

# THE FORAMINIFERA OF THE BYRAM CALCAREOUS MARL AT BYRAM, MISSISSIPPI.

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## INTRODUCTION.

The lower Oligocene of the southeastern Coastal Plain of the United States is in Mississippi divisible into several distinct members. Farther east these divisions are not so clearly distinguishable. Of the divisions in Mississippi the Byram calcareous marl is the youngest. The type section for the Byram marl is an exposure at the bridge over Pearl River at Byram, Hinds County, Miss. The formation is mainly a sandy glauconitic marl with thin beds of impure limestone, clay and sand.

Small lots of the marl from the type section, United States Geological Survey station 6455, collected by E. N. Lowe in 1912, were examined after careful washing. Although but a few cubic centimeters of the original material was taken it has given 68 species and varieties of Foraminifera. More species will probably be added by a further search of the material, but it is probable that all the common species are described in this paper. An examination of the Byram marl from other localities will undoubtedly greatly increase the fauna, but it is very desirable in close stratigraphic studies to have the type section very definitely worked up for comparison with sections in other areas, and in this paper it has been the aim to furnish data for such comparisons.

## RELATIONSHIPS OF THE BYRAM FAUNA.

Of the 68 species and varieties which are here recorded from the type section of the Byram calcareous marl, 28 appear to have been previously undescribed, and 8 of these are recorded under the genus only, as the available material was not abundant enough to warrant specific determination. This statement may be compared with the data given in the accompanying paper by Cooke, who lists 134 species of mollusks, 5 corals, and 2 echinoderms, 54 of which are peculiar to the marl at Byram.

One of the most interesting features disclosed in the study of the Foraminifera of this collection has been their relationships with other faunas. The different species are very definitely related both to the fossil Foraminifera so far known from the Atlantic and Gulf Coastal Plain of the United States and to the living Foraminifera of certain regions, especially the Indo-Pacific.

By far the larger proportion of the species and varieties are identical with or closely related to species now living in the Indo-Pacific. Such species as *Textularia folium* Parker and Jones, *Bolivina amygdalaeformis* H. B. Brady, *Bolivina nitida* H. B. Brady, and *Hauerina fragilissima* H. B. Brady are now living in the Indo-Pacific region but are not recorded elsewhere nor have they been previously recognized in the fossil form. They show rather conclusively that there is a very close relationship between the fossil fauna at Byram and the living fauna of the Indo-Pacific.

Of the species here described as new there are several that are also clearly related to the living Indo-Pacific fauna. For example, *Discorbis byramensis* Cushman, n. sp., is nearest in its affinities to *D. corrugata* Millett, described from specimens collected in the Malay Archipelago and recorded by Heron-Allen and Earland from the Kerimba Archipelago, off the southeastern coast of Africa, from the coast of Burma, and from West Australia, thus having a wide Indo-Pacific range. In the characters of its ventral surface *D. byramensis* Cushman is also related to *D. patelliformis* H. B. Brady and *D. tabernacularis* H. B. Brady, both typical Indo-Pacific species. The Byram species is then a fossil representative of a small well-distinguished group of species, the others of which are now living in the Indo-Pacific.

*Polymorphina regina* H. B. Brady, Parker, and Jones also shows a definite faunal relation. As a recent species it is known from the shallow

waters of the tropical and subtropical parts of the Pacific and Indian oceans. As a fossil it is also known from the Miocene of the Coastal Plain of the United States, from the Calvert formation of Chesapeake Beach, Md., and from the Duplin marl of Mayesville, S. C. This form thus represents a group which lived in this region in early Oligocene time and persisted into the Miocene but then apparently died out here, though it continued in the Indo-Pacific region, to which it may have migrated during the Oligocene.

Certain other species, such as *Truncatulina byramensis* Cushman, n. sp., are evidently characteristic of the Miocene and may not have persisted later than that time. *Truncatulina byramensis* is closely related to *T. basiloba* Cushman and *T. concentrica* Cushman, from the Miocene of South Carolina and Florida.

*Lepidocyclina supera* (Conrad) is characteristic of a group which so far as known is limited to this horizon and not known elsewhere. *L. supera* seems to be an index fossil of the Byram marl.

#### RELATION OF BYRAM FAUNA TO FAUNAS OF OTHER LOWER OLIGOCENE FORMATIONS.

The foraminiferal faunas of the other divisions of the lower Oligocene have not been thoroughly studied except at the type stations. Evidence is therefore incomplete as to the definite relationships of the several faunas. Enough is known, however, to show that a number of the species of the Byram marl are found also in the Mint Spring marl and a lesser number in the Red Bluff clay, both of which lie below the Byram marl in Mississippi. Some of these species are also found in the Marianna limestone of Alabama and Florida, but the ecologic conditions of Florida and Mississippi in early Oligocene time were evidently very different, and that alone would account for a considerable difference in the faunas.

#### ECOLOGIC CONDITIONS UNDER WHICH THE BYRAM MARL WAS DEPOSITED.

From a comparison of the records for those species which are found fossil in the marl at Byram and also living in the Indo-Pacific region it is evident that the Byram marl was deposited in comparatively shallow water (10 to 25 fathoms). As nearly all these species occur in the tropical and subtropical waters of the Indo-Pacific, it would seem that the water at Byram must have had at least subtropical temperature (between 20° and 24° C.). As the

Miocene climate was evidently colder, especially along the Atlantic coast, this alone is probably sufficient reason for the extinction of those species which persisted in the general region until that time.

#### SPECIES INCLUDED.

Figures are given of most of the species here described. A close study of the material has shown how little is the variation of any particular species in this marl, and it may be questioned whether I am right in the specific references of certain forms, such as those of *Polymorphina*. However, until a comparative study of recent and fossil material can be made they may best be left as at present. It will undoubtedly become possible at some future time to distinguish the fossil species of our Coastal Plain and to divide them much more closely and definitely.

Something of the known distribution of the species is given as well as full descriptions. A list of the species is given below and is followed by the systematic presentation of the fauna.

#### Textulariidae:

- Textularia agglutinans* D'Orbigny.
- Textularia tumidulum* Cushman, n. sp.
- Textularia subhauerii* Cushman, n. sp.
- Textularia mississippiensis* Cushman, n. sp.
- Textularia folium* Parker and Jones.
- Bolivina amygdalaeformis* H. B. Brady.
- Bolivina nitida* H. B. Brady.
- Bolivina robusta* H. B. Brady.
- Bolivina mississippiensis* Cushman, n. sp.
- Verneuilina spinulosa* Reuss var. *glabrata* Cushman, n. var.
- Clavulina byramensis* Cushman, n. sp.
- Virgulina* sp.
- Bulimina ovata* D'Orbigny?
- Ehrenbergina glabrata* Cushman, n. sp.

#### Lagenidae:

- Nodosaria* sp.
- Nodosaria* sp.?
- Cristellaria* sp.
- Vaginulina legumen* (Linnaeus) D'Orbigny var. *elegans* D'Orbigny?
- Polymorphina gibba* D'Orbigny.
- Polymorphina gibba* D'Orbigny, fistulose form.
- Polymorphina regina* H. B. Brady, Parker, and Jones.
- Polymorphina byramensis* Cushman, n. sp.
- Polymorphina problema* D'Orbigny?
- Polymorphina amygdaloides* (Reuss) Reuss.
- Uvigerina byramensis* Cushman, n. sp.

#### Globigerinidae:

- Globigerina bulloides* D'Orbigny.
- Globigerina triloba* Reuss.

#### Rotaliidae:

- Spirillina subdecorata* Cushman, n. sp.
- Discorbis byramensis* Cushman, n. sp.
- Discorbis orbicularis* (Terquem) Berthelin.

## Rotaliidae—Continued.

- Truncatulina lobatula* (Walker and Jacob) D'Orbigny.  
*Truncatulina byramensis* Cushman, n. sp.  
*Truncatulina americana* Cushman.  
*Truncatulina pseudoungeriana* Cushman, n. sp.  
*Anomalina bilateralis* Cushman, n. sp.  
*Anomalina grosserugosa* (Gümbel) H. B. Brady? var.  
*Anomalina mississippiensis* Cushman, n. sp.  
*Siphonina advena* Cushman, n. sp.  
*Gypsina rubra* (D'Orbigny) Heron-Allen and Earland.  
*Pulvinulina byramensis* Cushman, n. sp.  
*Pulvinulina advena* Cushman, n. sp.  
*Pulvinulina glabrata* Cushman, n. sp.  
*Rotalia byramensis* Cushman, n. sp.  
*Rotalia dentata* Parker and Jones.  
*Asterigerina subacuta* Cushman, n. sp.

## Nummulitidae:

- Nonionina umbilicatula* (Montagu) Parker, Jones, and H. B. Brady.  
*Nonionina scapha* (Fichtel and Moll) Parker and Jones.  
*Nummulites* sp.  
*Lepidocyclina supera* (Conrad) H. Douvillé.

## Miliolidae:

- Cornuspira involvens* (Reuss) Reuss.  
*Spiroloculina grateloupi* D'Orbigny.  
*Spiroloculina byramensis* Cushman, n. sp.  
*Spiroloculina imprimata* Cushman, n. sp.  
*Vertebralina advena* Cushman, n. sp.  
*Vertebralina* sp.?  
*Quinqueloculina crassa* D'Orbigny?  
*Quinqueloculina bicostata* D'Orbigny, var.  
*Quinqueloculina cuvieriana* D'Orbigny.  
*Quinqueloculina venusta* Karrer?, var.  
*Quinqueloculina* sp.?  
*Hauerina fragilissima* (H. B. Brady) Millett.  
*Hauerina* sp.?  
*Articulina byramensis* Cushman, n. sp.  
*Massilina crusta* Cushman, n. sp.  
*Massilina oclusa* Cushman, n. sp.  
*Massilina oclusa* Cushman, n. sp., var. *costulata* Cushman, n. var.  
*Triloculina rotunda* D'Orbigny.  
*Triloculina oblonga* (Montagu) D'Orbigny.  
*Triloculina trigonula* (Lamarck) D'Orbigny.  
*Biloculina* sp.?

## DESCRIPTIONS.

## Family TEXTULARIIDAE.

## Genus TEXTULARIA DeFrance, 1824.

*Textularia agglutinans* D'Orbigny.

Plate XIV, figures 1a, 1b.

- Textularia agglutinans* D'Orbigny, in De la Sagra, *Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères*, p. 136, pl. 1, figs. 17, 18, 32-34, 1839.  
H. B. Brady, *Challenger Rept., Zoology*, vol. 9, p. 363, pl. 43, figs. 1, 2, 1884.  
Cushman, *U. S. Nat. Mus. Bull.* 71, pt. 2, p. 9, figs. 10a, b (in text), 1911.

Test elongate, large and stout, gradually tapering from the initial end, chambers nearly as high as wide, tumid; sutures depressed, dis-

tinged, early portion somewhat compressed; wall coarsely arenaceous, but in section with a calcareous base; aperture in a well-marked depression at the base of the inner margin of the last-formed chamber; early chambers usually rougher than the later ones. Length 2 millimeters or less.

*Textularia agglutinans* is rather common in the Byram marl. The specimens are closely similar to the types from Cuba described by D'Orbigny.

This name has been used for a great variety of forms, but it should be limited to the one described by D'Orbigny, which has a generally tapering form and very rounded chambers, with the surface arenaceous but rather smoothly finished.

*Textularia tumidulum* Cushman, n. sp.

Plate XV, figures 1, 2a, 2b.

Test large, elongate, compressed, thickest in the central region, thence thinning toward the periphery, initial end rapidly broadening in the adult, the sides nearly parallel to a point near the apertural end, where the breadth of the test is reduced; chambers numerous, in the adult about three times as wide as high, and the last-formed chamber in many old-age specimens somewhat distinctly set off from the others, the inner portion of each chamber much thicker than the other portions and in the rapid decrease in thickness often leaving a channel running lengthwise of the test between this central tumid area and the gradually sloping outer portion, usually very well marked in adult specimens; sutures not very distinct; wall arenaceous but smoothly finished. Largest specimens 2.5 millimeters in length.

This is one of the most common and most conspicuous of the species of the Byram marl at Byram. It is very well characterized by its central tumid area with longitudinal channels at each side, and the general slope to the rounded periphery. The figures show a typical adult (except that the sutures are more distinct than is typical) and a specimen in its earlier stage before the tumid central portions are so strongly developed.

*Textularia subhauerii* Cushman, n. sp.

Plate XIV, figures 2a, 2b.

Test large, stout, elongate, early portion rapidly increasing in width with each newly added chamber, later adult portion with the

sides nearly parallel, slightly lobulated; periphery rounded but the median portion nearly flat; chambers eighteen to twenty, increasing in height as added, those of the later portion nearly as high as broad, sutures usually rather indistinct; wall coarsely arenaceous but smoothly finished on the exterior; aperture at the base of the inner margin of the chamber. Length 2 millimeters or less.

This species is represented by a few specimens from the Byram marl of rather uniform size and general character.

Heron-Allen and Earland<sup>1</sup> figure a *Textularia* from the Kerimba Archipelago, off the southeastern coast of Africa, which they refer to *T. hauerii* D'Orbigny. In some of its characters our Byram marl species resembles this. A similar form from the Philippines I have referred to *T. hauerii*. A study of D'Orbigny's *T. hauerii* from the Vienna Basin, however, shows that it is very different from the Byram species and apparently also different from the Philippine and Kerimba species.

***Textularia mississippiensis* Cushman, n. sp.**

Plate XIV, figure 4.

Test elongate, fairly broad, thickest in the middle, thence thinning toward the periphery, in end view biconvex, central portion curved; chambers rather low and broad, especially in the early stages, becoming higher in the adult and often less broad so that the later chambers in the adult make a test less wide than at earlier stages; sutures covered by a coarsely arenaceous layer meeting in the center and at the periphery, leaving the central portion of each chamber uncovered, periphery irregular, not definitely or regularly spinose; chamber walls smooth and finely perforate. Length 0.40 to 0.55 millimeter.

This is a common small species in the Byram marl. It is in general character very uniform in the material studied and also very constant in size. In some of its features it resembles *T. pseudocarinata* Cushman (*T. carinata* H. B. Brady; not *T. carinata* D'Orbigny), but it is much smaller and lacks the strongly rhomboidal shape in end view, and the carinae and especially the spines are not so definitely developed. *T. pseudocarinata* is especially characteristic of the Philippine region. The Byram species also resembles very much the form I

have described as *T. sagittula* var. *atrata*,<sup>2</sup> which came from the eastern channel of Korea Strait, in 59 fathoms.

***Textularia folium* Parker and Jones.**

Plate XIV, figure 3.

- Textularia folium* Parker and Jones, Roy. Soc. Philos. Trans., vol. 155, pp. 370, 420, pl. 18, fig. 19, 1865.  
 Moebius, Beiträge zur Meeresfauna der Insel Mauritius, p. 92, pl. 8, figs. 16, 17, 1880.  
 H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 357, pl. 42, figs. 1-5, 1884.  
 Egger, K. Bayer Akad. Wiss. München Abh., Cl. 2, vol. 18, p. 272, pl. 6, figs. 27, 28, 1893.  
 Chapman, Linnean Soc. London Jour. (Zoology), vol. 28, p. 184, 1900 [1902]; Quekett Micr. Club Jour., 2d ser., vol. 10, p. 127, pl. 9, fig. 4, 1907 [1909].  
 Rhumbler, Zool. Jahrb., Abt. Syst., vol. 24, p. 59, pl. 5, figs. 51, 52, 1906.  
 Bagg, U. S. Nat. Mus. Proc., vol. 34, p. 130, 1908.  
 Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 19, figs. 31-33 (in text), 1911.  
 Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 623, 1915.

Test small, very much flattened, broad, in front view triangular, in edge view narrow, tapering toward the acute margins; chambers, especially in later development, broad and low, somewhat recurved, the inner and distal margins thickened, prolonged at the periphery into short backward-pointing spinose processes, smooth; wall fairly thick. Length not usually exceeding 0.5 millimeter.

This species is rare in the Byram marl at Byram (U. S. G. S. station 6455). The only difference between this and living specimens lies in its more regular development of spinose projections. It is very interesting, however, in showing the relationship of the Byram marl fauna to existing faunas. At the present time the species seems to be confined to the Indo-Pacific region and is more abundant in the south Pacific than elsewhere. It is known from rare specimens obtained in Mauritius (Moebius) and in the Kerimba Archipelago, off southeastern Africa (Heron-Allen and Earland). It was originally described from specimens collected in the shore sands of Melbourne, Australia, by Parker and Jones. H. B. Brady gives the following localities in the *Challenger* report: Off East Moncoeur Island, Bass Strait, 38 fathoms; off Raine Island, Torres Strait, 155 fathoms; off Kandavu, Fiji, 255 fathoms; off Levuka, Fiji; Nares Harbor, Admiralty Islands, 17 fathoms; Honolulu coral reefs,

<sup>1</sup> Zool. Soc. London Trans., vol. 20, p. 628, pl. 47, figs. 21-23, 1915.

<sup>2</sup> U. S. Nat. Mus. Bull. 71, pt. 2, p. 7, figs. 2-5 (in text), 1911.

40 fathoms. It has also been found in the lagoon of Funafuti and off the coast of Victoria (Chapman); off Laysan (Rhumbler); and at several localities off the Hawaiian Islands (Bagg, Cushman).

Most of the recorded specimens of the species were obtained in 40 fathoms or less, although off Fiji it was found at a depth of 255 fathoms, and off the Hawaiian Islands at 249 to 305 fathoms. It is evidently most abundant on tropical coral reefs of the south Pacific.

Genus *BOLIVINA* D'Orbigny, 1839.

*Bolivina amygdalaeformis* H. B. Brady.

Plate XV, figure 3.

*Bolivina amygdalaeformis* H. B. Brady, Quart. Jour. Micr. Sci., vol. 21, p. 59, 1881; *Challenger* Rept., Zoology, vol. 9, p. 426, pl. 53, figs. 28, 29, 1884.  
Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 42, figs. 69a, b (in text), 1911.

Test elongate, somewhat fusiform, thickest in the middle, periphery well rounded, chambers comparatively few; sutures hidden by the ornamentation of the surface, consisting of numerous longitudinal irregularly anastomosing costae; the last-formed chambers lacking the costae but with numerous large depressions; aperture terminal, elongate-oval, somewhat constricted near the middle. Length 0.80 millimeter or less.

This species is rare in the Byram marl, yet it is very distinct. In its recent distribution it is decidedly a Pacific form. It was originally described by Brady from specimens obtained off the Philippines at 95 fathoms, off the Admiralty Islands at 16 to 25 fathoms, off the north coast of New Guinea at 1,070 fathoms, and in Torres Strait at 155 fathoms. I have recorded specimens from two *Albatross* stations—D4875, in 59 fathoms, eastern channel of Korea Strait, and D4964, in 37 fathoms, off the southern coast of Japan.

This is one of the species which shows the relation of the Byram marl fauna to the existing fauna of the south Pacific, Australian, East Indian, and Philippine regions.

*Bolivina nitida* H. B. Brady.

Plate XV, figure 4.

*Bolivina nitida* H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 420, pl. 52, figs. 30a, b, 1884.  
*Bolivina laevigata* H. B. Brady (not *B. laevigata* D'Orbigny), Quart. Jour. Micr. Sci., vol. 21, p. 57, 1881.

Test elongate, thin, complanate, broadest at the center, tapering and rounded toward the ends. Segments few

in number, regularly textularian in arrangement; broad, flattened on both faces, and bordered both at sutures and periphery by a narrow band of clear shell substance. Sutures even; aperture large, irregularly oval, oblique. Length 1/60th inch (0.42 millimeter).

The above description, quoted from the *Challenger* report, is very accurate for the species as found in the Byram marl. The specimen figured here is one of the most extreme, the majority of the specimens being very close to the figure given by Brady. The large oblique aperture and the flattened test, carinate, with the carinae continued between and separating the chambers, are distinguishing characters.

Brady's material came from two *Challenger* stations off Australia—off East Moncoeur Island, Bass Strait, at 38 fathoms, and off Raine Island, Torres Strait, at 155 fathoms. The species was rare at both these stations, and the lack of records elsewhere seems to show that it is either local or rare. Its occurrence in the Byram marl is therefore decidedly interesting.

*Bolivina robusta* H. B. Brady.

*Bolivina robusta* H. B. Brady, Quart. Jour. Micr. Sci., vol. 21, p. 57, 1881; *Challenger* Rept., Zoology, vol. 9, p. 421, pl. 53, figs. 7-9, 1884.  
Egger, K. Bayer. Akad. Wiss. München Abh., Cl. 2, vol. 18, p. 294, pl. 8, figs. 31, 32, 1893.  
Millett, Roy. Micr. Soc. Jour., p. 543, 1900.  
Cushman, U. S. Nat. Mus. Bull. 71, pt. 2, p. 36, figs. 59, 60 (in text), 1911.  
Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 646, 1915.

Test small, in front view rhomboid, thickest along the median line, thence gradually sloping to the sides; chambers numerous, usually much lower than wide, slightly tumid, especially in the last-formed portion, sutures distinct, curved, slightly depressed, in the later chambers often with the posterior side of the chamber crenulate with numerous reentrants; wall with numerous rather coarse perforations. Length usually less than 0.5 millimeter.

Small specimens of this species are common in the Byram marl material examined. None of the specimens have the stout apical spine which appears in at least one form of the species in its living form.

There is probably more than one form or variety of this species in recent seas. Most of the specimens recorded by Brady were found in the Pacific, especially the south Pacific. Later records add numerous stations from the Pacific, and Heron-Allen and Earland record it

from the western part of the Indian Ocean, off the coast of Africa. In spite of other records the typical form of the species occurs mainly in the Indo-Pacific region.

***Bolivina mississippiensis* Cushman, n. sp.**

Plate XV, figure 5.

Test elongate, slender, gradually tapering from the subacute initial end to the broadly rounded apertural end; thickest in the median line; chambers numerous, wider than high, curved, sutures marked by limbate lines, broadly curved and somewhat broken near the inner end, not depressed; surface of test smooth and even. Length about 0.4 millimeter.

This species is rare in the Byram marl. It may be distinguished by the narrow, tapering form, the peculiarly marked sutures, and the very even smooth surface.

**Genus VERNEUILINA D'Orbigny, 1840.**

***Verneuilina spinulosa* Reuss var. *glabrata* Cushman, n. var.**

Test pyramidal, three-sided, widest above the middle, generally triangular in transverse section, the sides somewhat concave; angles of the test bluntly angled or even rounded, without spines; surface smooth; aperture small, at the inner side of the last-formed chamber. Length 0.75 millimeter or less.

This variety of the species is fairly common in the typical Byram marl. It differs from the typical form of the species in its lack of spines, the edges often being rounded and thickened. No specimens approaching the typical form were found.

The species is very characteristic of shallow tropical and subtropical waters of the Indo-Pacific region.

**Genus CLAVULINA D'Orbigny, 1826.**

***Clavulina byramensis* Cushman, n. sp.**

Plate XVI, figure 1.

Test elongate, subcylindrical, the early chambers triserial, forming but a small portion of the test; later ones uniserial, both portions rounded; sutures slightly depressed, often not very distinct otherwise; aperture terminal, central, rounded; wall coarsely arenaceous but smoothly finished. Length 2 millimeters or less.

This form is very common in the Byram marl and one of the characteristic species.

The early portion is small in proportion to the whole test and consists of a considerable number of rounded chambers in a triserial arrangement, but the resulting mass with rounded angles forms a bulbous tip to the otherwise tapering test. The sutures of this early portion are usually very indistinct.

This resembles certain tropical Pacific species and probably has its affinities in that region. It is quite likely that Pacific forms which have been referred by authors to *C. parisiensis* D'Orbigny are closer to this species.

**Genus VIRGULINA D'Orbigny, 1826.**

***Virgulina* sp.**

Plate XVI, figures 2a, 2b, 3.

A rare species in the marl at Byram is figured. It is much compressed, the later chambers resembling those of *Bolivina* in being elongate and curved. The surface is smooth, and in some of its characters this form resembles *V. subsquamosa* Egger, but it does not have the curved axis of that species. Certain specimens from the Indo-Pacific region suggest this form from Byram. Some of the figures of the Kerimba Archipelago material which Heron-Allen and Earland<sup>3</sup> assign to *V. schreibersiana* Czjzek are very similar to this. They note that the typical form is very rare and then say: "The form generally assumed throughout the gatherings is a broad-mouthed, somewhat compressed but regular-chambered type, varying greatly in proportionate length and breadth." Our specimens in certain respects resemble this form.

**Genus BULIMINA D'Orbigny, 1826.**

***Bulimina ovata* D'Orbigny?**

Plate XVI, figure 4.

*Bulimina ovata* D'Orbigny, Foraminifères fossiles du bassin tertiaire de Vienne, p. 185, pl. 11, figs. 13, 14, 1846.

H. B. Brady, *Challenger* Rept., Zoology, vol 9, p. 400, pl. 50, figs. 13a, b, 1884.

This species is very rare in the Byram marl, and the correctness of the identification is very questionable. The specimen figured is elongate, oval, and has a smooth surface and somewhat elongate chambers with fairly depressed sutures.

<sup>3</sup> Zool. Soc. London Trans., vol. 20, p. 643, pl. 49, figs. 1-12, 1915.

**Genus EHBENBERGINA** Reuss, 1850.**Ehrenbergina glabrata** Cushman, n. sp.

Plate XVII, figures 4a-4c.

Test small, in front view broadly triangular, chambers numerous, distinct, low and broad, sutures distinct, on the ventral side at the bottoms of deep rounded depressions, on the dorsal side but slightly depressed below the general surface, periphery lobulate; surface smooth, aperture elliptical at the base of the inner margin of the last-formed chamber. Length 0.4 millimeter.

This species is rare in the Byram marl at the type station. It differs from the widely distributed deep-water species *E. serrata* Reuss in the rounded chambers, smooth surface, and lack of spines or sharp angles.

A form that occurs in comparatively shallow water in the Australian region is very similar to the species figured here and may be the same. The identity would not be surprising, in view of the relationships of other species already noted.

**Family LAGENIDAE.****Genus NODOSARIA** Lamarck, 1812.**Nodosaria** sp.

Plate XVI, figure 5.

A single specimen of *Nodosaria* in the material from the Byram marl is incomplete, showing only the last four chambers. It has a tapering form, well-defined chambers, and the surface ornamented by ten to twelve longitudinal costae. This specimen is here figured but not identified specifically, as the material is not well enough preserved.

**Nodosaria** sp.?

Plate XVI, figure 6.

The figured specimen shows the characters of a single, fragmentary specimen with both ends missing. It is smaller than the specimen described above but has nearly twice as many costae, and the chambers are not well marked. It can not be identified specifically until more material is available.

**Genus CRISTELLARIA** Lamarck, 1812.**Cristellaria** sp.

A single specimen of the genus *Cristellaria* is included in the Byram marl material exam-

ined from the type locality. It has very few chambers, seven or eight in the visible coil; the surface is generally smooth, except on the sutures, which are marked by rather broad, curved, raised ridges, those near the earlier part of the coil broken into rounded knobs, the later ones more continuous; periphery angled but not carinate, the apertural face smooth and somewhat concave; aperture at the angle of the chamber. Length about 0.65 millimeter.

As this is a unique form its specific assignment should await the finding of more material.

**Genus VAGINULINA** D'Orbigny, 1826.**Vaginulina legumen** (Linnaeus) D'Orbigny var. *elegans* (D'Orbigny) Fornasini.

Plate XVII, figure 1.

A single specimen from the marl at Byram shows the earlier chambers with a fairly well developed spine, the chambers as long as wide, surface smooth, sutures somewhat oblique, and showing a ventral side where the suture runs backward somewhat. This is not unlike certain forms now found living in the Philippine region.

**Genus POLYMORPHINA** D'Orbigny, 1826.**Polymorphina gibba** D'Orbigny.

Plate XVII, figure 3.

*Polymorphina subcordiformia* vel *oviformia* Soldani, *Testaceographiae*, vol. 1, pt. 2, p. 114, pl. 113, figs. zz, C, etc., 1791.

*Polymorphina (Globulina) gibba* D'Orbigny, *Annales sci. nat.*, vol. 7, p. 226, No. 20, Modèles, No. 63, 1826.

Egger, *Neues Jahrb.*, 1857, p. 288, pl. 13, figs. 1-4.

*Polymorphina gibba* H. B. Brady, Parker, and Jones (part), *Linnean Soc. London Trans.*, vol. 27, p. 216, pl. 39, figs. 2a-d, 1870.

H. B. Brady, *Challenger Rept.*, Zoology, vol. 9, p. 561, pl. 71, figs. 12a, b, 1884.

Sidebottom, *Manchester Lit. and Philos. Soc. Mem. and Proc.*, vol. 51, No. 9, p. 10, pl. 2, figs. 15-17, 1907.

Cushman, *U. S. Nat. Mus. Bull.* 71, pt. 3, p. 85, pl. 41, fig. 4, 1913; *U. S. Geol. Survey Bull.* 676, p. 11, pl. 2, fig. 4, p. 52, pl. 11, fig. 5, 1918.

Test rotund, in front view nearly circular, in end view broadly oval; chambers few, distinct, sutures distinct, but little if at all excavated; wall smooth and translucent; aperture slightly produced, radiate. Length 0.75 millimeter or less.

Specimens that seem identical with this species are common in the Byram marl. They have usually not more than three chambers. The earliest one, the proloculum before the later chambers are added, is very similar to *Lagena globosa* in form and could easily be mistaken for it, even the aperture not having clearly developed its radiate character at this stage. Specimens that would be classed as *L. globosa* are found in the Byram marl, but with them are specimens in the two and three chambered stages, showing that they are the young of *Polymorphina gibba*.

This is a widely distributed species, both in recent seas and in the fossil series. I have already recorded it from the Pliocene and Miocene of the Coastal Plain.

***Polymorphina gibba* D'Orbigny, fistulose form.**

Plate XVIII, figures 3a, 3b.

The figured specimen shows a fistulose form which may be referred to *P. gibba*. It has numerous branched, semicylindrical processes, mostly from the last-formed chamber.

***Polymorphina regina* H. B. Brady, Parker, and Jones.**

Plate XVIII, figure 4.

*Polymorphina regina* H. B. Brady, Parker, and Jones, *Linnean Soc. London Trans.*, vol. 27, p. 241, pl. 41, figs. 32a, b, 1870.

H. B. Brady, *Challenger Rept.*, Zoology, vol. 9, p. 571, pl. 73, figs. 11-13, 1884.

Egger, K. bayer. *Akad. Wiss. München Abh.*, Cl. 2, vol. 18, p. 310, pl. 9, figs. 45, 50, 51, 1893.

Millett, *Roy. Micr. Soc. Jour.*, p. 265, 1903.

Bagg, *Maryland Geol. Survey, Miocene*, p. 478, pl. 133, fig. 7, 1904; *U. S. Nat. Mus. Proc.*, vol. 34, p. 149, 1908.

Chapman, *Quekett Micr. Club Jour.*, 2d ser., vol. 10, p. 132, pl. 10, fig. 4, 1907 [1909]; *Roy. Soc. Victoria Proc.*, vol. 22, p. 281, 1910.

Cushman, *U. S. Nat. Mus. Bull.* 71, pt. 3, p. 91, pl. 41, figs. 6, 7, 1913; *U. S. Geol. Survey Bull.* 676, p. 54, pl. 11, figs. 3, 4, 1918.

Heron-Allen and Earland, *Zool. Soc. London Trans.*, vol. 20, p. 673, 1915.

Test elongate, fusiform; chambers tumid, distinct, especially in the later portion, sutures deep; wall ornamented by numerous longitudinal costae, usually continuing unbroken across several chambers; aperture radiate, somewhat produced. Length 1 millimeter or less.

This species is rare in the Byram marl. It is known from the Miocene of the Coastal Plain in

the Calvert formation of Chesapeake Beach, Md. (Bagg), and the Duplin marl of Mayesville, S. C. (Cushman). It is not known to occur in the Tertiary of Europe but is a typical species in the shallow water of the tropical and subtropical Pacific and Indian oceans.

This is another of the species by which the foraminiferal fauna of the Byram marl is correlated with the living fauna of the Indo-Pacific.

The specimen here figured is a young one with but a few chambers developed, not showing the typical adult form.

***Polymorphina byramensis* Cushman, n. sp.**

Plate XVII, figures 2a, 2b.

Test short and broad, triangular, composed of a few chambers, usually only four, all except a final fifth chamber extending back to the base of the proloculum, forming a truncate test; chambers inflated, sutures deep and distinct; surface smooth; aperture radiate, only slightly produced. Length 0.75 millimeter or less.

This is one of the most common species in the Byram marl. It is characterized by its truncate base and triangular form. It resembles the group of *Polymorphina* represented by *P. trigonula* Reuss. Sidebottom<sup>4</sup> has figured a specimen which he refers to *P. lactea* but states that it is not typical. It is near this species.

The proloculum alone strongly resembles that of *P. gibba* in being spherical and translucent. Most of the specimens have the three or four chambers with the triangular, truncate test, but a few have a fifth chamber, usually smaller than the rest and near the upper part of the test. This seems to mark the full development of the species.

***Polymorphina problema* D'Orbigny?**

Plate XVIII, figure 1.

*Polymorphina (Guttulina) problema* D'Orbigny, *Annales sci. nat.*, vol. 7, p. 266, No. 14, Modèles, No. 61, 1826.

*Guttulina problema* D'Orbigny, *Foraminifères fossiles du bassin tertiaire de Vienne*, p. 224, pl. 12, figs. 26-28, 1846.

The form of *Polymorphina problema* found in the Byram marl is not unlike that figured by Brady<sup>5</sup> but is even more like recent specimens

<sup>4</sup> Manchester Lit. and Philos. Soc. Mem. and Proc., vol. 51, No. 9, p. 9, pl. 2, fig. 11, 1907.

<sup>5</sup> *Challenger Rept.*, Zoology, vol. 9, p. 568, pl. 72, fig. 20; pl. 73, fig. 1, 1884.



from the Philippine region, where this species attains a large size. This is by far the largest of the Byram species but is not so common as some of the others. The truncate apertural end is the usual character in both the fossil and recent material of this form.

**Polymorphina amygdaloides (Reuss) Reuss.**

Plate XVIII, figures 2a, 2b.

*Globulina amygdaloides* Reuss, Deutsch. geol. Gesell. Zeitschr., vol. 3, p. 82, pl. 6, fig. 47, 1851.

*Polymorphina amygdaloides* (Reuss) Reuss, Akad. Wiss. Wien Sitzungsber, vol. 18, p. 250, pl. 8, fig. 84, 1855.

H. B. Brady, *Challenger Rept.*, Zoology, vol. 9, p. 560, pl. 71, fig. 13 (?), 1884.

Millett, Roy. Micr. Soc. Jour., p. 261, 1903.

Sidebottom, Manchester Lit. and Philos. Soc. Mem. and Proc., vol. 51, No. 9, p. 9, pl. 2, figs. 12-14, 1907.

Bagg, U. S. Nat. Mus. Proc., vol. 34, p. 148, 1908.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 85, pl. 41, fig. 5, 1913.

Test elongate-oval, much compressed, composed of few chambers which are elongate and narrow; sutures rather indistinct, not depressed; surface smooth; aperture somewhat produced. Length 0.65 millimeter or less.

A few compressed, elongate specimens from the Byram marl may best be referred to this species.

An examination of the figures of specimens referred to this species by different authors will show a very considerable range of forms.

**Genus UVIGERINA D'Orbigny, 1826.**

***Uvigerina byramensis* Cushman, n. sp.**

Plate XVIII, figure 5.

Test minute, elongate, somewhat fusiform, initial end pointed, chambers numerous, distinct, sutures depressed, surface ornamented by longitudinal costae, rather thin and sharp, the last-formed chamber more distinct than the rest, the inner side concave, the other two sides slightly convex, giving a generally triangular section, the surface of this last-formed chamber smooth, the apertural end produced into a short cylindrical neck with a slight lip, the aperture circular. Length 0.25 to 0.35 millimeter.

This species, which is the only one of the genus in the Byram marl at its type locality, is very distinct and constant in its characters. The size is very uniform, and the peculiar shape of the last-formed chamber in the adult is characteristic.

**Family GLOBIGERINIDAE.**

**Genus GLOBIGERINA D'Orbigny, 1826.**

***Globigerina bulloides* D'Orbigny.**

Plate XIX, figures 1-3.

*Globigerina bulloides* D'Orbigny, Annales sci. nat., vol. 7, p. 277, No. 1, Modèles, Nos. 17, 76, 1826; in Barker, Webb, and Berthelot, Histoire naturelle des îles Canaries, pt. 2, Foraminifères, p. 132, pl. 2, figs. 1-3 28, 1839.

H. B. Brady, *Challenger Rept.*, Zoology, vol. 9, p. 593, pl. 77; pl. 79, figs. 3-7, 1884.

There are in the typical Byram marl but few specimens of either this species or *G. triloba*, listed below. The specimens referred to *G. bulloides* are very constant in their characters and are of the form shown in the figures given. They are very similar except in their lower spire to the form figured by Brady in the *Challenger* report, plate 79, figure 7. There are but four visible chambers from the ventral side.

***Globigerina triloba* Reuss.**

*Globigerina triloba* Reuss, Akad. Wiss. Wien Denkschr., vol. 1, p. 374, pl. 47, figs. 11a-e, 1849.

*Globigerina bulloides* D'Orbigny var. *triloba* H. B. Brady, *Challenger Rept.*, Zoology, vol. 9, p. 595, pl. 81, figs. 2, 3, 1884.

Specimens which are very similar to the species described by Reuss and figured by Brady are found rarely in the Byram marl. In all the specimens the three visible chambers make up the whole of the exterior of the test. The walls are very thin and translucent.

**Family ROTALIIDAE.**

**Genus SPIRILLINA Ehrenberg, 1841.**

***Spirillina subdecorata* Cushman, n. sp.**

Plate XIX, figures 4, 5.

Test discoidal, much flattened, consisting of eight or more coils, slightly embracing, dorsal side slightly convex, ventral side strongly concave in the middle, chamber broad, the periphery with a broad, thin keel, the main surface of the chamber on the dorsal side granular, ventral side more nearly smooth; aperture at the end of the tube. Diameter about 0.5 millimeter.

Several specimens of this same character were found in the marl at Byram. One of these is attached to a shell fragment by the ventral side.

This species is perhaps nearest in character to *S. decorata* H. B. Brady, an Indo-Pacific species.

**Genus DISCORBIS Lamarck, 1804.****Discorbis byramensis Cushman, n. sp.**

Plate XIX, figures 6-8.

Test pyramidal, low, octagonal, ventral side slightly concave, peripheral margin subacute; eight chambers in each of the four or more coils, their margins uniting to form a series of eight ribs extending radially from the apex of the test to the periphery, the lateral sutures much less distinct, surface between the ridges concave but smooth; ventral surface composed of numerous radiating rounded costae broken up transversely to form a beaded surface; umbilical area hollow; aperture at the base of the last-formed chamber. Diameter 0.35 to 0.40 millimeter, height 0.10 millimeter.

This well-characterized species is very rare in the marl at Byram. It is probably nearest in its affinities to *D. corrugata* Millett, described from specimens obtained in the Malay Archipelago and recorded by Heron-Allen and Earland from the Kerimba Archipelago, off the southeastern coast of Africa. *D. corrugata* seems to have but half as many chambers to a coil as *D. byramensis* and is much higher in proportion. The Kerimba specimens show the sutural lines, but the Malay specimens do not. This species is also recorded by Heron-Allen and Earland from Sandoway, Arakan coast, Burma, and Rottnest Island, West Australia, thus having a wide Indo-Pacific range. In the characters of the ventral surface it is also related to *D. patelliformis* H. B. Brady and *D. tabernacularis* H. B. Brady, both typical Indo-Pacific species.

With the geographic relationships of *D. byramensis* its occurrence in the lower Oligocene of Mississippi is very interesting.

**Discorbis orbicularis (Terquem) Berthelin.**

Plate XIX, figures 9, 10.

*Rosalina orbicularis* Terquem, Essai sur le classement des animaux qui vivent sur la plage de Dunkerque, fasc. 2, p. 75, pl. 9, figs. 4a, b, 1870.

*Discorbis orbicularis* (Terquem) Berthelin, Liste des foraminifères recueillis dans la baie de Borgneuf et à Pornichet, p. 39, No. 63, 1878.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 5, p. 16, pl. 11, fig. 1; figs. 18a-c (in text), 1915.

*Discorbina orbicularis* (Terquem) H. B. Brady, *Challenger Rept., Zoology*, vol. 9, p. 647, pl. 88, figs. 4-8, 1884 (and numerous subsequent authors).

A few specimens of the broad, flat, scalelike form that is common in shallow water of tropical and subtropical seas were found in the marl

at Byram. They are here referred to *D. orbicularis* Terquem, although the number of chambers is much less than in the usual form of that species. All the specimens are of similar size and character. Diameter 0.55 millimeter or less.

The figures of specimens referred to this species by various authors show a considerable range of form and character.

**Genus TRUNCATULINA D'Orbigny, 1826.****Truncatulina lobatula (Walker and Jacob) D'Orbigny.**

Plate XX, figures 1-3.

"*Nautilus spiralis lobatus*, etc.," Walker and Boys, *Testacea minuta rariora*, p. 20, pl. 3, fig. 71, 1784.

*Nautilus lobatula* Walker and Jacob, *Adams's Essays on the microscope*, Kanmacher's ed., p. 642, pl. 14, fig. 36, 1798.

*Truncatulina lobatula* (Walker and Jacob) D'Orbigny, in Barker, Webb, and Berthelot, *Histoire naturelle des îles Canaries*, vol. 2, pt. 2, Foraminifères, p. 134, pl. 2, figs. 22-24, 1839; *Foraminifères fossiles du bassin tertiaire de Vienne*, p. 168, pl. 9, figs. 18-23, 1846.

H. B. Brady, *Challenger Rept., Zoology*, vol. 9, p. 660, pl. 92, fig. 10; pl. 93, fig. 1, 1884.

Specimens of an abundant form in the Byram marl are referred to this species. In most of them the last half of the final whorl is somewhat angled so that a shallow depression is formed on the dorsal surface. The ventral surface is well rounded. This is a very widespread species, but from the appearance of the fossil forms from various horizons it may have more than one form.

It has been recorded from the Pliocene (Waccamaw formation) at Cronly, N. C.,<sup>6</sup> from several Miocene formations in Maryland, Virginia, South Carolina, and Florida,<sup>7</sup> and from the Miocene of Santo Domingo.<sup>8</sup>

**Truncatulina byramensis Cushman, n. sp.**

Plate XX, figures 4-6.

Test planoconvex, dorsal side slightly convex, ventral side flattened, peripheral margin subcarinate; about eight chambers in the last-formed whorl, chambers on the ventral side failing to reach the center of the test, leaving a definite umbilical area which is filled with clear shell material; on the dorsal side each chamber at its inner border has the angles somewhat produced and a broad, rounded reentrant near the middle; on the ventral side the inner half of the chamber is rather in-

<sup>6</sup> U. S. Geol. Survey Bull. 676, p. 16, pl. 1, fig. 10, 1918

<sup>7</sup> Idem, p. 60, pl. 17, figs. 1-3.

<sup>8</sup> Carnegie Inst. Washington Pub. 291, p. 41, 1919.

tricately lobed, the chambers themselves of lighter color, the sutures darker, of clear shell material; surface finely granular; aperture an elongate opening at the base of the last-formed chamber near its inner ventral border. Diameter 0.35 to 0.75 millimeter.

This species is rather common in the marl at Byram. In the form of the lobed chambers it is related to two other Miocene species I have described—*T. basiloba*, from South Carolina, and *T. concentrica*, from the Choctawhatchee marl of Florida. In the peculiar labyrinthic form of the chamber it is not unlike some forms of *Pulvinulina elegans* D'Orbigny, but the shape of the test, chambers, and aperture is different.

***Truncatulina americana* Cushman.**

Plate XX, figures 7, 8.

*Truncatulina americana* Cushman, U. S. Geol. Survey Bull. 676, p. 63, pl. 20, figs. 2, 3; pl. 21, fig. 1, 1918; U. S. Nat. Mus. Bull. 103, p. 68, pl. 23, figs. 2a-c, 1918.

Test planoconvex, dorsal side nearly flat, ventral side slightly convex, chambers numerous, ten to fifteen in the last-formed coil, rather rapidly increasing in size, peripheral margin subangular, dorsal side with the last few chambers failing to meet the umbilicus, ventral side similar in this respect in most specimens; sutures distinct, slightly limbate on the dorsal side, depressed on the ventral side; wall smooth, punctate, aperture peripheral with a slight lip. Diameter 0.75 millimeter or less.

This species is not so common in the Byram marl as in the Miocene deposits. It is known from the Choctawhatchee marl at Coes Mills and Jackson Bluff, Fla., the Duplin marl at Mayesville, S. C., and Wilmington, N. C., the Yorktown formation at Yorktown, Va., and the Choptank formation at Jones Wharf, Md. I have also recorded it from the lower Miocene of Florida and from the upper Oligocene Culebra formation of the Canal Zone. It is found in the Miocene penetrated by wells in different parts of the peninsula of Florida.

***Truncatulina pseudoungeriana* Cushman, n. sp.**

Plate XX, figure 9.

*Truncatulina ungeriana* H. B. Brady (not *Rotalina ungeriana* D'Orbigny, 1826), *Challenger Rept.*, Zoology, vol. 9, pl. 94, figs. 9a-c, 1884.

Cushman, U. S. Nat. Mus. Bull. 103, p. 69, pl. 24, fig. 1, 1918.

Test biconvex, almost equally so; periphery subacute, chambers nine to eleven in the last-

formed whorl, those of the earlier whorls not showing on the dorsal side because they are hidden by the roughness of the surface, or on the ventral side because of the involute character; periphery lobulated; sutures distinct above in the last whorl and very distinct below, as the sutures are somewhat tumid on the ventral side; umbilical region filled nearly flush with the chambers by clear shell material, last few chambers on the dorsal side slightly above the surface on the inner margin; surface dorsally with coarse punctae, below smooth and more finely punctate; aperture at the periphery. Diameter 1 millimeter or less.

In the Byram marl the same form appears that is figured by Brady as *T. ungeriana*. Brady says of his figure, "The drawing (Pl. XCIV, fig. 9) is not a good illustration of the species, the specimen being relatively thicker and altogether more stoutly built than the typical form." A comparison of Brady's figure with that given by D'Orbigny in the Vienna Basin monograph will show the numerous differences in the two. Brady does not give the locality for the specimen from which his drawing was made, but I have seen identical material from the Philippine and Australian regions. The occurrence of this same form in the Byram marl seems to show that the species is distinct and that discrimination will show it to have a definite geographic range in the present ocean. Material from the Oligocene Culebra formation of the Canal Zone that I have referred to *T. ungeriana* may be this new species.

**Genus ANOMALINA D'Orbigny.**

***Anomalina bilateralis* Cushman, n. sp.**

Plate XXI, figures 1, 2.

Test of about four coils, bilateral or nearly so, composed of numerous chambers, ten or more in the last-formed whorl, umbilical region on both sides with a knob of clear shell material, more pronounced on the dorsal side, chambers smooth but coarsely punctate, more coarsely so on the ventral side, sutures broad and somewhat limbate with clear shell material; aperture a narrow curved opening at the base of the final chamber. Diameter 1 millimeter or less.

This form is rare in the Byram marl. It is close to *A. ammonoides* Reuss but differs from that species as figured by Reuss. It is very close to the form figured in the *Challenger* report by Brady (pl. 94, fig. 2). The *Challenger* material in which Brady found it was almost entirely

from the south Pacific, and it may be predicted that a study of the rather shallow-water material from that region will show that the species there is closely related to if not identical with this one from the Byram marl.

Reuss's original material was from the Cretaceous of Europe. A critical study of the various figures assigned to *A. ammonoides* will show that several forms have been included under the one name.

***Anomalina grosserugosa* (Gümbel) H. B. Brady? var.**

Plate XXI, figures 3-5.

A form in the Byram marl may questionably be referred to this species. It is very close to the form figured by Brady in the *Challenger* report (pl. 94, fig. 4), which is very different from the original of Gümbel, as a comparison of the two will show.

Millett records this species with *A. ammonoides* as widely distributed in the Malay Archipelago, and as both are recorded from a number of stations off the Hawaiian Islands a review of tropical Pacific material should be made to see just what forms are really present there.

***Anomalina mississippiensis* Cushman, n. sp.**

Plate XXI, figures 6-8.

Test small, planoconvex, of about two and one-half coils, periphery slightly lobulate, bluntly rounded, dorsal side very much flattened, even slightly concave, ventral side very convex; chambers comparatively few, six to eight in the last-formed coil, sutures curved, on the dorsal side broad and limbate, even with the surface of clear shell material, on the ventral side narrower and depressed; the last-formed two or three chambers on the inner margin on the dorsal side slightly above the general surface; wall thin and translucent, especially on the dorsal side, smooth; on the ventral side finely punctate and not so clear; aperture a curved opening at the inner margin at the periphery. Length 0.25 to 0.35 millimeter, breadth 0.20 to 0.30 millimeter.

This species is fairly common in the marl at Byram but might easily be overlooked on account of its small size. It is very constant in its chambers and in size and seems to be a well-distinguished little species. In some respects it has affinities with *Truncatulina*

*americana* Cushman, and in others with *Anomalina grosserugosa* (Gümbel) ? var., already mentioned, but it is very distinct from either.

**Genus SIPHONINA Reuss, 1849.**

***Siphonina advena* Cushman, n. sp.**

Plate XXII, figures 1, 2.

Test unequally biconvex, dorsal side usually less convex than the ventral, periphery subacute, chambers in three or more coils, four chambers making up the last-formed coil, sutures distinct, on the dorsal side flush with the surface, on the ventral side slightly depressed, on the dorsal side somewhat broadened and limbate, ventrally narrow, surface smooth but punctate; aperture with a short neck, compressed, with a phialine lip and elliptical aperture; color even in the fossil specimens somewhat brownish, wall thin and translucent. Diameter 0.50 millimeter or less.

This species is common in the marl at Byram but never shows any of the characters of *S. reticulata* (Czjzek), to which it is related. It is nearer to *S. pulchella* Cushman, from the Miocene of Yumuri River gorge, near Matanzas, Cuba, but differs in the size and shape of the chambers and the character of the sutures.

**Genus GYPSINA Carter, 1877.**

***Gypsina rubra* (D'Orbigny) Heron-Allen and Earland.**

Plate XXII, figure 3.

*Planorbulina rubra* D'Orbigny, Annales sci. nat., vol. 7, p. 280, No. 4, 1826.

Fornasini, Acad. sci. Ist. Bologna Mem., 6th ser., vol. 5, p. 44, pl. 2, fig. 3, 1908.

*Gypsina rubra* (D'Orbigny) Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 725, pl. 53, figs. 35-37, 1915.

A number of specimens of this species were collected in the marl at Byram.

Although in the fossil specimens the color is of course lacking, the characteristic secondary growth seems to be developed.

This is an Indo-Pacific species recorded by D'Orbigny from the South Seas and Sarawak. Heron-Allen and Earland note its occurrence in the Kerimba Archipelago, off the southeastern coast of Africa. They also record it in shore sands from Fremantle, West Australia, from Lord Howe Island, and from Apia Beach and the Lufi-lufi reef, Samoa, and note that "it is probably widely distributed in shallow water across the Indo-Pacific region."

Genus *PULVINULINA* Parker and Jones, 1862.*Pulvinulina byramensis* Cushman, n. sp.

Plate XXII, figures 4, 5.

Test small, biconvex, rotaliform, consisting of about three coils, seven or eight chambers in the last-formed coil; on the dorsal side sutures oblique and at a considerable angle with the periphery, somewhat limbate; on the ventral side the chambers extend in to the center, which is usually not umbilicate; sutures nearly straight; surface polished, punctations appearing as light tubules against the translucent wall; aperture near the inner end of the chamber on the ventral side, with a definite valvular lip, the aperture hidden below but when examined found to be composed, in the adult, of several adjacent small rounded openings. Diameter 1.5 millimeters or less.

This is a common species in the marl at Byram.

The features of the aperture in this species are peculiar, and with its other characters it seems to be well defined.

*Pulvinulina advena* Cushman, n. sp.

Plate XXII, figure 8.

Test minute, planoconvex, composed of two and a half coils, periphery deeply lobulate, chambers few, elongate, broadest at the outer end, six or seven in the last-formed whorl, periphery of the chambers somewhat tubulated, remainder of surface slightly papillose on the dorsal side, which is flat, ventral side with each chamber more tumid, sutures depressed and distinct, the surface granulose with coarse, almost spinose projections, chambers continuing in to the umbilicus, where they meet; aperture near the periphery of the test at the base of the last-formed chamber. Diameter 0.20 millimeter.

This species is rare in the Byram marl. It finds its nearest ally, so far as ornamentation shows, in *Rotalia schroeteriana* Parker and Jones var. *inflata* Millett. It has a similar surface ornamentation in the spinose or granular surface and in the fimbriated character of the peripheral margins of the chambers. This variety, described by Millett from specimens obtained in the Malay Archipelago, was found again by Heron-Allen and Earland in the material from the Kerimba Archipelago, off the southeastern coast of Africa.

*Pulvinulina glabrata* Cushman, n. sp.

Plate XXII, figures 6, 7.

Test biconvex, elongate, somewhat lobulate, composed of about two coils, seven chambers in the last-formed coil, dorsal side convex, the sutures depressed, curved, chambers convex between, rapidly increasing in size as added; dorsal side very coarsely punctate, the sutures somewhat limbate; ventral side umbilicate, surface smooth and with very fine punctations; sutures distinct, last-formed chamber with a long, straight valvular lip across the whole of the depressed umbilicus; aperture beneath the lip. Length 0.5 millimeter.

*P. glabrata* is rare in the marl at Byram. It differs from such closely related species as *P. auricula*, *P. sagra*, and *P. oblonga* in its very coarsely punctate dorsal surface and the shape of the test. From *P. oblonga*, which has a somewhat similar aperture, it differs in the shorter form of the test. There are a number of records for *P. oblonga* from the Indo-Pacific region, and it would be interesting to know the relation of this Byram marl species to that from the Indo-Pacific.

Genus *ROTALIA* Lamarck, 1804.*Rotalia byramensis* Cushman, n. sp.

Plate XXIII, figure 1.

Test unequally biconvex, rotaliform, in the last-formed coil six or seven chambers, dorsally with the chambers somewhat triangular, the sutures oblique, limbate, broad, of clear shell material; ventral side with a large circular mass in the umbilical region, with the sutures deep and ending in a depressed ring about it; aperture with a somewhat valvular lip often divided into several teeth; surface on the dorsal side somewhat roughened, on the ventral side scrobiculate near the periphery, smoother near the center. Diameter 2 millimeters or less.

This species is not common in the marl at Byram. While it belongs to the *Rotalia beccarii* group, it is much more like the tropical species now living in the Indo-Pacific than those of temperate regions. *R. beccarii* itself is used as a name to cover a great variety of things, and the forms now passing under that name should be more critically treated if their geographic and geologic distribution is to be of value.

**Rotalia dentata Parker and Jones.**

Plate XXIII, figure 2.

*Rotalia dentata* Parker and Jones, Philos. Trans., vol. 155, p. 387, pl. 19, fig. 13. 1865.

Several specimens from the marl at Byram are very close to this species from Bombay figured by Parker and Jones. They are also close to the figure given by Brady in the *Challenger* report (pl. 108, fig. 4). *R. dentata* is a different species from *R. calcar*, though probably included under that name by several authors.

As shown in the figure of the type, the sutures are limbate with clear shell material, and the outer border of each whorl is marked in a like manner. The spinose projections from the edge are very much like those in the figure given by Brady and seem to be different from those ordinarily seen in *R. calcar*.

**Genus ASTERIGERINA D'Orbigny, 1839.*****Asterigerina subacuta* Cushman, n. sp.**

Plate XXIV, figures 1-3.

Test planoconvex or unequally biconvex, composed of about three and one-half coils, the dorsal side slightly convex, smooth, the chambers all visible in well-preserved specimens, even those of the earlier coils showing through the layer of transparent shell material covering them; chambers about ten in the last-formed coil, the sutures oblique and curved backward but not depressed below the surface, slightly thickened and clear, joining at the periphery with the slight keel; from below, the chambers of the last coil only visible; sutures ending at a point about one-third of the way in from the periphery, from which a secondary chamber is developed to the umbilical region, where the sutures come together in a central boss of clear shell material; aperture elongate, curved, at the base of the inner margin on the ventral side. Diameter about 1 millimeter.

Specimens of this species are fairly common in the marl at Byram. It is clearly related to *Asterigerina carinata* D'Orbigny and *A. angulata* Cushman. From the former it differs in the larger number of chambers and the narrower coils, and from the latter in the smaller number of the chambers, simpler aperture, and much narrower coils. *A. subacuta* is nearer *A. carinata* than *A. angulata* but is very constant in its characters. From above it has the appearance of a *Pulvinulina*, but an examination of the ventral side shows the typical

characters of *Asterigerina*. It shows traces of granules on the ventral side near the aperture.

**Family NUMMULITIDAE.****Genus NONIONINA D'Orbigny, 1826.*****Nonionina umbilicatula* (Montagu) Parker, Jones, and H. B. Brady.**

Plate XXIII, figures 3, 4.

There are several specimens from the marl at Byram that at present may be referred to this species. It should be noted, however, that the specimens described by Montagu are different from many of the forms later assigned to his species and that there are apparently several species or varieties which occur in different regions which should be distinguished. The specimens from the Byram marl are very constant in all their characters and are very close to one of the forms figured by Brady in the *Challenger* report (pl. 109, fig. 8). This species is common in comparatively shallow water in the Indo-Pacific region, but in the north Atlantic it is found largely in deeper water. It is to be suspected, therefore, that the species from the Byram marl and that from the Indo-Pacific may be found to be closely allied.

***Nonionina scapha* (Fichtel and Moll) Parker and Jones.**

Plate XXIII, figures 5-7.

*Nautilus scapha* Fichtel and Moll, Testacea microscopica, p. 105, pl. 19, figs. d-f, 1803.*Nonionina scapha* (Fichtel and Moll) Parker and Jones, Annals and Mag. Nat. Hist., 3d ser., vol. 5, p. 102, No. 4, 1860.H. B. Brady, *Challenger* Rept., Zoology, vol. 9, p. 730, pl. 109, figs. 14, 15, 16?, 1884.

There are two forms of *Nonionina* in the Byram marl, both of which are referred to *N. scapha*. One of them is very close to two of the figures given by Brady in the *Challenger* report (pl. 109, figs. 14, 15). The other is somewhat more elongate. Both forms are figured here to facilitate subsequent reference when the various forms of *Nonionina* found in the Tertiary of the Coastal Plain may be studied as a whole.

**Genus NUMMULITES Lamarck, 1801.*****Nummulites* sp.**

Plate XXIV, figure 4.

There are a few specimens of *Nummulites* from the marl at Byram of the character

shown in the figure. Definite placing of these forms under a specific name is left until the study of the various species of our Coastal Plain Tertiary is undertaken.

**Genus LEPIDOCYCLINA Gumbel, 1868.**

**Lepidocyclina supera (Conrad) H. Douvillé.**

*Orbitolites supera* Conrad, Acad. Nat. Sci. Philadelphia Proc., No. 2, p. 74, 1865.

*Orbitoides supera* Conrad, Am. Jour. Sci., 2d ser., vol. 43, p. 31, 1867.

*Lepidocyclina supera* (Conrad) H. Douvillé, Compt. Rend., 1918, pp. 263, 264, figs. 6-8, 11.

Cushman, U. S. Geol. Survey Prof. Paper 125, p. 69, pl. 26, figs. 5-7, 1920.

Test flattened or slightly sellaeform, typically circular but occasionally irregular with lobes at one side or elongated oval; thickest in the central region but not distinctly umbonate, gradually decreasing in thickness to the periphery; surface apparently smooth but with slight enlargement becoming papillate, the papillae, which are the ends of the pillars, rounded and projecting above the general surface slightly, or where the test is eroded becoming more prominent. Diameter as much as 18 millimeters in adult specimens, thickness about 2 millimeters.

This species is abundant in the Byram marl, of which it is one of the index fossils.

**Family MILIOLIDAE.**

**Genus CORNUSPIRA Schultze, 1854.**

**Cornuspira involvens (Reuss) Reuss.**

Plate XXV, figure 1.

*Operculina involvens* Reuss, Akad. Wiss. Wien Denkschr., vol. 1, p. 370, pl. 45, fig. 20, 1849.

*Cornuspira involvens* (Reuss) Reuss, Akad. Wiss. Wien Sitzungsber., vol. 48, p. 39, pl. 1, fig. 2, 1863 [1864].

H. B. Brady, *Challenger Rept.*, Zoology, vol. 9, p. 200, pl. 11, figs. 1-3, 1884.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 25, pl. 1, fig. 2; pl. 2, fig. 2, 1917.

There are but a few specimens of this species in the Byram marl. They are smooth and of small size, only about 0.4 millimeter.

The species is very widely distributed. It is common in the shoal waters of the Tropics and reaches a large size in the warm waters of the Indo-Pacific region, as, for example, in the Philippines. Elsewhere it seems to be of small size.

**Genus SPIROLOCULINA D'Orbigny, 1826.**

**Spiroloculina grateloupi D'Orbigny.**

Plate XXV, figure 2.

*Spiroloculina grateloupi* D'Orbigny, Annales sci. nat., vol. 7, p. 298, 1826.

Terquem, Soc. géol. France Mém., 3d ser., vol. 1, p. 52, pl. 5, figs. 5, 6, 1878.

Weisner, Archiv Protisten-Kunde, vol. 25, p. 208, 1912.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 31, pl. 4, figs. 4, 5, 1917.

*Spiroloculina excavata* H. B. Brady (not D'Orbigny), *Challenger Rept.*, Zoology, vol. 9, p. 151, pl. 9, figs. 5, 6, 1884.

The marl from Byram contains a number of specimens which seem nearer to this species than to any other. The periphery, however, is not greatly rounded, but the sides of the test are deeply excavated, and there is a strong keel at the outer edge of each chamber, the neck is produced, and the surface is smooth. One specimen exhibits the series of openings at either end of each coil seen in a number of other species. This is a microspheric specimen.

The species is widely distributed and is especially abundant in the Indo-Pacific, occurring in great numbers in certain parts of the Philippine region and elsewhere in shallow warm waters.

**Spiroloculina byramensis Cushman, n. sp.**

Plate XXV, figures 4a, 4b.

Test compressed, broadly rounded in side view; peripheral margin squarely truncate, sides of the chambers sloping in somewhat toward the center, surface with a beautiful ornamentation consisting of fine hexagonal depressed areas with very narrow thin ridges between covering the entire surface. Length 0.85 millimeter.

This is rare in the marl at Byram, but its beautifully ornamented surface is very distinctive. It resembles Terquem's figures of *Quinqueloculina variolata* D'Orbigny, from the Pliocene of the Isle of Rhodes.

**Spiroloculina imprimata Cushman, n. sp.**

Plate XXV, figures 3a, 3b.

Test broad and flat, complanate, nearly circular in outline, composed of numerous chambers, those of the last-formed coil failing to extend to the base of the preceding chamber, leaving a gap; periphery square, lateral faces nearly flat; the surface ornamented by a

series of pits in a more or less linear arrangement. Length about 1 millimeter.

Plate XXV, figure 3b, shows the character of this ornamentation, much enlarged. This is not a common species in the Byram marl, but several specimens were found.

**Genus VERTEBRALINA D'Orbigny, 1826.**

***Vertebralina advena* Cushman, n. sp.**

Plate XXV, figures 5, 6.

Test compressed, in the adult with three chambers in the final whorl, the chamber angled, surface with numerous strong longitudinal costae, aperture elongate, with a flaring everted lip. Diameter 1 millimeter.

This species is rare in the Byram marl. It may be that some of the specimens which have been assigned to *Articulina sulcata*, based on the figure given by Brady, are *V. advena*. Heron-Allen and Earland record *A. sulcata* from the Kerimba Archipelago. Sidebottom records the species from the Mediterranean, and his figures show that his specimens were evidently *Articulina*. The specimen from the Abrolhos Bank figured by Brady, Parker, and Jones is apparently not the same.

Forms similar to this should be looked for in the tropical Indo-Pacific. A specimen I have figured as *Articulina sulcata*<sup>9</sup> is very close to if not identical with the Byram marl species.

***Vertebralina* sp.**

Plate XXV, figure 7.

In the marl at Byram was found a single specimen of a very thin, complanate species with numerous distinct anastomosing costae as a surface ornamentation.

It is very distinct from *V. advena*, described above, but the single specimen is not enough for specific determination and description.

**Genus QUINQUELOCULINA D'Orbigny.**

***Quinqueloculina crassa* D'Orbigny?**

Plate XXVII, figures 1, 2.

*Quinqueloculina crassa* D'Orbigny, *Annales sci. nat.*, vol. 7, p. 301, No. 14, 1826.

Terquem, *Soc. géol. France Mém.*, 3d ser., vol. 2, pt. 3, p. 186, pl. 20 (28), figs. 20, 21, 1882.

Fornasini, *Accad. sci. Ist. Bologna Mem.*, 6th ser., vol. 2, p. 65, pl. 3, fig. 5, 1905.

*Miliolina crassa* Heron-Allen and Earland, *Zool. Soc. London Trans.*, vol. 20, p. 572, pl. 42, figs. 37-41, 1915.

<sup>9</sup> U. S. Nat. Mus. Bull. 71, pt. 6, pl. 22, figs. 5a, b, 1917.

A species that is fairly common in the marl at Byram is rather close to *Q. crassa* as figured by Heron-Allen and Earland from their Kerimba Archipelago material. It is referred questionably to this species. The Byram specimens have perhaps a little finer costae but are otherwise similar to the Kerimba form.

***Quinqueloculina bicostata* D'Orbigny, var.**

Plate XXVI, figures 2-4.

A form of *Quinqueloculina* which is one of the most common fossils in the Byram marl may be referred to *Q. bicostata* D'Orbigny. The specimens are, however, more elongate than the types,<sup>10</sup> or those of Heron-Allen and Earland, from the Kerimba Archipelago.<sup>11</sup>

The Byram specimens are referred to this species provisionally, but they may represent a distinct variety or species, their main resemblance to the typical form being in the bicostate character of the periphery of the chambers.

The species which perhaps comes nearest to this Byram marl material is that figured by D'Orbigny<sup>12</sup> as *Q. juleana*.

***Quinqueloculina cuvieriana* D'Orbigny.**

Plate XXVI, figure 1.

*Quinqueloculina cuvieriana* D'Orbigny, in De la Sagra, *Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères*, p. 164, pl. 11, figs. 19-21, 1839.

Cushman, *U. S. Nat. Mus. Bull.* 71, pt. 6, p. 47, pl. 12, fig. 2, 1917.

The typical form of this species described by D'Orbigny from specimens obtained from the shore sands of Cuba occurs very rarely in the marl at Byram. Several authors cite the figures in the *Challenger* report, which do not represent this species but rather *Q. lamarckiana* D'Orbigny. The typical form is found, however, in eastern waters. I have had it from shallow water in Hongkong Harbor, and it occurs elsewhere in the Indo-Pacific region.

The accessory costae at either side of the sharp margin are characteristic of the species.

***Quinqueloculina venusta* Karrer?, var.**

Plate XXVI, figure 5.

This elongate, angled form is somewhat like the form figured by Brady in the *Challenger*

<sup>10</sup> D'Orbigny, A. D., in De la Sagra, Ramón, *Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères*, p. 195, pl. 12, figs. 8-10, 1839.

<sup>11</sup> *Zool. Soc. London Trans.*, vol. 20, p. 572, pl. 42, figs. 42-45, 1915.

<sup>12</sup> *Foraminifères fossiles du bassin tertiaire de Vienne*, pl. 20, figs. 1-3, 1846.



report (pl. 5, fig. 5) and placed as *Miliolina venusta* Karrer. The specimens from the Byram marl are even longer and more slender and may not be this species at all. They are figured and noted here so that the form may be made available for later comparisons.

**Quinqueloculina sp.?**

Plate XXVI, figure 6.

A few specimens from the Byram marl are large (1.50 to 1.75 millimeters long) and have much the form of *Triloculina oblonga* (Montagu) but are quinqueloculine. The surface is in most of them worn and smooth, but in one of the largest, best-preserved specimens there is a faint longitudinal striation. In this connection the note which Heron-Allen and Earland give under *Miliolina oblonga* in their Kerimba work (p. 567) is interesting. "At stations 9 and 12 the specimens were large and showed signs of superficial markings linking the species with *M. striata*."

**Genus HAUERINA D'Orbigny, 1846.**

***Hauerina fragilissima* (H. B. Brady) Millett.**

Plate XXVII, figure 3.

*Spiroloculina fragilissima* H. B. Brady, *Challenger Rept.*, Zoology, vol. 9, p. 149, pl. 9, figs. 12-14, 1884.

*Hauerina fragilissima* (H. B. Brady) Millett, *Roy. Micr. Soc. Jour.*, p. 610, pl. 13, figs. 8-10, 1898.

Heron-Allen and Earland, *Zool. Soc. London Trans.*, vol. 20, p. 587, pl. 46, figs. 1, 2, 1915.

Cushman, *U. S. Nat. Mus. Bull.* 71, pt. 6, p. 64, pl. 24, fig. 4, 1917.

A number of very typical specimens of this species have been identified from the marl at Byram.

All the known records for this species are Indo-Pacific. Brady's original localities are off Tahiti, Society Islands, 420 and 620 fathoms; off Kandavu, Fiji Islands, 255 fathoms; south coast of New Guinea, 3 to 28 fathoms; north coast of New Guinea, 16 to 25 fathoms. Millett records it from the Malay Archipelago. Heron-Allen and Earland found it in material from the Kerimba Archipelago, off the southeastern coast of Africa. I have found the species in material collected off the Hawaiian Islands in 271 fathoms.

This record from the lower Oligocene Byram marl confirms the Indo-Pacific relations of the Byram fauna.

The test of this species is very thin and of a peculiar opalescent character, the surface

smooth or slightly pitted, the sutures usually appearing as whitish lines in the test.

***Hauerina* sp.?**

Plate XXVII, figure 4.

A single somewhat broken specimen in the marl from Byram belongs to the genus *Hauerina*. It differs from *H. fragilissima* in the sharp edge to the peripheral borders of the chambers, even carinate, and the character of the wall, which though thin and transparent seems to have deep pits or possibly perforations at wide but regular intervals, in a single irregular line down the curved part of the chamber.

**Genus ARTICULINA D'Orbigny, 1826.**

***Articulina byramensis* Cushman, n. sp.**

Plate XXVII, figures 5, 6.

Test of two portions, a basal triloculine portion followed by a single linear chamber, the earlier portion with the lip of the antepenultimate chamber standing out free at the base, that of the penultimate chamber covered by the base of the last-formed one, last chamber rounded in transverse section or slightly compressed, with a broadly flaring, slightly downward-curved lip; aperture rounded, slightly longer than wide; surface of the test with numerous longitudinal costae, sharp, sometimes, especially in the final chamber, anastomosing. Length 1.25 millimeters.

This is a fairly common species in the marl at Byram and is very constant in its characters. The free lip of the chamber projecting at the base is peculiar and constant in all specimens, and the single linear chamber with very wide lip and the sharply cut, often anastomosing costae are also points that distinguish the species.

*A. byramensis* is allied to certain of the species usually classed under *A. conico-articulata*. It is close to the specimen from waters off the Hawaiian Islands I have referred to *A. conico-articulata*<sup>13</sup> and is even more strikingly like the specimens from the Kerimba Archipelago figured by Heron-Allen and Earland<sup>14</sup> as *Articulina sagra* D'Orbigny. This suggests that we have here a definite species, fossil in the Byram marl and living in the Indo-Pacific.

<sup>13</sup> U. S. Nat. Mus. Bull. 71, pt. 6, pl. 22, figs. 5, 6, 1917.

<sup>14</sup> Zool. Soc. London Trans., pl. 45, figs. 22-25, 1915.

Genus **MASSILINA** Schlumberger, 1893.**Massilina crusta** Cushman, n. sp.

Plate XXVIII, figure 1.

Test elliptical, compressed, periphery carinate, early chambers quinqueloculine, later ones 180° from one another, making a flat test, sutures distinct, central portion of each chamber elliptical in transverse section, surface with a slight secondary thickening, the test itself ornamented by a series of very short longitudinal pits, apertural and basal ends of each chamber strongly projecting, the basal end rounded, the aperture rounded with a bifid tooth; surface dull. Length 1.60 millimeters or less.

A few specimens in various stages occurred in the marl at Byram. This species in some ways resembles the figures of *Spiroloculina planissima* (Lamarek) from the Kerimba Archipelago given by Heron-Allen and Earland.<sup>15</sup> Our specimens are, however, much more involute and belong to *Massilina*. The shape of the apertural end and the carinate periphery are very similar in the two forms.

**Massilina occlusa** Cushman, n. sp.

Plate XXVIII, figure 2.

Test elongate, narrowly elliptical in face view, involute, the peripheral margins squarely truncate, initial end of the chamber projecting backward beyond the former aperture, rounded, apertural end somewhat produced, whole chamber nearly square in transverse section; sutures distinct; aperture rounded, neck square; surface dull, smooth. Length 0.75 millimeter or less.

This species is represented in the marl at Byram by several specimens, all of this same shape and character.

The involute character of the last-formed chambers hides the early chambers almost completely. The whole test has a squarish form that is continued even to the apertural neck. The shape of the initial end of the last-formed chamber is also very constant and characteristic.

**Massilina occlusa** Cushman, n. sp., var. **costulata** Cushman, n. var.

Test differing from the typical form in the surface, which instead of being smooth and

polished as in the type has an ornamentation of several longitudinal, more or less irregular costae, running out on the neck of the last-formed chamber, the angles of the chambers sharp and carinate, the periphery of the test concave.

This form is rare in the marl at Byram and seems to be either a distinct species or a variety of *M. occlusa*. It may be compared to such forms as *Spiroloculina costigera* Terquem, *S. costata* Terquem, *S. striata* Terquem, and *S. semi-ovata* Terquem, from the Eocene of the Paris Basin, though it is unlike any of these.

Genus **TRILOCULINA** D'Orbigny, 1826.**Triloculina rotunda** D'Orbigny.

*Triloculina rotunda* D'Orbigny, Annales sci. nat., vol. 7, p. 299, No. 4, 1826.

Schlumberger, Soc. zool. France Mém., vol. 6, p. 206, pl. 1, figs. 48-50, figs. 11, 12 (in text), 1893.

Several specimens from the marl at Byram are here referred to this species. They are triloculine, smooth, nearly as broad as long, and the chambers rounded. The longest are about 0.75 millimeter in length.

*T. rotunda* is recorded from widely separated localities, but there are various forms, as noted in the literature on the species.

**Triloculina oblonga** (Montagu) D'Orbigny.

Plate XXVIII, figures 3, 4.

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

*Triloculina oblonga* (Montagu) D'Orbigny, Annales sci. nat., vol. 7, p. 300, No. 16, Modèles, No. 95, 1826; in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba, Foraminifères, p. 155, pl. 10, figs. 3-5, 1839.

Cushman, U. S. Nat. Mus. Bull. 71, pt. 6, p. 69, pl. 26, fig. 3, 1917.

*Miliolina oblonga* (Montagu) H. B. Brady, Challenger Rept., Zoology, vol. 9, p. 160, pl. 5, figs. 4a, b, 1884. Millett, Roy. Micr. Soc. Jour., p. 267, pl. 5, fig. 14, 1898.

Heron-Allen and Earland, Zool. Soc. London Trans., vol. 20, p. 566, 1915.

A few small but otherwise typical specimens of this species were found in the marl at Byram. They are widest near the base and thence taper to the narrower apertural end; the surface is smooth and polished. Length about 0.35 millimeter.

The specimen figured by Brady seems to be a *Quinqueloculina* and to lack the characteristic shape of the tropical specimens in shallow

<sup>15</sup> Zool. Soc. London Trans., vol. 20, pl. 41, figs. 1-5, 1915.

water. It may be that the Byram specimens and the one I have figured from waters off the Hawaiian Islands, together with that figured by Millett, really constitute a tropical species different from that of British waters.

***Triloculina trigonula* (Lamarck) D'Orbigny.**

*Miliolites trigonula* Lamarck, Annales du Mus., vol. 5, p. 351, No. 3, 1804; Animaux sans vertèbres, vol. 7, p. 612, No. 3, 1822.

*Triloculina trigonula* (Lamarck) D'Orbigny, Annales sci. nat., vol. 7, p. 299, No. 1, pl. 16, figs. 5-9, Modèles, No. 93, 1826.

A single specimen of this species was found in the marl at Byram. It is a short, rather rotund form.

Genus **BILOCULINA** D'Orbigny, 1826.

***Biloculina* sp.?**

Plate XXVIII, figures 5, 6.

There are a very few specimens of a small rotund *Biloculina* in the Byram marl. They are smooth with a large aperture and a tooth very small in comparison, as shown in the figure.

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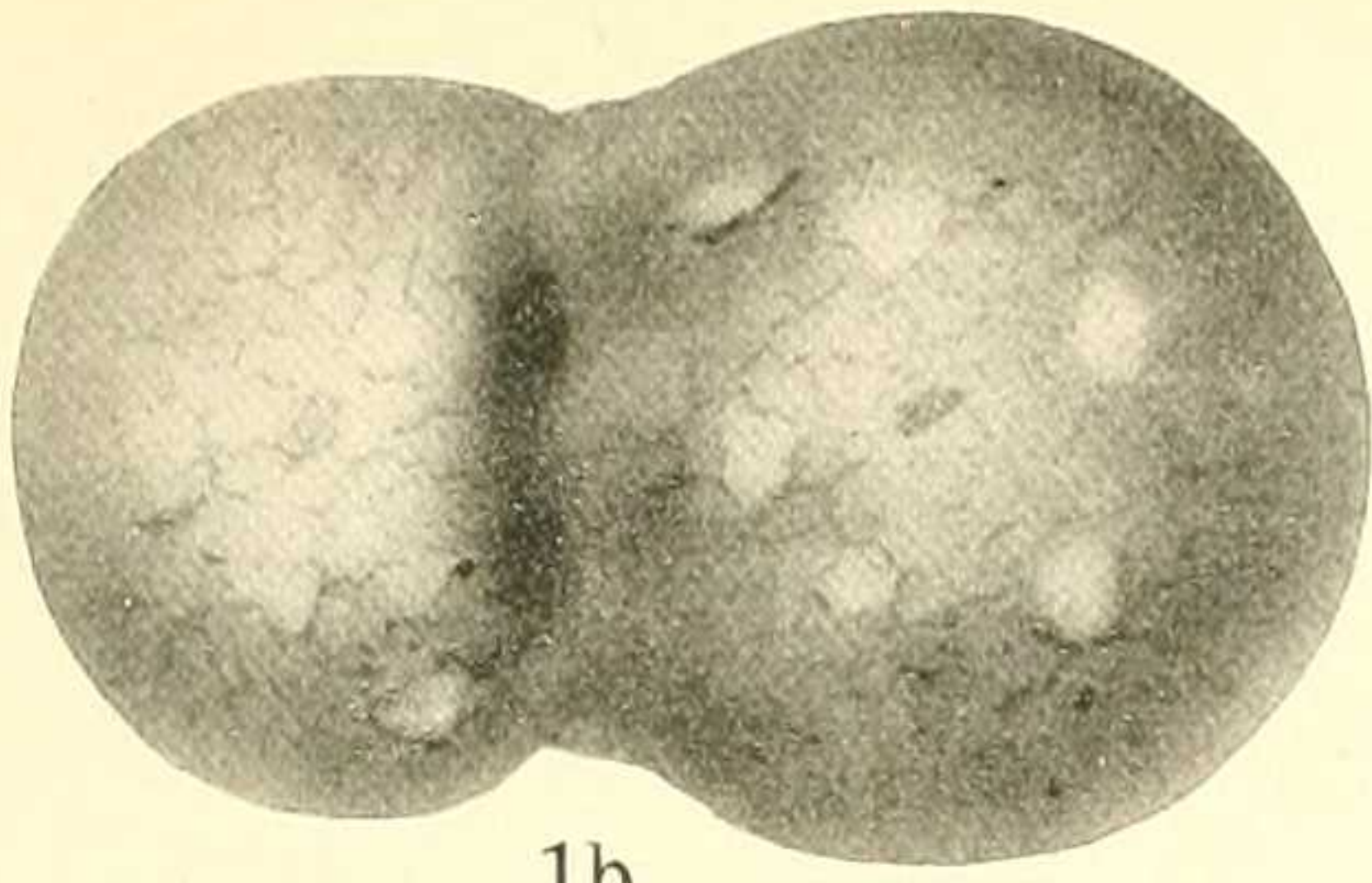
**PLATES XIV-XXVIII.**

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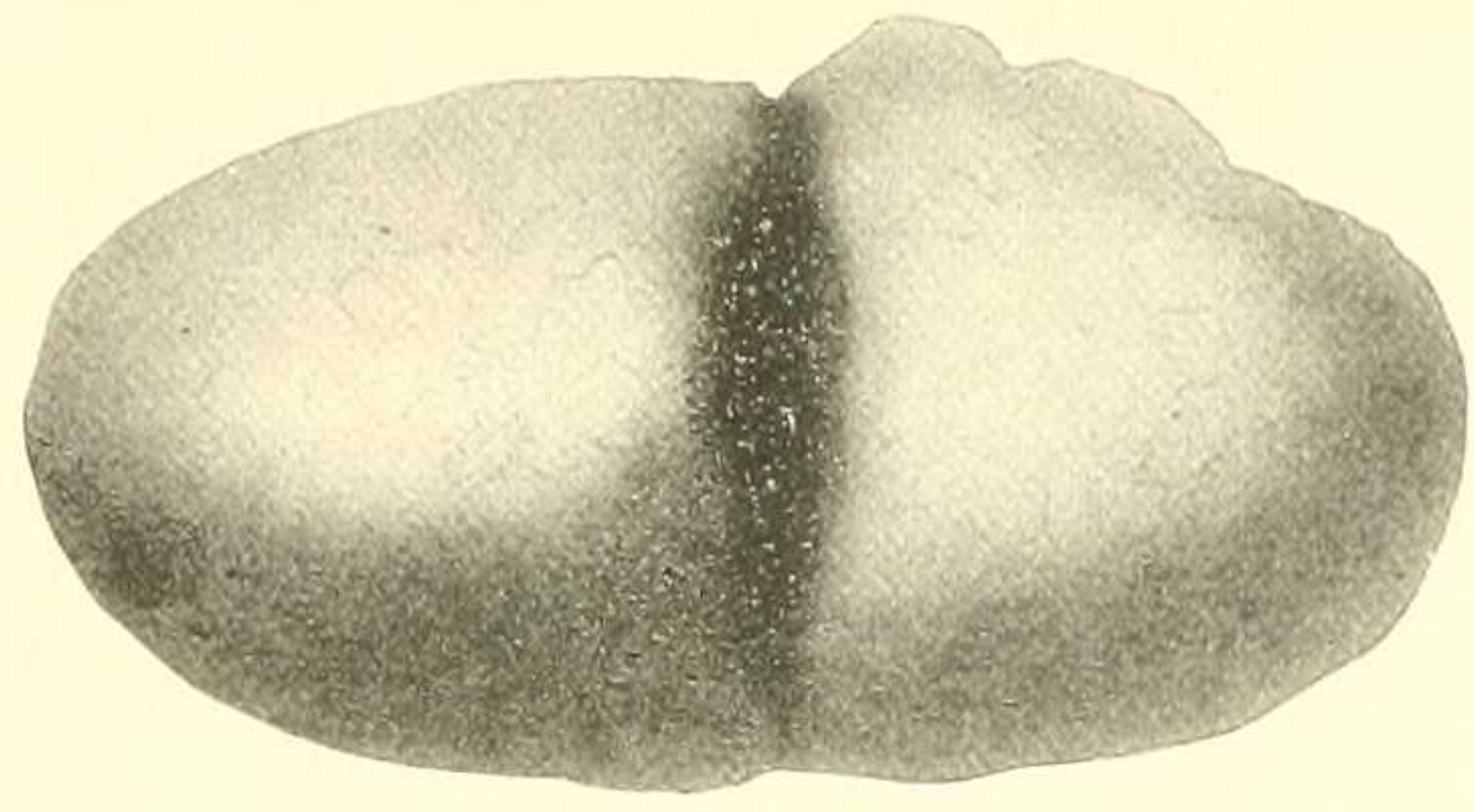
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PLATE XIV.

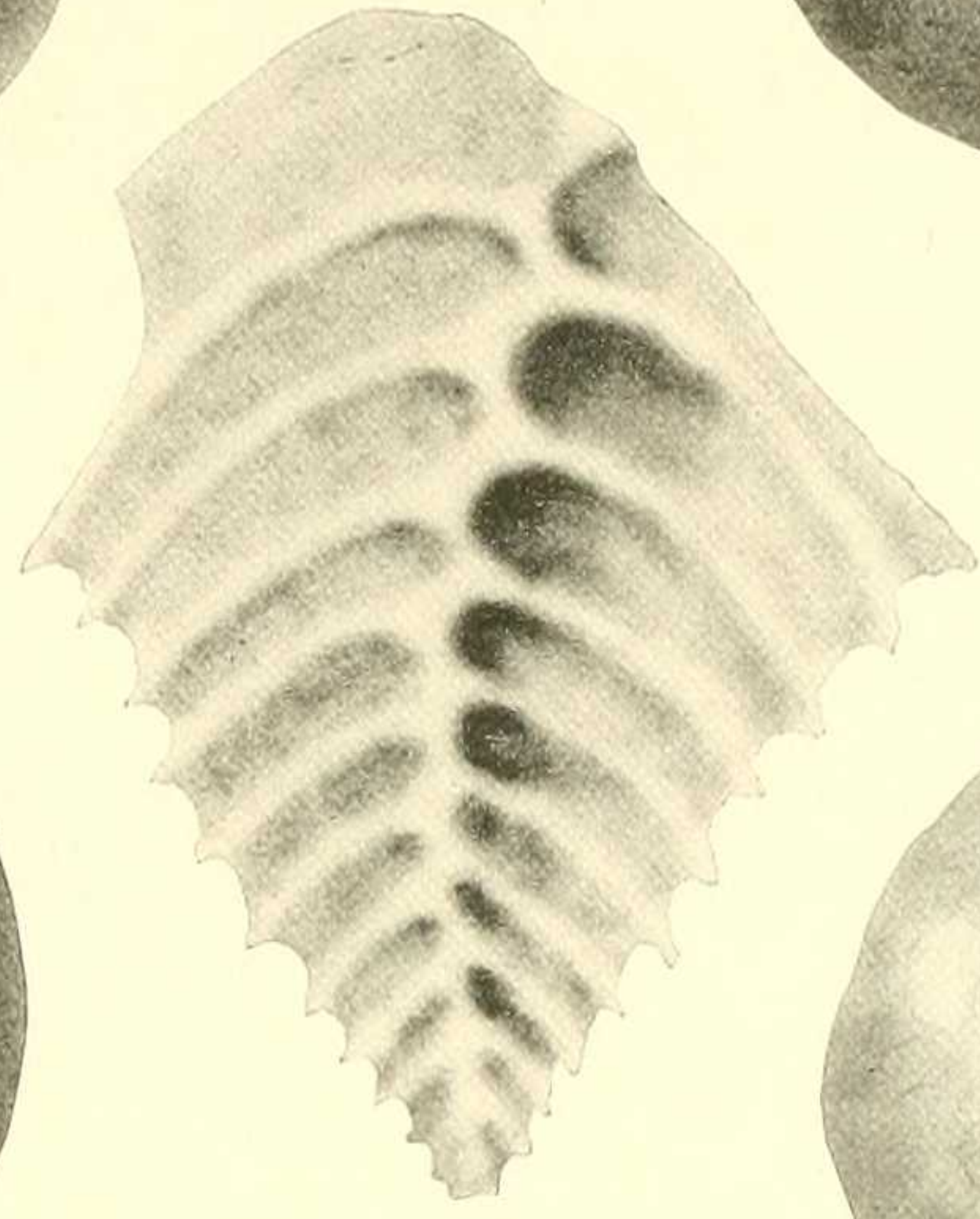
- FIGURE 1. *Textularia agglutinans* D'Orbigny. *a*, Front view; *b*, apertural view. × 30.  
2. *Textularia subhauerii* Cushman, n. sp. *a*, Front view; *b*, apertural view. × 50.  
3. *Textularia folium* Parker and Jones. Front view of a typical specimen. × 100.  
4. *Textularia mississippiensis* Cushman, n. sp. Front view showing the darker secondary covering of the sutures and the periphery. × 80.



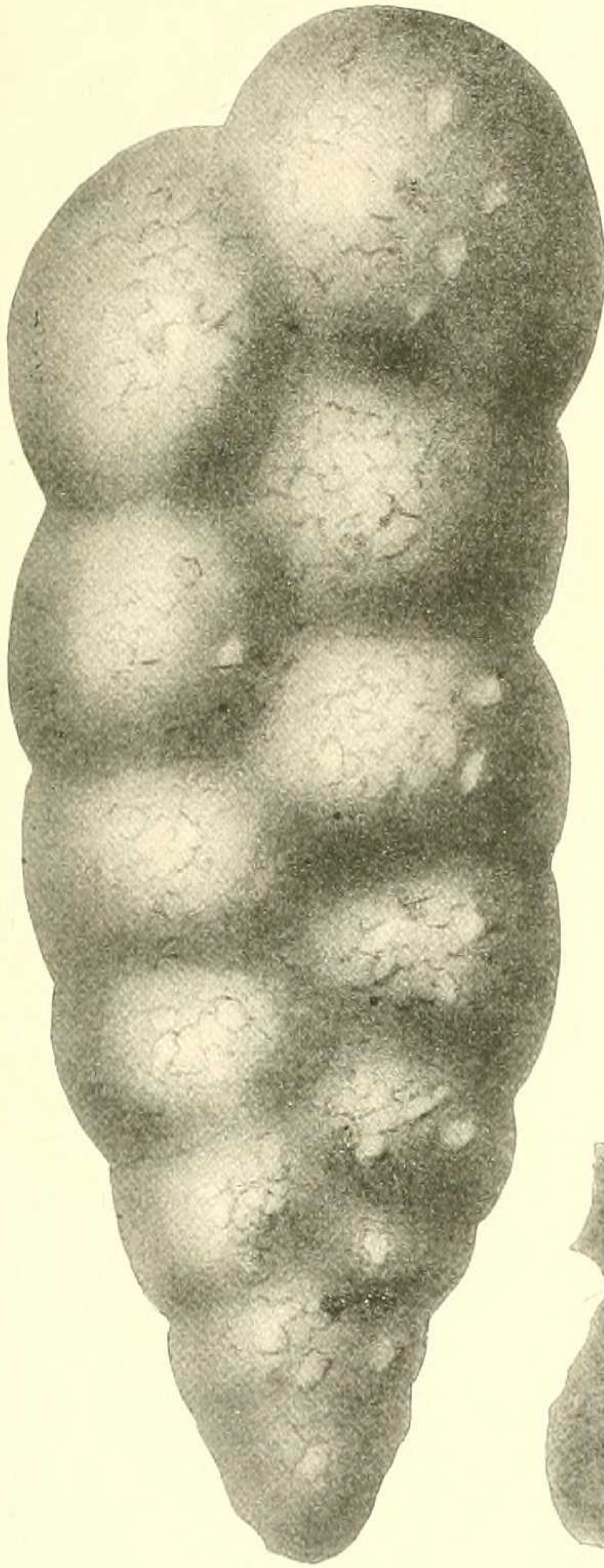
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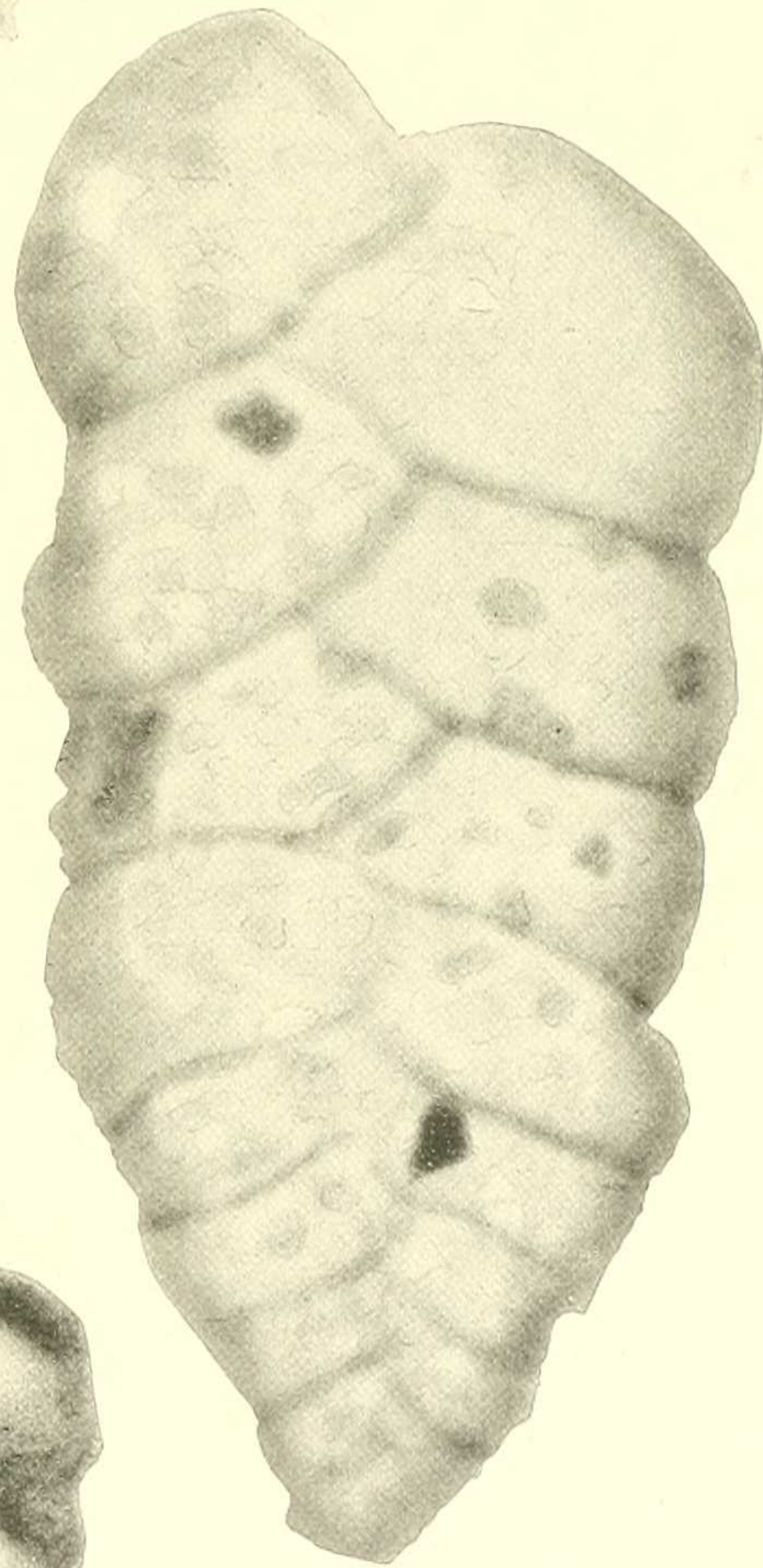
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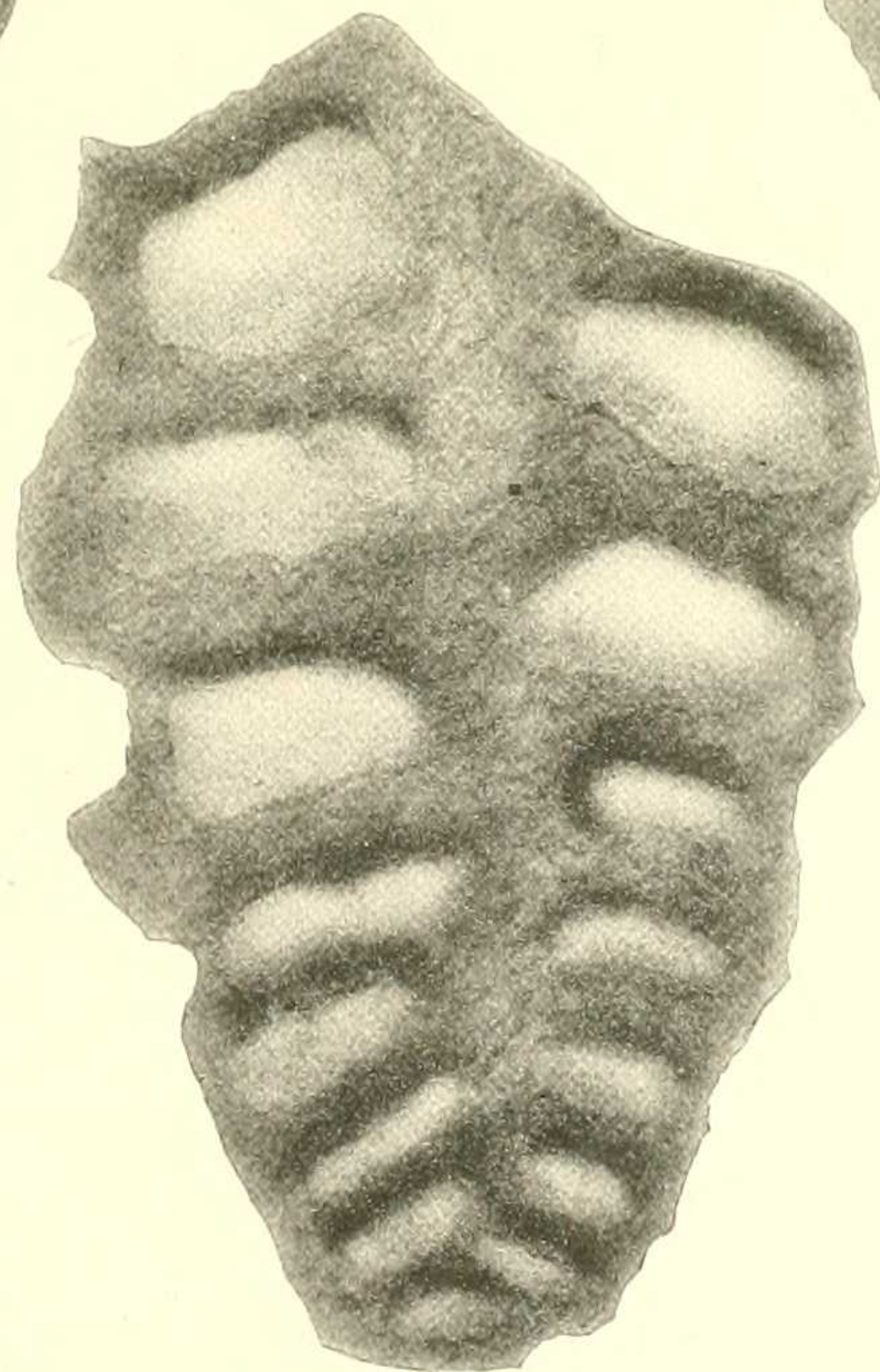
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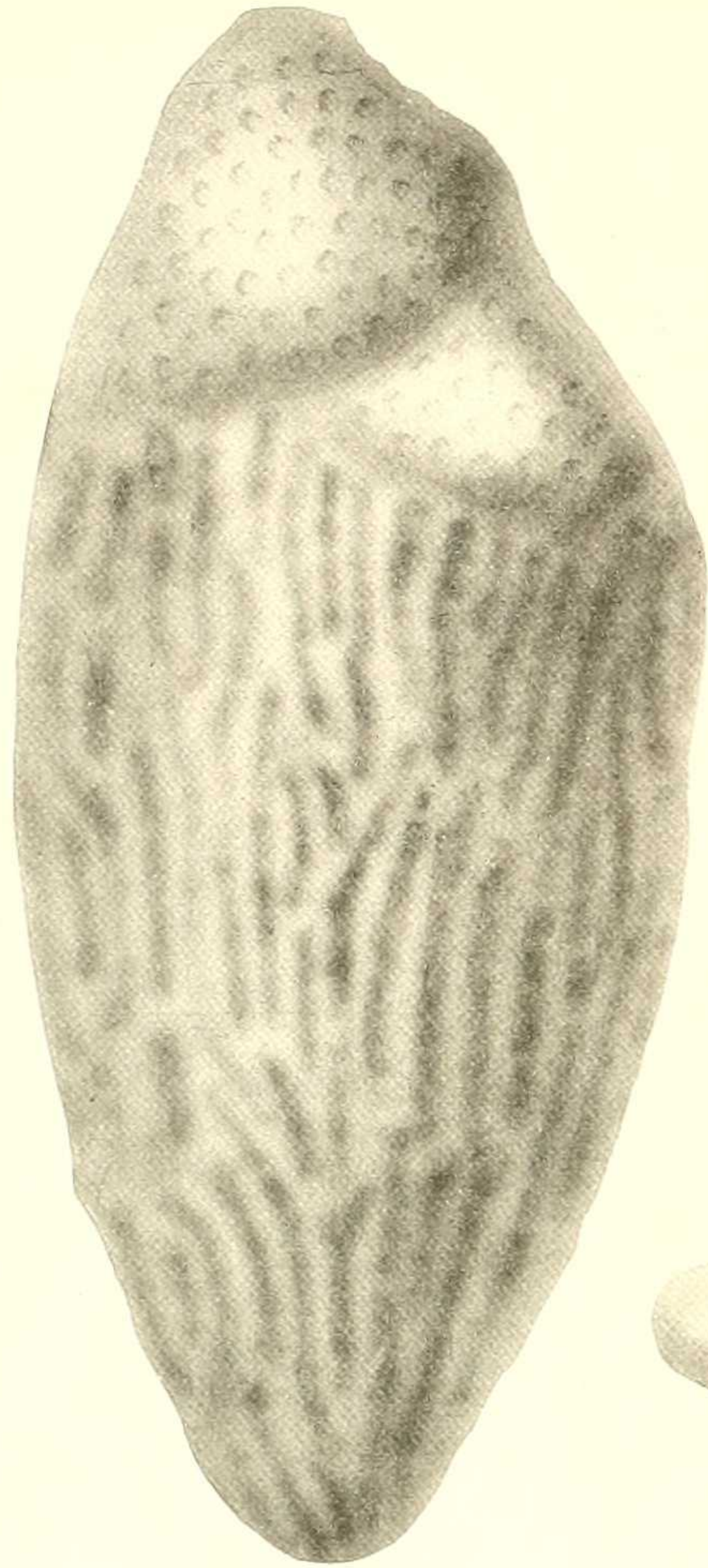


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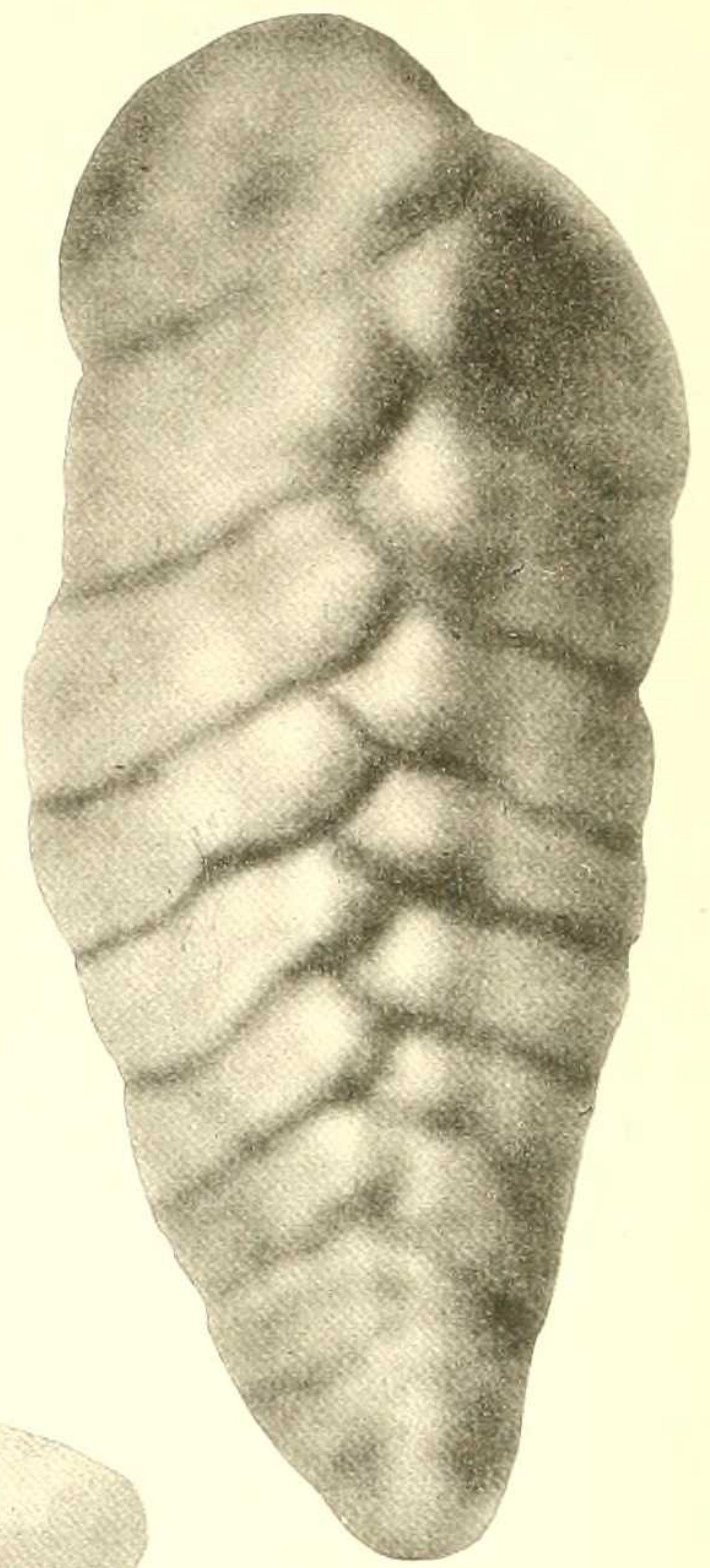
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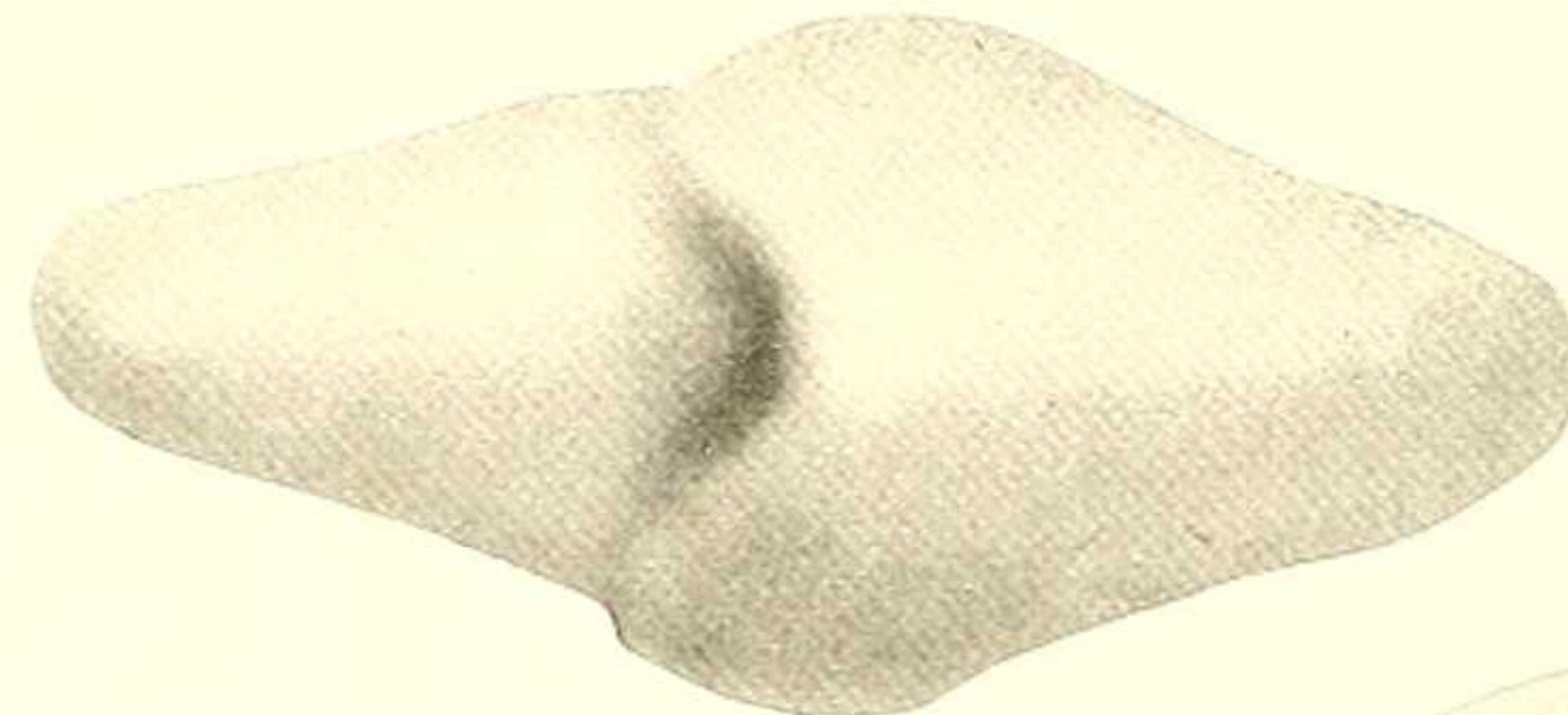
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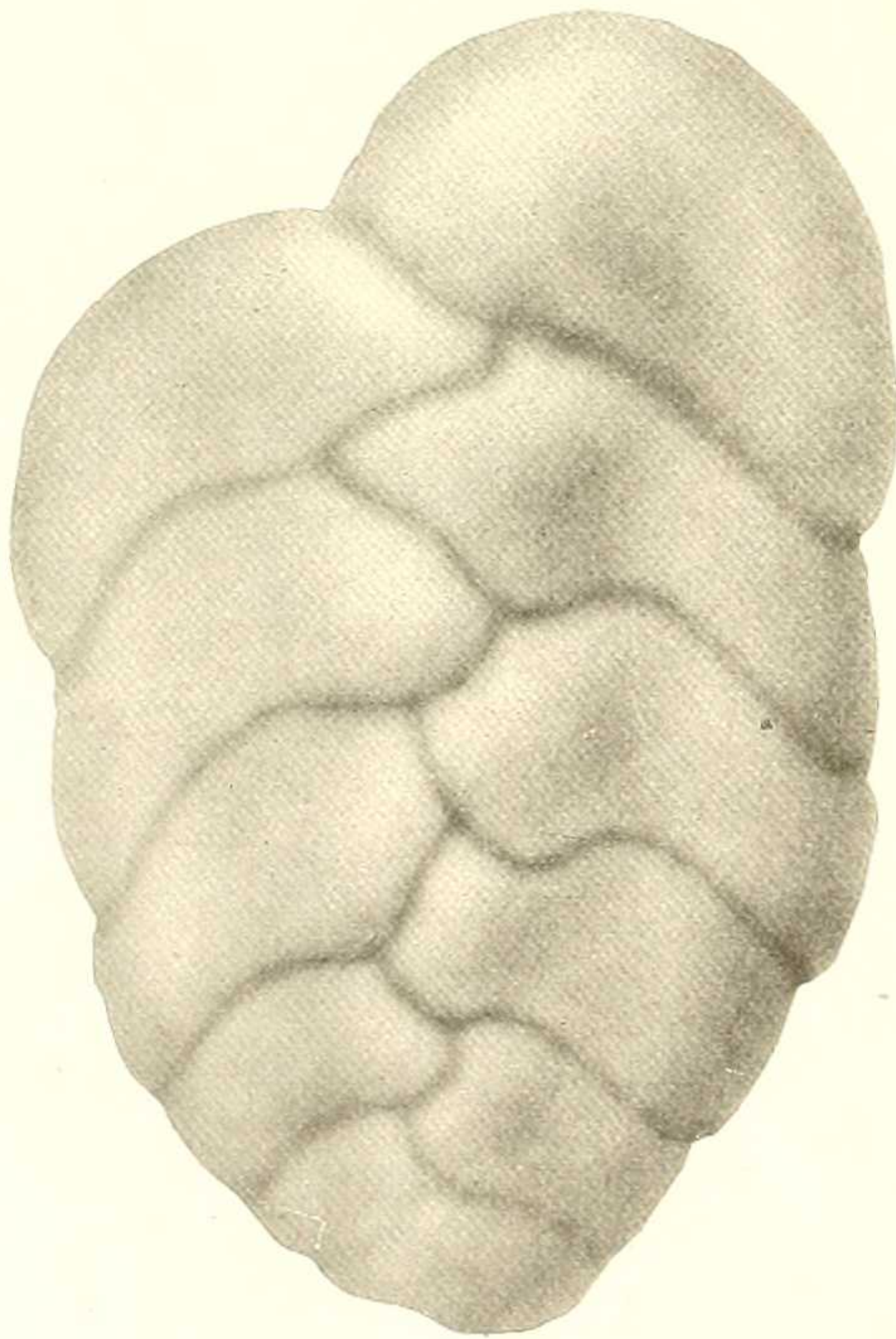
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1



2b



2a



4

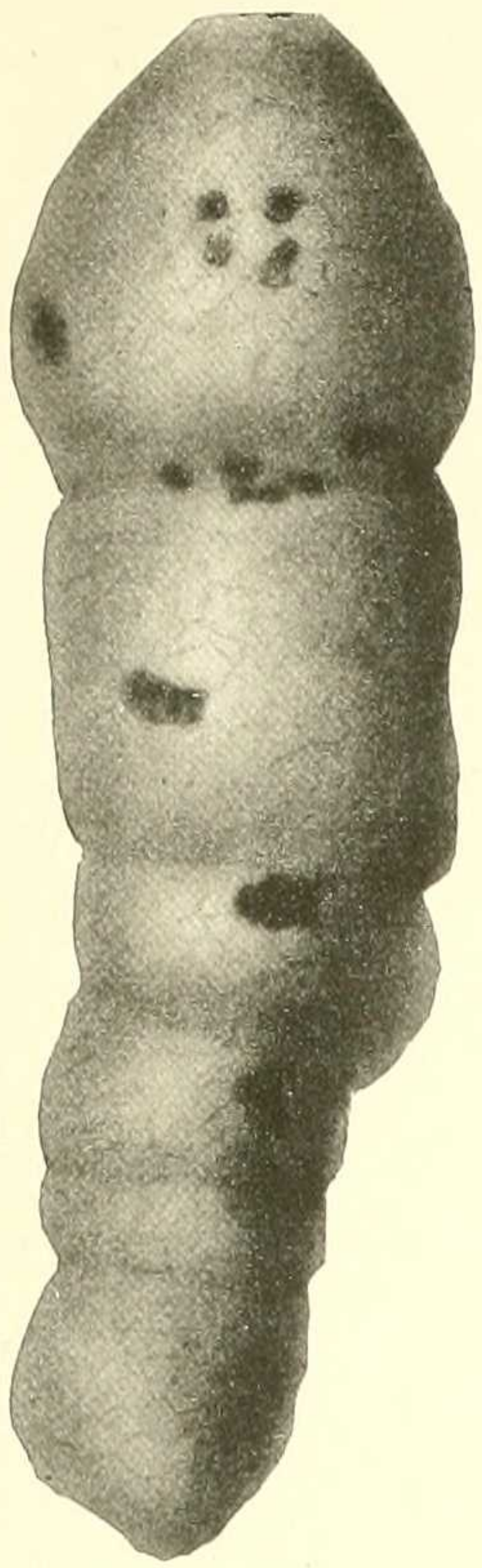
PLATE XV.

- FIGURE 1. *Textularia tumidulum* Cushman, n. sp. Front view of adult showing central tumid area.  $\times 25$ .  
2. *Textularia tumidulum* Cushman, n. sp. *a*, Front view; *b*, apertural view of young specimen.  $\times 40$ .  
3. *Bolivina amygdalaeformis* H. B. Brady. Front view, showing the anastomosing ornamentation of the early portion and the coarsely pitted last chambers.  $\times 120$ .  
4. *Bolivina nitida* H. B. Brady. Front view.  $\times 120$ .  
5. *Bolivina mississippiensis* Cushman, n. sp. Front view.  $\times 160$ .

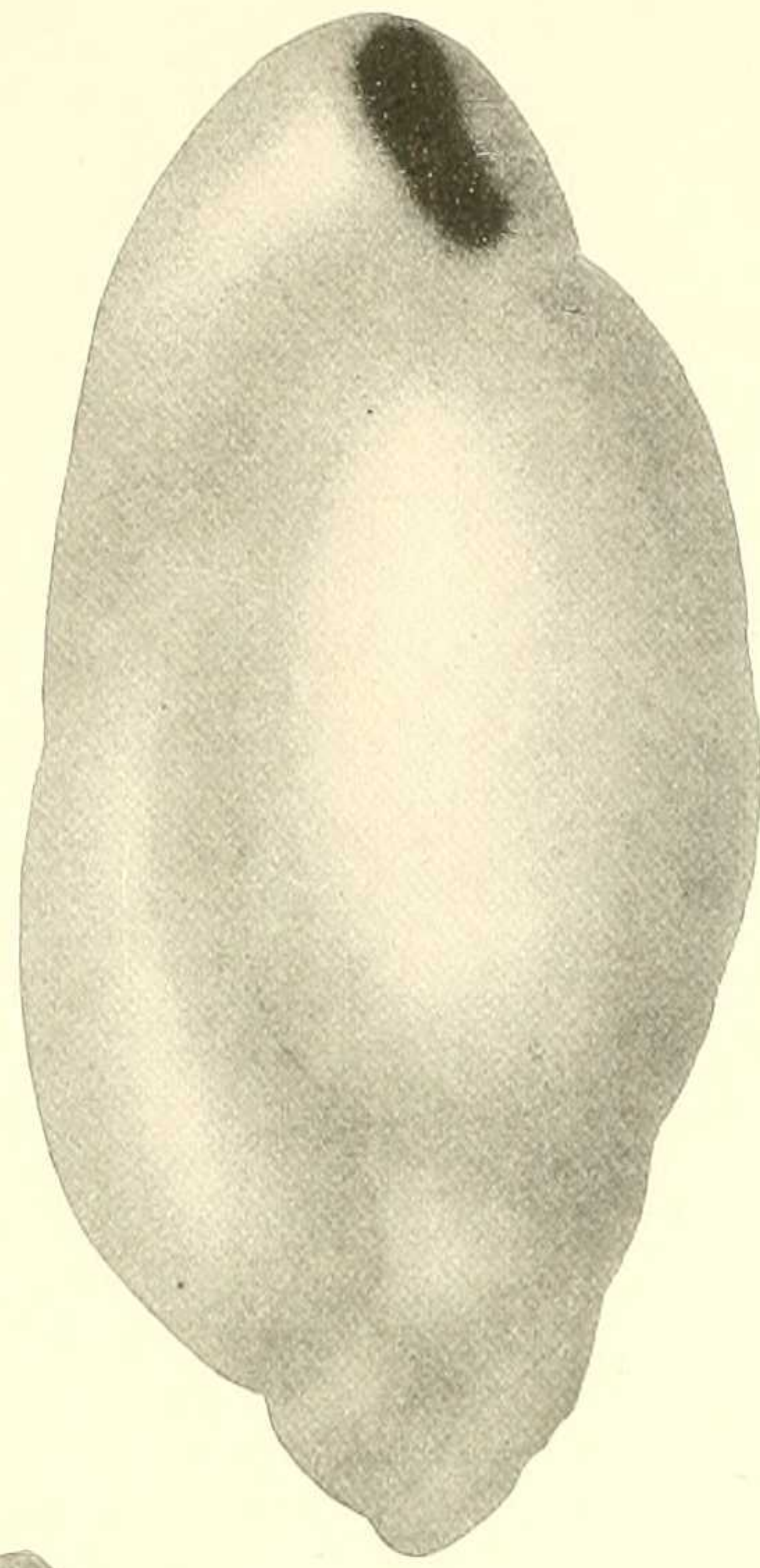


## PLATE XVI.

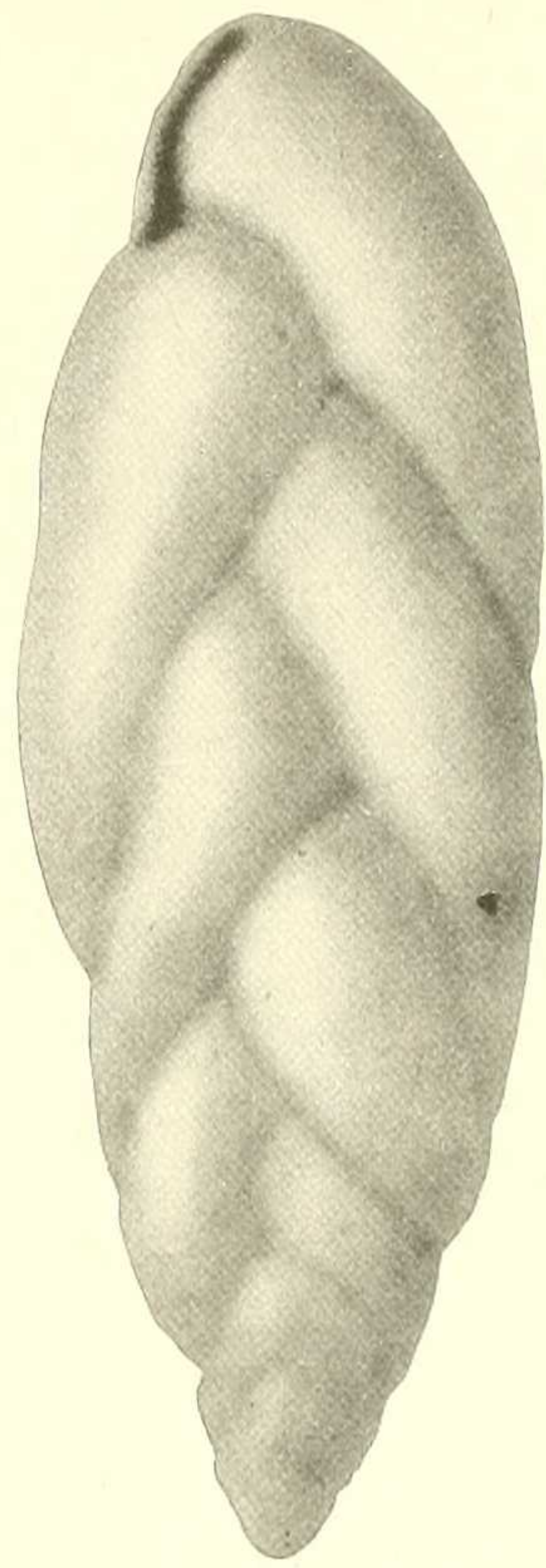
- FIGURE 1. *Clavulina byramensis* Cushman, n. sp. Front view.  $\times 30$ .  
2. *Virgulina* sp.? *a*, Side view; *b*, front view.  $\times 120$ .  
3. *Virgulina* sp.? Front view of another specimen.  $\times 120$ .  
4. *Bulimina ovata* D'Orbigny? Front view.  $\times 120$ .  
5. *Nodosaria* sp. Incomplete specimen, with but four chambers, showing form and sculpture.  $\times 60$ .  
6. *Nodosaria* sp. Middle portion of an incomplete specimen with a different surface ornamentation from the preceding.  $\times 100$ .  
7. *Nodosaria?* sp.? Broken specimen of a *Nodosaria* or possibly the linear portion of an *Articulina*.



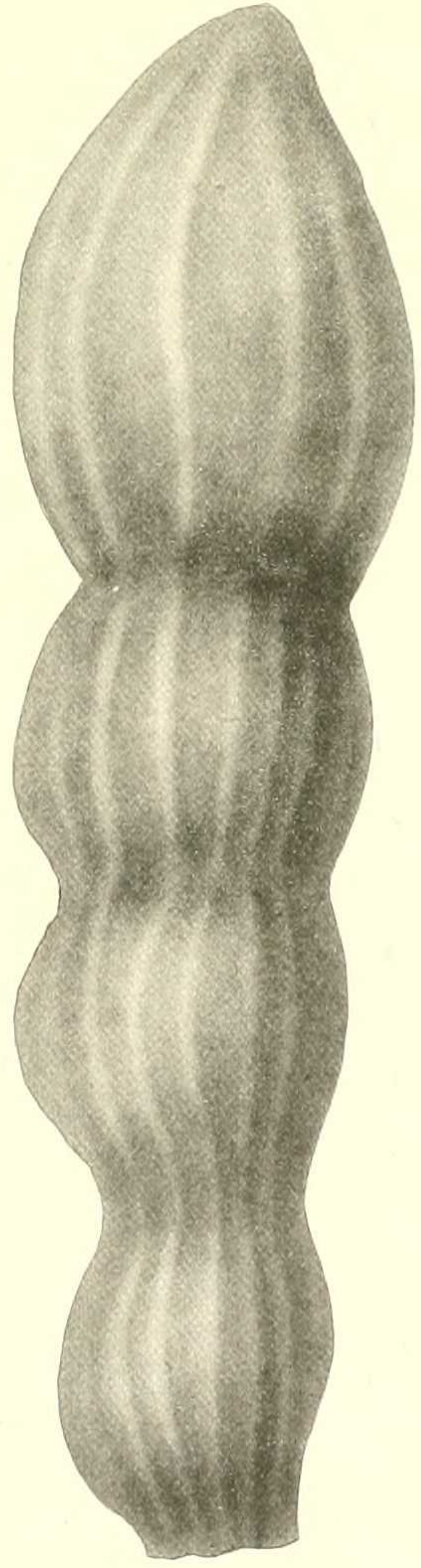
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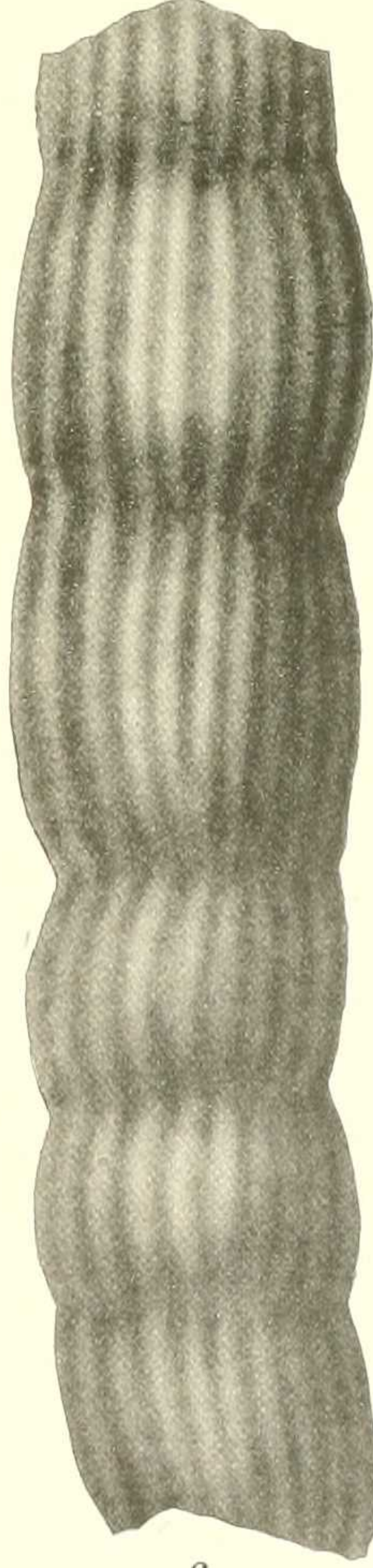
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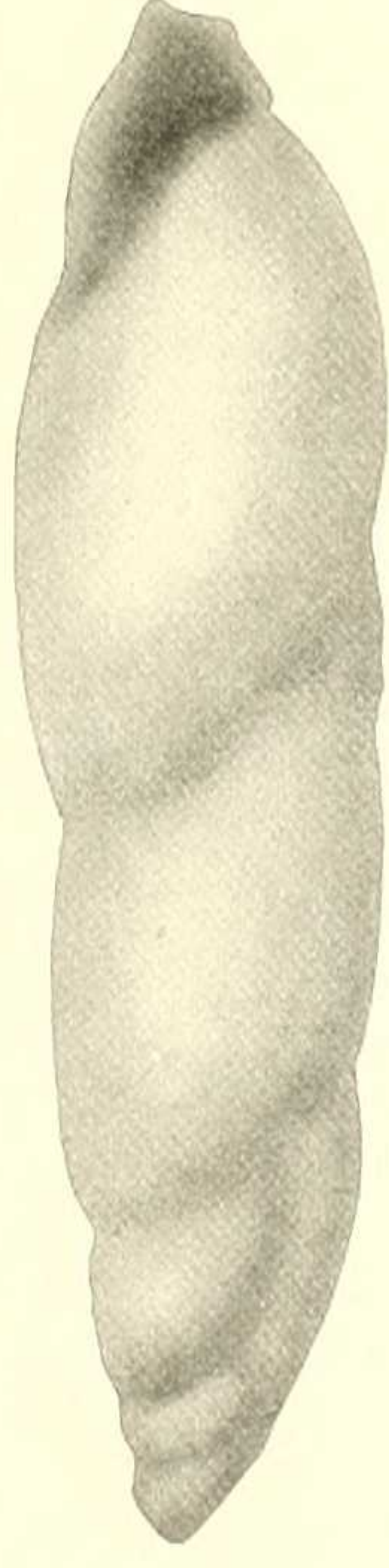
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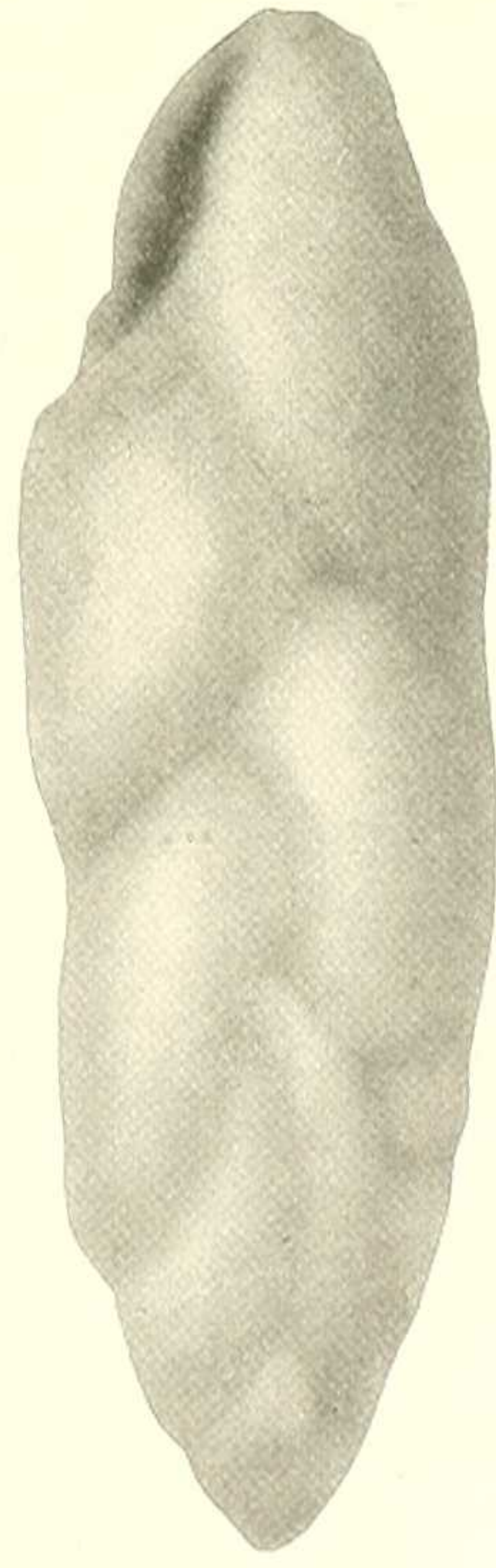
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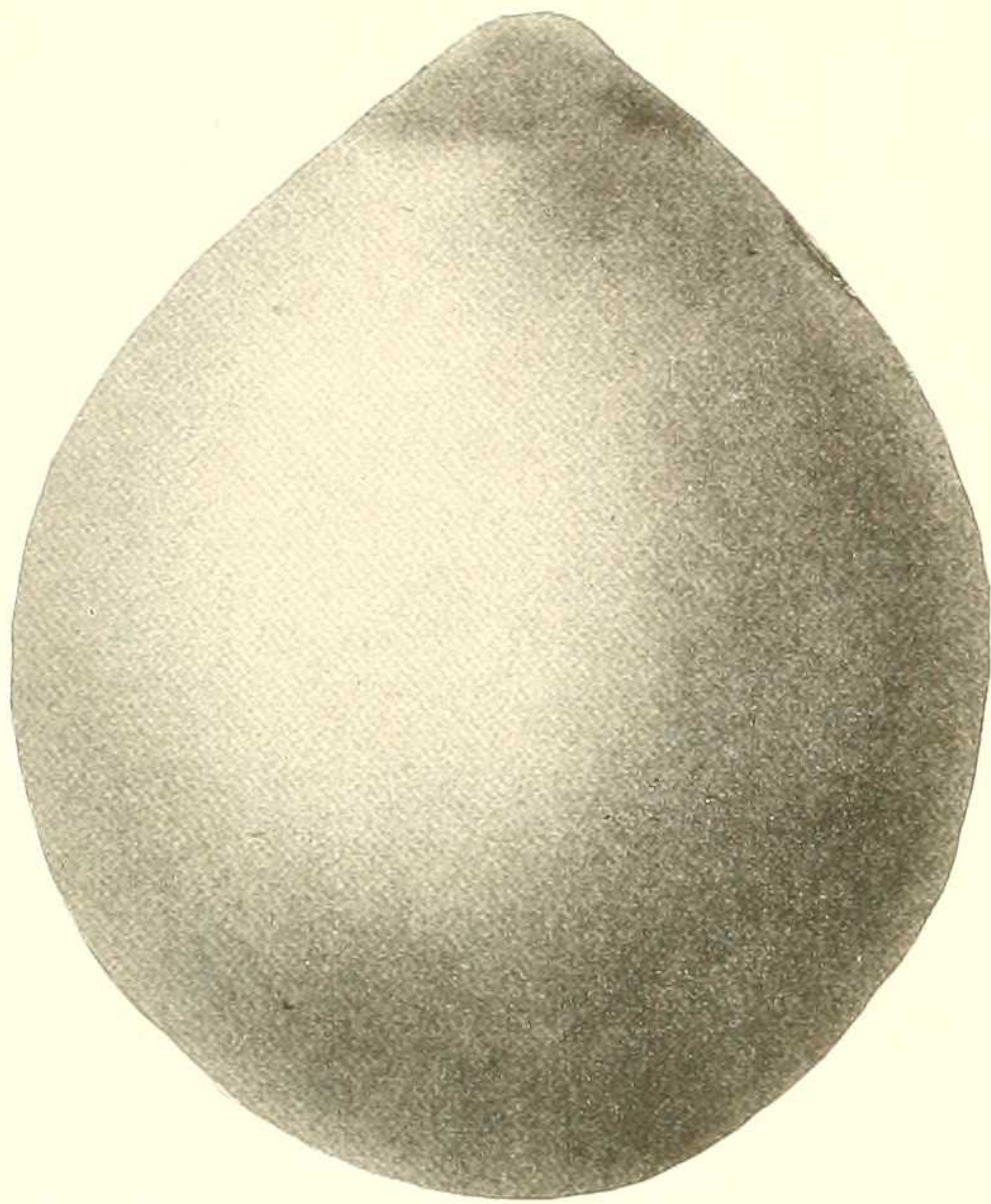
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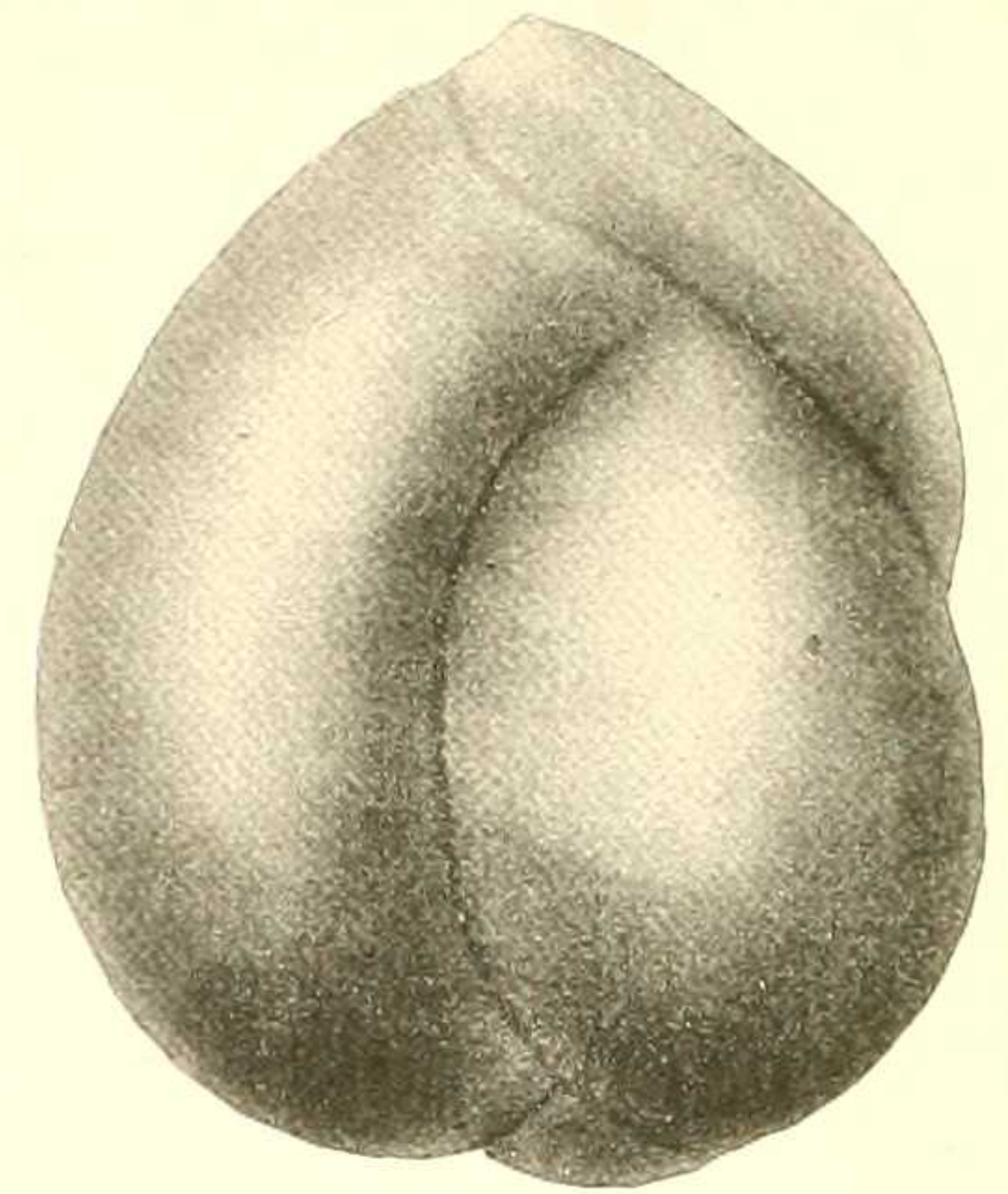
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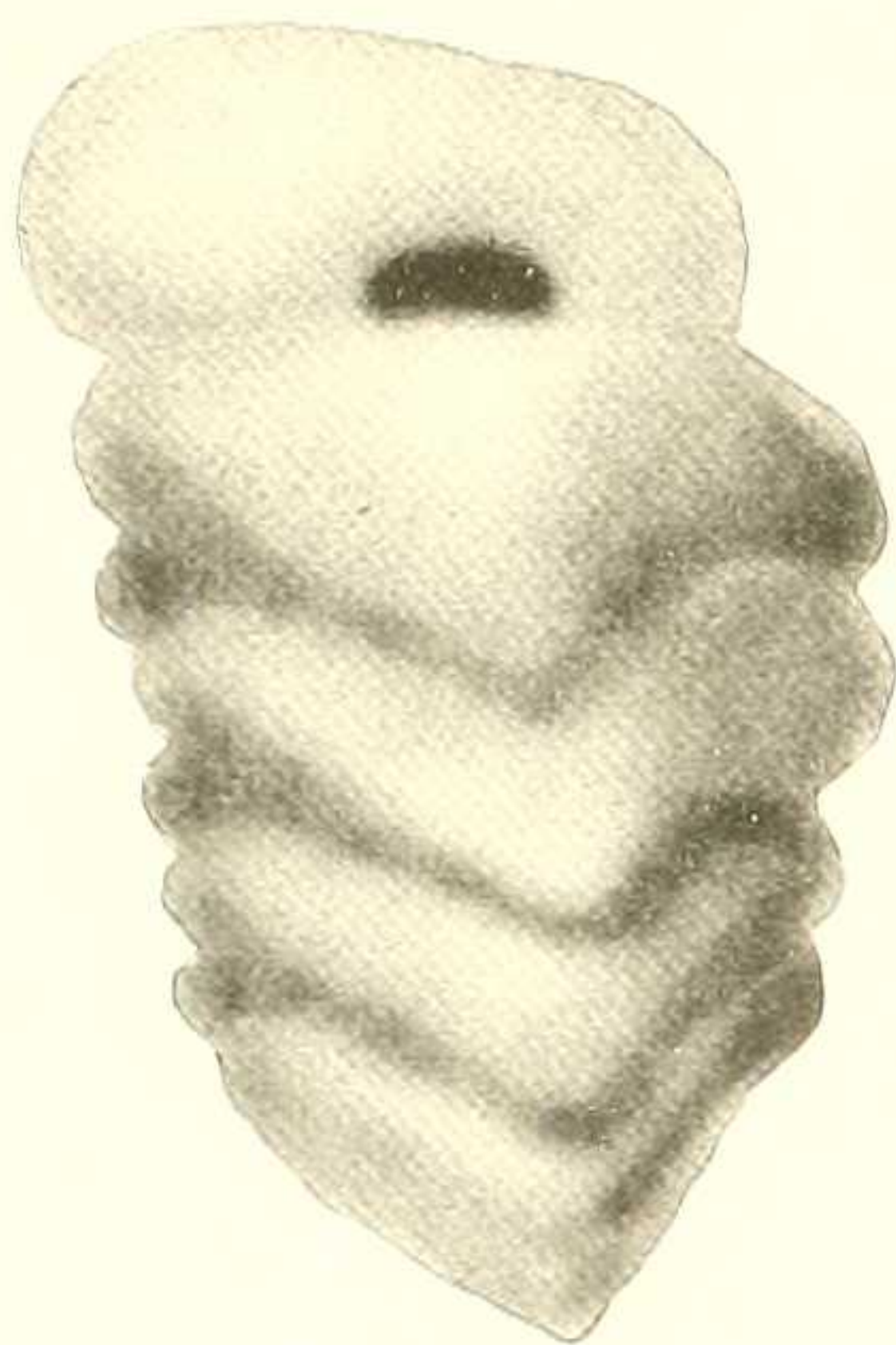
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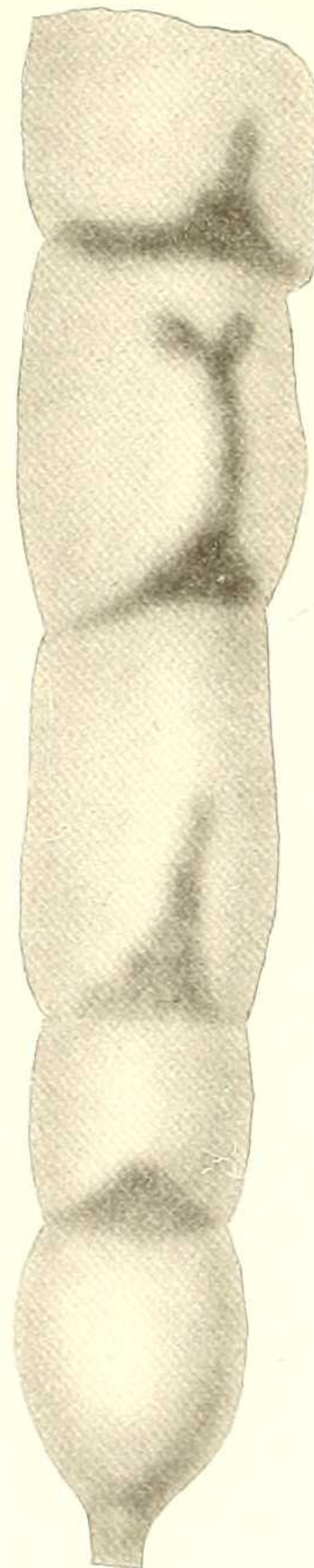
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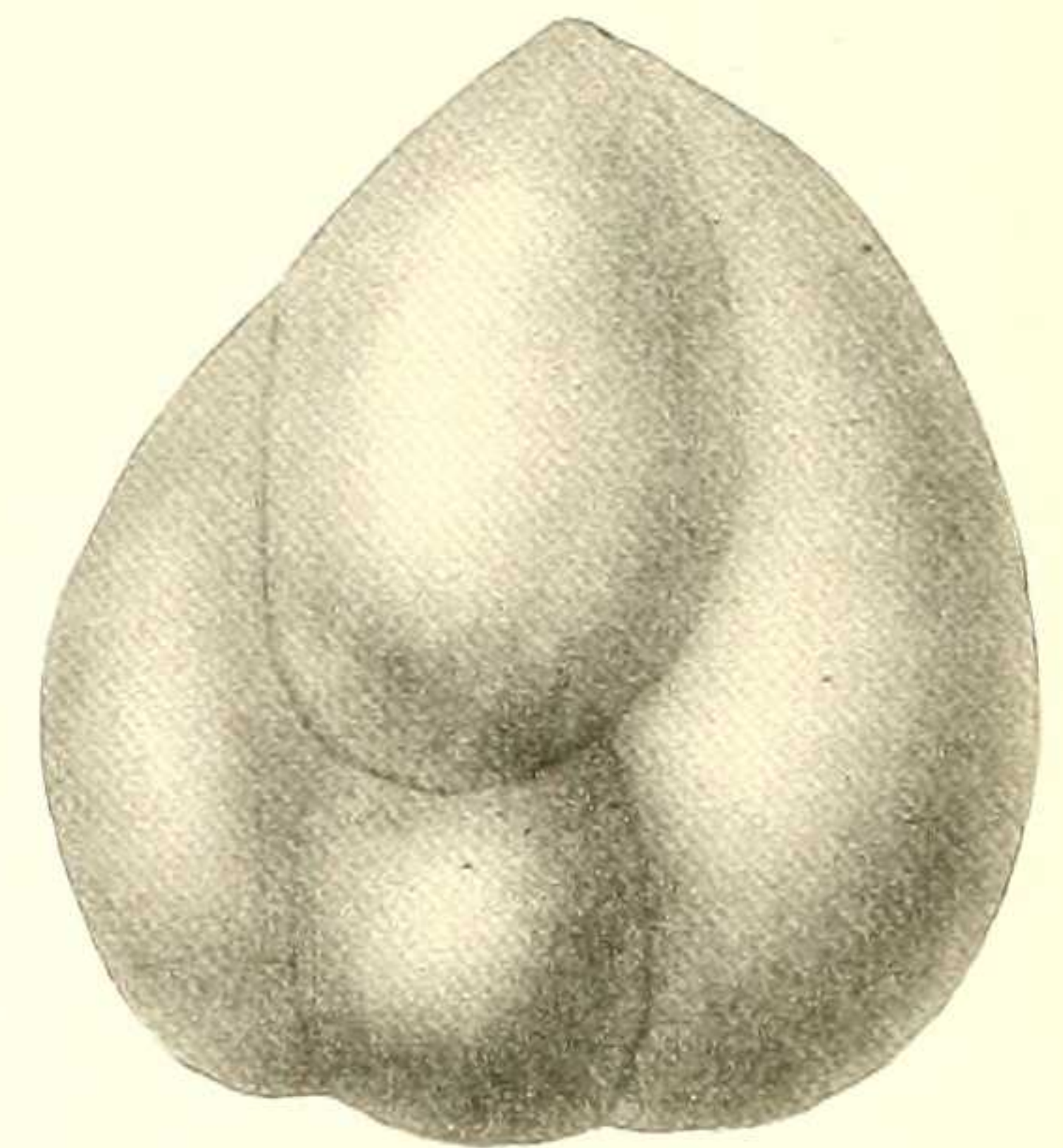
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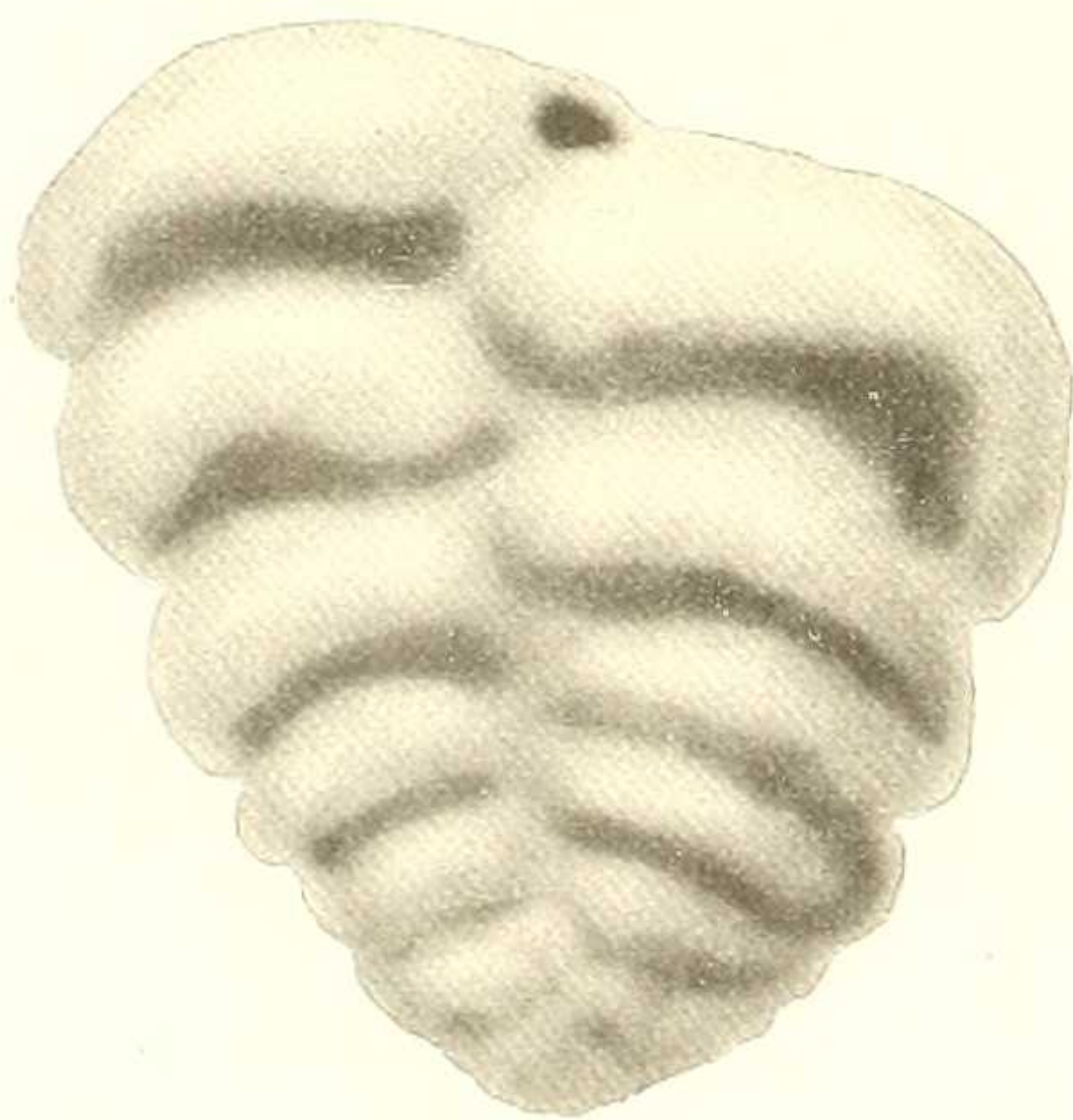
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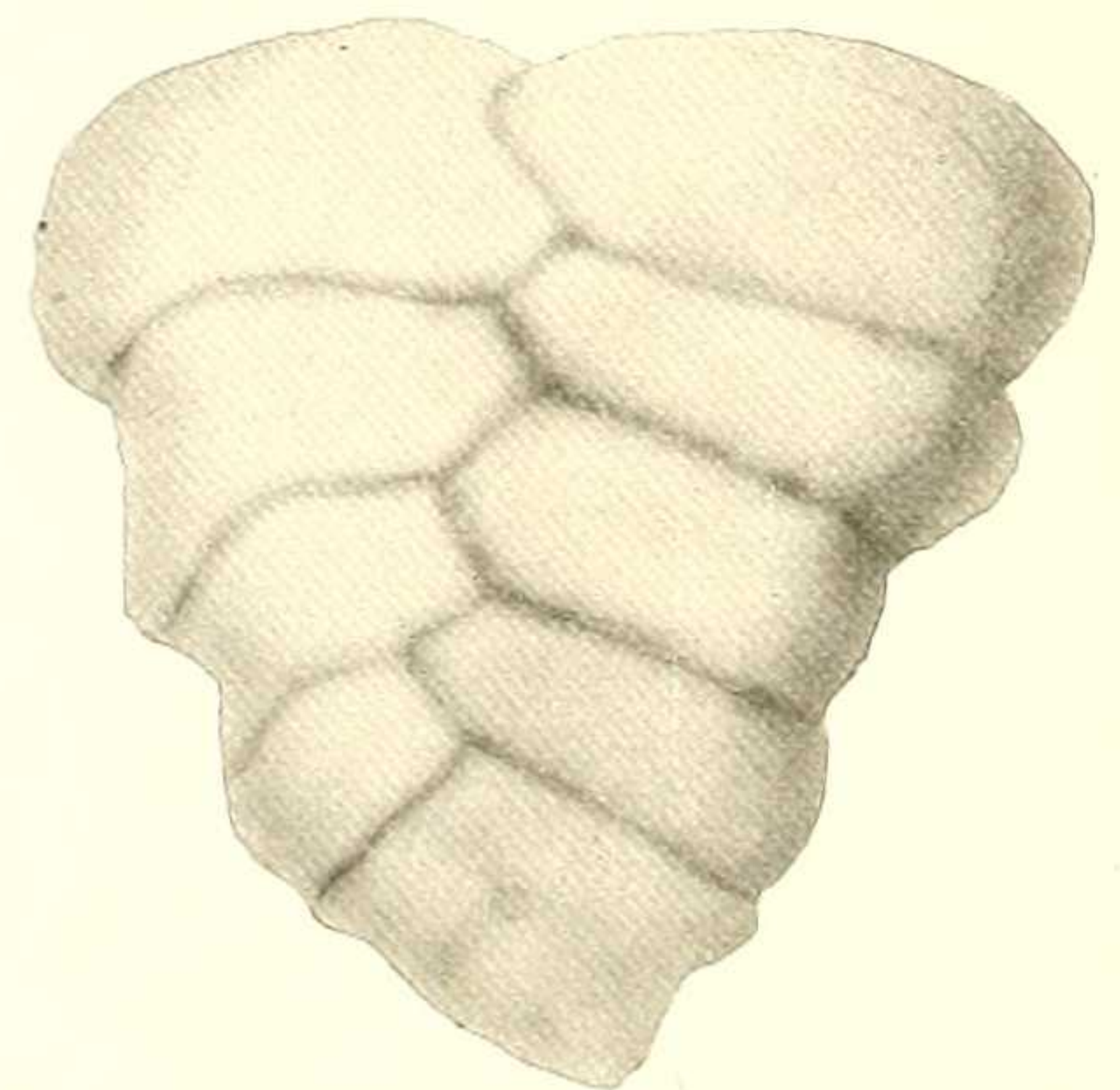
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2b



4a



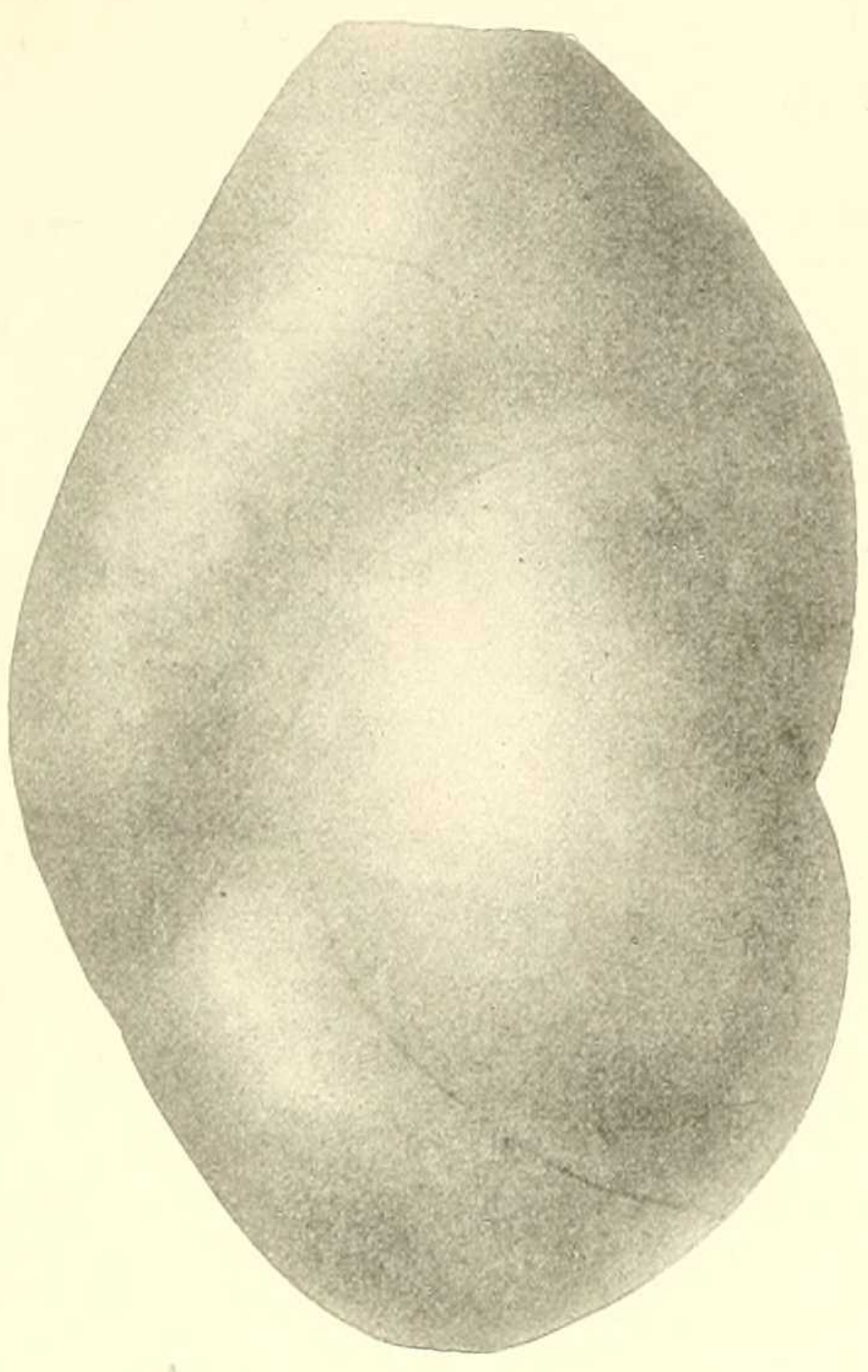
4b

PLATE XVII.

- FIGURE 1. *Vaginulina legumen* (Linnaeus) D'Orbigny var. *elegans* (D'Orbigny) Fornasini? Basal five chambers of an incomplete specimen. × 100.
2. *Polymorphina byramensis* Cushman, n. sp. *a*, View of one side; *b*, opposite side. × 60.
3. *Polymorphina gibba* D'Orbigny. Young specimen. × 120.
4. *Ehrenbergina glabrata* Cushman, n. sp. *a*, Ventral view; *b*, dorsal view; *c*, side view. × 120.

PLATE XVIII.

- FIGURE 1. *Polymorphina problema* D'Orbigny? Front view.  $\times 60$ .  
2. *Polymorphina amygdaloides* Reuss. *a*, Front view; *b*, side view.  $\times 80$ .  
3. *Polymorphina gibba* D'Orbigny, fistulose form. *a*, Front view; *b*, opposite side.  $\times 60$ .  
4. *Polymorphina regina* H. B. Brady, Parker and Jones. Front view.  $\times 40$ .  
5. *Urigerina byramensis* Cushman, n. sp. Front view of a specimen without fully developed last chambers.  
 $\times 120$ .



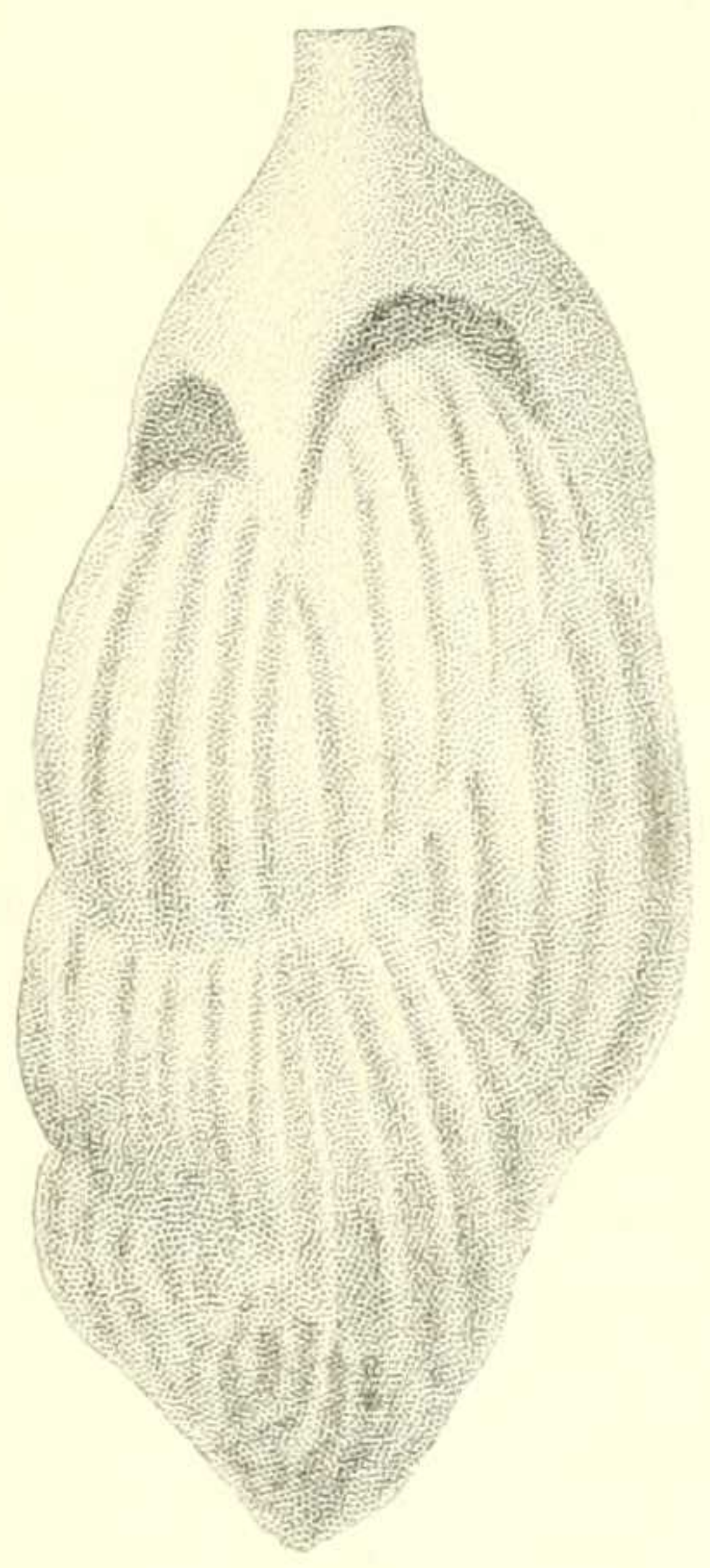
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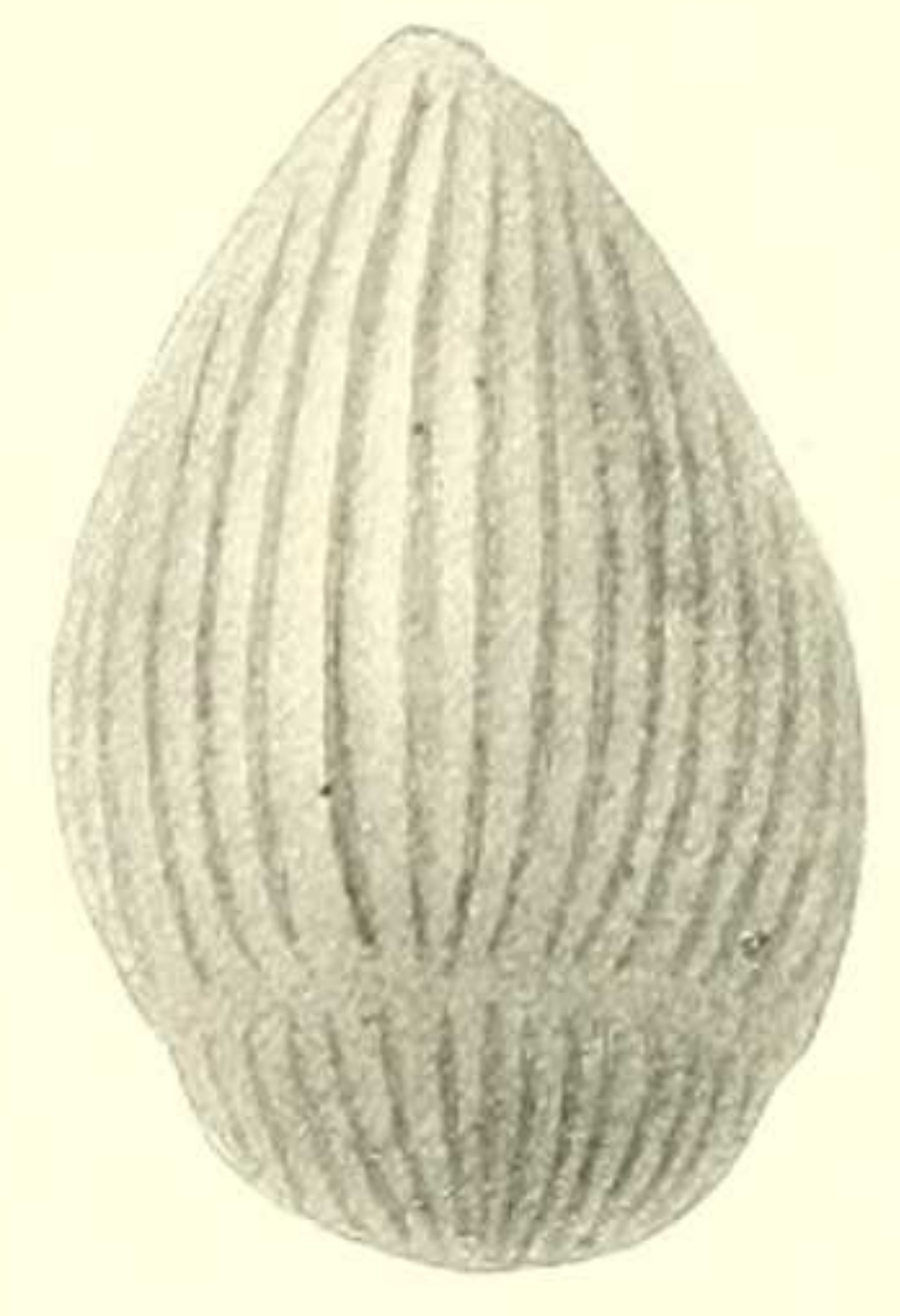
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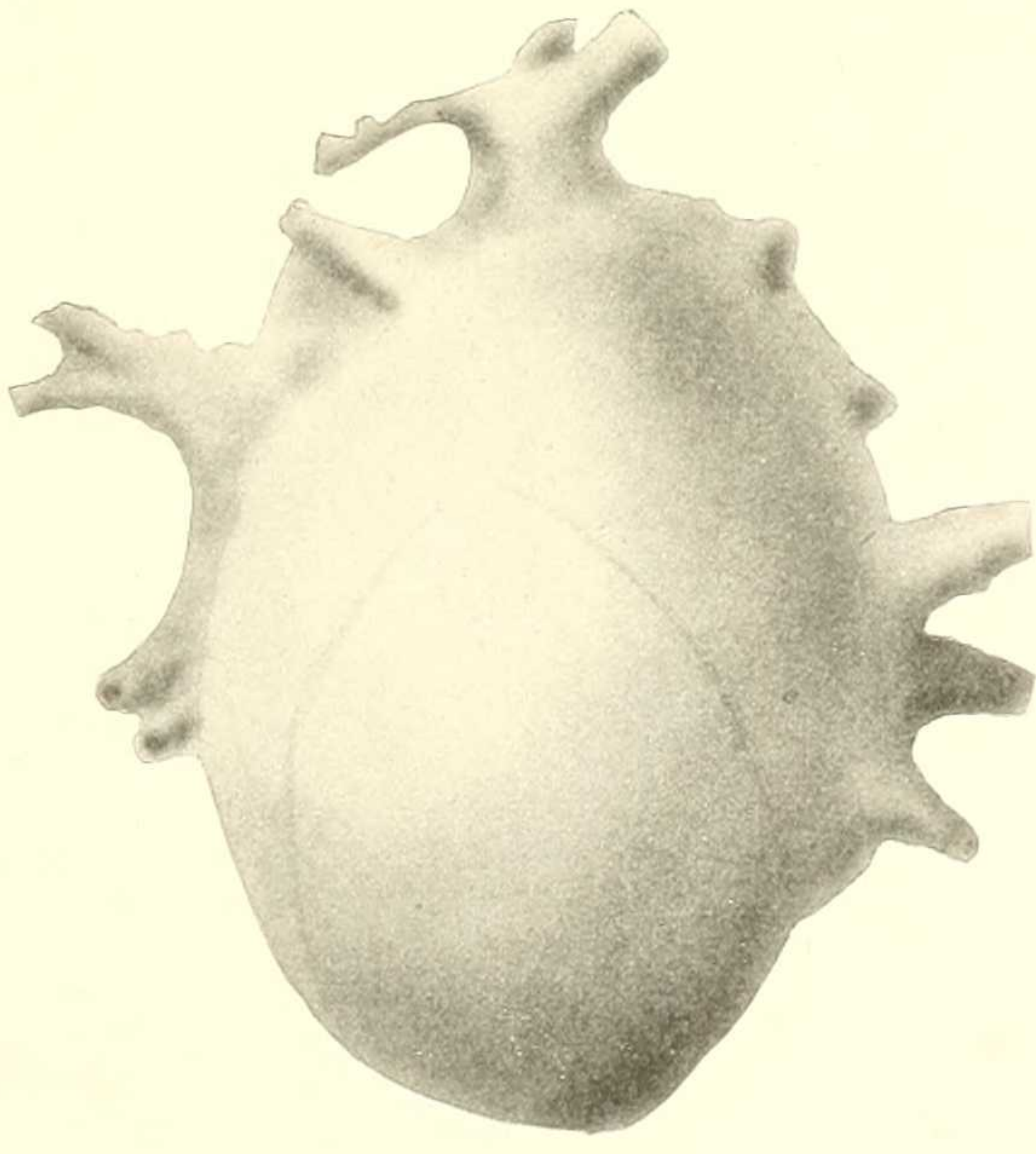
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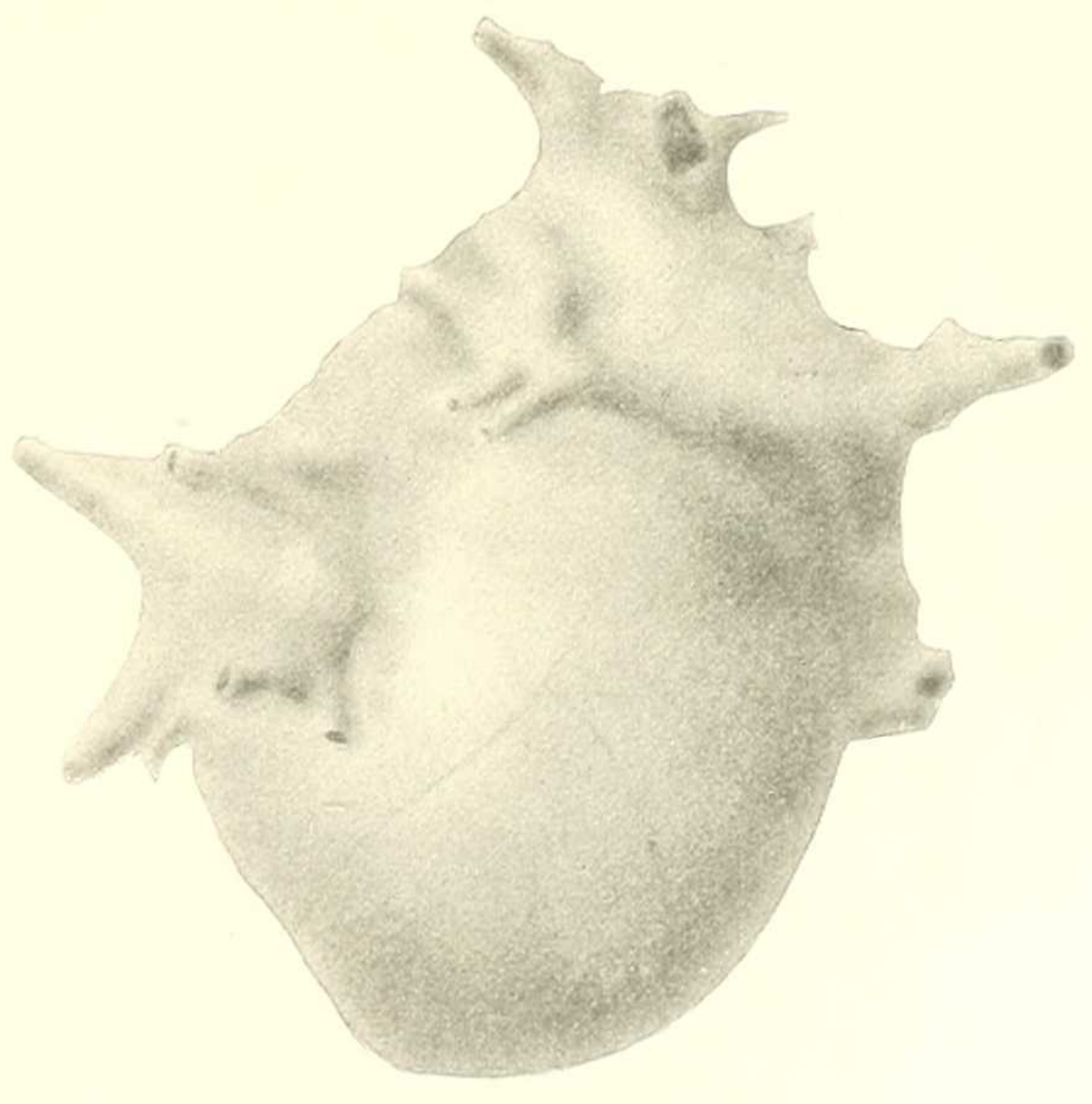
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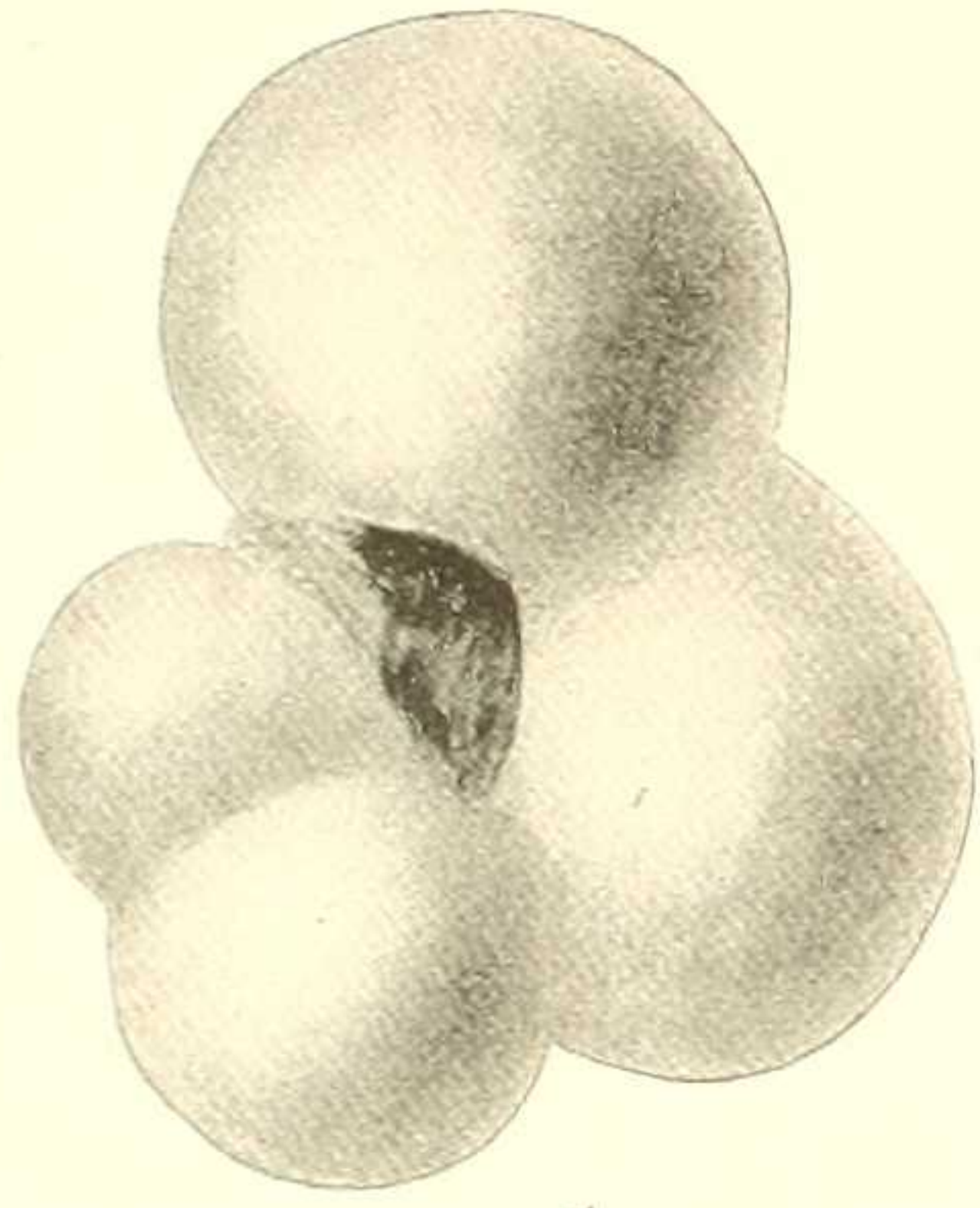
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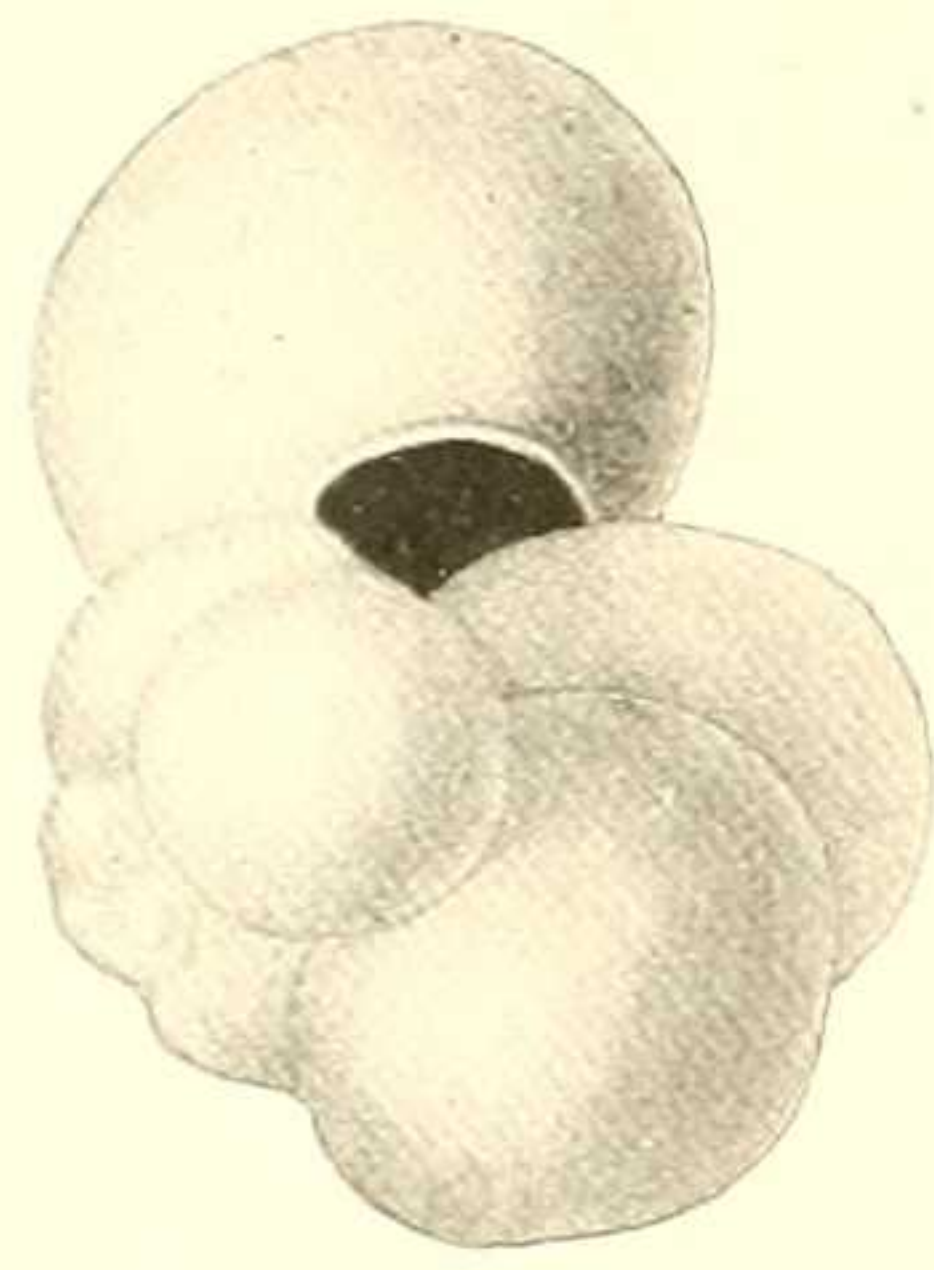
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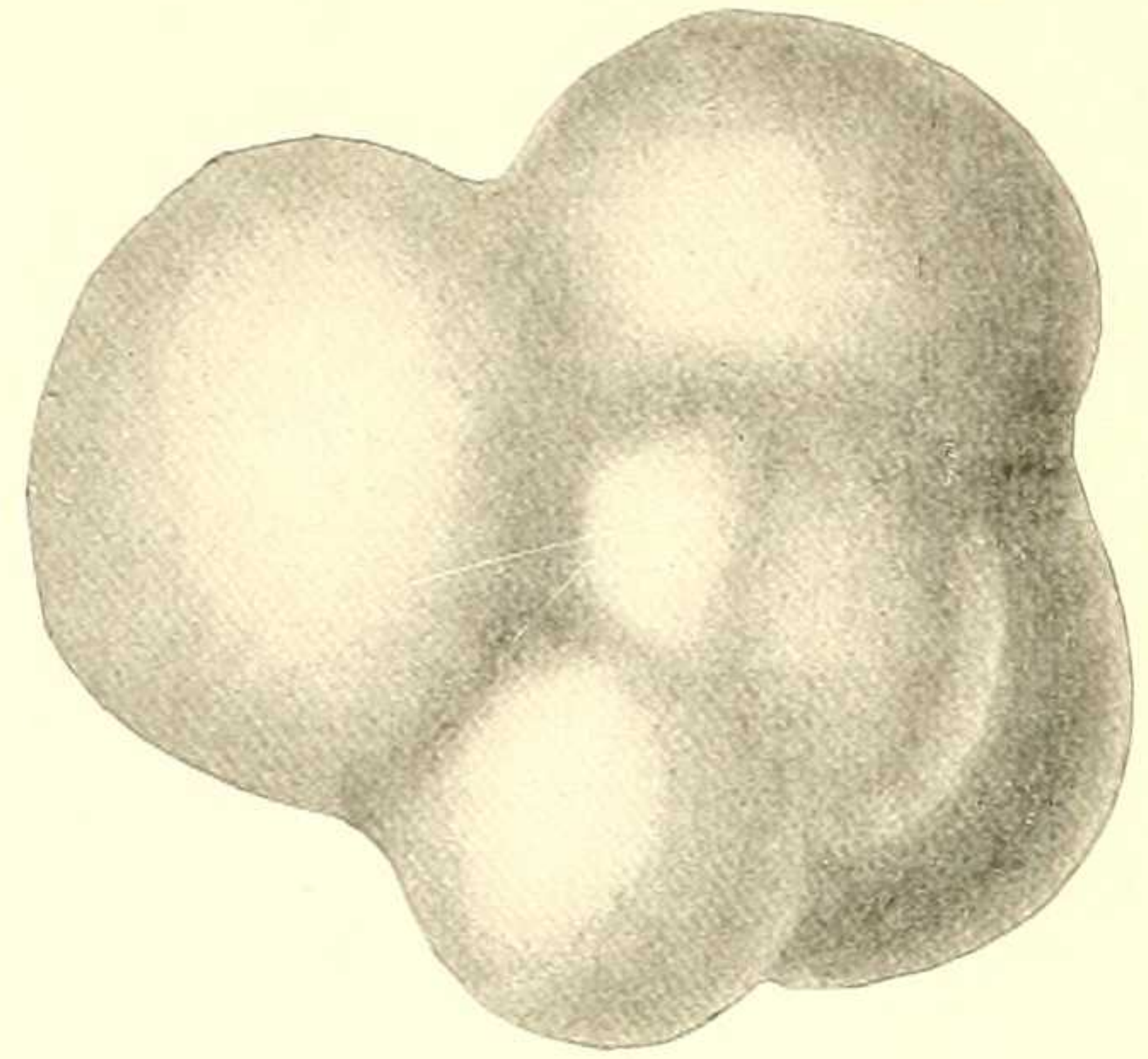
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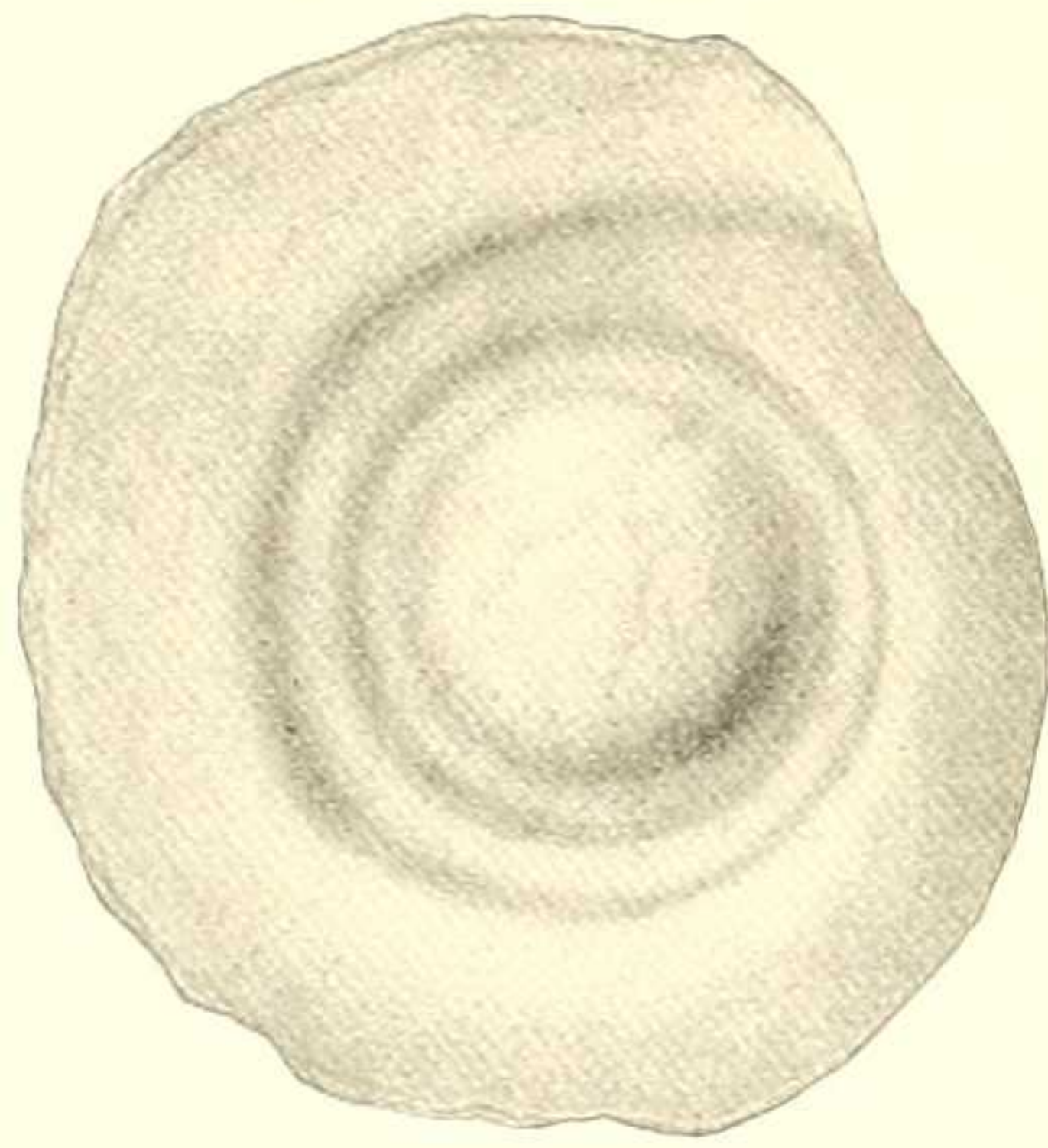
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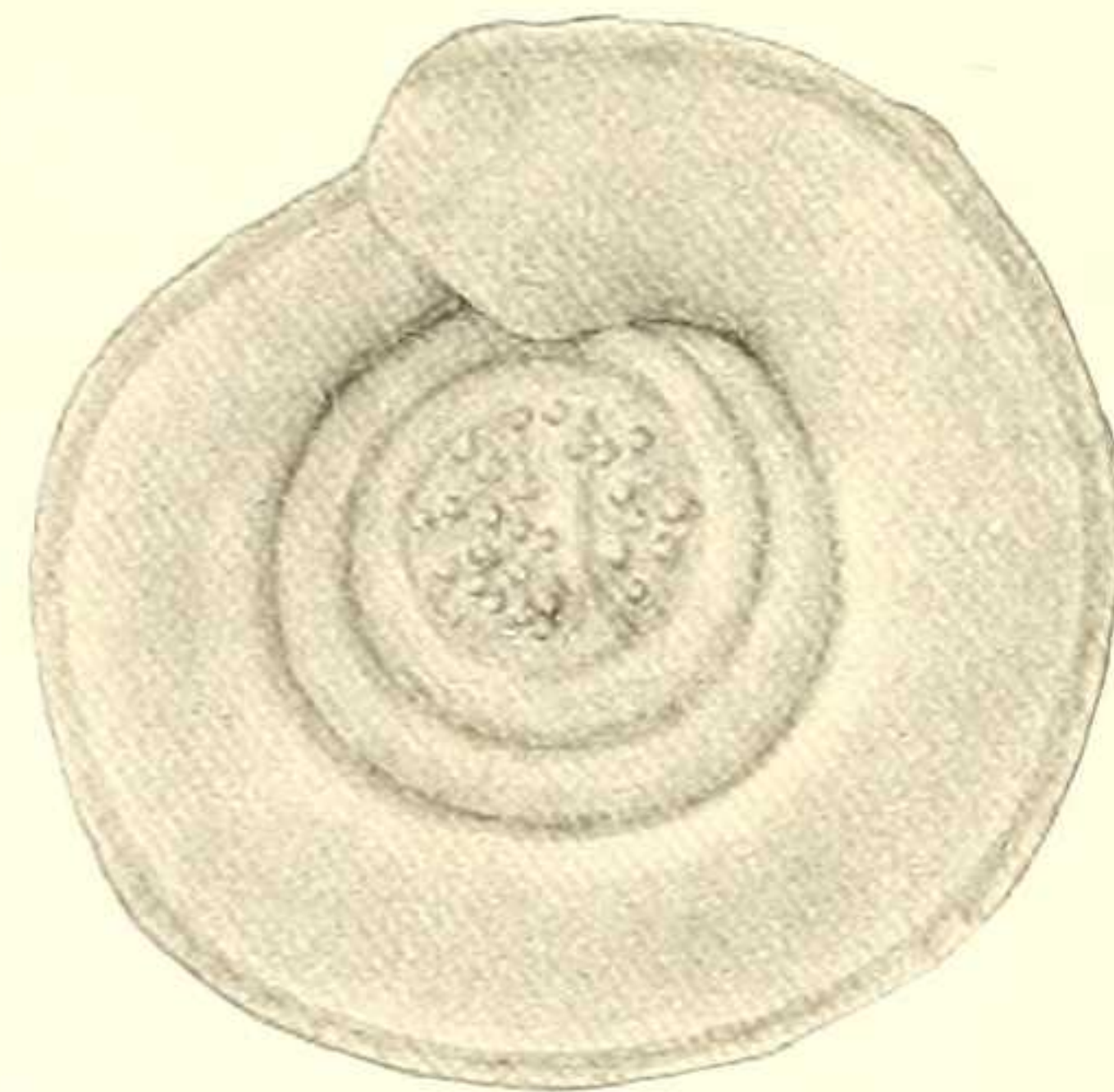
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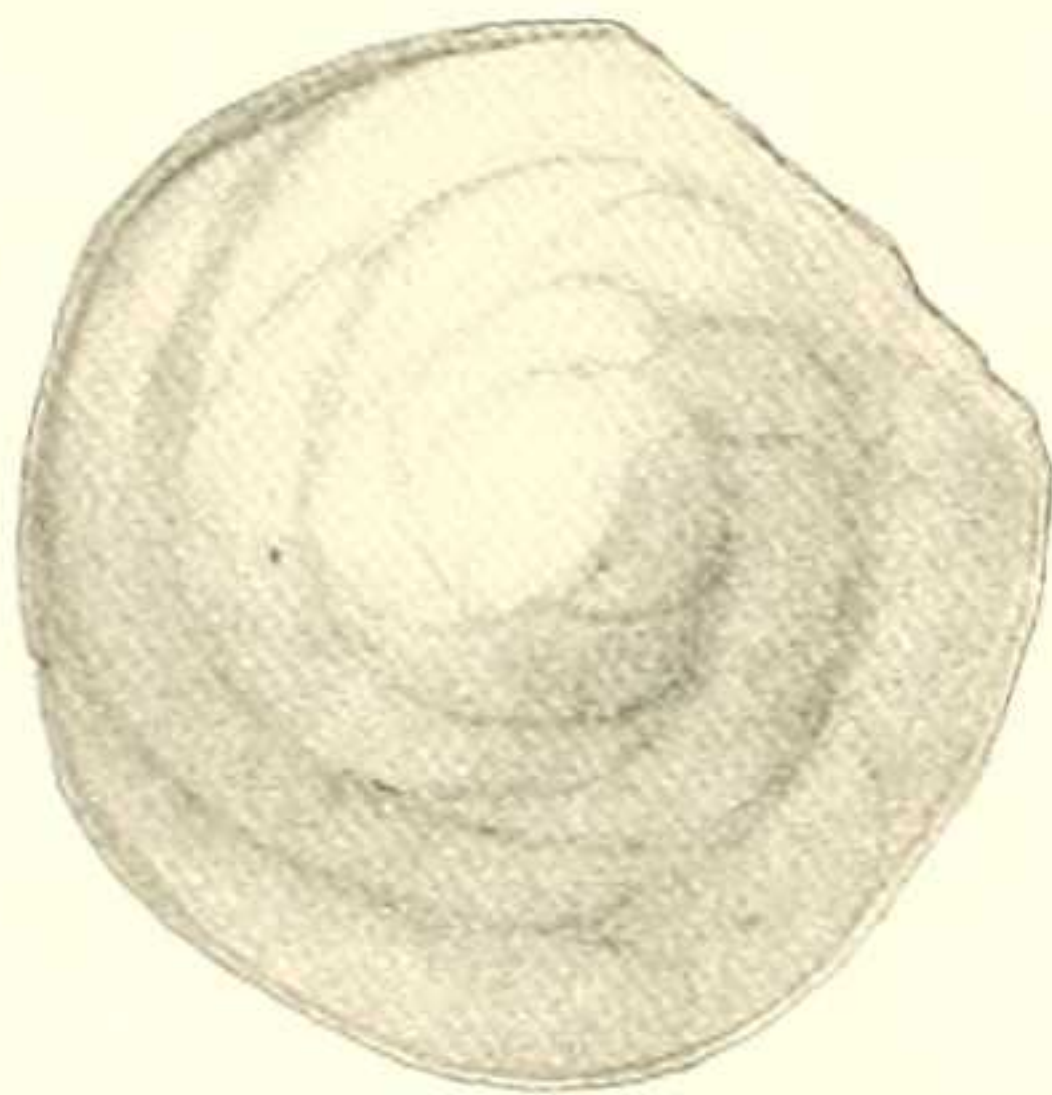
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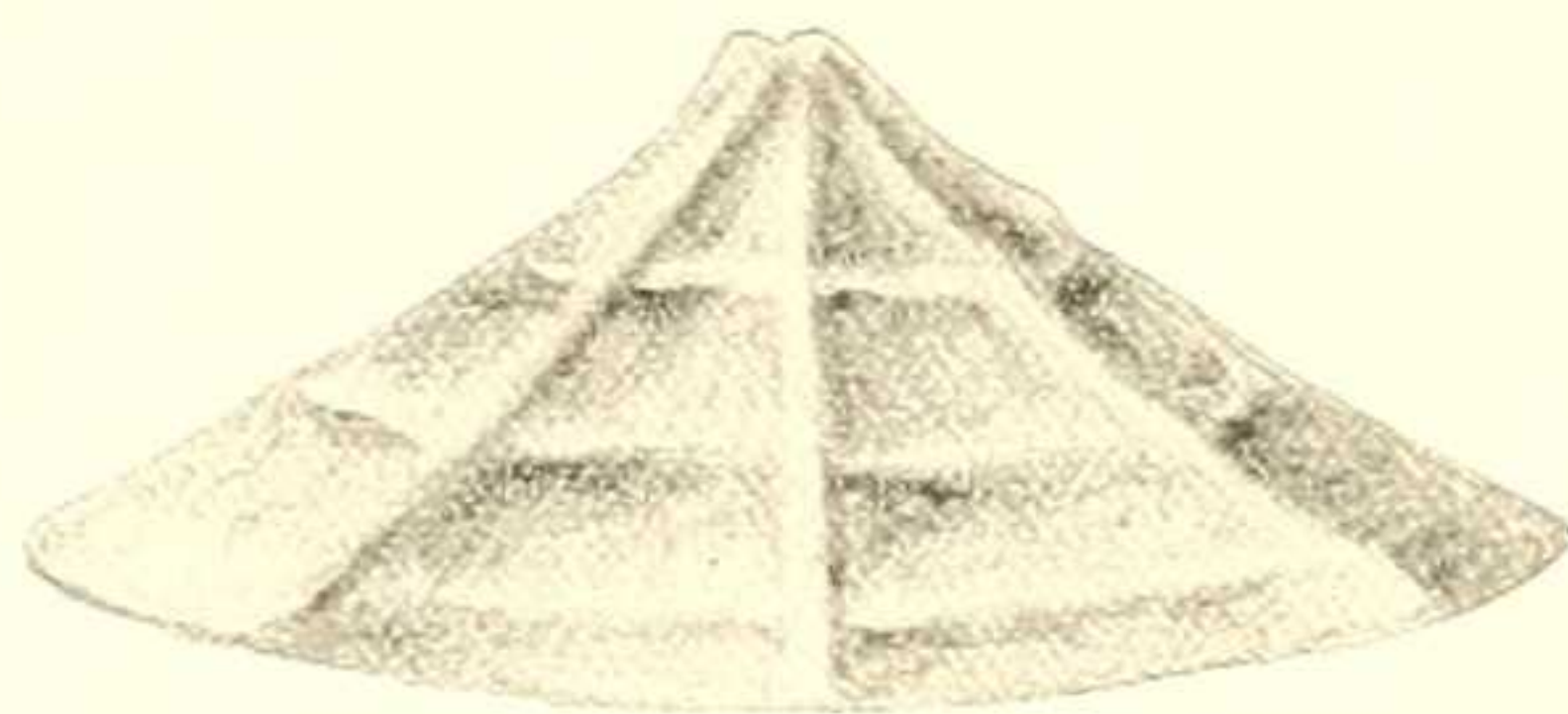
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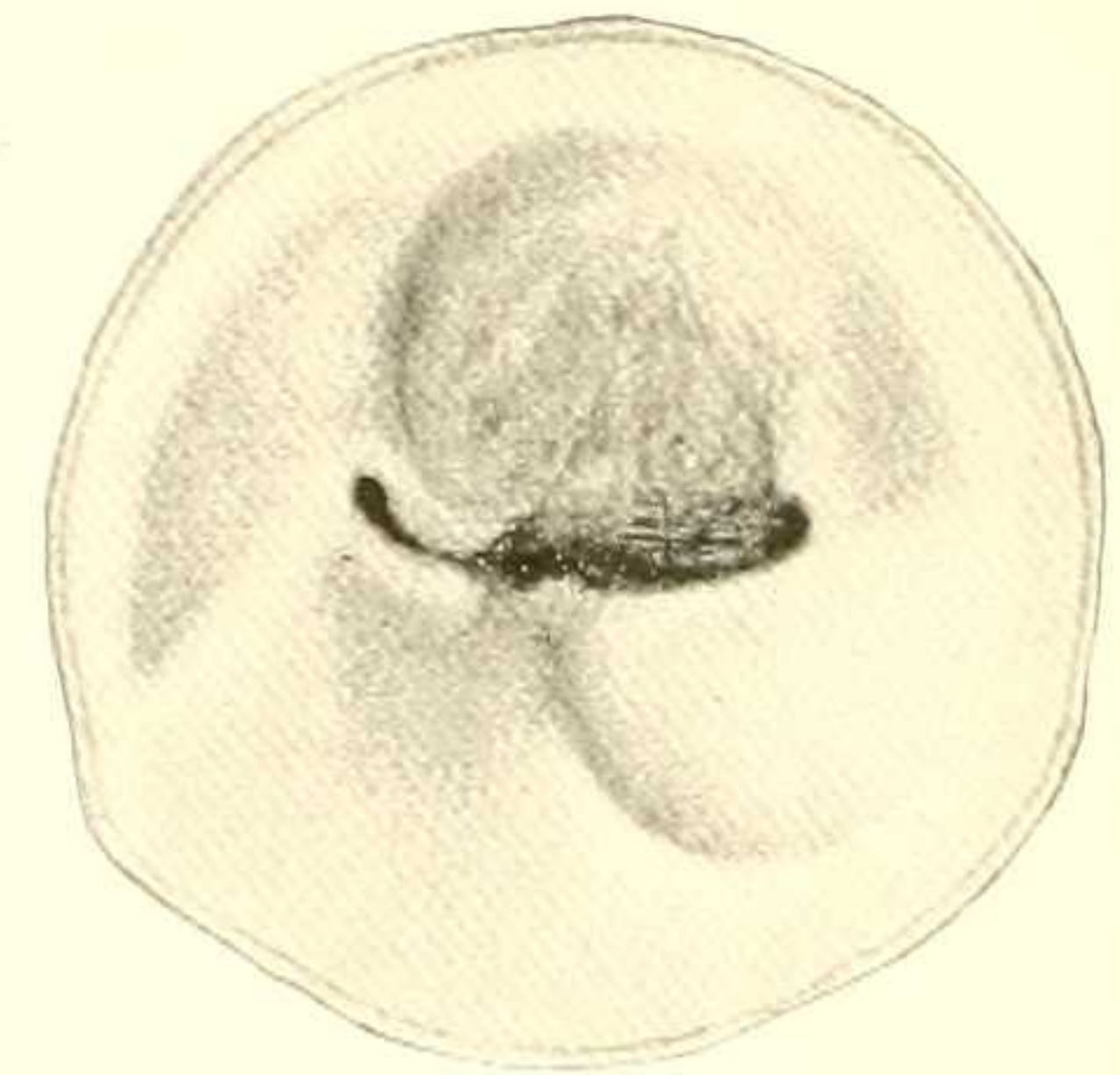
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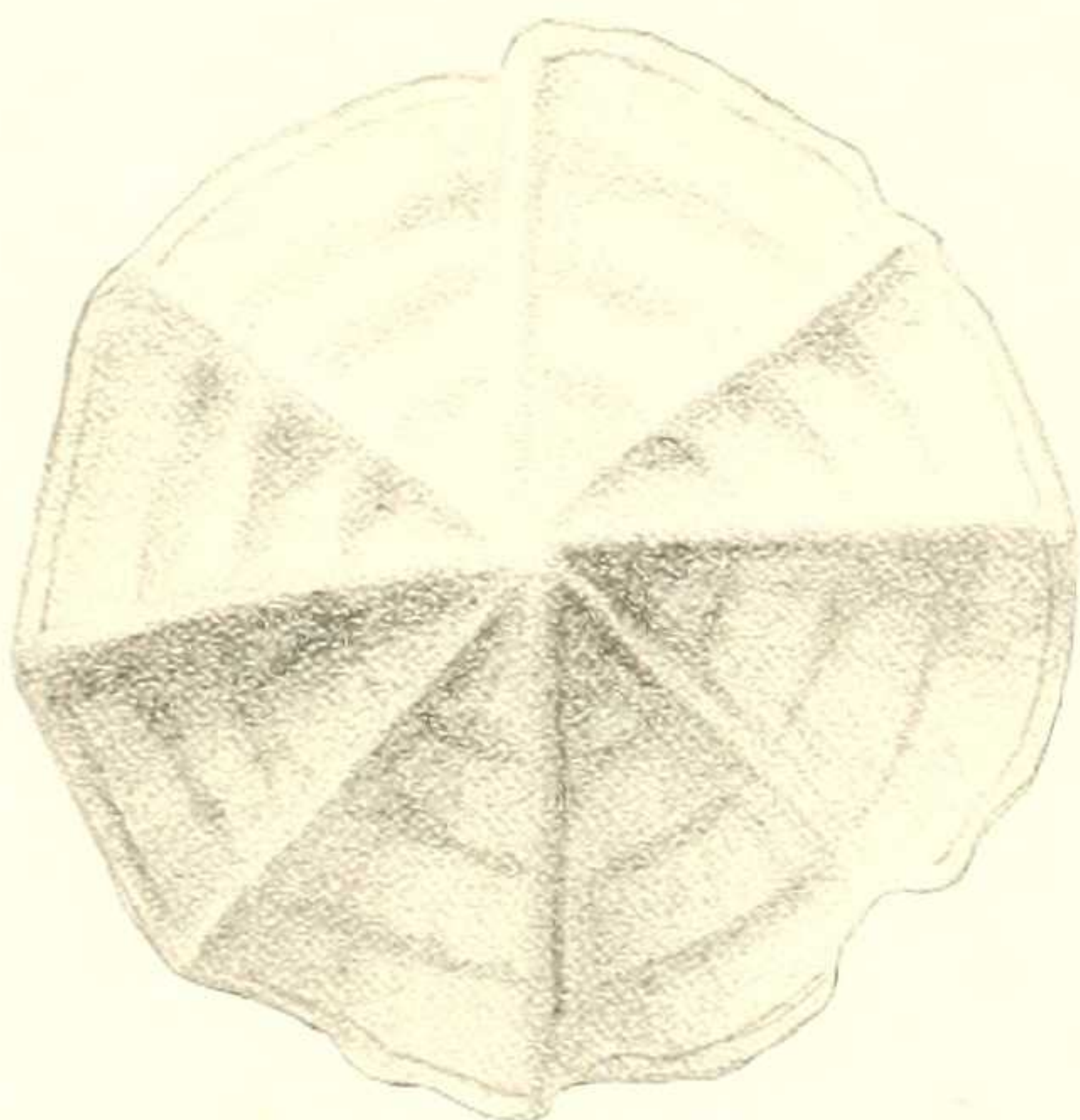
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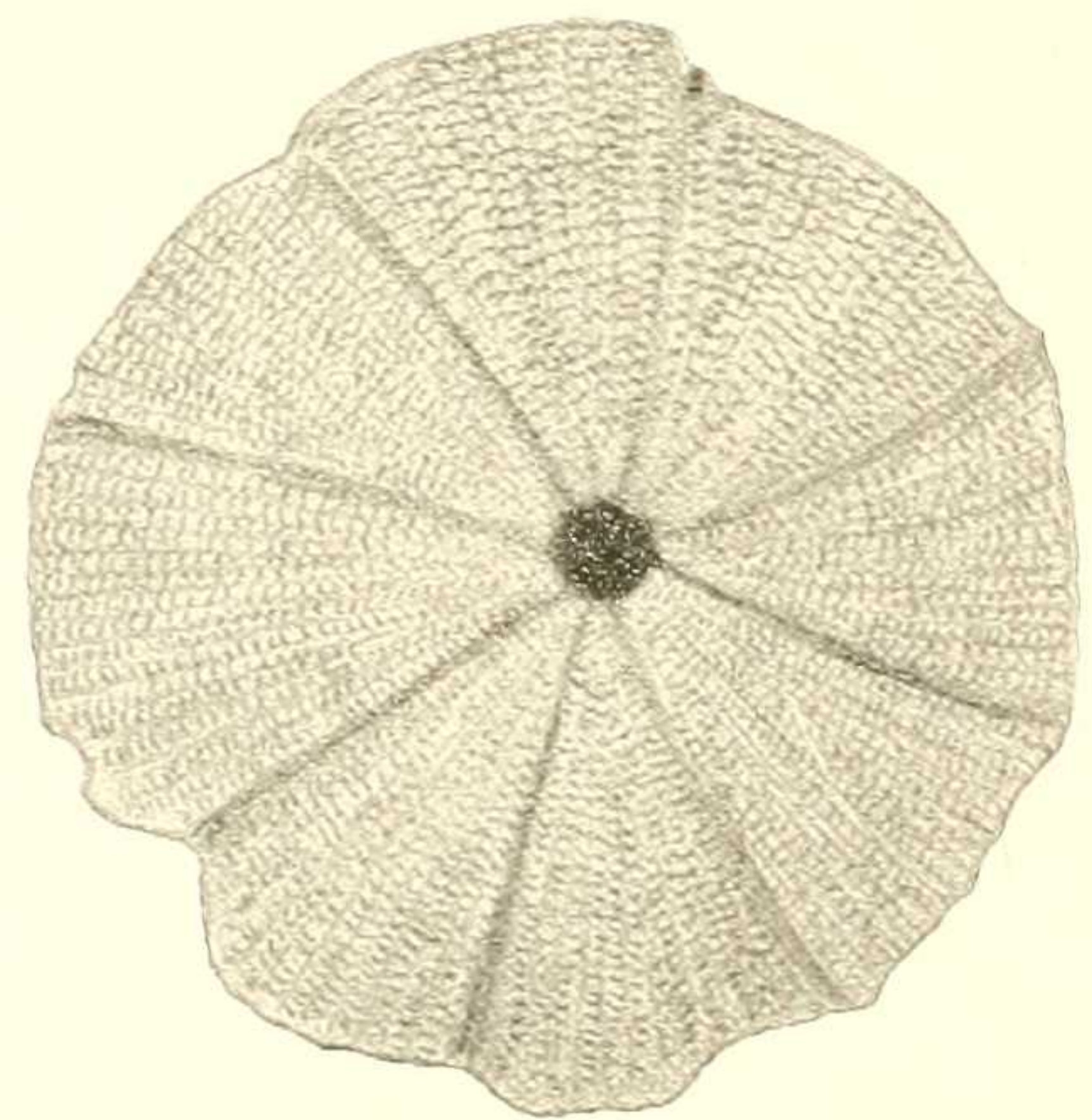
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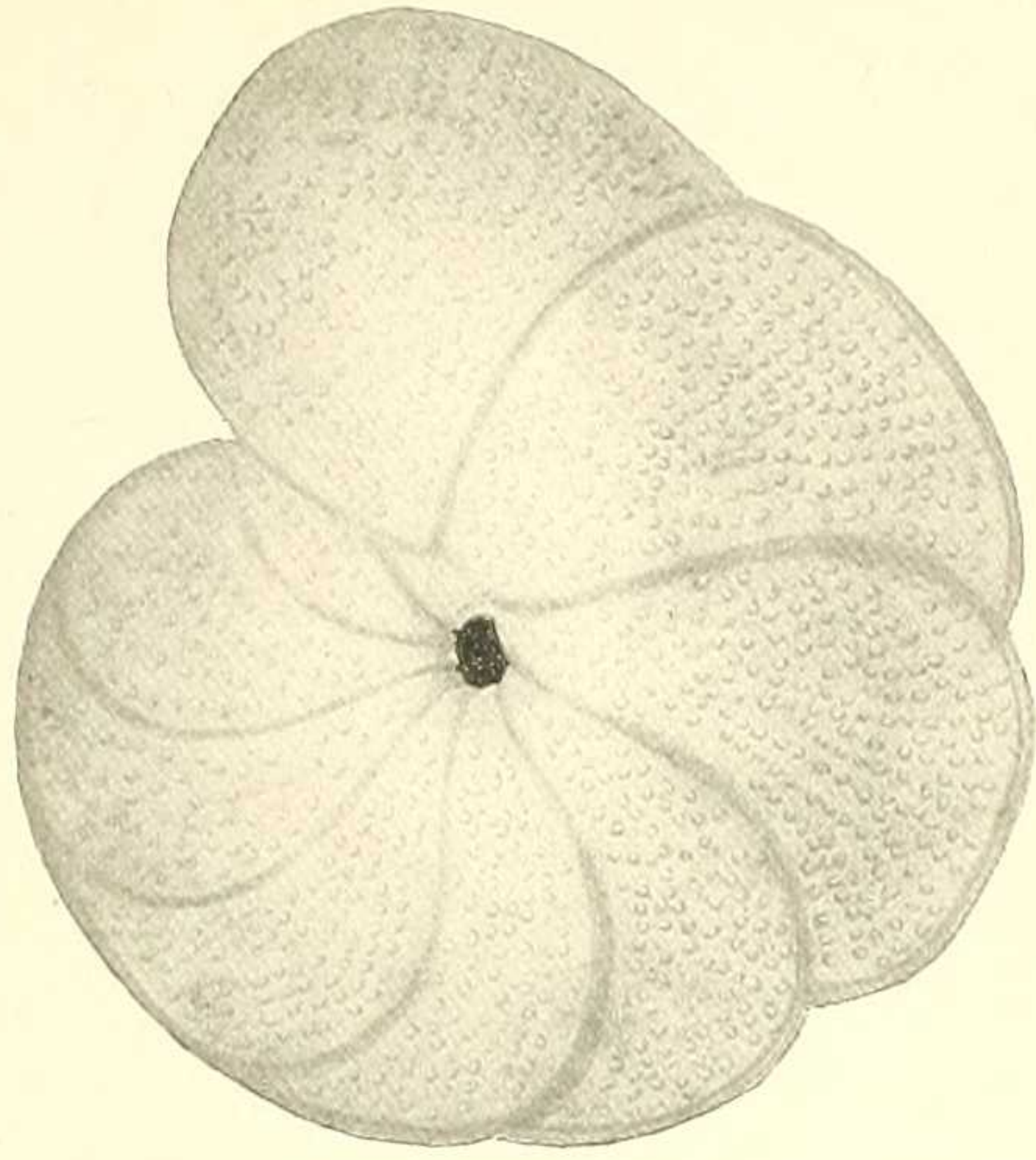
## PLATE XIX.

- FIGURE 1. *Globigerina bulloides* D'Orbigny. Ventral view.  $\times 80$ .  
2. *Globigerina bulloides* D'Orbigny. Apertural view of another specimen.  $\times 80$ .  
3. *Globigerina bulloides* D'Orbigny. Dorsal view of another specimen.  $\times 80$ .  
4. *Spirillina subdecorata* Cushman, n. sp. Dorsal view.  $\times 80$ .  
5. *Spirillina subdecorata* Cushman, n. sp. Ventral view.  $\times 80$ .  
6. *Discorbis byramensis* Cushman, n. sp. Dorsal view.  $\times 100$ .  
7. *Discorbis byramensis* Cushman, n. sp. Side view.  $\times 100$ .  
8. *Discorbis byramensis* Cushman, n. sp. Ventral view.  $\times 100$ .  
9. *Discorbis orbicularis* (Terquem) Berthelin. Dorsal view.  $\times 80$ .  
10. *Discorbis orbicularis* (Terquem) Berthelin. Ventral view of another specimen.

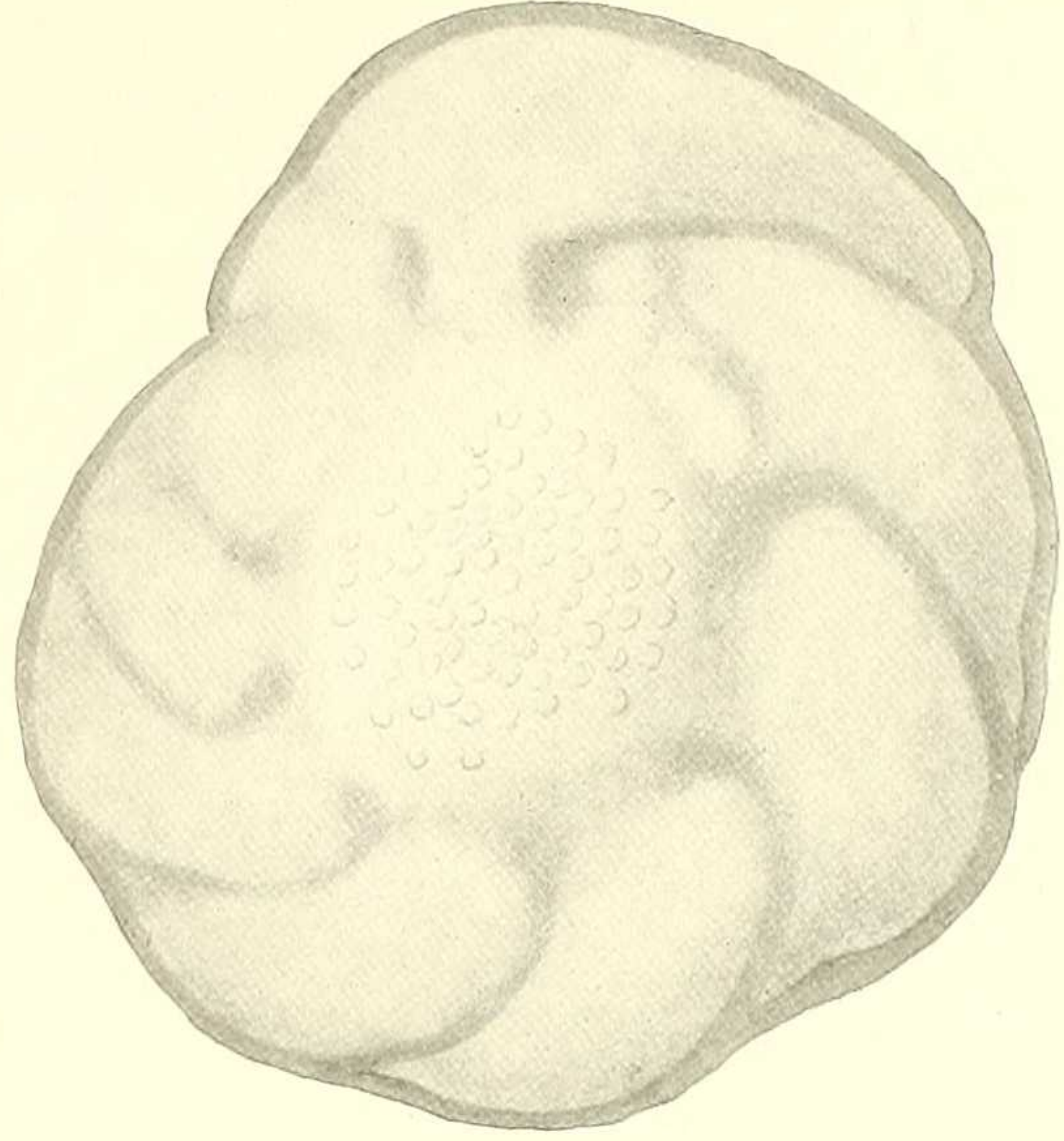


PLATE XX.

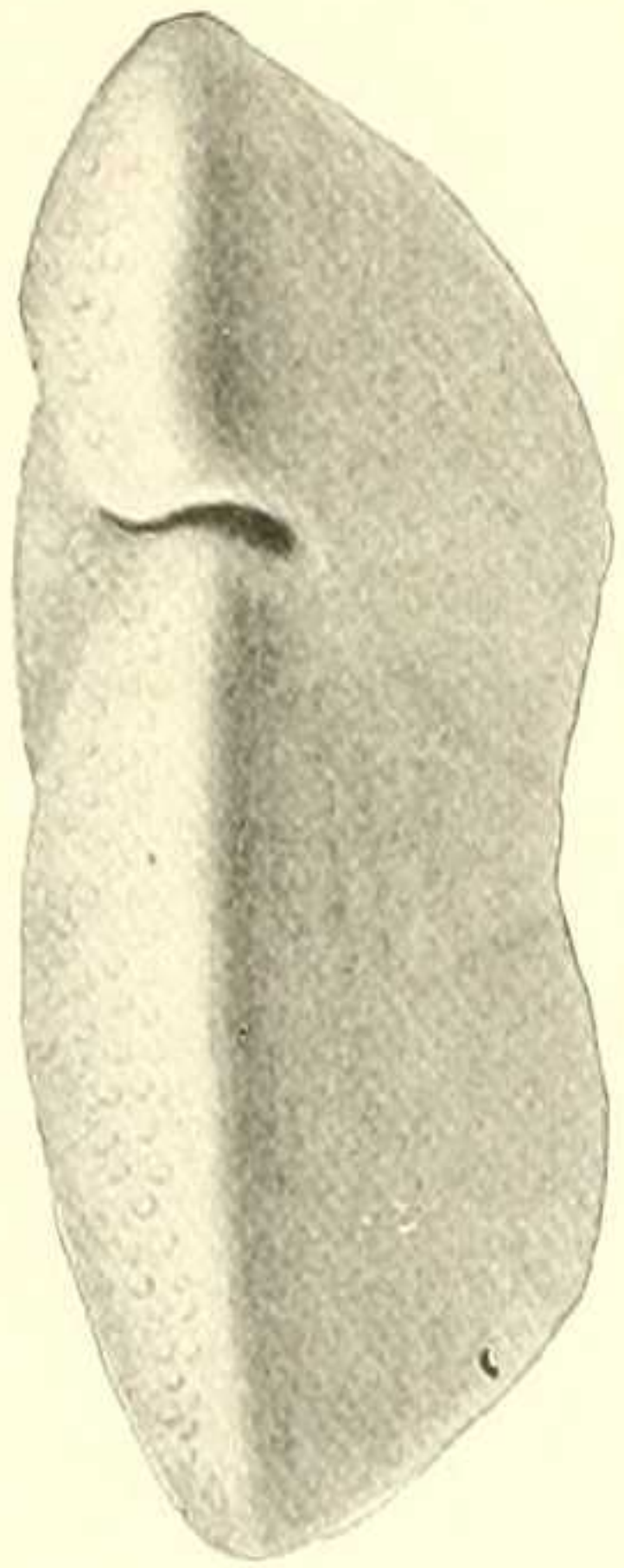
- FIGURE 1. *Truncatulina lobatula* (Walker and Jacob) D'Orbigny. Ventral view.  $\times 80$ .  
2. *Truncatulina lobatula* (Walker and Jacob) D'Orbigny. Apertural view of another specimen.  
3. *Truncatulina lobatula* (Walker and Jacob) D'Orbigny. Dorsal view of another specimen.  $\times 80$ .  
4. *Truncatulina byramensis* Cushman, n. sp. Dorsal view.  $\times 80$ .  
5. *Truncatulina byramensis* Cushman, n. sp. Apertural view of another specimen.  $\times 80$ .  
6. *Truncatulina byramensis* Cushman, n. sp. Ventral view of a young specimen, showing the peculiar lobes at the base of the chambers.  
7. *Truncatulina americana* Cushman, n. sp. Ventral view.  $\times 80$ .  
8. *Truncatulina americana* Cushman, n. sp. Dorsal view of another specimen.  $\times 80$ .  
9. *Truncatulina pseudoungeriana* Cushman, n. sp. Ventral view.  $\times 100$ .



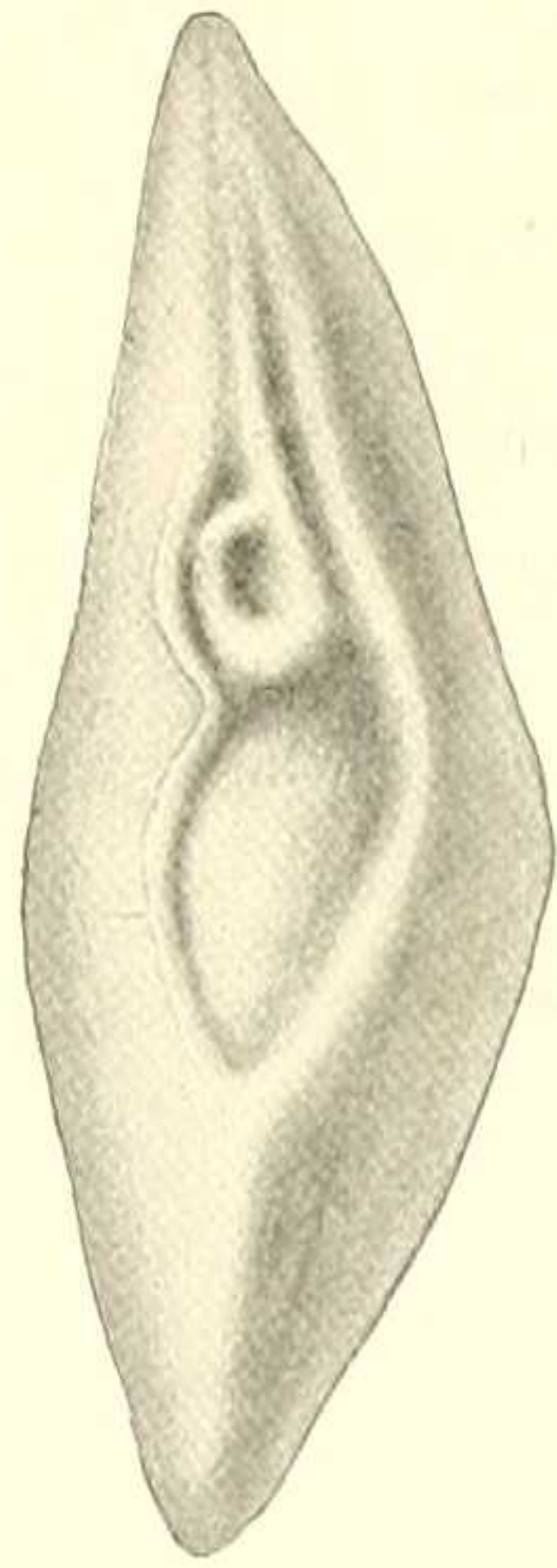
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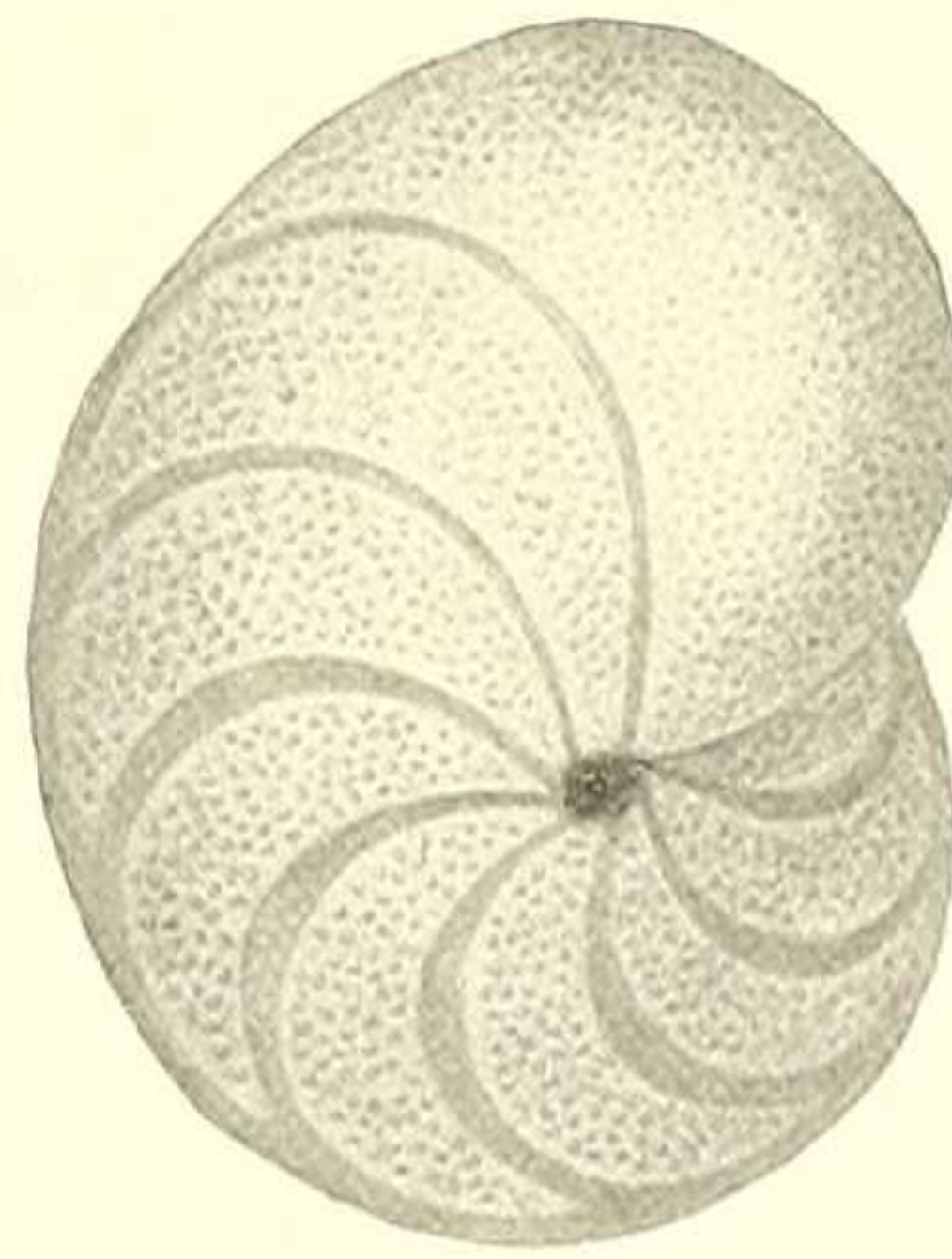
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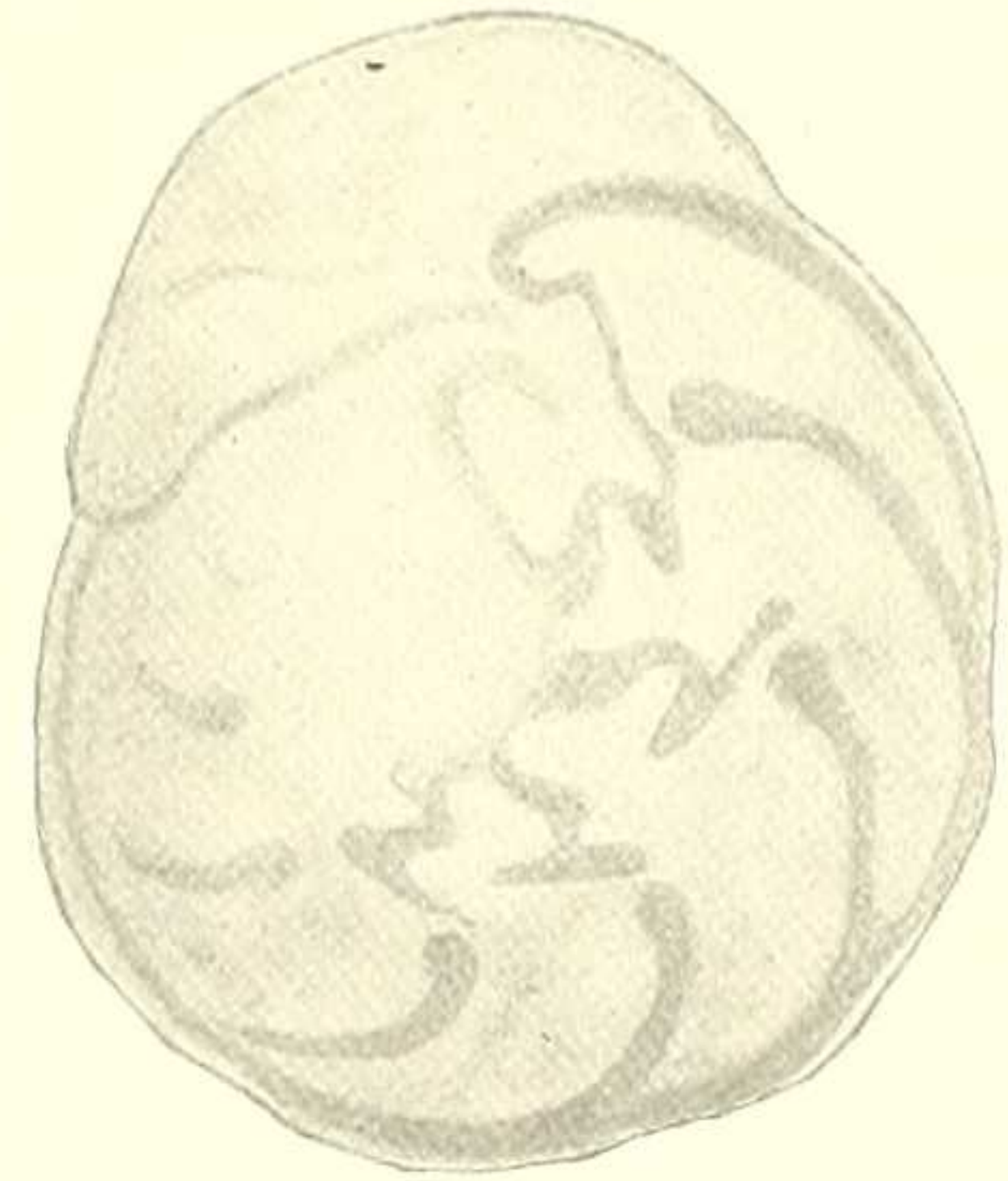
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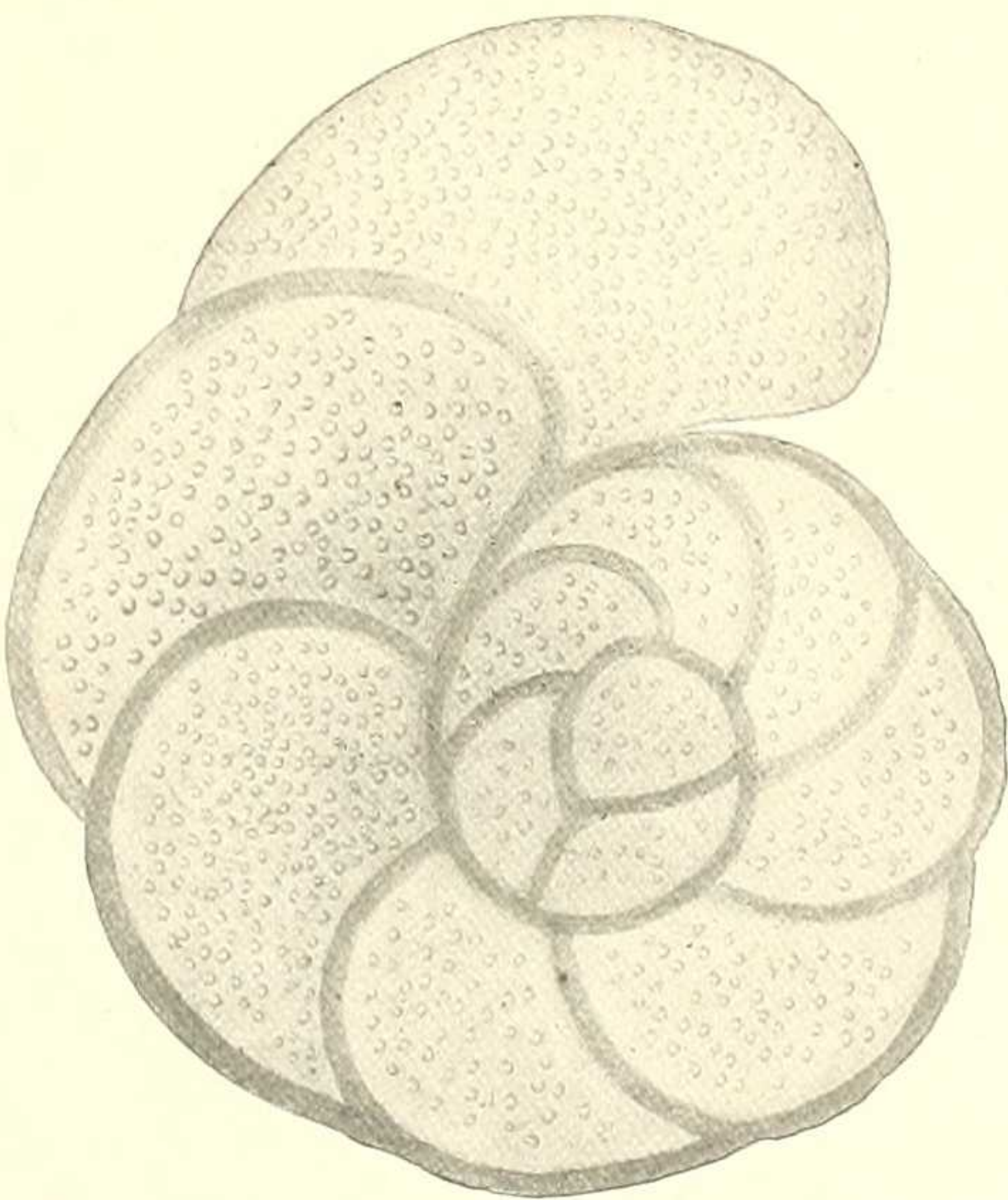
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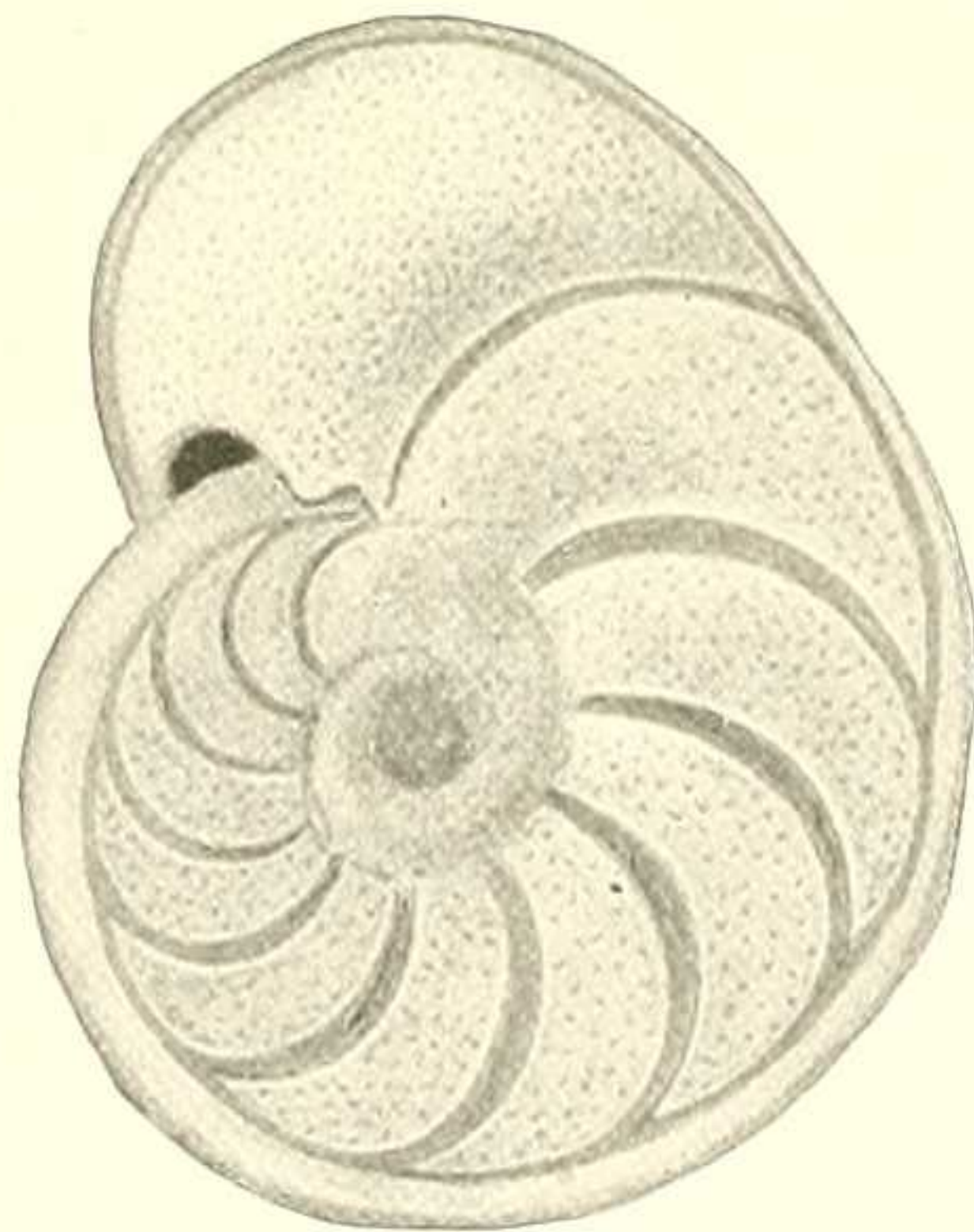
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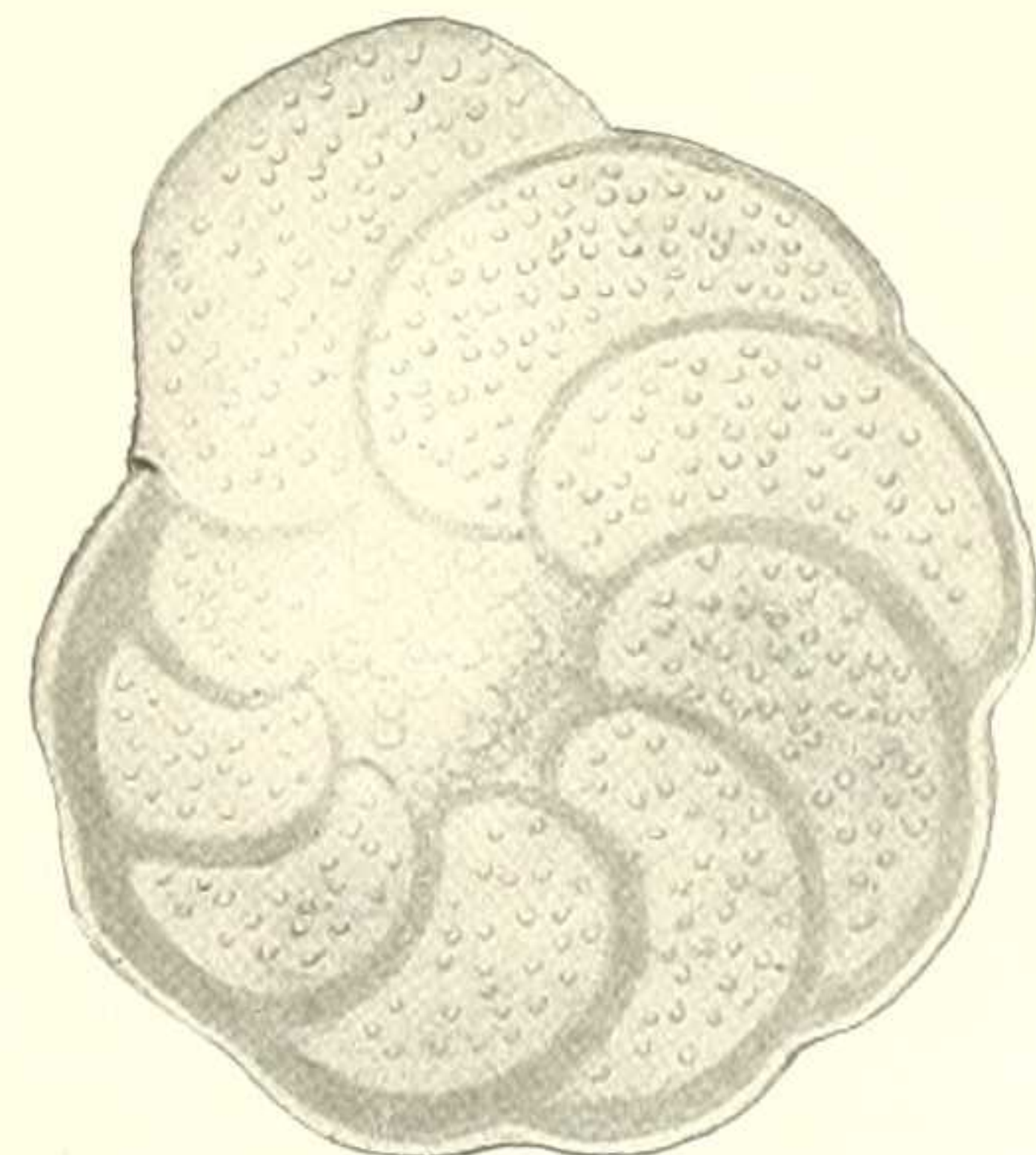
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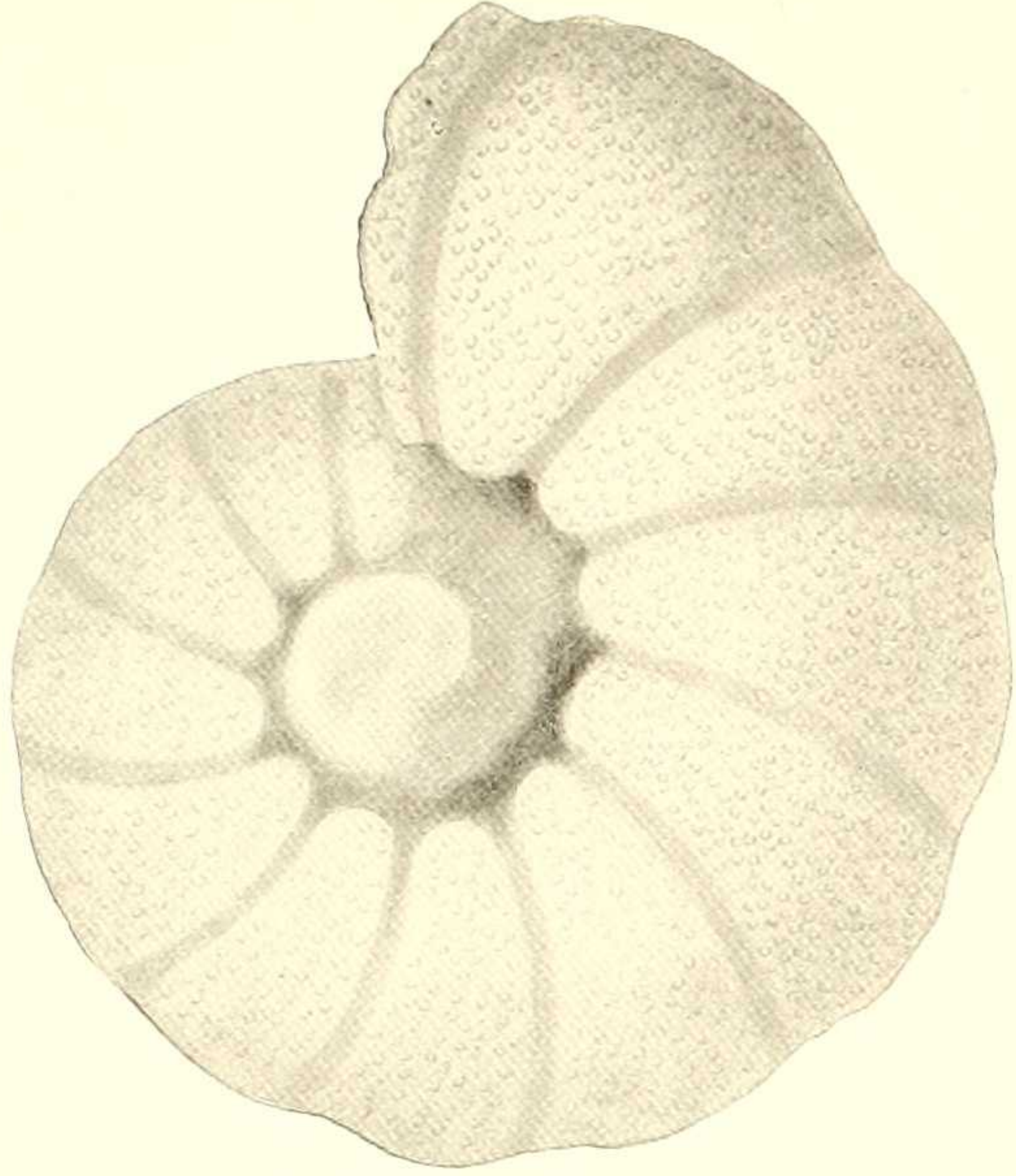


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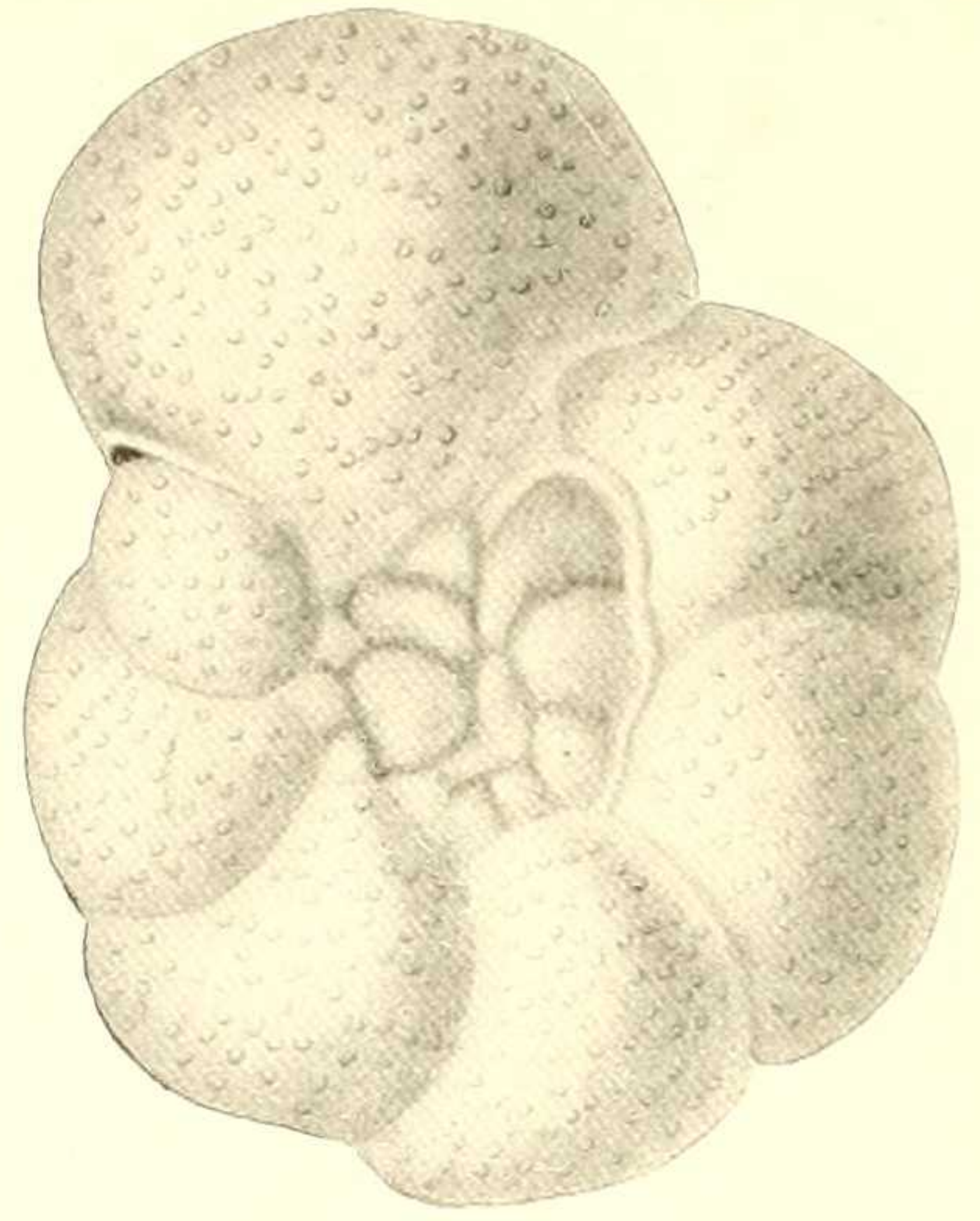


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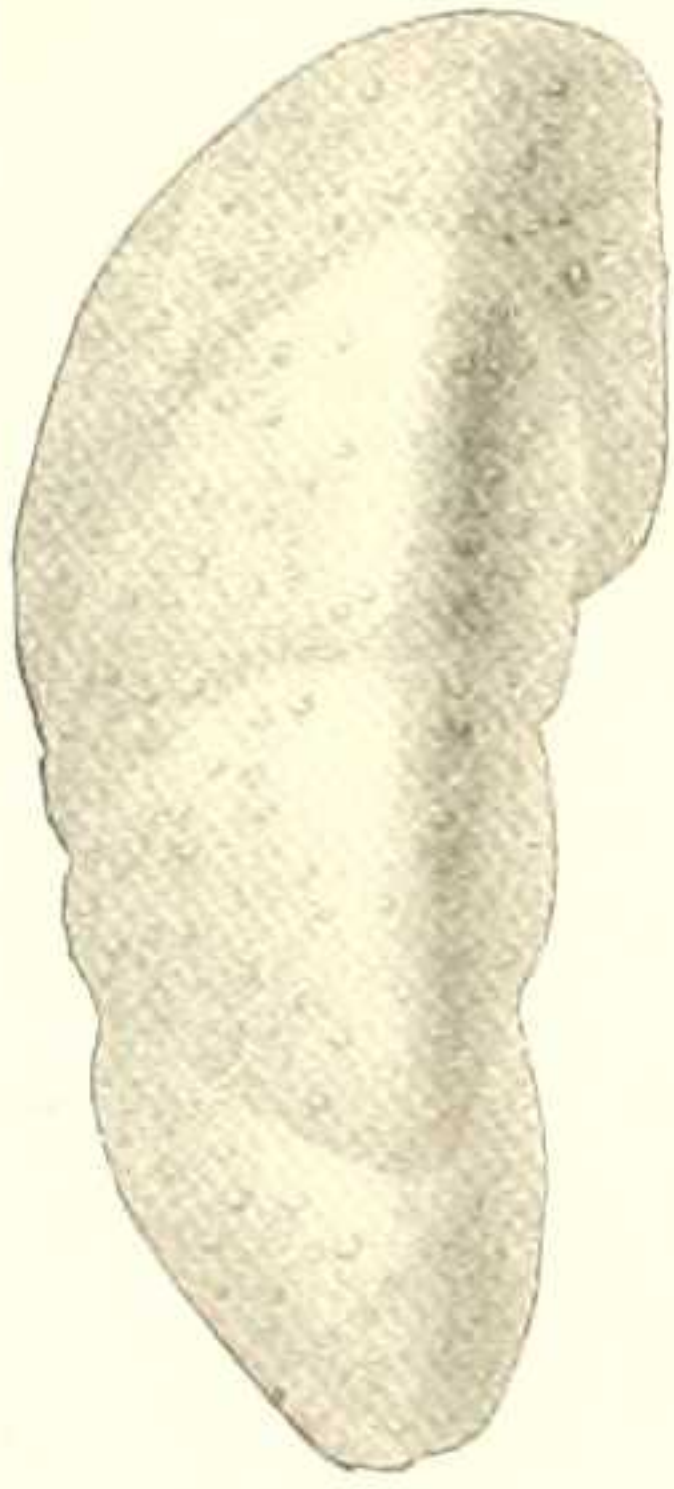
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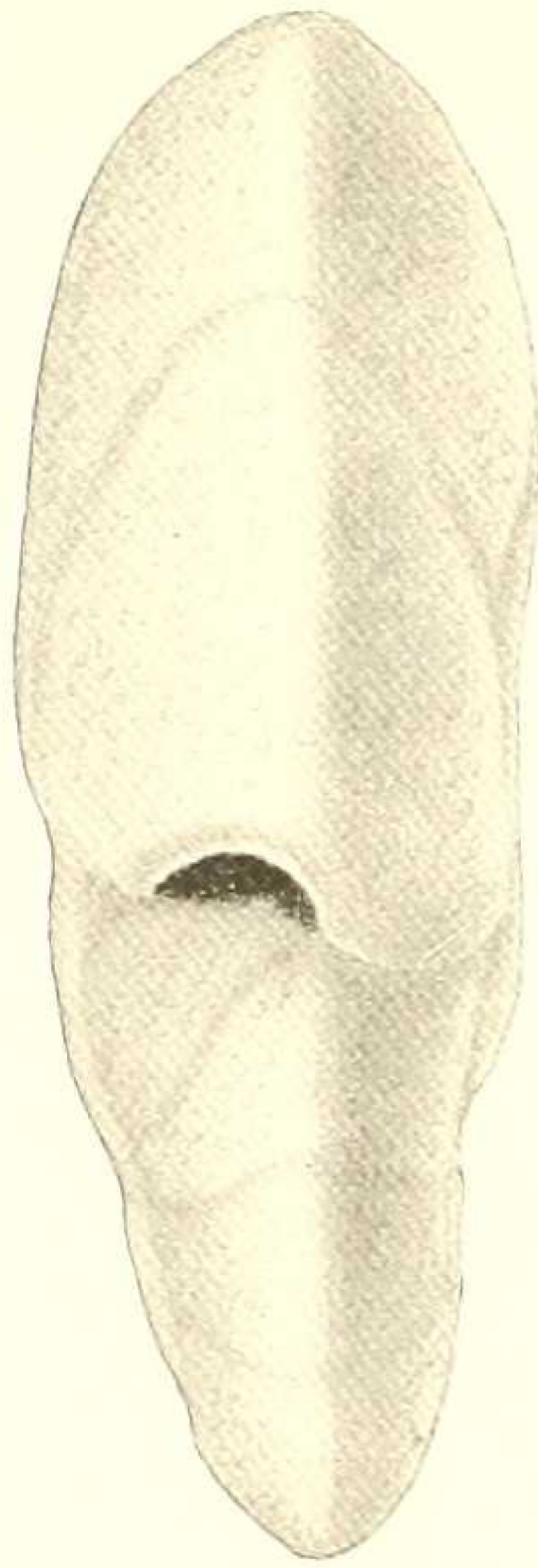
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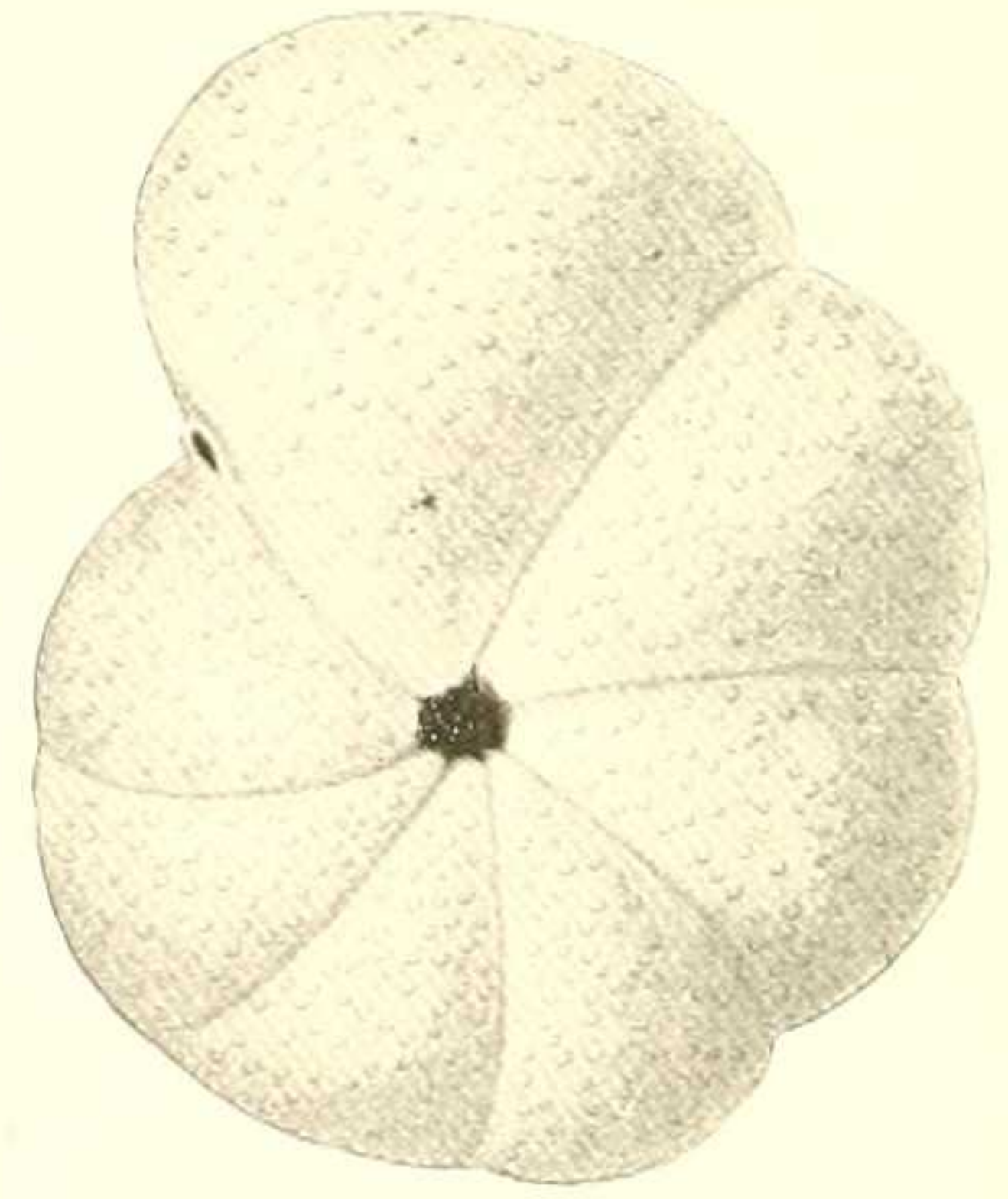
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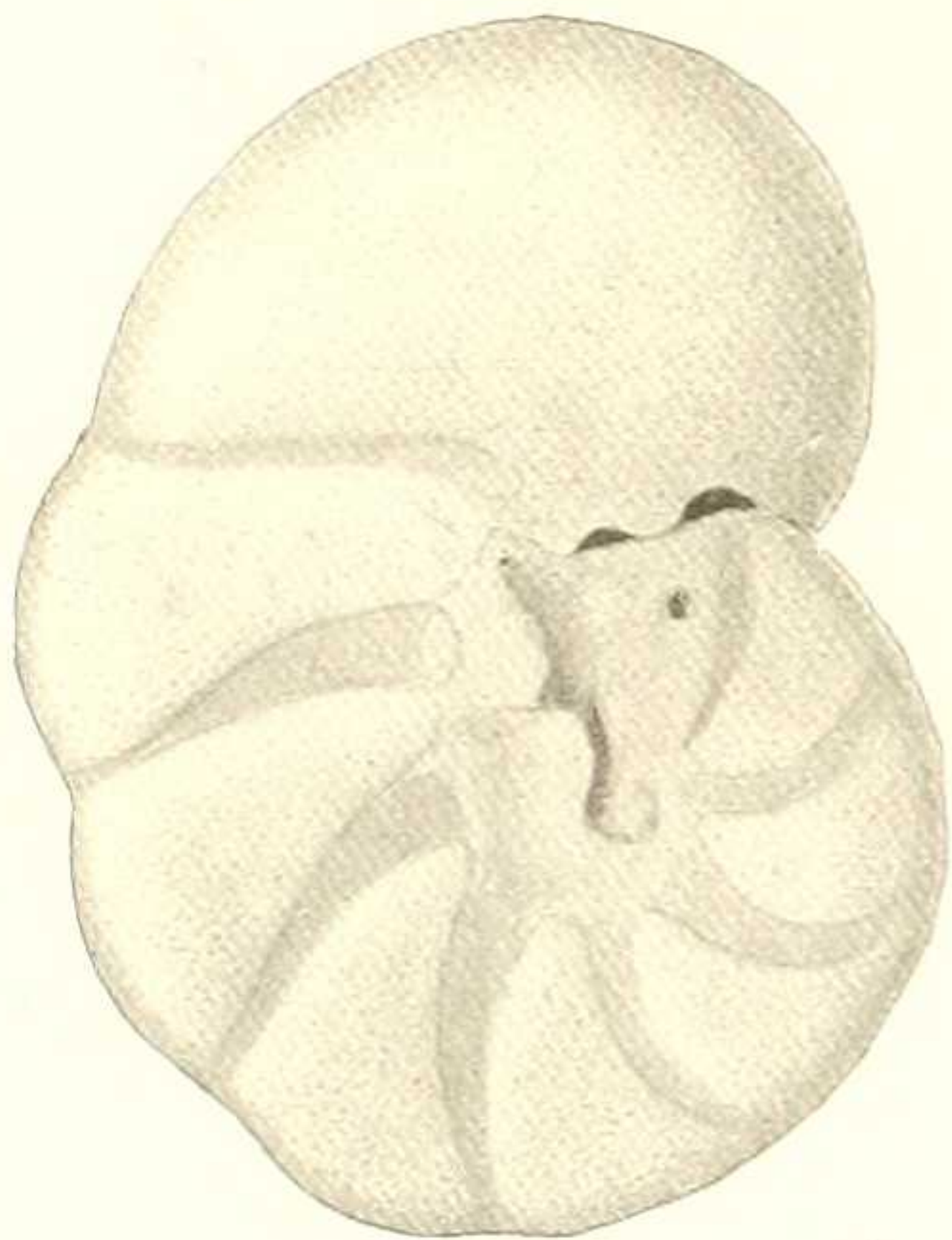
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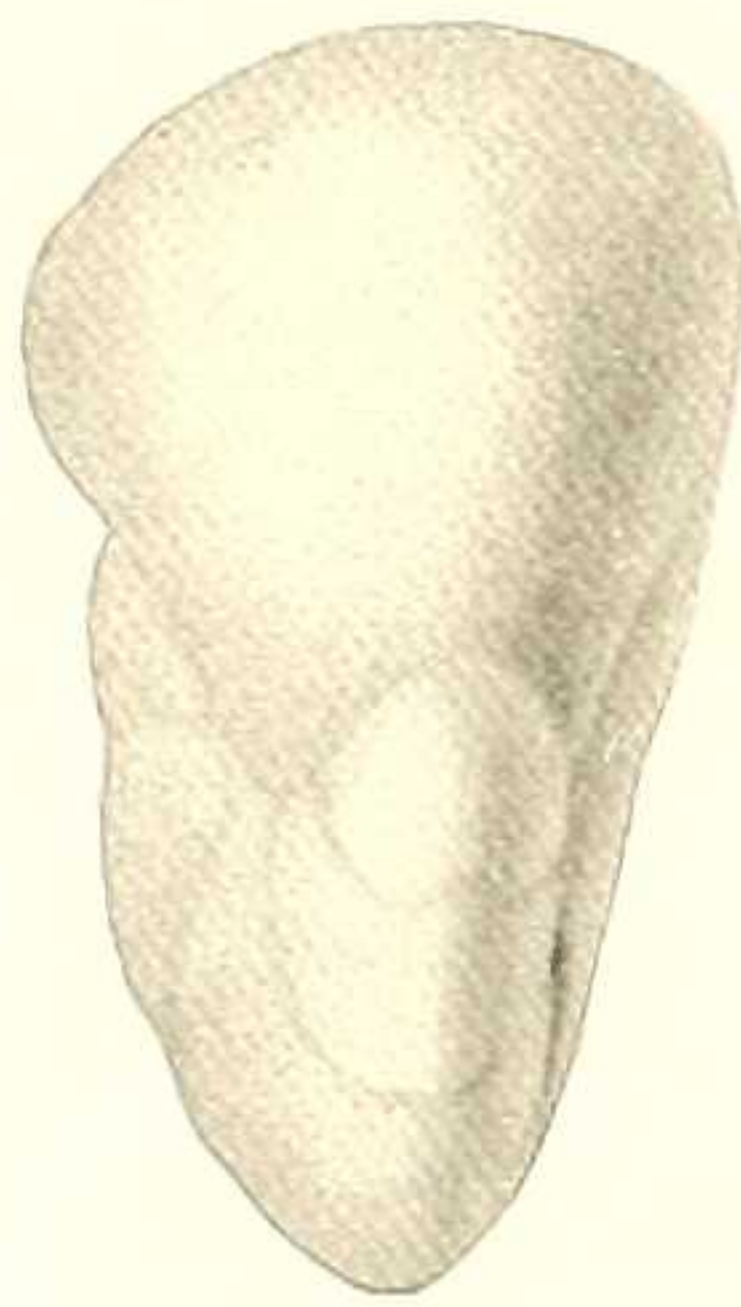
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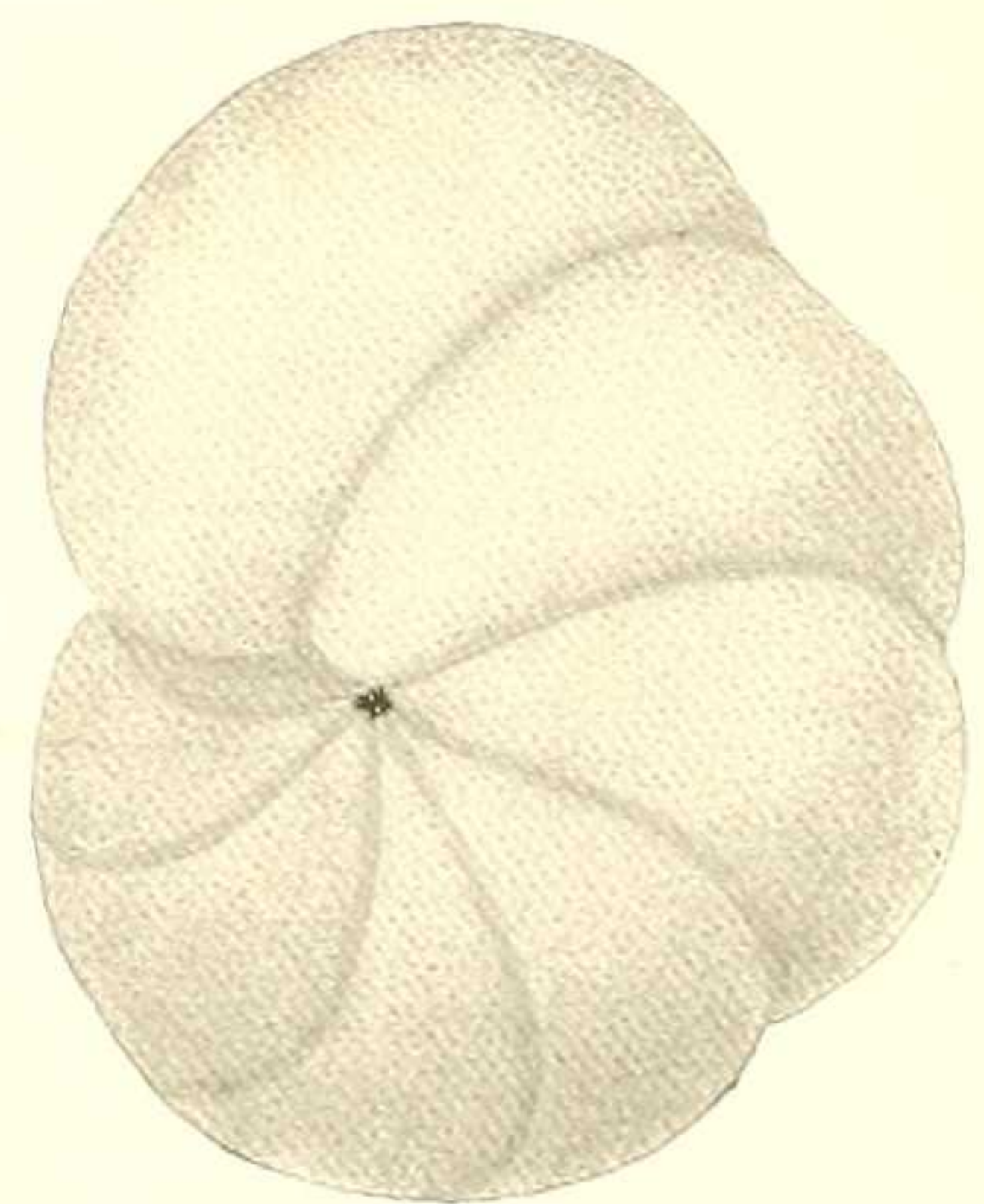
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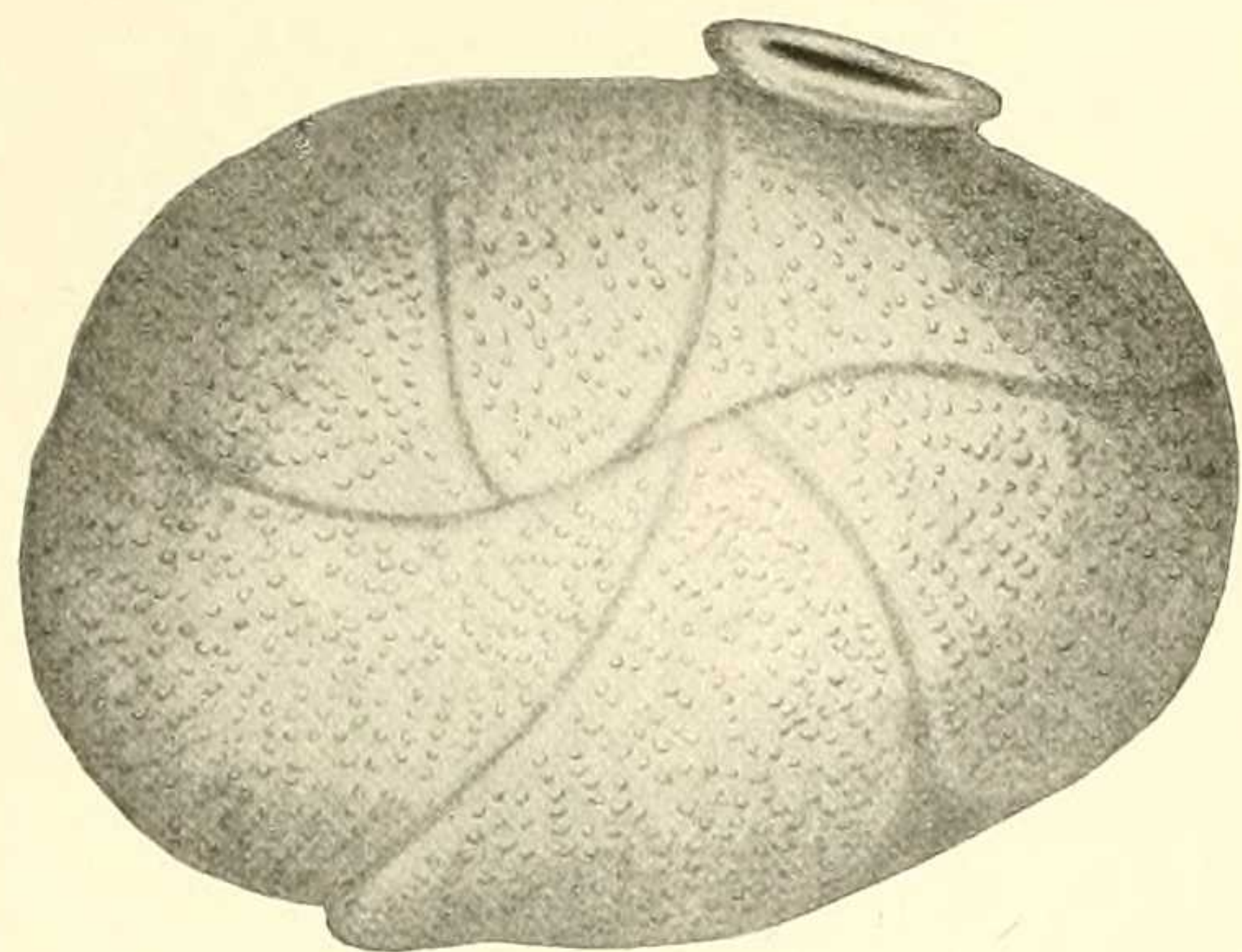
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## PLATE XXI.

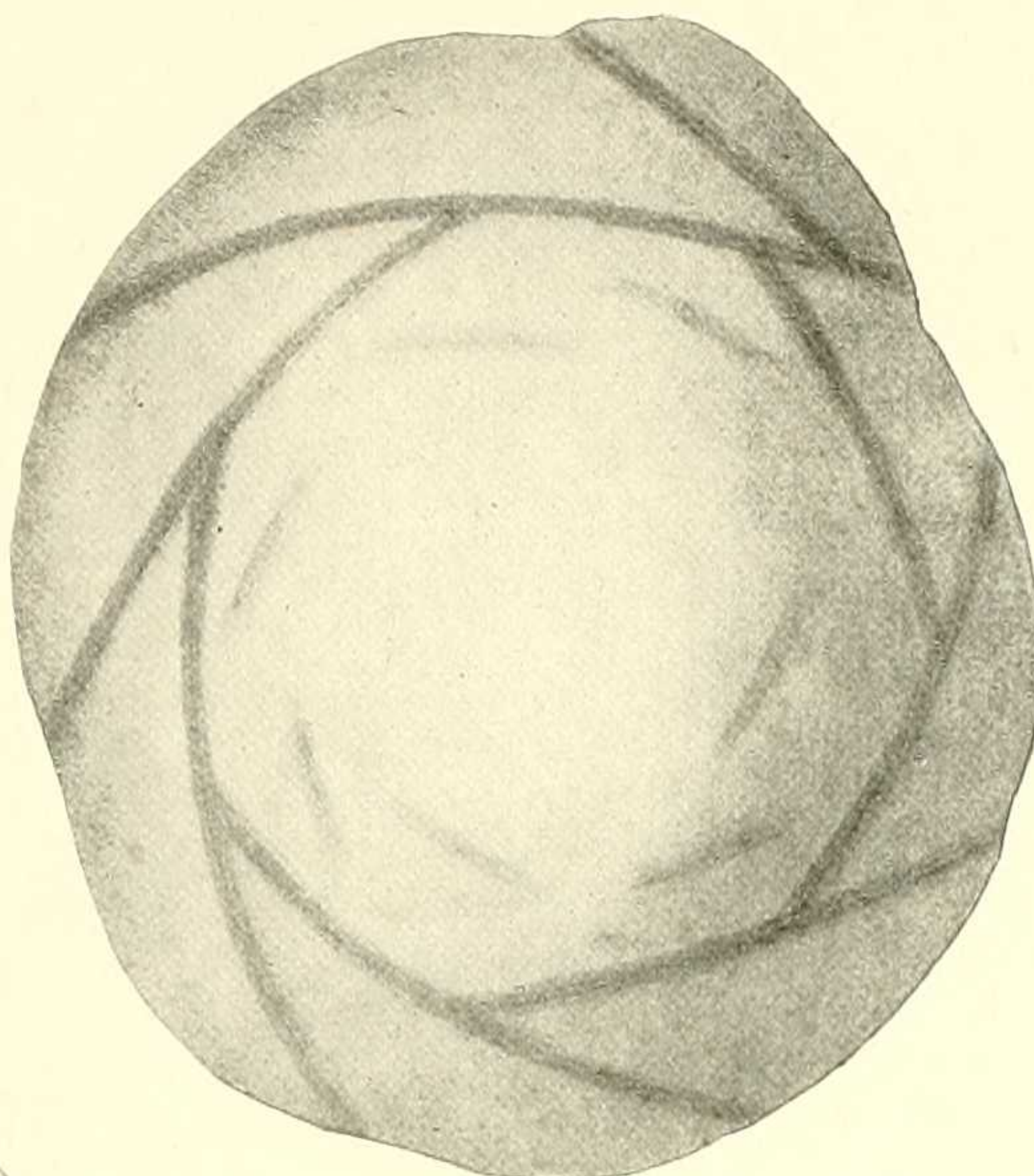
- FIGURE 1. *Anomalina bilateralis* Cushman, n. sp. Dorsal view.  $\times 80$ .  
2. *Anomalina bilateralis* Cushman, n. sp. Apertural view of another specimen.  $\times 80$ .  
3. *Anomalina grosserugosa* (Gümbel) H. B. Brady? var. Dorsal view.  $\times 80$ .  
4. *Anomalina grosserugosa* (Gümbel) H. B. Brady? var. Apertural view of another specimen.  $\times 80$ .  
5. *Anomalina grosserugosa* (Gümbel) H. B. Brady? var. Ventral view of another specimen.  $\times 80$ .  
6. *Anomalina mississippiensis* Cushman, n. sp. Ventral view.  $\times 80$ .  
7. *Anomalina mississippiensis* Cushman, n. sp. Apertural view of another specimen.  $\times 80$ .  
8. *Anomalina mississippiensis* Cushman, n. sp. Dorsal view of another specimen.  $\times 80$ .

## PLATE XXII.

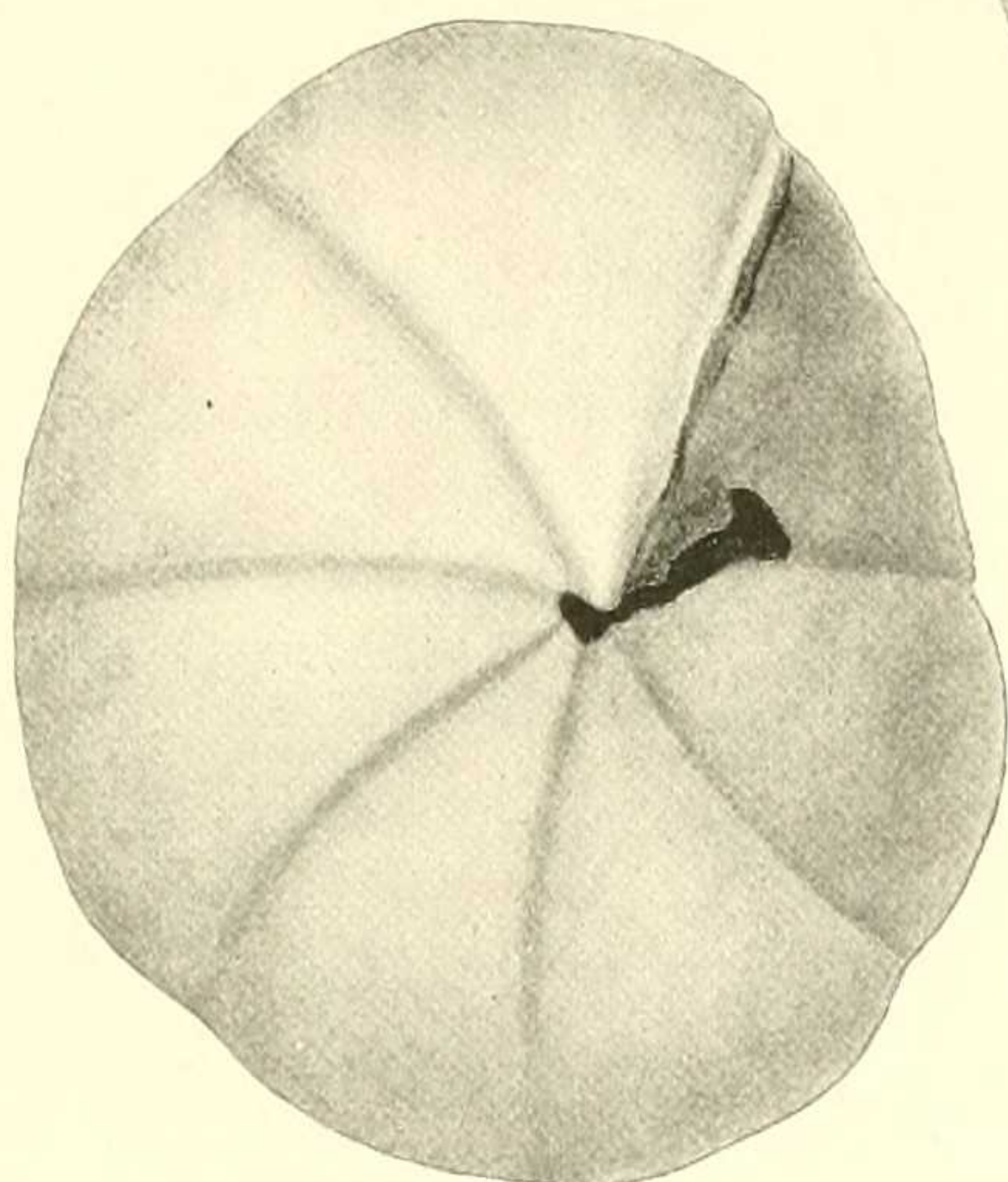
- FIGURE 1. *Siphonina advena* Cushman, n. sp. Side view.  $\times 80$ .  
2. *Siphonina advena* Cushman, n. sp. Apertural view of another specimen.  $\times 80$ .  
3. *Gypsina rubra* D'Orbigny. Dorsal view.  $\times 80$ .  
4. *Pulvinulina byramensis* Cushman, n. sp. Ventral view.  $\times 40$ .  
5. *Pulvinulina byramensis* Cushman, n. sp. Dorsal view.  $\times 40$ .  
6. *Pulvinulina glabrata* Cushman, n. sp. Dorsal view.  $\times 80$ .  
7. *Pulvinulina glabrata* Cushman, n. sp. Ventral view of a larger specimen, showing the smooth polished surface of the ventral side.  $\times 80$ .  
8. *Pulvinulina advena* Cushman, n. sp. Dorsal view.  $\times 100$ .



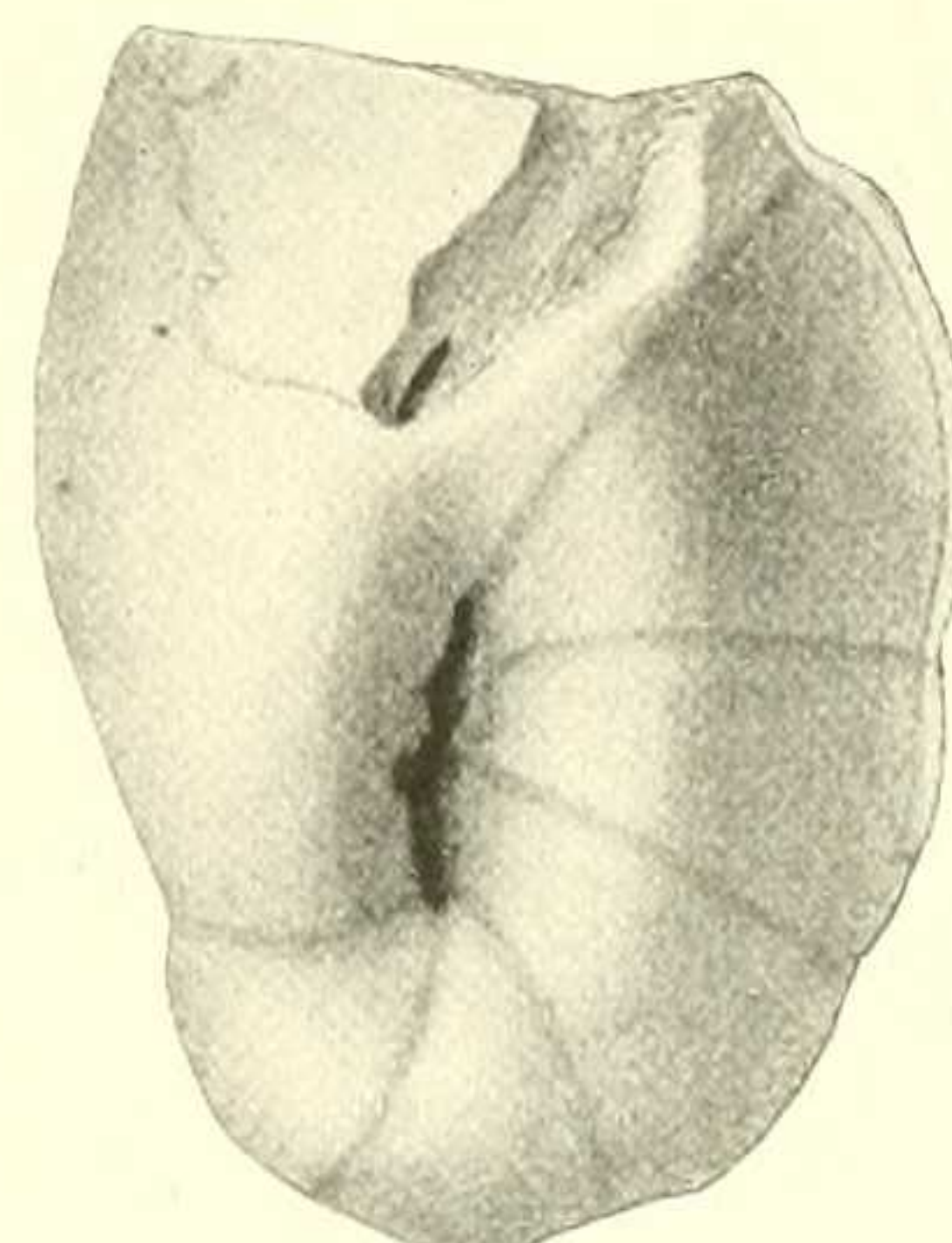
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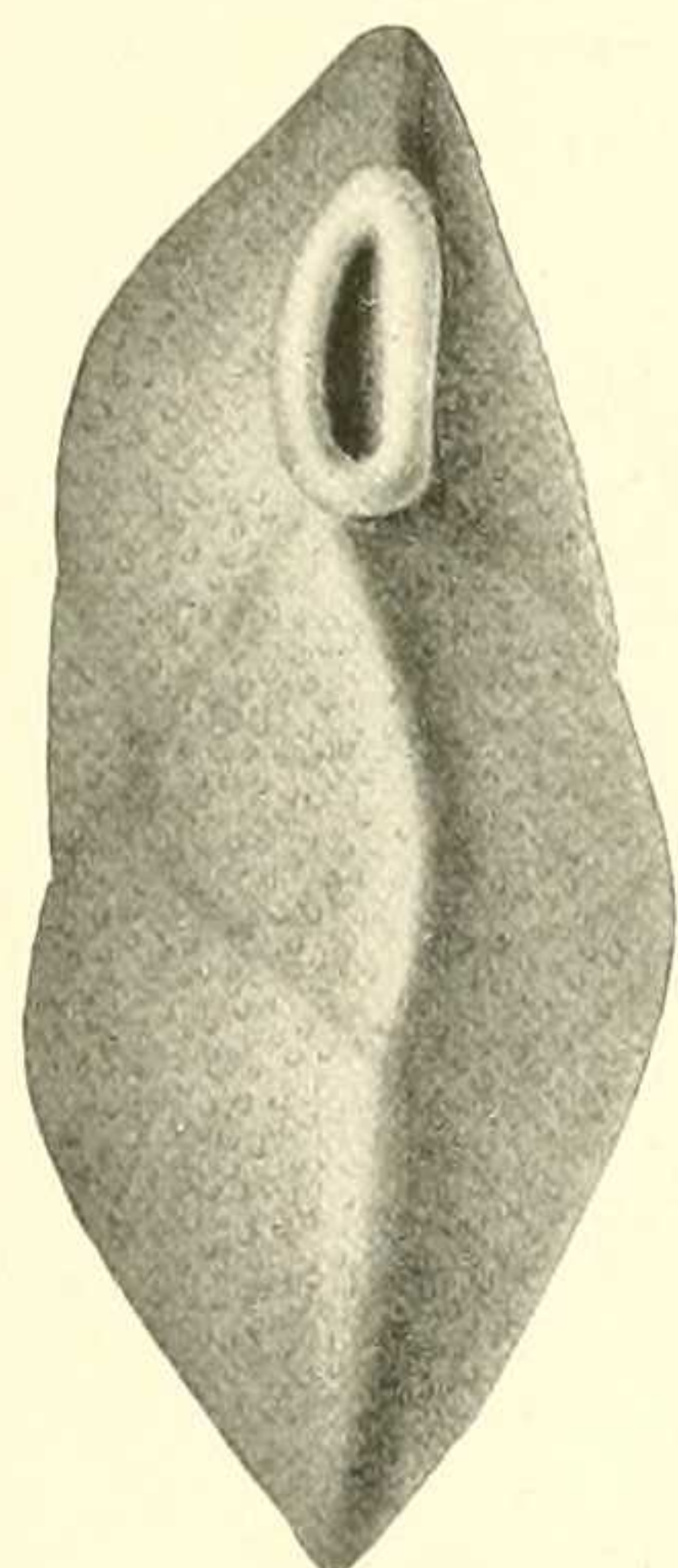
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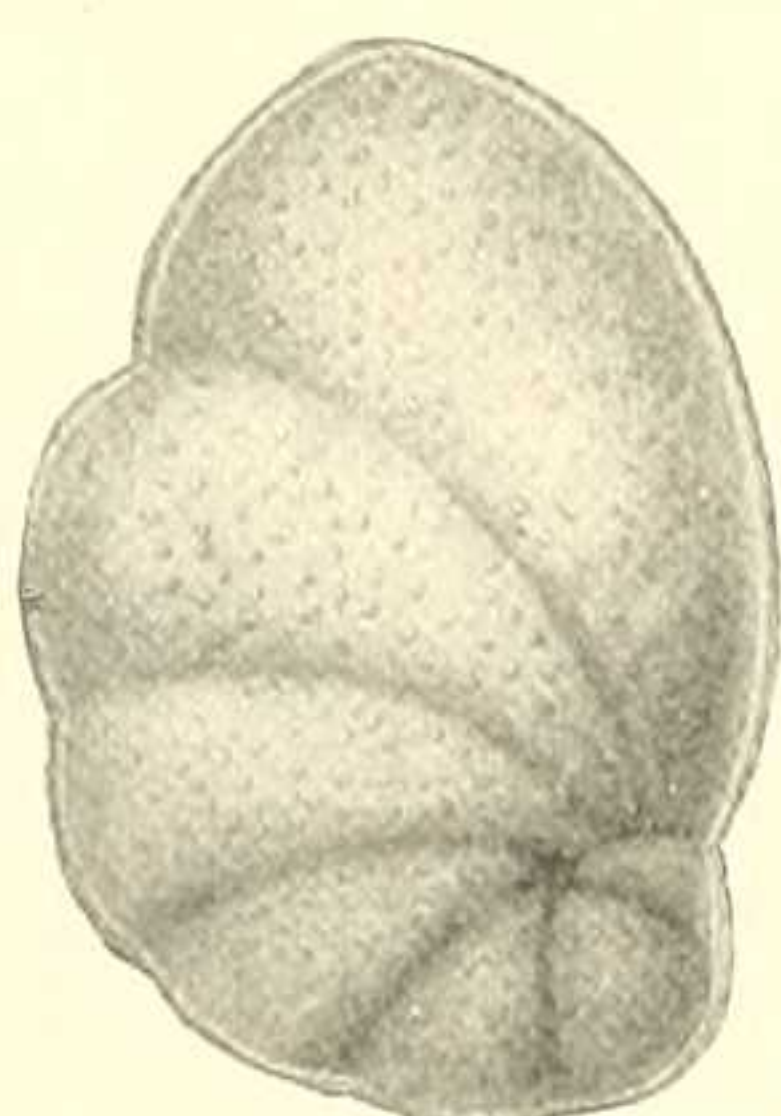
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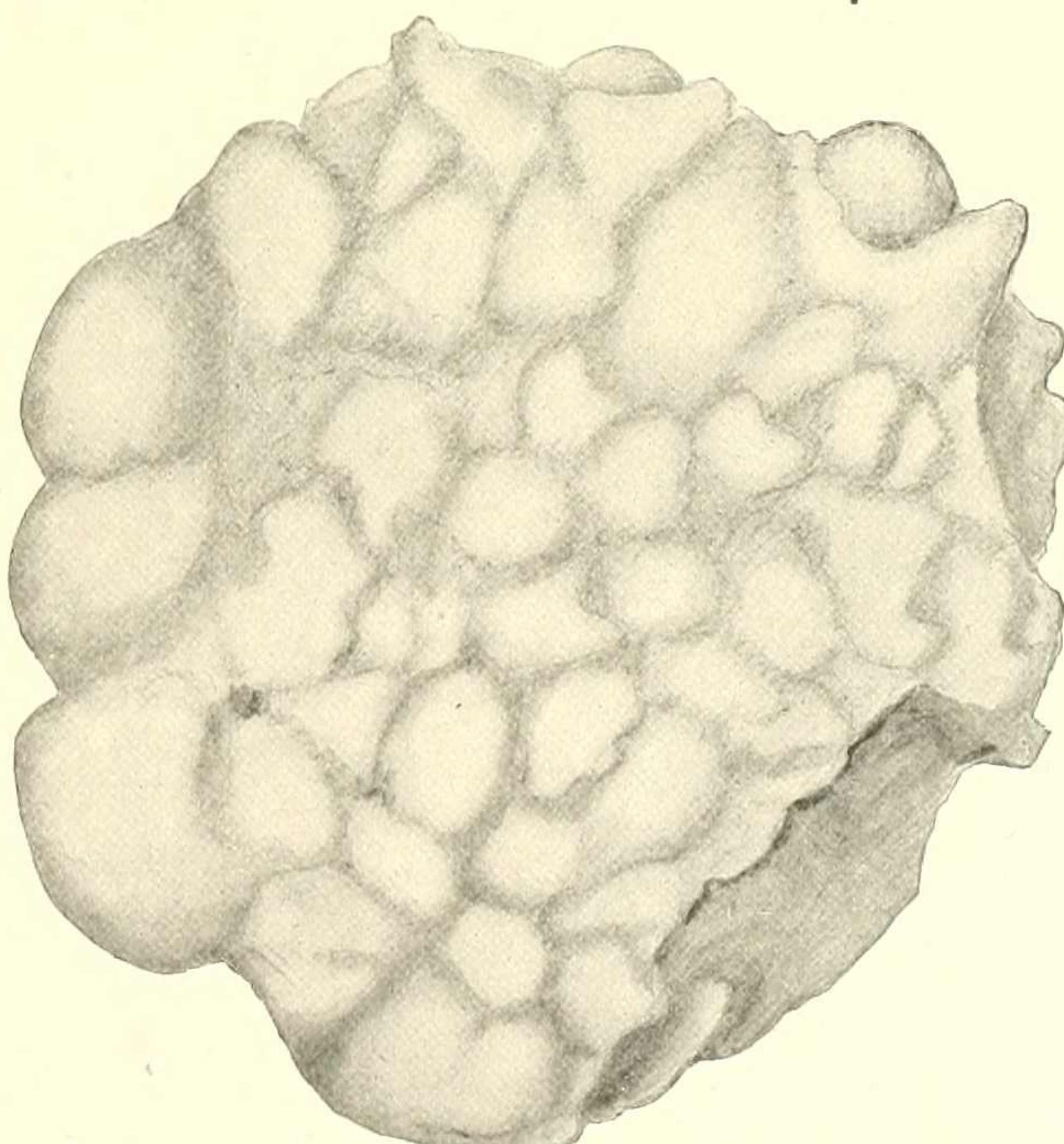
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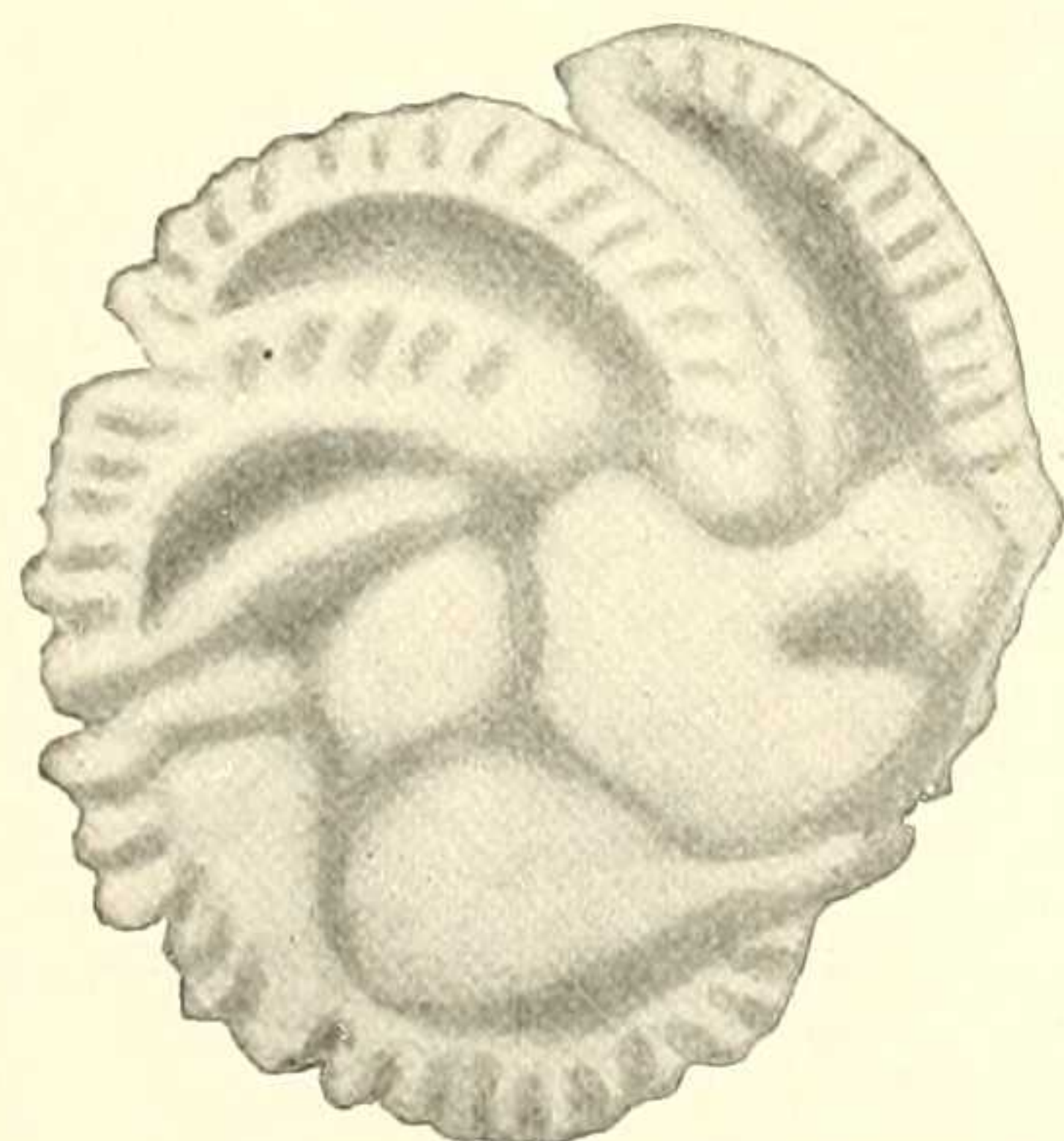
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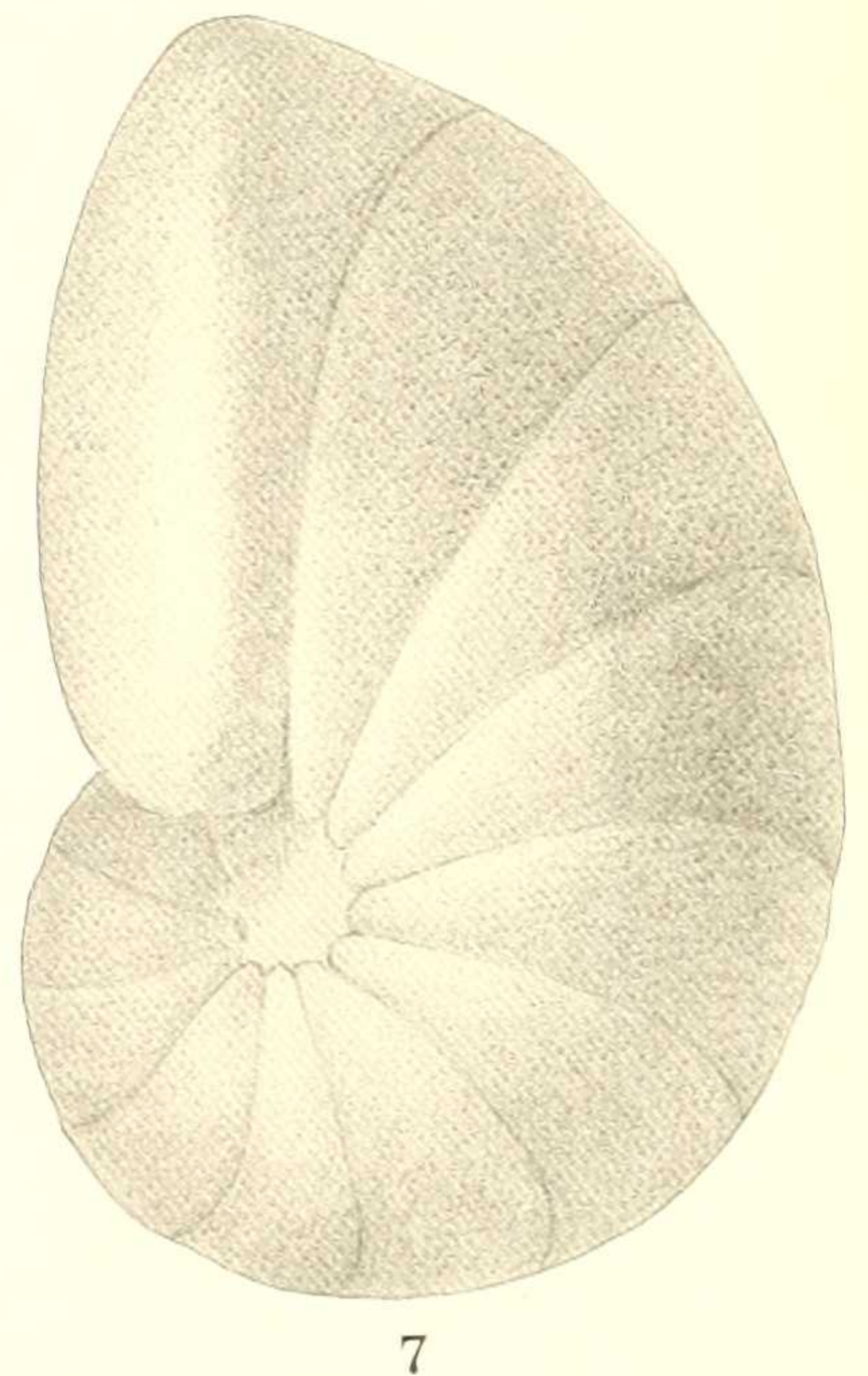
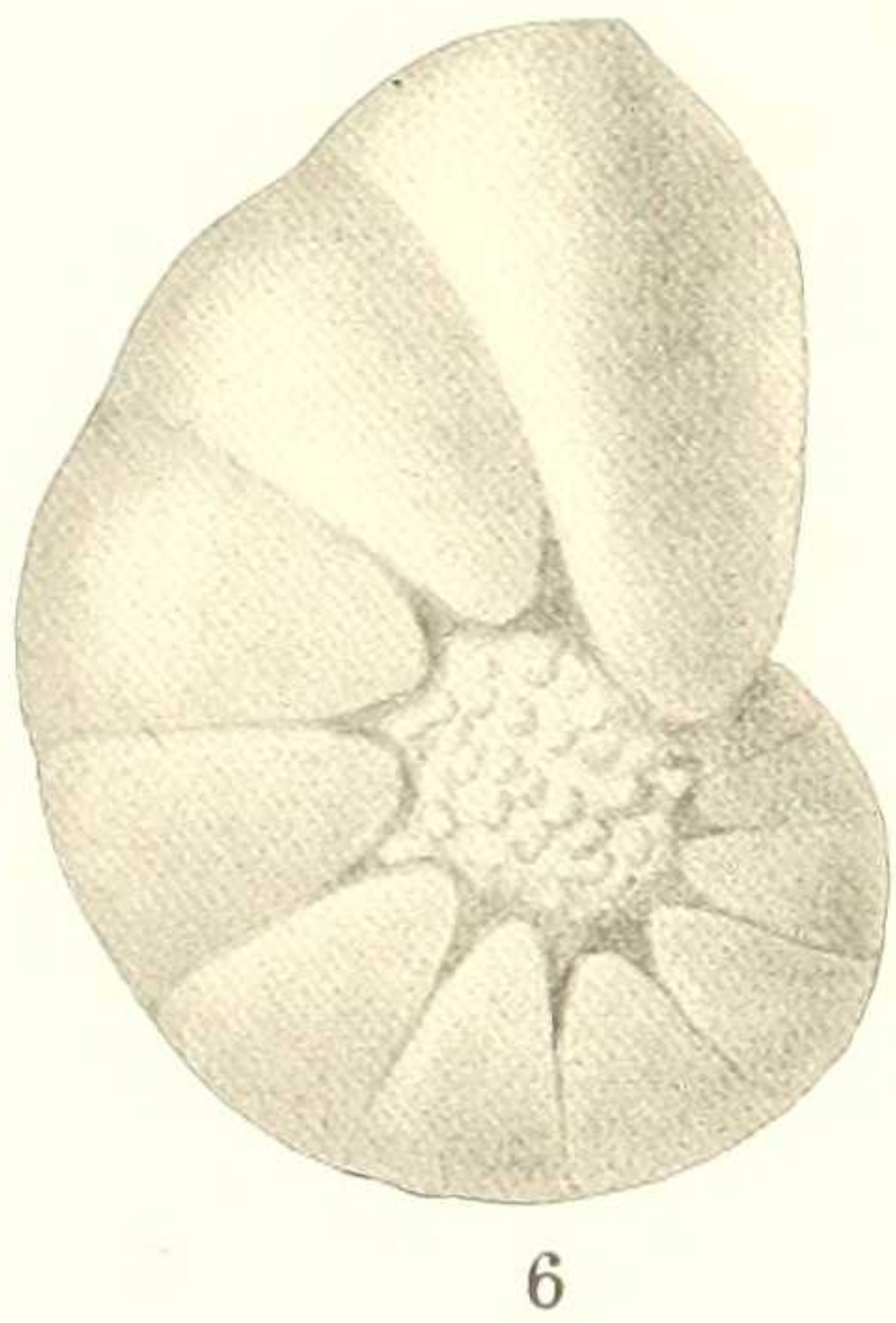
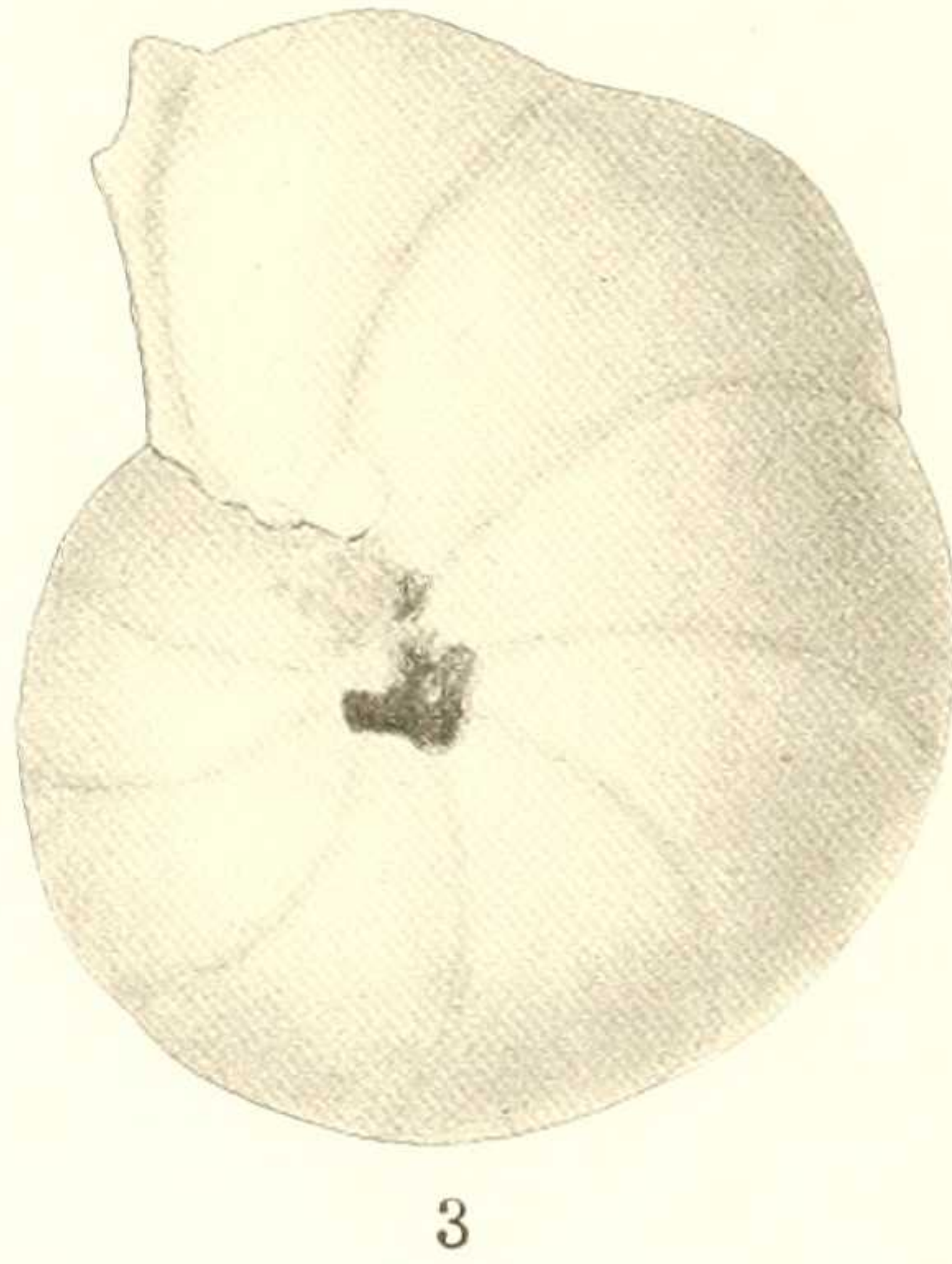
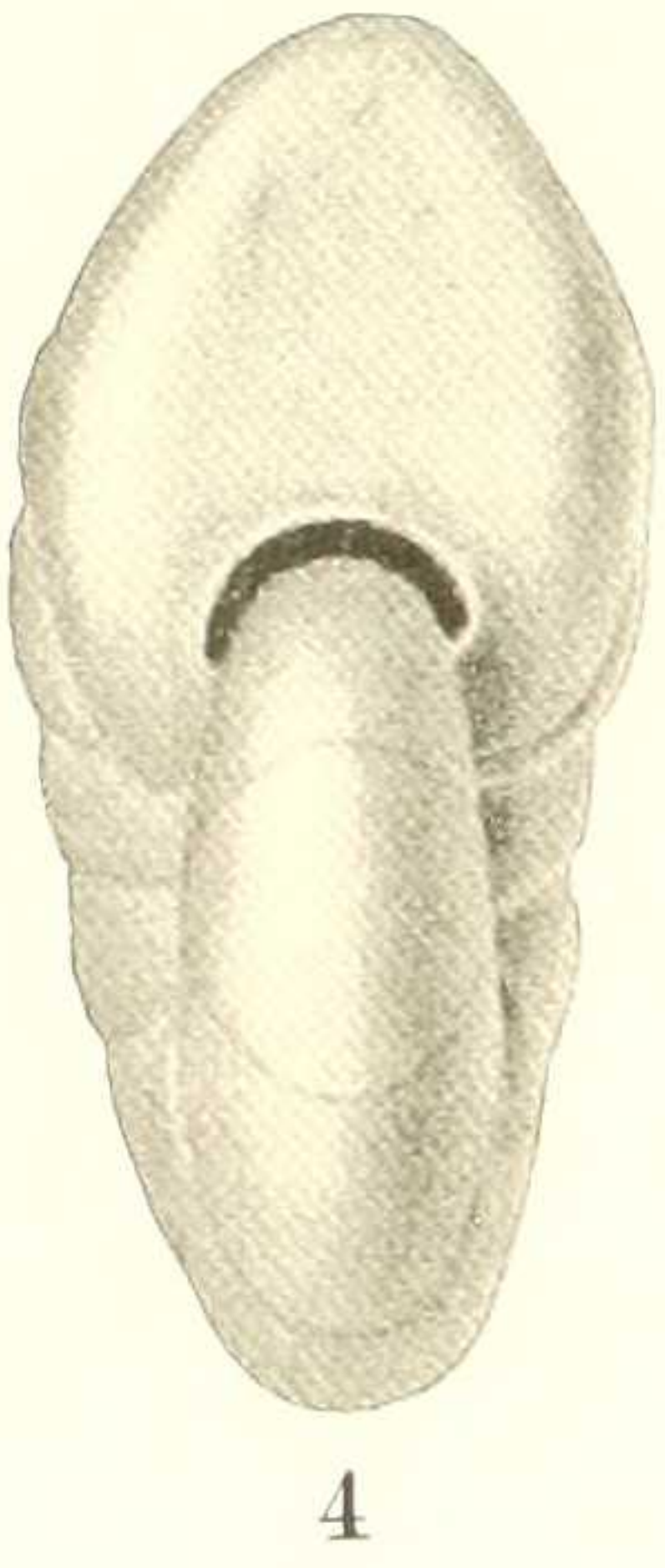
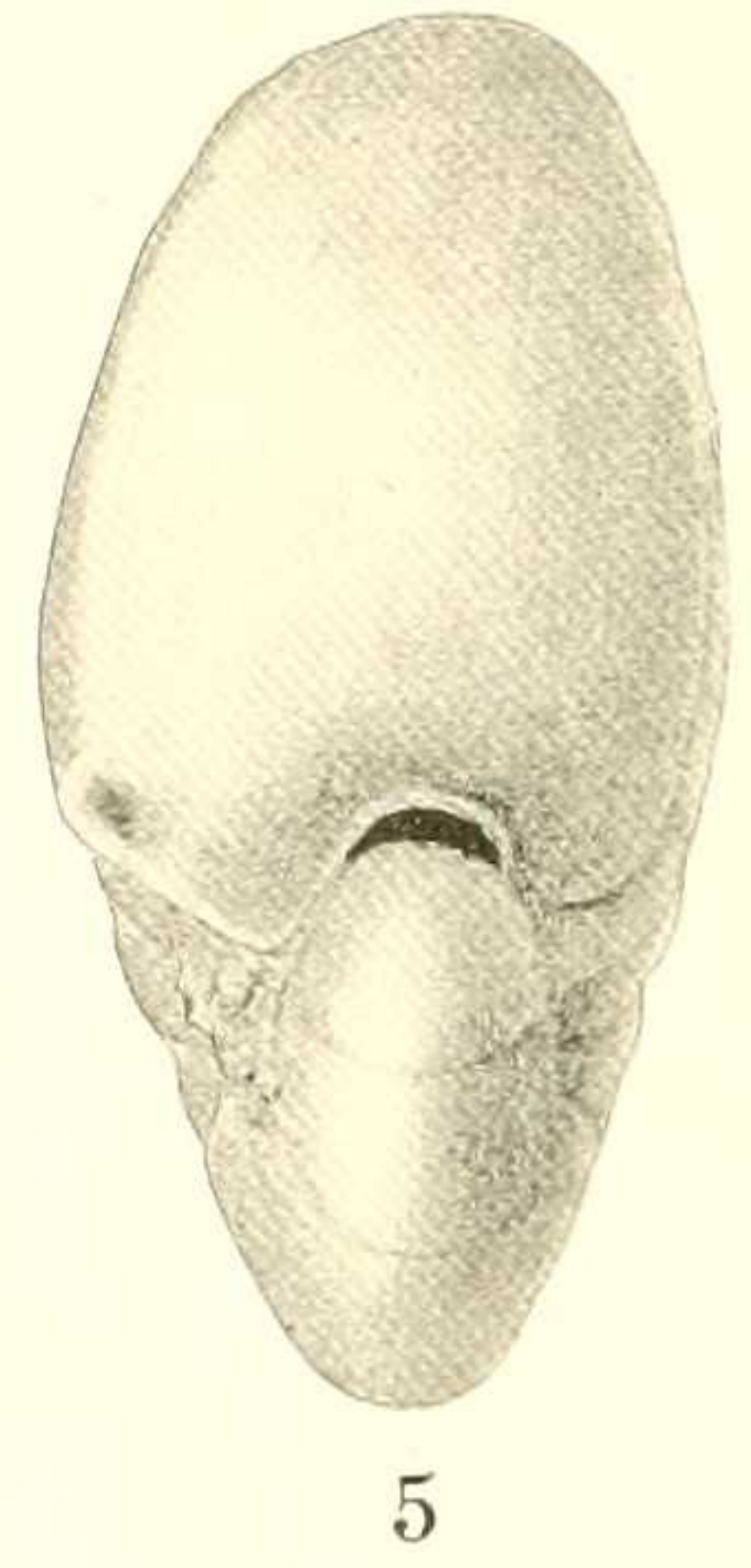
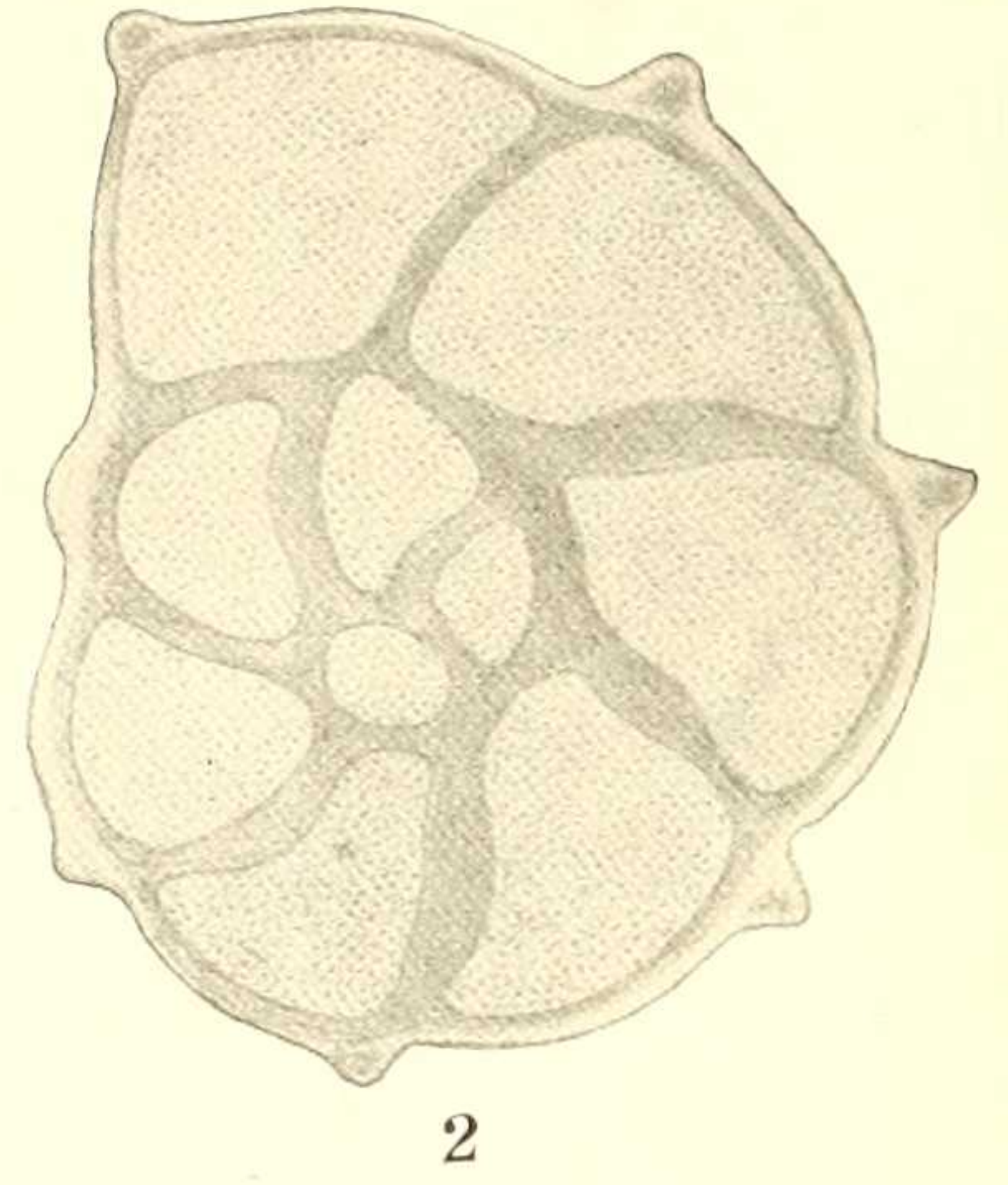
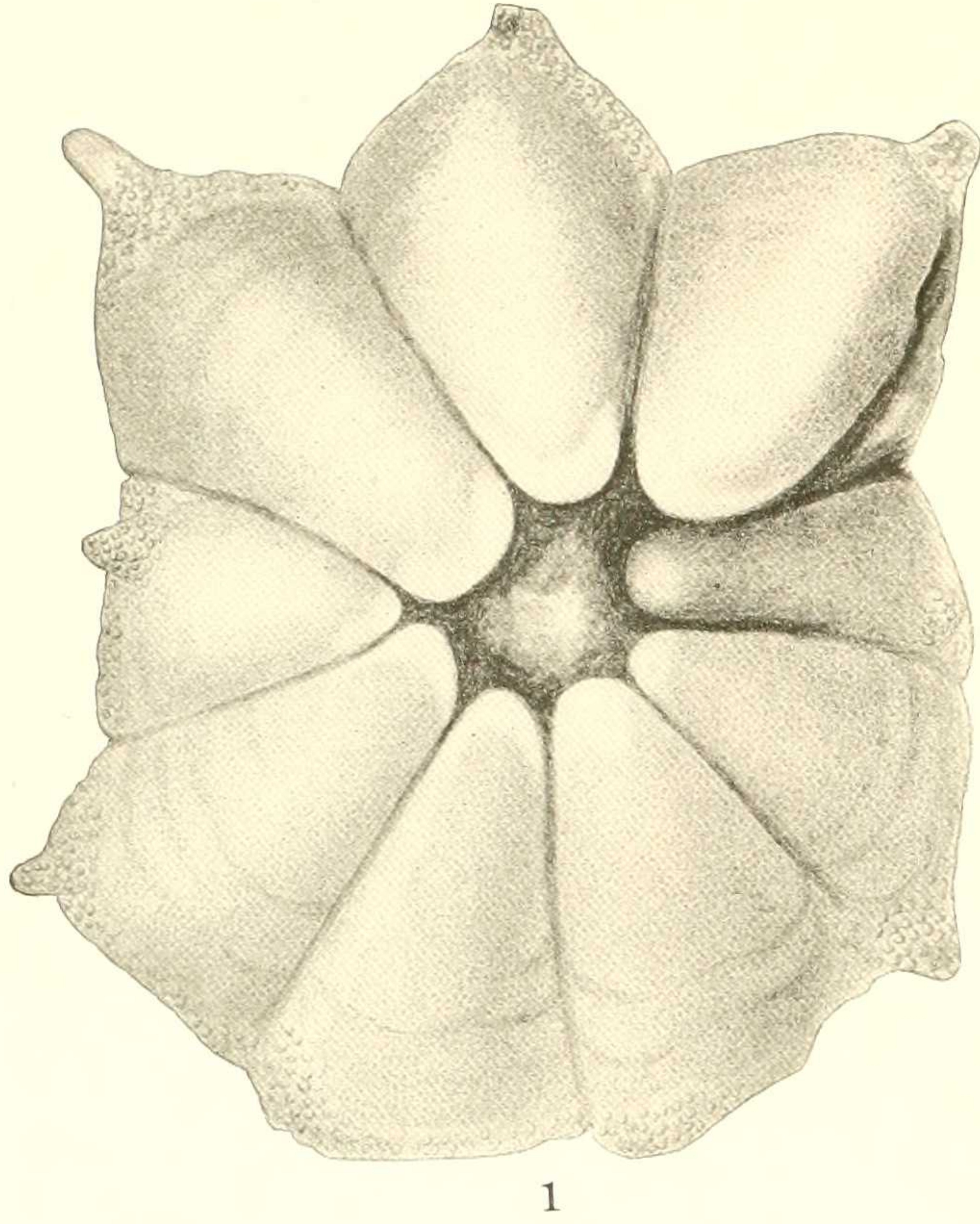


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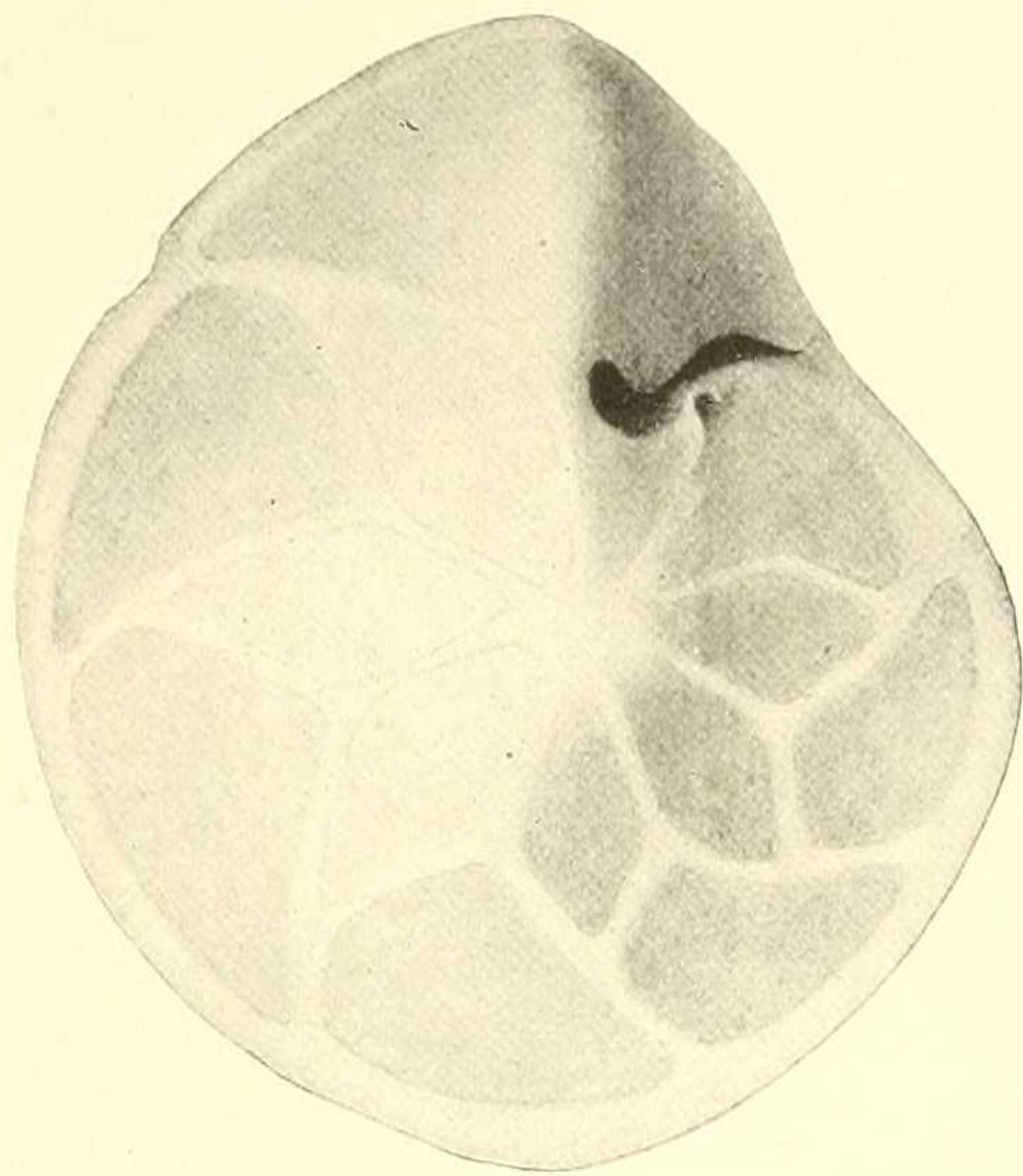
### PLATE XXIII.

- FIGURE 1. *Rotalia byramensis* Cushman, n. sp. Ventral view.  $\times 80$ .  
2. *Rotalia dentata* Parker and Jones? Dorsal view.  $\times 80$ .  
3. *Nonionina umbilicatula* (Montagu) Parker, Jones, and H. B. Brady. Side view.  $\times 80$ .  
4. *Nonionina umbilicatula* (Montagu) Parker, Jones, and H. B. Brady. Apertural view of another specimen.  
 $\times 80$ .  
5. *Nonionina scapha* (Fichtel and Moll) Parker and Jones. Apertural view.  $\times 80$ .  
6. *Nonionina scapha* (Fichtel and Moll) Parker and Jones. Side view of another specimen.  $\times 80$ .  
7. *Nonionina scapha* (Fichtel and Moll) Parker and Jones. Side view of a larger, more elongate specimen.  
 $\times 80$ .

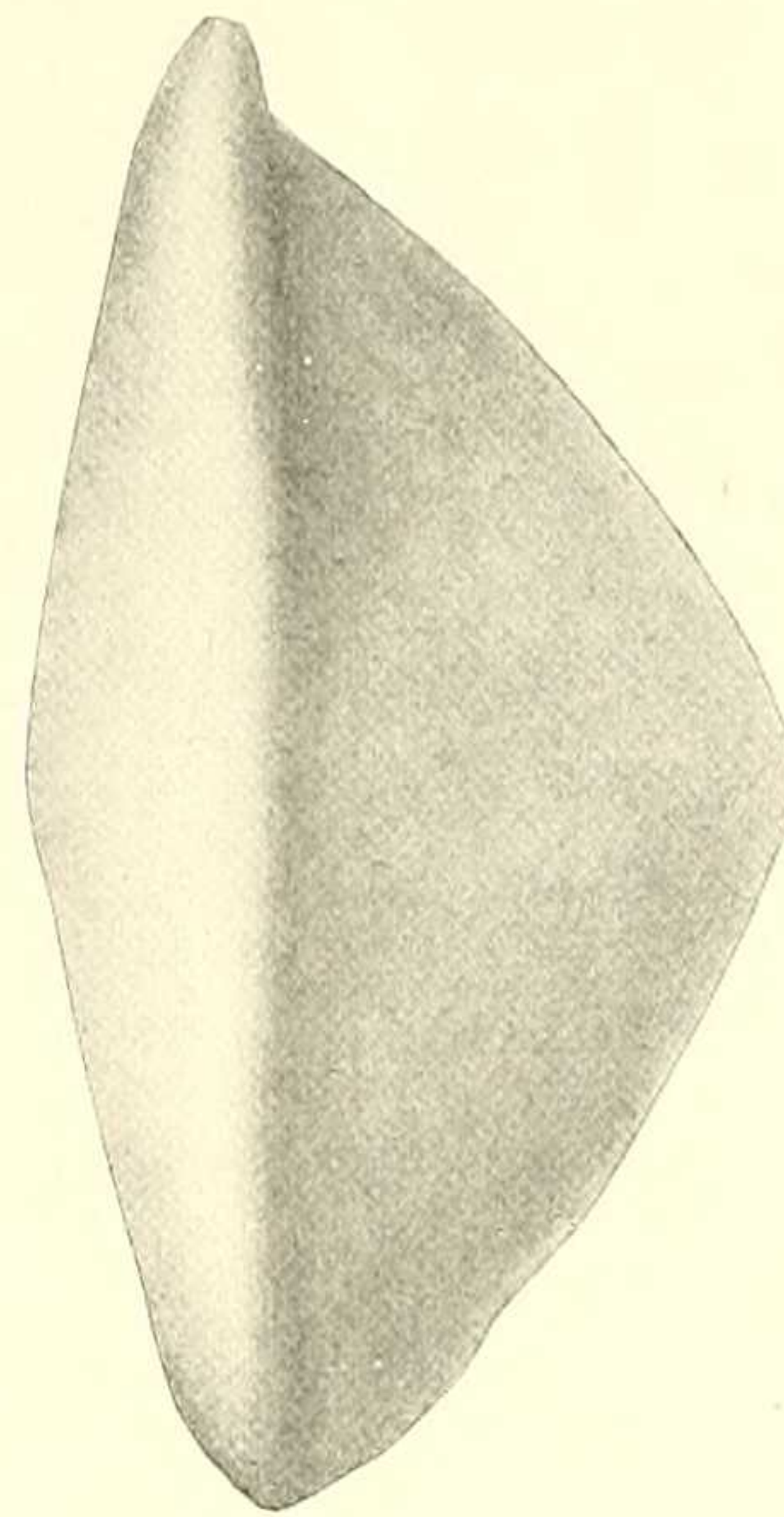


PLATE XXIV.

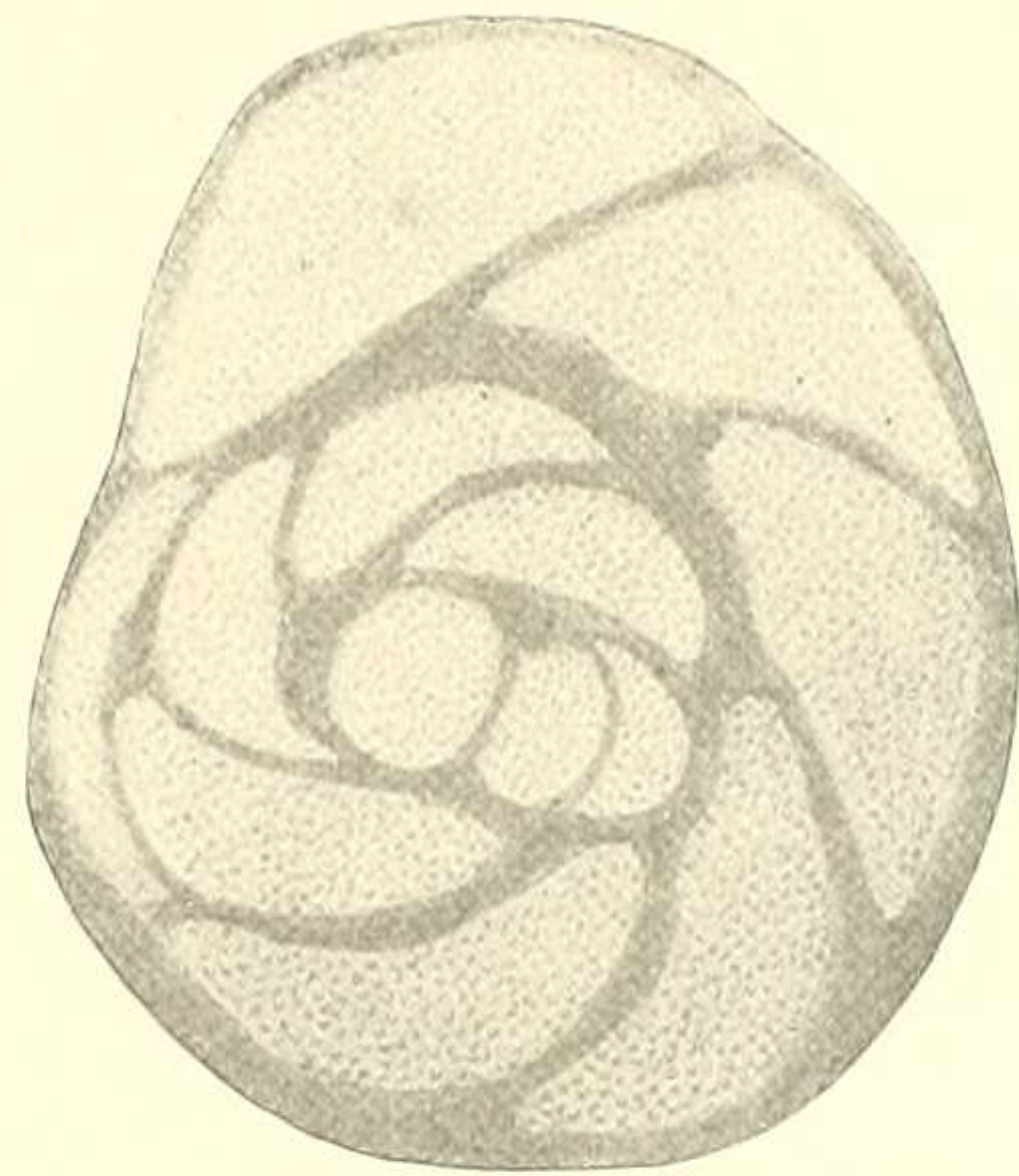
- FIGURE 1. *Asterigerina subacuta* Cushman, n. sp. Ventral view.  $\times 80$ .  
2. *Asterigerina subacuta* Cushman, n. sp. Dorsal view of a small specimen.  $\times 80$ .  
3. *Asterigerina subacuta* Cushman, n. sp. Side view of another specimen showing the general shape.  $\times 80$ .  
4. *Nummulites* sp. Side view of a somewhat eroded specimen.  $\times 40$ .



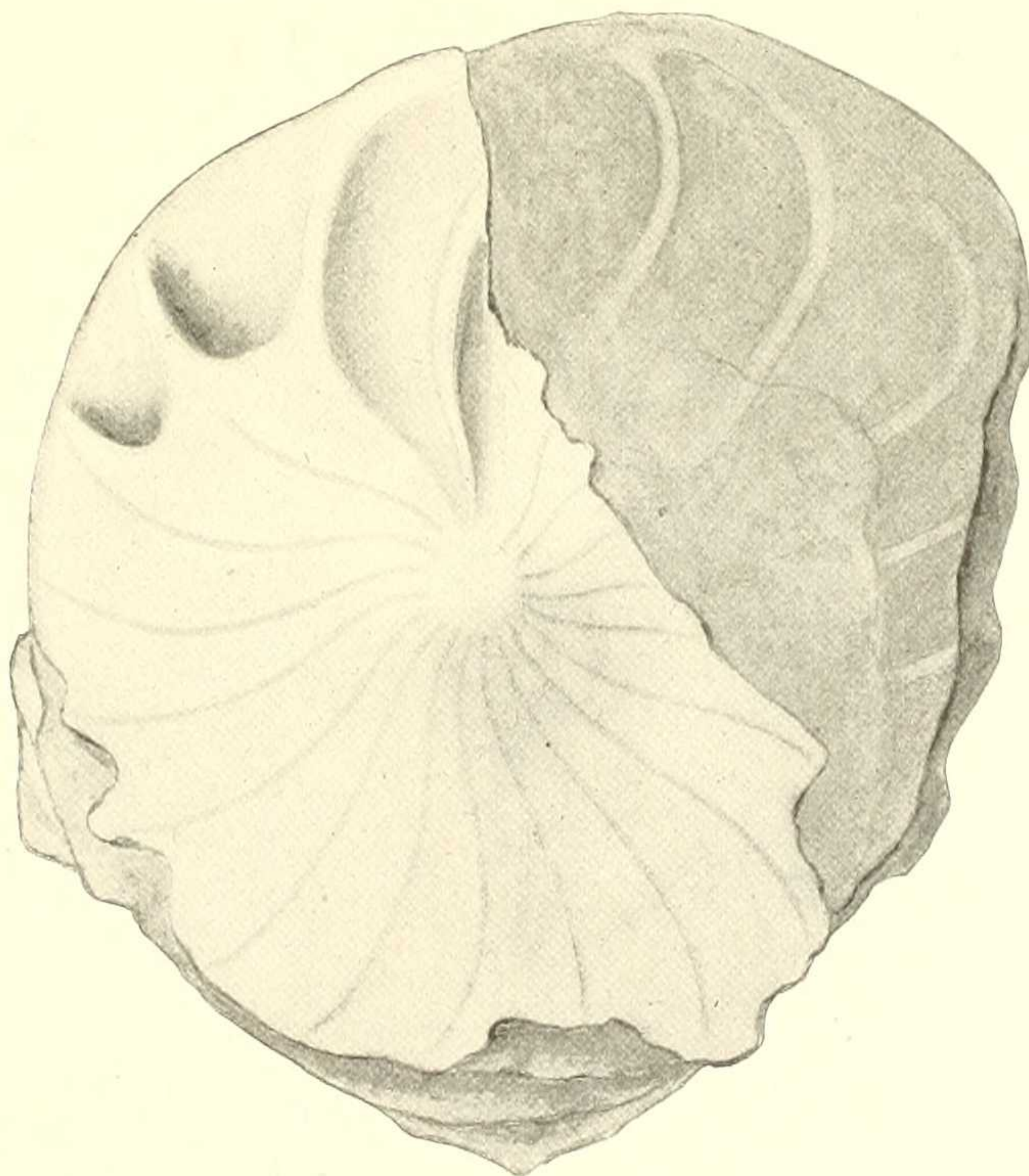
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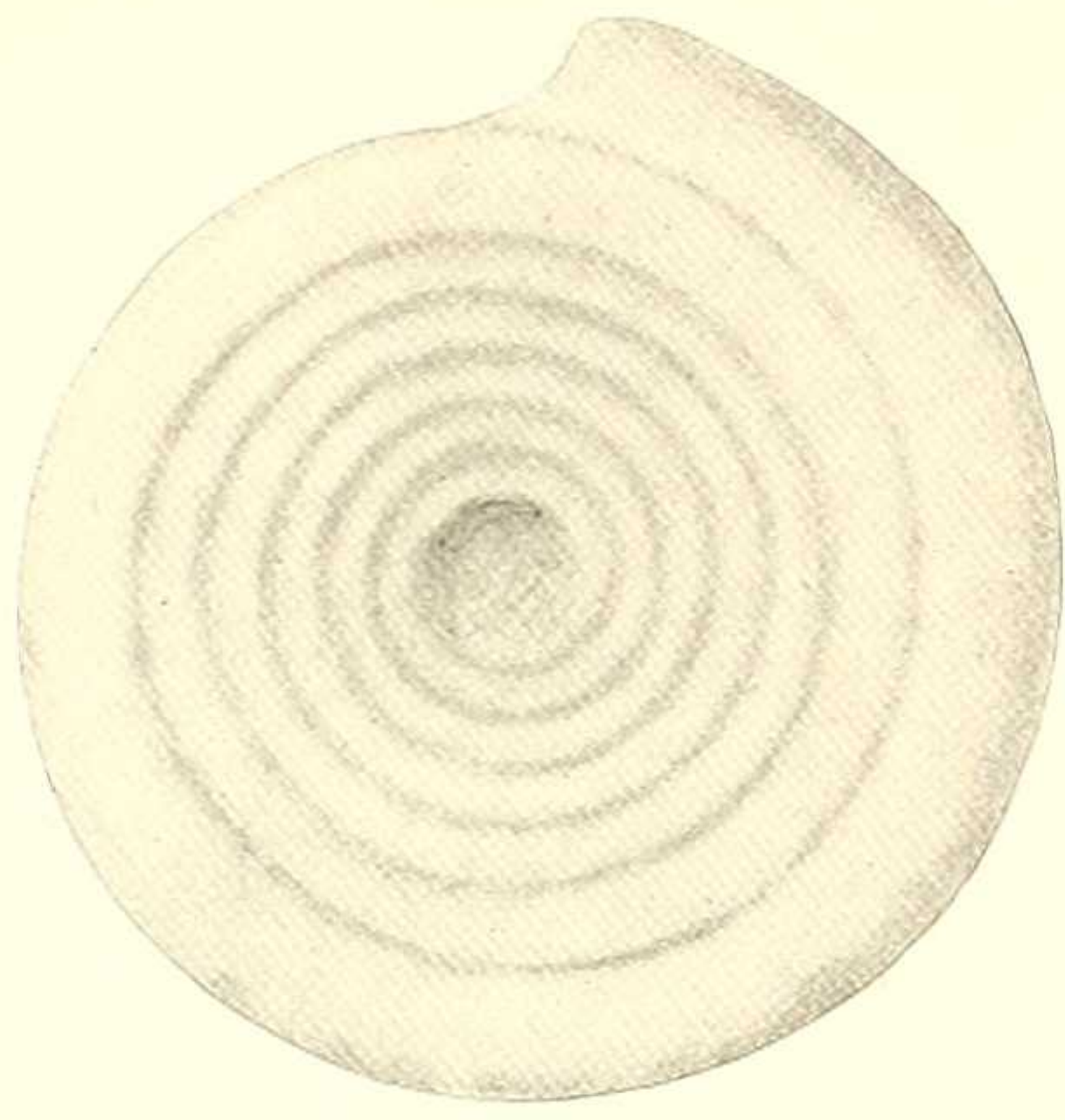


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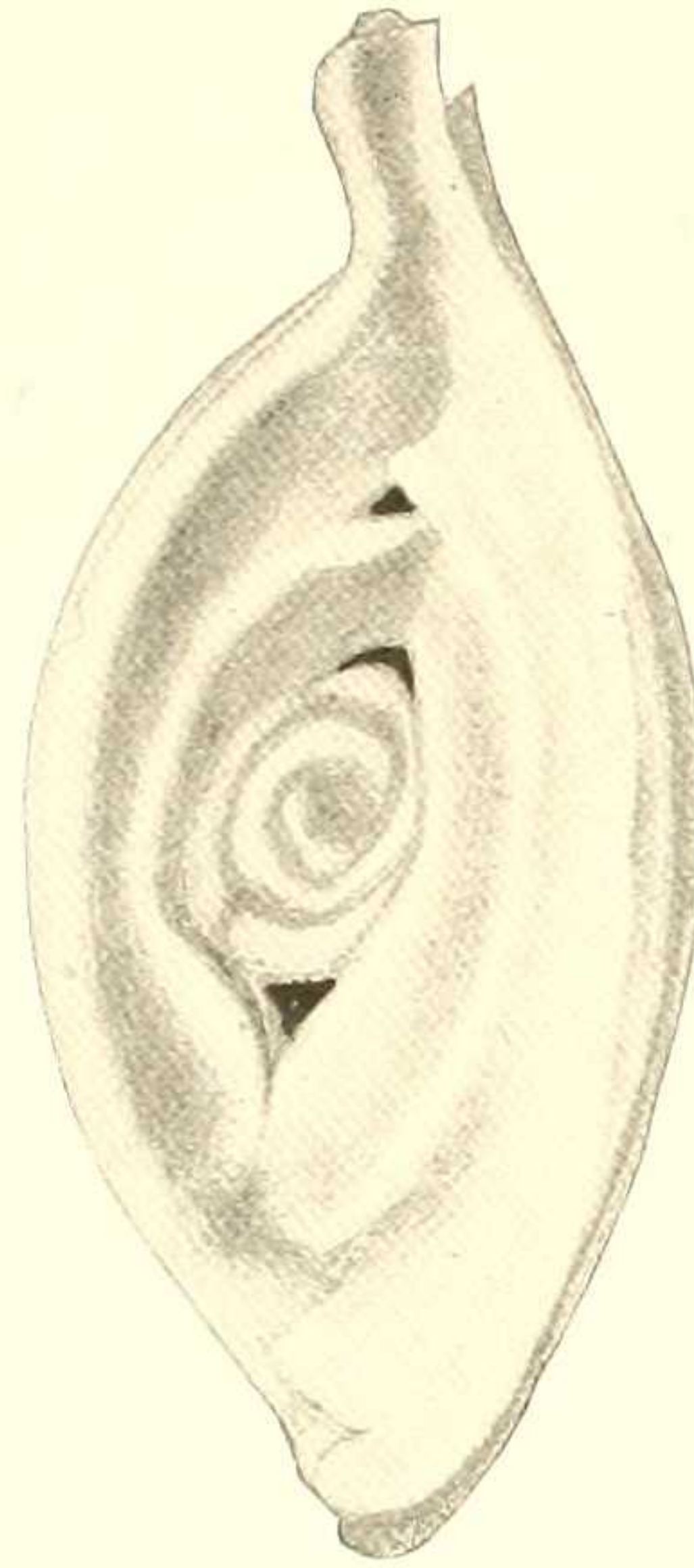


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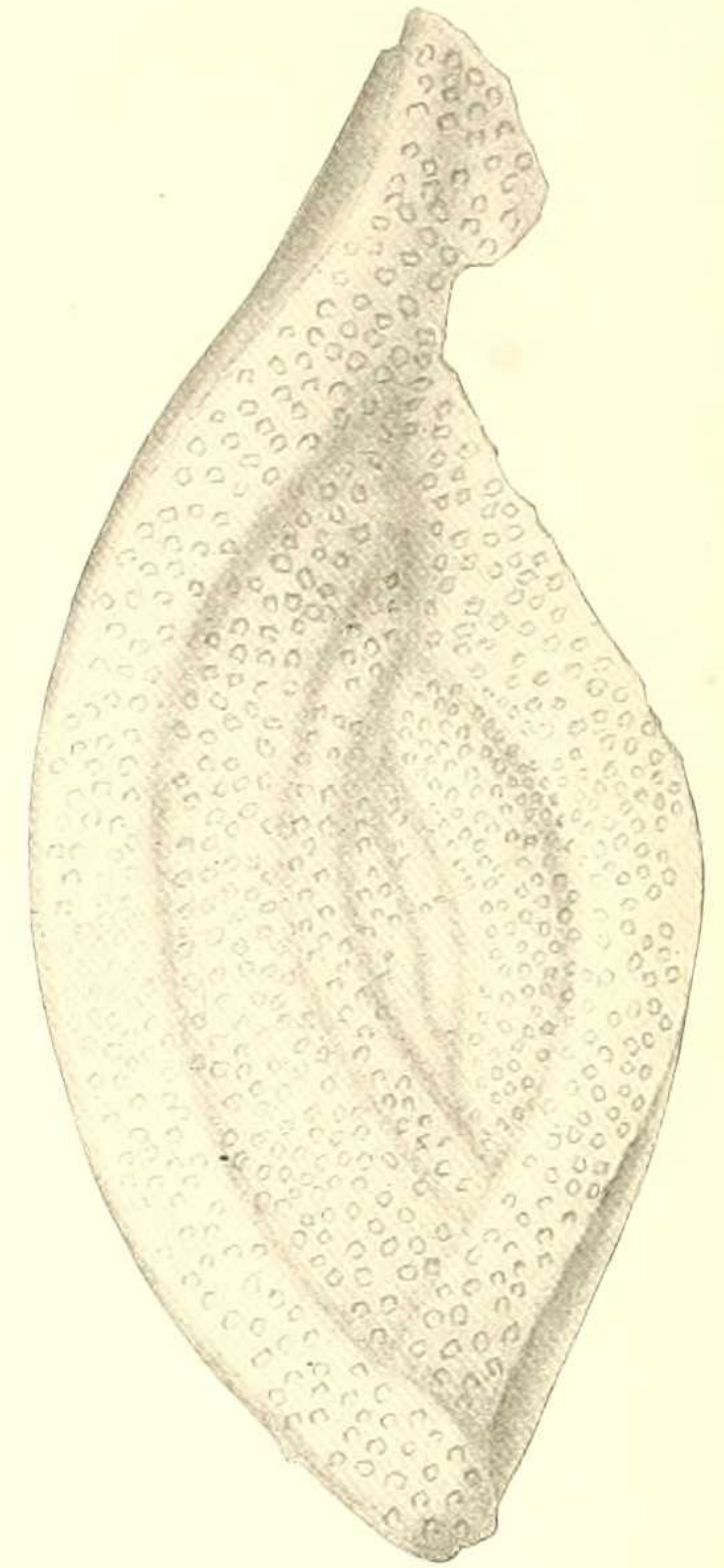
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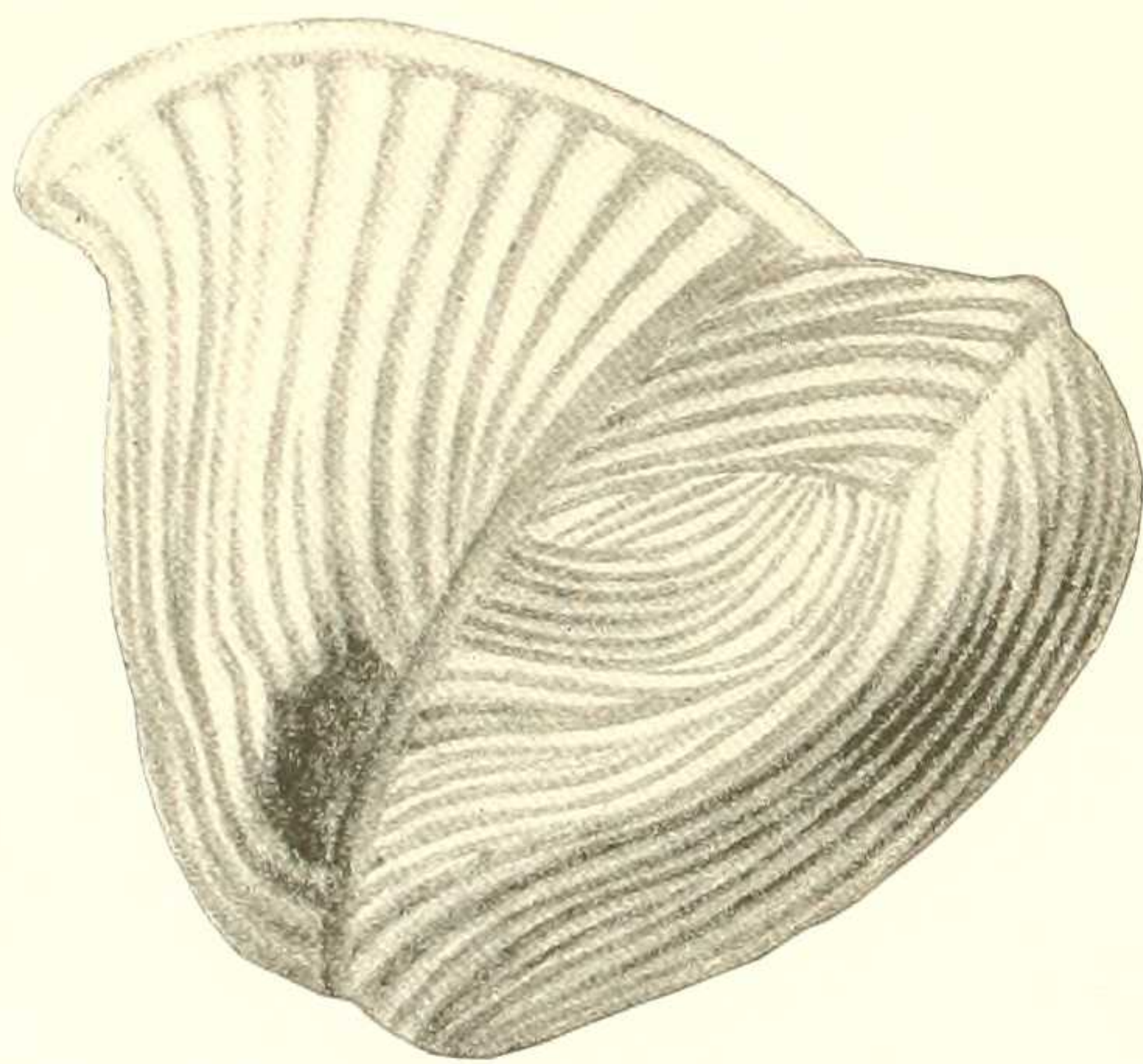
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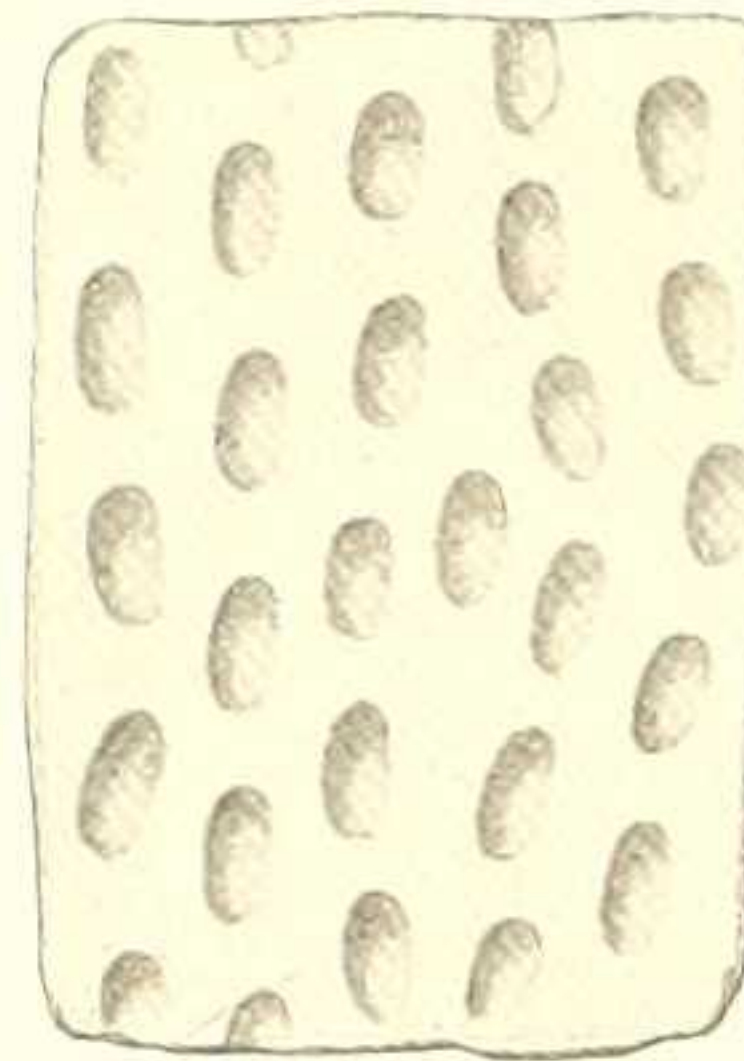
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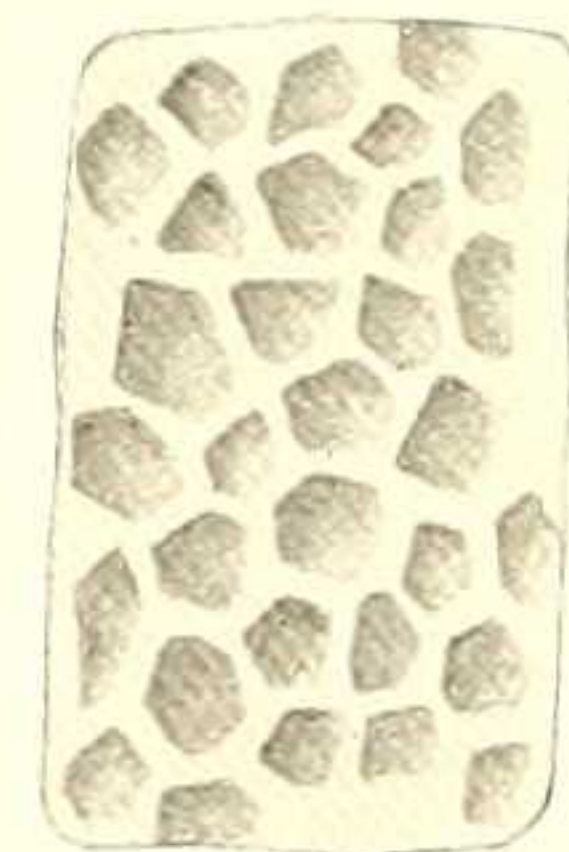
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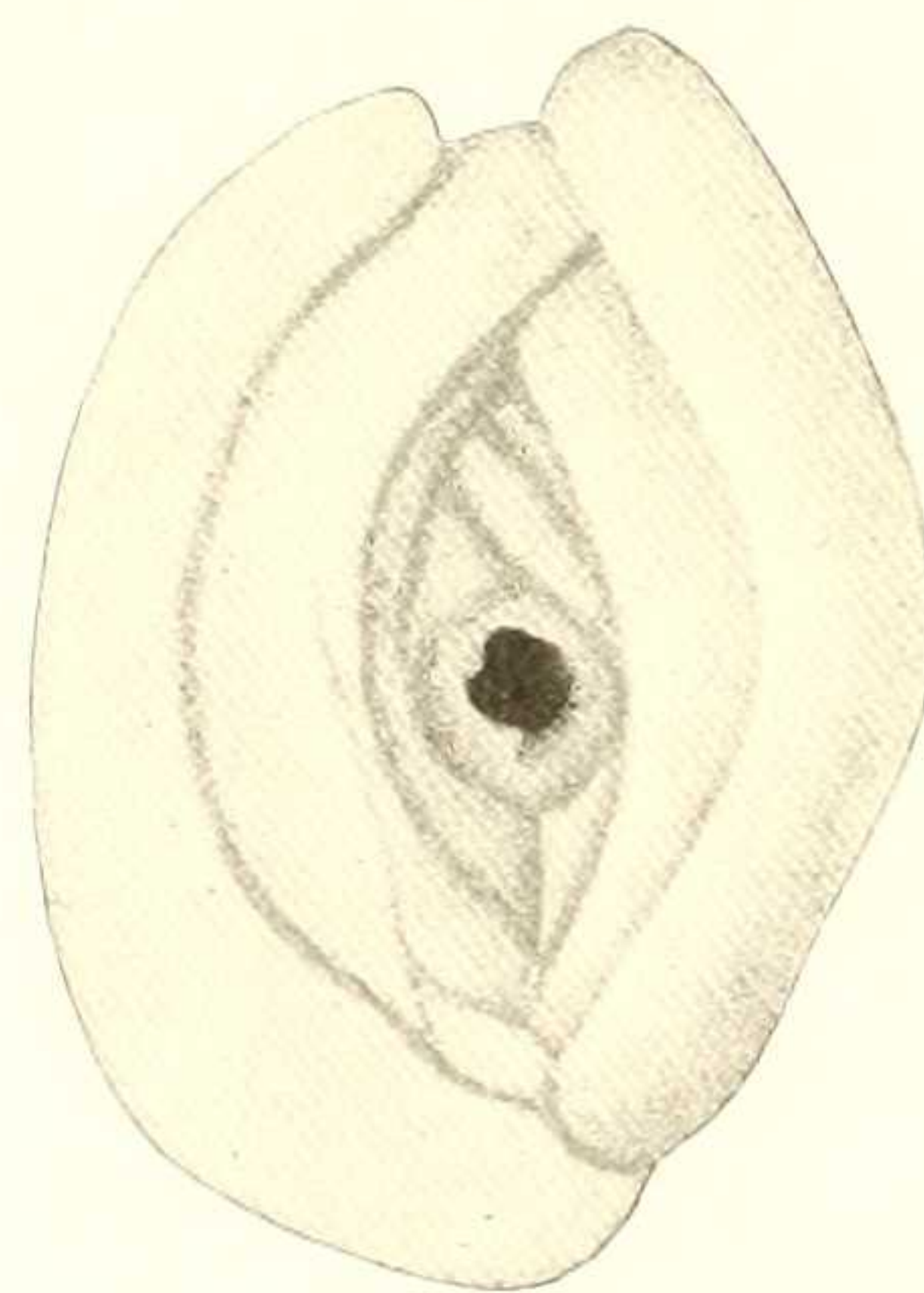
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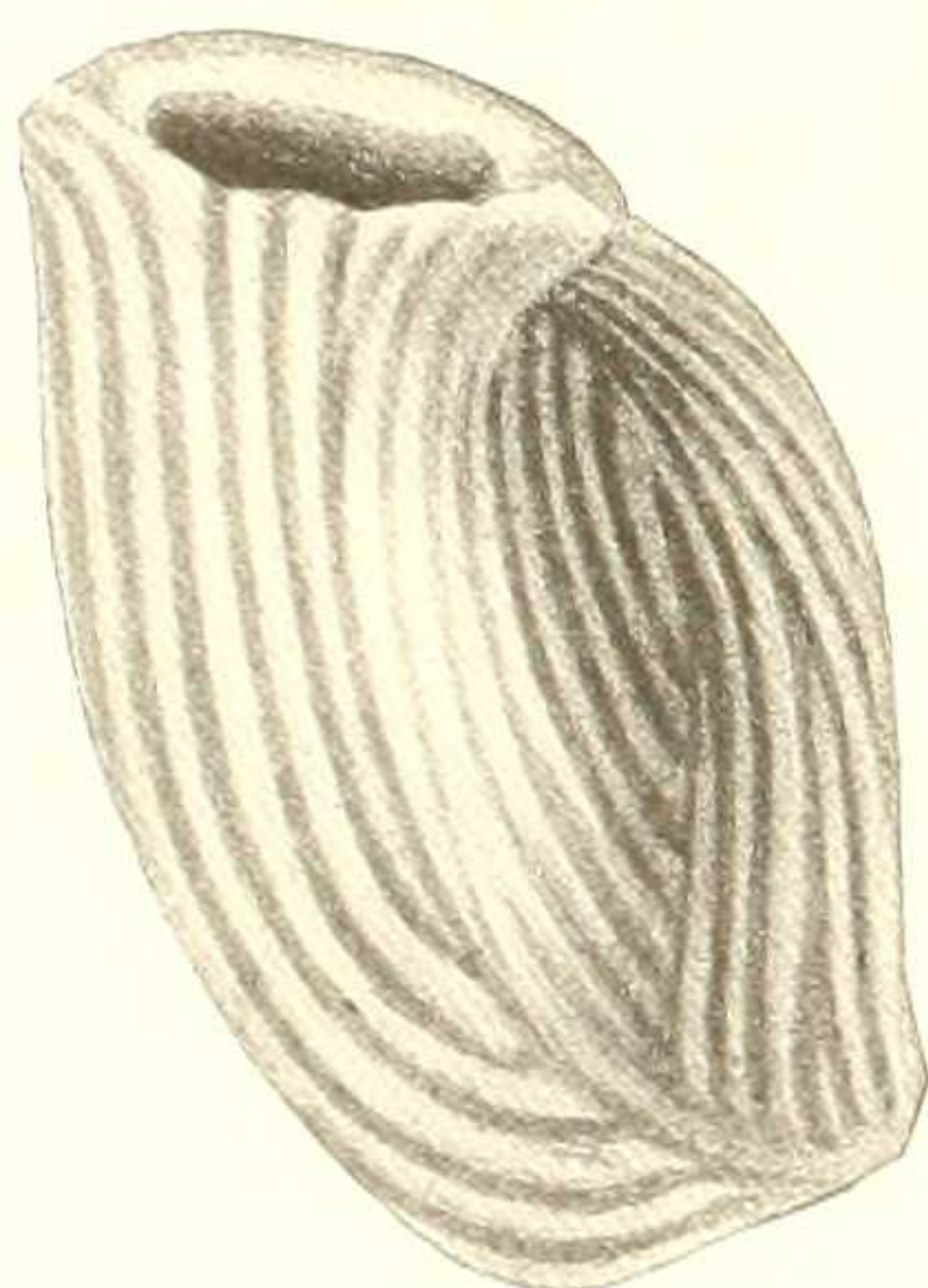
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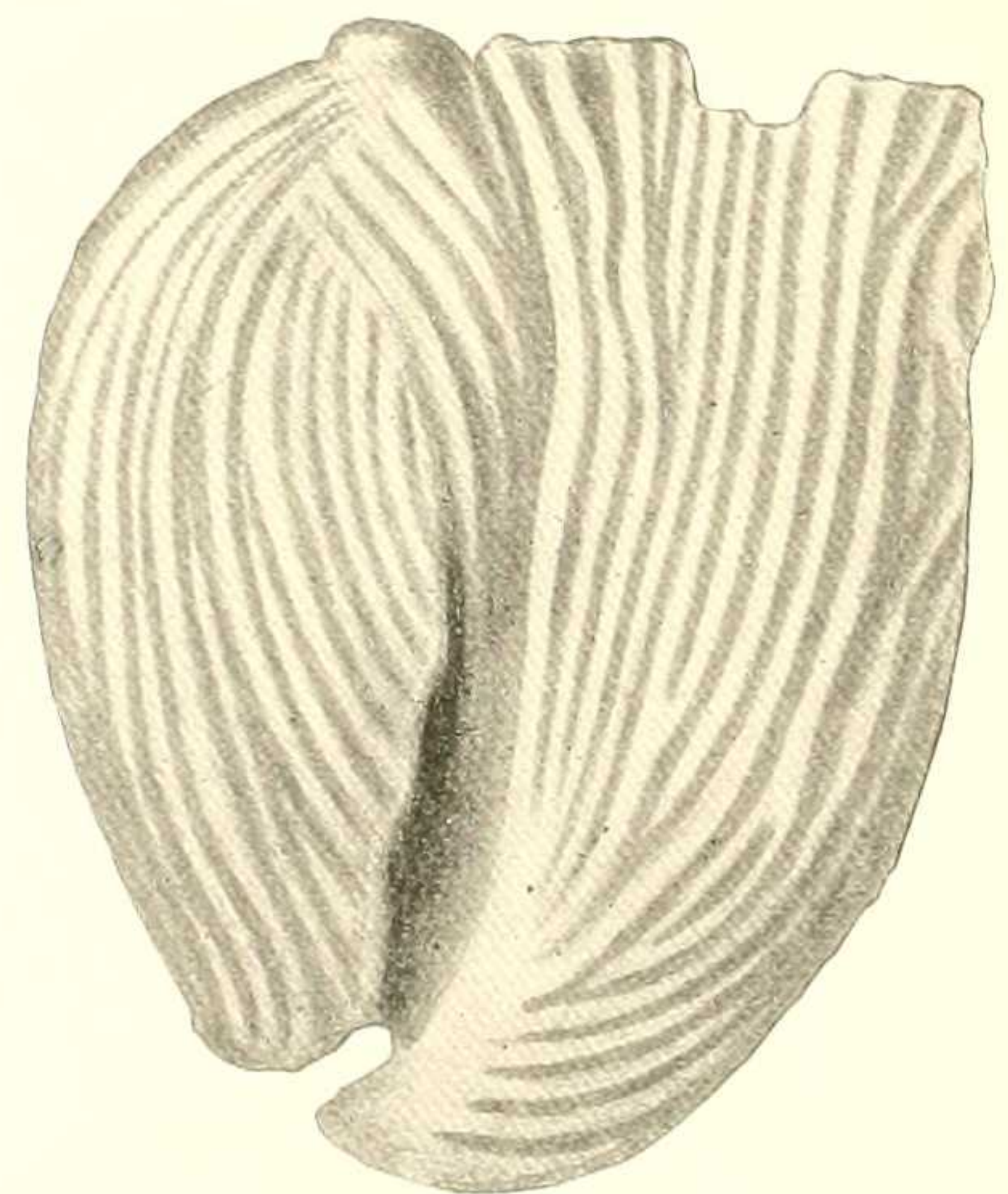
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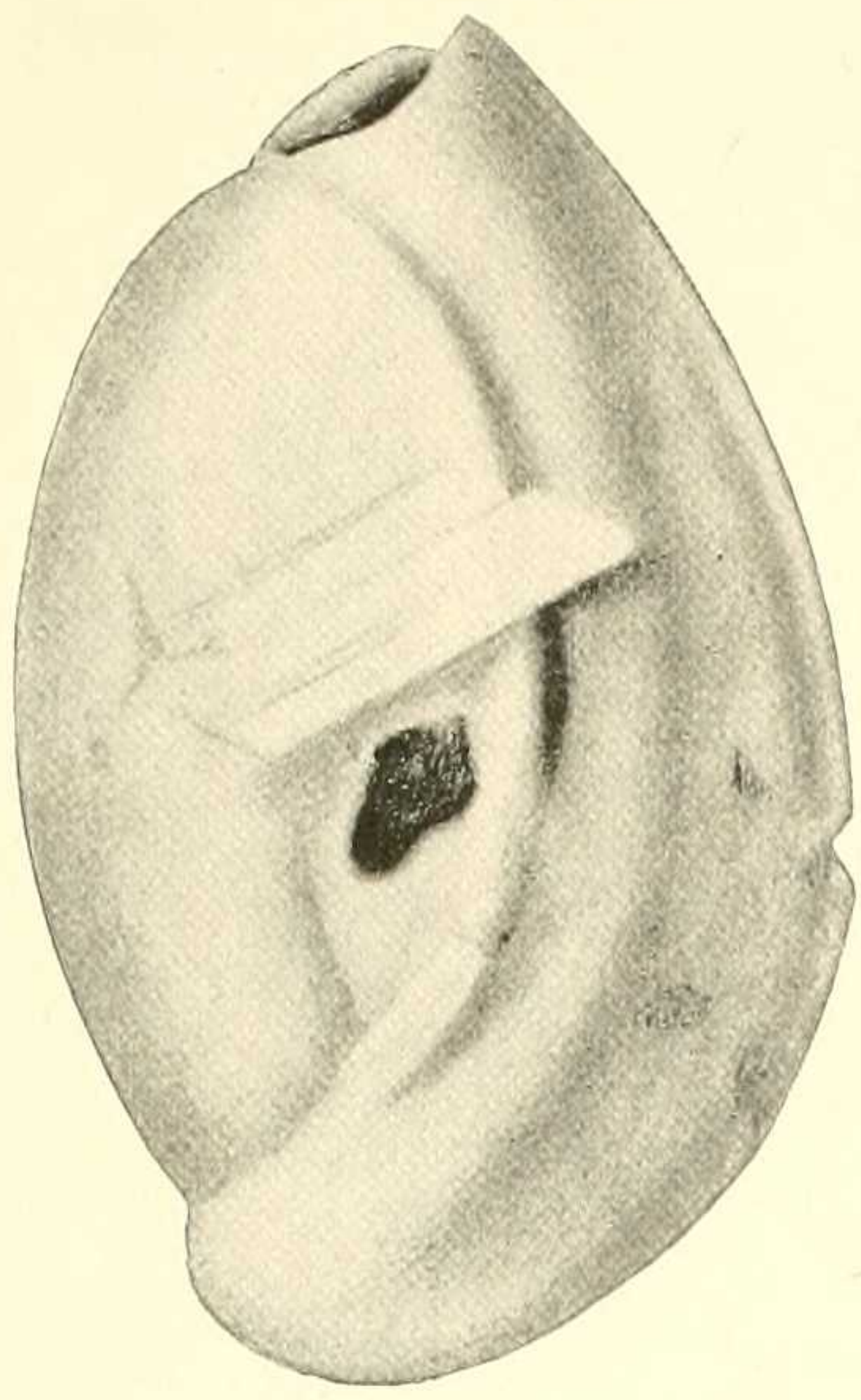
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## PLATE XXV.

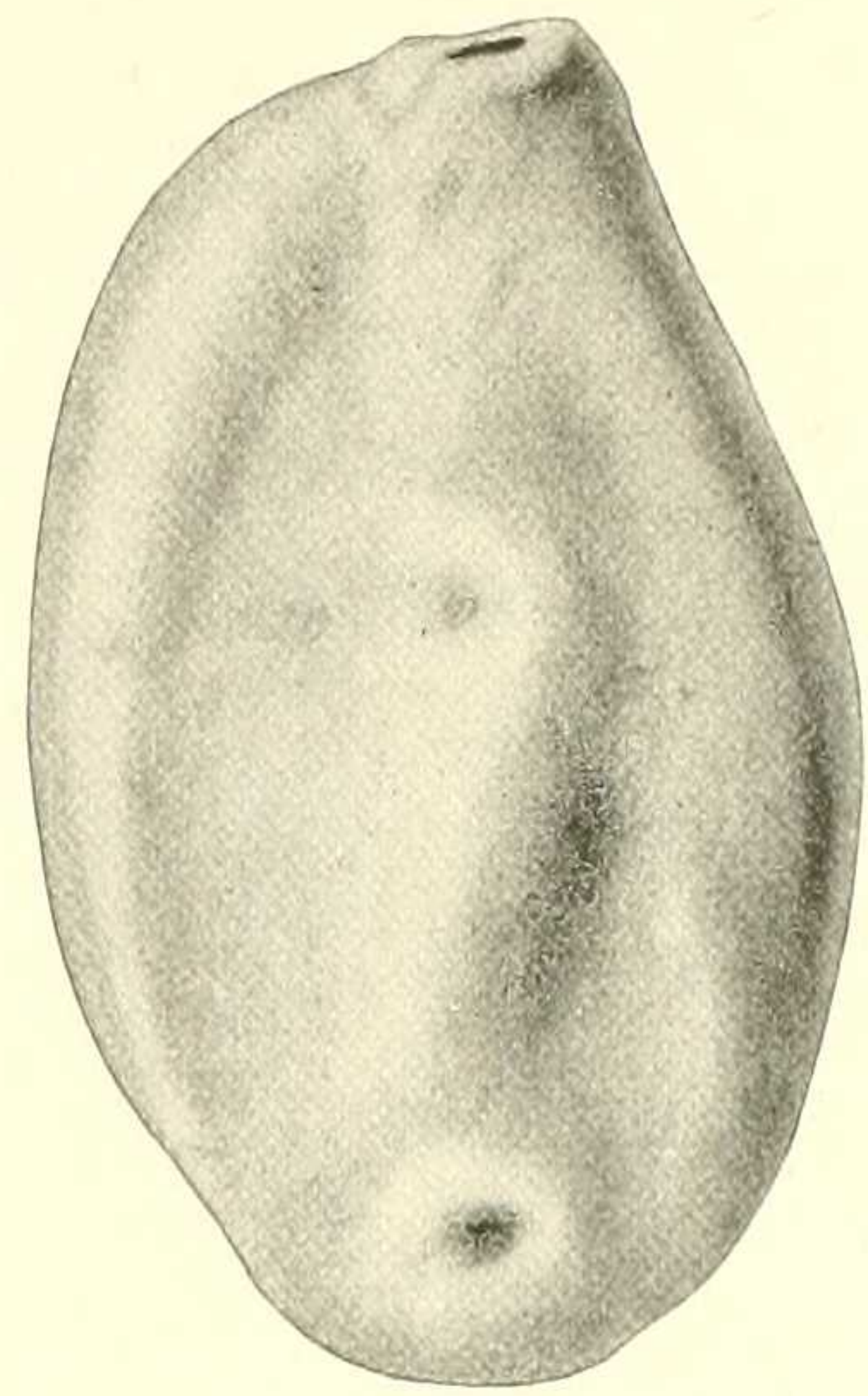
- FIGURE 1. *Cornuspira involvens* Reuss. Side view.  $\times 100$ .  
2. *Spiroloculina grateloupi* D'Orbigny. Side view.  $\times 80$ .  
3. *Spiroloculina imprimata* Cushman, n. sp. *a*, Side view.  $\times 40$ . *b*, Surface detail.  $\times 200$ .  
4. *Spiroloculina byramensis* Cushman, n. sp. *a*, Side view of a partly broken specimen.  $\times 40$ . *b*, Surface detail.  $\times 200$ .  
5. *Vertebralina advena* Cushman, n. sp. Side view of an adult specimen.  $\times 80$ .  
6. *Vertebralina advena* Cushman, n. sp. Side view of a young specimen.  $\times 80$ .  
7. *Vertebralina* sp.? Side view showing ornamentation.  $\times 80$ .

PLATE XXVI.

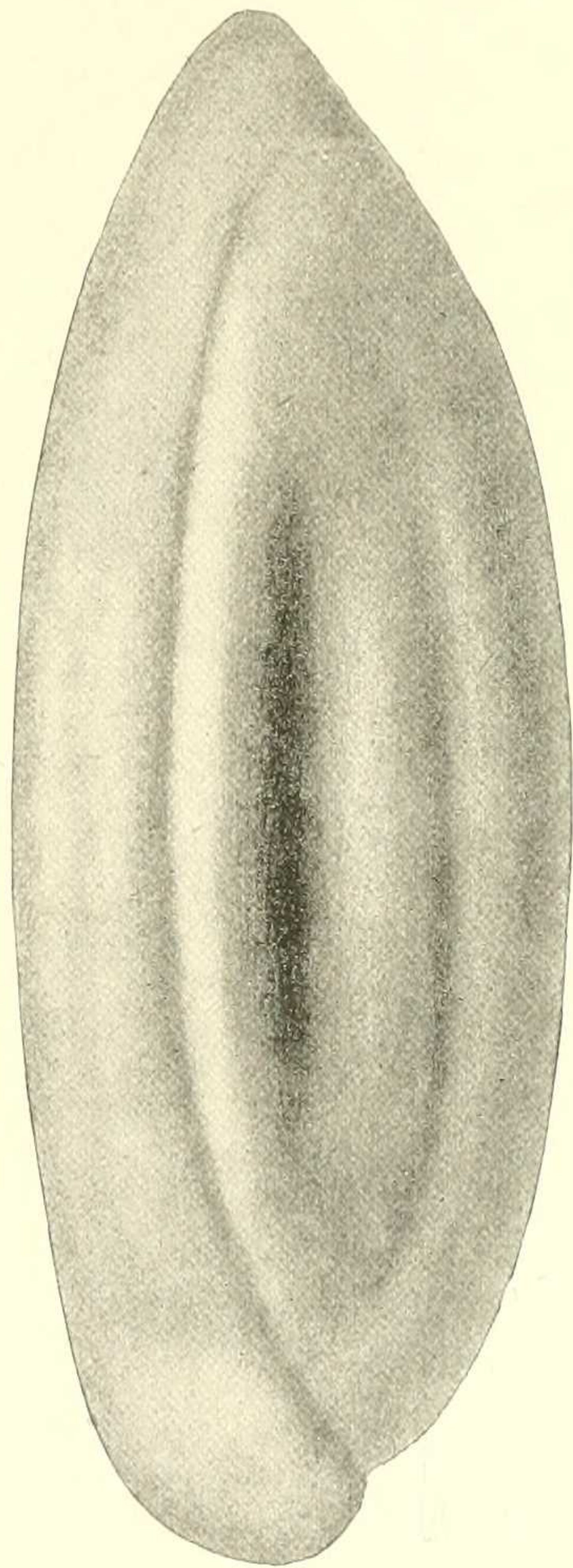
- FIGURE 1. *Quinqueloculina cuvieriana* D'Orbigny. Side view.  $\times 80$ .  
2. *Quinqueloculina bicostata* D'Orbigny. Side view.  $\times 80$ .  
3. *Quinqueloculina bicostata* D'Orbigny. Apertural view of a third specimen.  $\times 80$ .  
4. *Quinqueloculina bicostata* D'Orbigny. Opposite side of another specimen.  $\times 80$ .  
5. *Quinqueloculina venusta* Karrer? var. Side view.  $\times 80$ .  
6. *Quinqueloculina* sp.? Side view.  $\times 40$ .



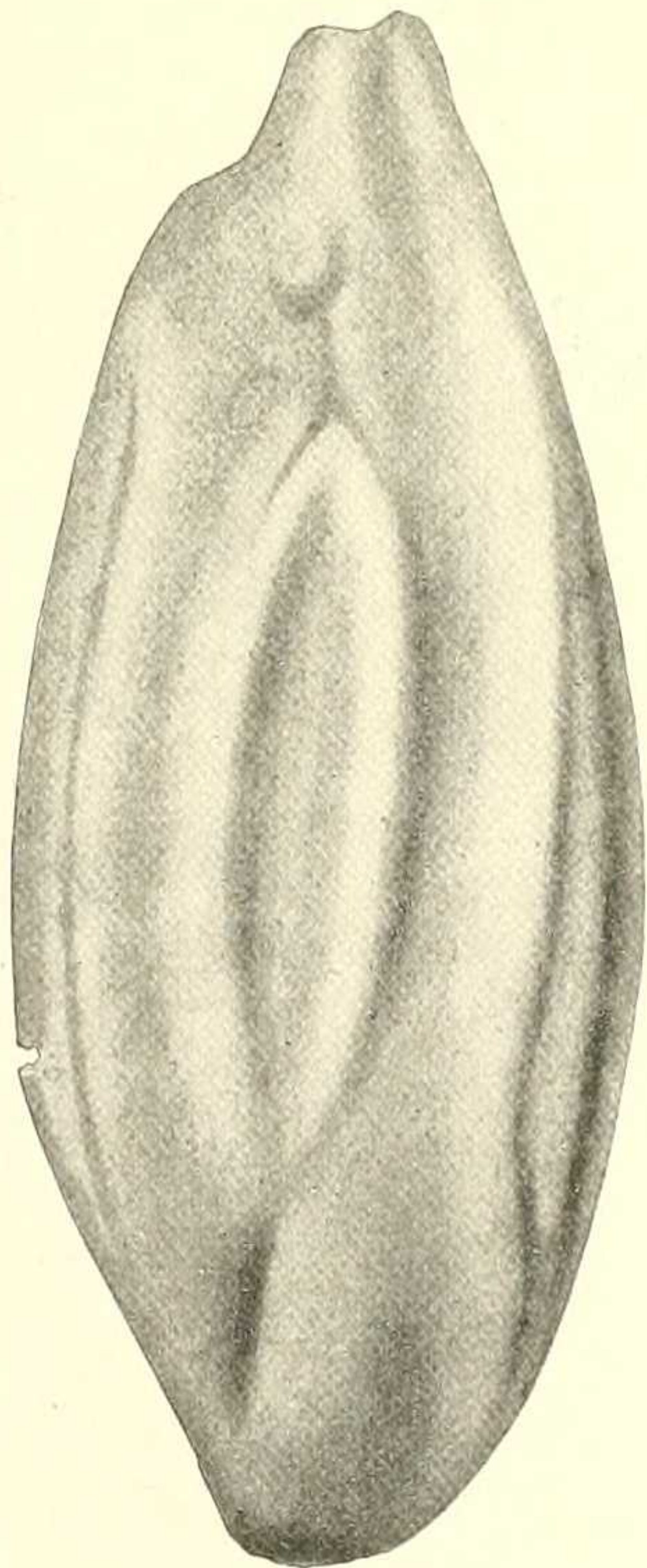
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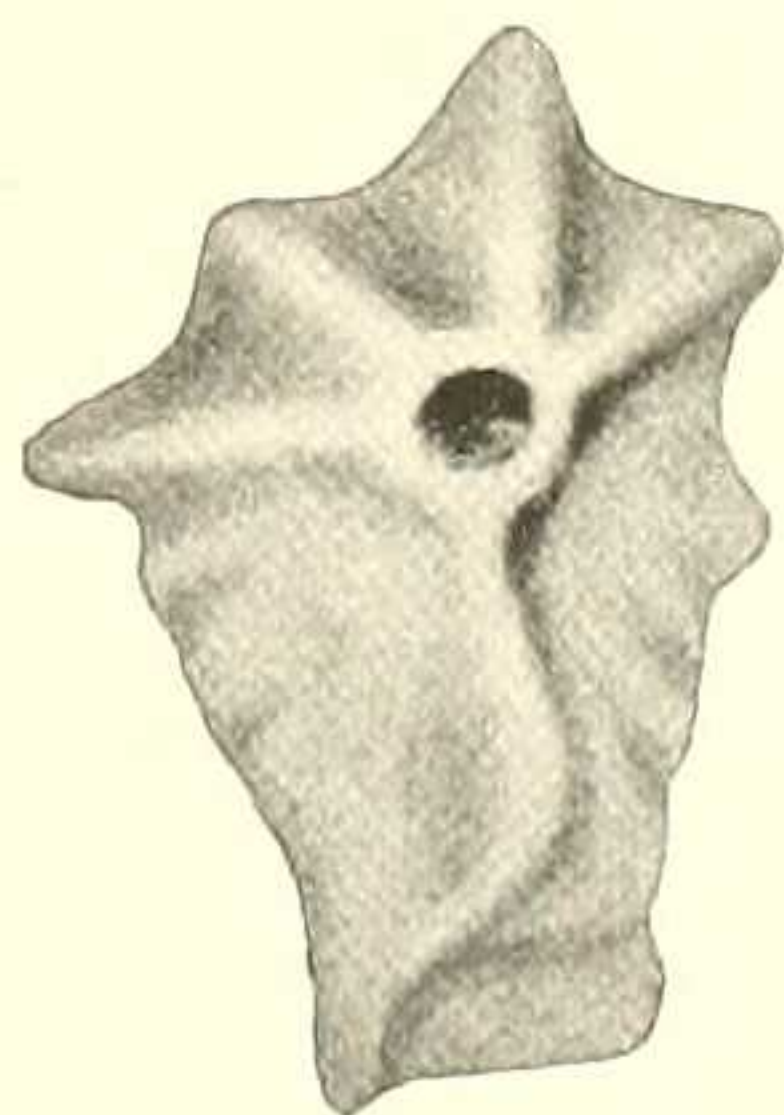
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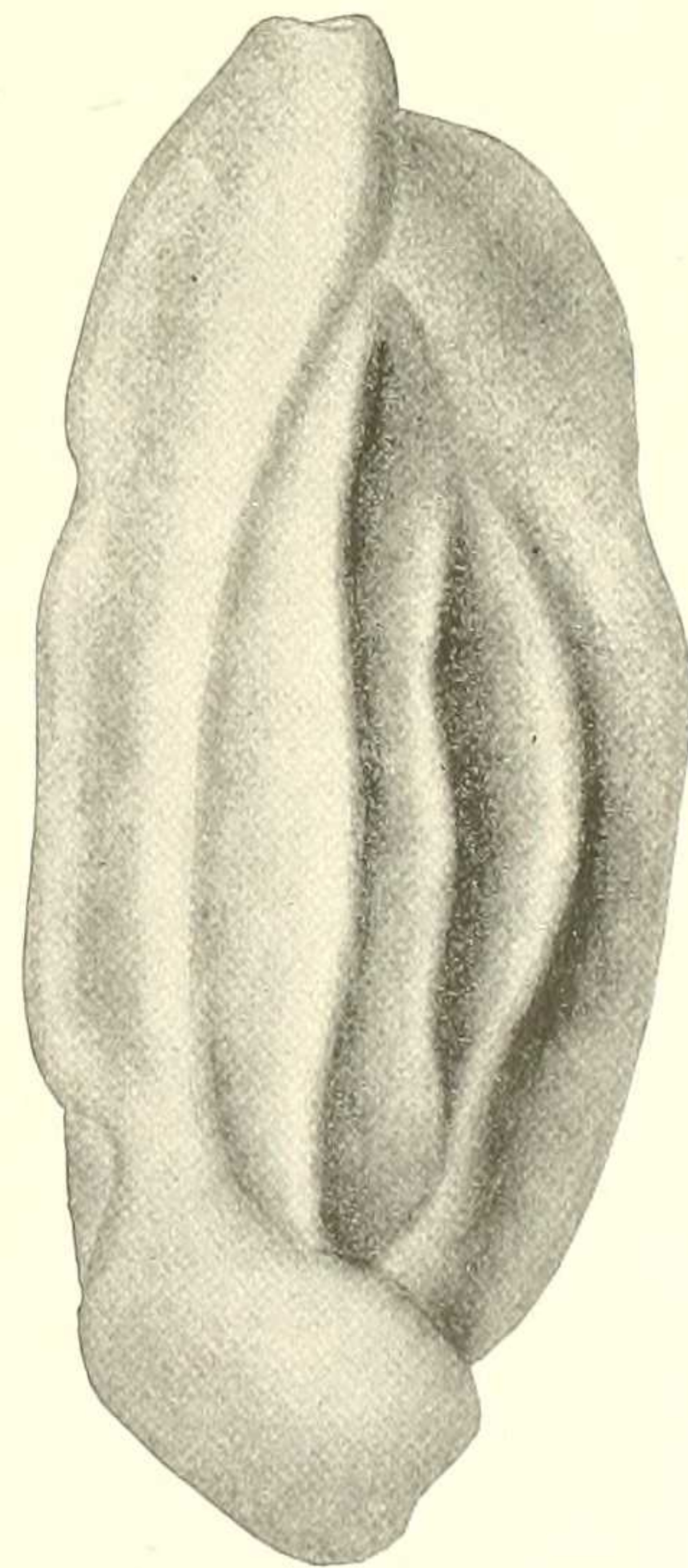
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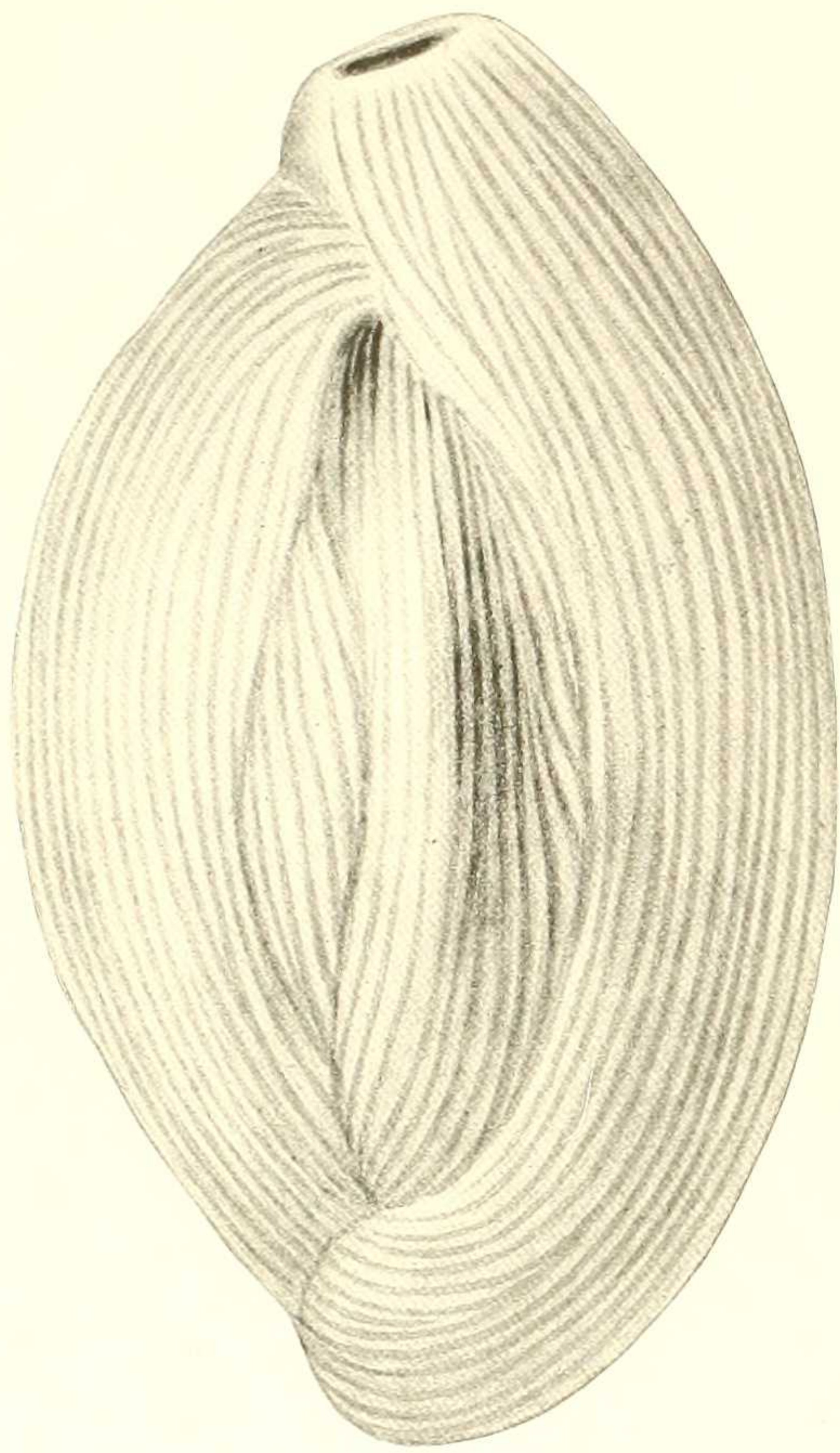


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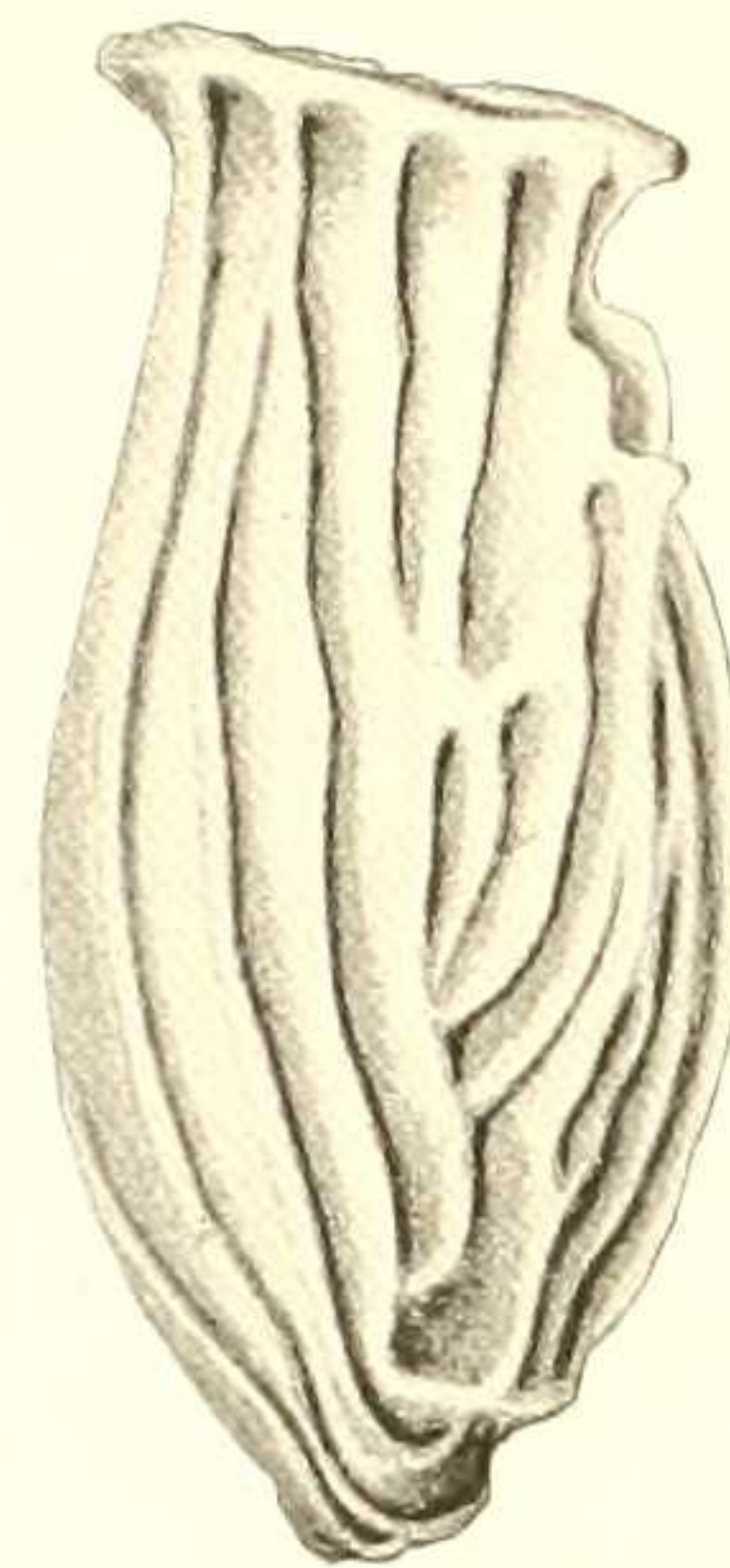


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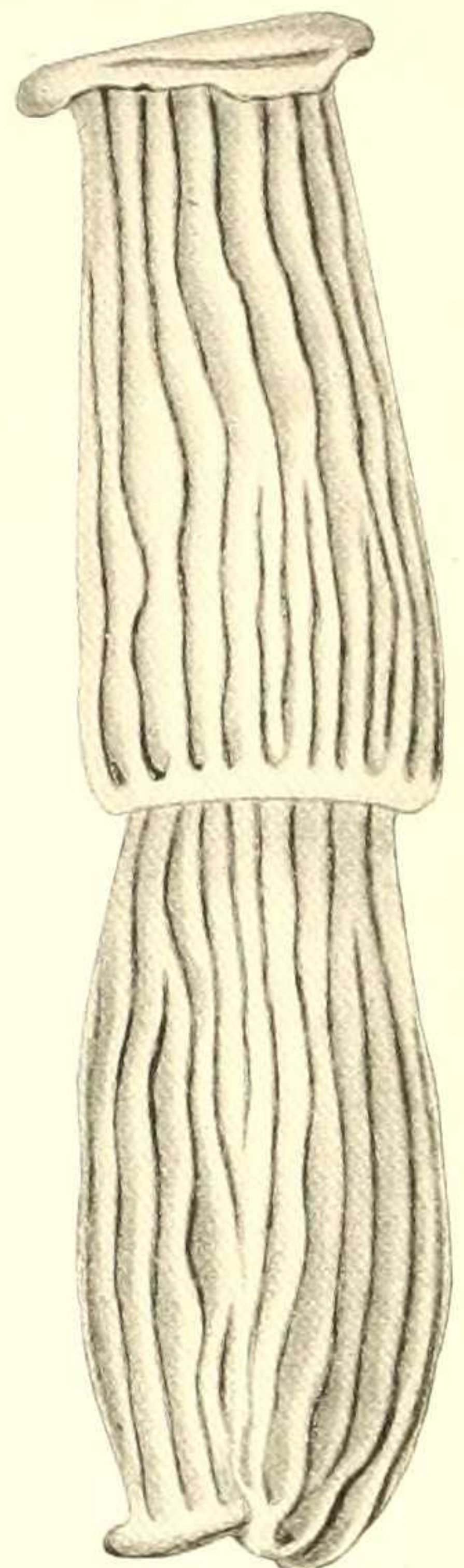
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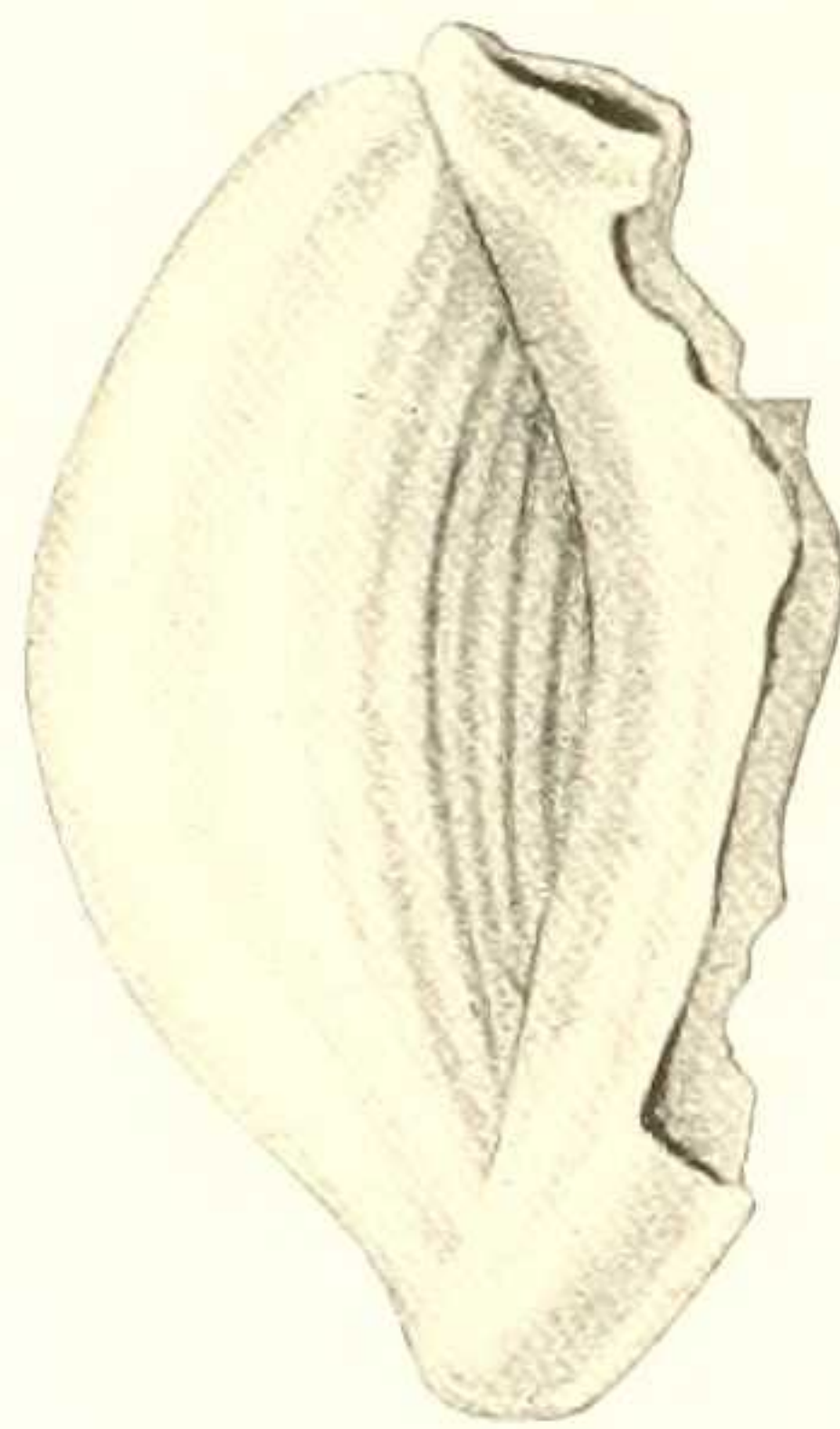
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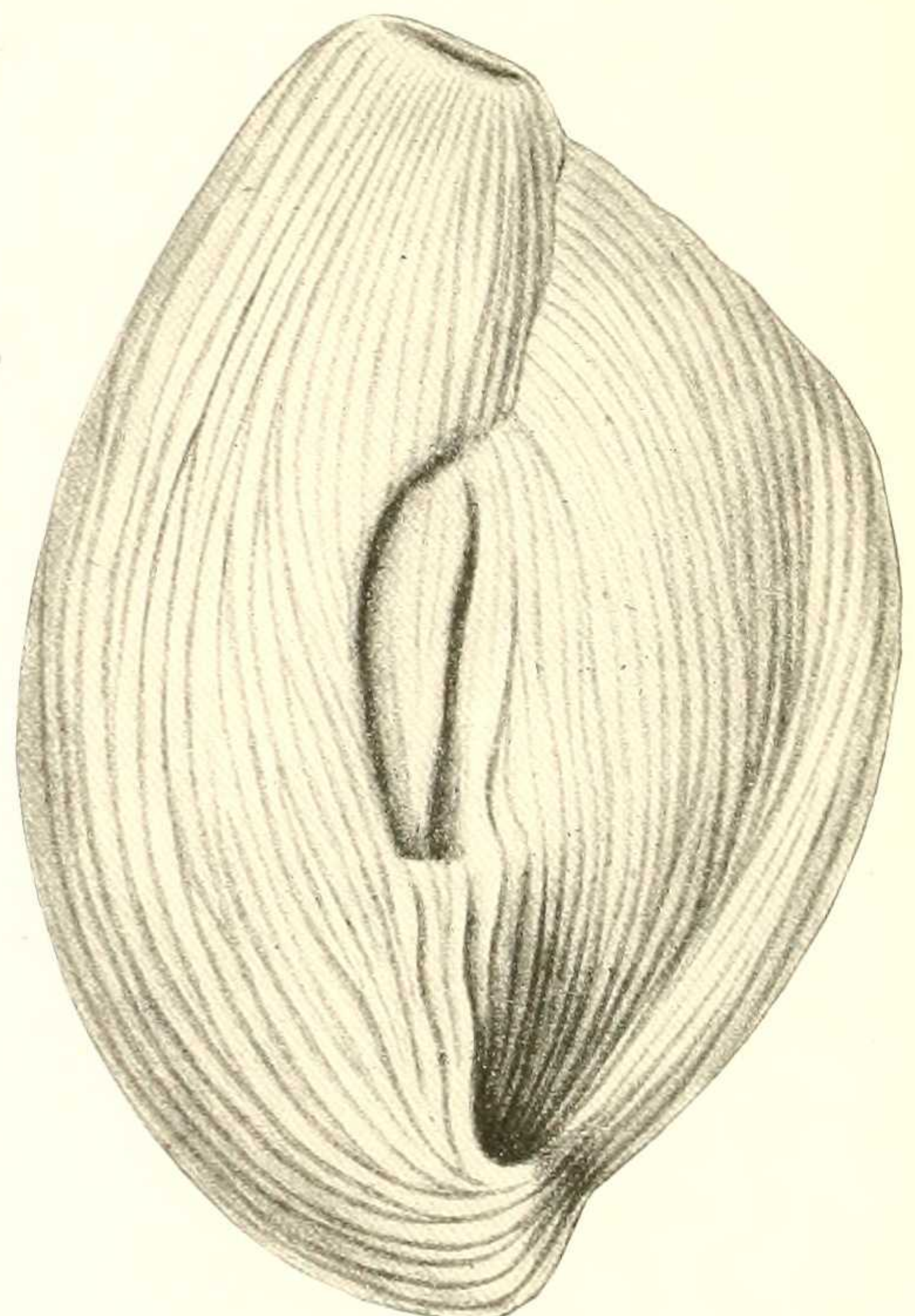
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FORAMINIFERA OF THE BRYAM MARL.

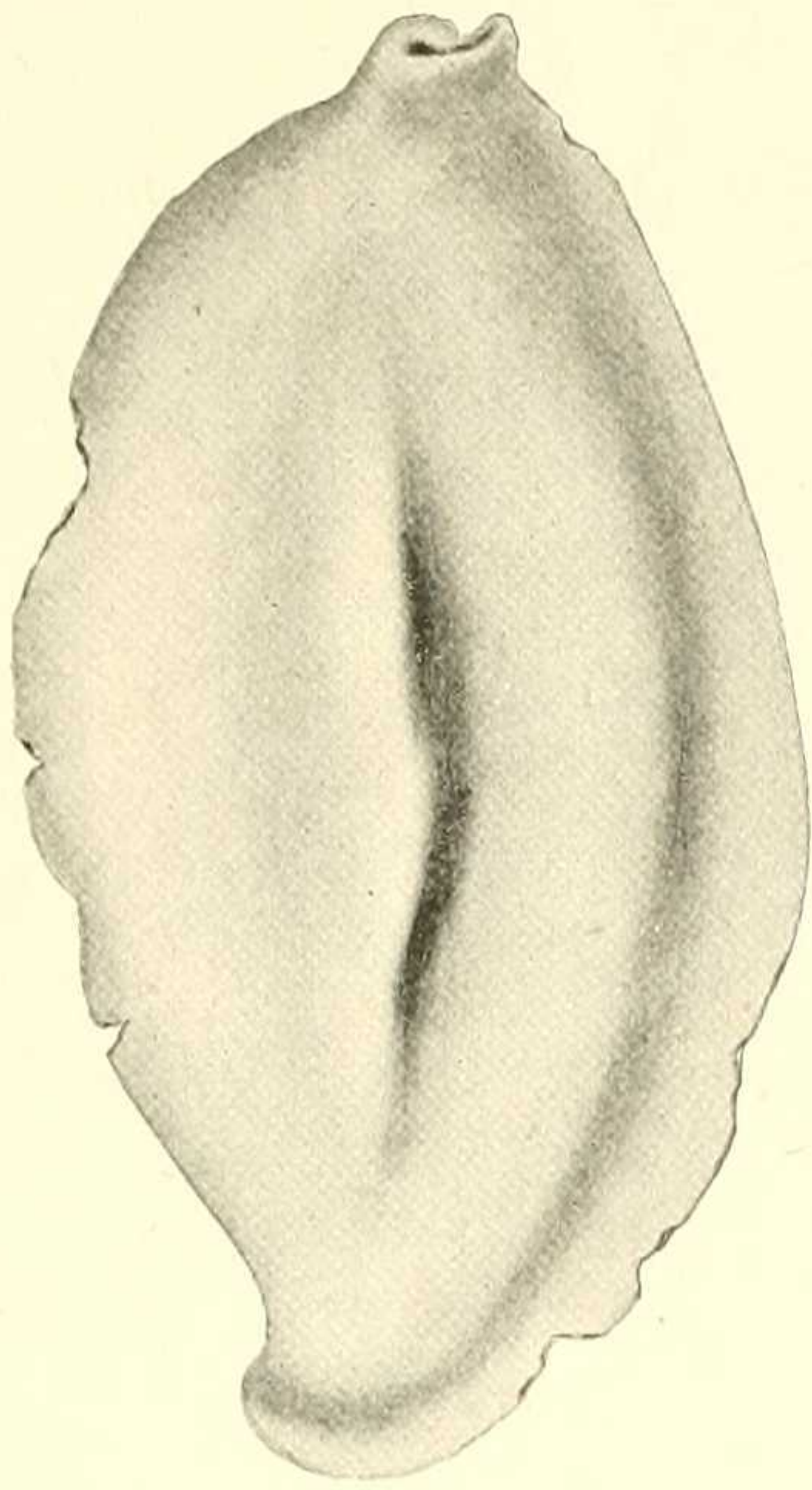
PLATE XXVII.

- FIGURE 1. *Quinqueloculina crassa* D'Orbigny. Side view.  $\times 80$ .  
2. *Quinqueloculina crassa* D'Orbigny. Opposite side of another specimen.  $\times 80$ .  
3. *Hauerina fragilissima* Brady. Side view.  $\times 80$ .  
4. *Hauerina* sp. Side view of a broken specimen showing peculiar pitted ornamentation of the surface.  $\times 80$ .  
5. *Articulina byramensis* Cushman, n. sp. Side view of specimen which has not yet reached the adult stage.  
 $\times 80$ .  
6. *Articulina byramensis* Cushman, n. sp. Side view of adult specimen.  $\times 80$ .

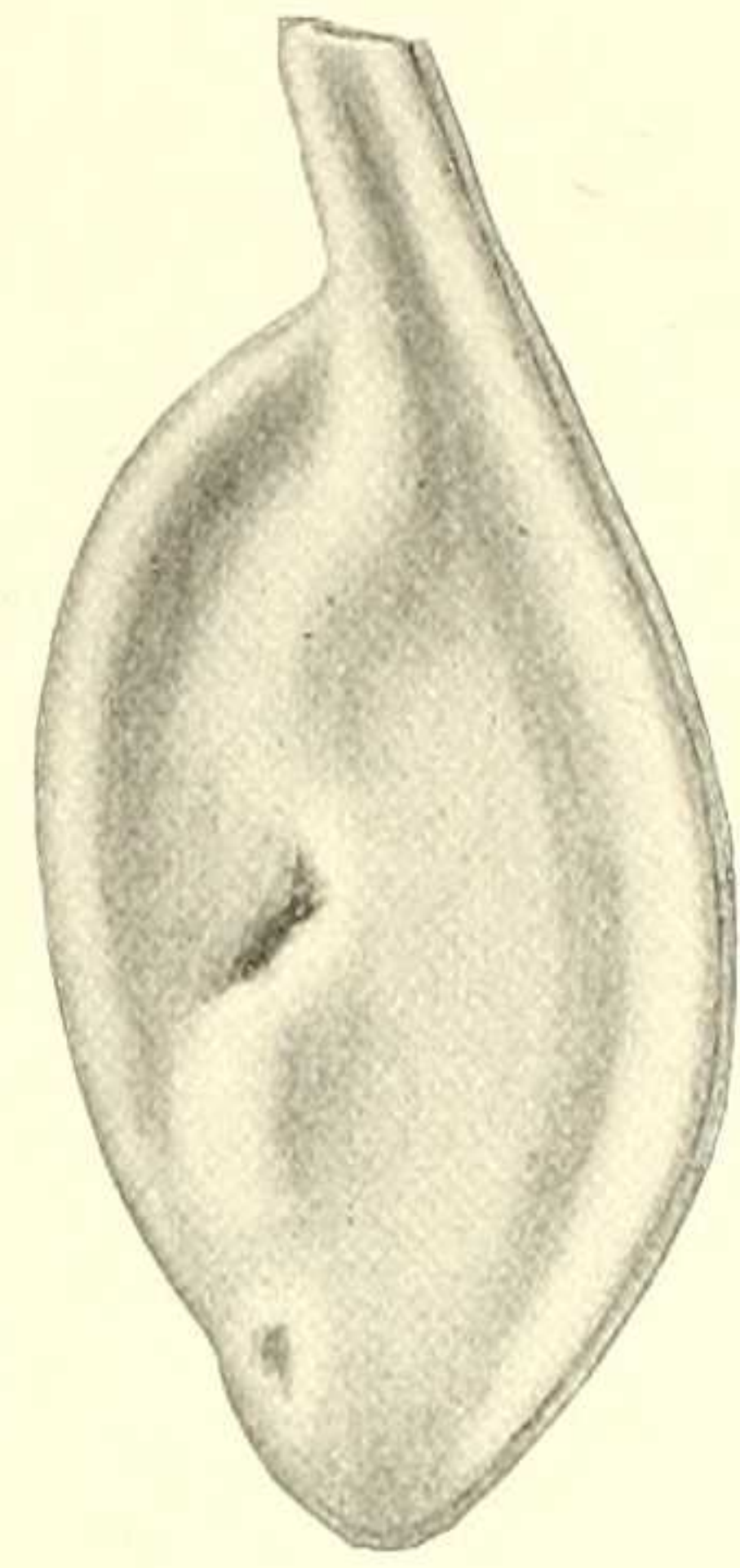


PLATE XXVIII.

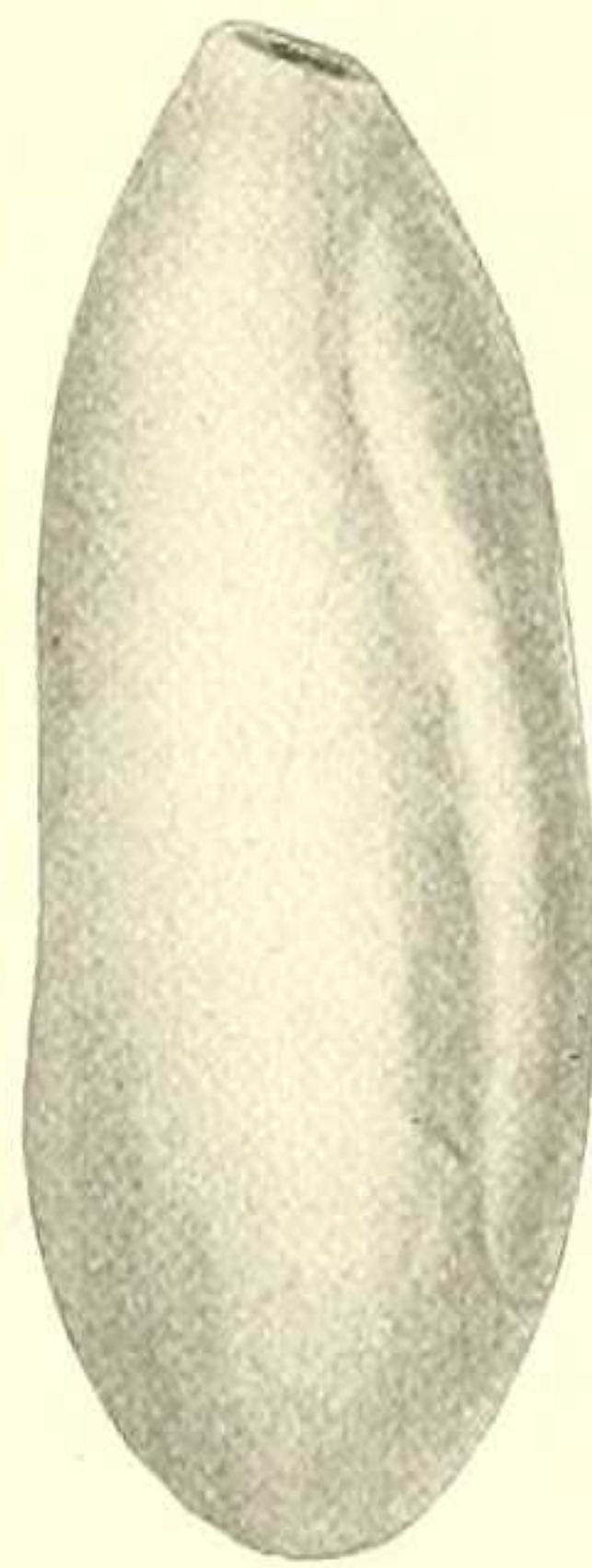
- FIGURE 1. *Massilina crusta* Cushman, n. sp. Side view.  $\times 40$ .  
2. *Massilina occlusa* Cushman, n. sp. Side view.  $\times 80$ .  
3. *Triloculina oblonga* (Montagu) D'Orbigny. Side view.  $\times 80$ .  
4. *Triloculina oblonga* (Montagu) D'Orbigny. Opposite side of another specimen.  $\times 80$ .  
5. *Biloculina* sp.? Apertural view, showing aperture and tooth.  $\times 40$ .  
6. *Biloculina* sp.? Side view of another specimen.  $\times 40$ .



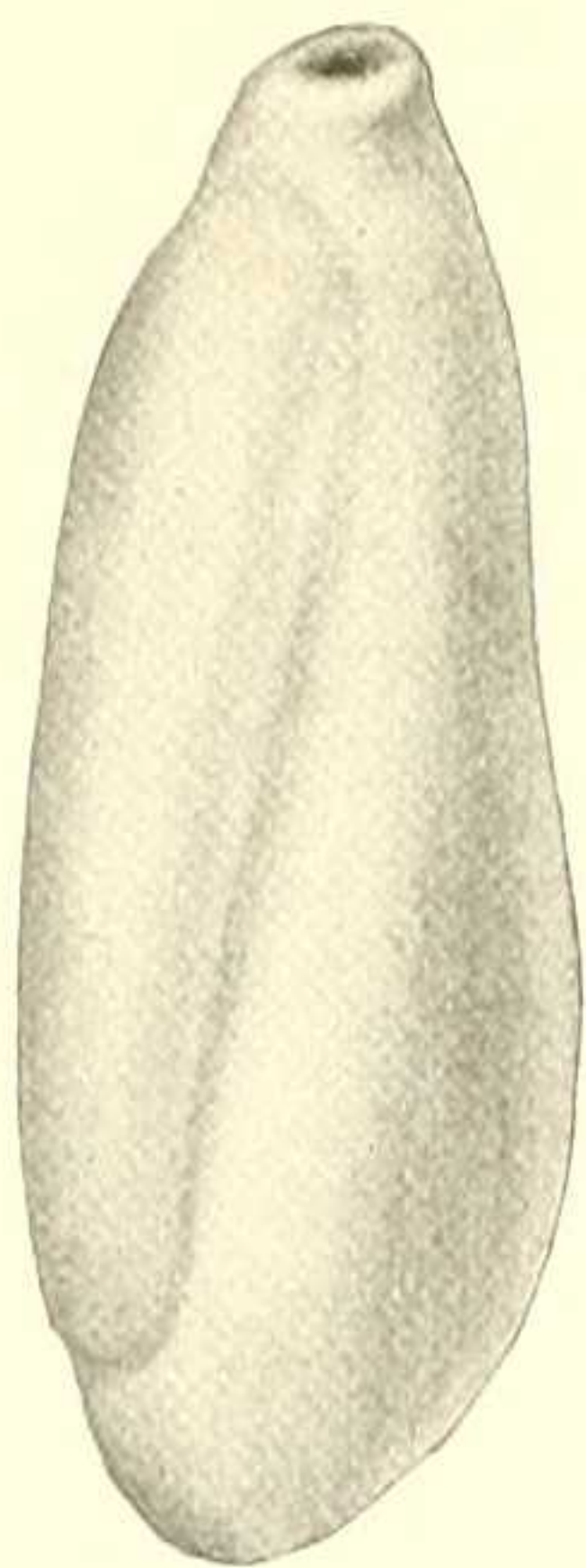
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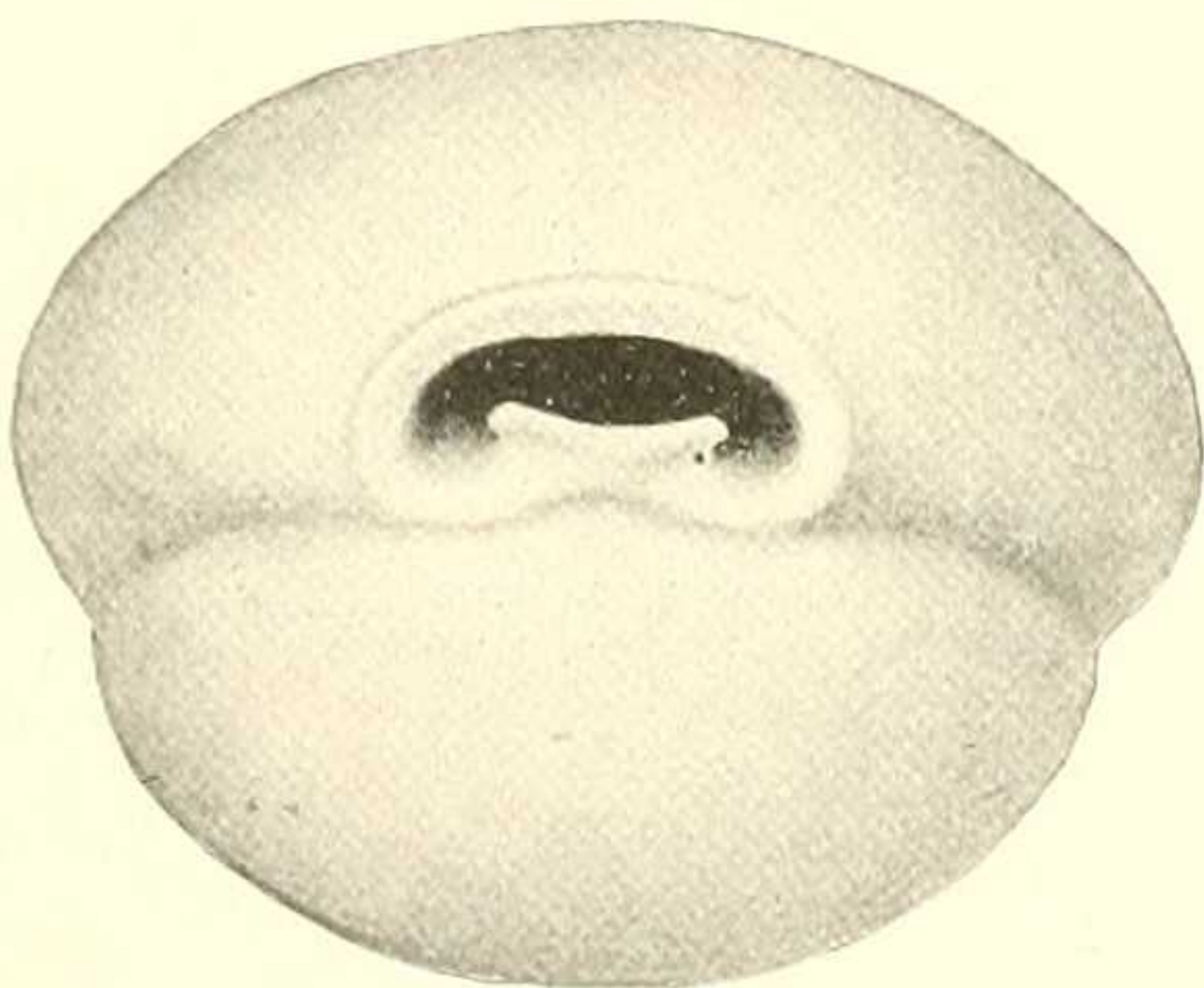
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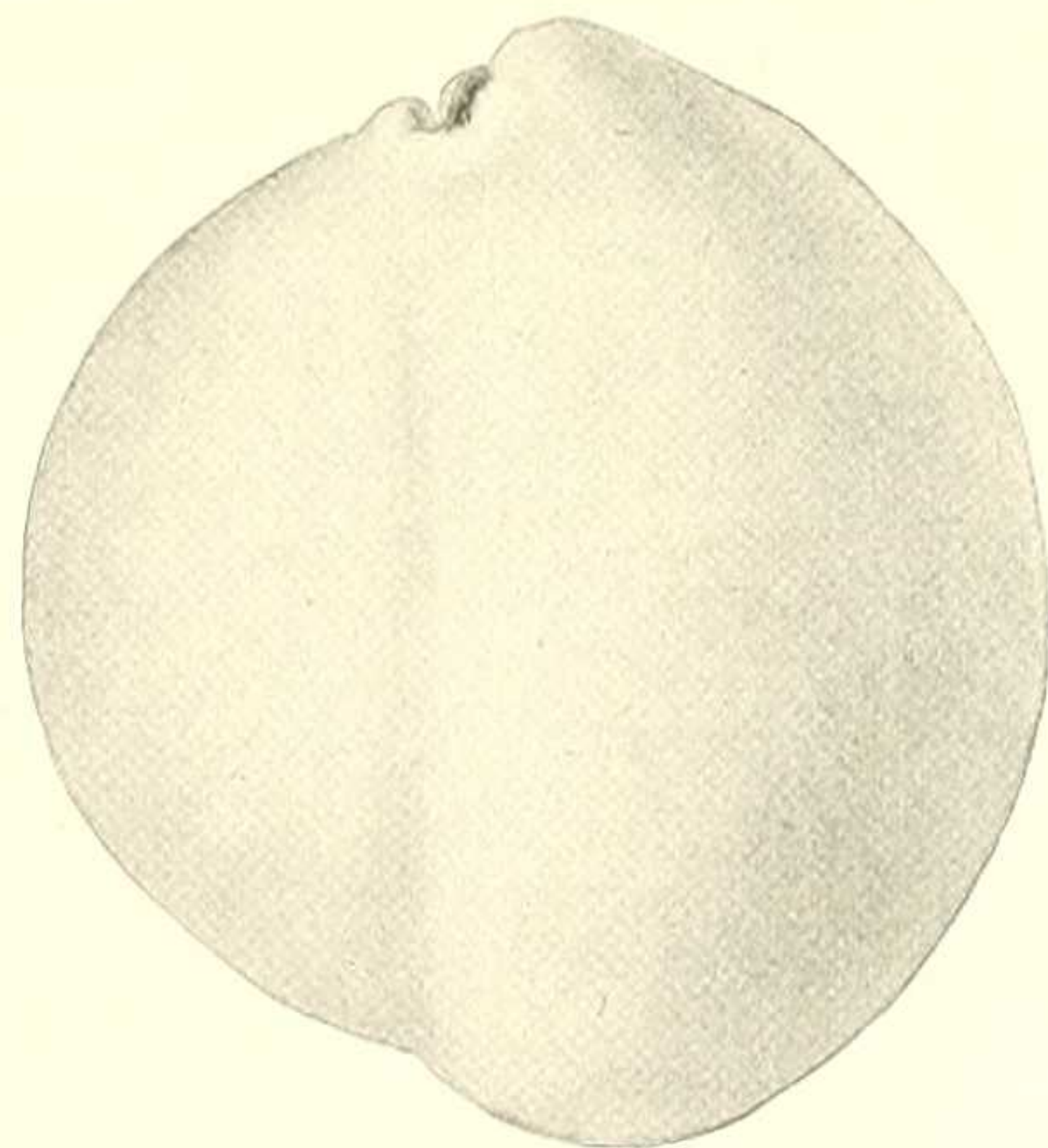
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3



5



6

FORAMINIFERA OF THE BRYAM MARL.

# INDEX.

A.	Page.		Page.
<i>Abietites ernestinae</i> Lesquereux, description of.....	212	Bend series, units K and L of well borings from.....	13-15
<i>longifolius</i> (Fontaine) Berry, description of.....	211-212	volcanic origin of material from.....	12
plate showing.....	225	white shale in well borings from.....	12
Accuracy in computations, excessive.....	41	<i>Benzoin venustum</i> (Lesquereux) Knowlton, description of.....	171-172
Acknowledgment for aid.....	22	<i>venustum</i> , plate showing.....	181
Akinetic surface, proposed use of term.....	8	Berry, Edward Wilber, fossils determined by.....	153-154
Alinement charts, nature of.....	42	The flora of the Cheyenne sandstone of Kansas.....	199-225
preparation and use of.....	44-46, 48, 49-50	The flora of the Woodbine sand at Arthurs Bluff, Tex.....	153-181
Allen, E. G., acknowledgment to.....	22	Big Horn Mountains, Ariz., hills of chloritic schist at north end	
<i>Andromeda novaecaesareae</i> Hollick, description of.....	177-178	of, plate showing.....	184
<i>novaecaesareae</i> , plate showing.....	181	<i>Biloculina ornata</i> D'Orbigny, description of.....	143
<i>snowii</i> Lesquereux, description of.....	178	<i>ornata</i> , plate showing.....	150
<i>Anomalina bilateralis</i> Cushman, n. sp., description of.....	97-98, 137	sp.?, description of.....	105
<i>bilateralis</i> , plate showing.....	115	sp.?, plate showing.....	122
<i>grosserugosa</i> (Gümbel) H. B. Brady? var., description of.....	98	Bingen sand, relation of flora of, to that of the Woodbine sand..	156-157
plate showing.....	115	Black Butte, Ariz., plate showing.....	185
<i>mississippiensis</i> Cushman, n. sp., descriptions of.....	98, 137	Black Rock Canyon, Ariz., section in.....	70
plate showing.....	115	Black Rock Spring, Ariz., section near.....	75
<i>vicksburgensis</i> Cushman, n. sp., description of.....	137	Bloomington, Utah, sections on Virgin River near.....	75-76, 77
plate showing.....	152	Bloomington dome, Utah, section at.....	74
Antelope Hill, Ariz., sandstone composing.....	188	<i>Bolivina amygdalaeformis</i> H. B. Brady, description of.....	91
Antelope Wash, Ariz., section on.....	70	<i>amygdalaeformis</i> , plate showing.....	109
<i>Aralia newberryi</i> Berry, description of.....	220-221	<i>cookei</i> Cushman, n. sp., description of.....	126
<i>ravniana</i> Heer, description of.....	219-220	plate showing.....	146
plate showing.....	225	<i>frondea</i> Cushman n. sp., description of.....	126-127
<i>saportana</i> Lesquereux?, description of.....	177	plate showing.....	146
<i>wellingtoniana</i> Lesquereux, description of.....	176-177	<i>mississippiensis</i> Cushman n. sp., description of.....	92
plates showing.....	181	plate showing.....	109
<i>Araliopsoides cretacea</i> (Newberry) Berry, description of.....	221-222	<i>nitida</i> H. B. Brady, description of.....	91
<i>cretacea</i> , plate showing.....	225	plate showing.....	109
Arizona, northwestern. See Mohave County, Ariz.		<i>robusta</i> H. B. Brady, description of.....	91-92
Arthurs Bluff, Tex., fossil plants collected at.....	153	<i>vicksburgensis</i> Cushman, n. sp., description of.....	126
<i>Articulina byramensis</i> Cushman, n. sp., descriptions of.....	103, 143	plate showing.....	146
<i>byramensis</i> , plate showing.....	121	cf. <i>B. punctata</i> D'Orbigny, description of.....	126
<i>Arundo groenlandica</i> Heer?, description of.....	213	<i>Brachyphyllum macrocarpum formosum</i> Berry, description of... 160-161	
<i>Asplenium dicksonianum</i> Heer, description of.....	207-208	<i>macrocarpum formosum</i> , plate showing.....	181
<i>Asterigerina subacuta</i> Cushman, n. sp., description of.....	100	<i>Bulimina ovata</i> D'Orbigny?, description of.....	92
<i>subacuta</i> , plate showing.....	118	<i>ovata</i> , plate showing.....	110
		<i>pupoides</i> D'Orbigny, description of.....	127
		plate showing.....	146
		<i>Buliminella contraria</i> (Reuss) Cushman, description of.....	128
		<i>subteres</i> H. B. Brady var. <i>angusta</i> Cushman, n. var., descrip-	
		tion of.....	127-128
		plate showing.....	146
		Bullrush, Ariz., section near.....	70
		Byram, Miss., fossils found near.....	83-85
		Byram calcareous marl, deposition of.....	88
		exposures of, at Byram, Miss.....	81
		at Woodward, Miss.....	82
		near Vicksburg, Miss.....	80-81
		on Leaf River, Miss.....	82
		fauna of, descriptions of.....	89-105
		occurrence of.....	81, 82-85
		relationships of.....	87-88
		features of.....	79-80
		foraminifera found in, at the type station.....	124-125
			C.
		Caliche, occurrence of, in the lower Gila region, Ariz.....	190
		<i>Carpolithus belviderensis</i> Berry, n. sp., description of.....	224
		<i>belviderensis</i> , plate showing.....	225
		sp. 1, description of.....	179
		sp. 2, description of.....	180
		plate showing.....	181
		sp. 3, description of.....	180
		plate showing.....	181
		Cartesian coordinates, disadvantages of.....	41
		Casey, T. L., cited.....	79

- |   | Page.                   |  | Page.      |
|---|-------------------------|--|------------|
| <i>Cassidulina crassa</i> D'Orbigny, description of.....  | 128                     | <i>Discorbis auracana</i> (D'Orbigny) Cushman, description of.....                 | 135        |
| Charts for stratigraphic computations, preparation and use of.....  | 44-45, 45-46, 48, 49-50 | <i>auracana</i> , plate showing.....   | 149        |
| Cheyenne sandstone of Kansas, flora of, age of.....   | 204-206                 | <i>bertheloti</i> (D'Orbigny) Cushman, description of.....                         | 135        |
| flora of, climate and conditions of growth and embedment.....   | 203                     | plate showing.....   | 149        |
| descriptions of.....  | 207-224                 | <i>byramensis</i> Cushman, n. sp., description of.....                             | 96         |
| early work on.....  | 200                     | plate showing.....   | 113        |
| features of.....  | 202-203                 | <i>orbicularis</i> (Terquem) Berthelin, description of.....                        | 96         |
| stratigraphic distribution of.....  | 206                     | plate showing.....   | 113        |
| fossil plants from, plates showing.....   | 225                     | Distance to a stratum, method for computing.....                                   | 46-48      |
| invertebrates in.....   | 199                     | Dome Rock Mountains, Ariz., plug of latite in, plate showing....                   | 185        |
| localities in, from which fossils were collected.....   | 202                     |  |            |
| mechanical analysis of.....   | 203-204                 | E.   |            |
| microscopic examination of.....   | 204                     | Eagle Tail Mountains, coloration of rocks in.....                                  | 186        |
| nature of.....  | 199                     | <i>Ehrenbergina glabrata</i> Cushman, n. sp., description of.....                  | 93         |
| Chinle formation in Utah, features of.....  | 62-63                   | <i>glabrata</i> , plate showing.....   | 111        |
| near Springfield, Utah, plate showing.....  | 62                      |  |            |
| Cinder cones north of St. George, Utah, plates showing.....   | 66                      | F.   |            |
| <i>Cinnamomum membranaceum</i> (Lesquereux) Hollick, description of.....                                      | 174                     | <i>Feistmantelia oblonga</i> Ward, description of.....                             | 222-224    |
| <i>newberryi</i> Berry, description of.....   | 173-174                 | <i>oblonga</i> , plate showing.....  | 225        |
| plate showing.....  | 181                     | <i>Ficus daphnogenoides</i> (Heer) Berry, description of.....                      | 163-164    |
| <i>Cissites formosus</i> Heer, description of.....  | 170-171                 | <i>daphnogenoides</i> , plate showing.....   | 181        |
| <i>formosus</i> , plate showing.....  | 181                     | <i>glascoeana</i> Lesquereux, description of.....                                  | 164        |
| <i>Cladophlebis dakotensis</i> (Lesquereux) Berry, description of.....  | 207                     | Foraminifera. See Cushman, Joseph A.   |            |
| Clanton Hills, Ariz., limestone composing.....  | 188                     | Fossils, from well borings in the Bend series, Texas.....                          | 16         |
| <i>Clavulina byramensis</i> Cushman, n. sp., description of.....  | 92                      | occurrence of, in the lower Gila region.....                                       | 189-190    |
| <i>byramensis</i> , plate showing.....  | 110                     |  |            |
| Coalpits Wash, near Grafton, Utah, panorama along east side of, plate showing.....                            | 59                      | G.   |            |
| Coconino sandstone in Utah and Arizona, features of.....  | 57-58                   | Gabb, William M., cited.....   | 27, 28     |
| south of Hurricane, Utah, plate showing.....  | 58                      | <i>Gaudryina triangularis</i> Cushman, description of.....                         | 127        |
| <i>Colutea primordialis</i> Heer, description of.....   | 168                     | sp. ?, description of.....   | 127        |
| Computations, graphic, facilities needed for.....   | 39-40                   | plate showing.....   | 146        |
| graphic, publications on.....   | 39                      | Gila, lower, region, Ariz., basal complex of, age of.....                          | 185-186    |
| numerical, disadvantages of.....  | 41                      | basal complex of, classes of rocks in.....   | 183-184    |
| Computer, trigonometric, advantages of.....   | 50                      | igneous rocks in.....  | 184        |
| trigonometric, construction of.....   | 50-51                   | least-metamorphosed sediments in.....  | 185        |
| use of.....   | 52                      | metamorphosed schistose rocks in.....  | 184-185    |
| Cooke, C. Wythe, cited.....   | 123                     | nature and distribution of.....  | 184-186    |
| <i>Orthaulax</i> , a Tertiary guide fossil.....   | 23-37                   | faults older than the Tertiary lava in.....  | 192-193    |
| The Byram calcareous marl of Mississippi.....   | 79-86                   | faults younger than the Tertiary lava in.....                                      | 193        |
| <i>Cornophyllum vetustum</i> Newberry, description of.....  | 177                     | folds in.....  | 192        |
| <i>Cornuspira involvens</i> (Reuss) Reuss, descriptions of.....   | 101, 140                | geologic map of.....   | In pocket. |
| <i>involvens</i> , plate showing.....   | 119                     | intrusive rocks in.....  | 187        |
| Court House Rock, Ariz., description of.....  | 187                     | mineral deposits in.....   | 197        |
| Cragin, F. W., fossils determined by.....   | 155                     | Paleozoic and Mesozoic events in.....  | 194        |
| Cretaceous (?) sandstone in Utah, features of.....  | 65                      | pre-Cambrian events in.....  | 194        |
| Cretaceous time, sequence of events in.....   | 201-202                 | Quaternary basalt in.....  | 191-192    |
| Cretaceous (?) variegated shale in Utah, features of.....   | 64-65                   | Quaternary faults in.....  | 193        |
| <i>Cristellaria convergens</i> ? Bornemann, description of.....   | 130                     | Quaternary history of.....   | 196-197    |
| <i>cultrata</i> (Montfort) Parker and Jones, description of.....  | 130                     | Quaternary sediments in.....   | 190-191    |
| plate showing.....  | 148                     | rocks of, variety of.....  | 183        |
| <i>rotulata</i> (Lamarck) D'Orbigny, description of.....  | 130                     | situation and development of.....  | 183        |
| plate showing.....  | 149                     | structure of.....  | 192-193    |
| <i>vicksburgensis</i> Cushman, n. sp., description of.....  | 130-131                 | Tertiary history of.....   | 195-196    |
| plate showing.....  | 148                     | Tertiary sedimentary formations in, features of.....                               | 186        |
| sp., description of.....  | 93                      | fossils in.....  | 189-190    |
| <i>Cupressinoxylon cheyennense</i> Penhallow, description of.....   | 212-213                 | nature and distribution of.....  | 188-189    |
| Cushman, Joseph A., The foraminifera of the Mint Spring calcareous marl member of the Marianna limestone..... | 123-152                 | Tertiary lavas in, nature and distribution of.....                                 | 186-188    |
| The Byram calcareous marl of Mississippi and its Foraminifera.....  | 87-122                  | Girty, G. H., cited.....   | 67, 68     |
| <i>Cycadeoidea munita</i> Cragin, description of.....   | 209                     | fossils determined by.....   | 66-68      |
| <i>Cycadosperrum lineatum</i> Lesquereux, description of.....   | 209                     | Glauconite, occurrence of, above stratigraphic breaks.....                         | 3-4, 20-21 |
|   |                         | <i>Gleichenia? bohémica</i> (Corda) Berry, description of.....                     | 208-209    |
| D.  |                         | <i>bohémica</i> , plate showing.....   | 225        |
| Dakota sandstone, use of term.....  | 199-200                 | <i>nordenskiöldi</i> Heer, description of.....                                     | 208        |
| Dall, William H., cited.....  | 23, 27, 29-30           | plate showing.....   | 225        |
| fossils determined by.....  | 189-190                 | <i>Globigerina bulloides</i> D'Orbigny, descriptions of.....                       | 95, 134    |
| Denison, Tex., fossil plants collected at.....  | 153                     | <i>bulloides</i> , plate showing.....  | 113        |
| Depth to a stratum, graphic computation of.....   | 48                      | <i>dutertrei</i> D'Orbigny, description of.....                                    | 134        |
| <i>Dentaluca insigniformis</i> Berry, description of.....   | 167                     | <i>triloba</i> Reuss, description of.....  | 95         |
| Diamond Valley, Utah, section on north side of.....   | 77                      | <i>Glyptostrobus gracillimus</i> Lesquereux, erroneous identification of.....      | 209-210    |
| <i>Diospyros primaeva</i> Heer, description of.....   | 178-179                 | Goldman, Marcus I., cited.....   | 203-204    |
| <i>primaeva</i> , plate showing.....  | 181                     | Lithologic subsurface correlation in the "Bend series" of north-central Texas..... | 1-24       |
|   |                         | Gonzales Wells, Ariz., plate showing.....  | 184        |
|   |                         | <i>Gypsina rubra</i> (D'Orbigny) Heron-Allen and Earland, descriptions of.....     | 98, 138    |
|   |                         | <i>rubra</i> , plate showing.....  | 116        |

H.	Page.	H.	Page.
Hacks Canyon, Ariz., section in .....	69	Mohave County, Ariz., fossils collected in.....	66-68
Harrisburg dome, Utah, section at.....	73-74	general section in.....	54-56
Harrisburg gypsiferous member of the Kaibab limestone, fossils collected from.....	66	local sections in.....	69-77
<i>Hauerina fragilissima</i> (H. G. Brady) Millett, description of.....	103	stratigraphy of.....	54-66
<i>fragilissima</i> , plate showing.....	121	structure of.....	54
sp.,? description of.....	103	<i>Myrica emarginata</i> Heer, description of.....	161
Haynes Bluff, Miss., fossils found in.....	83-85	<i>longa</i> (Heer) Heer, description of.....	161-162
Heald, K. C., acknowledgment to.....	22	plate showing.....	181
Heilprin, A., cited.....	28-29	<i>Myrtonium geinitzi</i> (Heer) Berry, description of.....	175-176
Hill, R. T., cited.....	18	N.	
Hurricane, Utah, section south of.....	71-72	<i>Nodosaria communis</i> D'Orbigny, description of.....	129
J.		<i>communis</i> plate showing.....	147
Jurassic limestone and shale in Utah, features of.....	64	<i>filiformis</i> D'Orbigny, description of.....	129
Jurassic sandstone, in Utah, features of.....	63-64	plate showing.....	147
massive, near Springdale, Utah, plate showing.....	62	<i>obliqua</i> (Linnaeus) H. B. Brady, description of.....	129-130
north of St. George, Utah, plate showing.....	62	plate showing.....	147
K.		sp., description of.....	93
Kaibab limestone, fossils collected from.....	66-67	plate showing.....	110
in Utah and Arizona, features of.....	58-59	sp.?, description of.....	93
south of Hurricane, Utah, plate showing.....	58	plate showing.....	110
west of Virgin City, Utah, plate showing.....	58	sp.?, description of.....	130
Knowlton, F. H., fossils determined by.....	153	plate showing.....	147
L.		<i>Nonionina advena</i> Cushman, n. sp., description of.....	139-140
<i>Lagena hexagona</i> (Williamson) Siddall, description of.....	129	<i>advena</i> , plate showing.....	149
<i>hexagona</i> , plate showing.....	146	<i>scapha</i> (Fichtel and Moll) Parker and Jones, description of.....	100, 139
<i>laevigata</i> (Reuss) Terrigi, description of.....	128	plate showing.....	117
<i>orbignyana</i> (Seguenza) H. B. Brady var. <i>flintii</i> , Cushman n. var., description of.....	129	<i>umbilicatula</i> (Montagu) Parker, Jones, and H. B. Brady, description of.....	100, 139
var. <i>flintii</i> , plate showing.....	146	plate showing.....	117
<i>striata</i> (D'Orbigny) Reuss var. <i>substriata</i> Williamson, description of.....	128	<i>Nummulites</i> sp., description of.....	100-101
var. <i>substriata</i> , plate showing.....	146	sp., plate showing.....	118
Latite, plug of, in the Dome Rock Mountains, plate showing.....	185	O.	
La Verkin, Utah, section near.....	72	Oilsands, position of, in the "Bend series," in north-central Texas.....	18-20
<i>Laurophyllum minus</i> Newberry, description of.....	175	<i>Oreodaphne alabamensis</i> , Berry description of.....	172-173
<i>Laurus antecedens</i> Lesquereux?, description of.....	175	<i>alabamensis</i> , plate showing.....	181
<i>plutonia</i> Heer, description of.....	174-175	<i>Orthaulax</i> , correlation table of.....	25-26
plate showing.....	181	criteria for discriminating species of.....	24
Leaf River, Miss., exposure of Byram marl on.....	82	description of.....	27-28
fossils found on.....	83-85	generic features of.....	23-24
<i>Lepidocyclina supera</i> (Conrad) H. Douvillé, description of.....	101	occurrence and stratigraphic position of species of.....	24-26
Lesquereux, Leo, cited.....	177, 207, 209, 212	species of, plates showing.....	33-37
Lime, conditions affecting the deposition of.....	2	<i>aguadillensis</i> Maury, description of.....	30-31
<i>Liriodendron quercifolium</i> Newberry, description of.....	166	occurrence and stratigraphic position of.....	25
<i>quercifolium</i> , plate showing.....	181	plate showing.....	36, 37
M.		<i>caepa</i> Cooke, n. sp., description of.....	31
<i>Magnolia lacoena</i> Lesquereux, description of.....	165	occurrence and stratigraphic position of.....	25
<i>speciosa</i> Heer, description of.....	165	plate showing.....	37
plate showing.....	181	<i>gabbi</i> , description of.....	29-30
<i>Malapoenna facilifolia</i> (Lesquereux) Knowlton, description of.....	172	occurrence and stratigraphic position of.....	25
<i>Massilina crusta</i> Cushman, n. sp., description of.....	104	plates showing.....	35, 36
<i>crusta</i> , plate showing.....	122	<i>inornatus</i> , description of.....	28
<i>decorata</i> Cushman, n. sp., description of.....	143	occurrence and stratigraphic position of.....	24-25
plate showing.....	151	plate showing.....	34
<i>occlusa</i> Cushman, n. sp., description of.....	104	<i>pugnax</i> , description of.....	28-29
plate showing.....	122	occurrence and stratigraphic position of.....	25
var. <i>costulata</i> Cushman, n. var., description of.....	104	plates showing.....	34, 35
Matteson, W. G., cited.....	18	Osage Rock, near Belvidere, Kans., plate showing.....	202
Maury, Carlotta J., cited.....	24, 30-31	Osborne Wash., Ariz., plate showing.....	188
Mertie, J. B., jr., Graphic and mechanical computation of thickness of strata and distance to a stratum.....	39-52	P.	
"Millsap division," use of name.....	15-16	<i>Paleocassia laurinea</i> Lesquereux, description of.....	167-168
Minerals, marking of horizons by.....	21	<i>laurinea</i> , plate showing.....	181
Mint Spring marl, features of.....	123	Palmer, H. S., method of, for making stratigraphic computations.....	44
fossils found in.....	82, 83-85	<i>Patellina advena</i> Cushman, n. sp., description of.....	135
foraminifera found in, at six stations.....	124-125	<i>advena</i> , plate showing.....	148
Moenkopi formation, features of, in Utah and Arizona.....	59-62	Percentage log, description of.....	1-2
fossils collected from.....	67-68	Phosphate rock, conditions affecting deposition of.....	4
north of Virgin City, Utah, plate showing.....	67	<i>Platanus latior</i> (Lesquereux) Knowlton, description of.....	164-165
west of Virgin City, Utah, plate showing.....	58	Plummer, F. B., cited.....	6, 15
Mohave County, Ariz., age of the formations in.....	66-69	<i>Podozamites lanceolatus</i> (Lindley and Hutton) F. Braun, description of.....	159-160
features of.....	53-54	<i>lanceolatus</i> , plate showing.....	181
		<i>Polymorphina advena</i> Cushman, n. sp., description of.....	132
		<i>advena</i> , plate showing.....	148
		<i>amygdaloides</i> (Reuss) Reuss, description of.....	95, 132
		plate showing.....	112

- |   | Page.          |  | Page.        |
|---|----------------|--|--------------|
| <i>Polymorphina byramensis</i> Cushman, n. sp., description of..... | 94, 131        | <i>Rotalia dentata</i> Parker and Jones, description of.....                   | 100          |
| plate showing.....  | 111            | plate showing.....   | 117          |
| <i>cuspidata</i> H. B. Brady, description of.....                   | 133            | var. <i>parva</i> Cushman, n. var., description of.....                        | 139          |
| plate showing.....  | 147            | plate showing.....   | 152          |
| var. <i>costulata</i> Cushman, n. var.....                          | 133            | <i>vicksburgensis</i> Cushman, n. sp., description of.....                     | 139          |
| plate showing.....  | 148            | plate showing.....   | 152          |
| <i>equalis</i> D'Orbigny, description of.....                       | 132            | Roxana Petroleum Corporation, acknowledgment to.....                           | 22           |
| plate showing.....  | 148            | Rudd No. 1 well, location of.....  | 5-6          |
| <i>gibba</i> D'Orbigny, description of.....                         | 93-94, 132     | log of, plate showing.....   | In pocket.   |
| plate showing.....  | 111            | section of, correlated with type section.....                                  | 15           |
| fistulose form, description of.....                                 | 94             | sections of, thicker than-corresponding sections of Seaman                     |              |
| plate showing.....  | 112            | well.....  | 6, 7, 17     |
| <i>problema</i> D'Orbigny?, description of.....                     | 94-95, 131-132 |  |              |
| plate showing.....  | 112            | S.   |              |
| <i>regina</i> H. B. Brady, Parker, and Jones, description of.....   | 94, 131        | Saddle Mountain, Ariz., plate showing.....                                     | 188          |
| plate showing.....  | 112, 147       | St. George, Utah, sections north, east, and south of.....                      | 73-75, 76-77 |
| <i>spinosa</i> (D'Orbigny) Egger, description of.....               | 133            | <i>Salix delata</i> Lesquereux, description of.....                            | 163          |
| plate showing.....  | 148            | <i>lesquereuxii</i> Berry, description of.....                                 | 162          |
| <i>vicksburgensis</i> Cushman, n. sp., description of.....          | 133            | <i>Sapindopsis belviderensis</i> Berry, n. sp., description of.....            | 216-217      |
| plate showing.....  | 148            | <i>belviderensis</i> , plate showing.....                                      | 225          |
| <i>Populus harkeriana</i> Lesquereux, description of.....           | 163            | <i>brevifolia</i> Fontaine, description of.....                                | 216          |
| <i>Pulvinulina advena</i> Cushman, n. sp., description of.....      | 99             | plate showing.....   | 225          |
| <i>advena</i> , plate showing.....                                  | 116            | <i>magnifolia</i> Fontaine, description of.....                                | 214-215      |
| <i>byramensis</i> Cushman, n. sp., description of.....              | 99, 138        | plate showing.....   | 225          |
| plate showing.....  | 116            | <i>variabilis</i> Fontaine, description of.....                                | 213-214      |
| <i>glabrata</i> Cushman, n. sp., description of.....                | 99, 138        | plate showing.....   | 225          |
| plate showing.....  | 116            | <i>Sapindus morrisoni</i> Heer, description of.....                            | 168          |
| Q.  |                | <i>Sassafras mudgii</i> Lesquereux, description of.....                        | 219          |
| <i>Quinqueloculina bicostata</i> D'Orbigny, description of.....     | 141            | <i>mudgii</i> , plate showing.....   | 225          |
| <i>bicostata</i> D'Orbigny var., description of.....                | 102            | Seaman No. 1 well, location of.....  | 5-6          |
| var., plate showing.....  | 120            | log of, comparison of synthetic log with.....                                  | 17-18        |
| <i>contorta</i> D'Orbigny, description of.....                      | 142            | plate showing.....   | In pocket.   |
| plate showing.....  | 151            | oil in.....  | 12           |
| <i>cookei</i> Cushman, n. sp., description of.....                  | 141            | sections of, thicker than corresponding sections of Rudd                       |              |
| plate showing.....  | 150            | well.....  | 6, 7, 17     |
| <i>crassa</i> D'Orbigny?, description of.....                       | 102            | <i>Sequoia condita</i> , Lesquereux, description of.....                       | 209-211      |
| plate showing.....  | 121            | <i>condita</i> , plate showing.....  | 225          |
| <i>cuvieriana</i> D'Orbigny, description of.....                    | 102, 141       | <i>gracillima</i> Newberry, erroneous naming of.....                           | 209-210      |
| plate showing.....  | 120            | Shinarump conglomerate, features of, in Utah and Arizona.....                  | 62           |
| <i>glabrata</i> Cushman, n. sp., description of.....                | 141            | north of Virgin City, Utah, plate showing.....                                 | 67           |
| plate showing.....  | 151            | <i>Siphonina advena</i> Cushman, description of.....                           | 98, 137      |
| <i>lamarckiana</i> D'Orbigny, description of.....                   | 142-143        | <i>advena</i> , plate showing.....   | 116          |
| <i>lustra</i> Cushman, n. sp., description of.....                  | 141-142        | Smith's Mesa, Utah, section in.....  | 73           |
| plate showing.....  | 150            | view northward toward, plate showing.....                                      | 59           |
| <i>seminulum</i> (Linnaeus) D'Orbigny, description of.....          | 142            | <i>Spirillina limbata</i> H. B. Brady var. <i>bipunctata</i> Cushman, n. var., |              |
| <i>tessellata</i> Cushman, n. sp., description of.....              | 142            | description of.....  | 134-135      |
| plate showing.....  | 150, 151       | <i>limbata</i> var. <i>bipunctata</i> , plate showing.....                     | 149          |
| <i>venusta</i> Karrer?, var., description of.....                   | 102-103        | <i>subdecorata</i> Cushman, n. sp., description of.....                        | 95           |
| plate showing.....  | 120            | plate showing.....   | 113          |
| <i>vicksburgensis</i> Cushman, n. sp., description of.....          | 141            | <i>Spiroloculina antillarum</i> D'Orbigny, description of.....                 | 140          |
| plate showing.....  | 151            | <i>antillarum</i> , plate showing.....   | 150          |
| <i>vulgaris</i> D'Orbigny, description of.....                      | 142            | <i>byramensis</i> Cushman, n. sp., description of.....                         | 101          |
| plate showing.....  | 149            | plate showing.....   | 119          |
| sp., description of.....  | 103            | <i>gratcloupi</i> D'Orbigny, description of.....                               | 101          |
| plate showing.....  | 120            | plate showing.....   | 119          |
| R.  |                | <i>imprimata</i> Cushman, n. sp., description of.....                          | 101-102, 140 |
| Red Bluff clay, fossils found in.....                               | 82, 83-85      | plate showing.....   | 119          |
| Redwall limestone, features of, in Utah and Arizona.....            | 56-57          | <i>Sterculia lugubris</i> Lesquereux?, description of.....                     | 171          |
| Reeside, John B., jr., and Bassler, Harvey, Stratigraphic sections  |                | <i>lugubris</i> , plate showing.....   | 181          |
| in southwestern Utah and northwestern Arizona.....                  | 53-77          | <i>mucronata</i> Lesquereux, description of.....                               | 218          |
| Reeves, Frank, cited.....   | 18             | <i>towneri</i> (Lesquereux) Berry, description of.....                         | 217-218      |
| Rhamey Hill, Tex., fossil plants collected from.....                | 153            | plate showing.....   | 225          |
| <i>Rhamnus tenax</i> Lesquereux, description of.....                | 169-170        | Stratigraphic units, use of term.....  | 5            |
| <i>tenax</i> , plate showing.....                                   | 181            | <i>Strombus costatus</i> , plate showing.....                                  | 34           |
| <i>Rhus reddiformis</i> Berry, description of.....                  | 169            | Sulphide, conditions affecting deposition of.....                              | 4-5          |
| <i>reddiformis</i> , plate showing.....                             | 181            | Supai formation, features of, in Utah and Arizona.....                         | 57-58        |
| Rhythm in movements of ancient seashores.....                       | 201            | Synthetic log, description of.....   | 3            |
| Rock Canyon Ariz., section at head of.....                          | 70-71          | T.   |              |
| section at mouth of.....  | 71             | Tertiary (?) sandstone, features of, in Utah.....                              | 65           |
| Rock Canyon conglomeratic member of the Moenkopi formation,         |                | Tertiary (?) and Quaternary rocks, features of, in Utah and                    |              |
| fossils collected from.....   | 67             | Arizona.....   | 66           |
| Ross, Clyde P., Geology of the lower Gila region, Ariz.....         | 183-197        | Texas, north-central, generalized log for.....                                 | 18-20        |
| <i>Rotalia byramensis</i> Cushman, n. sp., description of.....      | 99, 138        | generalized log for, plate showing.....  | In pocket.   |
| <i>byramensis</i> plate showing.....                                | 117            | <i>Textularia agglutinans</i> D'Orbigny, description of.....                   | 89           |
|   |                | <i>agglutinans</i> , plate showing.....  | 108          |

	Page.
<i>Textularia folium</i> Parker and Jones, description of.....	90-91
plate showing.....	108
<i>mississippiensis</i> , description of.....	90, 125-126
plate showing.....	108
<i>subhauerii</i> Cushman, description of.....	89-90, 126
plate showing.....	108
<i>tumidulum</i> , description of.....	89, 125
plate showing.....	109
Thickness of strata, graphic computation of, alinement chart for..	44-46
graphic computation of, data needed for.....	40
geometric construction for.....	40-41
trigonometric formula for.....	41
graphic representation of.....	41-43
mathematical analysis of.....	43-44
Toroweap Canyon, Ariz., section in.....	69-70
Triangle, right, graphic solution of.....	48-50
right, graphic solution of, preparation and use of chart for...	49-50
graphic solution of, alinement chart for.....	50
<i>Tricalycites papyraceus</i> Hollick, description of.....	179
<i>papyraceus</i> , plate showing.....	181
<i>Triloculina oblonga</i> (Montagu) D'Orbigny, description of.....	104-105
<i>oblonga</i> , plate showing.....	122
<i>peroblonga</i> Cushman, n. sp., description of.....	143
plate showing.....	151
<i>rotunda</i> D'Orbigny, description of.....	104
<i>sculpturata</i> Cushman, n. sp., description of.....	143
plate showing.....	150
<i>trigonula</i> (Lamarck) D'Orbigny, description of.....	105
<i>Trochodendroides</i> Berry, n. gen., description of.....	166
<i>rhomboideus</i> (Lesquereux) Berry, description of.....	166-167
plate showing.....	181
<i>Truncatulina americana</i> Cushman, description of.....	97
<i>americana</i> , plate showing.....	114
var., description of.....	136
<i>byramensis</i> Cushman, n. sp., description of.....	96-97, 136
plate showing.....	114
<i>lobatula</i> (Walker and Jacob) D'Orbigny, description of..	96, 135-136
plate showing.....	114
<i>pseudoungeriana</i> Cushman n. sp., description of.....	97, 136
plate showing.....	114
<i>vicksburgensis</i> Cushman, n. sp., description of.....	136-137
plate showing.....	152

U.

Utah, southwestern. See Washington County, Utah.	
<i>Uvigerina byramensis</i> , Cushman, n. sp., descriptions of.....	95, 133-134
<i>byramensis</i> , plate showing.....	112
<i>pigmaea</i> D'Orbigny, description of.....	134
plate showing.....	149

V.

<i>Vaginulina legumen</i> (Linnaeus) D'Orbigny var. <i>elegans</i> (D'Orbigny) Fornasini, description of.....	93, 131
---	---------

	Page.
<i>Vaginulina legumen</i> (Linnaeus) D'Orbigny var. <i>elegans</i> (D'Orbigny) Fornasini, plate showing.....	111
Vaughan, T. W., fossils determined by.....	82
<i>Verneuilina spinulosa</i> Reuss var. <i>glabrata</i> Cushman, n. var., description of.....	92
<i>rectimargo</i> Cushman, n. sp., description of.....	127
plate showing.....	146
<i>Vertebrulina advena</i> Cushman, n. sp., description of.....	102
<i>advena</i> , plate showing.....	119
sp., description of.....	102
plate showing.....	119
sp., description of.....	140
<i>Viburnum robustum</i> Lesquereux, description of.....	179
<i>robustum</i> , plate showing.....	181
Vicksburg, Miss., exposures of Byram marl near.....	80-81
fossils found near.....	81, 83-85
Vicksburg beds, early paleontologic work on.....	79
Virgin City, Utah, sections west of.....	72-73
Virgin limestone member of the Moenkopi formation, fossils collected from.....	67-68
<i>Virgulina</i> sp., description of.....	92
sp., plate showing.....	110

W.

Washington County, Utah, age of the formations in.....	66-69
features of.....	53-54
fossils collected in.....	66-68
general section of.....	54-56
local sections in.....	69-77
stratigraphy of.....	54-66
structure of.....	54
Washington dome, Utah, section in.....	74
White, David, acknowledgment to.....	22
<i>Widdringtonites reichii</i> (Ettingshausen) Heer, erroneous identification of.....	209, 210
Wolf Hole, Ariz., section north of.....	75
Woodbine, Tex., fossil plants collected at.....	153
Woodbine sand, fauna of.....	155
flora of, descriptions of.....	159-180
distribution of, in other formations.....	159
early collections of.....	153
features of.....	155-156
plates showing.....	181
relations of, to that of other formations.....	156-158
naming of.....	154
nature and distribution of.....	154-155
Woodwards, Miss., exposure of Byram marl at.....	82
Woolsey Tank, Ariz., plate showing.....	189
bank of wash near, plate showing.....	189

Z.

<i>Zizyphus lamarensis</i> Berry, description of.....	170
<i>lamarensis</i> , plate showing.....	181

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ALBERT B. FALL, Secretary

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GEORGE OTIS SMITH, Director

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# SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY

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DAVID WHITE, CHIEF GEOLOGIST



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## CONTENTS.

[The letters in parentheses preceding the titles are those used to designate the papers for advance publication.]

	Page.
(A) Lithologic subsurface correlation in the "Bend series" of north-central Texas, by M. I. Goldman (published Mar. 7, 1921).....	1
(B) <i>Orthaulax</i> , a Tertiary guide fossil, by C. W. Cooke (published Sept. 29, 1921).....	23
(C) Graphic and mechanical computation of thickness of strata and distance to a stratum, by J. B. Mertie, jr. (published March 14, 1922).....	39
(D) Stratigraphic sections in southwestern Utah and northwestern Arizona, by J. B. Reeside, jr., and Harvey Bassler (published March 22, 1922).....	53
(E) The Byram calcareous marl of Mississippi, by C. W. Cooke (published March 17, 1922).....	79
The Foraminifera of the Byram calcareous marl at Byram, Miss., by J. A. Cushman (published March 17, 1922).....	87
(F) The Foraminifera of the Mint Spring marl member of the Marianna limestone, by J. A. Cushman (published March 28, 1922).....	123
(G) The flora of the Woodbine sand at Arthurs Bluff, Tex., by E. W. Berry (published March 23, 1922).....	153
(H) Geology of the lower Gila region, Ariz., by C. P. Ross (published March 29, 1922).....	183
(I) The flora of the Cheyenne sandstone of Kansas, by E. W. Berry (published April 11, 1922).....	199
Index.....	227