi*.  $\times 65$ . *a*, from above; *b*, from below; *c*, from side.  
 2. *Cymbalopora poeyi*, var. *bradyi*.  $\times 65$ . *a*, from above; *b*, from below; *c*, from side.

## PLATE 11.

- Fig. 1. *Discorbis orbicularis*.  $\times 100$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 2. *Discorbis turbo*.  $\times 60$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 3. *Discorbis opercularis*.  $\times 100$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)

## PLATE 12.

- Fig. 1. *Planorbulina mediterraneensis*.  $\times 75$ . *a*, from above; *b*, from below; *c*, from side.  
 2. *Truncatulina refulgens*.  $\times 75$ . *a*, from above; *b*, from below; *c*, from side.  
 3. *Truncatulina wuellerstorfi*.  $\times 38$ . *a*, from above; *b*, from below; *c*, from side.

## PLATE 13.

- Fig. 1. *Discorbis ventricosa*.  $\times 50$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 2. *Discorbis irregularis*. (After Rhumbler.)  
 3. *Discorbis irregularis*. (After Rhumbler.)  
 4. *Truncatulina mundula*.  $\times 40$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 5. *Truncatulina haidingerii*.  $\times 30$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)



## PLATE 14

- Fig. 1. *Planorbulina acervalis*.  $\times 35$ . (After Brady.)  
 2. *Cymbalopora poeyi*, var. *bradyi*.  $\times 50$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)  
 3. *Tretomphalus bulloides*.  $\times 60$ . (After Brady.)  
 4. *Tretomphalus bulloides*.  $\times 60$ . (After Brady.)  
 5. *Cymbalopora poeyi*.  $\times 50$ . *a*, from above; *b*, from below; *c*, from side. (After Brady.)

## PLATE 15.

- Fig. 1. *Truncatulina lobatula*.  $\times 65$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Truncatulina dutemplei*.  $\times 65$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 3. *Truncatulina tumidula*.  $\times 125$ . *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 16.

- Fig. 1. *Truncatulina culter*.  $\times 90$ . *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 2. *Truncatulina tenera*.  $\times 75$ . *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 3. *Truncatulina akneriana*.  $\times 45$ . *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 4. *Siphonina reticulata*.  $\times 100$ . *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)

## PLATE 17.

- Fig. 1. *Truncatulina margaritifera*.  $\times 33$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Truncatulina ungeriana*.  $\times 66$ . *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 18.

- Fig. 1. *Siphonina echinata*.  $\times 100$ . (After Brady.)  
 2. *Siphonina echinata*.  $\times 100$ . (After Brady.)  
 3. *Siphonina echinata*.  $\times 100$ . (After Brady.)  
 4. *Siphonina echinata*.  $\times 100$ . (After Brady.)  
 5. *Anomalina coronata*.  $\times 40$ . *a*, dorsal view; *b*, side view. (After Brady.)  
 6. *Polytrema miniaceum*.  $\times 20$ . (After Brady.)

## PLATE 19.

- Fig. 1. *Anomalina ariminensis*.  $\times 30$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Anomalina ammonoides*.  $\times 60$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 3. *Anomalina polymorpha*.  $\times 30$ .  
 4. *Anomalina polymorpha*.  $\times 30$ .

## PLATE 20.

- Fig. 1. *Anomalina grosserugosa*.  $\times 60$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Carpenteria proteiformis*.  $\times 30$ .  
 3. *Carpenteria monticularis*.  $\times 30$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 4. *Polytrema miniaceum*.  $\times 30$ .



## PLATE 21.

- Fig. 1. *Carpenteria proteiformis*. × 18. (After Brady.)  
 2. *Rupertia stabilis*. × 40. (After Brady.)  
 3. *Rupertia stabilis*. × 40. (After Brady.)  
 4. *Rupertia stabilis*. × 40. (After Brady.)  
 5. *Rupertia stabilis*. × 40. (After Brady.)  
 6. *Gypsina inhærens*. × 30. (After Brady.)  
 7. *Gypsina inhærens*. × 30. (After Brady.)

## PLATE 22.

- Fig. 1. *Pulvinulina auricula*. × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Pulvinulina menardii*. × 30. *a*, dorsal view; *b*, ventral view.  
 3. *Pulvinulina tumida*. × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.  
 4. *Pulvinulina hauerii*. × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 23.

- Fig. 1. *Pulvinulina canariensis*. × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Pulvinulina pauperata*—young specimen. × 30.  
 3. *Pulvinulina pauperata*—adult specimen. × 30.  
 4. *Pulvinulina truncatulinoides*. × 60. *a*, dorsal view; *b*, ventral view.  
 5. *Pulvinulina exigua*. × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.  
 6. *Truncatulina tenera*. × 50. *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 24.

- Fig. 1. *Pulvinulina punctulata*. × 16. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 2. *Pulvinulina procera*. × 35. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 3. *Pulvinulina repanda*. × 40. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)

## PLATE 25.

- Fig. 1. *Pulvinulina concamerata*. × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Pulvinulina procera*. × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 26.

- Fig. 1. *Pulvinulina karsteni*. × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Truncatulina præcineta*. × 30. *a*, dorsal view; *b*, ventral view; *c*, side view.  
 3. *Pulvinulina elegans*. × 60. *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 27.

- Fig. 1. *Pulvinulina crassa*. × 40. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 2. *Pulvinulina umbonata*. × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 3. *Tinoporus baculatus*. × 30. *a*, dorsal view; *b*, side view. (After Brady.)  
 4. *Rotalia broeckhiana*. × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 5. *Pulvinulina oblonga*, var. *scabra*. × 50. *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)



## PLATE 28.

- Fig. 1. *Truncatulina haidingerii*.  $\times 65$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Rotalia calcar*.  $\times 65$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 3. *Siphonina reticulata*.  $\times 125$ .  
 4. *Pulvinulina concentrica*.  $\times 38$ . *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 29.

- Fig. 1. *Rotalia soldani*.  $\times 40$ . *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 2. *Rotalia calcar*.  $\times 50$ . *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 3. *Rotalia orbicularis*.  $\times 50$ . *a*, dorsal view; *b*, ventral view; *c*, side view. (After Brady.)  
 4. *Calcarina hispida*.  $\times 30$ . (After Brady.)  
 5. *Calcarina hispida*.  $\times 30$ . (After Brady.)

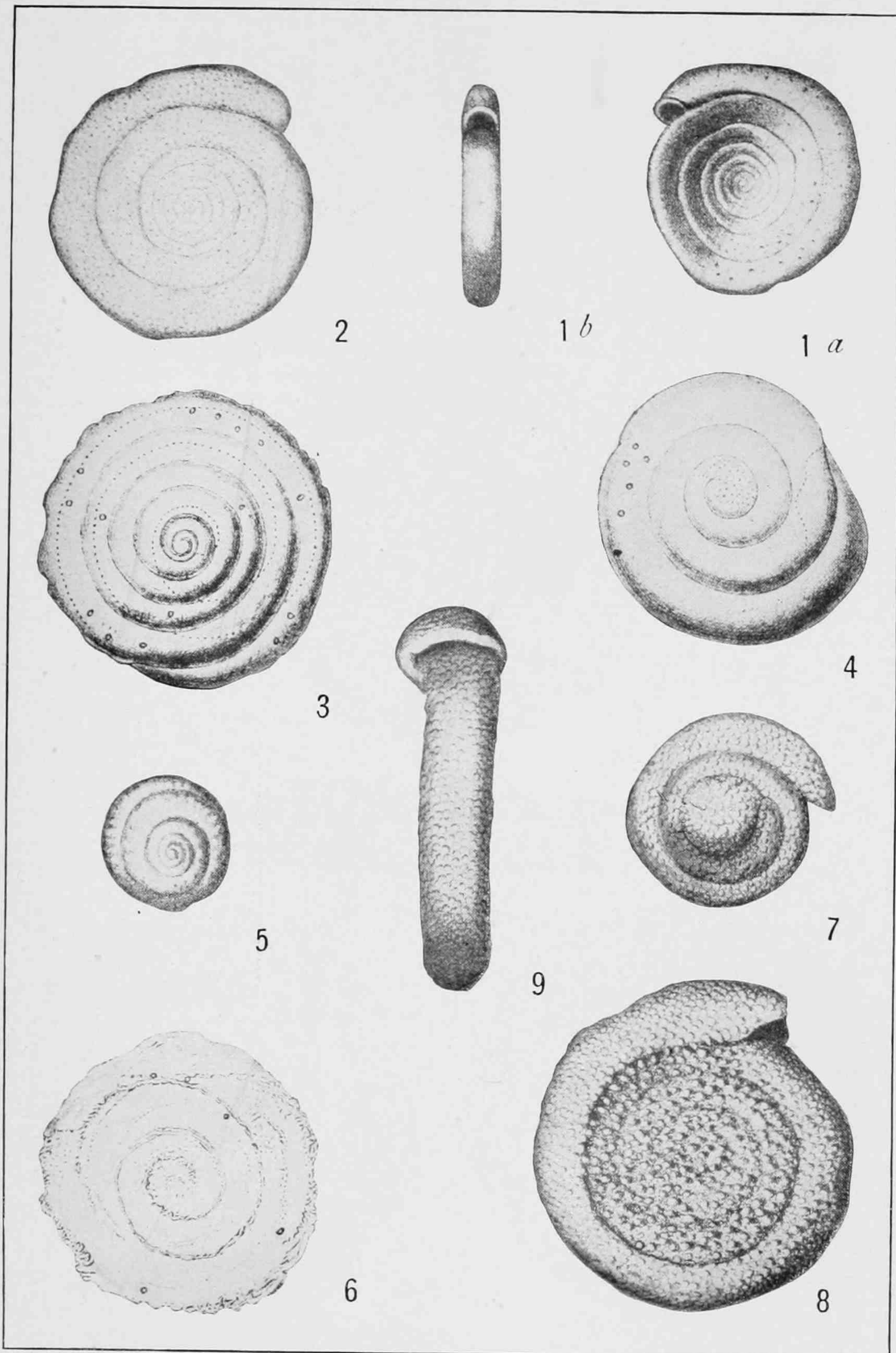
## PLATE 30.

1. *Rotalia papillosa*, var. *compressiuscula*.  $\times 33$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Rotalia broeckhiana*.  $\times 66$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 3. *Rotalia beccarii*.  $\times 33$ . *a*, dorsal view; *b*, ventral view; *c*, side view.

## PLATE 31.

- Fig. 1. *Rotalia papillosa*.  $\times 30$ . *a*, dorsal view; *b*, ventral view; *c*, side view.  
 2. *Calcarina spengleri*.  $\times 30$ . *a*, dorsal view; *b*, ventral view.  
 3. *Calcarina hispida*.  $\times 30$ .  
 4. *Rotalia soldanii*.  $\times 60$ . *a*, dorsal view; *b*, ventral view; *c*, side view.

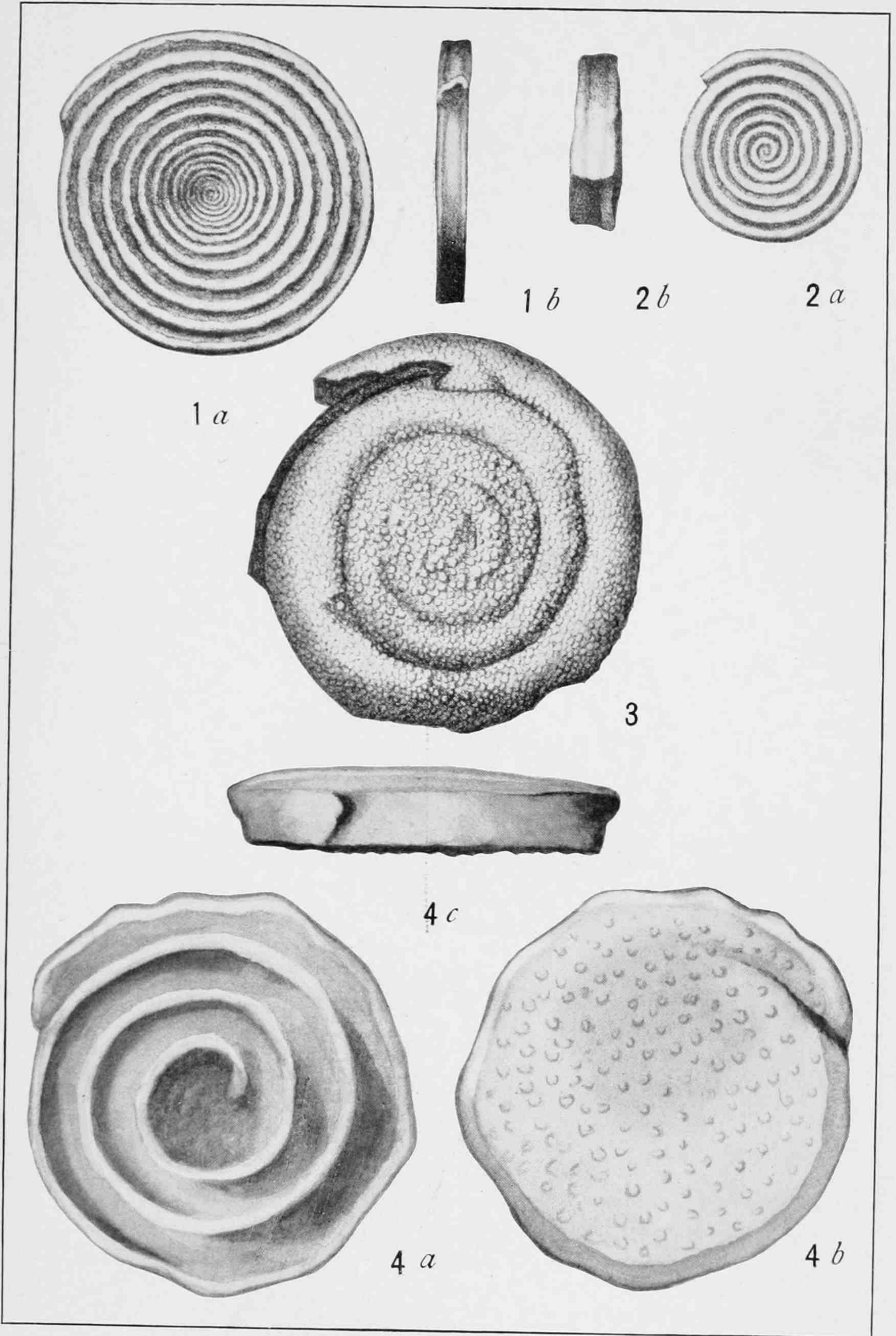




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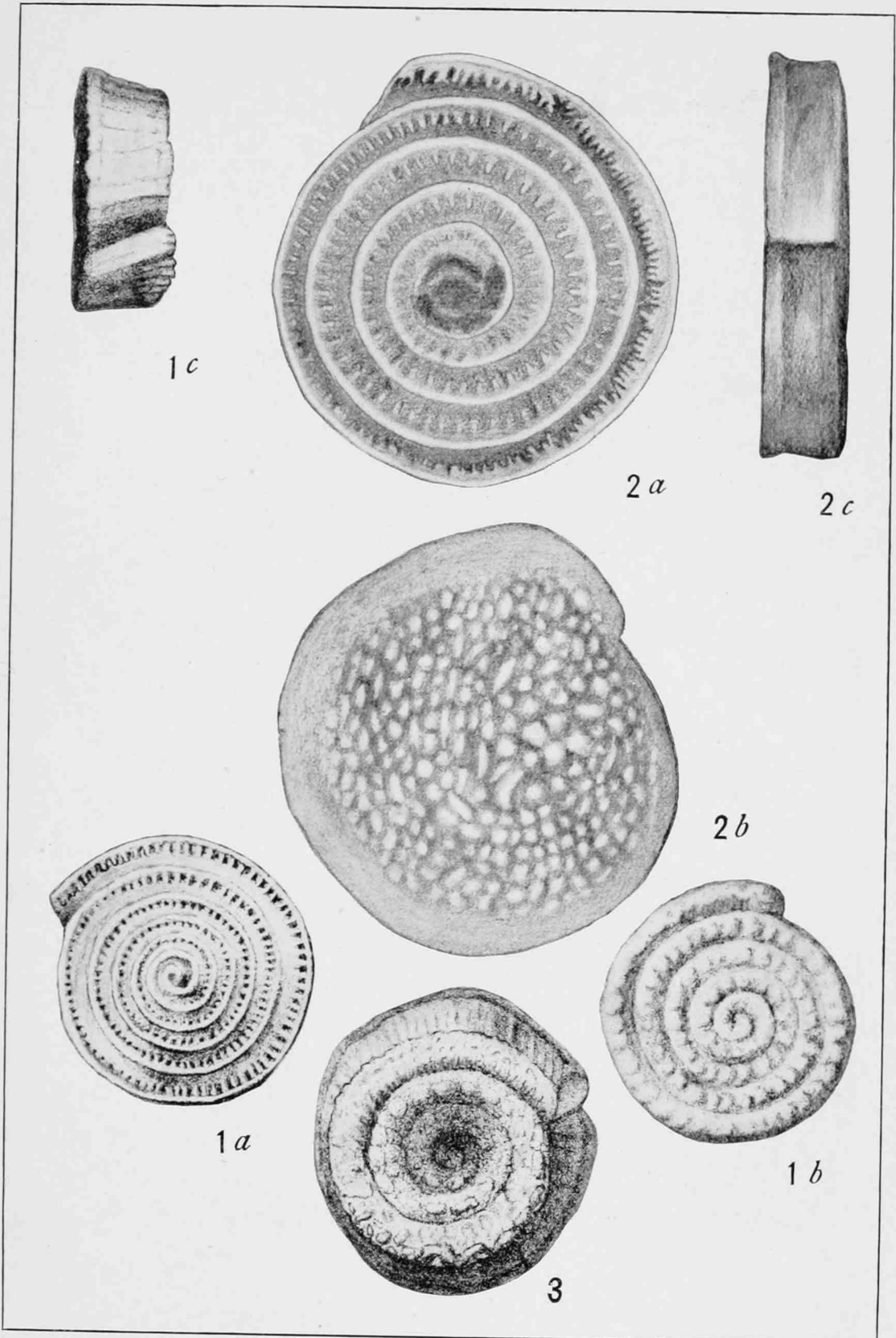




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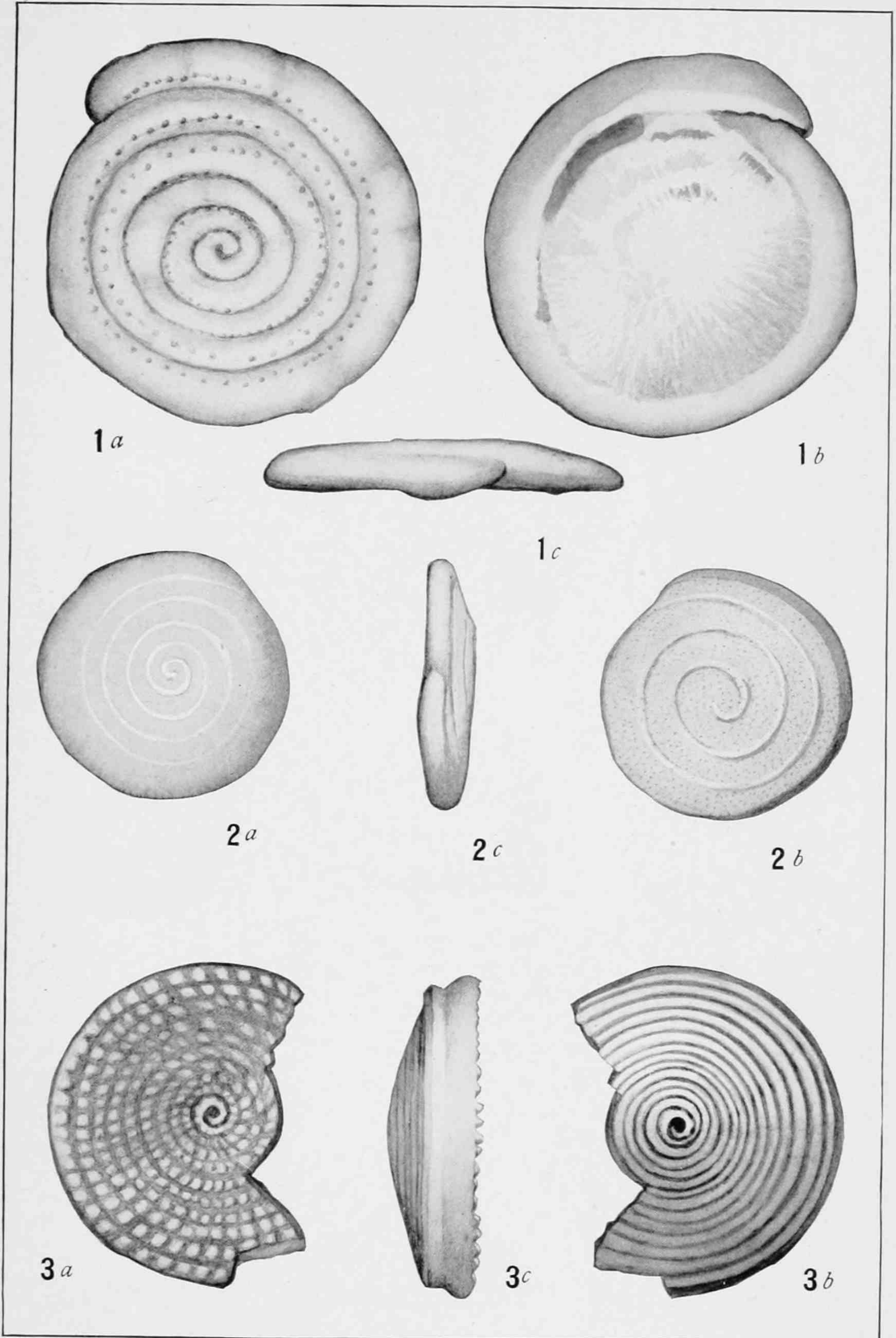




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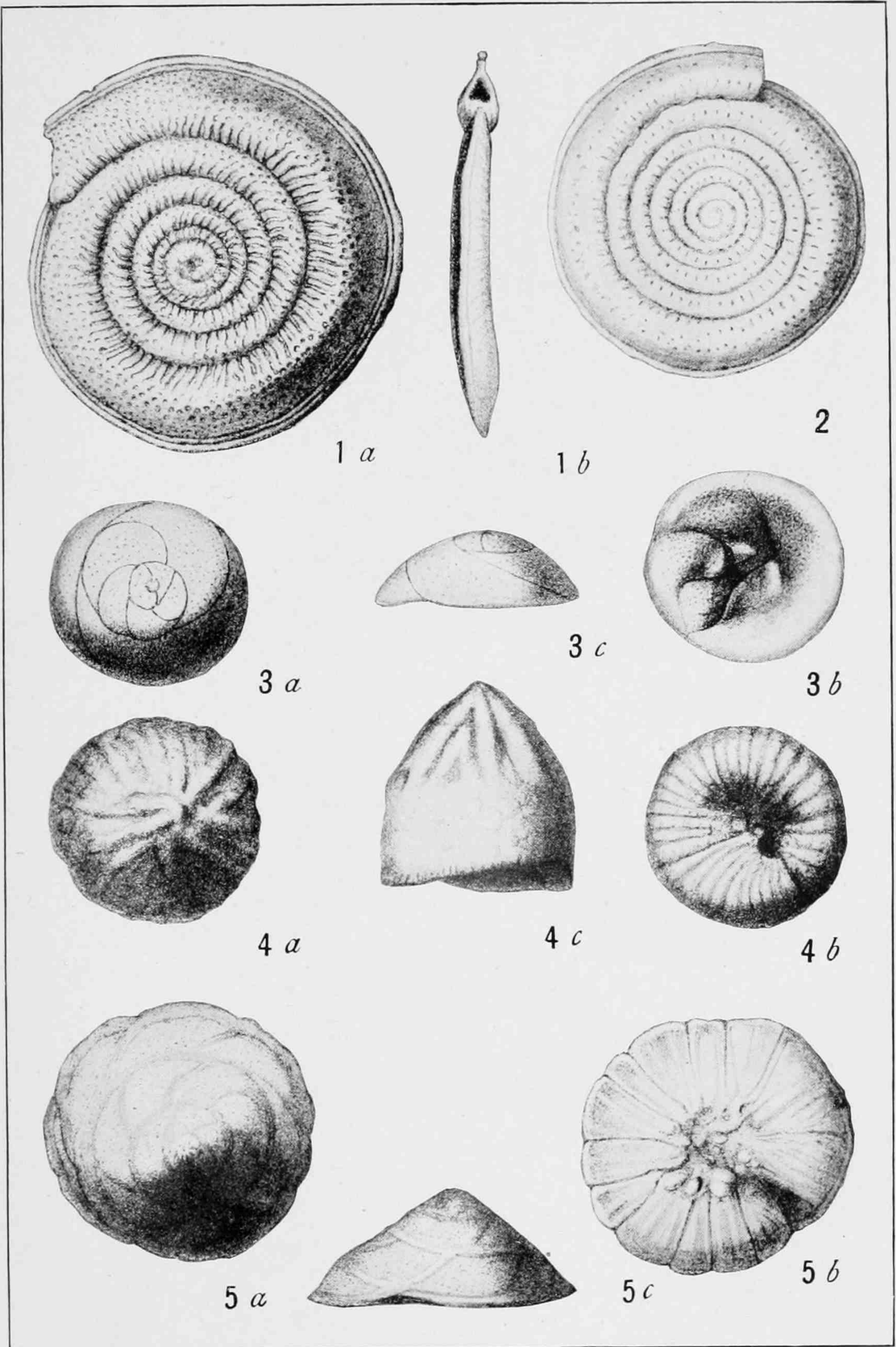




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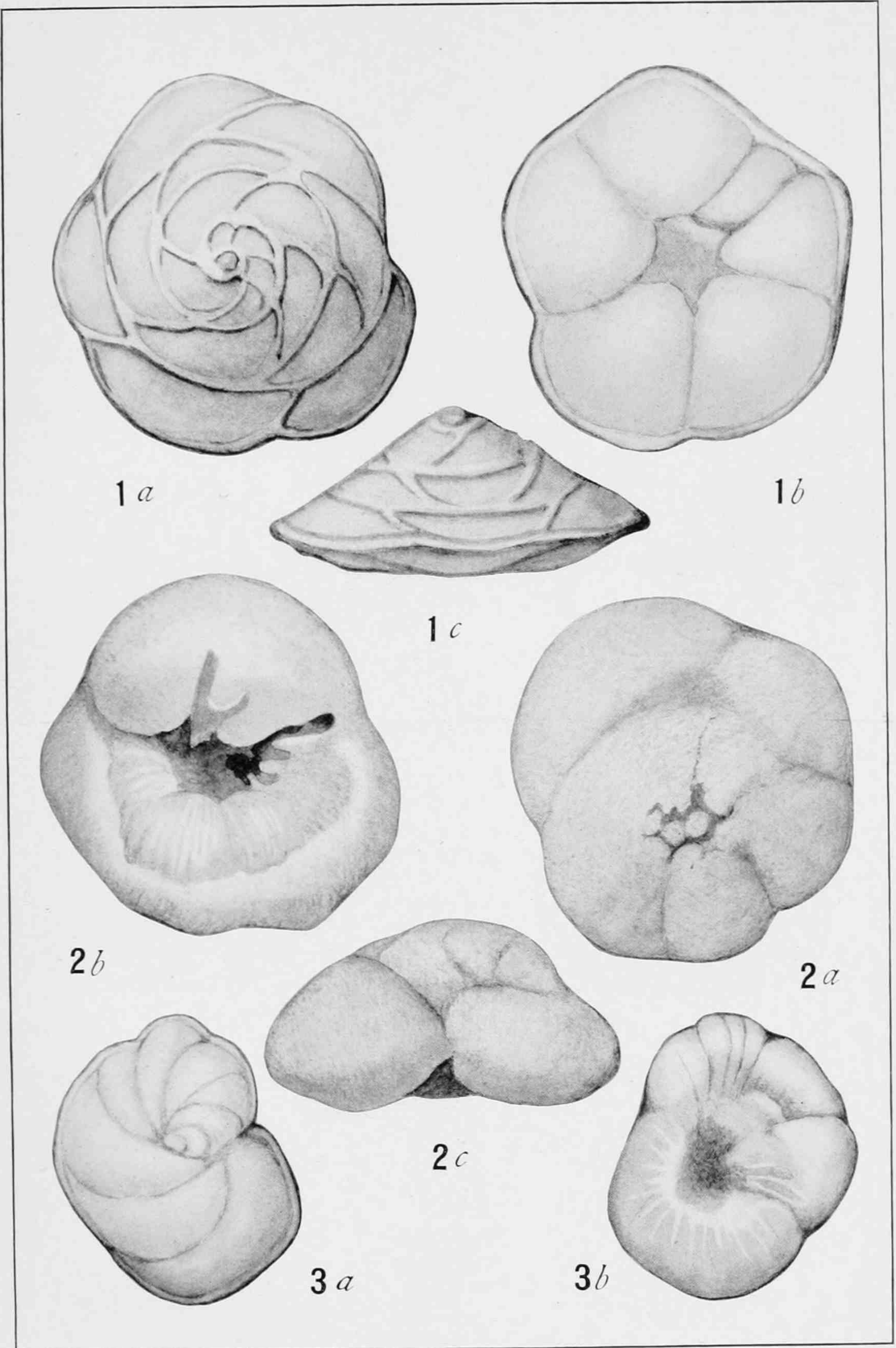




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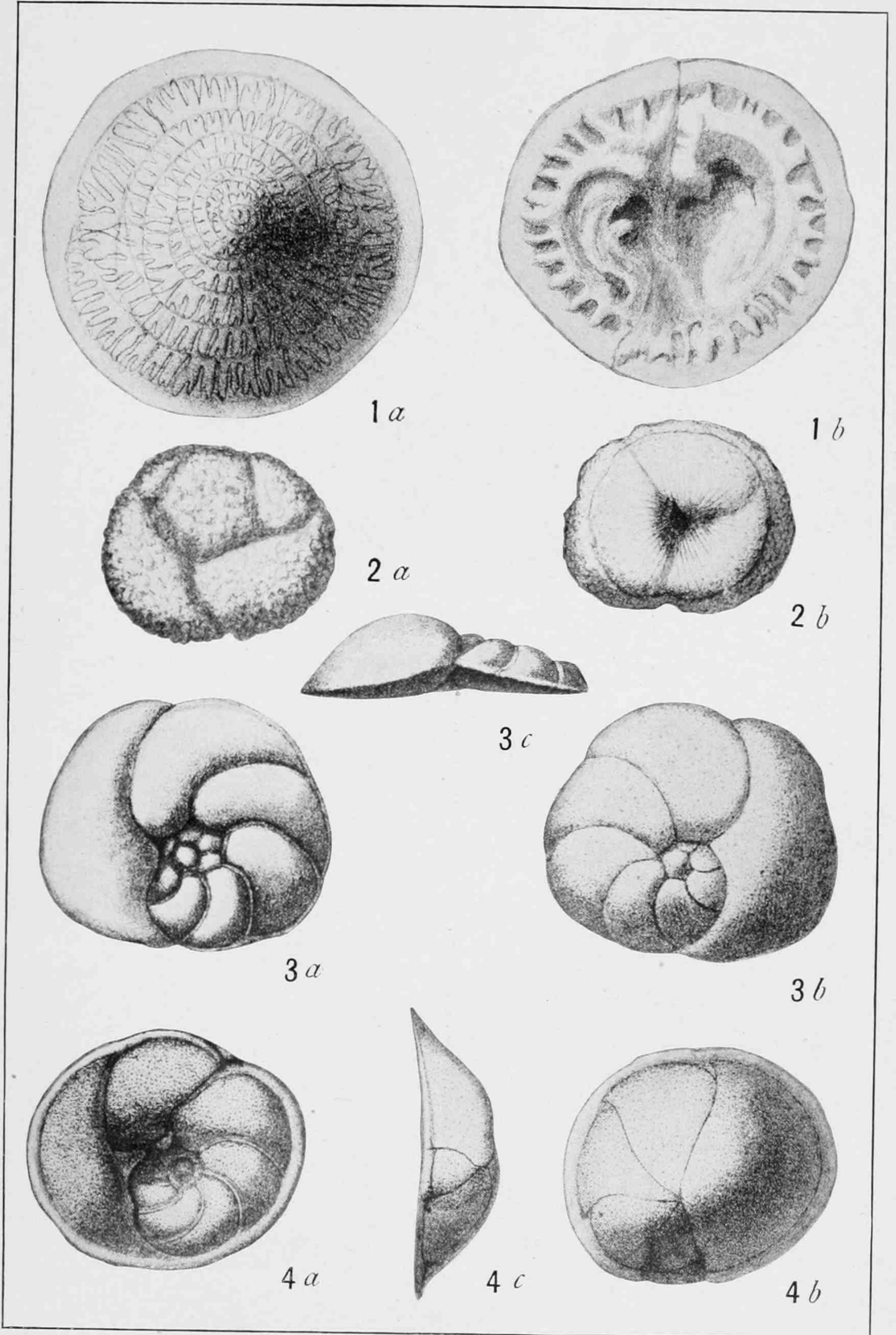




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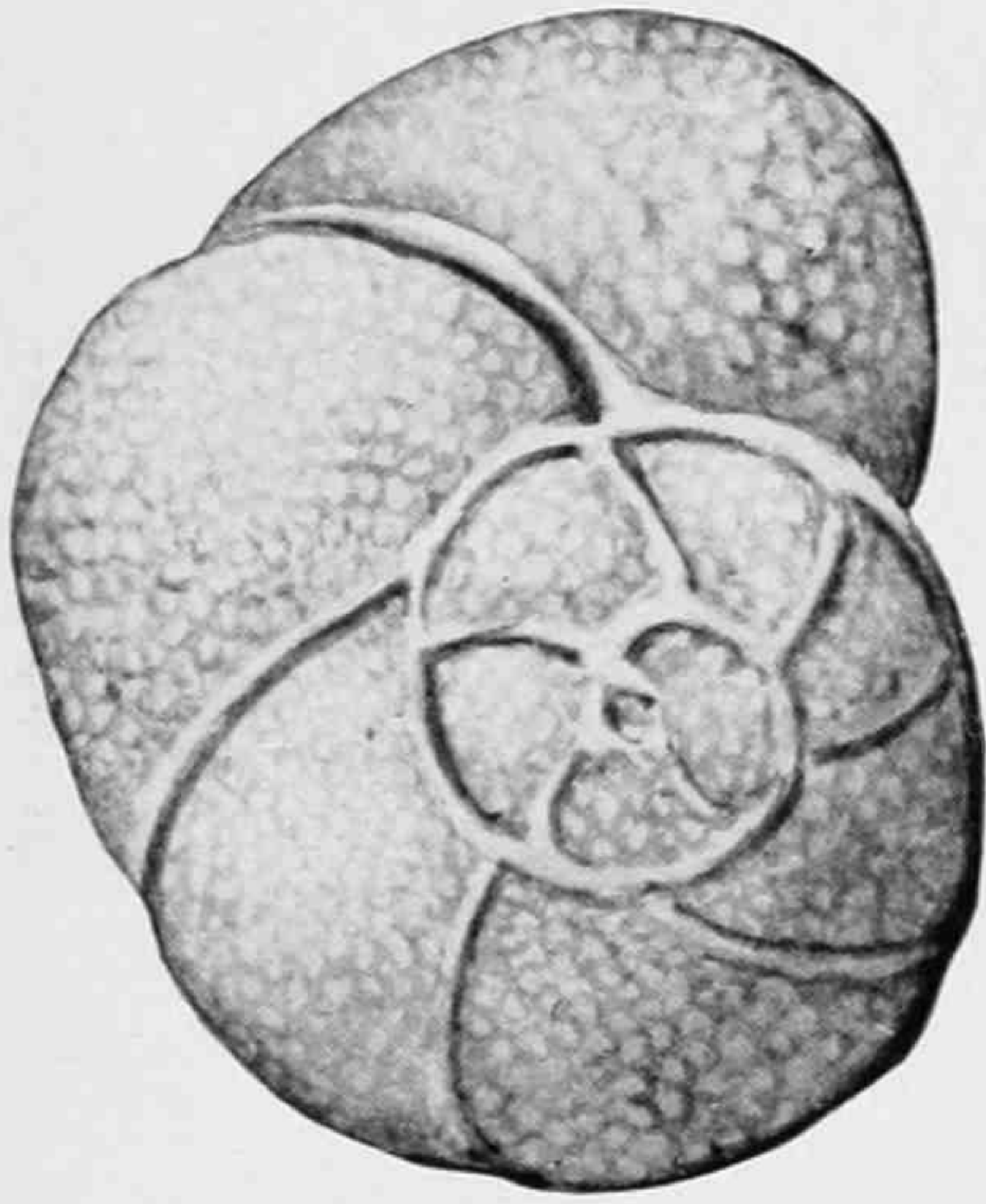




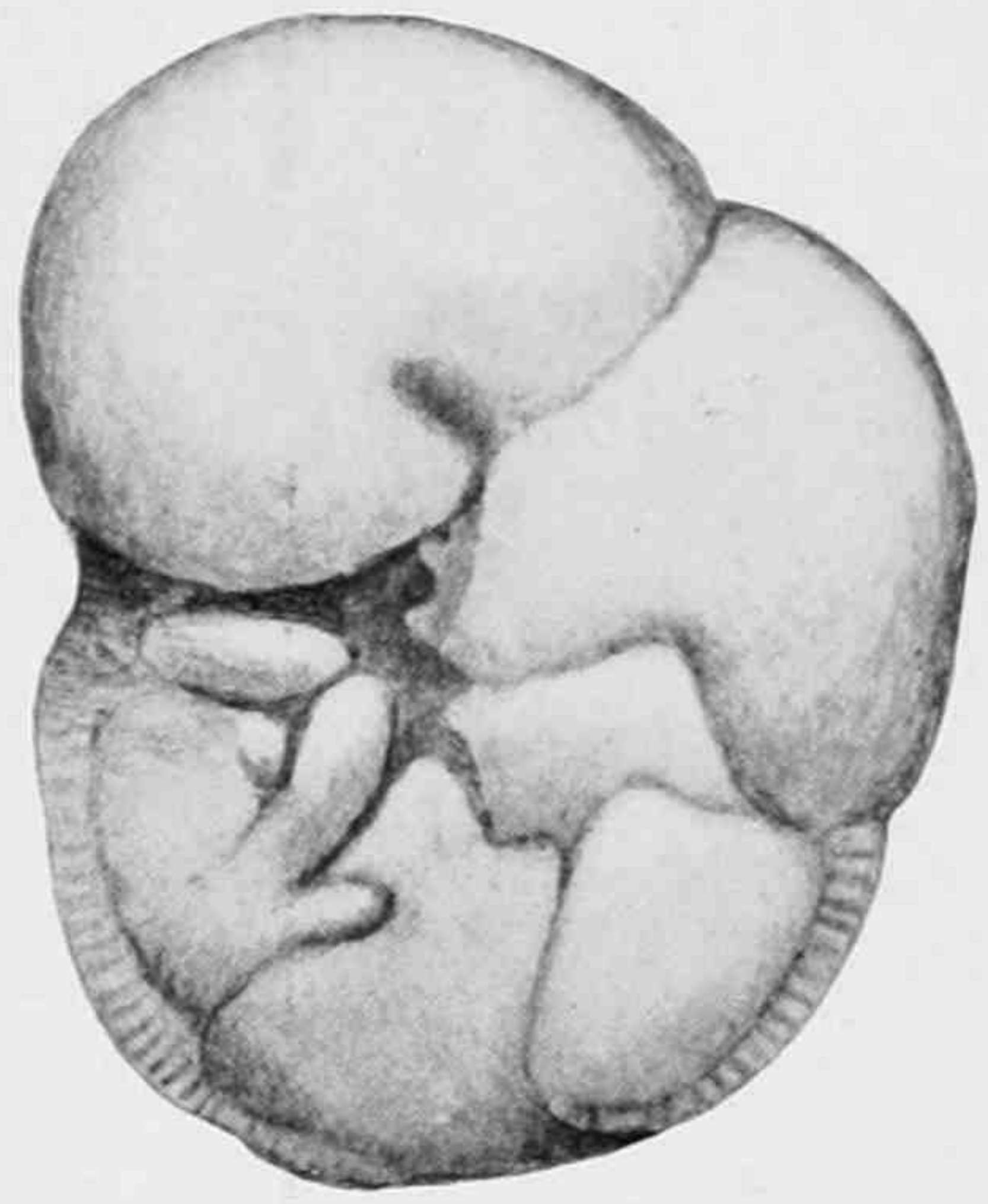
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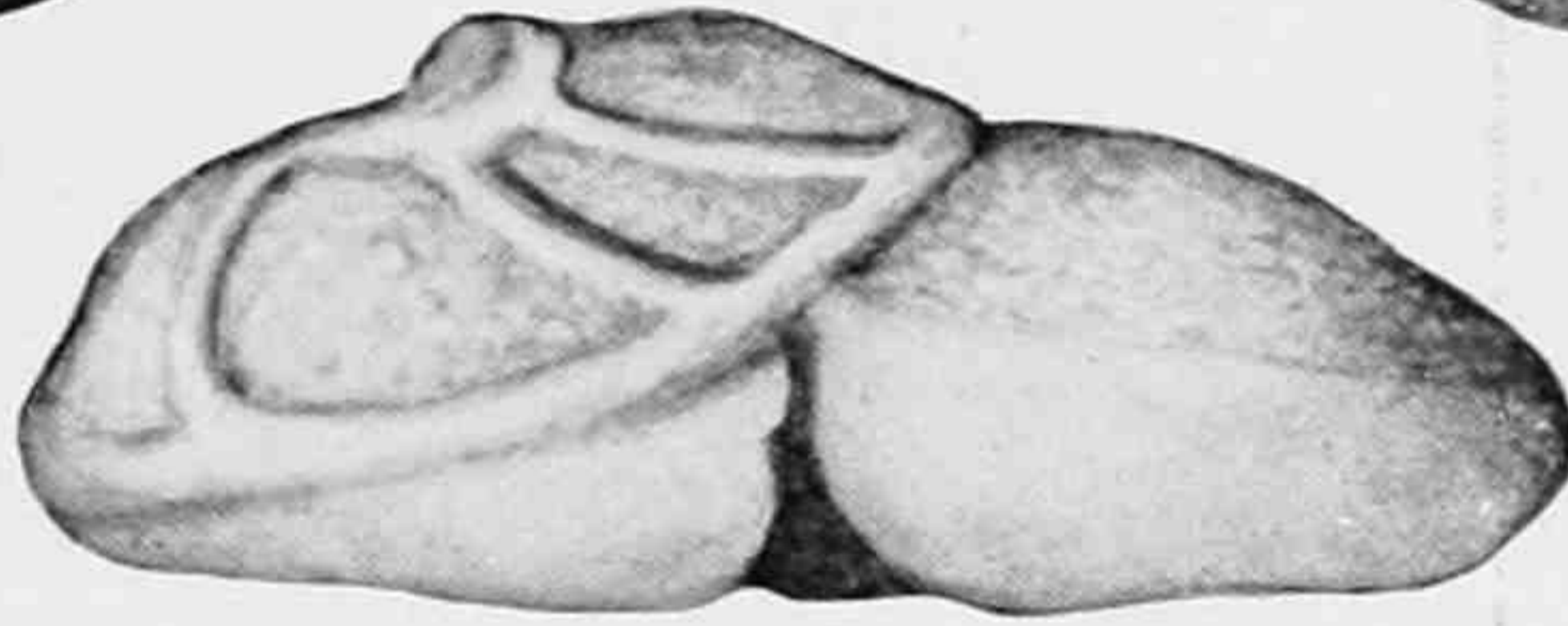




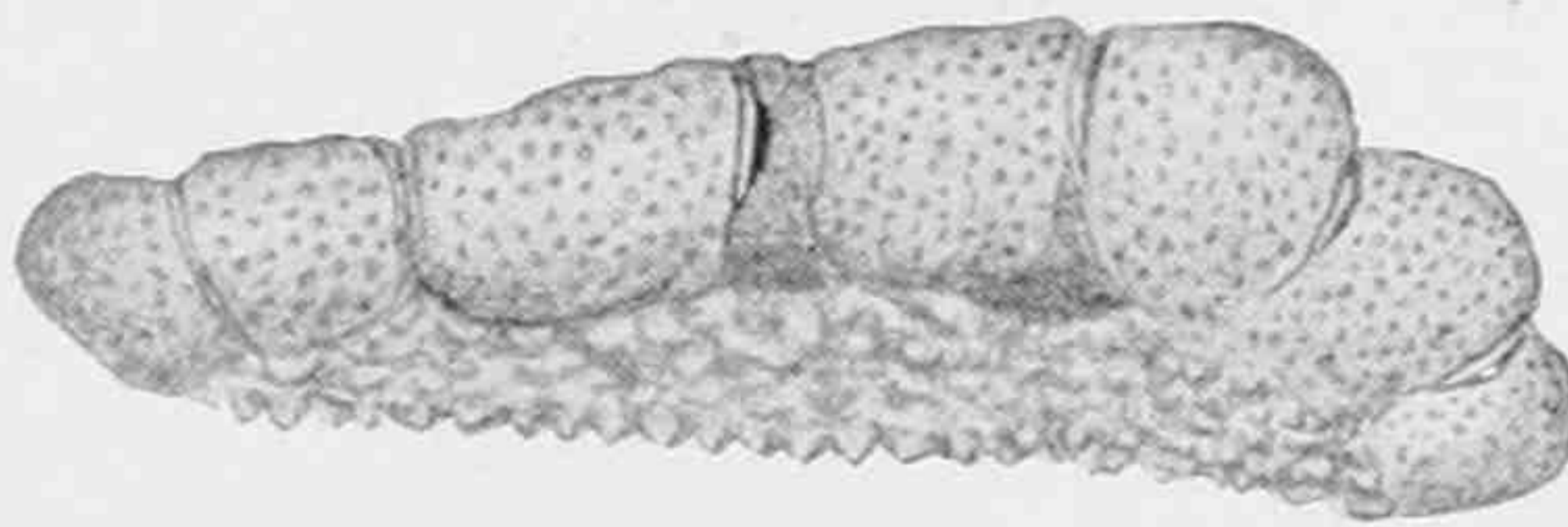
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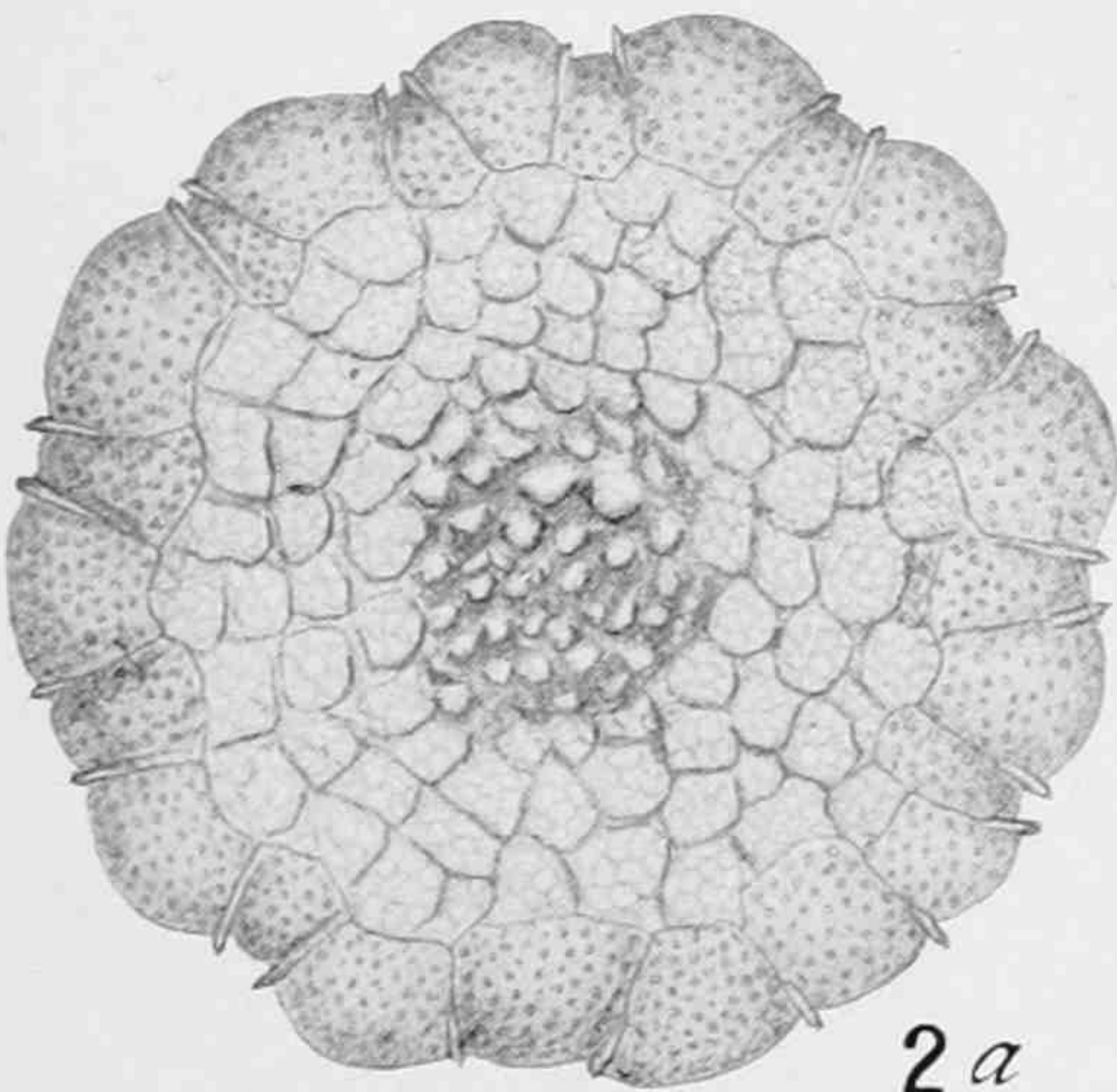
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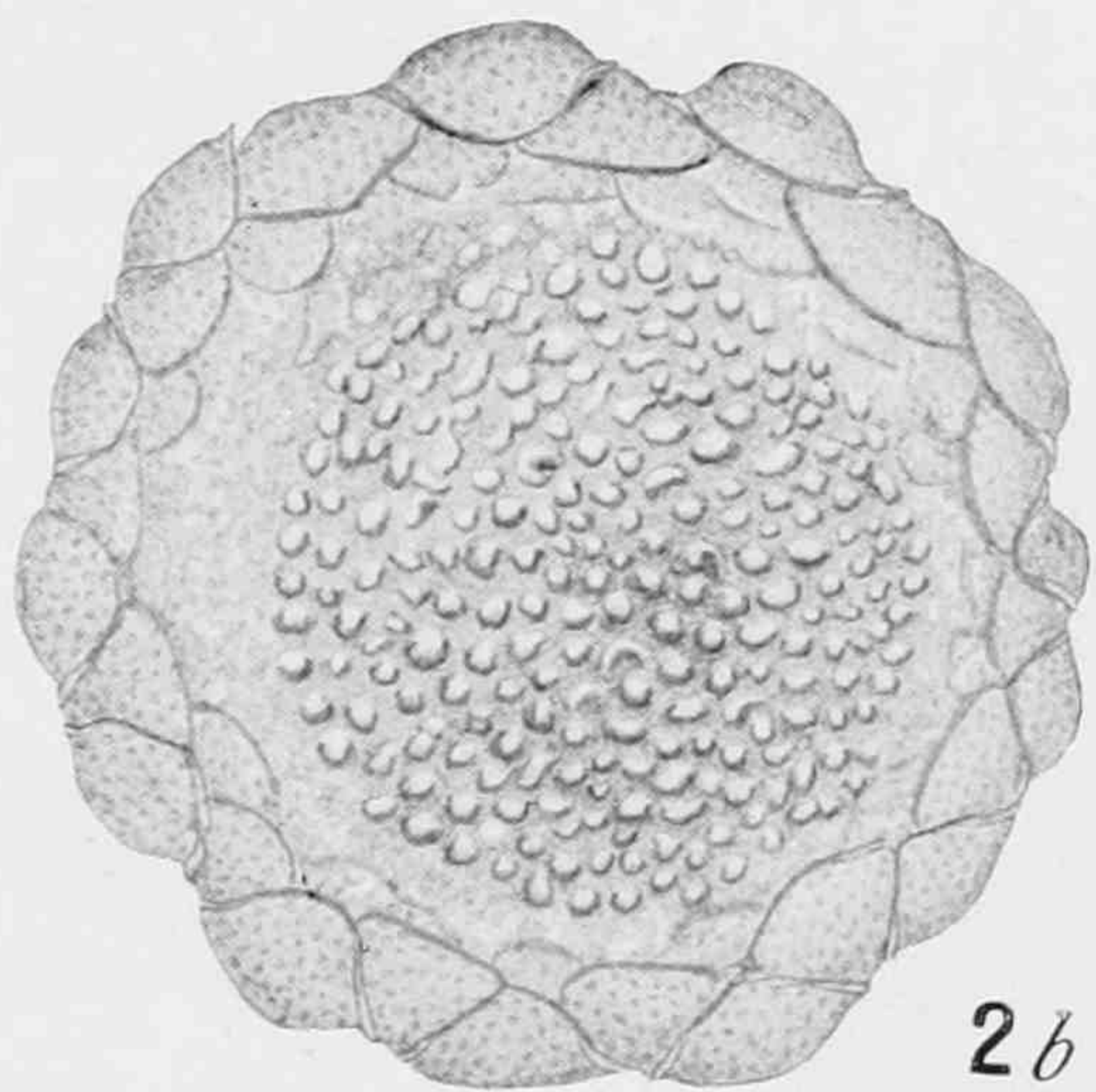
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2c



2a

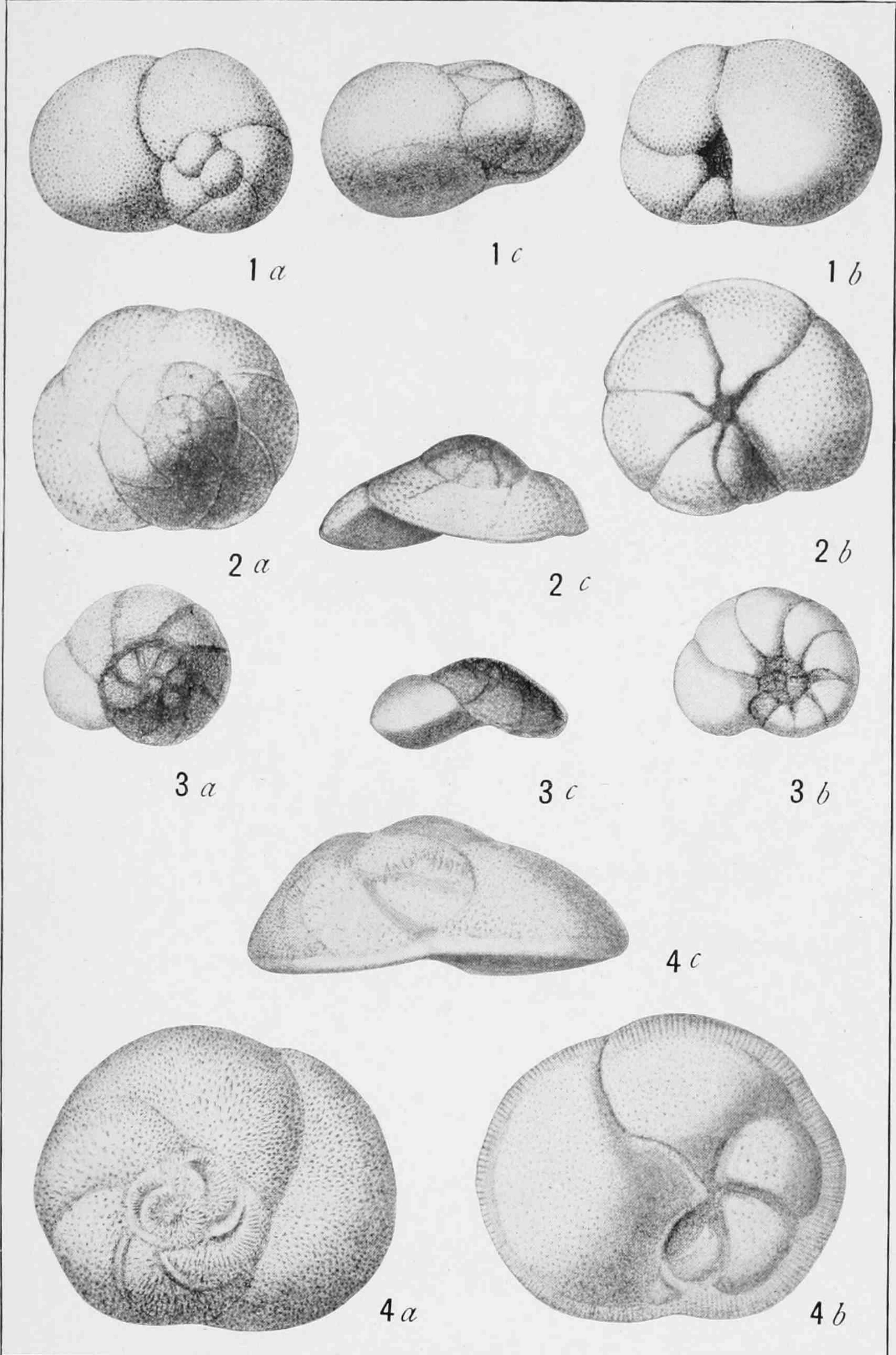


2b

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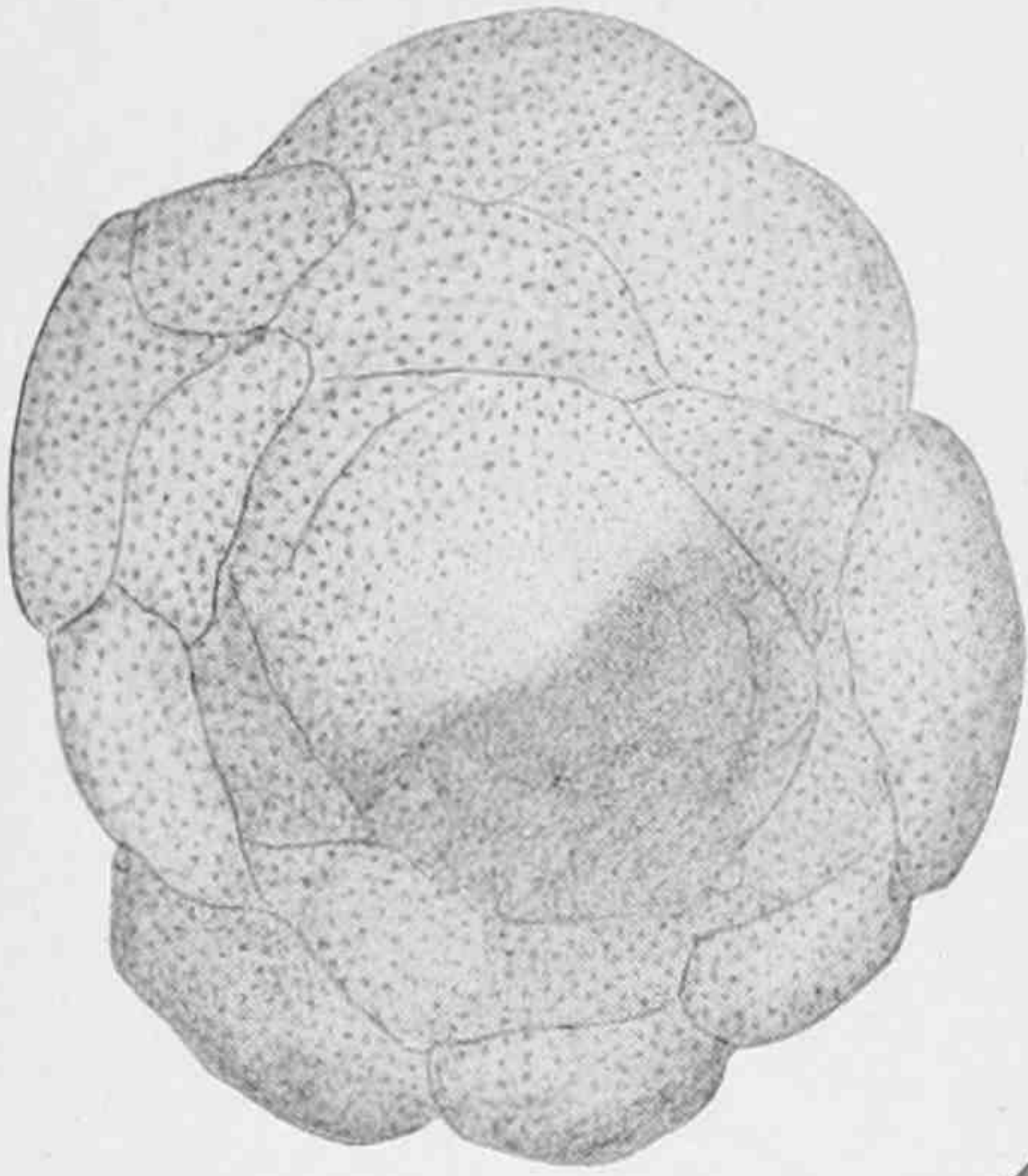




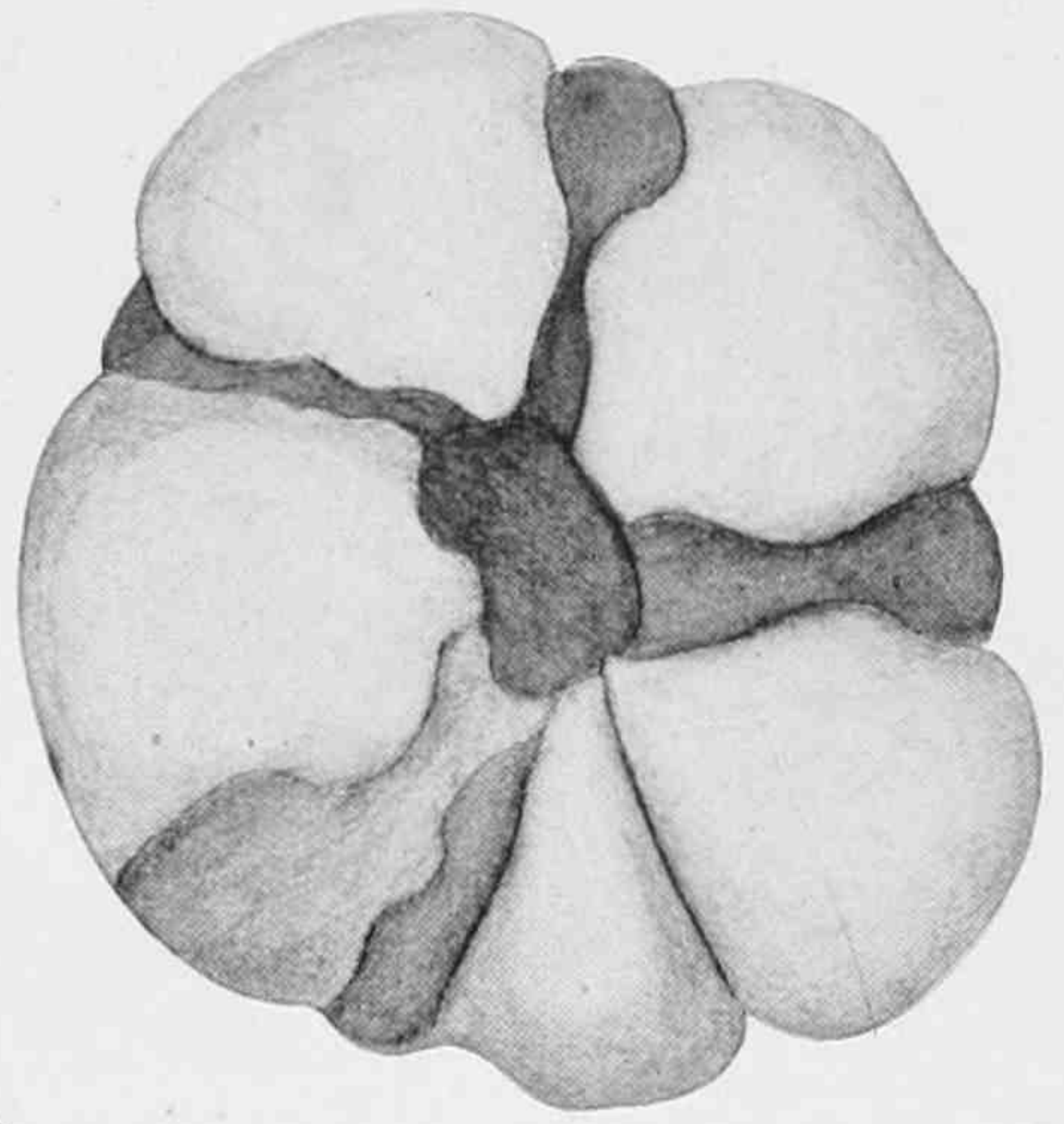
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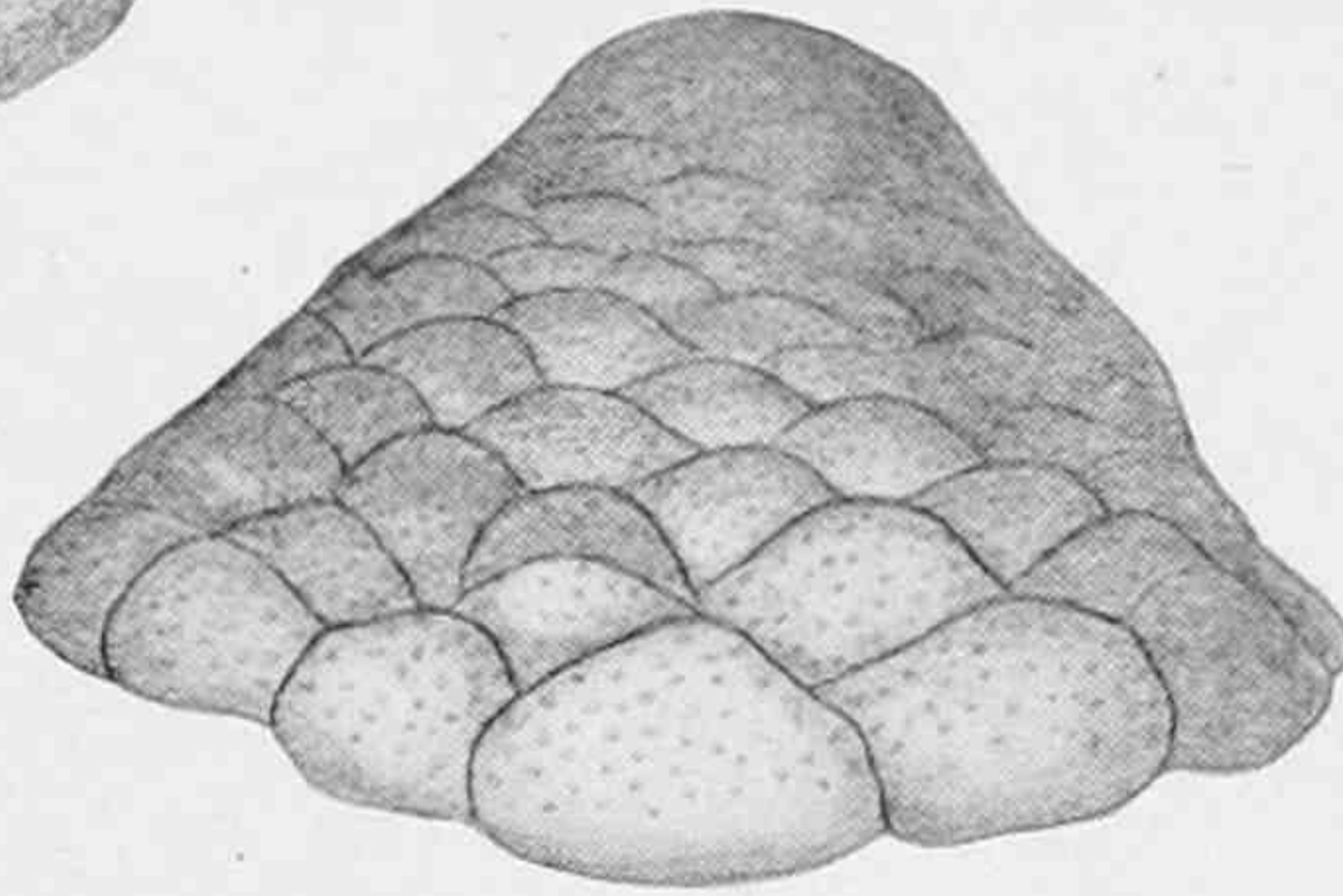




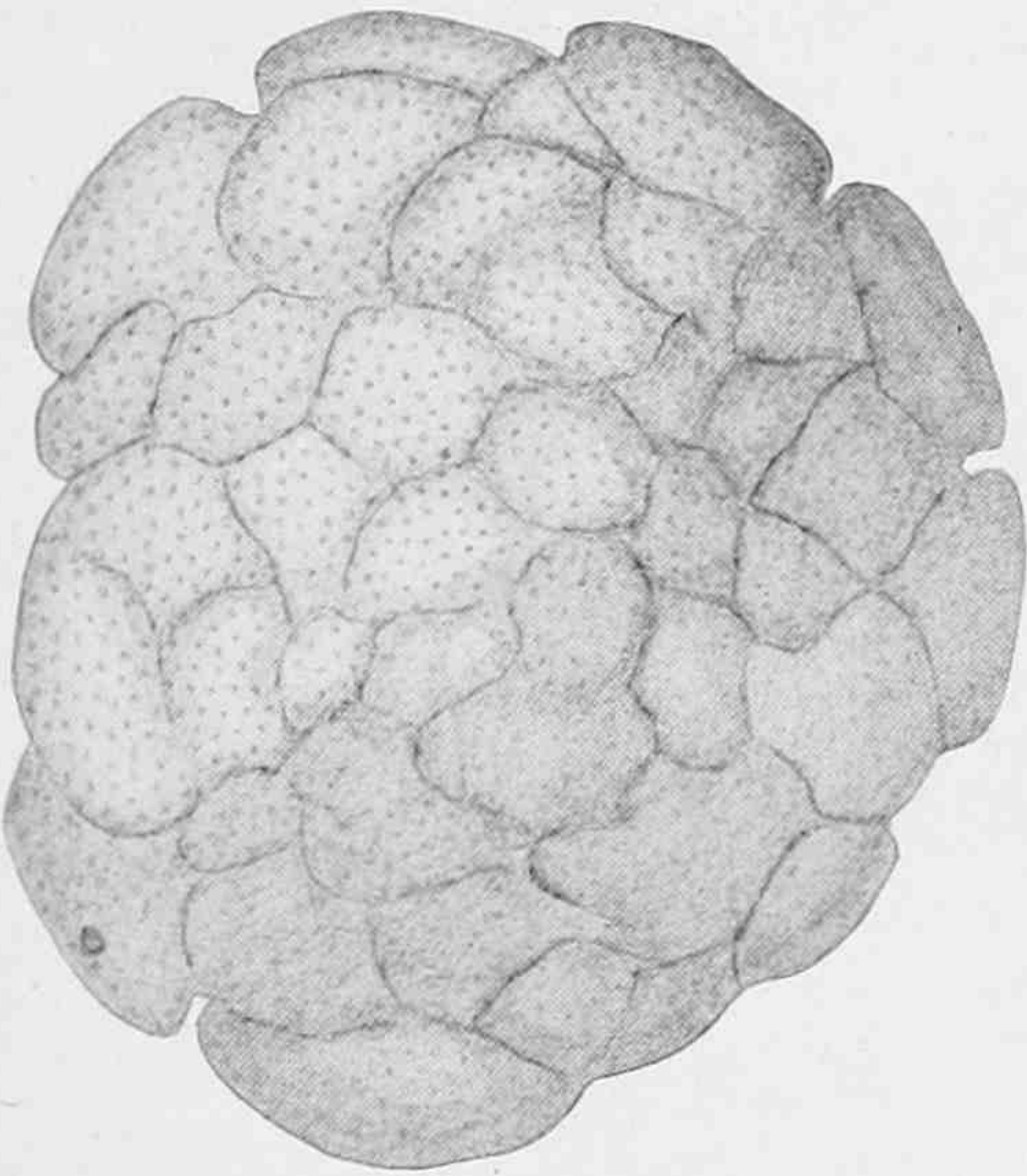
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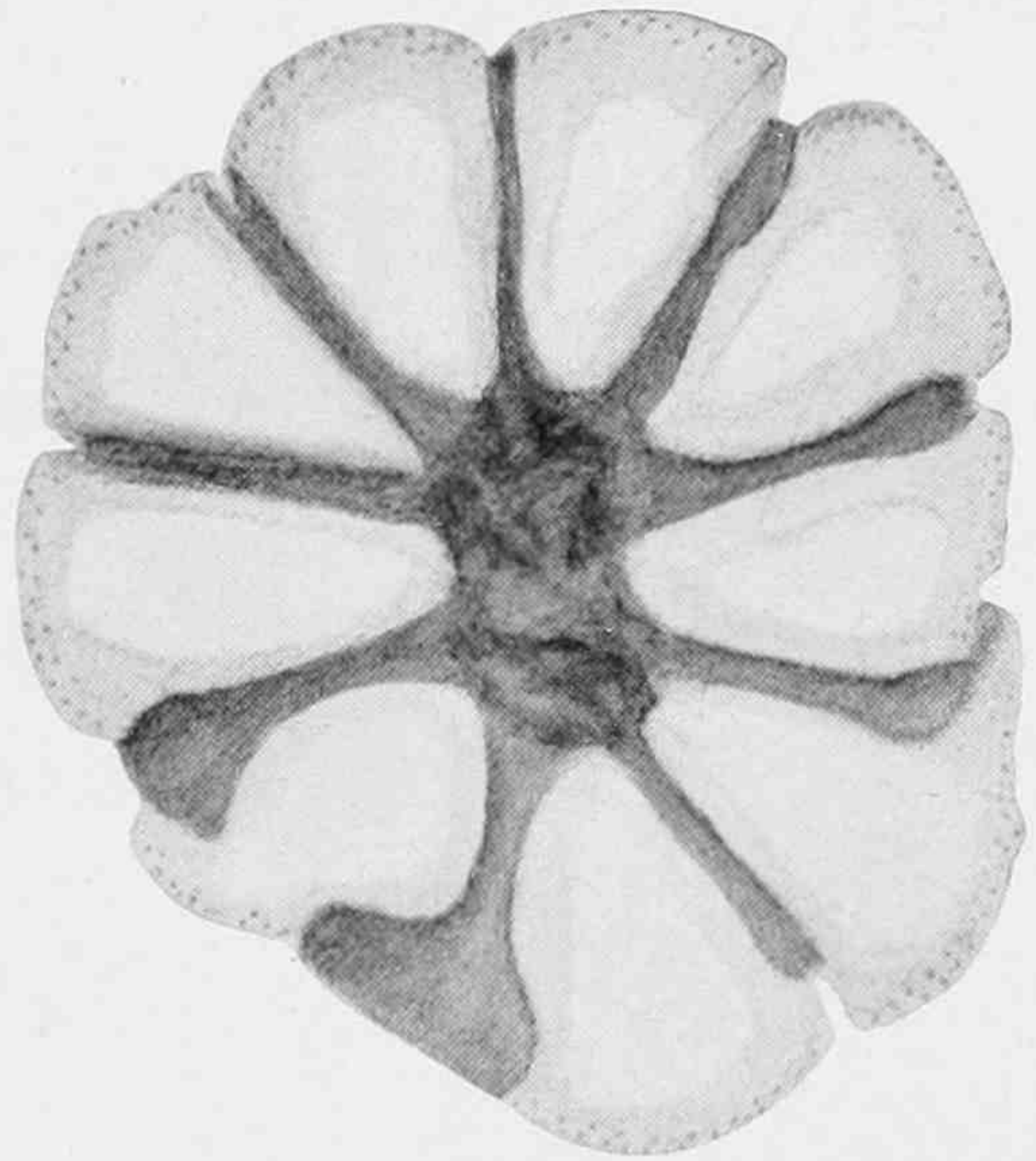
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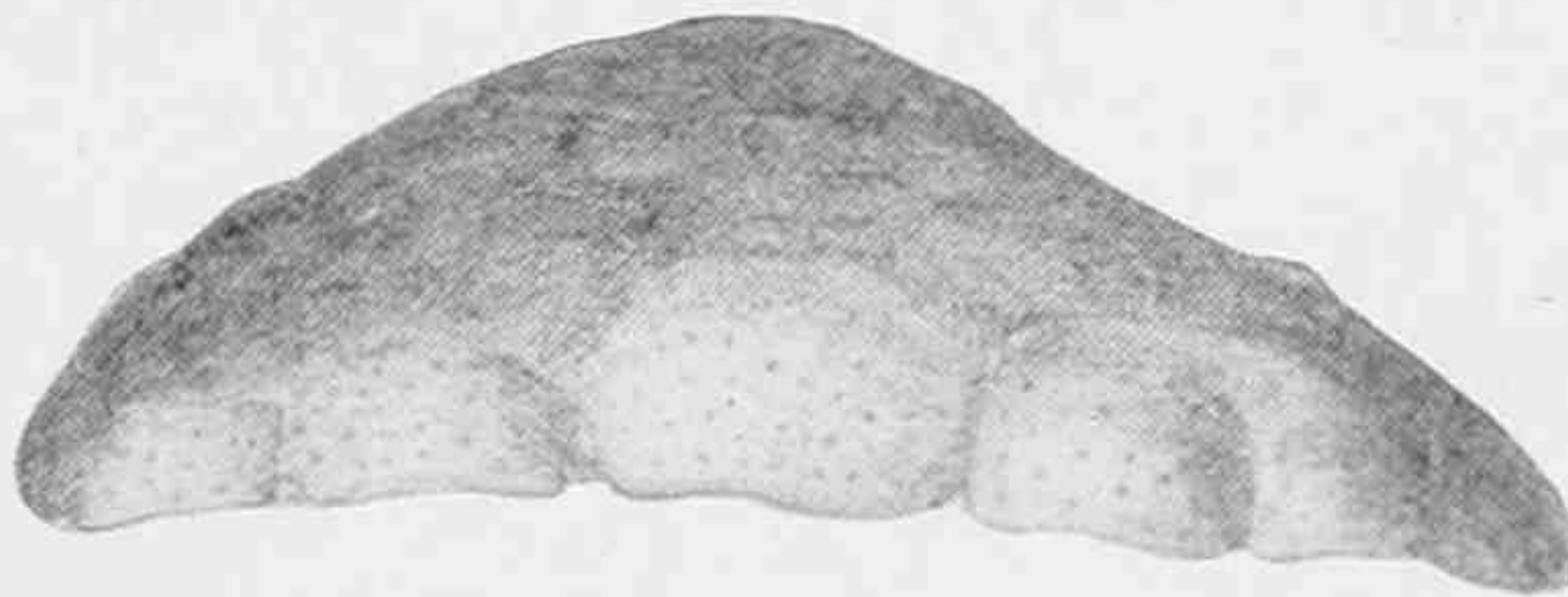
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2b

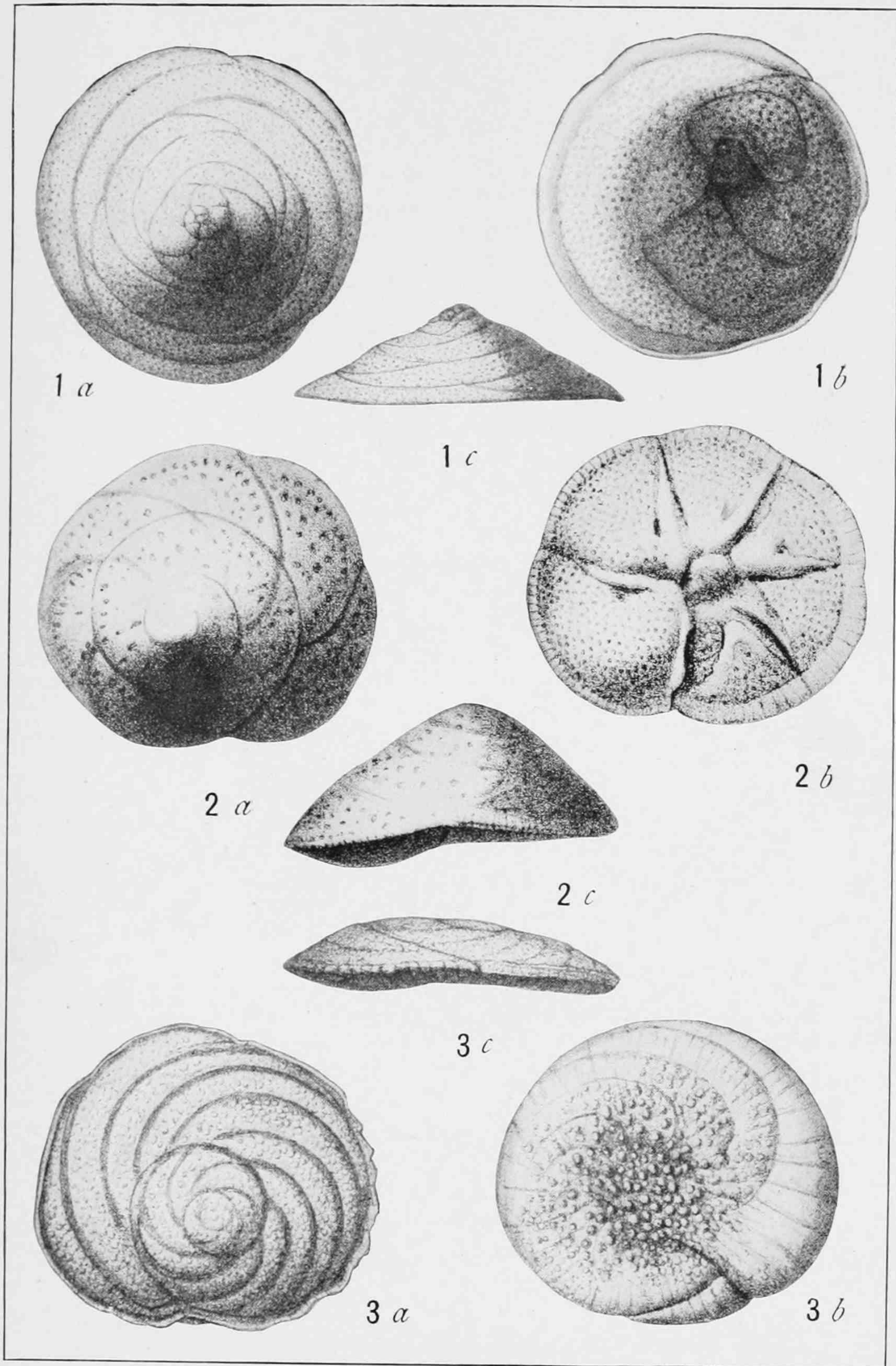


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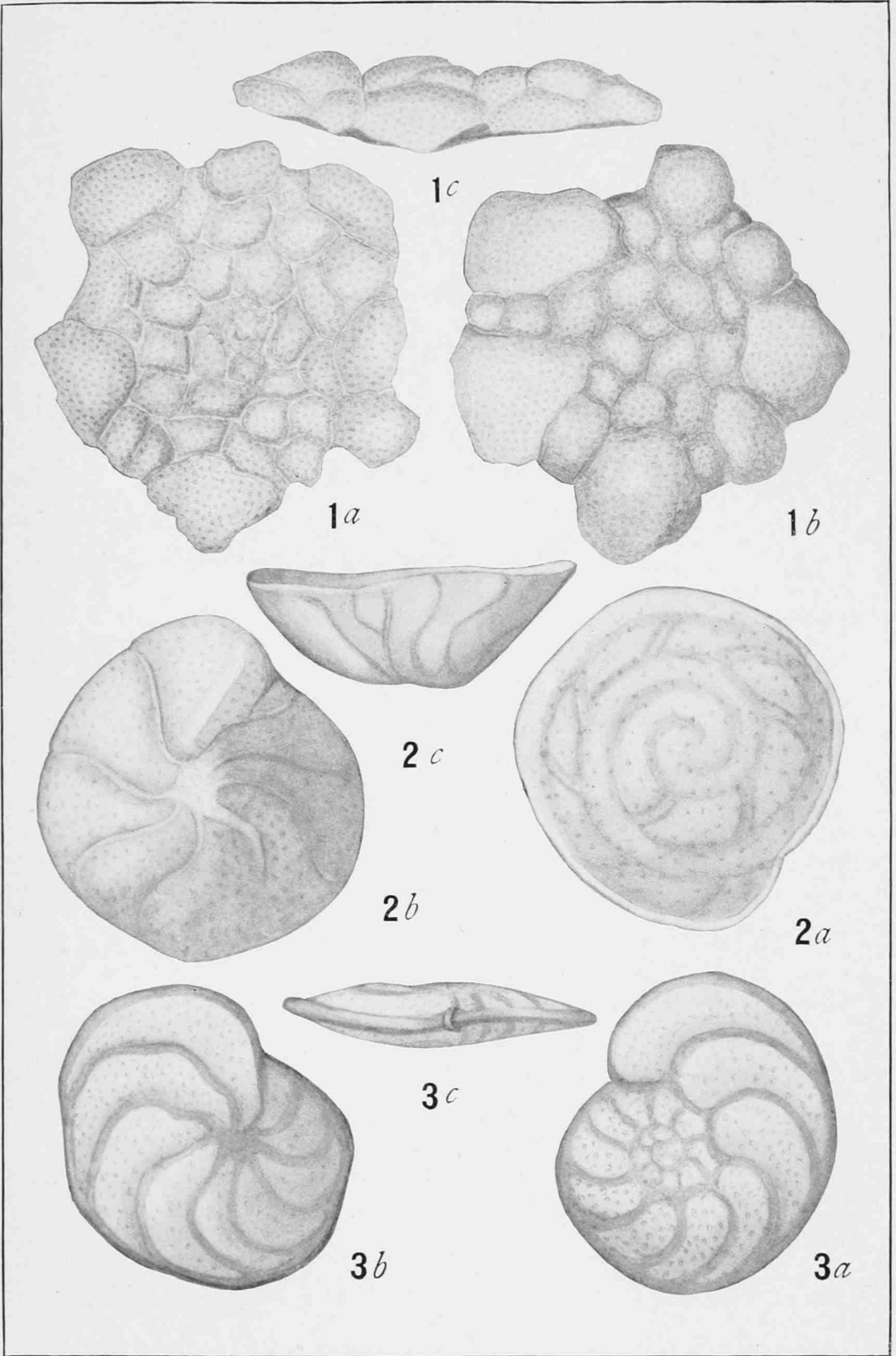




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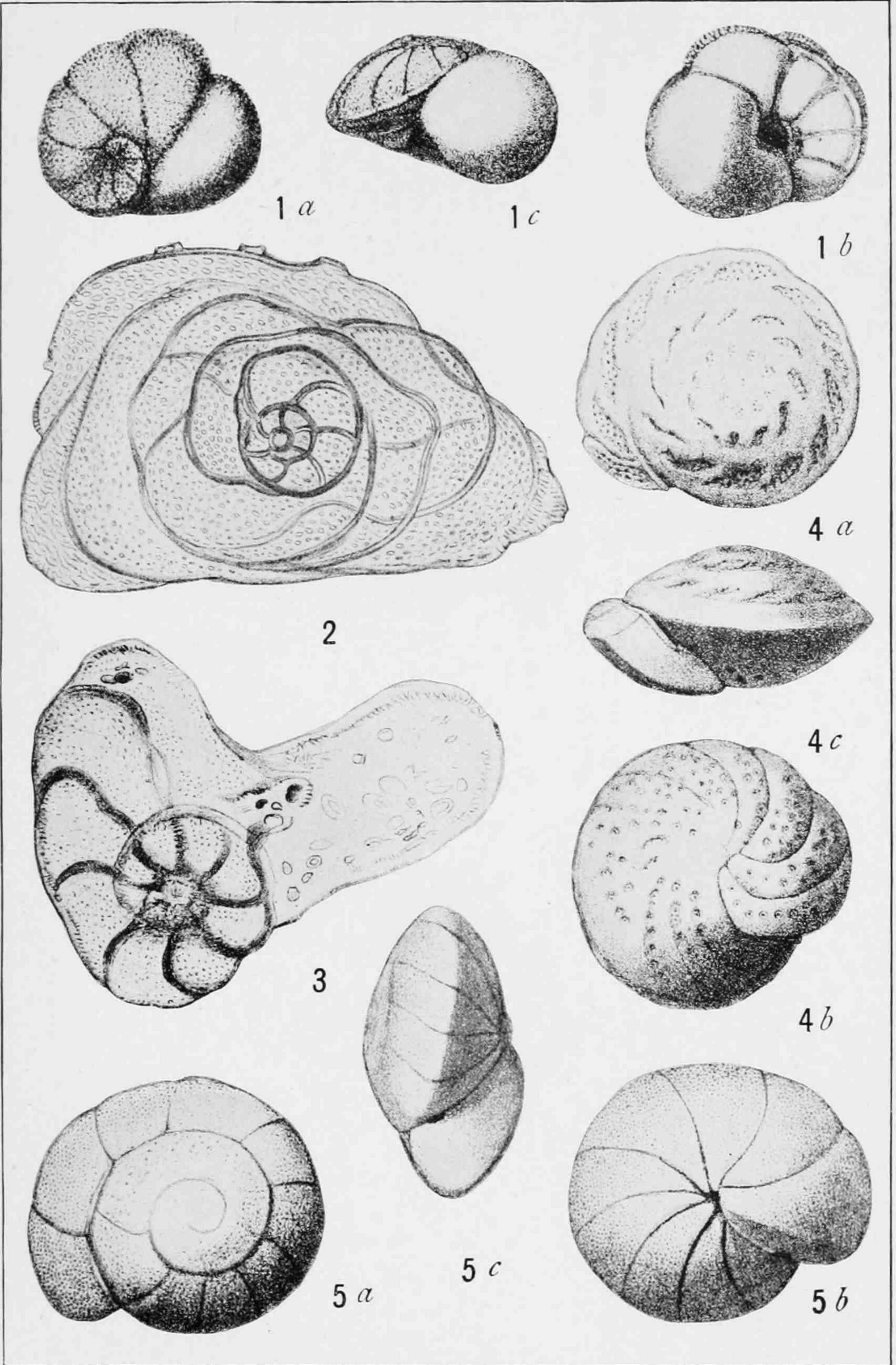




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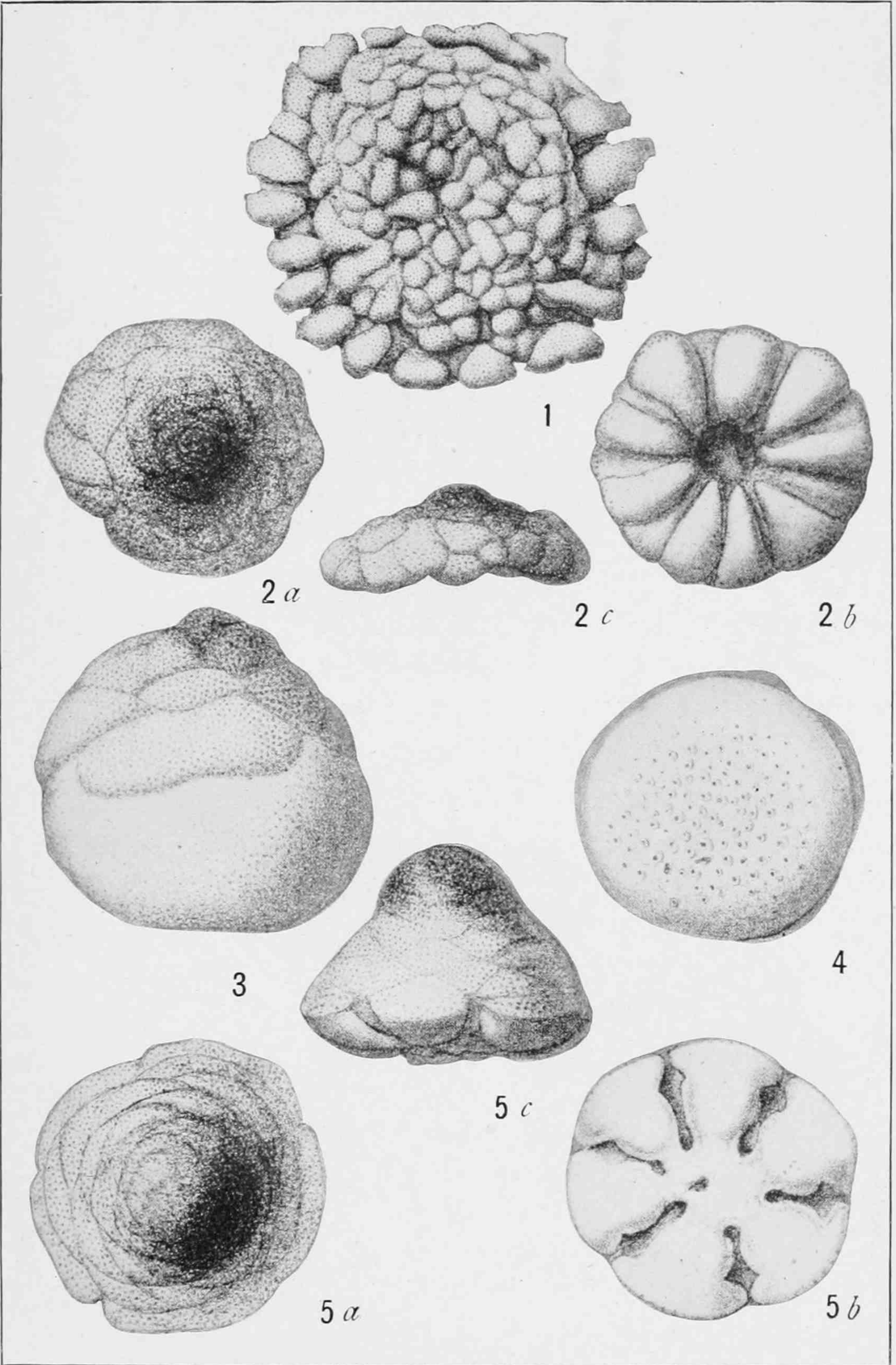




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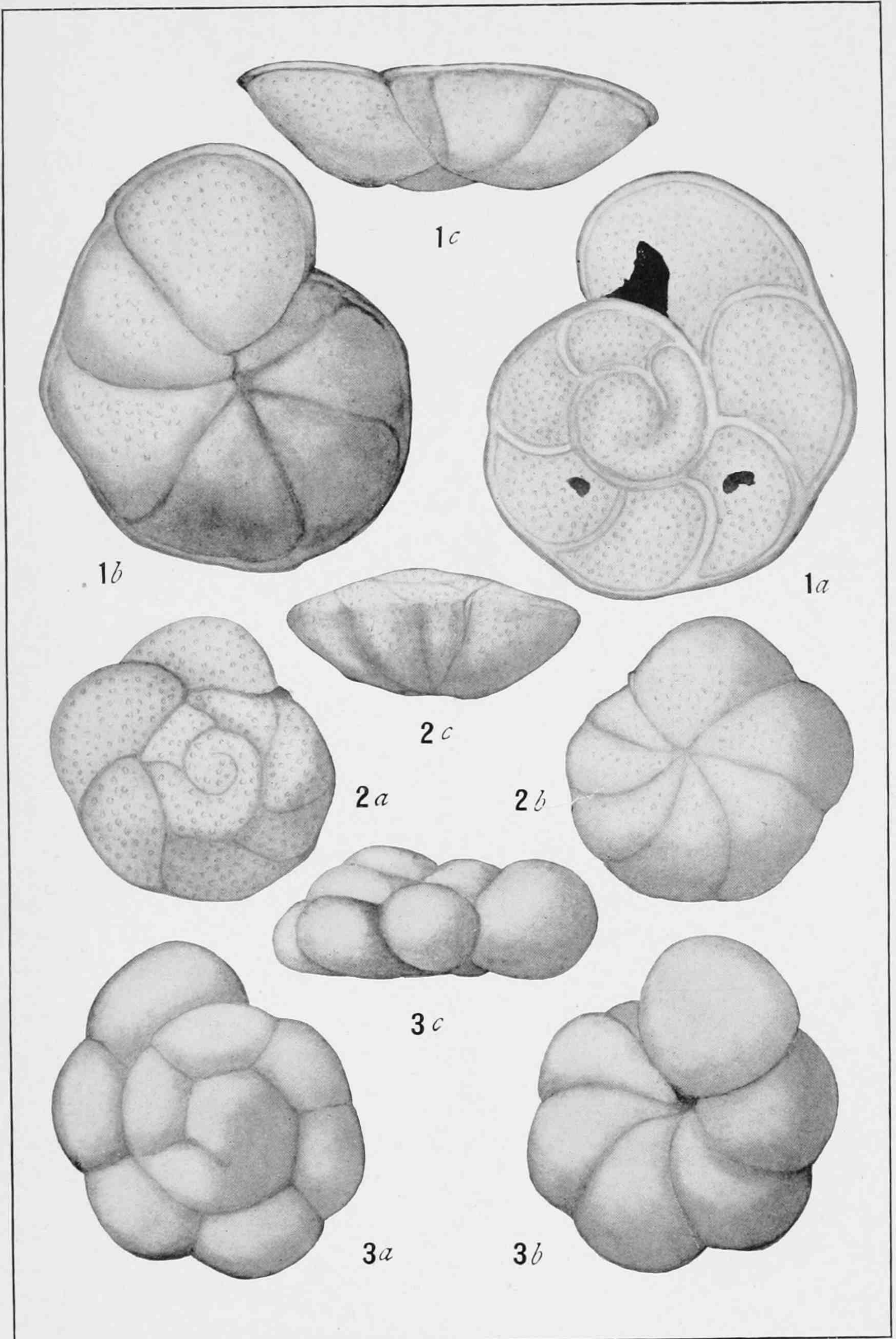




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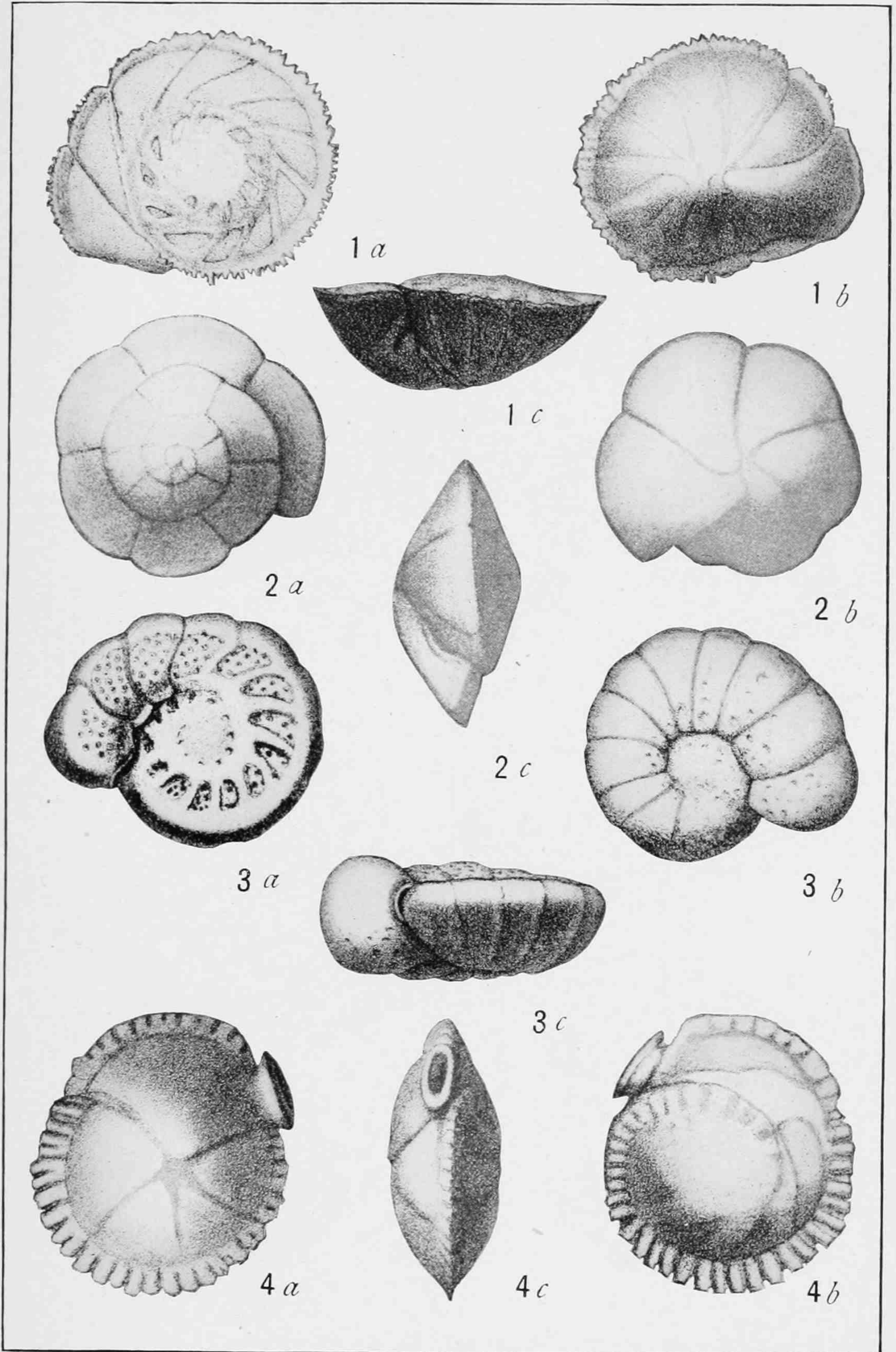




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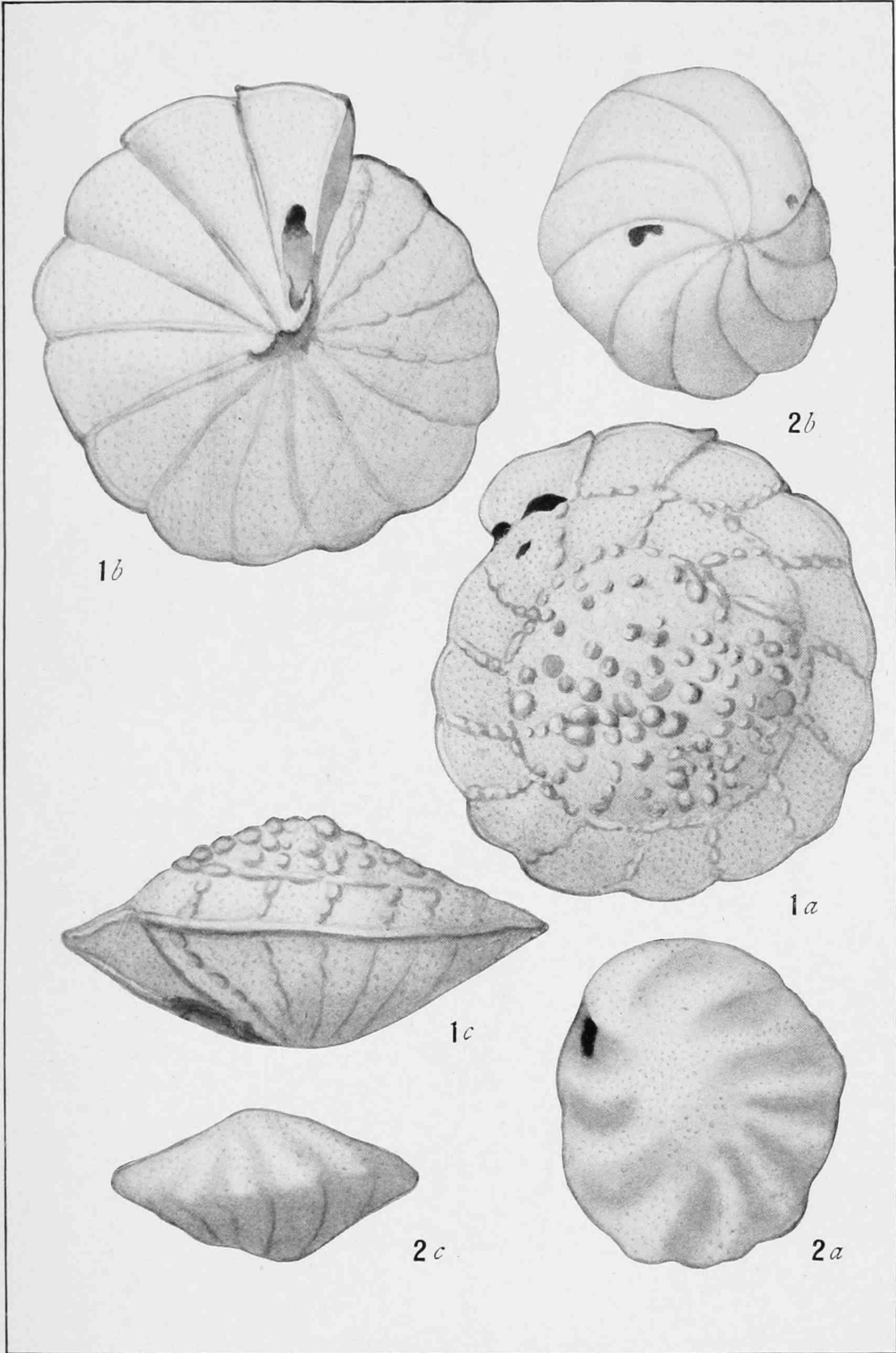




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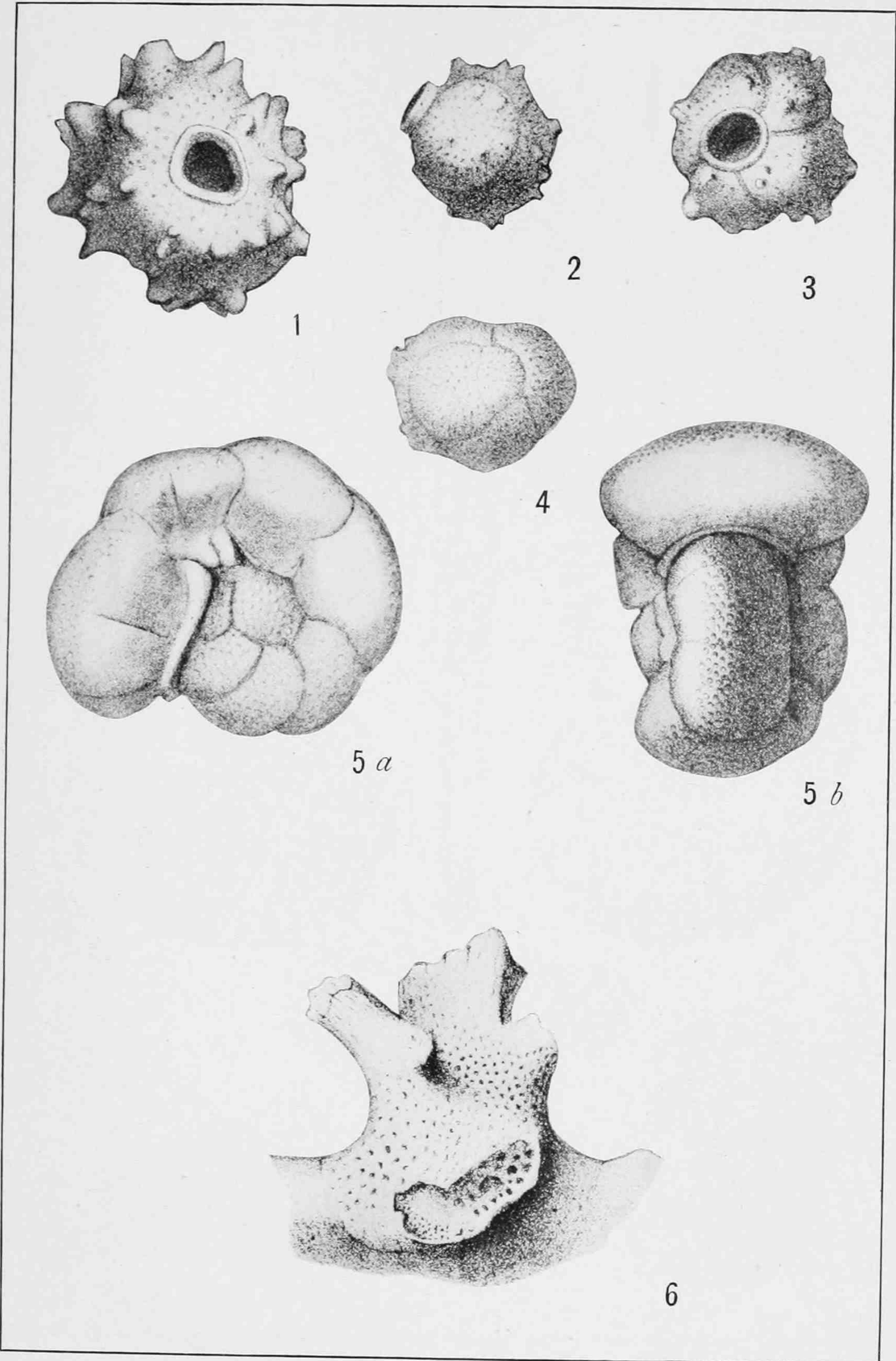




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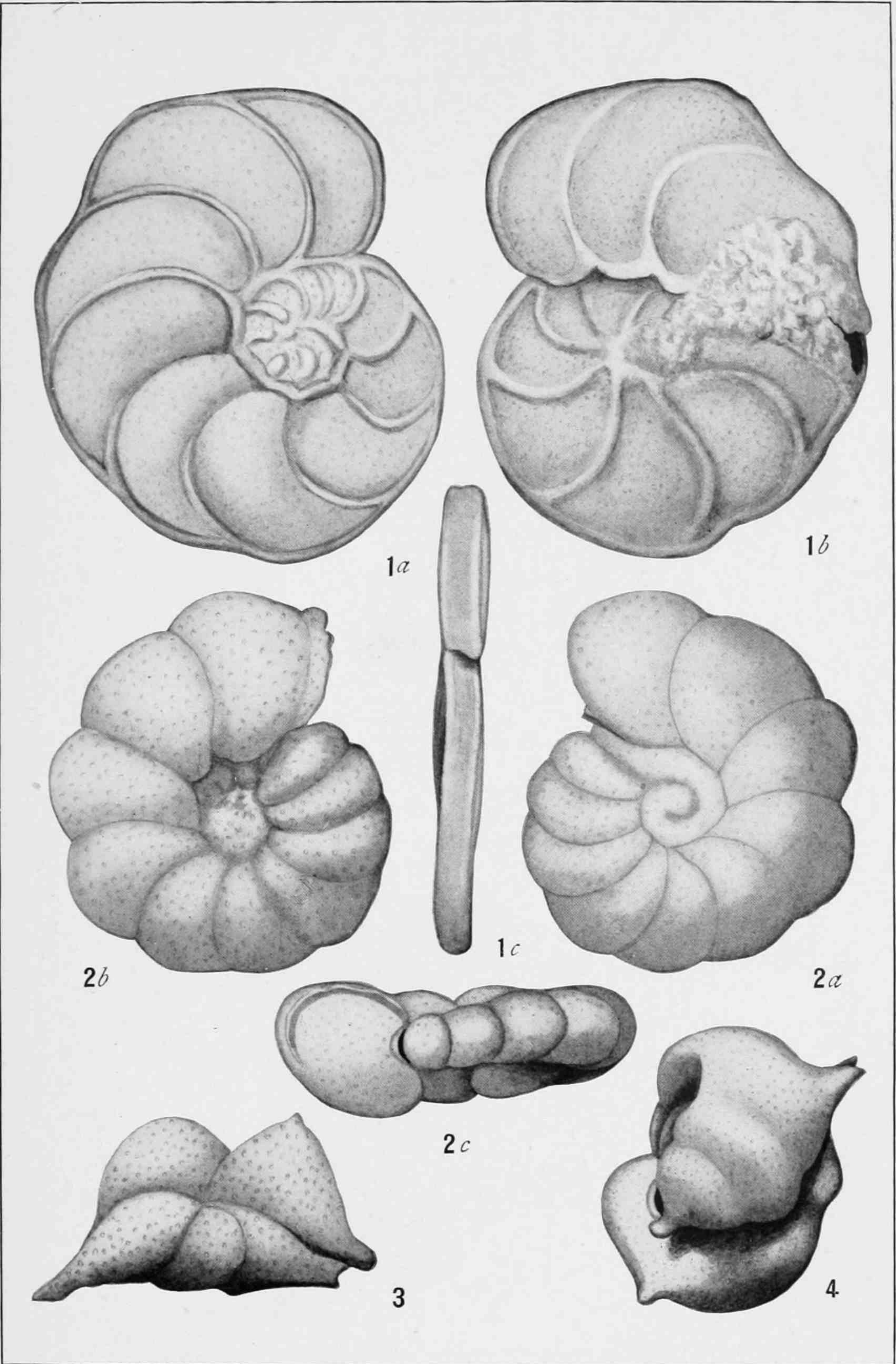




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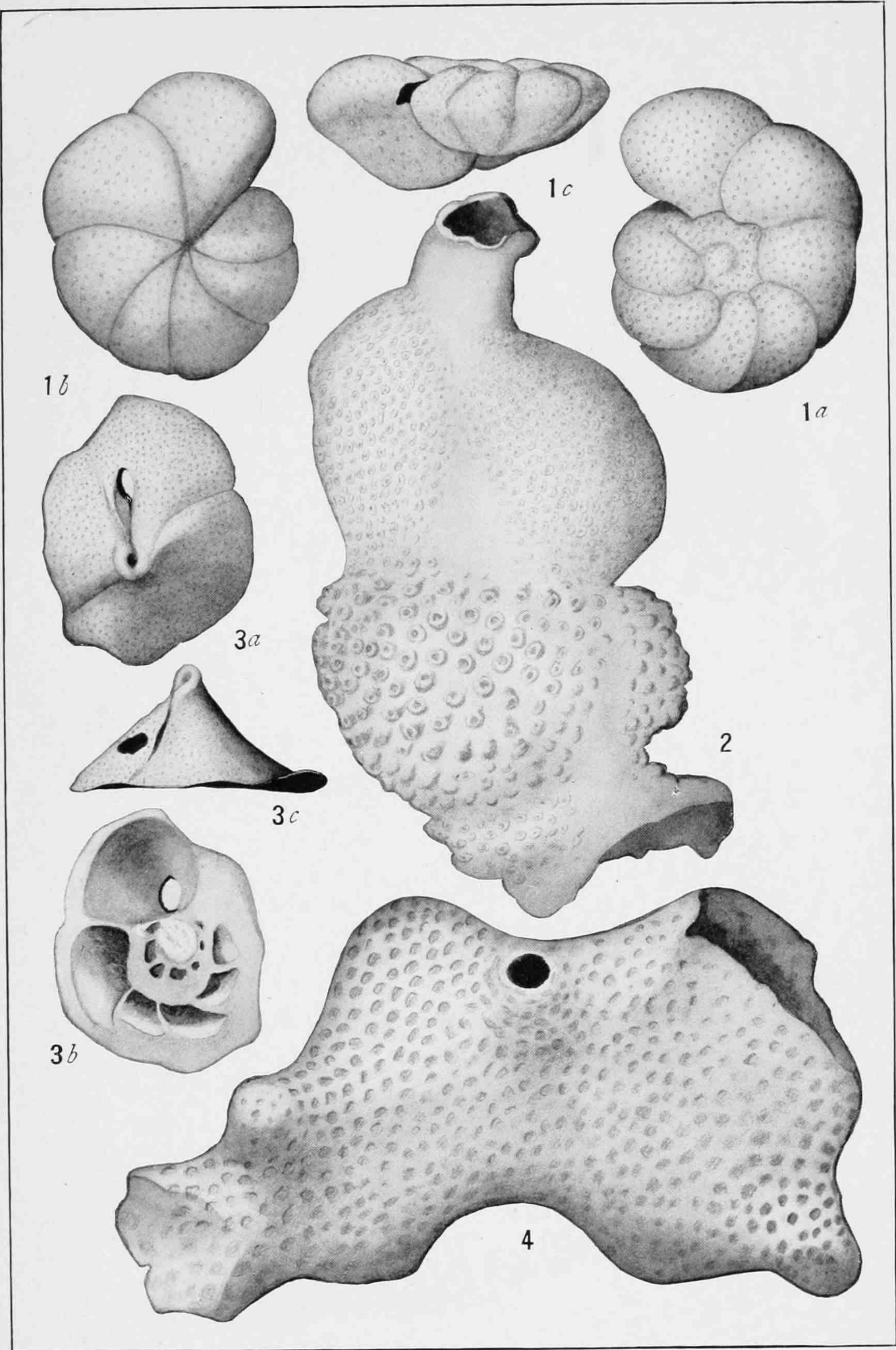




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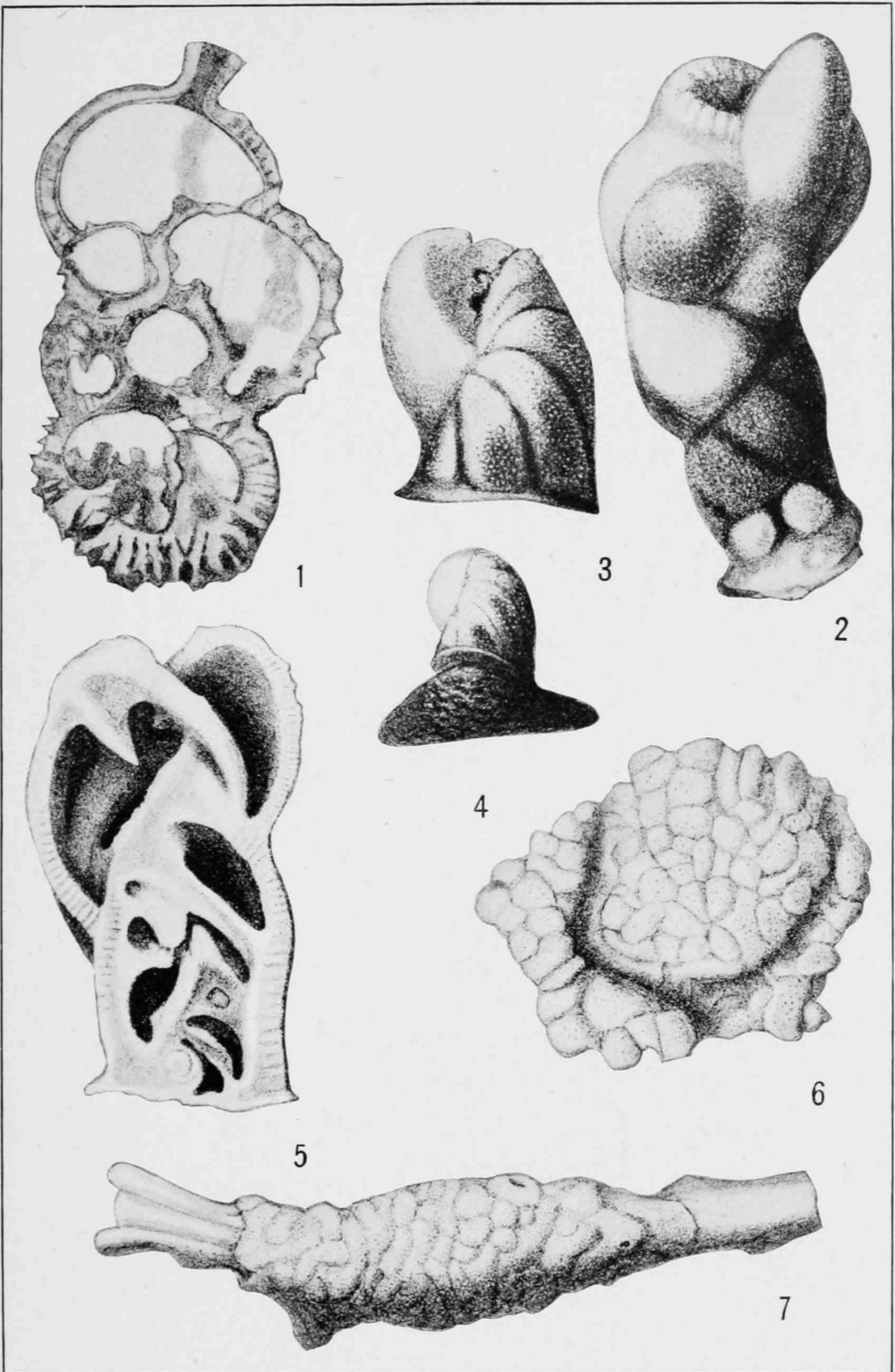




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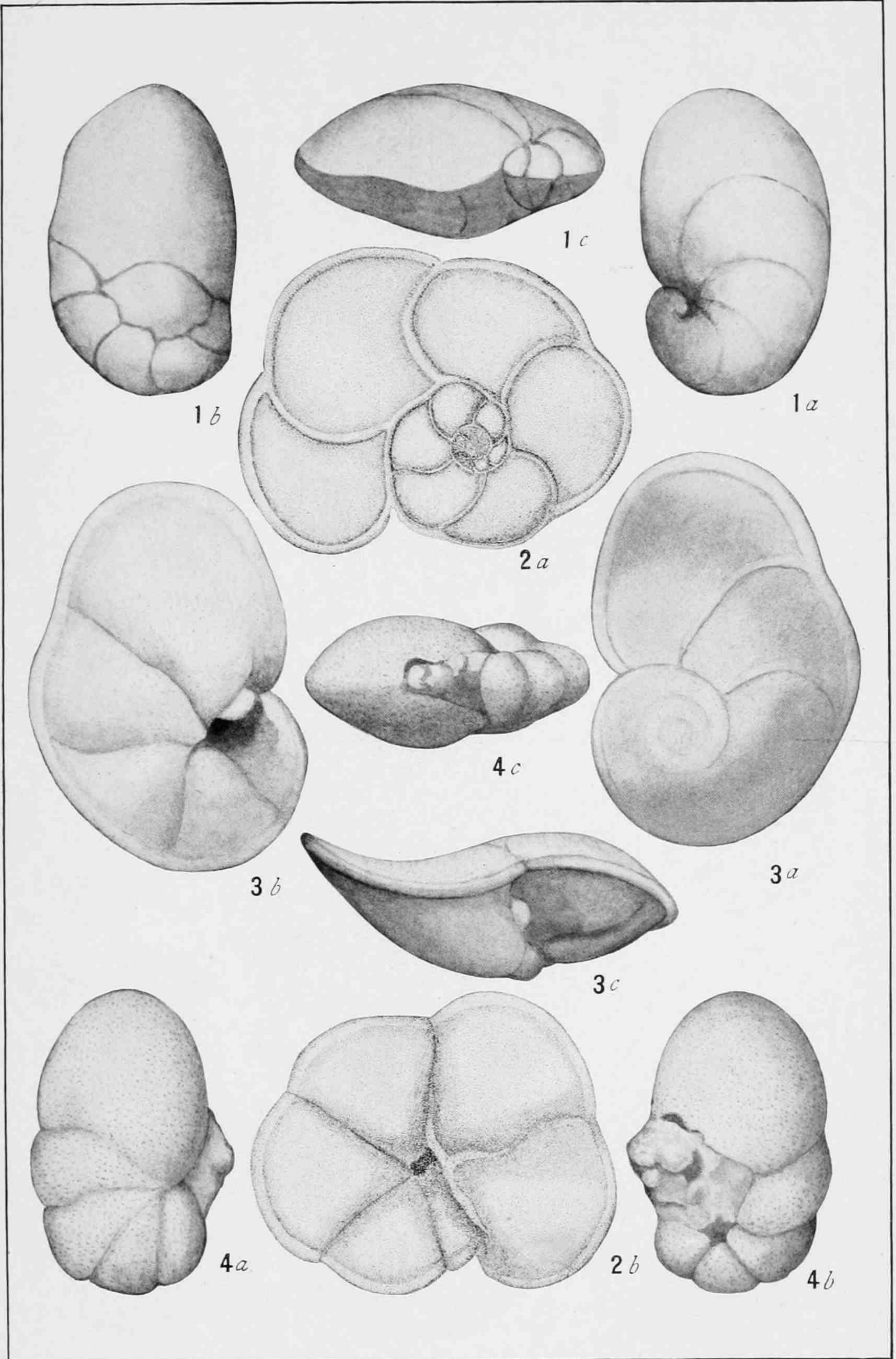




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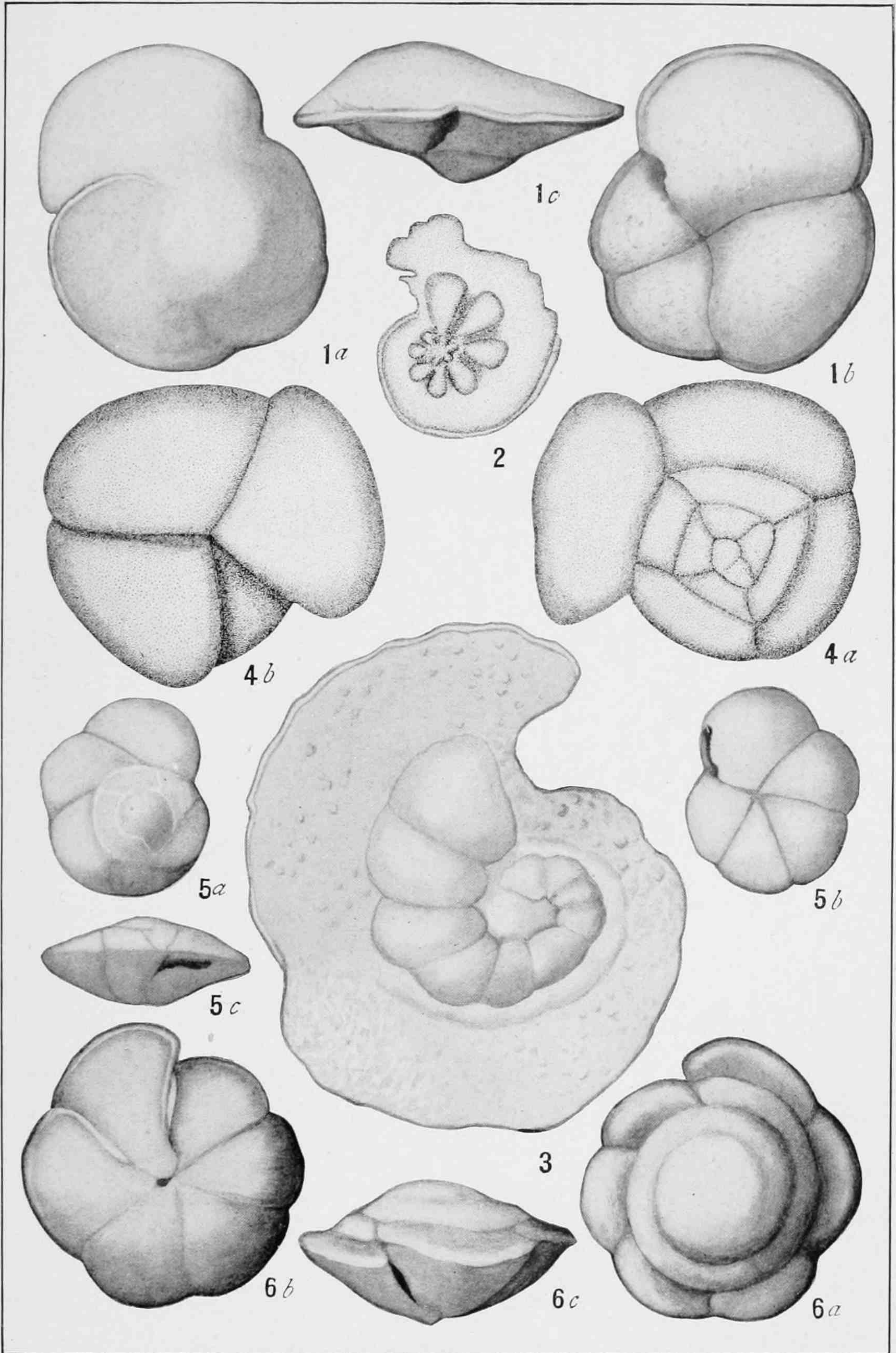




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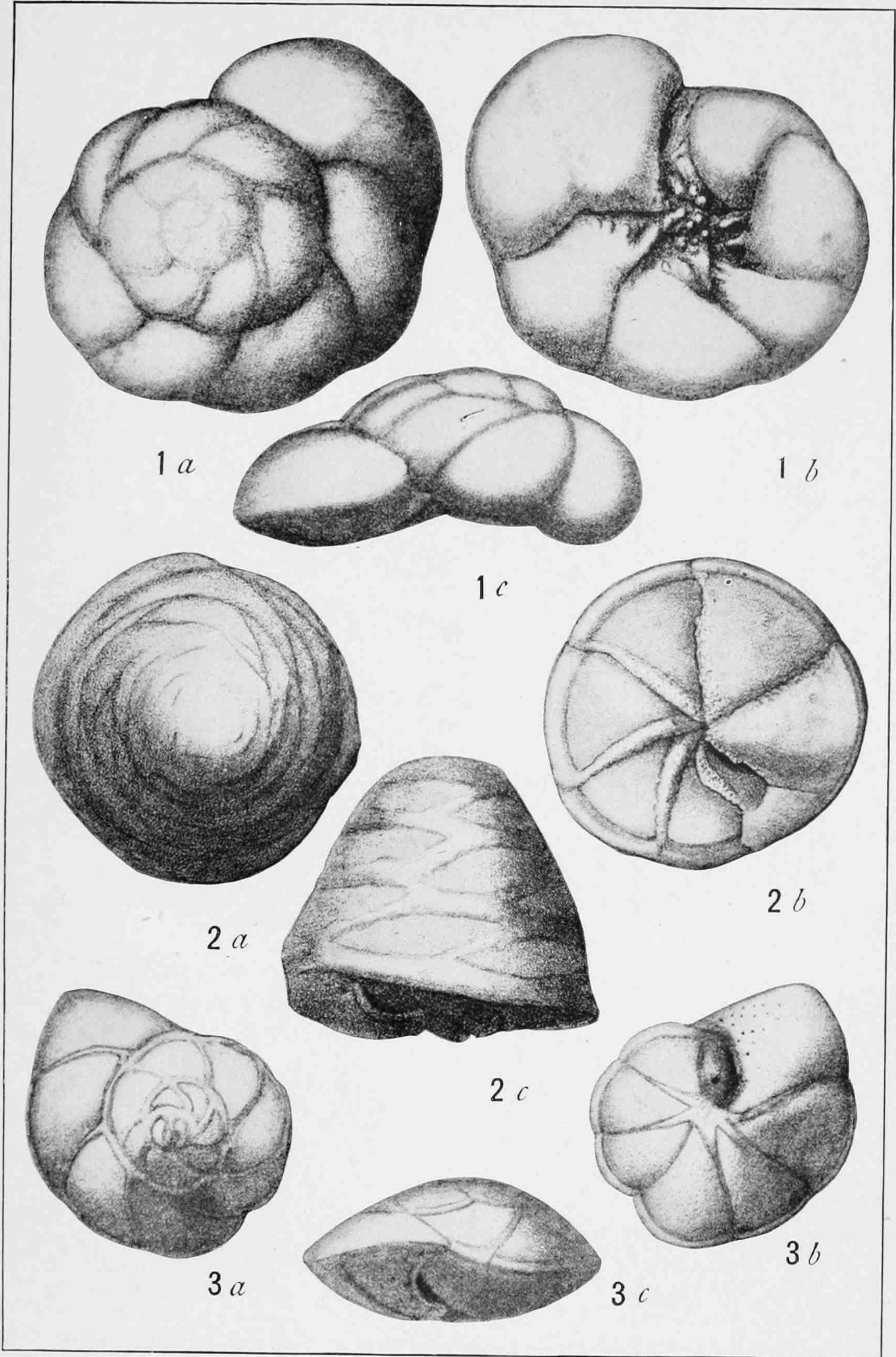




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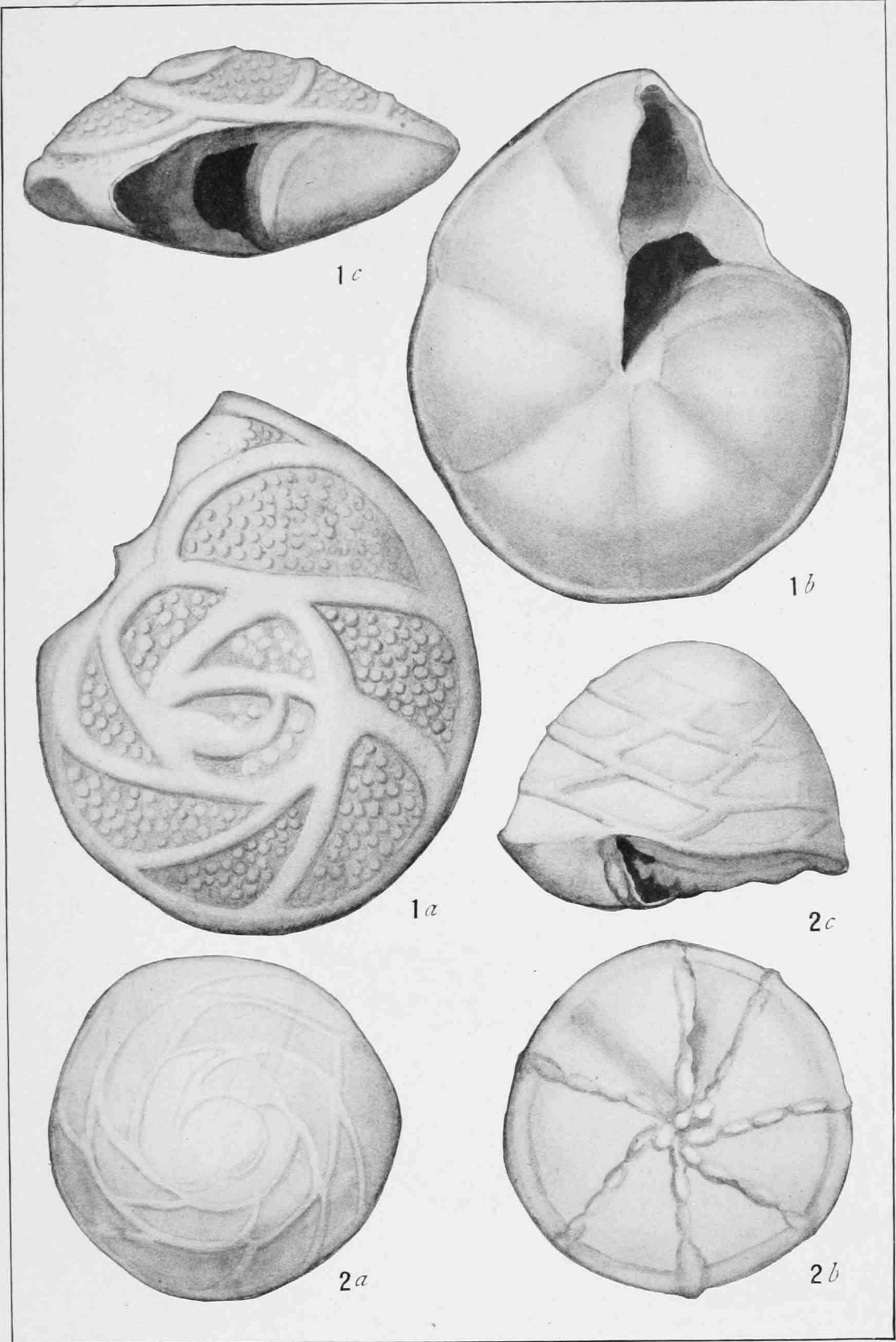




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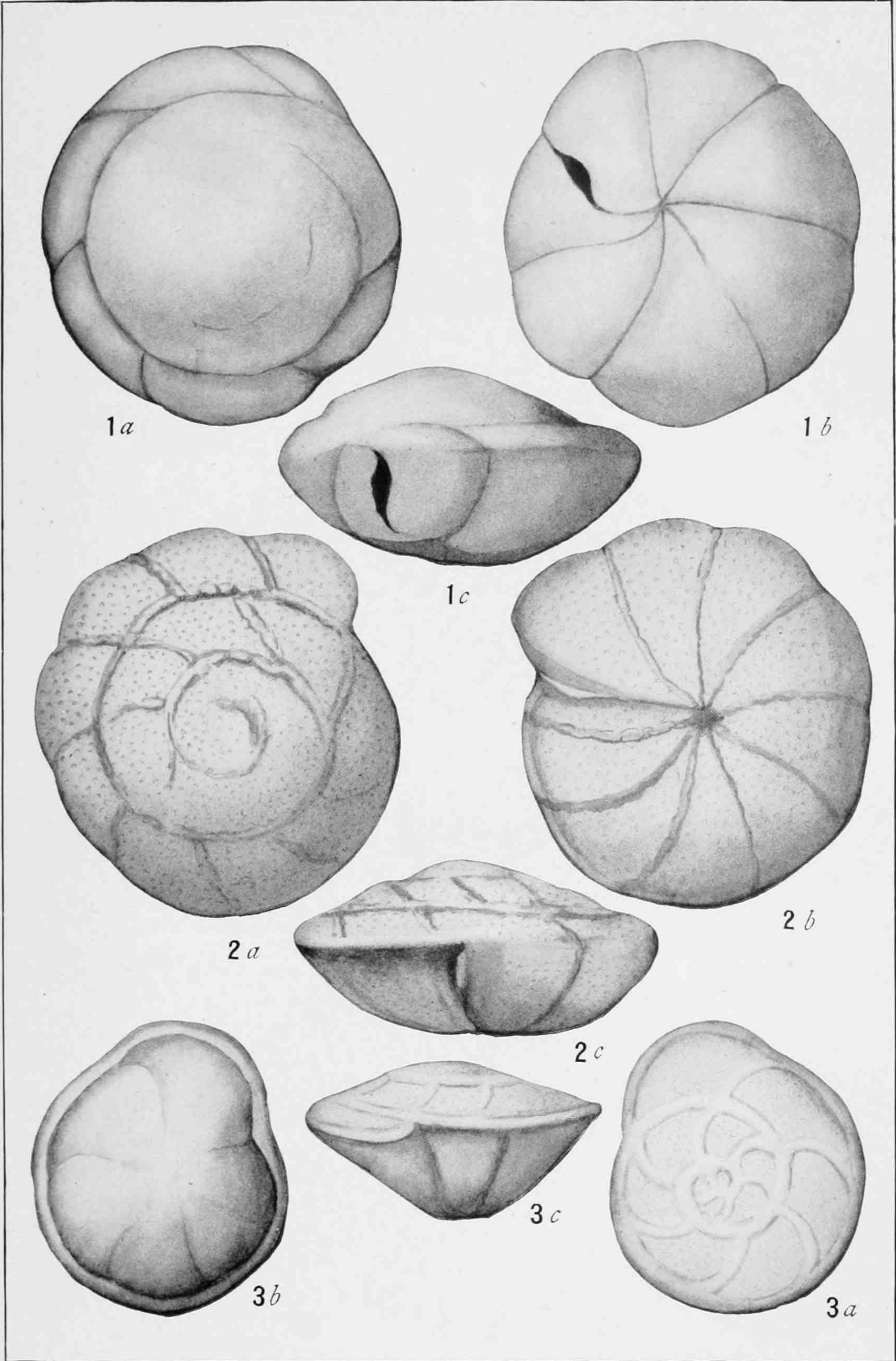




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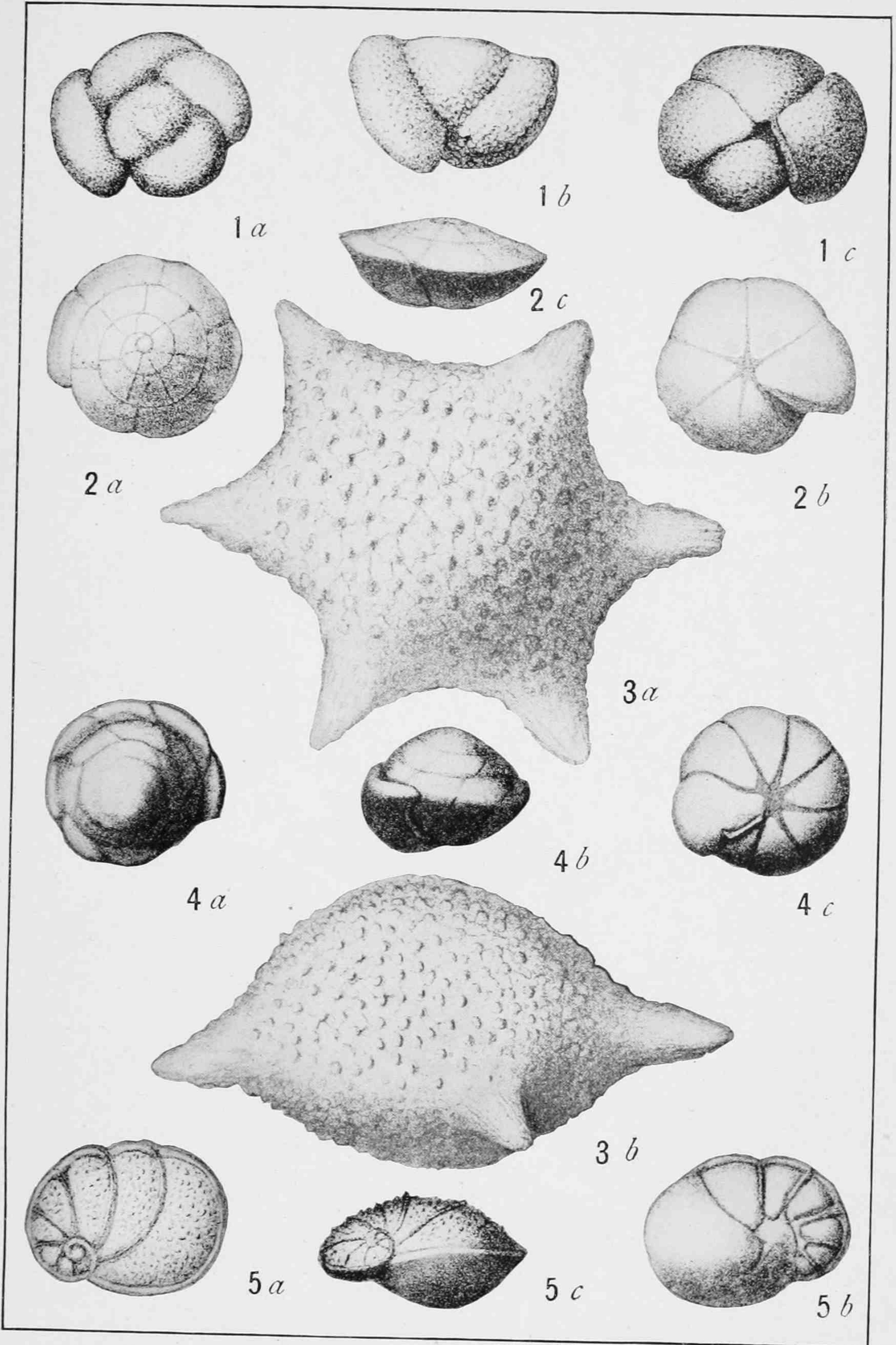




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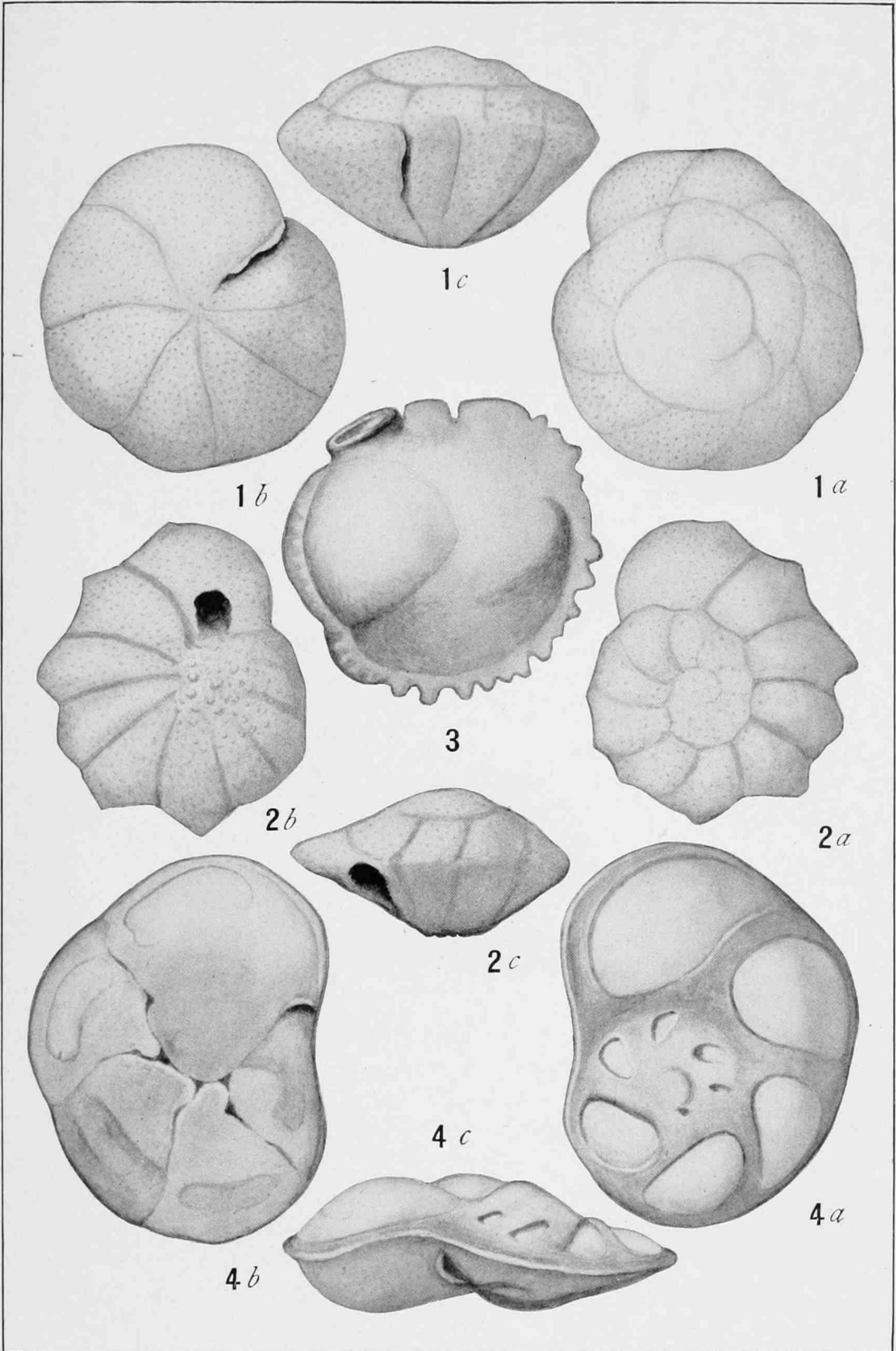




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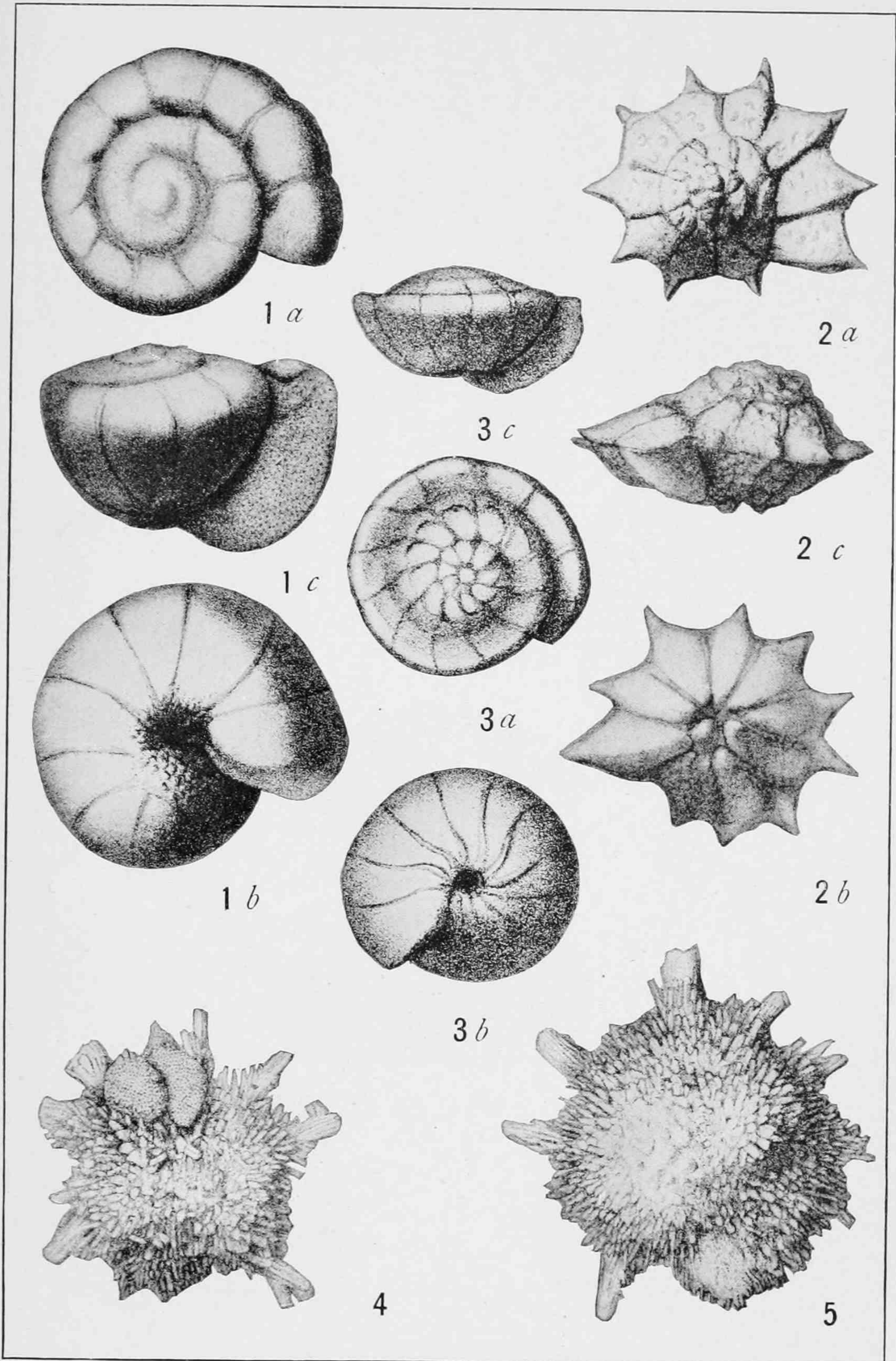




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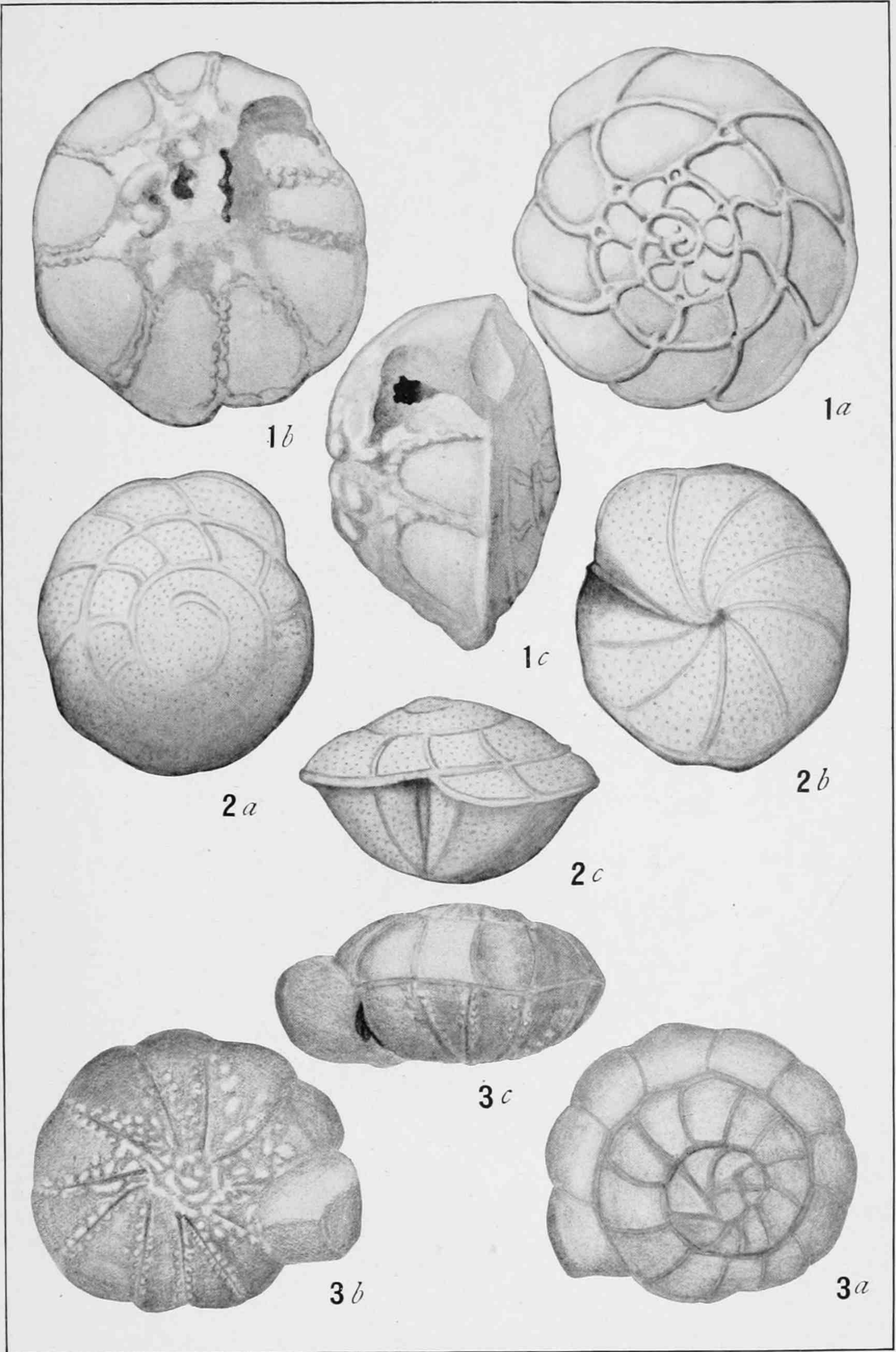




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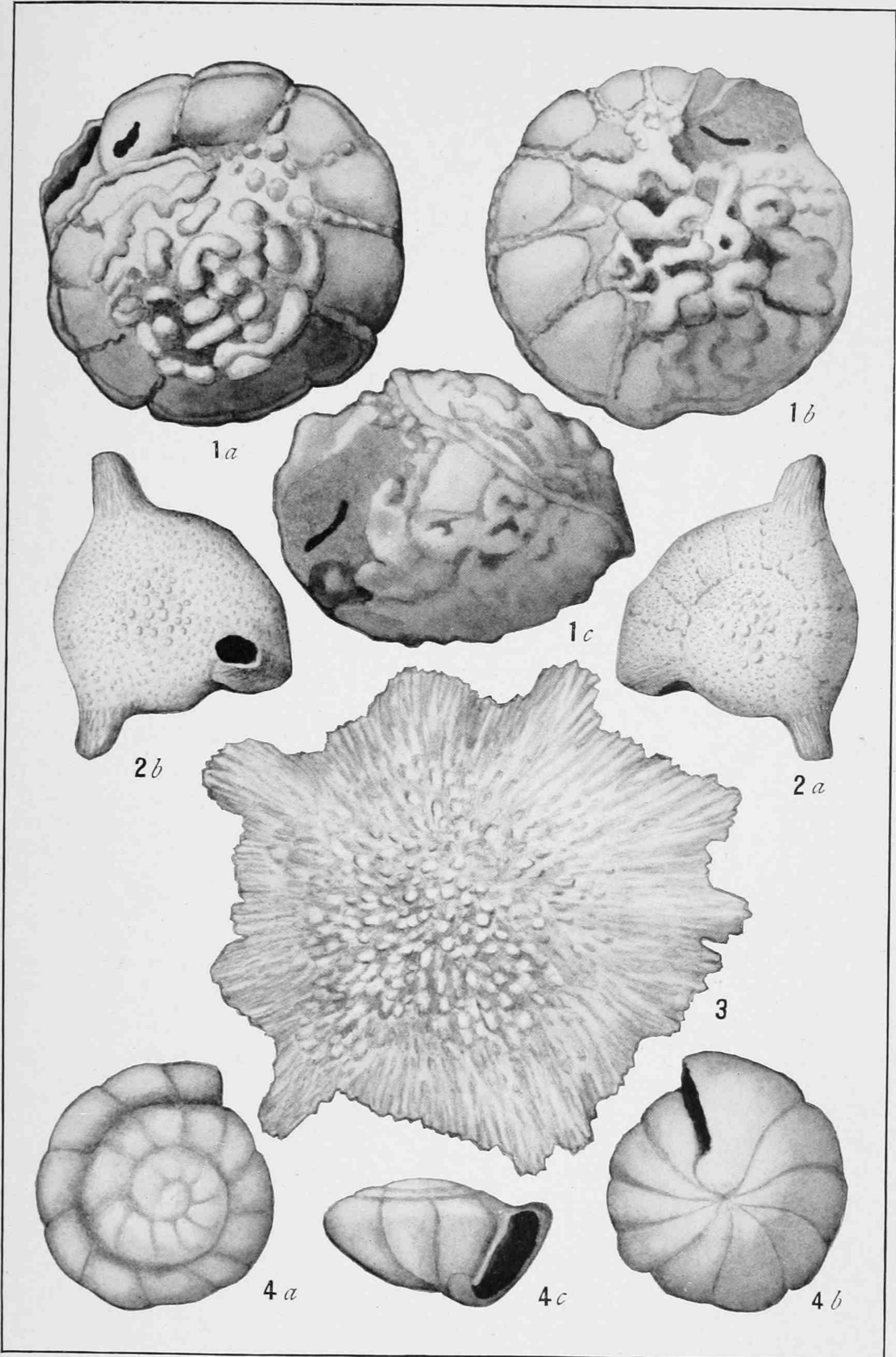




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