STUDIES ON THE MELOBESIOIDEAE OF JAPAN

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Contents

I. Introduction

Calcareous crustaceous red algae have been left untouched by biologists for a long time because of their unfamiliar external appearances and the deposition of lime in their body tissues which seemed to make a study of them rather difficult. It was in 1837 that Philippi made clear for the first time the fact that the crustaceous coralline organisms belonged to the plant kingdom. He established two genera, *Lithothamnium* and *Lithophyllum*, distinguishing them from each other only by external characters. In his conception, *Lithothamnium* comprised the species of erect and branched forms while *Lithophyllum* the species of wholly crustaceous forms. The current definitions of these genera are very different from those given by Philippi. Studies on the calcareous red algae in early days were undertaken by Decaisne (1842), Harvey (1849) and Kützing (1849). Areschoug (1859) divided the order Corallineae into two suborders, Corallineae verae and Melobesieae, and Rosanoff (1866) studied *Melobesia*, *Lithophyllum* and *Lithothamnium* in detail. Solms-Laubach (1881) discussed the interrelation between *Lithophyllum* and *Melobesia*, and suggested also that, as a result of detailed studies on many species, it would be possible to use the characteristics of reproductive organs in distinguishing genera. Hauck (1883) published a new system of classification of these algae differing slightly from that of his predecessor. Rothpletz (1891) studied fossil crustaceous algae and divided them on the basis of the character of tetrasporangium into three groups, *Archaeolithothamnium*, *Lithothamnium* and *Lithothamniscum* (*Lithophyllum*). He adopted for the first

time the nature of reproductive organs as the standard in classifying these algae. A system of classification given by Schmitz and Hauptfleisch (1897) was nearly the same as that presented by Solms-Laubach (1881) except that two monotypic genera, *Schmitziella* Bornet et Batters and *Choreonema* Schmitz, were newly added. From the end of the last century until fairly recently, Heydrich (1897–1911) and Foslie (1890–1929) carried out extensive studies very actively, and exchanged discussions with each other from opposite standpoints. Heydrich (1897) established his system at first on the basis of morphology and anatomy of thallus, but in the same year he suggested another system based on the arrangement of tetrasporangia, and in 1900 he again reformed his system on the basis of the development of cystocarp. However, his systems and genera are not without shortcomings in some respects, so his views are not always adopted by us today. On the contrary, Foslie's system is still prevailing today and his excellent works on the coralline algae are generally accepted. His system, like that of Hedyrich, is mainly based on the nature of tetrasporangia, in addition to the nature of cystocarps and the anatomical structure of thalli. Lemoine (1911) proposed a system classifying these algae on the basis only of the anatomical structures of thalli, since reproductive organs are not always observable. In her specimens, especially in fossil ones, she distinguished three patterns of vegetative structures, which she named *Lithothamnium*-type, *Lithophyllum*-type, and *Melobesia*-type. However, if her system is used, some species which belong with good reasons to *Lithothamnium* must be removed to *Lithophyllum*, and some others belonging to *Lithophyllum* must be transfered to the other. Though Lemoine's system is artificial, it has been welcomed by paleobotanists because of general absence of reproductive organs in fossil specimens. Nichols (1908, 1909) described the morphology of six species from California, and Rosenvinge (1917) reported a detailed morphological observations of many species in the course of his studies on the algae of Denmark. Howe (1920) established *Fosliella* on the basis of *Melobesia farinosa*, but Kylin (1956) was of differing opinion. Suneson (1937, 1943) observed the development of reproductive organs of many Swedish species in the Corallinaceae, especially of the Melobesioideae. Balakrishnan (1947) studied the anatomy, cytology, and the development of the reproductive structure of *Melobesia farinosa* of India. Mason (1953) studied 20 species belonging to 8 genera from the Pacific coast of North America. Dawson (1944, 1945, 1946, 1954, 1955, 1957, 1960, 1963) also gave descriptions of many species from various localities, and reported in 1960 53 species and 2 forms from the Pacific coast of Mexico. Recently, Adey (1964, 1965, 1966, 1966a) studied the ecology, anatomy, cytology, and the development of the reproductive structure of the crustose corallines of the Gulf of Maine. And he clarified the distinction among *Clathromorphum*, *Phymatolithon*, *Lithothamnium*, and *Leptophytum*.

The species belonging to the Family Corallinaceae are divided into two

subfamilies, viz., Corallinoideae (Mason, 1953) and Melobesioideae (Mason, 1953), of which the former was rather throughly studied in Japan by Yendo (1902, 1916, 1936) and Segawa (1940, 1941, 1942, 1946, 1947, 1949, 1957, 1958, 1959), while the latter was mainly studied by Fosile (1900, 1901, 1905, 1906, 1907, 1908, 1909) to whom the Japanese specimens were sent by Yendo and Miyabe for identification. As a result, Yendo enumerated in 1902, 6 genera and 21 species and 4 forms and in 1916 and 1936, 8 genera and 36 species as the members of the Melobesioideae found in Japan and vicinity. Segawa (1956) illustrated 12 species belonging to 9 genera, and Chihara (1961) mentioned that Segawa had studied more than 40 species of Melobesioideae of Japan including more than 10 new species before his sudden death in 1960.

I have engaged in morphological researches of the Japanese species of Melobesioideae for eight years under the guidance of Emeritus Professor Jun Tokida, and already published six preliminary reports in collaboration with Emeritus Professor Tokida. In the present paper I give descriptions and figures of species belonging to 11 genera, including 7 species belonging to 4 genera new to science and 18 species belonging to 8 genera new to Japan. According to Yendo (in Okamura, 1936) and Segawa (1965), the total number of Melobesioideae already known for Japan is 44 species belonging to 12 genera. The materials used for my researches have been collected in Hokkaido and at several localities in Honshû including Mie, Wakayama, and Kochi Prefectures.

II. Materials and method

The materials used for this study were fixed and preserved in 8 to 10 per cent formaline in sea-water. They were collected in the period from 1958 to 1965 at the following places (Fig. 1): Hakodate City and vicinity; Muroran City; Kushiro City; Akkeshi Town; Nemuro City; Oshoro Bay; Imabetsu Town, Aomori Prefecture; Nou Town, Niigata Prefecture; Kominato Town, Chiba Prefecture; Shimoda Town, Shizuoka Prefecture; Arashima, Mie Prefecture; Shio-no-misaki, Wakayama Prefecture; Shirahama Town, Wakayama Prefecture; Muroto-misaki, Kochi Prefecture; Usa, Kochi Prefecture; and Susaki, Kochi Prefecture. The fixed materials were decalcified with Pérényi's solution and cut in paraffin. Sections were cut 8 to 10μ in thickness and stained in Heidenhain's iron haematoxylin, Delafield's haematoxylin, and lactic blue.

III. Description of the species

Family Corallinaceae (Gray) Harvey

Harvey, 1853, p. 80; Rosenvinge, 1917, p. 208; Okamura, 1936, p. 497; Kylin, 1956, p. 175.

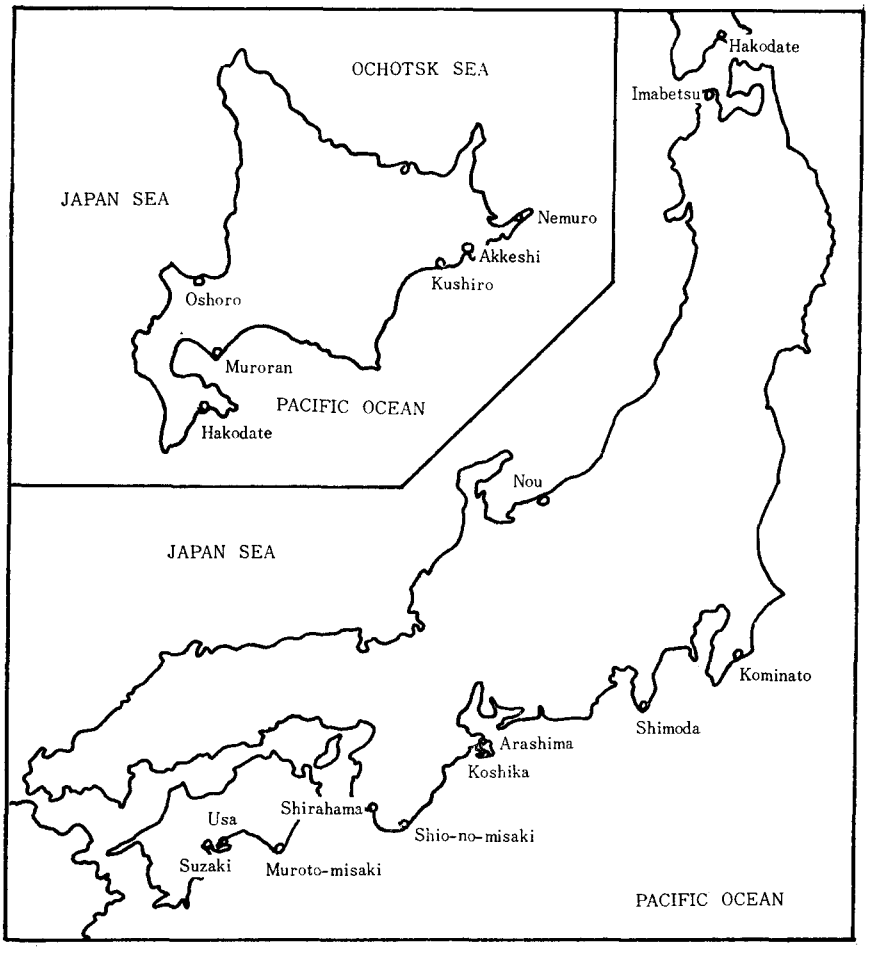

Fig. 1. Map showing the sites of the collecting localities

Corallideae Gray, 1821, p. 339.

The family Corallinaceae is a member of the order Cryptonemiales. This order is characterized by the auxiliary cells which are produced on accessory cell-branches or are especially derived, and differentiated prior to fertilization. In the Corallinaceae, the auxiliary cells stand on the floor of the conceptacle. The family Corallinaceae is divided into two subfamilies: Corallinoideae and Melobesioideae. In Corallinoideae (the jointed corallines) the thallus is provided with erect jointed branches which are made of alternation of calcified and uncalcified segments. The uncalcified segment is called geniculum and the calcified segment intergeniculum. In the Melobesioideae (the crustose corallines), the thallus is exclusively composed of completely calcified portions.

Key to the subfamily

1. Plant erect, branched, with genicula, except for the crustose basal portion ....Corallinoideae
1. Plant crustaceous or fruticose without genicula .....Melobesioideae

Subfamily MELOBESIOIDEAE L. R. Mason

Mason, 1953, p. 313.

Melobesieae Areschoug, *in* J.G. Agardh, 1852, p. 508.

Melobesiae Yendo, 1902, p. 185; *in* Okamura, 1902, p. 97; *in* Okamura, 1916, p. 118; *in* Okamura, 1936, p. 499.

Plants crustaceous, subramose or branched; vegetative tissue consisting of three parts: 1. hypothallium which corresponds to the basal attaching portion of the crust and the medullary portion of the branch, composed of one to several layers of cells; 2. perithallium which corresponds to the inner (cortical) portion of the crust and branch; and 3. epithallium (comparable to an outer cortex or epidermis) which covers the thallus surface, composed of one to several layers of cells. Heterocysts may be present, either solitary, or grouped in transverse or longitudinal lines.

The subfamily Melobesioideae is divided into two tribes, Lithothamnieae and Lithophylleae. The former is characterized by the asexual conceptacle provided with many minute mucilagenous canals perforating its roof, and the latter by the asexual conceptacle with a single pore in its roof.

Key to the tribes and genera

I. Sporangial conceptacles with roof perforated by few to many mucilagenous canals .....Tribe Lithothamnieae (p. 6)
  1. Thalli hemiparasitic; hypothallium attached to host by penetrating base .....*Polyporolithon* (p. 6)
  1. Thalli autotrophic 2
    2. Hypothallium monostromatic; thallus epiphytic ....*Melobesia* (p. 7)
    2. Hypothallium polystromatic; thallus attached to rocks and stones, sometimes epiphytic 3
  3. Roof of asexual conceptacles flat or convex .....*Lithothamnium* (p. 9)
  3. Roof of asexual conceptacles concave .....*Clathromorphum* (p.19)

II. Sporangial conceptacles with roof perforated by a single pore ....Tribe Lithophylleae (p.21)
  1. Thalli thickly calcified 2
  1. Thalli weakly calcified 5
    2. Sporangia standing on the whole surface of conceptacle floor; thalli with singly scattered heterocysts; hypothallium polystromatic ....*Neogoniolithon* (p.46)

2. Sporangia standing on the periphery of conceptacle floor.....3
3. Thalli with heterocysts grouped in short transverse rows .....
.....*Porolithon* (p.42)
3. Heterocysts absent 4
4. Hypothallium consisting of one layer of elongated cells standing obliquely on the substratum .....*Dermatolithon* (p.49)
4. Hypothallium polystromatic or monostromatic; when monostromatic, standing not obliquely to the substratum .....*Lithophyllum* (p.28)
5. Thalli flexible, epiphytic, epizoic or attached to hard objects including rocks, and regularly superimposed .....*Lithoporella* (p.55)
5. Thalli fragile, epiphytic, not regularly superimposed 6
6. Heterocysts presents .....*Fosliella* (p.21)
6. Heterocysts absents.....*Heteroderma* (p.25)

Tribe **Lithothamnieae** Foslie ex Svedelius

Svedelius *in* Engler and Prantl, 1911, p. 265.
Section Lithothamnioneae Foslie, 1903, p. 25.
Subfamily Lithothamnieae (Foslie ex Svedelius) Setchell, 1943, p. 134.

Polyporolithon L. R. Mason

Mason, L.R., 1953, p. 316.

Polyporolithon reclinatum (Foslie) L.R. Mason

Mason, 1953, p. 319, pl. 30; Tokida & Masaki, 1960, p. 497; Masaki & Tokida, 1961, p. 188, pls. 1–4.

Syn. *Lithothamnium conchatum* Setchell et Foslie f. *reclinatum* Foslie, 1906a, p. 6. *Lithothamnium reclinatum* Foslie, 1907b, p. 14; 1929, p. 45, pl. 10, figs. 14–17; De Toni, 1924, p. 618.

Japanese name. Kasa-kinoko-ishimo (Tokida and Masaki)

Habitat and distribution, in literature. Hemiparasitic on *Cheilosporum* (*Bossiella*) *frondescens*, *Bossiella* and *Corallina*. From Vancouver Island, B.C., to central California along the coast of North America.

Specimens collected. Hemiparasitic on *Pachyarthron cretaceum*. Muroran, 20 March, 1960, Tokida and Masaki; 1 June, 1960, H. Yamamoto; Shirikishinai, near Hakodate, 23 July, 1960, H. Niihama.

The following description is based on the specimens from Muroran.

Thallus an irregularly circular or elliptical small disk, sessile, often recurved and encircling host partly or completely, up to 1.8 cm long by 0.7 cm broad, 0.3–1.0 mm thick, attached to host by subpenetrating base near the center of lower surface, deep reddish purple in color, polystromatic to margin; epithallium 1–3 layers of cells thick except at the very edge of thallus where it is lacking, cells

in section rectangular and 7μ in diam. or subquadrate and 5–9μ long by 4–7μ diam.; perithallium 0.15–1.3 mm thick, cells subquadrate, 10–17μ diam., or elongated and 15–26μ long by 8–12μ diam., uppermost cells deeply stained with haematoxylin and anilin blue, vertically elongated and 12–30μ long by 5–9μ diam.; hypothallium 50–230μ thick, composed of branched cell-rows curved upward and downward, cells rectangular, 13–50μ long by 8–13μ diam.; coalescence of cells between adjacent cell-rows in perithallium and hypothallium present; sporangial conceptacles 147–273μ high, 290–435μ diam., deeply embedded, roof flat or slightly convex, perforated by 25–30 pores, sporangia tetrasporic, 109–197μ long, 45–87μ diam.; sexual plants normally dioecious but sometimes monoecious; procarpic conceptacles slightly convex, 126–252μ high, 147–190μ diam., auxiliary cells carrying one or two carpogonial branches, procarps and their supporting cells filled with protoplasmic contents and stained deeply with haematoxylin and anilin blue; cystocarpic conceptacles slightly convex, (230–)273–380μ high, 292–462μ diam., carpospores arising from the periphery of fusion cell which is often discontinuous in section; spermatangial conceptacles nearly flat on surface, sometimes embedded deeply, 90–230μ high, 290–460(–700)μ diam., opened by a very narrow orifice, without a spout, spermatangia globular, 3μ diam., when detached and set free in conceptacle cavity which is wholly lined with a layer of uninucleate palisade-like cells or spermatangium mother cells.

The genus *Polyporolithon* was established by L.R. Mason in 1953 to include four hemiparasitic and mushroom-shaped species formerly classified in *Lithothamnium*. One species is from Australia and New Zealand and the remaining three are from the Pacific coast of North America. My specimens from Muroran are referable to one of those from North America, as is a specimen from Shirikishinai collected by Mr. Hidehiro Niihama. The male plant is described here for the first time. This species is at first a small circular disk attaching laterally on an intergeniculum of the host by means of a sub-penetrating base. The disk later becomes irregularly expanded laterally or lengthwise, and more or less recurved, sometimes encircling the host partly or completely. In such cases the disk may cover several articulations of the host but makes no other attachments than the original one. In some cases, however, several articulations of the host plant may firmly adhere to a disk due to activities of animals such as Bryozoa or Spirorbis. Spirorbis is commonly found attached in groups to the lower concave surface of the disk. Its calcareous tubes sometimes happen to hold some of the host articulations making the attachment of the epiphyte to the host much more stable.

Melobesia Lamouroux

Lamouroux, 1812, p. 186; Smith, 1944, p. 218; Taylor, 1945, p. 175; Mason, 1953, p. 319.

Epilithon Heydrich, 1897a, p. 408; Foslie, 1909, p. 55; Svedelius, *in* Engler

and Prantl, 1911, p. 267; Hamel et Lemoine, 1952, p. 112; Kylin, 1956, p. 206.
Lithothamnium Philippi subgenus *Epilithon* (Heydrich) Foslie, 1898a, p. 7.

Melobesia pacifica Masaki sp. nov.

Pls, I, XXXIX & XL

Thallus aliquatenus orbicularis vel irregularis primo, 1–3 mm diam., deinde crustis confluentibus et leviter superpositis, distromaticis ad partem marginis polystromaticis prope conceptaculum; cellulae basidum monostromaticae, subtriangulares, subrectangulares vel subquadratae, 5–9μ alt., 5–9μ diam.; perithallium polystromaticum, ex 7–9 cellulis prope conceptaculum compositum, generaliter cellula tertia ex cellula basidis praelonga, cellula superiorissima triangularis, 5–100μ long., 3–5μ diam.; epithallium monostromaticum, cellulis subquadratis et 5μ diam., vel rectangularis et 3–9μ alt., 6–14μ diam.; cellulae confluentis saepe in parte perithallii et cellularum basidum; conceptacula sproangifera dense conferta, fere plana aut leniter convexa, 147–1400μ diam., 122–210μ alt. partim perforata a 4–15 canalibus muciferis, sporangiferis tetrasporis, (85–)120–170μ long., (40–)65–100(–140)μ diam., stantes super tota superficie pavimenti conceptaculorum; conceptacula feminarum fere plana, 65–85μ diam., 85–140μ alt., conceptacula cystocarpiorum fere plana, aut leniter convexa 120–220 μ diam., 125–210(–250) μ alt., carposporis a peripheria fusio-cellularum exurgentibus; conceptacula mascula dense conferta, fere plana aut leniter convexa, 85–140(–150) μ diam., 65–170μ alt., apertura conceptaculi potius lata et longa, spermatibus elongatis et 5μ long., 2μ diam., aut globularis, ca 2μ diam., a tota superficie conceptaculi exurgentibus.

Japanese name. Abata-mokasa (n.n.)

Type. Epihytic on *Phyllospadix iwatensis.* Shireto-misaki, Kushiro City, 14 Feb. 1958, T. Masaki.

Specimens collected. Epiphytic on *Phyllospadix iwatensis.* Muroran City, 1 June 1960, H. Yamamoto; Habomai (the beach facing the Pacific), near Nemuro City, 27 June 1960, S. Sasaki; Moheji, near Hakodate City, 23 April 1962, T. Masaki; Tachimachi-misaki, Hakodate City, 24 Dec. 1963, T. Masaki; Shinori, Hakodate City, 3 Feb. 1964, T. Masaki.

The following description is based on the specimens collected at Kushiro City.

Thallus somewhat circular or irregular in outline at first, 1–3 mm diam., later becoming confluent with each other and slightly overlapping, sometimes coexisting with *Heteroderma zostericola* on one and the same blade of *Phyllospadix* but distinguishable from it by the thick upheaved thallus, purple red in color, distromatic in the peripheral portion, polystromatic in the neighborhood of conceptacle; basal cells monostromatic, subtriangular, subrectangular or subquadrate in shape, 5–9μ high, 5–9μ diam.; perithallium polystromatic, consisting of 7–9 cells in the neighborhood of conceptacle, cells 5–100μ long, 3–5μ diam., of

which the third cell from the base generally much elongated and the uppermost cell triangular; epithallium monostromatic, cells subquadrate, 5μ diam., or rectangular, 3–9μ high, 6–14μ diam.; lateral coalescence of cells frequently occurring in perithallium and basal cells: sporangial conceptacles crowded, 122–210μ high, 147–400μ diam., roof nearly flat or slightly convex, 34–42μ thick, perforated by 4–15 pores, sporangia tetrasporic, (85–)120–170μ long, (40–)65–100(–140)μ diam., standing on the whole surface of conceptacle floor; female conceptacles nearly flat, 85–140μ high, 65–85μ diam., one or two carpogonial branches standing on an auxiliary cell; cystocarpic conceptacles nearly flat or slightly convex, 125–210 (–250)μ high, 120–220μ diam., carpospores arising from the periphery of the fusion cell; spermatangial conceptacles crowded, nearly flat or slightly convex, 65–170μ high, 85–140(–150)μ diam., orifice rather broad and long, spermatia immediately after detaching from the mother cells standing on the whole inner surface of conceptacle, 5μ long, 2μ diam., becoming gloublar, about 2μ diam., when set free in the conceptacle cavity.

Lithothamnium Philippi

Foslie, 1900c, p. 10; Lemoine, 1911, p. 54; Svedelius, *in* Engler and Prantl, 1911, p. 268; Okamura, 1936, p. 499; Hamel et Lemoine, 1952, p. 79; Mason, 1953, p. 322; Kylin, 1956, p. 205.

Eleutherospora Heydrich, 1900, p. 64.

Mesophyllum Lemoine, 1928, p. 251; Kylin, 1956, p. 206.

Key to the species of **Lithothamnium**

1. Thallus epiphytic on *Gelidium* ..... 3. *L. cystocarpideum* (p.11)
1. Thallus attached to rocks and stones 2
   2. Thallus without excrescences, surface smooth .... 6. *L. lenormandii* (p.15)
   2. Thallus with excrescences 3
3. Excrescences short, not branched 4
3. Excrescences branched 6
   4. Excrescences up to 6 mm high ..... 7. *L. pacificum* (p.16)
   4. Excrescences up to 1.5 mm high 5
5. Sporangial conceptacles 190–450μ diam ..... 8. *L. sonderi* (p.18)
5. Sporangial conceptacles 150–190μ diam ..... 1. *L. aculeiferum* (p.10)
   6. Branches 5–10 mm long, compound and subdichotomously divided..... ..... 4. *L. erubescens* (p.12)
   6. Branches up to 5 mm long, simple or subdichotomously divided 7
7. Cell-rows of hypothallium disposed concentrically ..... 2. *L. canariense* (p.10)
7. Cell-rows of hypothallium disposed parallel to substratum .... 5. *L. intermedium* (p.14)

1. **Lithothamnium aculeiferum** L.R. Mason

Pls. II, III & XLI

Setchell and Mason, 1943, p. 94; Mason, 1953, p. 326, pl. 33, fig. c; Dawson, 1960, p. 10, pl. 3, figs. 1–3, pl. 5, fig. 1; Hollenberg & Abbott, 1966, p. 58.

Japanese name. Seto-ishimo (n.n.)

Habitat and distribution, in literature. On pebbles moving freely with the wave motion, California (White's Point, San Pedro, type locality; from Duxbury Reef, Marin County, to La Jolla, San Diego County); Mexico (Pacific Baja California).

Specimens collected. On rocks. Shiso-jima, Seto, Wakayama Pref., 18 Sept. 1963, T. Masaki.

Crust firmly adherent to rocks, 300–800μ thick, surface provided with excrescences, excrescences angular, 1.0–1.5 mm high, 1.0–2.0 mm diam. at basal portion; hypothallium poorly or irregularly developed, about 50μ thick, cells rectangular, 10–25μ long, 5–7μ diam., filamentous cell-rows parallel or slightly curved downward to substratum; cells of perithallium ovoid, 3–4μ diam., slightly elongated vertically to substratum, often shorter than diameter, 3–6μ high, 3–6 μ diam.; epithallium composed of one layer of cells, cells subrectangular or subtriangular, 1–3μ high, 5–6μ diam.; cell-fusions often occurring; sporangial conceptacles convex, 65–100μ high, 140–200μ diam., roof 25–30μ thick, perforated by 20–30 mucilagenous canals which are about 10μ diam., sporangia tetrasporic, 45–55μ long, 20–35μ diam.; spermatangial conceptacles convex or nearly hemispherical, 110–190μ diam., 90–100μ high, roof 25–35μ thick, spermatangia globular, about 2μ diam., produced on dendroid systems of filaments developed from the whole inner surface of conceptacle; female plants not observed.

According to Mason (1953), Foslie (1901) had a mixture of material of *L. aculeiferum* and of *Lithothamnium rugosum* Foslie f. *crassiuscula* Foslie in the type material of the latter. Since the two entities differ in both external appearance and internal structure, Mason segregated the material raising to specific rank foslie's f. *crassiuscula*, and giving a new name, *L. aculeiferum*, to the remaining material. The present specimens were compared with the type of this species sent from the Herbarium of the University of California by courtesy of Professor Papenfuss and Dr. Silva, and were found to agree in general with the type but differ from it in having thinner crusts.

2. **Lithothamnium canariense** Foslie

Pl. IV; Pl. XLII, Figs. 1–3

Foslie, 1906, p. 1; 1929, p. 39, pl. 14, figs. 7–8; De Toni, 1924, p. 634.

Syn. *Mesophyllum canariense* (Foslie) Lemoine, 1928, p. 252; *in* Børgesen, 1929, p. 31, pl. 1, figs. 1–2, pl. 2, figs. 2 and 4.

Japanese name. Kanaria-ishimo (n.n.)

Habitat and distribution, in literature. On shells (Vermetus) and thalli of other melobesioidean algae. The Canary Islands.

Specimens collected. On rocks. Shio-no-misaki, Wakayama Pref., 30 Sept. 1963, T. Masaki.

Thallus attached firmly to rocks, about 0.5–1.5 cm high, crust thin, 300–500μ thick, covered with branches, branches short, simple, subcylindrical, 2–5 mm high, 1.5–2.0 mm diam., subdichotomously divided, anastomosing with each other, apex round or flat; hypothallium of the crust well developed, composed of branched cell-rows curved upward and downward and disposed concentrically, cells rectangular, 15–25(–30)μ long, 5–10μ diam.; cell of perithallium subquadrate, 5–8μ diam., or subrectangular, 8–14μ long, 7–10μ diam., with round corners; epithallium subtriangular, 3μ high, 6–8μ diam.; medullary cells in longitudinal section of branches subqaudrate, 6–8μ diam., or subrectangular, 6–12μ long, 5–8μ diam.; cell-fusion frequently occurring between adjacent cell-rows, especially remarkable in hypothallium of the crust; sporangial conceptacles crowded in branches, convex or depressed hemispherical, 75–130μ high, 150–400μ diam., roof 20–30μ thick, perforated by 30–50 muciferous canals, sporangia tetrasporic, 60–110μ long, 25–50μ diam.; sexual plants not observed.

This species was described at first by Foslie in 1906 on the basis of the materials collected by C. Sauvageau at Puerto Orotava, Canary Islands. Lemoine (1929) reproted it again from Canary Islands under the name of *Mesophyllum canariense* together with its two new varieties, var. *fasciata* and var. *difformis*. She states that the transverse cell-walls in longitudinal section of branches are stained well with "acide iodhydrique iodé". In my specimens, the cell-walls are also well stained with haematoxylin and anilin blue as shown in Pl. IV, fig. 7.

Though Fosile described both the tetrasporangial and cystocarpic conceptacles in the present species, I could find only tetrasporic plants in my collection.

3. **Lithothamnium cystocarpideum** Foslie (prox.)

Pls. V & VI, XLIII & XLIV

Foslie, 1906a, p. 7; 1929, p. 40, pl. 10, figs. 7–9; De Toni, 1924, p. 613.

Japanese name. Kusa-no-kaki (n.n.)

Habitat and distribution, in literature. Epiphytic on *Cheilosporum wardii*. Chatham Island, Galapagos Islands.

Specimens collected. Epiphytic on *Gelidium amansii*, *G. japonica*, *G. subcostatum* and *Acanthopeltis japonica*. On the coast of the Izu Peninsula, Shizuoka Pref.: Akazawa, Ito City, 17 Sept. 1962, Y. Iwahashi; Inatori, Higashi-izu Town, 10 Sept. 1962, Y. Iwahashi; Shirahama, Shimoda Town, 1 June 1961, T. Masaki; 15 June 1962, Y. Iwahashi; Minami-izu Town, 12 June 1962, Y. Iwahashi; Iro-zaki,

Minami-izu Town, 12 Sept. 1962, Y. Iwahashi; Nishi-izu Town, 14 Sept. 1962, Y. Iwahashi.

Thallus lamelliform, lamella irregularly roundish in shape, 1.3–2.5 cm × 1.0–1.5 cm, 150–300μ thick, more or less curved and partly encircling host, attached to host at the central portion of under surface directly or by a short stalk, margin more or less irregularly undulate; hypothallium well developed, as thick as 1/3–1/2 of perithallium, composed of branched cell-rows curved upward and downward, cells quadrate, 10μ diam., or rectangular, 15–35μ long, 5–10μ diam.; cells of perithallium subrectangular, 8–20μ long, 3–10μ diam. or subquadrate, 6–9μ diam.; epithallium composed of one layer of cells which are subrectangular, 3–4μ high, 5–7μ diam.; cell-fusion frequently occurring between adjacent cell-rows in perithallium and hypothallium; sporangial conceptacles nearly flat or convex, 190–340(–780)μ × 125–280μ in surface view, 105–205μ high, 125–545 (–625) μ diam. in sectional view, gathered in groups in nemathecial elevations of thallus surface, sometimes two or three conceptacles are confluent, conceptacle roof 25–40μ thick, perforated by 20–50 muciferous canals, sporangia tetrasporic, (80–) 90–105μ long, (20–)35–65μ diam.; procarpic conceptacles hemispherical, 105μ high, 460μ diam., conceptacle floor is at the same level as the thallus surface, roof 85μ thick; cystocarpic conceptacles conical, 300–600μ high, 470–780μ diam., ostiole well developed, 125–265μ long, carposopores arising from the whole surface of conceptacle floor, fusion-cell discontinuous in section; spermatangial conceptacles subconical, 140–210μ high, 325–420μ diam., roof 50–85μ thick, spermatangia globular, 1.5μ diam., produced on dendroid systems of filaments developed from the whole inner surface of conceptacle; monoecious.

The present alga is a common epiphyte on the thalli of the agarophytes growing along the coast of the Izu Peninsula. According to the key in Foslie (1929, p. 54), this species is characterized by the nature of sporangial conceptacles which are convex or hemispherical with a deeply depressed central part, and is distinguished from the nearly related species, *Polyporolithon conchatum* (Setchell et Foslie) L.R. Mason and *Polyporolithon patena* (Hooker f. et Harvey) L.R. Mason by the sporangial conceptacles deeply depressed in the central part. This is scarcely a distinction, but the original description of this species is so simple that the present identification remains uncertain until Foslie's type specimen is examined.

4. **Lithothamnium erubescens** Foslie

Foslie, 1900a, p. 9; 1904a, p. 31; Segawa, 1956, p. 70, pl. 40, fig. 308.
Syn. *Mesophyllum erubescens* (Foslie) Lemoine, 1928, p. 252,

4a. **Lithothamnium erubescens** Foslie f. **madagascarensis** Foslie

Pls. VII & VIII; Pl. XLII, Figs. 4–7

Foslie, 1901b, p. 3; Yendo, 1902, p. 187.

Japanese name. Edauchi-ishimo (Segawa)

Habitat and distribution, in literature. Miyazaki Pref., Japan; Madagascar.

Specimens collected. On rock below the lowest tide mark. Muroto-misaki, Kochi Pref. 11 June 1964, T. Masaki.

Thallus attached firmly on rocks, subhemispherical or irregular in shape, maximal diameter about 10 cm, about 2 cm high, 300–700μ thick, bearing numerous branches, branches subcylindrical or subcompressed, 5–10 mm long, 1–2 mm diam., sometimes simple or more often subdichotomously divided, usually anastomosing at the basal portion and frequently becoming round or depressed at their apices; hypothallium of the crust well developed, 125–170μ thick, composed of branched cell-rows which are curved upward and downward and disposed concentrically, cells rectangular, 12–25μ long, 3–5μ diam.; cells of perithallium subrectangular, round in corners, 8–13μ long, 4–7μ diam.; epithallium composed of single layer of cells, cells subrectangular or subtriangular, 2–3μ high, 5μ diam.; in longitudinal sections of branches medullary part clearly distinguished, cells rectangular, 13–22μ long, 5–10μ diam.; cells of peripheral part subquadrate, 8–12μ diam., or subrectangular and 10–16μ long by 6–10μ diam.; in transverse section the distinction between medullary and peripheral parts is not so clear as in longitudinal section, cells of peripheral part subquadrate and 8–10μ diam., or subrectangular and 7–20μ long by 4–8μ diam.; cell-fusions frequently occurring between adjacent cell-rows, remarkable in hypothallium of the crust; sporangial conceptacles convex, prominent, 250–400μ diam., 110–150μ high, roof flattened, 25–35μ thick, perforated by 25–30 (up to 50) muciferous canals, sporangia bisporic, uninucleate, 90–115μ long, 30–50μ diam.; sexual plants unknown.

This species was described by Foslie in 1900 on the basis of the materials from Brazil. Afterward, he distinguished the following five forms in the species: f. *americana* Foslie from Brazil and Bermuda; f. *prostrata* Foslie from Bermuda; f. *haigsisiana* A. Weber et Foslie from Timor; f. *madagascarensis* Foslie from Madagascar and Japan; and f. *subflabellata* Foslie from the Indian Archipelagos in the south-west Pacific Ocean. However, he stated in the report on the Siboga Expedition (1904a, p. 32) that he was not able to draw any definite line between the type of this species from Brazil and the nearly allied forms from the Indian and Pacific Ocean. As mentioned above, Foslie reported f. *madagascarensis* Foslie from Madagascar and Japan, but his specimens were very young and small. Moreover, he got only a single specimen from Madagascar. So he mentions (1901b, p. 4; 1904a, p. 35) that it can not be decided whether this form represents an independent species or identical with the present species as a form until mature

specimens are collected. This form is distinguished from f. *americana* by the fact that its branches are less regularly divided and slightly thicker in diameter, and its cell-rows in longitudinal section of branches do not show clear cup-shaped layers, the cells also being frequently shorter in length.[1]).

Judging from the external and internal structures, the present specimens are considered to be referable to f. *madagascarensis*.

5. **Lithothamnium intermedium** Kjellman

Kjellman, 1883a, p. 127, pl. 4, figs. 1–10; Foslie, 1890, p. 7; 1891, p. 6, pl. 3, fig. 5; 1905, p. 36; 1929, p. 42, pl. 22, figs. 1–5; Rosenvinge, 1893, p. 774. Masaki & Tokida, 1963, p. 3, pl. 4, figs. 1–4, pl. 5, figs. 1–3, pls. 6–8.

Syn. *Lithothamnium fruticulosum* (Kützing) Foslie f. *intermedia* (Kjellman) Foslie, 1895, p. 18. *Lithothamnium ungeri* Kjellman f. *intermedia* (Kjellman) Foslie, 1900c, p. 11.

Japanese name. Ibo-ishimo (Tokida and Masaki)

Habitat and distribution, in literature. On sandy or clayish bottom at a depth of 4.5–22.5 meters. Iceland and Norway.

Specimens collected. On calcareous animal body remains containing Foraminifera shells which are scattered on the *Laminaria* beds at a depth of about 20 meters. Imabetsu, Aomori Pref., 5 Nov. 1960, T. Masaki; 9 July & 5 Nov. 1961, T. Masaki.

Thallus in the form of crusts, 300–1500μ thick, 6–8 cm in diam., firmly adherent to subglobose, sometimes hollow, substrata composed of calcareous animal body remains, crusts bearing numerous flat-topped excrescenses on the whole surface, excrescenses simple or subdichotomously divided, up to 4–5 mm long, 2 mm diam., marginal portion of crust lobate and sometimes free from substratum; hypothallium consisting of about 5–6 layers of cells which are elongated, 10–27μ long by 5–10μ diam.; perithallium abruptly arising from hypothallium consisting of vertically elongated cells which are 7–17μ long by 5–8μ diam., cells sometimes subspherical or ovoid, 5–9μ diam., cell-fusion frequently occurring between adjacent cell-rows; epithallium consisting of 1–3 layers of cells which are subquadrate, 4–5μ diam. by 3μ high; sporangial conceptacles scattered all over the thallus surface, convex, (168–)210–380μ diam., 110–180μ high, roof (12–)21–23(–28)μ thick, perforated by 65–80 or even up to 110 muciferous canals, sporangia tetrasporic, (59–)80–134μ high, 29–62μ diam.; procarpic conceptacles hemispherical, 70–84μ high, 42–50μ diam., conceptacle cavity surrounded by a thick wall of cells, auxiliary cells not always distinctly differentiated, procarps few in number; cystocarpic conceptacles hemispherical, (210–)252–290(–320)μ high, 190–312(–340)μ diam., carpospores arising from the whole surface of conceptacle floor, fusion-cell discontinuous in section, conceptacle cavity flask-shaped, surrounded by tissue which stains well with haematoxylin and anilin-blue; spermatangial plant unknown.

1) Foslie (1901b) described that the cells were 10–20μ, frequently 12–15μ, in length.

My specimens agree well in general characters with the descriptions given by Kjellman and Foslie except for the number of muciferous canals in each sporangial conceptacle. Foslie (1905) gives 30–60 in his description of the species. Besides the sporangial and cystocarpic plants, procarpic individuals, but not the spermatangial, are among the specimens described here. *Lithothamnium intermedium* Kjellman is one of the main components of the *Lithothamnion* banks developed along the coasts of the northern part of Honshû.

6. **Lithothamnium lenormandii** (Areschoug) Foslie

De Toni, 1905, p. 1756; 1924, p. 620; Hamel et Lemoine, 1953, p. 88, text-figs. 49–50, pls. 16, 17, pl. 18, fig. 1; Zinova, 1955, p. 83, fig. 72; Dawson, 1960, p. 20, pl. 11, figs. 4–6, pl. 14, fig. 2; Masaki & Tokida, 1961, p. 163, pl. 1, figs. 3–5, pl. 2, figs. 6–9, pl. 4. *Lithothamnium lenormandi* (Aresch.) Foslie, 1895, p. 150; 1905, p. 12; 1929, p. 43, pl. 3, figs. 14–20; Heydrich, 1897, p. 53; 1897a, p. 413; 1900, p. 78, pl. 2, figs. 23–25; Rosenvinge, 1917, p. 216, figs. 133–135; Suneson, 1943, p. 5, text-figs. 1–3, pl. 1, figs. 1–4, pl. 8, fig. 36; Taylor, 1937, p. 262; 1957, p. 245; Skottsberg, 1953, p. 554. *Lithothamnium lenormandi* Areschoug, Lemoine, 1911, p. 81.

Syn. *Melobesia lenormandi* Areschoug, *in* J. Agardh, 1852, p. 514. *Lithophyllum lenormandi* (Aresch.) Rosanoff, 1866, p. 85, pl. 5, figs. 16–17, pl. 6, figs. 1–3, 5; Hauck, 1885, p. 267, text-fig. 110, pl. 3, fig. 4. *Phymatolithon lenormandi* (Aresch.) Adey, 1966a, p. 325. figs. 25–26, 43–50, 57, 91–95, 99–101, 102–112.

Japanese name. Akkeshi-ishimo (Tokida and Masaki)

Habitat and distribution, in literature. On rocks, stones, shells of molluscs (e.g. *Littorina, Modiola, Mytilus* and *Trochus*), lime tubes of a worm (*Pomatoceros triqueter*), and on other calcareous algae. From tide-pools and lower sublittoral to 14–36 meters. Pacific and Atlantic coasts of North America; Pacific coast of Mexico; Arctic; Iceland; Faeröes,; British Isles; Norway; Sweden; Denmark; Germany; France; Mediterranean; Adriatic; Australia; Antarctic.

Specimens collected. On stones and pebbles. Akkeshi, Hokkaido, 29 May 1960, H. Yamamoto.

Thallus in the form of firmly adherent thin crusts, 100–200μ thick, 2–5 cm diam., confluent with each other, surface smooth but microscopically rough, peripheral portion forming rounded zonate lobes with whitish margins; hypothallium 40–85μ thick, consisting of 5–8 layers of cells, cells rectangular, 12–25(–34)μ long, 7–12μ diam.; perithallium arising abruptly from hypothallium, cells subspherical and 9μ diam., or subrectangular to elliptical or ovoid and 7–12μ long by 4–7μ diam., coalescence of cells occurs; epithallium consisting of 1–2 layers of cells, cells rectangular, 4μ high by 9μ diam.; sporangial conceptacles crowded, depressed-hemispherical, often subprominent with floor at the same level as the crust surface, but sometimes immersed, 200–350μ diam., 84–160μ high, roof 21–42μ thick,

perforated by numerous muciferous canals up to 80 in number, ultimately decorticate, leaving a large depression visible from surface, sporangia quadrinucleate before division, producing usually binucleate bispores or rarely also tetraspores, both kinds of spores produced in one and the same conceptacle, bi- and tetrasporangia of similar size, 80–145μ long, 20–75 μ diam.; procarpic conceptacles hemispherical to subconical, 100–190μ in inner diam., ca. 170μ high, roof about 50μ thick, cystocarpic conceptacles hemispherical to subconical, 190–380μ in inner diam., 125–230μ high, roof 42–63μ thick, carpospores arising from the whole surface of the conceptacle floor, no fusion-cell developed after fertilization, ripe carpospores 97–105μ long, 30–55μ diam.; spermatangial conceptacles subhemispherical or subconical, 105–210μ in inner diam., 63–105μ high, roof ca 42μ thick, spermatangia globular, 3μ diam., produced on dendroid systems of filaments developed from the whole inner surface of conceptacle; dioecious.

My specimens from Akkeshi here described are in general referable to this species which is widely distributed in the world but not reported before from Japan. However, as compared with the descriptions of this species given by previous authors, my specimens show some differences in certain respects, namely in rather smaller size of the sexual conceptacles, in larger number of pores[1] in the roof of a sporangial conceptacle, and in the production of usually binucleate bispores or rarely also tetraspores in one and the same conceptacle instead of producing only tetraspores but also uninucleate bispores in different crusts (cf. Suneson, 1943, p. 6, fig. 2 B). The spermatangia in this species are described by Suneson (1943, p. 7) as being produced in dendroid clusters developed only from the bottom of the conceptacle, while those of my specimens show dendroid clusters developed not only from the bottom of the conceptacle but also from the inside of its roof. Some crust looks like to bear both male and female conceptacles. However, there can be seen a clear boundary of tissues beneath the female conceptacle disclosing the fact that such an apparent monoecious crust is only overlapping growth of two crusts differing in sex from each other.

7. **Lithothamnium pacificum** (Foslie) Foslie

Pl. IX, Figs. 1 & 2; Pls. X, XLV & XLVI

Foslie, 1906a, p. 10; 1929, p. 44, pl. 4, figs. 13, 14; Smith, 1944, p. 221, pl. 49, fig. 3; Taylor, 1945, p. 173; Dawson, 1946, p. 65; 1960, p. 22; Doty, 1947, p. 170; Mason, 1953, p. 328, pl. 34.

Syn. *Lithothamnium sonderi* Hauck f. *pacificum* Foslie, 1902, p. 4; 1905, p. 24 (as f. *pacifica*); Setchell and Gardner, 1903, p. 358.

Japanese name. Akkeshi-iboishi (n.n.)

Habitat and distribution, in literature. On rocks, pebbles and shells (especially

1) 45–50 in smaller conceptacles but up to 80 or more in larger ones.

limpets, and the gastropod, *Searlesia dira*) in tide-pools just below water mark. Pacific coast of North America, from Vancouver Island to Mexico; Galapagos Islands.

Specimens collected. On pebbles at low water mark. Aikapu-misaki, Akkeshi, Kushiro Prov., Hokkaido, 28 May and 24 July 1964, T. Masaki; Shinori, Hakodate City, 23 Oct. 1964, T. Masaki.

Thallus in the form of crusts firmly adherent to substratum, covering it partly or completely with expanses of about 8 cm in diameter, and about 1.5 mm in thickness, adjacent thalli superimposed or anastomosing with each other forming a prominent ridge at their border lines; thallus provided with rugose upheavals or wart-like excrescences in early stage, with developed protuberances covering almost whole surface of thallus in advanced stage; protuberances 2–6 mm high, 2–4 mm diam., subterete, solitary or anastomosing with each other at their base or occasionally their whole length; hypothallium poorly developed, attaining to about 80μ thick, cells rectangular, 6–25μ long, 4–6μ diam.; perithallium arising abruptly from hypothallium and occupying the greater part of thallus tissue, cells subquadrate, 5–7μ diam., or rectangular, or irregular, or elongated at right angles to the substratum, 7–15μ long, 3–7μ diam.; epithallium one cell-layered, cells rectangular, 1–2μ high, 3–4μ diam.; sporangial conceptacles crowded especially on protuberances, convex, 180–450μ diam., 100–125μ high, roof 18–25μ thick, perforated by about 30–70 muciferous canals, sporangia bisporic, 70–150μ long, 25–58μ diam., spores uninucleate; procarpic conceptacles hemispherical, with floor at the same level as the crust surface, 215–420μ diam., 115–240μ high, ostiole 65–175μ long; cystocarpic conceptacles conical, 350–600μ diam., 125–400μ high, ostiole well developed, 65–250μ long, carpospores arising from the whole surface of conceptacle floor, fusion-cell discontinuous in section; cystocarpic and sporangial conceptacle cavities are surrounded by a tissue which stains well with haematoxylin and anilin blue; spermatangial conceptacles conical, 100–350μ diam., 125–240μ high, ostiole 30–90μ long, spermatangia globular, 2μ diam., produced on dendroid systems of long filaments developed from the whole inner surface of conceptacle; dioecious.

Since Foslie (1906) described this species with two forms, f. *typica* and f. *crassiuscula*, many authors have reported the occurrence of this species mainly on the Pacific coast of North America. Compared with those descriptions, my specimens also have a close resemblance to *Lithothamnium rugosum* in both babit and inner structure of the thallus, but differ from it in having simple wart-like excrescences instead of branched ones. They are referable to *Lithothamnium pacificum* in both the thickness of hypothallium and the dimensions of sporangial conceptacles.

8. **Lithothamnium sonderi** Hauck

Pl. IX, Fig. 3; Pls. XI, XLVII & XLVIII

Hauck, 1885, p. 273, pl. 3, fig. 5; Foslie, 1895, p. 127; 1900c, p. 14; 1902, p. 4 (as f. *pacifica*); 1905, p. 23 (as f. *typica*, f. *sublaevigata* and f. *pacifica*); 1929, p. 45, pl. 4, figs. 4–8 (as f. *typica* and f. *sublaevigata*); Heydrich, 1897, p. 58 (nomen nudum); 1900, p. 77; De Toni, 1905, p. 1747; 1924, p. 626; Lemoine, 1911, p. 96, fig. 45; Rosenvinge, 1917, p. 219, figs. 136–137; Suneson, 1943, p. 9, text-figs. 4–5, pl. 2, figs. 5–7, pl. 8, fig. 35.

Japanese name. Ibo-okoshi (n.n.)

Habitat and distribution, in literature. On rocks, stones and pebbles or on the tubes of the worm, *Pomatoceros triqueter*, sometimes on shells of molluscs or other calcareous algae, on soft stones such as chalk and lime stones, in the sublittoral region or, especially in Norway and Sweden, to a depth of 5–30 meters. South-west coast of Norway; Sweden; Denmark; Helgoland; South-west coast of Scotland; Ireland; France (Finistere); Pacific coast of North America.

Specimens collected. On pebbles at the low tide mark. Arashima, Toba City, Mie Pref., 16 May 1965, T. Masaki; Koshika, near Wagu Town, Mie Pref., 19 May 1965, T. Masaki; Koza Village, near Kushimoto Town, Wakayama Pref., 4 Oct. 1963 and 2 June 1965, T. Masaki.

Thallus firmly adherent on pebbles, 0.2–0.7 mm thick, surface covered with wart-like excrescences or sometimes uneven, excrescences small, simple, up to 1.5 mm long, 0.5–0.8 mm diam.; hypothallium poorly developed, composed of 2–6 layers of cells, parallel to substratum or curved slightly downward, cells elongated, 10–20μ long, 5–7μ diam.; cells of perithallium subquadrate or ovoid, about 5μ diam., or subquadrate or irregularly elongated, often shorter than diameter, 5–9 (–12)μ long, 4–6μ diam.; epithallium composed of one layer of cells, cells rectangular, 4μ diam., 2μ high; cell-fusion frequently occurring in perithallium; sporangial conceptacles convex, more or less prominent, 190–450μ diam., 80–115μ high, roof 15–25μ thick, perforated with 30–70 muciferous canals, sporangia tetrasporic, 50–105μ long, 20–65μ diam.; female conceptacles subconical, 150–160μ in inner diam., 250–300μ in outer diam., 90–125μ high, ostiole well developed, 20–100μ long; spermatangial conceptacles, conical, 115–200μ in inner diam., 200–300μ in outer diam., 45–100μ high, roof 10–55μ thick, spermatangia globular, 2μ diam., produced on dendroid systems of filaments developed from the whole inner surface of conceptacle.

This species was established by Hauck in 1885. Afterward, Foslie (1905) distinguished in it the following three forms: f. *typica*, f. *sublaevigata*, and f. *pacifica*. Suneson (1943) studied this species morphologically in detail. My specimens agree in general with the plant studied by Suneson, but they have generally a thinner crust than the specimens studied by other authors. In my

specimens I could often observe young procarpic conceptacles but no cystocarpic one.

Clathromorphum Foslie

Foslie, 1898, p. 4; 1900c, p. 9; Mason, 1953, p. 330; Adey, 1965, p. 539.
Phymatolithon Foslie subgenus *Clathromorphum* Foslie, 1905, p. 87.

Clathromorphum compactum (Kjellman) Foslie

Foslie, 1898, p. 4; 1898a, p. 8; 1900c, p. 10; 1908, p. 11; 1929, p. 29, pl. 41, figs. 1–4; De Toni, 1905, p. 1726; Mason, 1953, p. 331, pl. 37, fig. c; Segawa, 1956, p. 70, pl. 40, fig. 309; Kawabata, 1959, p. 292; Masaki & Tokida, 1961a, p. 161, pl. 1, figs. 1–2, pl. 2, figs. 1–5, pl. 3; Adey, 1965, p. 541, pl. 1, figs. 12, 16–18, pl. 2, figs. 24–25, pl. 3, figs. 36–39.

Syn. *Lithothamnium compactum* Kjellman, 1883a, p. 101, pl. 6, figs. 8–12; Foslie, 1895, p. 103, pl. 19, figs. 1–4; Lemoine, 1911, p. 98; Zinova, 1955, p. 78, fig. 67. *Phymatolithon compactum* (Kjellm.) Foslie, 1905, p. 88; Taylor, 1937, p. 260; 1957, p. 243. *Ph. compactum* f. *typicum* Foslie, 1905, p. 88.

Japanese name. Kita-ishimo (Segawa).

Habitat and distribution, in literature. On rocks, stones and shells, or epiphytic on *Lithothamnium*, in sublittoral belt to 40 meters depth. Shirikishinai, Prov. Oshima, Hokkaido, and eastern coast of Hokkaido, Japan; Kurile Islands; Behring Sea; Alaska; northeastern coast of North America; Greenland; Ellesmere Island; Spitsbergen; Novaya Zemlya; Norway.

Specimens collected. On stones and shells, and epiphytic on *Lithothamnium lenormandii*, Akkeshi, Prov. Kushiro, Hokkaido, 5 Nov. 1958, F. Iwata; 29 April 1960, H. Yamamoto; Erimo-misaki, Prov. Hidaka, 24 August 1961, T. Kaneko.

Thallus in the form of crusts firmly adherent to substratum, nearly orbicular in outline, 2–5 cm diam., often overgrowing one another in old specimens, surface usually smooth and flat, but sometimes more or less uneven owing to the shape of substratum, upheaved at border lines of confluent individuals, surface becoming coarse in the greater part of old crusts, being provided with numerous minute concave holes visible to the naked eye, especially in tetrasporic individuals which have a honeycomb-like appearance under a magnifying glass after the spores have been liberated; single crust 1.0–1.5 mm thick in tetrasporic, 0.5–0.7 mm thick in female, and 0.3–0.7 mm thick in male individuals; hypothallium poorly developed, consisting of 1–5 layers of cells which are elongated parallel to substratum, 12–43μ long by 5–9μ diam.; perithallium abruptly arising from hypothallium, cells rectangular, 5–11μ long by 5–12μ diam., often shorter than diameter; cell-fusion frequently occurring between adjacent cell-rows; epithallium conspicuous, consisting of 3–8 layers of subquadrate cells which are 5μ in diam.; sporangial conceptacles crowded, immersed, subspherical or elliptical in section,

190–313μ diam., 168–230μ high, roof 42–63μ thick, nearly flat or slightly elevated on surface, but at maturity becoming sunken as a result of decortication, intersected by 10–20 muciferous canals; sporangia tetrasporic, 92–147μ long, 42–80μ diam., four sporangia standing in section on the central part of floor in each conceptacle; female conceptacles flat, 84–105μ high, 126–168μ diam., carpogonial branches and their supporting cells stained deeply with haematoxylin and anilin blue; cystocarpic conceptacles flat, 210–292μ diam., 168–230μ high, ostiole narrow, fusion-cell discontinuous in section, supporting cell of carpogonial branch fused or not after fertilization with fusion-cell, carpospores arising from periphery of fusion-cell; spermatangial conceptacles flat, (126–)168–230μ diam., 55–70μ high, roof 25–34μ thick, orifice narrow and short without a spout, spermatangia globular, 2μ diam.

Foslie established *Clathromorphum* in 1898, but in 1905 he reduced it to the rank of subgenus in *Phymatolithon* because its sporangia appeared to have a close resemblance to those of the latter genus. However, in 1908 he treated *Clathromorphum* as a genus again. Lemoine (1911) pointed out that there was no difference between *Clathromorphum* and *Lithothamnium* so far as the number of muciferous canals and the form of sporangial conceptacles were concerned. Procarpic and cystocarpic plants have been unknown to this genus to date. I fortunately could observe all of them besides the hitherto known sporangial plants in the specimens collected at Akkeshi on November 5, 1958, by Dr. Fumio Iwata of the Faculty of Science, Hokkaido University, to whom I am much obliged for his kindness in sending the specimens. The sexual conceptacles of these specimens show characters different from those of *Phymatolithon polymorphum*, the type of the genus. The spermatangia in *Phymatolithon* and *Lithothamnium* are produced in dendroid clusters (cf. Suneson, 1943, fig. 11; Adey, 1964, pl. 3, figs. 44 & 50) while those of the specimens under consideration are of simple type. And also Adey (1965) reports that the spermatangial conceptacle in *Clathromorphum circumscriptum* are markedly similar to those of *Polyporolithon reclinatum*. The procarpic and cystocarpic conceptacles of the present specimens have a strong resemblance to those of *Polyporolithon reclinatum* (cf. Masaki & Tokida, 1961) and *Mesophyllum lichenoides* rather than those of *Phymatolithon polymorphum*.

Of the three species enumerated by Mason (1953) under *Clathromorphum*, *C. compactum* is that to which the present specimens are best referred. However, as compared with the descriptions of the species given by previous authors, the present specimens don't exactly match them in that they have a somewhat thinner single crust, a slightly thicker epithallium, and the sporangia divided always into four spores.

Clathromorphum is characterized as having a deeply sunken, concave roof in mature sporangial conceptacles. The roof which is at first nearly flat or slightly elevated becomes concave as a result of decortication. Besides them, Adey

(l. c.) emphasizes that "all conceptale primordia are formed adventitiously from sunken in the perithallium, and overlying perithallium is raised and cut-off as disks while conceptacles develop."

Tribe **Lithophylleae** L.R. Mason

Mason, L.R., 1953, p. 333
Subfamily Lithophylleae Setchell, 1943, p. 134.

Fosliella Howe

Howe, 1920, p. 587
Melobesia Lamouroux emend. Foslie subgen. *Eumelobesia* Foslie, 1905, p. 96.

Key to the species of Fosliella

1. Heterocysts arising from the intercalary cells of the thallus cell-rows in surface view; plants growing on *Zostera nana* .....2. *F. lejolisii* (p.23)
1. Heterocysts arising from the end cells of the thallus cell-rows in surface view; plants growing on various algae 2
   2. Thallus becoming conspicuously superimposed; asexual conceptacles 125–170μ diam .....1. *F. farinosa* (p.21)
   2. Thallus not superimposed; asexual conceptacles 100–150μ diam ....3. *F. paschalis* (p.24)

1. **Fosliella farinosa** (Lamouroux) Howe

Howe, 1920, p. 587; Taylor, 1937, p. 270; 1939, p. 10; 1942, p. 91; 1957, p. 252.

Syn. *Melobesia farinosa* Lamouroux, 1816, p. 515; Kützing, 1849, p. 696; Rosanoff, 1866, p. 69; Solms-Laubach, 1881, p. 11; Ardissone, 1883, p. 445; Hauck, 1885, p. 263; Foslie, 1900c, p. 20; 1905, p. 96; Yendo, 1902, p. 186; *in* Okamura, 1902, p. 67; *in* Okamura, 1916, p. 125; *in* Okamura, 1936, p. 506; De Toni, 1905, p. 1764; 1924, p. 645; Balakrishnan, 1947, p. 305, 36 text-figs., pl. 1; Rayss, 1959, p. 20; Iwamoto, 1960, p. 36; Masaki & Tokida, 1960a, p. 39, pl. 1, figs. 4 & 5, pl. 2, figs. 8–12, pls. 6 & 7.

Japanese name. Ibo-mokasa (Tokida and Masaki)

Habitat and distribution, in literature. Epiphytic on *Caulerpa freycinetii*, *Caulerpa* sp., *Valonia ventricosa*, *Padina pavonia*, *Spathoglossum* sp., *Ecklonia radiata*, *Fucus linifolius*, *F. serratus*, *Cystoseira articulata*, *C. granulata*, *C. myrica*, *Hormophysa* sp., *Sargassum crispum*, *S. herbaceum*, *S. hornschuchii*, *S. linifolium*, *S. turneri*, *Sargassum* sp., *Turbinaria* sp., *Chondrus crispus*, *Phyllophora nervosa*, *Rhodymenia palmata*, *R. phyllophora*, *Bryothamnion triangulare*, *Laurencia obtusa*, *L. papillosa*, *Laurencia* sp., *Cymodocea manatorum*, *C. serrulata*, *Potamogeton* sp., *Zostera marina*, *Zostera* sp. Middle Honshû, Japan (?)[1]; Ryûkyû (?)[1], Formosa (?)[1];

1) Cf. Yendo, 1916, p. 125; 1936, p. 507.

China Sea; Celebes Sea; Malay Archipelago; Indian Ocean; Pacific coast of N. America; South Pacific Ocean; Australia; Caribbean Sea; West Indies; Atlantic coast of N. America, Europe and Africa; Canaries; Mediterranean Sea; Adriatic Sea; Red Sea.

Specimens collected. Epiphytic on the leaves of *Sargassum confusum*: Nanaehama, near Hakodate City, Dec. 1958, T. Masaki; Oshoro, 24 Nov. 1959, T. Yamazaki. On *Ecklonia kurome*: Nou, Niigata Pref., 29 Nov. 1959, Y. Saito. On *Padina arborescens*: Misaki, Kanagawa Pref., 8 April 1960, J. Tokida. On *Dictyopteris undulata* and *Sargassum* sp., Shirahama, Wakayama Pref., 30 March 1960, J. Tokida.

Thallus epiphytic on various large brown algae, firmly adherent to the host, at first suborbicular and 2–4 mm diam., later becoming confluent and overlapping, purplish red in color when fresh, monostromatic in vegetative part, cells in marginal portion 12–20μ long by 5–9μ diam. in surface view, 5–13μ high by 7–13μ diam. in section, cell-fusion frequent, each cell (except those along the thallus margins and heterocyst initials) obliquely cutting off a cover cell, cover cells rectangular to roundish in surface view and triangular in section, heterocyst initials elongated, 22–25μ long by 7–10μ diam.; tetrasporangial conceptacles hemispherical, 63–126μ high, (84–)126–168(–189)μ diam., tetrasporangia 40–80μ long, (20–)25–50(–63)μ diam., always tetrasporic in my material, central part of conceptacle floor occupied by a columella, roof of conceptacle thin, composed of one to two layers of cells; female conceptacles hemispherical, 45–55μ high, 45–60μ diam. when young, (25–)42–63(–91)μ high, (29–)105–126μ diam. when carpospores are formed, provided with papillae on the inner wall of pore, carpospores arising from periphery of floor; spermatangial conceptacles convex, (29–)33–46(–55)μ high, (42–)55–84μ diam., spermatangia narrowly cylindrical in shape, 3–7μ long by 2μ diam., while attached to their mother cells, but ellipsoidal to globular with no appendage when detached and set free in the conceptacle cavity.

Above description is based chiefly on the specimens growing on the leaves of *Sargassum confusum* from Nanaehama. It agrees well in general with the descriptions of the present species given by the authors cited above except in somewhat smaller dimensions of both tetrasporangial and cystocarpic conceptacles. (Cf. Foslie, 1905, p. 98; Taylor, 1957, p. 252).

This species has already been listed in the marine flora of Japan (Yendo, 1902, 1916 and 1936) as *Melobesia farinosa*. However, Yendo commented (translated from Japanese) in his treatment on the Corallinaceae published in Okamura (1916) to the following effect. "On examining the specimens preserved in the Berlin Botanical Museum, it was revealed that; Marten's specimens from Yokohama and Warburg's from Ryûkyû and Formosa, both reported to be identical with this species, were epiphytic on the leaves of *Zostera marina* and they seemed to be referable to '*Heteroderma zostericola* Foslie'; Marten's specimens reported from

Yokohama under the name of *Melobesia granulata* Menegh. were attached to the stipe of *Gracilaria textorii* and they seemed to be identical with '*Melobesia canescens Foslie.*' or other related species. As far as I have investigated to date, it is doubtful whether *Melobesia farinosa* Laxm. is distributed in Japan or not."

In view of the above comment of Yendo, the occurrence of *Fosliella farinosa* in Japan is first firmly established in the present study.

2. **Fosliella lejolisii** (Rosanoff) Howe

Pls. XII, XLIX & L

Howe, 1920, p. 588; Taylor, 1937, p. 270, pl. 36, figs. 6–8; 1942, p. 91; 1957, p. 253, pl. 36, figs. 6–8; 1960, p. 387; Iwamoto, 1960, p. 36.

Syn. *Melobesia lejolisii* Rosanoff, 1866, p. 62, pl. 1, figs. 1–13, pl. 7, figs. 9–11; Kjellman, 1883a,p. 137; Hauck, 1885, p. 264, fig. 108; Foslie, 1905, p. 102; De Toni, 1905, p. 1766; 1924, p. 647; Kylin, 1907, p. 198; Lemoine, 1911, p. 180, fig. 103; Rosenvinge, 1917, p. 238, figs. 156–159; Suneson, 1937, p. 7, figs. 1–5; 1943, p. 23, fig. 13, pl. 4, fig. 18, pl. 5, fig. 21; Hamel & Lemoine, 1952, p. 103, figs. 65–67. *Heteroderma lejolisii* (Rosanoff) Foslie, 1909, p. 56; Dawson, 1960, p. 55, pl. 50, figs. 4–6.

Japanese name. Shiro-mokasa (n.n.)

Habitat and distribution, in literature. Epiphytic on *Zostera, Posidonia, Ruppia, Laminaria, Fucus, Corallina rubens, Gigartina, Chondrus, Bornetia secundiflora, Polysiphonia violacea.* Norway; Denmark; the western Baltic; the North Sea; the British Isles; Holland; Germany; Atlantic coasts of France; the Mediterranean; the Gulf of Naples; Sicily; the Adriatic; Atlantic coast of North America; the eastern Pacific; Japan (the Okhotsk coast of Hokkaido).

Specimens collected. On *Zostera nana.* Uranouchi Bay, Usa, Kochi Pref., 24 May 1962, T. Masaki

Crust epiphytic on the leaves of *Zostera nana*, firmly adherent to the host, at first suborbicular or irregular fan-shaped in outline, up to 2–4 mm in diam., later densely confluent with each other, light red or whitish in color, marginal portion of crust monostromatic, cells in surface view arranged in radial cell-rows, subquadrate, 8–13μ long by 5–10μ broad, cells in section 7–11μ high by 6–10μ diam., heterocysts arising from the intercalary cells of the radial cell-rows, having no cover cells, 10–12μ long by 6μ broad in surface view; thallus monostromatic in vegetative part, but polystromatic in the neighborhood of conceptacles and composed of 3–4 layers of cells, basal cells subquadrate, or vertically or horizontally elongated, 6–8μ high by 5–9μ diam., perithallium cells 7–20μ high by 6–7μ diam., cover cells rectangular and 3–7μ long by 2–3μ broad in surface veiw, somewhat triangular and 5μ diam. by 4–5μ high in section, cell-fusion often occurring between adjacent radial cell-rows; sporangial conceptacles convex or hemispherical, 75–100 (–120)μ diam., (25–)43–63μ high, floor flat, one cell-layered, sterile columella at

the central part of the floor obscure, roof consisting of one to three layers of cells, 10–13μ thick, sporangia tetrasporic (25–)30–50μ long by (13–)23–30(–48)μ diam.; female conceptacles convex or hemispherical 28–50μ diam., 33–70μ high; cystocarpic conceptacles convex, hemispherical, 60–80μ diam., (25–)38–50μ high, floor one cell-layered, roof consisting of one to three layers of cells, 10–13μ thick, carpospores arising from the periphery of the floor; male conceptacles convex, 21–33μ diam., 21–33μ high, spout often existing, roof thin, consisting of two layers of cells, spermatia ellipsoidal to globular, 2–4μ long by 1μ diam., sometimes with a stalk-shaped appendage attached to one end; monoecious.

This species was first described by Rosanoff in 1866. Afterward Foslie (1905) distinguished f. *limitata* from f. *typica* which was based on Rosanoff's plant. Heterocysts which have been described by most authors except Rosanoff, Foslie and Dawson, are observed in my specimens. The dimensions of sporangial conceptacles in the present material agree well with that described by Suneson and Dawson but smaller than those reported by Hauck, Foslie, and Lemoine. This species has been reported mainly from the European coasts and the Atlantic coast of North America under various generic names such as *Melobesia, Heteroderma,* and *Fosliella.* Recently Dawson and Iwamoto reported it from the eastern coast of the Pacific and the Okhotsk coast of Hokkaido respectively.

3. **Fosliella paschalis** (Lemoine) Setchell & Gardner

Pl. XIII, Figs. 1, 3–8; Pl. LI

Setchell & Gardner, 1930, p. 176; Dawson, 1960, p. 31

Syn. *Melobesia paschalis* Lemoine, *in* Børgesen, 1924, p. 289, fig. 32, f-g; De Toni, 1924, p. 652.

Japanese name. Ibo-mokasa-modoki (n.n.)

Habitat and distribution, in literature. Easter Island and the Pacific coast of Mexico.

Specimens collected. Epiphytic on the leaves and stems of *Sargassum* sp. Rinkai-ura, Shirahama, Wakayama Pref., 16 Sept. 1963, T. Masaki.

Thallus epiphytic on *Sargassum* sp. firmly adherent to host, at first irregular in outline, later becoming confluent, but never superimposed on each other, covering the host partly or completely, attaining 1 cm in extent, monostromatic except in the neighborhood of conceptacles; cells rectangular, 11–17μ long, 6–7μ diam. in surface view, rectangular, 5–10μ high, 5–13μ diam., often shorter than diameter in section, cell-fusion frequent, cover cells triangular, 4–6μ diam. by 2–3μ high in section, cut off obliquely from the underlying cells, rectangular to roundish, 5–8μ long by 4μ diam. in surface view, heterocysts present, terminal; sporangial conceptacles hemispherical, 100–140μ diam., 50–75μ high, roof 10–18μ thick, sporangia tetrasporic, 33–60μ long, 18–40μ diam.; female conceptacles hemispherical, 28–42μ diam., 28–50μ high; cystocarpic conceptacles hemispherical, 65–100μ

diam., 38–58μ high, roof 15–18μ thick; spermatangial conceptacles convex or hemispherical, 38–70μ diam., 25–45μ high, often provided with a spout, roof–8–13μ thick, spermatangia 4–6μ long, 1.5–2.0μ diam.

This species closely resembles *Fosliella farinosa* and has been known to differ from it only in having smaller sporangial conceptacles. Sexual conceptacles were undescribed in this species to date, but my material shows that, compared with *Fosliella farinosa*, this species has much smaller female conceptacles and somewhat smaller male conceptacles. *Fosliella farinosa* var. *solmsiana* as described by Hamel and Lemoine (1953) was distinguishable from the typical *F. farinosa* in having a loose tissue composed of cells irregular in shape, roundish heterocyts and smaller conceptacles. Though my specimens agree with that variety in the dimensions of conceptacles, they seem to differ from it in other respects.

Heteroderma Foslie

Foslie, 1909, p. 56.

Melobesia Lamouroux emend. Foslie subgen. *Heteroderma* Foslie, 1905, p. 102; 1905a, p. 8.

Key to the species of Heteroderma

1. Asexual conceptacles nearly flat or slightly convex; basal cells evident; plants growing on *Phyllospadix* .....2. *H. zostericola* (p.27)
1. Asexual conceptacles convex or subconical; basal cells usually not evident 2
   2. Asexual conceptacles more than 140μ diam.; plants growing on *Sargassum* .....1a. *H. sargassi* f. *sargassi* (p.26)
   2. Asexual conceptacles less than 100μ diam.; plants growing on *Laurencia* .....1b. *H. sargassi* f. *parvula* (p.26)

1. **Heteroderma sargassi** Foslie

Foslie, 1909, p. 57; Yendo, *in* Okamura, 1916, p. 125; *in* Okamura, 1936, p. 507; De Toni, 1924, p. 654; Yamada, *in* Okamura, 1936, fig. 237.

Syn. *Melobesia sargassi* Foslie, 1908a, p. 6 (as *Melobesia* (*Pliostroma*) *sargassi*). *Melobesia marginata* f. *sargassi* Foslie, 1904, (*fide* Foslie, 1906a, p. 26). *Lithophyllum* (*Carpolithon*) *sargassi* Foslie, 1906a, p. 26.

1a. **Heteroderma sargassi** Foslie f. **sargassi**

Masaki & Tokida. 1963, p. 4, pl. 4, fig. 5, pl. 5, figs. 4-9, pls. 9–10. (as *Melobesia sargassi*).

Japanese name. Moku-goromo (Tokida and Masaki)

Habitat and distribution, in literature. Epiphytic on *Sargassum serratifolium*, *S. fulvellum* and *S. confusum*. The Pacific coast of middle Honshû, Japan.

Specimens collected. On the stems, branches and vesicles of *Sargassum serratifolium* and *S. fulvellum*, Shimoda, Shizuoka, Pref., 11 April 1961, J. Tokida.

Thallus firmly adherent to the host, at first forming small irregular patches, 0.5–1.0 cm diam., later becoming confluent or overlapping, attaining to 2–3 cm in maximum diam., monostromatic only in narrow marginal portion which is composed of oblong cells, 12–20μ long by 5–8μ diam. in surface view, each cell except those at the extreme margin cutting off a cover cell; heterocyt absent; thallus polystromatic in inner portion which is 97–126μ thick, consisting of up to 13 layers of cells, cells of basal layer quadrate to elongate in section, 5–7μ high by 9–12μ diam. in plants growing on vesicles of the host, or 5–10μ high by 9–17μ diam. in those on stems and branches of the host; cells of perithallium quadrate to elongate, 7–11μ high by 9–21μ diam., cell-fusion frequent; epithallium one to three cell-layered, cells oblong, subtriangular or roundish, 5–7μ high by 9μ diam. in section, 12–20μ long by 5–8μ diam. in surface view; sporangial conceptacles convex or subconical, 55–105μ high, 140–210μ diam., roof two to three cell-layered, 21–25μ thick, sporangia tetrasporic, 46–63μ long, 30–42μ diam., standing on the periphery of conceptacle floor which is flat and surmounted at the central part by a columella; procarpic conceptacles nearly flat or subconvex, 42–63μ high, 42–63μ diam., one or two carpogonial branches standing on each auxiliary cell; cystocarpic conceptacles usually convex but sometimes nearly flat, 50–80μ high, (42–)84–134(–172)μ diam., roof 12–21μ thick, carpospores arising from periphery of fusion-cell; spermatangial conceptacles convex or nearly flat, 25–84μ high, 60–92μ diam., roof 13–34μ thick, often provided with a spout, sometimes embedded deeply in the tissue with or without an opening, spermatangia narrowly cylindrical, 4μ long, 1.7μ diam.; roof of conceptacles three to eight cell-layered in the specimens growing on stems and branches of the host but one to several cell-layered in those on vesicles of the host.

The above description based on the specimens from Shimoda agrees well with Foslie's diagnosis except for the dimensions of the basal cells. The sexual conceptacles are newly described on the basis of the present materials.

I have examined some specimens from the type collection in Foslie's Herbarium through the kindnesses of Dr. Olav Gjaerevoll and Dr. Olaf I. Rønning of Botanical Department, Royal Norwegian Society of Sciences, Trondheim. They are attached to the vesicles of *Sargassum fulvellum*. However, these specimens are unfortunately found to be different from *Heteroderma sargassi* in having a monostromatic thallus which attains a thickness of several cell-layers only in the neighborhood of conceptacles; the specimens are thus referable to *Fosliella farinosa*.

1b. **Heteroderma sargassi** Foslie

f. **parvula** Masaki f. nov.

Pl. XIII, Fig. 2

Thllus usque ad 150μ crass.; conceptacula sporangifera 65–85μ alt., 75–100μ diam., sporangiferis tetrasporis, 40–50μ long., 20–30μ diam.

Japanese name. Sozo-goromo (n.n.)

Type. Epiphytic on *Laurencia intermedia.* Nou, Niigata Pref., the Japan Sea coast of Middle Honshû, 31 August, 1960, Y. Saito.

Specimens collected. Epiphytic on *Laurencia intermedia.* Ikenoura, near Usa, Kochi Pref., 22 May 1962, T. Masaki.

Thallus up to 150μ thick; cells of perithallium 7–20μ long by 5–10μ diam.; sporangial conceptacles 65–85μ high, 75–100μ diam., sporangia tetrasporic, 40–50μ long, 20–30μ diam., cystocarpic conceptacles 50–75μ high, 75–100μ diam.

This form is epiphytic exclusively on *Laurencia,* and is characterized by having smaller sporangial conceptacles than f. *sargassi.*

2. **Heteroderma zostericola** Foslie

Foslie, 1909, p. 56; Yendo, *in* Okamura, 1916, p. 125; *in* Okamura, 1936, p. 507; Tokida, 1954, p. 159.

Syn. *Melobesia zostericola* Foslie, 1907b, p. 25 (as *Melobeisa* (*Heteroderma zostericola*); De Toni, 1924, p. 648; Masaki & Tokida, 1960, p. 286, pl. 1, figs. 5–6, pl. 3, 6–8. *Lithophyllum zostericolum* Foslie f. *tenuis* Foslie, 1900b, p. 5. *Lithophyllum zostericolum* Foslie, Yendo, 1902, p. 188; *in* Okamura, 1902, p. 100; De Toni, 1905, p. 1795; Cotton, 1915, p. 113. *Fosliella zostericola* (Foslie) Segawa, 1956, p. 70, pl. 40, fig. 311 (habit photo); Arasaki, 1964, p. 81, fig. 275 (habit photo).

Japanese name. Mokasa (Yendo)

Habitat and distribution, in literature. Epiphytic on *Zostera* and *Phyllospadix.* The Pacific coasts of Honshû and Hokkaido, Japan; Saghalien; Korea; China.

Specimens collected. Epiphytic on *Phyllospadix iwatensis.* Nobori, Saghalien, June ,1937, J. Tokida; Akkeshi, Prov. Kushiro, Hokkaido, 26 Nov. 1958, K. Yakushi; Yamasedomari, Hakodate City, 3 June 1958, K. Yakushi.

Thallus at first in the form of small roundish patches, later becoming confluent and more or less overlapping with each other, at last covering the host surface extensively, purple red in color, polystromatic except in the very narrow part of the thallus margin, cells in section 5–9μ long and 5–12μ diam., cell-fusion frequent, each cell except those along the thallus margins cutting off obliquely a cover cell, cover cells in section 7–9μ high and 7μ diam., heterocyst lacking; thallus polystromatic in the neighborhood of conceptacles, composed of 3–6(–8) layers of cells, cells 7–9μ diam., the second or third cell from the base elongated, up to 50μ long, the basal cells or cells of hypothallium usually flattened; sporangial conceptacles nearly flat or slightly convex on surface, 60–100(–140)μ high and (90–)100–170(–210)μ diam., floor single cell-layered, sporangia tetrasporic in the material from Hakodate but tetrasporic or bisporic in the material from

Saghalien and Akkeshi, bispores binucleate, each sporangium standing on a small stalk cell in the periphery of the conceptacle, 40–85μ long and 20–63μ diam., central part of conceptacle floor occupied by a columella; female conceptacles slightly convex, 42–60(–105)μ high and 38–55μ diam. when young, 55–85(–105)μ high and 85–125(–150)μ diam. when carpospores are formed, floor two cell-layered, orifice provided with a few papillae; spermatangial conceptacles slightly prominent in the center, 30–75μ high and (40–)50–85(–112)μ diam., spermatia ellipsoidal, 4μ long and 0.8μ diam.; female and male conceptacles usually occurring separately in different crust, bur rarely together with each other in one and the same crust.

This species was first described by Foslie (1900) as *Lithophyllum zostericolum* f. *tenuis* on the basis of the Japanese plant collected by K. Yendo at Misaki[1] Prov. Sagami, on the Pacific coast of middle Honshû. Up to the present, the zonately divided tetrasporangium has been the only described reproductive organ in this species (cf. De Toni, 1924, p. 648). My specimens, however, are often found to have tetrasporangial conceptacles together with the bisporangial ones in one and the same crust, and sometimes even to have tetrasporangia mingled with the bisporangia in one and the same conceptacle. The bispores are always binucleate. On the other hand, sexual plants bearing female and male conceptacles are also commonly met with. The conceptacles of both sexes are rarely found in one and the same crust. In surface view, the female crust has smaller vegetative cells than both the male and sporangial crusts. This difference in the size of the cells is hardly discernible in sections. The thickness of the crust in *Lithophyllum zostericolum* was given by Foslie (1900) as 60μ for f. *tenuis* and as up to 150μ for f. *mediocre*. This range of thickness, 60–150μ, was cited by Yamada (*in* Okamura, 1936) without mentioning the forms in the Japanese diagnosis of *Heteroderma zostericola*. However, the Californian f. *mediocre* was later raised to the rank of species by Foslie (1907, p. 27). So the crust of *Heteroderma zostericola* is now known from the literature to be 60μ in thickness. Compared with this value, my material has a thicker crust, being up to 75μ thick in the male, to 85–105μ in the female and to 100μ (rarely even to 140μ) in the sporangial specimens.

Lithophyllum Philippi

Foslie, 1900c, p. 16; Lemoine, 1911, p. 56; Svedelius, *in* Engler and Prantl, 1911, p. 270; Okamura, 1936, p. 510; Mason, 1953, p. 336; Kylin, 1956, p. 207.

Lithothamnium Philippi subgenus *Lithophyllum* (Philippi) Foslie, 1895, p. 150.

Tenarea Bory, Lemoine, 1911, p. 62; Hamel et Lemoine, 1952, p. 67; Kylin, 1956, p. 207.

1) The "Marine Laboratory at Sagami Province" (Foslie, 1900, p. 5) is situated at Misaki.

Key to the species of Lithophyllum

1. Thallus more or less spherical, with pronounced excrescences .... 6. *L. okamurai* f. *japonicum* (p.36)
1. Thallus not as above 2
2. Thallus lamellate, growing on *Gelidium* ..... 2. *L. amplexifrons* (p.30)
2. Thallus crustaceous, attached to rocks and stones 3
3. Thallus usually of a single individual 4
3. Thallus often confluent or overlapping with each other 6
4. Thallus lamelliform ..... 9. *L. tortuosum* (p.40)
4. Thallus not as above 5
5. Thallus surface smooth ..... 7. *L. samoense* (p.37)
5. Thallus surface with wart-like excrescences ..... 1. *L. absimile* (p.29)
6. Conceptacles concave ..... 5. *L. neoatalayense* (p.34)
6. Conceptacles nearly flat, convex, or subconical 7
7. Hypothallium monostromatic ..... 3. *L. caribaeum* f. *boreale* (p.31)
7. Hypothallium polystromatic 8
8. Hypothallium one to several layered 9
8. Hypothallium multi-layered 10
9. Thallus 5–7 mm in diam., 400–1000μ thick, with conspicuous wart-like excrescences ..... 8a. *L. shioense* f. *shioense* (p.38)
9. Thallus 1–3 mm in diam., 200–400μ thick, with inconspicuous wart-like excrescences ..... 8b. *L. shioense* f. *tenue* (p.39)
10. Thallus surface usually uneven, with conspicuous ridges .... 10. *L. yendoi* (p.41)
10. Thallus surface usually flat, sometimes with inconspicuous ridges .... 4. *L. decipiens* (p.33)

1. **Lithophyllum absimile** Foslie et Howe

Pl. XIV, Figs. 1–3; Pls. XV, LII-LIV

Foslie, 1907b, p. 27; 1929, p. 31, pl. 54, fig. 4; Lemoine, *in* Børgesen, 1917, p. 165(as *Lithophyllum* (?) *absimile* Foslie et Howe); De Toni, 1924, p. 676; Taylor, 1960, p. 393 (as *Lithophyllum* (?) *absimile* Foslie et Howe).

Japanese name. Iwa-no-sabi (n.n.)

Habitat and distribution, in literature. Sandy Bay, Jamaica; Santa Cruz Island, Lesser Antilles.

Specimens collected. On rocks. Zenikamezawa, Hakodate City, 24 August 1959, T. Masaki.

Thallus crustaceous, firmly adherent to rocks but free from substratum in marginal portion, 500–1200μ thick, polystromatic to margin, surface undulate, provided with minute wart-like excrescences which are 1–2 mm high by 2–5 mm

diam., whitish gray in color, but purplish red in the shade; hypothallium poorly developed, composed of 8 to 10 layers of cells arranged in upward and downward curves, cells rectangular, 9–22μ long by 4–9μ diam.; cells of perithallium subquadrate, 5–9μ diam., or vertically or transversely elongated, 7–13μ long by 5–8μ diam., or 5–7μ long by 7–9μ diam., groups of about 30 large cells present in some cases, cells 19–33μ long by 5–12μ diam.; epithallium composed of 2–3 layers of triangular cells, cells 5μ high by 3–5μ diam.; trichocytes consisting of two cells, upper one of which is triangular in shape; cell-fusion occurring in hypothallium and perithallium; sporangial conceptacles crowded, convex, (125–) 135–210μ diam., (90–)100–155μ high, sporangia tetrasporic, (40–)50–85μ long, 20–50μ diam., conceptacle floor almost even, occupied by a columella at the central portion, orifice well developed, 40–65μ long, provided with papillae; female conceptacles subconical 65μ high, 65μ diam., orifice rather wide and developed; cystocarpic conceptacles convex, 125–250μ diam., 100–150μ high, orifice provided with papillae; spermatangial conceptacles crowded, hemispherical to conical, 85–150(–175)μ diam., (40–)55–85(–105)μ high, orifice well developed, 40–55μ long, provided with papillae whose contents are stained strongly with haematoxylin and anilin blue, spermatangia small, numerous, globular in shape, 2μ diam., when detached and set free in the conceptacle cavity, but narrowly cylindrical, 5μ long, 1μ diam., while attached to their mother cells, sometimes stalks attached to their posterior end.

Lithophyllum absimile Foslie et Howe was established in 1907. Afterward it was reported by Lemoine (1917) and Taylor (1960), with some hesitation, since the sporangial conceptacles were unknown.

The present specimens agree in general with the descriptions by previous authors except for the presence of the groups of large cells in the perithallium. However, these cell-groups are observed only in some specimens and thought to be of abnormal nature. The present specimens were also compared with two specimens of this species which Dr. Lemoine kindly sent me from the National Museum of Natural History in Paris. One of them (no. 3193) was collected by Børgesen in Tenerife Island, Canary Islands, and the other was collected during the Qeen Mary College Azores Expedition in the Azores and identified by Dr. Lemoine. As the result of examination, I identify the specimens in my hand as this species with some hesitation, because of the slight difference in the arrangement of perithallic cells and of the presence of the large cells in some specimens.

2. **Lithophyllum amplexifrons** (Harvey) Heydrich

Pl. XIV, Figs. 4–6; Pls. XVI, LV & LVI

Heydrich, 1901, p. 536; De Toni, 1905, p. 1788; Foslie, 1898a, p. 10 (as *L.* (?) *amplexifrons* (Harvey) Rosanoff); 1907a, p. 27; Yendo, *in* Okamura, 1902, p. 100.

Syn. *Melobesia amplexifrons* Harvey, 1847, p. 110; Rosanoff, 1866, p. 76, pl. 7, figs. 2–3.

Japanese name. Kusa-no-kaki-modoki (n.n.)

Habitat and distribution, in literature. On *Liagora orientalis, Gelidium cristatum, Chrysmenia obovata* and marine phanerogams. New Ireland, Bismarck Archipelago; Port Natal, Cape of Good Hope, South Africa; Australia.

Specimens collected. Epiphytic on *Gelidium subcostatum* at a depth of about 5–10 meters. Shirahama, Shimoda Town, Shizuoka Pref., 17 May 1962, Y. Iwahashi; Minami-izu Town, Shizuoka Pref., 12 June 1962, Y. Iwahashi.

Thallus epiphytic on *Gelidium subcostatum*, sessile, peltate, often encircling the host partly or completely, confluent and overlapping, suborbicular, 2–6 mm diam., 250–500μ thick, polystromatic to margin, margin free from the host; hypothallium not clear at the portion in contact with the host, composed of several layers or cells at the marginal portion which is free from the host, cells rectangular, 15–20μ long, ca 5μ diam.; cells of perithallium rectangular, 10–25μ long, 6–8μ diam.; epithallium composed of one or two cell-layers, cells subtriangular, and 7–8μ diam., 5–7μ high, or roundish, ca. 7μ diam.; secondary pit-connections between cells present; sporangial conceptacles convex, or nearly flat or sometimes concave, 160–230μ diam., 100–150μ high, roof 25–30μ thick, sporangia tetrasporic, 45–90μ long, 20–45μ diam.; female conceptacles convex, 65μ diam., 65μ high, roof 25μ thick; cystocarpic conceptacles convex, 170–220μ diam., 90–150μ high, roof 20–40μ thick; spermatangial conceptacles convex or nearly flat, 75–115μ diam. 40–50μ high, roof 18–25μ thick, orifice often provided with a spout, sometimes embedded deeply in the tissue without opening, spermatangia narrowly cylindrical, 6–8μ long, 1.0–1.5μ diam.; conceptacles often developed at the opposite side of the thallus surface at the marginal portion which is free from the host.

This species has been reported as epiphytic on various seaweeds including *Gelidium* species by Harvey, Rosanoff and Heydrich. The present specimens agree well with the description by Heydrich. The sexual plants of this species except the cystocarps are described for the first time here.

3. **Lithophyllum caribaeum** Foslie

Foslie, 1907a, p. 22; 1909, p. 11; 1929, p. 32, pl. 53, figs. 7–8; Lemoine, *in* Børgesen, 1917, p. 160 (as *Lithophyllum* (?) *caribaeum*); De Toni, 1924, p. 685.

Syn. *Lithophyllum decipiens* Foslie f. *caribaeum* Foslie, 1906a, p. 18. *Lithophyllum caribaeum* (Foslie) Foslie, Howe, 1920, p. 586; Taylor, 1960, p. 391.

3a. **Lithophyllum caribaeum** Foslie f. **boreale** Masaki f. nov.

Pl. XX, Figs. 1 & 2; Pl. XXI, Figs. 6–9; Pl. LX; Pl. LXI, Figs. 1 & 2

Thallus crustosus, firme adherens ad lapillos, primum suborbicularis, aetate

provectiore confluentes formante, 150–300μ crass.; superficies levis, nonnumquam inaequali eveniente, asperitatis substrati; hypothallium ex unica strate cellularum compositum, cellulis rectangularis, 7–18μ long., 4–5μ diam.; cellulae perithalliorum subquadratae, 5–9μ diam., aut breviores in longitudine quam diameter, 9–12μ long., 5–9μ diam.; epithallium ex 2–3 stratis cellularum compositum, cellulis triangularis, 7–9μ diam., 3–5μ alt.; cellulae confluentes in parte perithallii; trichocytes sunt; conceptacula sporangifera aliquanto condensa, subhemispherico-conica, 150–250μ interioris diam., 200–350μ extorioris diam., (65–)85–170μ alt., sporangiferis tetrasporis, 50–90μ long., 20–45μ diam.; conceptacula feminarum prope plana aut leniter convexa, 50–135μ diam., 55–85μ alt.; conceptacula cystocarpiorum 125–210μ diam., 100–135μ alt., prope plana aut convexa; conceptacula mascularum condensa, subhemispherico-conica, 65–150μ diam., 45–85μ alt., spermatibus parivs, numerosis, anguste cylindratis, 5–7μ long., 1–5μ diam.

Japanese name. Kita-nise-umisabi-modoki (n.n.)

Type. On pebbles. Moheji, near Hakodate City, 18 June 1958, T. Masaki.

Specimens collected. On pebbles. 10 November 1959, T. Masaki.

Thallus crustaceous, firmly adherent to pebbles, at first suborbicular, later becoming confluent with each other, 150–300μ thick, composed of 20–50 layers of cells, polystromatic to margin, surface smooth, sometimes more or less rough owing to the roughness of substratum; hypothallium consisting of single layer of cells, cells rectangular, 7–18μ long, 4–5μ diam.; cells of perithallium subquadrate, 5–9μ diam., or rectangular, 9–12μ long, 5–9μ diam., often shorter than diameter; epithallium consisting of two or three layers of cells, cells triangular, 7–9μ diam., 3–5μ high; cell-fusion occurring between adjacent cell-rows of perithallium; trichocytes present; sporangial conceptacles rather crowded, hemispherical or conical, 150–250μ inner diam., 200–350μ outer diam., (65–)85–170μ high, orifice with papillae, sporangia tetrasporic, 50–90μ long., 20–45μ diam., sporangia standing on the periphery of floor of each conceptacle, central portion of floor crowned with a number of hairy cells; female conceptacles immersed just below the thallus surface, nearly flat or slightly convex, 50–135μ diam., 55–85μ high; cystocarpic conceptacles 125–210μ diam., 100–135μ high, nearly flat or convex, ostiole provided with papillary cells; spermatangial conceptacles crowded, hemispherical to conical, 65–150μ diam., 45–85μ high, ostiole provided with cells whose contents are stained deeply with haematoxylin and anilin blue, in some cases provided with a spout, spermatangia small, numerous, narrowly cylindrical, 5–7μ long, 1.0–1.5μ diam.

This form is characterized by having larger sporangial conceptacles than f. *caribaeum*. My specimens have a close resemblance to *Lithophyllum decipiens* (Foslie) Folsie in the shape and dimensions of all kinds of conceptacles except having a single layered hypothallium.

4. **Lithophyllum decipiens**(Foslie) Foslie

Pl. XIX; Pl. XXI, Figs. 1–5; Pl. LVII, Figs. 6–8; Pl. LVIII

Foslie, 1900c, p. 19; 1906a, p. 18; 1907, p. 10; 1909, p. 12; 1929, p. 33, pl. 53, fig. 14; De Toni, 1905, p. 1788 Levring, 1943, p. 754, fig. 1c; Dawson, 1944, p. 270, pl. 57, fig. 20; 1945, p. 42; 1946, p. 67; 1946a, p. 190; 1954, p. 5; 1957, p. 5; 1960, p. 37, pl. 26, figs. 1–2, pl. 27, figs. 1–3; 1963, p. 8; Mason, 1953, p. 338, pl. 40; Dawson, Neushul & Wildman, 1960, p. 16; Hollenberg & Abbott, 1966, p. 62.

Syn. *Lithothamnium decipiens* Foslie, 1897, p. 20; 1898a, p. 7. *Lithophyllum* (?) *decipiens* Foslie, 1900, p. 71. *Lithophyllum impressum* Foslie, 1906, p. 5; 1929, p. 35, pl. 57, fig. 6; De Toni, 1924, p. 674. *Lithophyllum incrustans* Philippi f. *orbiculare* Foslie, *in* Setchell and Gardner, 1903, p. 358; Collins, 1913, p. 129. Non *Lithophyllum orbiculatum* (Foslie) Foslie, 1900c, p. 19.

Japanese name. Umisabi-modoki (n.n.)

Habitat and distribution, in literature. On smooth rocks, pebbles and shells in the intertidal zone and to a depth of 14 meters. The Pacific coast of Canada, United States, Mexico and Panama; the Galapagos Islands; Fuegia Island; Subantarctic region.

Specimens collected. On rocks in the intertidal zone at a place protected from the open sea. Suzaki, Kochi Pref., 27 May 1962, T. Masaki; Tsubaki, Rinkai, Ezura and Shiso Island, Shirahama, Wakayama Pref., 16 Sept. 1963, T. Masaki.

The following description is based on the specimens from Suzaki.

Thallus crustaceous, firmly adherent to rocks, thin, 90–200μ thick, at first irregular in shape, later becoming confluent with each other, expanding in width considerably, surface smooth to the naked eye, but rough under a magnifying glass due to the crowded convex conceptacles, gray or whitish pink in color when dried; hypothallium consisting of about 3–6 layers of rectangular cells which are 10–20μ long by 8–10μ diam; cells of perithallium subquadrate about 8μ diam., or subrectangular, 7–10μ long by 5–12μ diam., often shorter than diameter; cell-fusion often occurring between adjacent cell-rows; epithallium one to two cell-layered, cells subtriangular, 5μ high by 5μ diam.; trichocytes 15–20μ long, 10μ diam., becoming empty in contents and embedded in tissue with the growth of the surrounding tissues; sporangial conceptacles convex, 125–175μ diam., (88–)100–140μ high, roof 25–38μ thick, sporangia tetrasporic, 45–80μ long, 20–60μ diam., standing on the periphery of conceptacle floor which is flat and crowned with hair cells at the central portion; procarpic conceptacles convex, 50–85μ diam., 50–75μ high, roof 40–45μ thick, one or two carpogonial branches standing on each auxiliary cell; cystocarpic conceptacles convex, 140–150μ diam., 90–125μ high., roof 25–30μ thick; spermatangial conceptacles convex, 80–140μ diam., 45–70μ high, roof 18–30μ thick, cells on the inner surface of roof and ostiole stains well with haematoxylin and anilin blue, spermatangia numerous, small, narrowly cylindrical,

4μ long, 1.5μ diam.

This species was reported as *Lithothamnium decipiens* by Foslie (1897) and he gave the description with some doubt in 1900 on the basis of a small number of imperfect materials from Fuegia and in 1909 described the dimensions of perithallium and hypothallium. Foslie also divided this species into two forms in 1906 and in 1909: f. *cariboea* and f. *subantarctica*.

Recently this species was reproted by the authors cited above from the Pacific coast of Nroth America with detailed descriptions and figures. The present specimens agree well with these descriptions except in having larger cystocarpic conceptacles. As for the difference between *Lithophyllum decipiens* and *Lithophyllum yendoi*, Foslie (1904) stated as follows: it may be questionable whether the plant (*Lithophyllum yendoi*) is in fact distinguishable from *Lithophyllum decipiens* from the south coast of South Africa. Dawson (1960) also expressed his opinion that *Lithophyllum yendoi* should be relegated to synonymy under *Lithophyllum decipiens* Foslie. My specimens from Wakayama Prefecture seem to be an intermediate form between these two species, being referable on one hand to *Lithophyllum decipiens* in having a thin crust, and on the other to *Lithphyllum yendoi* in having overlapping thalli which are uneven on surface and slightly upheaved at the borderlines between two thalli. Though it may be concluded from these facts that the two species would be identical with each other, I have treated them separately in the present paper. As to hypothallium, Foslie (1900, p. 72) and Levring (1943, p. 754) described that there is no any defined contrast between hypothallium and perithallium. Levring also showed the hypothallium which was consisted of one layer of cells in his figure. These plants must therefore be another species, probably *Lithophyllum caribaeum* Foslie.

5. **Lithophyllum neoatalayense** Masaki sp. nov.

Pls. XVII & XVIII; Pl. LVII, Figs. 1–5; Pl. LIX

Thallus firme adhaerens ad substratum, primum suborbicularis in forma, aetate provectiore crustis confluentibus, 200–700μ crass.; hypothallium indicretis, ex uno strates cellularum compositum, cellulis subrectangularibus, ca 10μ long., 5–8μ diam.; cellulae perithallorum subquadratae et 10μ diam., subrectangulares et 9–15μ long., 7–9μ diam.; epithallium ex 4–5 stratis cellularum compositum, cellulis subtriangularibus vel rectangularibus, 5–6μ diam., 3–5μ alt.; secundalis conjunctionibus in parte adjacentium ordinum cellularum perithallii praesentali; conceptacula sporangiferi leviter cava vel prope plana, aliquando leviter convexa, 210–245μ diam., 100–135μ alt. tecto 17–30μ crass., sporangiferis tetrasporis, 45–65μ long., 20–35μ diam.; conceptacula cystocarpiorum valide cava, 170–185 (–250)μ diam., 85–125μ alt., tecto 30–42μ crass.; conceptacula mascularum prope plana, 100–140μ diam., 40–75μ alt., tecto 25–50μ crass., spermatibus anguste cylindratis; conceptacula feminarum ignota.

Japanese name. Kubomi-ishigoromo (n.n.)

Type. On pebbles. Kominato Town, Chiba Pref. 2 June 1961, T. Masaki.

Specimens collected. On pebbles. Tuga, Wakayama Pref., 3 June 1965, T. Masaki.

Crust adherent firmly to pebbles, at first suborbicular but later confluent and superimposed on each other, in advanced stage each thallus losing individuality, 200–700μ thick; hypothallium not clearly distinguished from cells of perithallium, consisting of one layer of cells, cells subrectangular, about 10μ long, 5–8μ diam.; cells of perithallium subquadrate and 10μ diam., subrectangular and 9–15μ long, 7–9μ diam.; epithallium consisting of four or five layers of cells, cells subtriangular or rectangular, 5–6μ diam., 3–5μ high; secondary pit-connections of cells present; sporangial conceptacles slightly concave or nearly flat, sometimes slightly convex, 210–245μ diam., 100–135μ high, roof 17–30μ thick, sporangia tetrasporic, 45–65μ long, 20–35μ diam.; cystocarpic conceptacles markedly concave, 170–185 (–250)μ diam., 85–125μ high, roof 30–42μ thick; spermatangial conceptacles nearly flat, 100–140μ diam., 40–75μ high, roof 25–50μ thick, spermatangia narrowly cylindrical, 5μ long, 1μ diam; female conceptacles unknown.

The present specimens agree quite well with the description of *Lithophyllum atalayense* Lemoine in respect to the external appearance, the concave conceptacles and the one-layered hypothallium. However, when compared with the type specimen of *Lithophyllum atalayense* collected in the littoral zone of Station 24, Ile Atalaya, Archipel Reine, S.W. Patangonia by Carl Skottsberg, which Dr. Lemoine kindly sent me, the present specimens are found to differ from the type in having a thicker crust and larger perithallium cells, and also in the existence of lateral pit-connections. Of these differences, the nature of the connection between adjacent cell-rows seems to be most important. The connection is through the fusion-cells in *Lithophyllum atalayense*, while it is through the pit-connections in my specimens which I describe here as a new species.

6. **Lithophyllum okamurai** Foslie

Foslie, 1900b, p. 4; 1900c, p. 18; 1904a, p. 59, pl. 11, figs. 11–19; 1906, p. 7; 1909, p. 30 (as *Lithophyllum okamurae*); 1929, p. 36, pl. 64, figs. 1–9; Yendo, 1902, p. 187; *in* Okamura, 1902, p. 99; *in* Oakmura, 1916, p. 128; *in* Okamura, 1936, p. 512, fig. 241; De Toni, 1905, p. 1783; 1924, p. 684; Dawson, 1954a, p. 427, fig. 39a; Segawa, 1956, p. 71, pl. 40, fig. 317; Saito, 1956, p. 102; Tokida & Masaki, 1959, p. 185; Segawa & Ichiki, 1959, p. 109; Segawa & Yoshida, 1961, p. 15; Chihara & Numata, 1960, p. 168; Arasaki, 1964, p. 80, fig. 270; Lemoine, 1965, p. 4 (as f. *trincomaliensis*); 1966, p. 6.

6a. **Lithophyllum okamurai** Foslie f. **japonicum** Foslie

Pl. LXII, Fig. 6

Yendo, 1902, p. 187 (as f. *japonica*); *in* Okamura, 1916, p. 129 (as f. *japonica*); *in* Okamura, 1936, p. 512, fig. 241 (as f. *japonica*); Foslie, 1904a, p. 59, pl. 11, figs. 13–19 (as f. *japonica*); De Toni, 1905, p. 1783 (as f. *japonica*); Masaki & Tokida, 1963, p. 1, pls. 1–3.

Syn. *Lithophyllum cephaloides* Heydrich, 1901, p. 271 (According to Foslie, 1909, p. 30)

Japanese name. Hira-ibo (Yendo)

Habitat and distribution, in literature. On stones or other hard objects at 3–30 ft. below tide mark. Hokkaido, Honshû, Kyushû, Japan; Indonesia; Viet Nam; Philippines; New Guinea; Polynesia; Ceylon; Red Sea.

Specimens collected. On stones. Moheji, near Hakodate City, 20 July 1959, 22 Sept. 1960, T. Masaki; 24 April 1960, H. Yamamoto.

The specimens from Moheji are described as follows.

Thallus in the form of crusts firmly adherent to small stones, shells and algae (*Sargassum*), crust up to 600μ thick, in advanced stages completely surrounding the substratum and becoming free spherical or subspherical balls, 3–6 cm diam. and 1.5–3.0cm thick, producing on surface more or less crowded wart-like short branches, the branches simple or subdichotomously divided, 3–10 mm long, 2–3 mm diam., subterete, somewhat elliptical in cross section, often anastomosing with each other even towards the apex, more or less attenuate upwards, flat or depressed at the apex; tissue of branches consisting of three parts, viz., central (corresponding to hypothallium in the crusts), peripheral (perithallium in the crust) portions, and epithallium; cells of the central portion, not clearly distinguishable from those of the peripheral, roundish and 4–10μ diam. or elliptical and 5–10μ long by 4–7μ diam. in both transverse and longitudinal sections, intermixed here and there with groups of large oval or ellipsoidal cells, 12μ diam., 12μ long by 9μ diam., respectively, in longitudinal sections; cells of the peripheral tissue in branches subquadrate and 7μ diam. or elongated rectangular and 12–19μ long by 7–9μ diam. in longitudinal section, 7–15μ long by 7–9μ diam. in transverse section; hypothallium of the crust consisting of one layer of cells, cells rectangular, 20–30 μ long by 5–10μ diam.; cells of perithallium of the crust subquadrate and 9–12μ diam. or elongated rectangular and 9–19μ long by 9–15μ diam.; epithallium one to three cell-layered, cells rectangular or triangular, 2–4μ high by 6–8μ diam.; secondary pits between adjacent cell-rows present; conceptacles formed mainly in the upper parts of branches; tetrasporangial conceptacles flat or convex on surface, 126–190μ high, 190–252μ diam., tetrasporangia 55–80μ long by 21-42μ diam., standing on the periphery of conceptacle floor, central part of floor upheaved and crowned with hair cells, roof of conceptacle 34–63μ thick, orifice with poorly developed

papillae; procarpic conceptacles immersed, 84–126μ high, 105–168μ diam., roof 42–84μ thick, one to two carpogonial branches standing on each auxiliary cell; cystocarpic conceptacles submerged, 126μ high, 200–252μ diam., roof 70μ thick, carpospores arising from the periphery of fusion cell which is thin and continuous in section, orifice with well developed papillae; spermatangial conceptacles crowded, slightly convex, sometimes embedded deeply in the tissue without openings, (31–)42–84(–105)μ high, 84–122μ diam., roof 21–42μ thick, spermatangia numerous, small narrowly cylindrical, 5μ long, 2μ diam.

This species was established by Foslie in 1900 on the basis of the material collected by Yendo at Misaki, Kanagawa Pref., Japan. In this Japanese species Foslie distinguished two forms, viz., f. *japonica* and f. *angularis* in 1901, and later added two forms[1], viz., f. *contigua* in 1904 and f. *trincomaliensis* in 1906 from South Australia and Ceylon respectively. The type specimen of the species is shown by Foslie in the Corallinaceae of the Siboga Expedition (1904), Pl. XI, fig. 11. His fig. 11 and fig. 12 in Pl. XI are explained by Foslie (1904, p. 59) to show the habit of f. *angularis* Foslie, and fig. 12 as the type specimen of f. *angularis*. Then, f. *angularis* Folsie should be treated as *Lithophyllum okamurai* f. *okamurai* in accordance with Article 26 of the International Code of Botanical Nomenclature (1960). On the other hand, Foslie (1909, p. 30) proposed to treat f. *japonica* Foslie as f. *typica* Foslie on the ground, no doubt, that this form was considered to be typical of the species occurring most commonly. However, the type of the present species had already been indicated otherwise by Foslie himself as mentioned above. So the most typical and common form of the species should retain its original name, f. *japonicum* Foslie.

I examined two specimens of this species from Yendo's collection preserved in the Foslie Algae Herbarium in Trondheim, through the kindnesses of Dr. Olav Gjaerevoll and Dr. Olaf I. Rønning of Botanical Department, Royal Norwegian Society of Sciences, Trondheim. They agree quite well with my specimens from Moheji in the structure of the vegetative tissues and of the tetrasporangial conceptacle. Tetrasporangial and cystocarpic conceptacles were already observed by Foslie, but procarpic and spermatangial conceptacles are described for the first time in the present study.

7. **Lithophyllum samoense** Foslie

Pl. XX, Figs. 3 & 4; Pl. XXIII, Figs. 1–4; Pl. LXI, Figs. 3–6; Pl. LXII, Figs. 1–5

Foslie, 1906a, p. 20; 1929, p. 38, pl. 53, fig. 19; De Toni, 1924, p. 672; Dawson, 1954a, p. 427, fig. 40a; 1960, p. 50, pl. 28, fig. 2.

Japanese name. Samoa-ishigoromo (n.n.)

1) F. *valida* Foslie (1906, p. 7) from Ceylon and f. *ptychoides* Foslie (1909, p. 29) from the Indian Ocean were treated later as independent species respectively (Foslie, 1909, p. 32).

Habitat and distribution, in literature. On stones, Samoa; Tahiti; probably Easter Island or Vaihou; Viêt Nam; Baja California.

Specimens collected. On rocks. Oshoro, Hokkaido, 20 July 1959, T. Masaki

Thallus firmly adherent to rock, 400 to 1500μ thick, surface almost smooth, often provided with very small upheavals resulting from the irregular surface of the substratum; hypothallium poorly developed, composed of rectangular cells, 12–26(–32)μ long, 5–9μ diam.; cells of perithallium small, subquadrate, ca 7μ diam., or rectangular and 5–12μ long, 5–6μ diam., often shorter than diameter; epithallium consisting of two to three layers of cells, cells triangular, 7–9μ diam., 5–9μ high; cell-fusion present; sporangial conceptacles subconical or convex, 84–135μ diam., 50–90μ high, sporangia tetrasporic, 35–55μ long, 20–40μ diam.[1]; femal conceptacles convex or slightly elevated, 50–70μ diam., 36–60 μ high; cystocarpic conceptacles convex, 90–100μ diam., 50–70μ high, roof 20–25 μ thick, orifice provided with well-developed papillae; spermatangial conceptacles convex, often prominent, 50–65μ diam., 40μ high, roof 10–13(–20)μ thick, spermatangia narrowly cylindrical, 5μ long, 1μ diam.

My specimens seem to have a resemblance to *Lithophyllum detrusum*[2] with respect to the diameter of tetrasporangial conceptacles and the dimensions of cells of hypothallium and perithallium. Compared with the descriptions and illustrations of *Lithophyllum samoense* given by Foslie (1929, pl. 53, fig. 19) and Dawson (1954, fig. 40a; 1960, pl. 28, fig. 2), the present specimens are referable to this species although they have a crust which may be twice as thick as those described by Dawson (1960). More careful comparisons between the type specimens of these two species in question are necessary in future.

8. **Lithophyllum shioense** Foslie

Foslie, 1906, p. 7; 1929, p. 38, pl. 54, figs. 12–13; De Toni, 1924, p. 686; Yendo, *in* Okamura, 1916, p. 130; *in* Okamura, 1936, p. 513.

8a. **Lithophyllum shioense** Foslie f. **shioense**

Pl. XXII, Figs. 1–3; Pl. XXIII, Figs. 5–8; Pl. LXIII

Japanese name. Misaki-ishigoromo (n.n.)

Habitat and distribution, in literature. On rocks and pebbles. Shio-no-misaki, Wakayama Pref., Japan.

Specimens collected. On rocks in the intertidal zone. Usa, Kochi Pref., 22 May 1962, T. Masaki; Shio-no-misaki, Wakayama Pref., 3 Oct. 1963, T. Masaki.

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1) Folie (1906a, p. 20) gave (100–)120–200μ for the diameter of tetrasporangial conceptacles.

2) In *L. detrusum* Folie (1906a, p. 21) was described as having sporangial conceptacles 100–160μ diam., cells of hypothallium 11–22μ long, 6–7(–9)μ diam., and those of perithallium 5–9μ long, 4–7μ diam.

Thallus crustaceous, firmly adherent to substratum, 5–7mm in diam., 400–1000μ thick, at first suborbicular in outline, later becoming confluent and overlapping with each other, margin crenulate or lobed, upheaved at borderlines of confluent individuals, thallus surface in old crust nearly covered by short protuberances with flat tops, protuberances 1–2 mm diam., up to 2.5 mm high from the substratum, pink or whitish in color when dried; hypothallium very poorly developed, composed of 1–3 layers of cells, cells rectangular, 8–15μ long by 3–5μ diam.; cells of perithallium subquadrate, 5–8μ diam., or rectangular, 8–10μ long by 4–6μ diam., or occasionally elongated vertically, 15–35μ long by 5–6μ diam.; epithallium composed of two to three layers of cells, cells subquadrate, 3–5μ diam.; cell-fusion occurring between adjacent cell-rows of perithallium; sporangial conceptacles slightly convex, 150–240(–310)μ diam., (70–)100–165μ high, conceptacle floor nearly flat, crowned with hair cells at the central portion, roof 25–50μ thick, sporangia tetrasporic, 50–90μ long, 25–40μ diam.; procarpic conceptacles slightly convex, one or two carpogonial branches standing on each auxiliary cell, 75–80μ diam., 50–65μ high, orifice well developed, roof 28–40μ thick; cystocarpic conceptacles convex, 145–200μ diam., 100–150μ high, roof 25–50μ thick; male conceptacles convex, 55–110μ diam., 40–75μ high, roof 18–38(–50)μ thick, spermatangia numerous, narrowly cylindrical, 5μ long, 1.5μ diam.; conceptacles often embedded deeply in the tissue without an opening.

This species was established by Foslie (1906) on the basis of the specimens from Shio-no-misaki collected by K. Yendo. My specimens, including those from the type locality, agree in general with the description given by Foslie except that they have the hypothallium of shorter cells, the perithallium of longer cells, and also the crust of greater thickness.[1] Moreover, a peculiar feature of my specimens is that the perithallium is found to contain elongated cells scattered here and there. Foslie did not describe such elongated cells in his material of this species. So the present identification remains provisional until the type specimen is re-examined.

8b. **Lithophyllum shioense** Foslie f. **tenue** Masaki f. nov.

Pl. XXII, Figs. 4 & 5

Thallus suborbicularis, 1–3 mm diam., 200–400μ crass.; tuberis parum insignis.

Japanese name. Kita-misaki-ishigoromo (n.n.)

Type. On stone. Yamasedomari, Hakodate City, 10 Oct. 1961, T. Masaki.

Thallus suborbicular, 1–3 mm diam., 200–400μ thick, excrescences inconspicuous.

1) Foslie described the cells of hypothallium as up to 22μ in length, the elongated cells of perithallium as up to 14μ in length, and the thallu as 0.2–0.4 mm in thickness.

This specimen from Hakodate agrees well with the original description of *Lithophyllum shioense* given by Foslie (1906) except that it has crust smaller in diameter and thinner, and inconspicuous excrescences. It should be treated as a form different from the typical form of the species collected at Shio-no-misaki, the type locality.

9. **Lithophyllum tortuosum** (Esper) Foslie

Pl. XXIV, Figs. 2–5; Pls. XXVI & LXIV; Pl. LXV, Figs. 1 & 2

Foslie, 1900c, p. 20 (including f. *cristata*, f. *undulosa*, f. *crassa* and f. *decumbens*); 1929, p. 38, pl. 56, figs. 1–10; De Toni, 1905, p. 1792; Segawa, 1956, p. 71, pl. 40, fig. 318 (as *Lithophyllum tortuosum* Foslie); Arasaki, 1964, p. 81, fig. 271 (as *Lithophyllum tortuosum* Foslie).

Syn. *Millepora tortuosa* Esper, 1791, p. 118. *Tenarea undulosa* Bory, 1832, p. 207. *Lithophyllum cristatum* Meneghini, 1840, p. 9; Hauck, 1885, p. 270, pl. 2, figs. 5–6, pl. 3, figs. 8–9; Rosanoff, 1866, p. 95, pl. 7, fig. 6; Solms-Laubach, 1881, p. 20 (as *L. cristatum* Rosanoff); Heydrich, 1897a, p. 411; 1901, p. 537 (as *L. cristatum* (Menegh.) Heydrich, including f. *undulosa* Bory and f. *decumbens* Foslie). *Spongites cristata* Kützing, 1849, p. 698. *Goniolithon tortuosum* (Esper) Foslie f. *decumbens* Foslie, 1898b, p. 14. *Tenarea tortuosa* (Esper) Lemoine, 1911, p. 169.

Japanese name. Hachi-no-su-ishi (Segawa).

Habitat and distribution, in literature. On rocks exposed to surf. Atlantic; Mediterranean; Adriatic Sea; Pacific coast of middle Japan.

Specimens collected. On rocks. Susaki, Shimoda Town, Shizuoka Pref., 5 June 1965, T. Masaki.

Thallus composed of a crust and many vertical lamellate branches, adherent firmly to rock on the entire lower surface, lamellae crowded and tortuous, often fused with each other, 1.0–1.5 cm high, 0.5–1.0 mm thick, diminishing in height gradually towards the margin, finally becoming flat; crust 300–600μ thick, producing from the under surface rhizoid-like projections, 300–800μ long, 100–350μ diam., whose distal ends firmly attach to substratum, cells of projections disposed compactly, rectangular, 10–35μ long, 5–8(–12)μ diam., arranged parallel to the longitudinal axis of projections; lamellae hollow in the medulla, cells compactly disposed, arranged at right angles to longitudinal axis, cells of the innermost layer or hypothallium of lamellae rectangular, 10–25(–35)μ long, 4–5(–7)μ diam., cells of perithallium of lamellae subrectangular, 8–12μ long, 4–5μ diam., epithallium of lamellae 3–5 cell-layered, cells quadrate, 5μ diam., or rectangular, 5μ diam., 3–4μ high; hypothallium of crust well developed, cells compactly disposed, 14–22μ long, 5–6μ diam.; cells of perithallium of crust subrectangular, 10–15μ long, 5–6μ diam.; epithallium of crust 1–3 cell-layered, cells quadrate, 5μ diam., or rectangular, 6μ diam., 3μ high; secondary pit-connections present; sporangial conceptacles convex, prominent, or subconical, 200–300μ in outer diam., 150–200μ

in inner diam., 100–125μ high, roof 25–30μ thick; sporangia tetrasporic, 40–65μ long, 25–40μ diam.; female conceptacles convex, prominent, or subconical, 90–100μ diam., 65–90μ high, ostiole 40–50μ long, provided with papillary cells; male conceptacles nearly flat or slightly convex, 90–140μ diam., 40–75μ high, roof 15–40μ thick, spermatangia narrowly cylindrical, 5μ long, 1μ diam.; cystocarpic conceptacle unknown.

Lemoine (1911, p. 62) is of opinion that this plant is different from *Lithophyllum* in its very compact structure of hypothallium, and she revived the old genus *Tenarea* for it. However, jugding from the feature of the sporangial conceptacle which sporangia stand on the periphery of conceptacle floor and the anatomical structure of the vegetative tissues, this plant seems to be referable to *Lithophyllum*. The rhizoid-like projections from the under surface of the crust have not been observed by previous authors, so far as I know.

10. **Lithophyllum yendoi** Foslie

Pl. XXIV, Figs. 1 & 6; Pl. XXV; Pl. LXV, Figs. 3–6; Pl. LXVI

Foslie, 1900c, p. 20; 1904a, p. 61, pl. 11, figs. 1–4; 1906a, p. 19; 1929, p. 38, pl. 53, figs. 16–17; Yendo, 1902, p. 188; *in* Okamura, 1902, p. 100; *in* Okamura, 1916, p. 130; *in* Okamura, 1936, p. 513, fig. 242; De Toni, 1905, p. 1794; 1924, p. 675; Ishizima, 1934, p. 1373, figs. 1–2; Segawa, 1956, p. 71, pl. 40, fig. 316.

Syn. *Goniolithon* (*Lepidomorphum*) *yendoi* Foslie, 1900a, p. 25. *Lithothamnium yendoi* (Foslie) Lemoine, 1965, p. 10; 1966, p. 4.

Japanese name. Umisabi (Yendo)

Habitat and distribution, in literature. On rocks, stones, and wood. West coast of Kyushû, Pacific coast of middle Japan, and south and west coast of Hokkaido, Japan; China Sea; Gulf of Siam; Malaysia; Seychelles, Indian Archipelagos; Carolines; Polynesia; Red Sea.

Specimens collected. On rocks. Muroto-misaki, Kochi Pref., 11 June 1964, T. Masaki.

Thallus adherent firmly to substratum, 300–600μ thick, sometimes attaining a thickness of about 1 mm, often confluent or superimposed on each other, sometimes upheaved at borderlines of confluent individuals, surface uneven owing to the shape of substratum, producing small wart-like excrescences; hypothallium poorly developed, composed of about six layers of cells, cells rectangular, 8–20μ long by 5–6μ diam.; cells of perithallium subquadrate, about 5–8μ diam., or subrectangular, 5–10μ long by 3–6μ diam.; cell-fusion often occurring between the adjacent cell-rows; epithallium one cell-layered, cells subrectangular, 4–5μ diam. by 2–5μ high; trichocytes 6–12μ long by 6–10μ diam.; sporangial conceptacles convex or hemispherical to conical, 160–200μ inner diam., 200–300μ outer diam., 120–140μ high, roof 25–40μ thick; sporangia tetrasporic, 45–80 μ long, 20–50μ diam., standing on the periphery of conceptacle floor, most part of floor

occupied by hair cells; female conceptacles nearly flat or slightly convex, 75–80μ diam., 60–75μ thick, ostiole 40–50μ long; cystocarpic conceptacles convex, 155–190μ diam., 100–125μ high, ostiole 40–60μ long, roof 25–30μ thick; male conceptacles convex or subconical, 110–150μ inner diam., about 200μ outer diam., 65–90μ high, roof 25–40μ thick, spermatangia narrowly cylindrical while attached to their mother cells, but globular when set free in the conceptacle cavity, about 2μ diam.

Foslie (1900) described the tetrasporangial, cystocarpic and antheridial conceptacles together with the vegetative structure of this species under the name of *Goniolithon* (*Lepidomorphum*) *yendoi* on the basis of the materials collected at Shimoda and Otaru by K. Yendo. In the same year he transfered it to the genus *Lithophyllum* without any comment. Later in 1906, he distinguished four forms in this species, namely, f. *typica*, f. *siamensis*, f. *malaysica* and f. *maheica*. The relation between this species and *Lithophyllum decipiens* is stated in remarks under the latter species.

Porolithon Foslie

Foslie, 1909, p. 57; Lemoine, 1911, p. 61; Svedelius, *in* Engler and Prantl, 1911, p. 270; Taylor, 1950, p. 124; Kylin, 1956, p. 207.

Lithophyllum Philippi subgenus *Porolithon* Foslie, 1906a, p. 24.

Key to the species of Porolithon

1. Thallus with excrescences. 2
1. Thallus with no excrescence ..... 3. *P. orbiculatum* (p.44)
   2. Thallus with wart-like excrescences ..... 1. *P. boergesenii* (p.42)
   2. Thallus with subterete, simple or divided, excrescences ..... 2. *P. colliculosum* (p.43)

1. **Porolithon boergesenii** (Foslie) Lemoine

Pls. XXVII & XXVIII, LXVII & LXVIII

Lemoine, *in* Børgesen, 1917, p. 178, figs. 168–169; De Toni, 1924, p. 693.

Syn. *Goniolithon boergesenii* Foslie, 1901a, p. 19; 1929, p. 29, pl. 52, figs. 7–10; De Toni, 1905, p. 1801, *Goniolithon* (*Hydrolithon*) *boergesenii* Foslie, 1907a, p. 20 (including f. *africana*). *Hydrolithon boergesenii* Foslie, 1909, p. 56.

Japanese name. Seto-ibo-ishimo (n.n.)

Habitat and distribution, in literature. On corals, bryozoa, etc. Virgin Islands; Africa.

Specimens collected. On rocks, To-jima and Shiso-jima, Seto, Shirahama, Wakayama Pref., 17 Sept. 1963, T. Masaki.

Thallus crustaceous, attached firmly to rock, up to about 2.0 mm thick, living crust, which is 150μ to 500μ in thickness, superimposed on old dead one, surface uneven at the marginal portion, covered almost entirely with verruciform

excrescences, excrescences when well developed about 2.0 mm high, 2.0–5.0 mm diam., fused with each other; hypothallium often indistinguishable from cells of perithallium, consisting of one layer of cells, cells rectangular, or elongated obliquely or parallel to substratum, 18–23μ long, 5–10μ diam.; cells of perithallium variable in size, ovoid or subquadrate, 7–10μ diam., or subrectangular, 12–20(–30)μ long, 5–10μ diam., often shorter than diameter; epithallium consisting of one to two layers of cells, cells subrectangular, 5–10μ diam., 7–13μ high; heterocysts rectangular, 13–33μ long, 8–13μ diam., deeply embedded in perithallium tissue, standing in a line, in groups of 4–8 cells, heterocyst initials forming a group just beneath the thallus surface, provided with a hair at the apex; sporangial conceptacles prominent, convex or hemispherical, 300–350μ in outer diam., 150–200μ in inner diam., 100–125(–140)μ high, roof 30–45μ thick, sporangia tetrasporic, 38–60μ long, 25–33μ diam.; female conceptacles subconical, 60–110μ diam., 90–165μ high, ostiole well developed, 63–115μ long, provided with papillary cells deeply stained with dyes; cystocarpic conceptacles subconical, 125–225μ diam., 90–125μ high, ostiole well developed, 25–50μ long; male conceptacles nearly flat or slightly convex, 50–75μ diam., 40–65μ high, often embedded deeply in the tissue without an opening, roof 20–40μ thick, orifice sometimes provided with a spout, spermatangia ellipsoidal, ca 5μ long, 1μ diam.; monoecious.

This species is characterized by verruciform excrescences covering the surface of crust and by the single layer of cells of hypothallium. My specimens agree quite well with the descriptions of this species given by Foslie (1901) and Lemoine (1917) except for their smaller heterocysts. This species also resembles *Porolithon reinboldi* (Weber et Foslie) Lemoine (1911, p. 166) whose hypothallium is single cell-layered according to Lemoine (l. c.) but is apparently different from it in the dimension of sporangial conceptacles. The sporangial conceptacles seen from surface are 300–400μ diam. in *Porolithon boergesenii* (Foslie) Lemoine (Lemoine, l. c.; Foslie, 1901a), while they are 300–500–700μ diam. in *Porolithon reinboldi* Foslie (Foslie, 1904a, p. 51; 1901, p. 5; Lemoine, 1911, p. 168).

2. **Porolithon colliculosum** Masaki sp. nov.

Pls. XXXI & XXXII; Pl. LXX, Figs. 4 & 5; Pls. LXXI & LXXII

Thalli firme adhaerentes ad rupes, 5–10 cm diam., forma externa hemispherica aut subpyramidari, crusta 350–2000μ crass.; superficie excrescentibus instituta; excrescentibus 1.5–6.0 mm alt., ca 2.0 mm diam., simplicibus, aut subdichotomis divisis, subteretibus, anastomosantibus; hypothallium comparate tenuiter evolutum, ex c. 10 stratis cellularum compositum, cellulis subquadratis et 9–10μ diam., aut rectangularis et 8–20μ long., 5–10μ diam.; cellulae perithallii subquadratae et 5–11μ diam., rectangularis et 4–11μ long., 4–8μ diam., saepe prolongatae horizontaliter; epithallium ex 1–2 stratis cellularum compositum, cellulis subrectangularis aut subtriangularis, 5–6μ diam., 4–5μ alt.; heterocystae in

aggregatione horizontali dispositae, vel in lines, vel cumulatae 6–9 cellularum, 15–22μ long., 8–13μ diam.; conceptacula sporangifera convexa, 150–240μ diam. exteriora, 130–165μ diam. interiora, 75–140μ alt., sporangiferis tetrasporis, (33–) 48–65μ long., (15–)23–33μ idam.; conceptacula feminarum prope plana, 50–65μ diam., 50–65μ alt.; conceptacula cystocarpiorum convexa, 115–165μ diam., 65–115μ alt.; conceptacula mascula prope plana aut leniter convexa, 93–150μ diam., 50–113μ alt., spermatibus minutis, anguste cylindratis, 5μ long., 1.5μ diam., sed in cavo conceptaculo sphericis, 2μ diam.

Japanese name. Toge-ibo (n.n.)

Type. On rock. Muroto-misaki, Kochi Pref., 6 June, 1962, T. Masaki.

Specimens collected. On rocks. Muroto-misaki, Kochi Pref., 11 June 1964, T. Masaki.

Thallus crustaceous, firmly adherent to rocks hemispherical or subpyramidal in form, 5–10cm diam., crust 350–2000μ thick, surface provided with excrescences, excrescences 1.5–6.0 mm high, about 2.0 mm diam., simple, or subdichotomously divided, subterete, often anastomosed with each other, margins lobed; hypothallium relatively poorly developed, consisting of about 10 layers of cells, cells subquadrate and 9–10μ diam., or rectangular and 8–20μ long by 5–10μ diam.; cells of perithallium subquadrate and 5–11μ diam., or rectangular and 4–11μ long by 4–8μ diam., often shorter than diameter; epithallium consisting of one to two layers of cells, cells subrectangular or subtriangular, 5–6μ diam. by 4–5μ high; heterocysts 15–22μ long by 8–13μ diam., standing in a line, 6–9 heterocysts in each line; sporangial conceptacles convex, 150–240μ outside diam., 130–165μ diam. by 75–140μ high inside, conceptacle floor flat, crowded with hair cells at the central portion, roof 25–42μ thick, sporangia tetrasporic, (33–)48–65μ long, (15–)23–33μ diam.; female conceptacles nearly flat, 50–65μ diam., 50–65 μ high, roof about 25μ thick; cystocarpic conceptacles convex, 115–165μ diam., 65–115μ high, roof 23–38μ thick; spermatangial conceptacles nearly flat or slightly convex, sometimes embedded deeply in the tissue without an opening, 93–150μ diam., 50–113μ high, roof 20–50μ thick, spermatangia small, numerous, narrowly cylindrical, 5μ long by 1μ diam., while attached to their mother cells, but becoming spherical, 2μ diam., when set free in the conceptacle cavity.

This species resembles *Porolithon pachydermum* Foslie in the dimension of sporangial conceptacles, but may be distinguished on following points. The cystocarpic conceptacles are smaller and the crust is more or less hemispherical and produces many small excrescences. This species grows gregariously on the rocks in the upper littoral zone.

3. **Porolithon orbiculatum** Masaki sp. nov.

Pls. XXIX, XXX & LXIX; Pl. LXX, Figs. 1–3

Thalli crustaeformes, firme adhaerentes ad substratum, orbiculares in linea-

mento, 5–10 mm diam., 150–400μ crass., aetate provectiore crustis confluentibus, margine lobatae aut crenulatae, crustis compluribus inter se adjacentibus marginibus in contactu compresso-elevatis, superficie levi aut leniter mamillari, microscopaliter exiguis conceptaculis totam superficiem thalli adoperientibus; hypothallium belle evoluans, saepe thalli crassitudinis medium partem comprehendens, ramificatis ordinibus cellarum compositum verticaliter vel horizontaliter curvatis, cellulis rectangularibus, 10–20μ long., 5–9μ diam.; cellulae perithalliales, aliae subquadratae et 7–10μ diam., aliae rectangulae et 5–14μ long., 5–9μ diam., aut saepe breviores quam diameter; epithallium ex unico stratu cellularum formatum, cellulis rectangulis 4–8μ diam., 3–5μ alt.; cellulae confluentes inter ordines adjacentes in parte hypothallii et perithallii; heterocystae in aggregatione horizontali dispositae, vel in linea, vel cumulatae 7–16 cellularum, subquadratae, 18–28μ long., 10–15μ diam., saepe exacte infra superficiem thallii, sed aliquando in partibus interioribus in sectione perithallii existae, aut e facie visis, in aggregationibus dissipatis 26–90 cellularum, cellulis fere circularibus et tamquam exigua formina inter cellulas superficiis apparenties; conceptacula sporangifera dense conferta, 113–132μ diam., 75–100μ alt., sporangiferis tetrasporis, 50–65μ long., 20–43μ diam., stantes super peripheriam pavimenti plani conceptaculorum, cellulis pilosis in parte centrali pavimenti tectente; conceptacula feminarum plana aut leniter convexa, 35–50μ diam., 45–50μ alt.; conceptacula cystocarpiorum convexa, 100–130μ diam., 75–90μ alt., carpospores exsurgentes ex peripheria pavimenti conceptaculorum; conceptacula mascula convexa, 48–78μ diam., 38–50 μ alt., spermatibus minutis, anguste cylindratis, 4–5μ long., 1.5μ diam.; monecio.

Japanese name. Onihasu-ishimo (n.n.)

Type. On pebble. Muroto-misaki, Kochi Pref., 7 June 1963, T. Masaki.

Specimens collected. On pebbles and stones in the intertidal zone. Seto, Shirahama, Wakayama Pref., 30 May, 1964, T. Masaki.

Thallus in the form of crusts, firmly adherent to substratum, orbicular in outline, 0.5–2.0 cm in diam., 150–400μ thick, in advanced stage of growth fused with each other, margins lobed or crenulate, upheaved at borderlines of confluent individuals, surface smooth, slightly mammillate, microscopic minute conceptacles covering the whole surface of crust, pink or whitish pink in color; hypothallium well developed, often occupying nearly half thickness of crust, consisting of branched cell-rows curved upward and downward, cells rectangular, 10–20μ long by 5–9μ diam.; cells of perithallium subquadrate, 7–10μ diam., or rectangular, 5–14μ long by 5–9μ diam., often shorter than diameter; epithallium consisting of one layer of cells, cells rectangular 3–5μ high by 4–8μ diam.; cell-fusion occurring in perithallium and hypothallium; heterocysts subquadrate in sectional view, 18–28μ long by 10–15μ diam., standing in a line just beneath the epithallium or in the inner portion of perithallium, 7–16 heterocysts in each line, but roundish in surface view, gathered in groups, 26–90 heterocysts in each group; sporangial

conceptacles crowded, convex, 115–160μ diam., 75–100μ high, roof 15–20μ thick, sporangia tetrasporic, 50–65μ long, 20–43μ diam., standing on the periphery of conceptacle floor which is flat and crownded with hair cells at the central portion; procarpic conceptacles flat or slightly convex, 35–50μ diam., 45–55μ high, roof 20–30μ thick, one or two carpogonial branches standing on each auxiliary cell; cystocarpic conceptacles convex, 100–130μ diam., 75–90μ high, roof 18–23μ thick, carpospores arising from the periphery of conceptacle floor; male conceptacles convex, 48–78μ diam., 38–50μ high, orifice sometimes provided with a spout, roof 13–25μ thick, spermatangia small, narrowly cylindrical, 4–5μ long, 1.5μ diam.; monoecious.

This plant is characterized by the possession of suborbiculate crusts upheaved at their margins which are in contact with neighboring thalli, and of abundant heterocysts which look like many minute pores in surface view of decalcified material.

Neogoniolithon Setchell et L.R. Mason

Setchell et Mason, 1943, p. 89; Hamel et Lemoine, 1952, p. 72; Kyin, 1956, p. 212.

Key to the species of Neogoniolithon

1. Thalli squamulose-imbricate ..... 2. *N. misakiense* (p.47)
1. Thalli crustaceous. 2
   2. Conceptacles not so densely scattered on thallus surface; asexual conceptacles 530–750μ diam..... 3. *N. pacificum* (p.48)
   2. Conceptacles very densely scattered on thallus surface; asexual conceptacles 320–550μ diam ..... 1. *N. accretum* (p.46)

1. **Neogoniolithon accretum** (Foslie et Howe) Setchell et Mason

Pls. XXXIII & XXXIV, LXXIII-LXXV

Setchell et Mason, 1943, p. 90.

Syn. *Goniolithon accretum* Foslie et Howe, 1906, p. 131, pl. 85, fig. 2, pl. 91; Foslie, 1929, p. 29, pl. 45, figs. 19–21; De Toni, 1924, p. 659. *Lithophyllum accretum* (Foslie et Howe) Lemoine, *in* Børgesen, 1917, p. 159.

Japanese name. Rinaki-ishimo (n.n.)

Habitat and distribution, in literature. On rocks and pebbles at the surf-beaten places partly protected from open sea. Florida and West Indies.

Specimens collected. On sandy rocks near beach. Ezura, Shirahama, Wakayama Pref., 24 and 27 Oct., 1963, T. Masaki.

Thallus crustaceous, adhering firmly to substratum, irregular in shape, margins lobed and confluent with each other in advanced stage of development, ca. 6 cm maximum diam., 80–400μ thick in thin crusts or in marginal portion, but often attaining 1.3 mm thick in overlapping crusts, surface very rough when fertile

owing to numerous conical conceptacles; hypothallium consisting of about 6–8 layers of cells, cells rectangular, 10–27μ long by 6–13μ diam., elongated parallel to substratum, arranged in filaments curved up to form perithallium; cells of perithallium suborbicular, 5–8μ diam., or subrectangular, 10–20μ long by 7–15μ diam.; epithallium consisting of one layer of subtriangular cells which are 9–12μ diam. by 5–6μ high, cell-fusion occurring between adjacent cell-rows of perithallium and hypothallium; heterocysts irregular in shape, scattered sparsely in outer part of perithallic tissue, 18–25μ maximum diam., 13–20μ minimum diam.; sporangial conceptacles[1] conical, (250–)320–550(–660)μ diam., 250–350μ high, ostiole well developed, 75–175μ long, sporangia bisporic, standing on the whole surface of conceptacle floor, 85–145μ long, 25–65μ diam., bispores binucleate; procarpic conceptacles conical, 175–250μ diam., ostiole well developed, 100–200μ long; cystocarpic conceptacles conical, 350–480μ diam., 230–310μ high, ostiole well developed, 75–113μ long, carpospores arising from the whole surface of the floor; spermatangial conceptacles, 200–250μ diam., 225–250μ high, ostiole well developed, 100–125μ long, spermatangia globular, 3μ diam., produced on dendroid systems of filaments developed from the whole inner surface of conceptacle.

This species resembles *Neogoniolithon pacificum* (Foslie) Setchell et Mason in general appearance of the frond tissues. However, it differs from the latter in both the external form of thallus and the dimension of heterocysts. This species was described by Foslie and Howe (1906) on the basis of specimens collected in Florida and Bahamas. Later, Lemoine (1917) studied the specimens from the Antilles, West Indies, and pointed out that the specimens collected by Howe in the Bahamas differed from hers in the dimensions of perithallium and hypothallium cells. She believed that the plant shown in the photograph by Foslie and Howe (1906, pl. 91) was apparently identical with *Lithophyllum absimile*. My specimens agree with the description given by Foslie and Howe rather than with that given by Lemoine.

2. **Neogoniolithon misakiense** (Foslie) Setchell et Mason

Pls. XXXV & LXXVIII; Pl. LXXIX, Fig. 1

Setchell and Mason, 1943, p. 90.

Syn. *Goniolithon misakiense* Foslie, 1905a, p. 4; 1929, p. 30, pl. 45, figs. 22–24; Yendo, *in* Okamura, 1916, p. 127; *in* Okamura, 1936, p. 509, fig. 239; De Toni, 1924, p. 663.

Japanese name. Kasane-ishimo (n.n.)

Habitat and distribution, in literature. On rocks. Misaki, Pacific coast of middle Honshû, Japan.

Specimens collected. On rocks. Usa, Kochi Pref., 24 May 1962, T. Masaki.

1) Foslie and Howe (1906) described the conceptacles (of sporangia?) as about 300–400μ in diameter.

Thallus in the form of squamulose-imbricate lamellae firmly adherent to rocks, up to 2.5 mm thick, lamellae suborbiculate, with crenulate and lobate margins, 100–200μ thick, consisting of about 15 layers of cells in the middle portion; hypothallium well developed in comparison with thickness of lamellae, consisting of about 10 layers of cells, cells rectangular, 15–35μ long by 7–13μ diam., arranged in filaments parallel to substratum, curved gradually upwards to form perithallium; perithallium poorly developed, cells subquadrate or vertically elongated, 10–25μ long by 8–11μ diam.; epithallium consisting of one layer of cells, cells subrectangular or subtriangular, 7–12μ high by 7–8μ diam.; coalescence of cells occurring in hypothallium and perithallium; heterocysts numerous, scattered singly in perithallium, rectangular, 27–45μ long by 13–25 μ diam.; sporangial conceptacles hemispherical to conical, 200–450μ diam., 120–300μ high, conceptacle floor is at the same level as the thallus surface, ostiole 75–140μ long, roof 50–90μ thick; sporangia tetrasporic, 75–95μ long, 25–40μ diam., standing on the whole surface of conceptacle floor; sexual plants unknown.

Goniolithon misakiense was established by Foslie in 1905 on the basis of the materials collected by Yendo at Misaki. It was transfered by Setchell and Mason in 1943 to the genus *Neogoniolithon* because of the presence of heterocysts. The reproductive organs of this species have not been described to date, but a number of relatively young tetrasporic plants and the development of the tetrasporic conceptacles was observed by me. Although Foslie described that this species was up to 5 mm thick and frequently proliferous in old fronds, my specimens are thinner, not beyond 2–5 mm in thickness, and have no proliferations.

3. **Neogoniolithon pacificum** (Foslie) Setchell et Mason

Pls. XXXVI & XXXVII, LXXVI & LXXVII

Setchell and Mason, 1943, p. 90.

Syn. *Goniolithon notarisii* f. *pacifica* Foslie, 1907a, p. 12. *Goniolithon pacificum* Foslie, 1908b, p. 6; 1929, p. 31, pl. 45, fig. 16; De Toni, 1924, p. 660; Yendo, *in* Okamura, 1916, p. 126; *in* Okamura, 1936, p. 509.

Japanese name. Suribachi-ishimo (n.n.)

Habitat and distribution, in literature. On coralline algae and rocks together with other calcareous algae. Kanagawa Pref. and Miyazaki Pref., Japan.

Specimens collected. On pebbles. Uranouchi Bay, Usa, Kochi Pref., 24 May 1962, T. Masaki.

Thallus firmly adherent to pebbles, suborbicular in outline, about 2–4 cm diam., 300–900μ thick, when fertile bearing many minute and conspicuous conceptacles; hypothallium consisting of several layers of cells which are 15–25μ long by 10–16μ diam.; perithallium abruptly arising from hypothallium, cells subspherical, 10–15μ diam., or subrectangular to elliptical or ovoid, 13–30μ long by 10–14μ diam., often shorter than diameter; epithallium consisting of one layer of cells which are

lenticular in form, 10–15μ diam. by 4–8μ high; heterocysts scattered sparsely in perithallic tissue, ovoid or elliptical, 25–45μ long by 13–33μ diam., cell-fusion occurring in perithallium; sporangial conceptacles conical, (400–)530–750μ inside diam., 600–1000μ outisde diam., (350–)450–700μ high, orifice 170–400μ long, provided with poorly developed papillae, sporangia bisporic with binucleate spores, 95–167μ long, 30–60μ diam., scattered on the whole surface of conceptacle floor; procarpic conceptacles convex, 238μ diam., 160μ high, roof 90μ thick; cystocarpic conceptacles conical, 370–600μ diam., 330–600μ high, orifice 100–270μ long, carpospores arising from the whole surface of fusion cell which is continuous in section; male plant unknown.

This species was described at first in 1907 under the name of *Goniolithon notarisii* f. *pacifica* by Foslie and he raised it to the rank of species in 1908. After making a critical study of the genus *Goniolithon*, Setchell and Mason (1943) transferred this species to their *Neogoniolithon* because of its possession of heterocysts. The procarpic and cystocarpic plants are reported here for the first time.

Dermatolithon Foslie

Foslie, 1898a, p. 11; 1909, p. 57; Svedelius, *in* Engler and Prantl, 1911, p. 269; Hamel et Lemoine, 1952, p. 58; Mason, 1953, p. 342; Kylin, 1956, p. 208.

Lithophyllum Philippi subgenus *Dermatolithon* (Foslie) Foslie, 1904, p. 3.

Key to the species of Dermatolithon

1. Thallus usually less than 120μ thick; cells of hypothallium short, 12 to 55μ long; asexual conceptacles 250–270μ diam.....1. *D. canescens* (p.49)
1. Thallus commonly over 120μ thick 2
   2. Cells of hypothallium less than 30μ long, not particularly variable in length in different parts of thallus.....4. *D. tumidulum* (p.53)
   2. Cells of hypothallium mostly more than 30μ long, very variable in length 3
3. Cells of epithallium rectangular, periclinally flattened; plants growing on various algae .....3. *D. dispar* (p.52)
3. Cells of epithallium triangular; plants growing on *Corallina* ....2. *D. corallinae* (p.50)

1. **Dermatolithon canescens** (Foslie) Foslie

Foslie, 1909, p. 58; De Toni, 1924, p. 666; Masaki & Tokida, 1960a, p. 38, pl. 1, figs. 2 & 3, pl. 2, figs. 4–7, pl. 5.

Syn. *Melobesia* (*Heteroderma*) *canescens* Foslie, 1900b, p. 6. *Melobesia canescens* Foslie, Yendo, 1902, p. 186; De Toni, 1905, p. 1769. *Lithophyllum* (*Dermatolithon*) *canescens* Foslie, 1905a, p. 8; 1909, p. 48. *Lithophyllum canescens*

Foslie, 1929, p. 32, pl. 72, fig. 3; Yendo, *in* Okamura, 1916, p. 128; *in* Okamura, 1936, p. 511.

Japanese name. Sôhan (Yendo)

Habitat and distribution, in literature. Epiphytic on *Padina arborescens*. Pacific coast of middle Honshû, Japan.

Specimens examined. Epiphytic on haptera of *Alaria crassifolia*: Shirikishinai, near Hakodate, Nov. 1958, K. Yakushi. On *Padina arborescens*: Enoshima, Kanagawa Pref., April 1898, Okamura (Alg. Jap. Exsic. No. 39); Misaki, Kanagawa Pref., April 1900, Yendo (Herb. Fac. Agr., Hokkaido Univ.); Kominato, Chiba Pref., 28 August 1959, K. Iwamoto. On *Galaxaura fastigiata*: Muroto-misaki, 11 June 1964, T. Masaki.

Thallus epiphytic on various algae, firmly adherent to the host, forming suborbicular patches, which later become confluent with each other, 2–10 cm. in diam., purplish red in color when fresh, whitish rose on drying, monostromatic at margins, polystromatic in the inner portion, usually up to 120μ thick, sometimes up to 200–300μ; hypothallium monostromatic, cells obliquely elongated, 12–55μ long, (7–)9–16μ diam., showing marked differences in length in one and the same individual; perithallium consisting of 2–5 layers of cells of various length, cells 10–42μ long, 7–13μ diam.; secondary pit-connections present between each vertical cell row; cells of epithallium triangular, 5–9μ diam. by 3–5μ high; sporangial conceptacles immersed, 252–268μ diam., 63–105μ high, sporangia tetrasporic, 42–84μ long, 25–42μ diam., central part of conceptacle floor slightly upheaved and surmounted by a number of hair cells which are surrounded by mucilaginous substance, orifice without papillae; procarpic conceptacles immersed or nearly flat on surface, 105–126μ diam., 63–84μ high, cystocarpic conceptacles nearly flat on surface, 155–210μ diam., 85–125μ high, orifice provided with well developed papillae; spermatangial conceptacles slightly elevated on surface, (55–)85–125μ diam., 40–65μ high, opening by a narrow pore which sometimes extends into a spout, sometimes embedded deeply in the tissue without an opening, spermatangia narrowly cylindrical in shape, ca. 3μ diam. by 9μ long.

In this species, tetrasporangial conceptacles have been described by Foslie (1900, 1909) and Yendo (1916, 1936), but cystocarpic and spermatangial ones have not been reported by anyone. In my specimens epiphytic on *Alaria* not only sporangial conceptacles but also female and male ones were observed and are described above. Among the specimens examined from Misaki, the type locality, were some identified by Yendo as *Melobesia canescens* Foslie.

2. **Dermatolithon corallinae** (Crouan) Foslie

Foslie, *in* Børgesen, 1902, p. 402; Masaki & Tokida, 1960, p. 285, pl. 1, figs. 1–4, pls. 2, 4 and 5.

Syn. *Melobesia corallinae* Crouan, 1867; Areschoug, 1875, p. 2; Hauck, 1885,

p. 266; Foslie, 1898a, p. 11. *Lithophyllum corallinae* (Crouan) Heydrich, 1897, p. 47; Rosenvinge, 1917, p. 265, text-figs. 186–190; Suneson, 1943, p. 43, text-figs. 24–26, pl. 6, fig. 28 (habit photo), pl. 8, fig. 38; Taylor, 1937, p. 268; 1957, p. 251. *Lithophyllum pustulatum* (Lamour.) Foslie f. *corallinae* (Crouan) Foslie, 1905, pp. 118, 121, 127. *Lithophyllum pustulatum* f. *similis* Foslie, 1909, p. 47 (tetrasporic form). *Lithophyllum* (*Dermatolithon*) *macrocarpum* (Rosanoff) Foslie f. *corallinae* (Crouan) Foslie, 1909, p. 47 (bisporic form).

Japanese name. Himegoromo (Tokida and Masaki)

Habitat and distribution, in literature. Epiphytic on *Corallina officinalis*, *Furcellaria fastigiata*, and *Phyllophora membranifolia*. Sweden; Denmark; Germany; Atlantic coasts of Europe and Nroth America; Mediterranean Sea; Adriatic Sea.

Specimens collected. Epiphytic on *Corallina pilulifera*. Nanaehama, Hakodate, 13 March 1959, T. Masaki; Tachimachi-misaki, Hakodate, 20 June 1959, T. Masaki; Oshoro, 20 July 1959, J. Tokida and T. Masaki.

Thallus in the form of reddish violet crusts, epiphytic on *Corallina pilulifera*, surrounding the host partly or entirely, or peltate with free margins and up to 2–5 mm diam., mostly polystromatic consisting of (2–)5–25 cell-layers, 170–700μ thick in the inner thicker portion, monostromatic marginal portion narrow; hypothallium consisting of oblique cells which are sometimes elongated, 12–80(–90)μ, mostly over 30μ long, tapering towards the base; perithallium consisting of several layers of various length, 17–50μ long, 5–12μ diam., transverse pits present but transverse cell-fusion lacking; cells of epithallium more or less triangular, 3–7μ high, 5–9μ diam.; sporangial conceptacles immersed, sometimes slightly convex, up to 190–250μ diam., sporangia tetrasporic, 75–115μ long. 25–60μ diam., central part of conceptacle floor occupied by a columella which is lightly stained with anilin blue, orifice provided with poorly developed papillae; procarpic conceptacles nearly flat or slightly elevated on thallus surface, 50–85μ high, up to 110μ diam.; cystocarpic conceptacles slightly convex, 105–155μ high and 165–210μ diam., orifice provided with more or less well developed papillae; spermatangial conceptacles 55–85μ high, 95–140μ diam., sometimes coexisting with female conceptacles in one and the same crust, slightly or not elevated on thallus surface, immersed not so deeply, orifice short, sometimes extended into a spout; conceptacles in older crusts frequently overgrown, spermatia narrowly cylindrical, 8μ long and 2μ diam., never produced at the end of long stalks.

This species has been known to be rather common in Europe and the North Atlantic coasts, but its occurrence in Japan is newly reproted. The specimens examined agree in general characters quite well with the descriptions of the species given by the authors cited above, except in dimensions; they are of somewhat thicker crusts consisting of slightly fewer cell-layers. The sporangial conceptacles are always tetrasporic. Bisporic sporangia are not found in the Japanese specimens, although Rosenvinge (1917), Suneson (1943) and Taylor (1937,

1957) described only bisporic sporangial conceptacles in this species. However, the plant from the Mediterranean has been known to produce tetrasporic and that from the Adriatic to produce both bisporic and tetrasporic sporangia (cf. Suneson, 1943, p. 47). In a recent treatise on the bispores in the Corallinaceae, Suneson (1950) reports that this species from the west coast of Sweden is found to have both tetraspores and binucleate, and even uninucleate, bispores in the material collected in early May while the material collected in summer produces only uninucleate bispores. The dimensions of the sporangia in the Japanese specimens are somewhat greater than those given by previous authors. Spermatangial conceptacles were described by Suneson (1943, p. 45) as very small; he gives a figure of a conceptacle resting on only six vertical cell rows (fig. 25A). The male conceptacles illustrated by Rosenvinge (1917, fig. 189 A & B) rest on five and eight cell rows respectively. On the other hand, the male conceptacles in the present specimens are somewhat larger as illustrated in two figures, one of which shows a conceptacle resting on eleven cell rows (cf. Masaki and Tokida, 1960, pl. 5, fig. 4) and the other a conceptacle on seventeen cell rows (cf. 1. c., pl. 4, fig. 6). Stalks have been observed by Rosenvinge (1917, fig. 159 A & C, fig. 189 A & B) in spermatangial conceptacles of *Fosliella lejolisii* and the present species but neither Suneson (1943) nor I have seen them. According to Suneson's interpretation given under *Fosliella lejolisii* (1937, p. 12), the stalks are nothing but stretched out spermatangium mother-cells which have become stalk-like after having repeatedly cut off spermatangia as the thalli mature.

3. **Dermatolithon dispar** (Foslie) Foslie

Foslie, 1909, p. 58; De Toni, 1924, p. 667; Mason, 1953, p. 343; Dawson, 1955, p. 276; 1960, p. 34, pl. 23, fig. 1, pl. 25, figs. 4–5; Scagel, 1957, p. 152; Dawson, Neushul & Wildman, 1960, p. 56, pl. 21, fig. 1; Masaki & Tokida, 1960a, p. 37, pl. 1, fig. 1, pl. 2, figs. 1–3, pls. 3–4; Hollenberg & Abbott, 1966, p. 61.

Syn. *Lithophyllum tumidulum* Foslie f. *dispar* Foslie,1907b, p. 29; Nichols, 1909, p. 357, pl. 10, fig. 6, pl. 11, figs. 11, 13, 14. *Lithophyllum* (*Dermatolithon*) *dispar* Foslie, 1909, p. 50. *Lithophyllum dispar* (Foslie) Foslie, 1929, p. 33, pl. 72, fig. 14. *Fosliella dispar* (Foslie) G.M. Smith., 1944, p. 225, pl. 50, fig. 6; Doty, 1947, p. 170.

Japanese name. Norimaki-modoki (Tokida and Masaki)

Habitat and distribution, in literature. Epiphytic on *Gelidium arborescens*, *G. nudifrons* (?)[1], *Bossiella* sp., *Corallina* sp., *Prionitis lyallii*, *Ahnfeltia gigartinoides*, *A. plicata*, *Gymnogongrus linearis*, and *Gigartina volans*. Pacific coast of North America, from Northern Washington to California.

Specimens collected. Nanaehama, near Hakodate City, on *Grateloupia filicina*

1) Cf. Dawson, et al., 1960, pl. 21, fig. 1

and *Rhodoglossum pulchrum*, June and Oct. 1959; T. Masaki on *Laurencia okamurai*, Muroto-misaki, Kochi Pref., 11 June 1964, T. Masaki.

Thallus epiphytic on various red algae, firmly adherent to and partly encircling the host, at first orbicular, later becoming confluent with each other and irregular in shape, reddish purple in color, ca. 1 cm in maximum diameter, up to 200–500μ thick, surface smooth, polystromatic but marginal portion here and there narrowly monostromatic, cells of marginal portion arranged radially in surface view, 42–84μ long by 11μ diam.; hypothallium consisting of cells obliquely elongated, 15–84μ long by 8–11μ diam., sometimes showing abrupt change in length of cells; perithallium polystromatic, consisting of 7–9 layers of cells in the neighborhood of conceptacles, cells 13–70μ long by 7–11μ diam.; cells of epithallium triangular in the marginal portion of thallus but rectangular in the inner, 3–5μ high, 5–10μ diam.; secondary pits present but coalescence of cells absent; sporangial conceptacles immersed, sometimes slightly convex, 210–273μ diam., (110–)126–170(–184)μ high, sporangia tetrasporic, 64–112μ long, 25–63μ diam., central part of conceptacle floor slightly upheaved and surmounted by a number of elongated cells which connect the floor and the gelatinous plug that closes the conceptacle pore; procarpic conceptacles immersed, up to ca. 105 μ diam. by 63μ high, cystocarpic conceptacles sometimes slightly convex, 210–252μ diam., 126–168μ high, orifice provided with well developed papillae; spermatangial conceptacles immersed deeply or immediately below the thallus surface, sometimes slightly convex, 85–115μ diam., 46–84(–105)μ high, orifice sometimes provided with a spout, spermatangia 5–7μ long by 2μ diam., not at the end of stalks.

The sporangial and male specimens examined agree well in general with the descriptions of the present species given by the authors cited above, except for somewhat smaller sporangial conceptacles and sporangia and somewhat taller spermatangial conceptacles. Female plants of this species have been previously unknown, and are described here for the first time. Above description is based on the material from Nanaehama.

4. **Dermatolithon tumidulum** (Foslie) Foslie

Foslie, 1909, p. 58; Segawa, 1956, p. 71, pl. 40, fig. 315 (habit photo); Tokida & Masaki, 1959, p. 83, pls. 1–4. Arasaki, 1964, p. 81, fig. 273 (habit photo).

Syn. *Lithophyllum tumidulum* Foslie, 1901b, p 5; 1929, p. 38, pl. 72, fig. 13 (habit photo); Yendo, 1902, p. 188; *in* Okamura, 1916, p. 129; *in* Okamura, 1936, p. 512. *Lithophyllum* (*Dermatolithon*) *tumidulum* Foslie, 1909, p. 50.

Japanese name. Norimaki (Yendo)

Habitat and distribution, in literature. Epiphytic on *Gelidium*, *Ahnfeltia paradoxa*, and other algae. Pacific coast of middle Honshû, Japan.

Specimens collected. On *Gelidium amansii*: Shirikishinai, near Hakodate

City, 15 Sept. 1956, J. Tokida and T. Masaki; 1 Oct. 1958, M. Imashima. On *Laurencia glandulifera*: Tachimachi-misaki, Hakodate City, 3 May 1958, T. Masaki; Murotomisaki, Kochi Pref., 11 June 1964, T. Masaki. On *Rhodomela larix*: Zenikamezawa, Hakodate City, 20 June 1958, T. Masaki.

The following description is based on the specimens growing on *Gelidium* and *Laurencia*.

Thallus epiphytic on various red algae, firmly adherent to host, encircling the host partly or completely, 0.2–2.0 cm in maximum diam., surface smooth but having ridges here and there, dark purple red in color, adjacent thalli sometimes overgrowing one another, monostromatic at margins when young, polystromatic throughout when matured, up to 200–800μ thick and composed of 10–30 layers of cells at the portion bearing conceptacles; hypothallium monostromatic, cells obliquely elongated and sometimes bow-shaped, arranged like palisade-cells, 12–30μ long, (5–)7–12μ diam., showing no marked difference in length in one and the same individual; perithallium polystromatic, cells 15–40(–54)μ long, (5–)7–12μ diam., the uppermost pigmented cells 15–30μ long, 7–12μ diam.; cells of epithallium cut off by an oblique wall from hypothallium cells at the marginal portion of a young thallus and toward the periphery of thallus, triangular in section, later flattened periclinally, each cell covering an underlying perithallium cell; secondary pits present among vertical cell rows, but coalescence of cells absent; sporangial conceptacles immersed, but fully matured ones sometimes slightly convex, (164–)190–250(–295)μ diam., 100–150(–170)μ high, sporangia tetrasporic, 45–85μ long, 15–50μ diam.,[1] central part of conceptacle floor slightly upheaved and crowned with a number of hair cells surrounded by mucilagenous substance which stains deeply with anilin blue; sexual plant monoecious; procarpic conceptacles usually immersed immediately below the thallus surface, opening by a pore, but in the specimens growng on *Laurencia* the conceptacles sometimes embedded deeply in the tissue without openings, nearly flat on thallus surface, mature conceptacles just before fertilization 105–125μ diam., to ca. 63μ high, procarps on the central part of conceptacle floor are fully developed while those in the periphery are generally undeveloped; cystocarpic conceptacles 150–260μ diam., 105–130μ high, nearly flat on surface, ostiole provided with papillae[2], carpospores arising from periphery of floor; antheridial conceptacles slightly convex, 85–105(–147)μ diam., 42–63μ high, immersed immediately below the thallus surface, opening by a narrow pore and in some cases provided with a spout, but in the specimens growing on *Gelidium* the conceptacles sometimes embedded deeply in the tissue without openings, spermatangia small, numerous, narrowly cylindrical in shape, ca 7μ long, ca 2μ diam., while attached to their mother cells, but ellipsoidal to globular when

1) Foslie (1909, p. 50) gave 50–60μ long, 20–30μ diam. for the dimensions of tetrasporangia in his description.

2) Cf. Rosenvinge, 1917, p. 251, fig. 171, A, C.

detached and set free in the conceptacle cavity, never produced at the end of long stalks contrary to the description of *Lithophyllum corallinae* (Crouan) Heydrich given by Rosenvinge (1917, p. 267, fig. 189).

Tetrasporangial conceptacles have been described by Foslie (1901, 1909) and Yendo (*in* Okamura, 1916, 1936), but cystocarpic and spermatangial ones have not been reported by anyone and are described above for the first time and could trace the development of the sexual reproductive orangs. The results obtained coincide fairly well with those reported in other species of *Dermatolithon* by Nichols (1909), Rosenvinge (1917) and Suneson (1943).

Lithoporella Foslie

Foslie, 1909, p. 58; Svedelius, 1911, *in* Engler and Prantl, 1911, p. 270; Kylin, 1956, p. 212.

Mastophora (Decaisne) Harvey subgenus *Lithoporella* Foslie, 1904a, p. 73.

Lithoporella melobesioides Foslie

Pl. XXXVIII; Pl. LXXIX, Figs. 2–4

Foslie, 1909, p. 59; De Toni, 1924, p. 694.

Syn. *Mastophora melobesioides* Foslie, 1903, p. 2; 1904a, p. 73, figs. 30–32; 1929, p. 48, pl. 73, figs. 1–4; De Toni, 1905, p. 1777. *Mastophora* (*Lithoporella*) *melobesioides* Foslie, 1909, p. 52.

Japanese name. Koshika-ishimo (n.n.)

Habitat and distribution, in literature. On calcareous algae, Bryozoa, coral and other hard objects. South-west Pacific Ocean; Indian Ocean; Red Sea.

Specimens collected. On rocks. Koshika, near Wagu Town, Mie Pref., 19 May 1965, T. Masaki.

Thallus in the form of crusts, attached loosely on rocks, growing superposed on one another, up to 1.5 mm thick, composed of one layer of cells, cells rectangular, with round corners, varying in size, 30–50(–75)μ long, (12–)15–25(–30)μ diam., cover cells triangular, 25–33μ diam., 8–13μ high, connecting cells often developed between cells of different crusts; cell-fusion occurring between neighboring cells; sporangial conceptacles hemispherical to conical, 850–1200μ outside diam., 400–500μ high, sporangia before division, 100–200μ long, 70–120μ diam.; sexual plants unknown.

This species was described by Foslie (1904) in the report of the Siboga Expedition. Up to date, only tetrasporangial conceptacles have been reported. Though I could observe immature sporangia only, the specimens examined agree quite well in general characters with the description given by Foslie.

IV. Discussion

The hair-bearing cells in the Melobesioideae were named heterocysts by Rosanoff (1866) and trichocytes or hair-cells by Rosenvinge (1917). They have been observed by previous researchers in the genera *Fosliella*, *Dermatolithon*, and *Phymatolithon*, and by the present author newly in several species of the genus *Lithophyllum*. According to Adey's observation (1964, figs. 51–54) and mine, the trichocytes of *Phymatolithon* and *Lithophyllum* are composed of two cells of which the basal is to be called the supporting cell and the upper the hair cell as its upper portion is elongated into a fine projection or a deciduous hair. The trichocytes in my material are stained so deeply with anilin blue and haematoxylin that one can easily distinguish them from other vegetative cells. The heterocysts of *Porolithon boergesenii* are newly observed to bear a hairy projection on the tip while they are in the initial stage of their development and situated near the thallus surface. The heterocysts of other species of *Porolithon* and in *Neogoniolithon*, though no hairy projection was observed on them, may be of the same character as those of *P. boergesenii*. The hairy projection in general must be deciduous and readily lost in a poorly preserved material as stated by Adey (1965a, p. 74). The hair-bearing cells or trichocytes in *Fosliella*, *Porolithon* and *Neogoniolithon* are larger than their neighboring vegetative cells and become heterocysts when buried in the tissue, while those in *Phymatolithon* and *Lithophyllum* do not differ from other cells in dimension and become indistinct when buried in the tissue. Accordingly, the trichocytes in the former genera are thought to be identical with the heterocysts as stated by Adey (1965a, p. 76) while the trichocytes in *Phymatolithon* and *Lithophyllum* should be distinguished from the heterocysts.

The genus *Fosliella* was estabished by Howe (1920) to be distinguished from *Heteroderma* by its possession of heterocysts. However, as stated by Kylin (1956, p. 203) and Mason (1953, p. 335), two of the three species placed by Howe in his *Fosliella* are lacking heterocyst. So Mason proposed to define the genus *Fosliella* as follows: "Although the name *Fosliella* is legitimate and correctly applied when it is restricted to those species with essentially monostromatic thalli containing heterocysts, it is incorrectly applied when it is extended to include species with monostromatic thalli lacking heterocysts, since this expanded circumscription includes the type of an earlier genus, *Heteroderma*. The presence or absence of heterocysts seems to be of fundamental phylogenetic significance, and therefore it seems best to recognize both *Fosliella* and *Heteroderma*". From the fact that Foslie (1909, p. 56) involved both trichocyte-bearing species and trichocyte-lacking ones in his genus *Heteroderma*, Kylin (l. c.) thought that *Melobesia* and *Heteroderma* were one and the same genus. According to Rosanoff (1866), Foslie (1905) and Dawson (1960), *Fosliella lejolisii* is destitute of the heterocyst. On the

contrary, Lemoine (1911), Rosenvinge (1917), Suneson (1937, 1943) and Taylor (1937) described this species to possess heterocysts. It could also confirm the presence of heterocyst in the specimens of the last mentioned species from Japan. Suneson (1943) stated in his description of the species that "the hyaline trichocytes occur rather frequently in some crusts, in other crusts they are rare or lacking". Thus, some authors placed the species in *Heteroderma*, some others in *Fosliella* or *Melobesia*, according to their respective conception of the species with regard to the presence or absence of heterocyst. Since the character whether the heterocyst is present or absent is of a great significance in the taxonomy of Melobesioideae, other species of *Fosliella* and *Heteroderma* await further studies with respect to this character. In a series of preliminary reports previously published I tentatively adopted *Melobesia* instead of *Fosliella* or *Heteroderma* as the generic name of the species concerned. However, for reasons which this problem is limited to only one species, *Fosliella lejolisii*, and I also agree with Mason's opinion mentioned above, I have followed the arrangement of Howe in this paper.

In the Melobesioideae, the lateral connection between the cells of adjacent cell-rows in the thallus tissues is accomplished either by cell-fusion or by secondary pit-connection. The cell-fusion has been known in the members of the Lithothamnieae-group and some of the Lithophylleae-group, such as *Fosliella*, *Heteroderma*, *Porolithon*, and *Neogoniolithon*, while the secondary pit-connection has been known in *Dermatolithon*, *Lithophyllum*, *Pseudolithophyllum*, and *Tenarea*. The secondary pit-connection was used by Rosenvinge (1917) as a basic character in distinguishing *Fosliella* and *Heteroderma* from *Lithophyllum*, and by Adey (1965) as a standard feature in the classification of the members of the Lithophylleae-group. However, Suneson (1943) reported that *Lithophyllum* (*Dermatolithon*) *littoralis* and *L.* (*D.*) *corallinae* were found to have, in addition to usual pit-connections, a few cell-fusions in the neighborhood of the ostiole of the conceptacle. As a result of my observations, the species belonging to *Lithophyllum* are divided into two groups with respect to the character in question, as follows: *L. amplexifrons*, *L. neoatalayense*, *L. okamurai* f. *japonicum*, and *L. tortuosum* belong to the group with pit-connections, while *L. absimile*, *L. caribaeum* f. *boreale*, *L. decipiens*, *L. samoense*, *L. shioense*, *L. yendoi* belong to the group with cell-fusions. The occurrence of cell-fusions in some species of *Lithophyllum* has been proved positively for the first time by the present study. The hair-cells are present in the species belonging to the group with cell-fusions, while they are lacking in the species belonging to the group with pit-connections.

When *Lithophyllum* is thus proved to contain a group of species possessing cell-fusions, there arises a question about the distinction between that group of *Lithophyllum* and thin-crusted *Heteroderma-Fosliella* group.

V. Summary

1. This paper deals with the morphological and systematical studies on the Melobesioideae of Japan which I have carried out since 1958 on the basis of materials collected mainly by myself at various places in Hokkaido, Honshû, and Shikoku.

2. Descriptions and illustrations of thirty-seven species and seven forms belonging to eleven genera make the main part of this paper. Of these species and forms, fourteen species and four forms belonging to seven genera have already been known to occur in Japan, while the following eighteen species belonging to eight genera are reported to be new to Japan: *Polyporolithon reclinatum*, *Lithothamnium aculeiferum*, *Lithoth. canariense*, *Lithoth. cystocarpideum* (prox.), *Lithoth. intermedium*, *Lithoth. lenormandii*, *Lithoth. pacificum*, *Lithoth. sonderi*, *Fosliella paschalis*, *Lithophyllum absimile*, *Lithoph. amplexifrons*, *Lithoph. decipiens*, *Lithoph. samoense*, *Porolithon boergesenii*, *Neogoniolithon accretum*, *Dermatolithon corallinae*, *D. dispar*, and *Lithoporella melobesioides*. The following seven species and three forms belonging to four genera are reported to be new to science: *Melobesia pacificum*, *Heteroderma sargassi* f. *parvula*, *Lithophyllum caribaeum* f. *boreale*, *Lithoph. neoatalayense*, *Lithoph. shioense* f. *tenue*, *Porolithon colliculosum*, and *P. orbiculatum*.

3. The species in which the tetrasporophyte was collected and described for the first time are *Lithophyllum absimile* and *Neogoniolithon misakiense*.

4. The species in which the male specimens were collected and described for the first time are as follows: *Polyporolithon reclinatum*, *Lithothamnium aculeiferum*, *Lithoth. cystocarpideum* (prox.), *Lithoth. pacificum*, *Clathromorphum compactum*, *Fosliella paschalis*, *Heteroderma sargassi* f. *sargassi*, *H. zostericola*, *Lithophyllum absimile*, *Lithoph. amplexifrons*, *Lithoph. okamurai* f. *japonicum*, *Lithoph. samoense*, *Lithoph. shioense* f. *shioense*, *Lithoph. tortuosum*, *Porolithon boergesenii*, *Neogoniolithon accretum*, *Dermatolithon canescens*, and *D. tumidulum*.

5. The female specimens were collected and described for the first time in the following twenty-two species and two forms, of which those marked with an asterisk are represented by both procarpic and cystocarpic individuals while the others by procarpic ones only: *Polyporolithon reclinatum*, *Lithothamnium cystocarpideum* (prox.), *Lithoth. intermedium*, *Lithoth. pacificum**, *Clathromorphum compactum**, *Fosliella paschalis**, *Heteroderma sargassi* f. *sargassi** *H. zostericola**, *Lithophyllum absimile**, *Lithoph. amplexifrons**, *Lithoph. decipiens*, *Lithoph. okamurai* f. *japonicum*, *Lithoph. samoense**, *Lithoph. shioense* f. *shioense**, *Lithoph. tortuosum*, *Lithoph. yendoi*, *Porolithon boergesenii**, *Neogoniolithon accretum*, *N. pacificum**, *Dermatolithon canescens**, *D. dispar**, and *D. tumidulum**.

6. Trichocytes or hair-bearing cells, heterocysts, cell fusion, and secondary pit-connection are discussed in relation to the classification of the Melobesioideae.

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Explanation of Plates

PLATE I

Melobesia pacifica Masaki

Figs. 1 & 2. Habit of plant growing on a leaf of *Phyllospadix iwatensis* Fig. 1, ×3.7; Fig. 2, ×5

Fig. 3. Part of surface view of tetrasporangial plant showing pores perforating roof of conceptacle ×22.5

Fig. 4. Part of surface view of cystocarpic plant showing pores perforating roof of conceptacle ×22.5

Fig. 5. Part of surface view of male plant showing pores perforating roof of conceptacle ×22.5

Fig. 6. Spermatangial and cystocarpic crusts growing on the upper and the under surface of the host plant respectively ×67

Fig. 7. Tetrasporangial crust ×67

PLATE II

Lithothamnium aculeiferum L. R. Mason

Figs. 1 & 2. Habit of plant Fig. 1, ×1.8; Fig. 2, ×1.2

Fig. 3. Surface detail of a sporangial plant ×18

Fig. 4. Enlargement of a part of the specimen shown in Fig. 3, showing pores perforating roof of conceptacles ×35

Fig. 5. Tetrasporangial specimen of the type preserved in the Herbarium of California University, U.S.A. ×1.5

Fig. 6. Surface detail of a part of the specimen shown in Fig. 5 ×2.0

PLATE III

Lithothamnium aculeiferum L. R. Mason

Photomicrographs of vertical sections of the plant from Shiso Island (Figs. 1–3) and of the type specimen (Figs. 4–6)

Fig. 1. Tetrasporangial conceptacle ×225

Fig. 2. Spermatangial conceptacle ×225

Fig. 3. Part of vegetative portion, showing hypothallium ×225

Fig. 4. Tetrasporangial conceptacles ×58.5

Figs. 5 & 6. Part of vegetative portion of crust, showing hypothallium ×234

PLATE IV

Lithothamnium canariense Foslie

Figs. 1 & 2. Habit of plant ×2.4

Fig. 3. Part of vegetative portion of a crust ×208

Figs. 4 & 5. Transverse section of branch through tetrasporangial conceptacles ×52

Fig. 6. Surface detail of a branch showing tetrasporangial conceptacles with minute pores perforating their roofs ×40

Fig. 7. Longitudinal section of a branch through tetrasporangial conceptacles ×32

PLATE V

Lithothamnium cystocarpideum Foslie (prox.)

Fig. 1. Habit of plant growing on *Gelidium japonicum* ×1.4

Fig. 2. Habit of tetrasporangial plant growing on *Gelidium japonicum* ×0.7

Fig. 3. Habit of cystocarpic plant growing on *Gelidium amansii* ×0.7

Fig. 4. Surface detail of plant shown in Fig. 2 ×3.2
Fig. 5. Surface detail of plant shown in Fig. 3 ×2.8
Fig. 6. Photomicrograph of vertical section through thallus base which encircles the host ×38.5
Fig. 7. Photomicrograph of surface view of tetrasporangial plant decalcified by Pérényi's solution ×63

PLATE VI

Lithothamnium cystocarpideum Foslie (prox.)

Photomicrographs of vertical sections of plants
Fig. 1. Tetrasporangial conceptacle provided with a flat roof ×38.5
Fig. 2. Ditto ×63
Fig. 3. Spermatangial conceptacle ×63
Figs. 4 & 5. Procarpic conceptacle in early developmental stage ×63
Fig. 6. Procarpic conceptacle ×63
Fig. 7. Cystocarpic conceptacle in early developmental stage ×63
Fig. 8. Cystocarpic conceptacle ×63
Fig. 9. Monoecious crust showing spermatangial and cystocarpic conceptacles ×63

PLATE VII

Lithothamnium erubescens Foslie
f. *madagascarensis* Foslie

Figs. 1–3. Habit of plant ×1.2

PLATE VIII

Lithothamnium erubescens Foslie
f. *madagascarensis* Foslie

Fig. 1. Surface detail of a branch of sporangial plant showing conceptacle and muciferous canals visible on conceptacle roof as minute black dots ×50
Fig. 2. Longitudinal section of a branch through tetrasporangial conceptacle ×30
Fig. 3. Part of vegetative portion of a crust ×260
Fig. 4. Transverse section of a branch through tetrasporangial conceptacles ×65

PLATE IX

Lithothamnium pacificum (Foslie) Foslie

Figs. 1 & 2. Habit of plant ×1

Lithothamnium sonderi Hauck

Fig. 3. Habit of plant from Koshika, near Wagu Town, Mie Pref. ×2

PLATE X

Lithothamnium pacificum (Foslie) Foslie

Photomicrographs of transverse sections of branches (Figs. 1–5)
Figs. 1 & 2. Sporangial conceptacle with bispores Fig. 1, ×61.6; Fig. 2 ×240
Fig. 3. Procarpic conceptacle ×61.6
Fig. 4. Cystocarpic conceptacle ×61.6
Fig. 5. Spermatangial conceptacle ×240
Fig. 6. Surface detail of a branch showing sporangial conceptacles perforated with minute muciferous canals ×40

PLATE XI

Lithothamnium sonderi Hauck

Photomicrographs of vertical sections of plants

Figs. 1–3. Part of vegetative portion of a crust, showing hypothallium and perithallium. Figs. 1 & 2, ×208; Fig. 3, ×480

Fig. 4. Marginal portion of crust ×240

Fig. 5. Tetrasporangial conceptacle ×64

Fig. 6. Procarpic conceptacle in early developmental stage ×208

Figs. 7 & 8. Procarpic conceptacle. Fig. 7, ×64; Fig. 8, ×208

Figs. 9 & 10. Spermatangial conceptacle ×208

PLATE XII

Fosliella lejolisii (Rosanoff) Howe

Figs. 1 & 2. Habit of plant growing on a leaf of *Zostera nana* Fig. 1, ×2.8; Fig. 2, ×17.5

Figs. 3 & 4. Surface view of crust ×420

Figs. 5–8. Photomicrographs of vertical sections of crust

Fig. 5. Tetrasporangial conceptacle ×210

Fig. 6. Procarpic conceptacle ×420

Fig. 7. Cystocarpic conceptacle ×420

Fig. 8. Monoecious crust with spermatangial and cystocarpic conceptacles ×420

PLATE XIII

Fosliella pascharis (Lemoine) Setchell & Gardner

Fig. 1. Habit of plant growing on a leaf of *Sargassum* sp. ×1.6

Fig. 3. Surface view of marginal portion of crust ×520

Figs. 4–8. Photomicrographs of vertical sections of plants

Fig. 4. Tetrasporangial conceptacle ×200

Figs. 5 & 6. Spermatangial conceptacle provided with a spout Fig. 5, ×200; Fig. 6, ×520

Fig. 7. Procarpic conceptacle ×200

Fig. 8. Cystocarpic conceptacle ×200

Heteroderma sargassi Foslie f. *parvula* Masaki

Fig. 2. Habit of plant growing on *Laurencia intermedium* from Ikenoura, near Usa, Kochi Pref. ×1.2

PLATE XIV

Lithophyllum absimile Foslie

Fig. 1. Habit of plant ×1.8

Fig. 2. Enlargement of a part of the specimen shown in Fig. 1 ×3.2

Fig. 3. Surface detail of the specimen shown in Figs. 1 and 2 ×20

Lithophyllum amplexifrons (Harvey) Heydrich

Habit of plant growing on a stem of *Gelidium subcostatum*

Fig. 4. Viewed from upper surface of thallus ×4.8

Fig. 5. Viewed from under surface of the same thallus as shown in Fig. 1 ×4.8

Fig. 6. Viewed from upper surface of thalli overlapping one another ×6.4

PLATE XV

Lithophyllum absimile Foslie

Photomicrographs of vertical sections of plants

Figs. 1 & 2. Tetrasporangial crust ×62.3

Fig. 3. Cystocarpic crust ×62.3

Fig. 4. Spermatangial crust ×54

Fig. 5. Perithallium, showing a group of large cells ×210

Fig. 6. Procarpic conceptacle ×227.5

Fig. 7. Cystocarpic conceptacle ×210

Fig. 8. Spermatangial conceptacle ×210

PLATE XVI

Lithophyllum amplexifrons (Harvey) Heydrich

Photomicrographs of vertical sections of plants

Fig. 1. Vegetative portion encircling the stem of *Gelidium subcostatum*, showing tetrasporangial conceptacle ×48

Fig. 2. Marginal portion of a crust ×64

Fig. 3. Tetrasporangial crust showing nearly flat roof of conceptacle ×64

Fig. 4. Tetrasporangial crust, showing slightly concave roof of conceptacle ×64

Figs. 5 & 6. Spermatangial crust Fig. 5, ×64; Fig. 6, ×80

Fig. 7. Spermatangial conceptacle ×240

Fig. 8. Procarpic crust ×64

Fig. 9. Procarpic conceptacle in Fig. 8, enlarged ×240

Fig. 10. Cystocarpic conceptacle ×64

PLATE XVII

Lithophyllum neoatalayense Masaki

Fig. 1. Habit of plant ×0.8

Fig. 4. Surface detail of the specimen shown in Fig. 1 ×17.5

Lithophyllum atalayense Lemoine

Fig. 2. Surface detail of the type specimen from Atalaya Island ×7

Fig. 3. Same as above, enlarged ×21

PLATE XVIII

Lithophyllum neoatalayense Masaki

Photomicrographs of vertical sections of plants

Fig. 1. Tetrasporangial crust, showing nearly flat roof of conceptacle ×72

Fig. 2. Tetrasporangial crust, showing slightly concave and convex roof of conceptacle ×72

Fig. 4. Spermatangial crust ×72

Fig. 5. Spermatangial conceptacle ×270

Fig. 6. Cystocarpic conceptacles with concave roof ×72

Fig. 7. Part of vegetative portion, showing epithallium and perithallium ×585

Lithophyllum atalayense Lemoine

Fig. 3. Tetrasporangial crust of the type specimen ×72

Fig. 8. Part of vegetative portion of the type specimen, showing hypothallium and perithallium ×585

PLATE XIX

Lithophyllum decipiens (Foslie) Foslie

Fig. 1. Habit of plant from Suzaki, Kochi Pref. ×1.6
Fig. 2. Habit of plant from Rinkai, Shirahama, Wakayama Pref. ×1.2

PLATE XX

Lithophyllum caribaeum (Foslie) Foslie f. *boreale* Masaki

Fig. 1. Habit of plant ×1.6
Fig. 2. Same as above, enlarged ×2.3

Lithophyllum samoense Foslie

Fig. 3. Habit of plant ×1.8
Fig. 4. Enlargement of the same specimen as above ×4.5

PLATE XXI

Lithophyllum decipiens (Foslie) Foslie

Photomicrographs of vertical sections of plants (Figs. 1–4, 6–9)
Fig. 1. Tetrasporangial crust ×210
Fig. 2. Spermatangial crust ×210
Fig. 3. Procarpic crust ×210
Fig. 4. Cystocarpic crust ×210
Fig. 5. Surface detail of a crust, showing conceptacles ×17.5

Lithophyllum caribaeum (Foslie) Foslie f. *boreale* Masaki

Fig. 6. Tetrasporangial crust ×59.5
Figs. 7 & 8. Spermatangial crust Fig. 7, ×59.5; Fig. 8, ×252
Fig. 9. Cystocarpic crust ×59.5

PLATE XXII

Lithophyllum shioense Foslie f. *shioense*

Fig. 1. Habit of plant from Usa, Kochi Pref. ×1.4
Fig. 2. Surface detail of the same specimen as above ×5.6
Fig. 3. Photomicrograph of sectional view of perithallium, showing long cells ×420

Lithophyllum shioense Foslie f. *tenue* Masaki

Figs. 4 & 5. Habit of plant from Yamasedomari, Hakodate City ×0.7

PLATE XXIII

Lithophyllum samoense Foslie

Photomicrographs of vertical sections of plants
Fig. 1. Tetrasporangial crust ×63
Fig. 2. Procarpic conceptacle ×227.5
Fig. 3. Cystocarpic conceptacles ×63
Fig. 4. Spermatangial conceptacle ×700

Lithophyllum shioense Foslie f. *shioense*

Photomicrographs of vertical sections of plants
Fig. 5. Tetrasporangial crust ×54

Fig. 6. Spermatangial conceptacles ×210
Fig. 7. Procarpic conceptacles ×210
Fig. 8. Cystocarpic conceptacles ×210

PLATE XXIV

Lithophyllum yendoi Foslie

Fig. 1. Habit of plant ×0.8
Fig. 6. Surface detail of crust, showing sporangial conceptacles ×17.5

Lithophyllum tortuosum (Esper) Foslie

Fig. 2. Habit of plant viewed from above ×0.7
Fig. 3. Enlargement of a portion of the same specimen as above ×0.9
Fig. 4. Habit of plant viewed from side; the specimen is the same as above ×0.9
Fig. 5. Surface detail of a lamella, showing conceptacles ×2.5

PLATE XXV

Lithophyllum yendoi Foslie

Photomicrographs of vertical sections of plants
Figs. 1 & 2. Tetrasporangial conceptacle ×225
Fig. 3. Spermatangial conceptacle ×225
Figs. 4 & 5. Procarpic conceptacle ×297
Fig. 6. Cystocarpic conceptacle ×225
Figs. 7 & 8. Part of epithallium and perithallium, showing trichocytes and cell-fusions ×900

PLATE XXVI

Lithophyllum tortuosum (Esper) Foslie

Photomicrographs of sections of plants
Fig. 1. Longitudinal section through the apical portion of a lamella ×225
Figs. 2 & 3. Part of vertical section of a crust, showing hypothallium ×225
Fig. 4. Part of vertical section of a crust, showing rhizoid-like projections ×58.5
Fig. 5. Sporangial conceptacle in longitudinal section of lamella ×225
Figs. 6 & 7. Spermatangial conceptacle in longitudinal section of lamella Fig. 6, ×72; Fig. 7, ×225
Fig. 8. Procarpic conceptacle in longitudinal section of lamella ×225

PLATE XXVII

Porolithon boergesenii (Foslie) Lemoine

Fig. 1. Habit of plant from Seto, Shirahama, Wakayama Pref. ×2.3
Figs. 2 & 3. Surface detail of the same specimen as above Fig. 2, ×7.2; Fig. 3, ×27

PLATE XXVIII

Porolithon boergesenii (Foslie) Lemoine

Photomicrographs of vertical sections of plants
Fig. 1. Tetrasporangial conceptacle ×225
Fig. 2. Spermatangial conceptacle provided with a spout ×225
Fig. 3. Procarpic conceptacle ×225

Fig. 4. Cystocarpic conceptacle ×108
Fig. 5. Same as above, enlarged ×225
Fig. 6. Part of vegetative portion, showing heterocyst initials ×135
Fig. 7. Same as above, enlarged ×765
Fig. 8. Part of vegetative portion of crust, showing perithallium and heterocysts ×495

PLATE XXIX

Porolithon orbicularis Masaki

Fig. 1. Habit of plant from Muroto-misaki, Kochi Pref. ×1.4
Fig. 2. Surface detail of crust, showing conceptacles ×22.5
Figs. 3 & 4. Surface detail of decalcified crust, showing heterocyst initials Fig. 3, ×69.3; Fig. 4, ×270

PLATE XXX

Porolithon orbicularis Masaki

Photomicrographs of vertical sections of plants
Fig. 1. Tetrasporangial crust ×210
Fig. 2. Spermatangial conceptacle ×420
Fig. 3. Procarpic conceptacle ×420
Fig. 4. Monoecious crust with cystocarpic and spermatangial conceptacles ×210
Fig. 5. Spermatangial crust ×210
Fig. 6. Part of vegetative portion of crust, showing perithallium and heterocysts ×420
Fig. 7. Part of vegetative portion of crust, showing heterocyst initials ×210

PLATE XXXI

Porolithon colliculosum Masaki

Figs. 1, 2, 4. Habit of plant seen from above. Fig. 1, ×1.4; Fig. 2, 4, ×1.1;
Figs. 3. Habit of plant seen from side ×1.5 .

PLATE XXXII

Porolithon colliculosum Masaki

Photomicrographs of vertical sections of plants (Figs. 1–6)
Fig. 1. Tetrasporangial crust ×77
Fig. 2. Tetrasporangial conceptacle ×210
Fig. 3. Procarpic conceptacle ×371
Fig. 4. Spermatangial crust ×77
Fig. 5. Cystocarpic conceptacle ×371
Fig. 6. Part of vegetative portion of crust, showing perithallium and heterocysts ×210
Fig. 7. Surface detail of crust, showing conceptacles ×17.5

PLATE XXXIII

Neogoniolithon accretum (Foslie et Howe) Setchell et Mason

Figs. 1 & 2. Habit of plant from Ezura, Shirahama, Wakayama Pref. Fig. 1, ×1.6; Fig. 2, ×2.4

PLATE XXXIV

Neogoniolithon accretum (Foslie et Howe) Setchell et Mason

Photomicrographs of vertical sections of plants

Fig. 1. Sporangial crust with bisporangia ×54

Fig. 2. Spermatangial conceptacle ×84

Fig. 3. Procarpic conceptacle ×70

Fig. 4. Detail of spermatangial conceptacle ×280

Fig. 5. Detail of procarpic conceptacle ×280

Figs. 6 & 7. Cystocarpic conceptacle ×70

Fig. 8. Part of vegetative portion, showing epithallium, perithallium and heterocyst initial ×840

Fig. 9. Part of vegetative portion, showing hypothallium and perithallium ×280

PLATE XXXV

Neogoniolithon misakiense (Foslie) Setchell et Mason

Fig. 1. Habit of plant from Usa, Kochi Pref. ×1.4

Fig. 2. Enlargement of the same specimen as above ×3.2

Fig. 3. Part of vertical section of crust, showing epithallium, perithallium and a heterocyst ×420

Fig. 4. Vertical section of tetrasporangial crust ×54

Fig. 5. Detail of crust surface, showing hemispherical tetrasporangial conceptacles ×17.5

PLATE XXXVI

Neogoniolithon pacificum (Foslie) Setchell et Mason

Figs. 1 & 2. Habit of plant from Uranouchi Bay, Usa, Kochi Pref. Fig. 1, ×1.1; Fig. 2, ×1.4

Fig. 3. Enlargement of a part of crust ×1.8

Fig. 4. Surface detail of crust, showing conceptacle ×17.5

PLATE XXXVII

Neogoniolithon pacificum (Foslie) Setchell et Mason

Photomicrographs of vertical sections of plants

Fig. 1. Part of vegetative portion of crust, showing epithallium, perithallium and heterocyst initials ×210

Fig. 2. Sporangial crust with bisporangia ×54

Fig. 3. Procarpic crust ×54

Fig. 4. A part of vegetative portion of crust, showing perithallium and heterocysts ×210

Fig. 5. Procarpic conceptacle ×210

Fig. 6. Procarpic crust, after the formation of a fusion-cell ×54

Fig. 7. Cystocarpic crust ×54

PLATE XXXVIII

Lithoporella melobesioides Foslie

Fig. 1. Habit of plant from Koshika, near Wagu Town, Mie Pref. ×3

Fig. 2. Surface detail of crust ×5.4

Fig. 3. Surface view of sporangial conceptacles ×18

Figs. 4–6. Photomicrograph of vertical section of sporangial conceptacle in various developmental stages ×72

Fig. 7. Photomicrograph of vertical section of two superposed crusts connected with each other by a connecting cell ×180

PLATE XXXIX

Melobesia pacifica Masaki

Fig. 1. Vertical section through marginal portion of a crust

Figs. 2–4. Vertical section through a crust showing procarpic conceptacle in early developmental stage

Fig. 5. Procarpic conceptacle

Figs. 6 & 7. Young cystocarpic conceptacle

PLATE XL

Melobesia pacifica Masaki

Fig. 1. Cystocarpic conceptacle

Figs. 2 & 3. Tetrasporangial conceptacle

Fig. 4. Spermatangial conceptacle

PLATE XLI

Lithothamnium aculeiferum L. R. Mason

Fig. 1. Vertical section through marginal portion of a crust ×375

Fig. 2. Part of vertical section through hypothallium and perithallium ×600

Fig. 3. Part of vertical section through perithallium and epithallium ×600

Fig. 4. Tetrasporangial conceptacle ×375

Fig. 5. Spermatangial conceptacle ×400

PLATE XLII

Lithothamnium canariense Foslie

Fig. 1. Vertical section of a crust ×320

Fig. 2. Vertical section of marginal portion of a crust ×300

Fig. 3. Tetrasporangial conceptacles, one of which is immersed in the tissue ×200

Lithothamnium erubescens Foslie
f. *madagascarensis* Foslie

Fig. 4. Vertical section of marginal portion of a crust ×320

Fig. 5. Part of vertical section through epithallium and perithallium ×480

Fig. 6. Part of vertical section through hypothallium and perithallium ×320

Fig. 7. Sporangial conceptacle with uninucleate bispores ×200

PLATE XLIII

Lithothamnium cystocarpideum Foslie (prox.)

Fig. 1. Tetrasporangial conceptacle with convex roof

Fig. 2. Detail of the middle part of cystocarpic conceptacle floor

Fig. 3. Vertical section of marginal portion of a crust

Fig. 4. Procarpic conceptacle

PLATE XLIV

Lithothamnium cystocarpideum Foslie (prox.)

Fig. 1. Cystocarpic conceptacle

Fig. 2. Detail of the marginal portion of cystocarpic conceptacle floor
Fig. 3. Detail of spermatangial mother cells in dendroid system
Fig. 4. Spermatangial conceptacle

PLATE XLV

Lithothamnium pacificum (Foslie) Foslie

Fig. 1. Part of vertical section through epithallium and perithallium
Fig. 2. Part of vertical section through hypothallium and perithallium
Fig. 3. Spermatangial conceptacle, showing spermatangial mother-cells in well-developed dendroid clusters
Fig. 4. Part of a procarpic conceptacle

PLATE XLVI

Lithothamnium pacificum (Foslie) Foslie

Fig. 1. Part of a cystocarpic conceptacle which is not fully developed yet ×320
Fig. 2. Sporangial conceptacle with sporangia in the course of formation of uninucleate bispores ×300

PLATE XLVII

Lithothamnium sonderi Hauck

Fig. 1. Vertical section through marginal portion of a crust ×600
Fig. 3. Part of vertical section through epithallium and perithallium ×600
Figs. 2 & 4. Part of vertical section through hypothallium and perithallium ×600

PLATE XLVIII

Lithothamnium sonderi Hauck

Fig. 1. Tetrasporangial conceptacle ×250
Fig. 2. Procarpic conceptacle ×400
Fig. 3. Spermatangial conceptacle ×600

PLATE XLIX

Fosliella lejolisii (Rosanoff) Howe

Figs. 1–3. Vertical section through marginal portion of a crust, in Fig. 1 is shown a heterocyst ×900
Figs. 4 & 5. Surface view of marginal monostromatic portion of a crust ×900
Fig. 6. Tetrasporangial conceptacle ×600

PLATE L

Fosliella lejolisii (Rosanoff) Howe

Figs. 1 & 2. Procarpic conceptacle ×900
Fig. 3. Spermatangial conceptacle ×900
Fig. 4. Young cystocarpic conceptacle ×900
Fig. 5. Fully developed cystocarpic conceptacle ×900

PLATE LI

Fosliella paschalis (Lemoine) Setchell et Gardner

Fig. 1. Surface view of monostromatic marginal portion of a crust ×600

Fig. 2. Vertical section through marginal portion of a crust, showing heterocysts ×600
Fig. 3. Spermatangial conceptacle ×600
Fig. 4. Tetrasporangial conceptacle ×400
Fig. 5. Procarpic conceptacle ×400
Fig. 6. Cystocarpic conceptacle ×600

PLATE LII

Lithophyllum absimile Foslie et Howe

Fig. 1. Vertical section through vegetative part of a crust, showing trichocyte initials
Fig. 2. Vertical section through the marginal portion of a crust
Figs. 3–4. Perithallium, showing groups of longer cells
Fig. 5. Part of perithallium, showing cell-fusion

PLATE LIII

Lithophyllum absimile Foslie et Howe

Fig. 1. Part of vertical section of a crust, showing epithallium, perithallium and a trichocyte
Fig. 2. Tetrasporangial conceptacle
Fig. 3. Spermatangial conceptacle

PLATE LIV

Lithophyllum absimile Foslie et Howe

Fig. 1. Young procarpic conceptacle
Fig. 2. Procarpic conceptacle
Fig. 3. Cystocarpic conceptacle

PLATE LV

Lithophyllum amplexifrons (Harvey) Heydrich

Fig. 1. Schmatic sketch of vertical section of thallus, the stippled part is cross section of the host ×12.8
Fig. 2. Part of vertical section through epithallium and perithallium ×320
Fig. 3. Part of vertical section through hypothallium and perithallium ×320
Fig. 4. Vertical section through marginal portion of thallus, showing conceptacle initials ×320
Fig. 5. Vertical section of thallus, the portion on the left side of the bold line is cross section of the host ×200
Fig. 6. Tetrasporangial conceptacle ×200

PLATE LVI

Lithophyllum amplexifrons (Harvey) Heydrich

Fig. 1. Spermatangial conceptacle ×320
Fig. 2. Procarpic conceptacle ×480
Fig. 3. Cystocarpic conceptacle ×300

PLATE LVII

Lithophyllum neoatalayense Masaki

Fig. 1. Part of vertical section through epithallium and perithallium ×320
Figs. 2 & 3. Part of vertical section through hypothallium and perithallium ×480

Lithophyllum atalayense Lemoine

Fig. 4. Part of vertical section through epithallium and perithallium ×480
Fig. 5. Part of vertical section through hypothallium and perithallium ×480

Lithophyllum decipiens (Foslie) Foslie

Fig. 6. Vertical section of a crust, showing trichocyte initial ×480
Fig. 7. Part of vertical section through epithallium and perithallium, showing trichocyte ×480
Fig. 8. Vertical section through the marginal portion of a crust ×480

PLATE LVIII

Lithophyllum decipiens (Foslie) Foslie

Fig. 1. Tetrasporangial conceptacle
Fig. 2. Spermatangial conceptacle
Fig. 3. Procarpic conceptacle
Fig. 4. Cystocarpic conceptacle

PLATE LIX

Lithophyllum neoatalayense Masaki

Fig. 1. Tetrasporangial conceptacle ×200
Fig. 2. Spermatangial conceptacle ×480
Fig. 3. Cystocarpic conceptacle ×300

PLATE LX

Lithophyllum caribaeum (Foslie) Foslie f. *boreale* Masaki

Fig. 1. Vertical section of a crust ×520
Fig. 2. Part of vertical section through hypothallium and perithallium ×480
Fig. 3. Perithallium cell-rows, showing cell-fusion ×800
Figs. 4 & 5. Tetrasporangial conceptacle Fig. 4, ×220; Fig. 5, ×320
Fig. 6. Procarpic conceptacle ×520

PABLE LXI

Lithophyllum caribaeum (Foslie) Foslie f. *boreale* Masaki

Fig. 1. Cystocarpic conceptacle ×320
Fig. 2. Spermatangial conceptacle ×520

Lithophyllum samoense Foslie

Figs. 3 & 4. Perithallium, showing cell-fusions Fig. 3, ×800; Fig. 4, ×520
Fig. 5. Part of vertical section through hypothallium and perithallium ×320
Fig. 6. Vertical section through the marginal portion of a crust ×320

PLATE LXII

Lithophyllum samoense Foslie

Figs. 1 & 2. Tetrasporangial conceptacle ×400
Fig. 3. Procarpic conceptacle ×520

Fig. 4. Cystocarpic conceptacle ×400
Fig. 5. Spermatangial conceptacle ×480

Lithophyllum okamurai Foslie f. *japonicum* Foslie

Fig. 6. Part of vertical section through perithallium and hypothallium ×400

PLATE LXIII

Lithophyllum shioense Foslie f. *shioense*

Fig. 1. Tetrasporangial conceptacle ×320
Fig. 2. Procarpic conceptacle ×480
Fig. 3. Cystocarpic conceptacle ×320
Fig. 4. Spermatangial conceptacle ×720
Fig. 5. Perithallium, showing cell-fusion and elongated cells ×480
Figs. 6 & 9. Part of vertical section through hypothallium and perithallium ×480
Figs. 7 & 8. Part of vertical section through epithallium and perithallium ×480

PLATE LXIV

Lithophyllum tortuosum (Esper) Foslie

Fig. 1. Part of vertical section of a crust through hypothallium and perithallium ×480
Fig. 2. Vertical section through vegetative part of an erect lamella ×480
Fig. 3. Tetrasporangial conceptacle ×300

PLATE LXV

Lithophyllum tortuosum (Esper) Foslie

Fig. 1. Procarpic conceptacle ×480
Fig. 2. Spermatangial conceptacle ×320

Lithophyllum yendoi Foslie

Fig. 3. Part of vertical section through epithallium and perithallium, showing trichocyte ×480
Fig. 4. Part of vertical section through hypothallium and perithallium ×480
Fig. 5. Vertical section through the marginal portion of a crust ×480
Fig. 6. Spermatangial conceptacle ×320

PLATE LXVI

Lithophyllum yendoi Foslie

Fig. 1. Tetrasporangial conceptacle ×300
Fig. 2. Procarpic conceptacle ×480
Fig. 3. Cystocarpic conceptacle ×300

PLATE LXVII

Porolithon boergesenii (Foslie) Lemoine

Figs. 1 & 2. Part of vertical section through epithallium and perithallium, showing immersed heterocysts (Fig. 1) and heterocyst initials (Fig. 2) ×320
Fig. 3. Vertical section through the marginal portion of a crust ×320
Figs. 4–6. Part of vertical section through hypothallium and perithallium Fig. 4, ×320; Figs. 5 & 6, ×480
Fig. 7. Tetrasporic conceptacle ×200

PLATE LXVIII

Porolithon boergesenii (Foslie) Lemoine

Figs. 1 & 2. Procarpic conceptacle ×320
Fig. 3. Cystocarpic crust, showing heterocysts ×200
Fig. 4. Spermatangial conceptacle ×480

PLATE LXIX

Porolithon orbicularis Masaki

Figs. 1 & 2. Vertical section through vegetative part of a crust, showing four heterocysts in Fig. 1 Fig. 1, ×320; Fig. 2, ×480
Fig. 3. Vertical section through the marginal section of a crust ×480
Fig. 4. Tetrasporangial conceptacle ×480

PLATE LXX

Porolithon orbicularis Masaki

Fig. 1. Procarpic conceptacle ×720
Fig. 2. Cystocarpic conceptacle ×320
Fig. 3. Spermatangial conceptacle ×480

Porolithon colliculosum Masaki

Fig. 4. Part of vertical section through hypothallium and perithallium ×320
Fig. 5. Perithallium, showing heterocysts ×480

PLATE LXXI

Porolithon colliculosum Masaki

Fig. 1. Perithallium, showing heterocysts ×480
Fig. 2. Part of vertical section through epithallium and perithallium ×480
Fig. 3. Tetrasporangial conceptacle in more advanced stage than that in Fig. 5 ×320
Fig. 4. Tetrasporangial conceptacle in early developmental stage ×320
Fig. 5. Tetrasporangial conceptacle in more advanced stage ×480

PLATE LXXII

Porolithon colliculosum Masaki

Fig. 1. Tetrasporangial conceptacle ×300
Fig. 2. Procarpic conceptacle ×480
Fig. 3. Spermatangial conceptacle ×480
Fig. 4. Cystocarpic conceptacle ×320

PLATE LXXIII

Neogoniolithon accretum (Foslie et Howe) Setchell et Mason

Figs. 1 & 2. Part of vertical section through epithallium and perithallium, showing heterocyst ×600
Fig. 3. Part of vertical section through hypothallium and perithallium ×400
Fig. 4. Vertical section through the marginal portion of a crust ×400
Fig. 5. Spermatangial conceptacle ×165

PLATE LXXIV

Neogoniolithon accretum (Foslie et Howe) Setchell et Mason

Fig. 1. Sporangial conceptacle with bisporangia ×132
Fig. 2. Cystocarpic conceptacle in early developmental stage ×200

PLATE LXXV

Neogoniolithon accretum (Foslie et Howe) Setchell et Mason

Fig. 1. Procarpic conceptacle ×132
Fig. 2. Cystocarpic conceptacle ×200
Fig. 3. Sporangial conceptacle in early developmental stage ×200

PLATE LXXVI

Neogoniolithon pacificum (Foslie) Setchell et Mason

Fig. 1. Vertical section through the marginal portion of a crust ×400
Figs. 2 & 3. Part of vertical section through epithallium and perithallium, showing heterocyst in Fig. 2 ×400
Fig. 4. Vertical section through vegetative part of a crust ×400
Fig. 5. Part of vertical section through hypothallium and perithallium ×400
Fig. 6. Procarpic conceptacle ×250

PLATE LXXVII

Neogoniolithon pacificum (Foslie) Setchell et Mason

Fig. 1. Sporangial conceptacle with binucleate bispores
Fig. 2. Young cystocarpic conceptacle
Fig. 3. Detail of young cystocarpic conceptacle floor with gonimoblast initials
Fig. 4. Cystocarpic conceptacle

PLATE LXXVIII

Neogoniolithon misakiense (Foslie) Setchell et Mason

Fig. 1. Vertical section through marginal portion of a crust ×320
Fig. 2. Vertical section through vegetative part of a crust, showing heterocyst ×320
Fig. 3. Tetrasporangial conceptacle in early developmental stage ×200
Fig. 4. Tetrasporangial conceptacle ×200

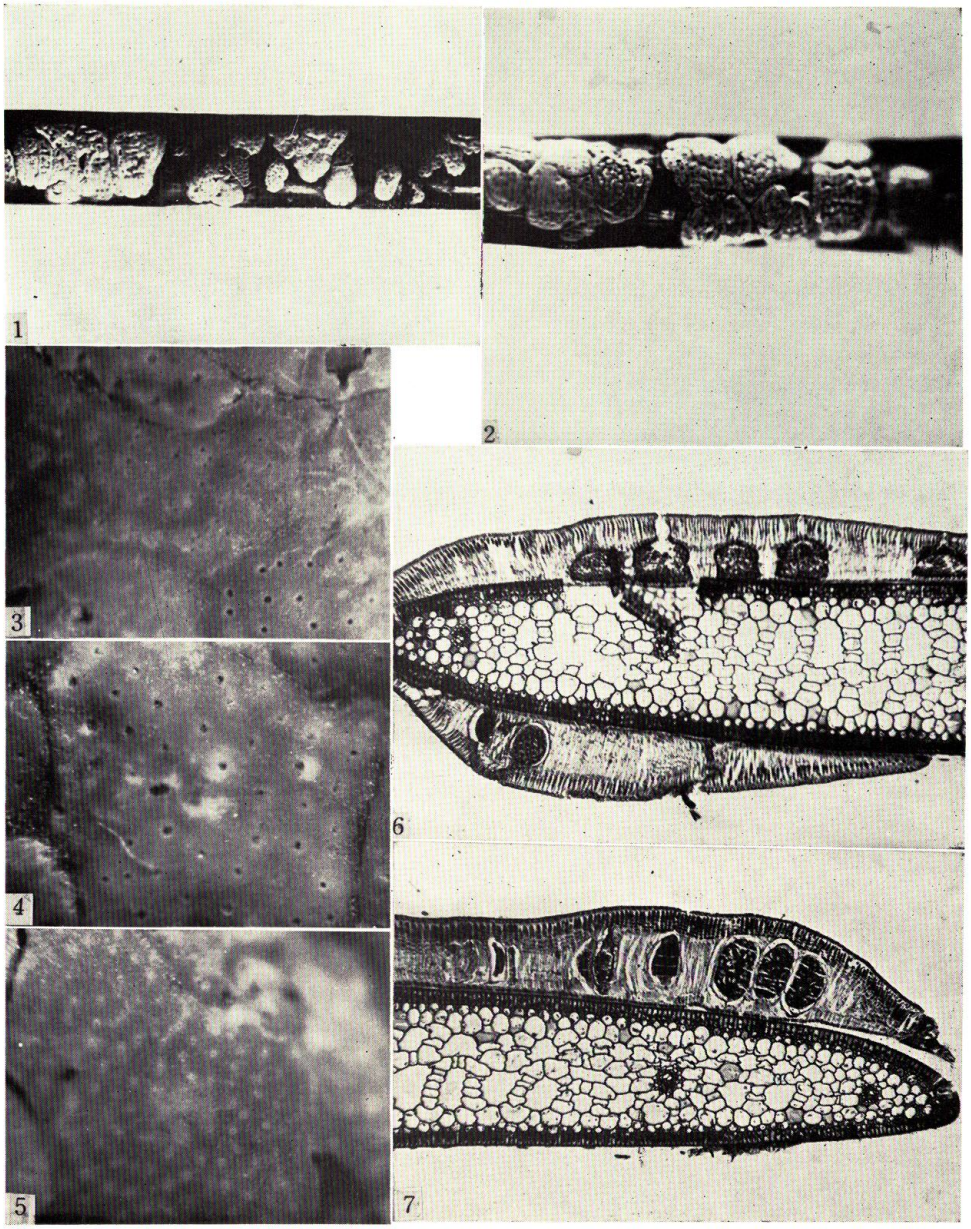
PLATE LXXIX

Neogoniolithon misakiense (Foslie) Setchell et Mason

Fig. 1. Tetrasporangial conceptacle in early developmental stage ×200

Lithoporella melobesioides Foslie

Figs. 2 & 3. Sporangial conceptacle in early developmental stage ×72
Fig. 4. Sporangial conceptacle showing a tetranucleate undivided sporangium ×72



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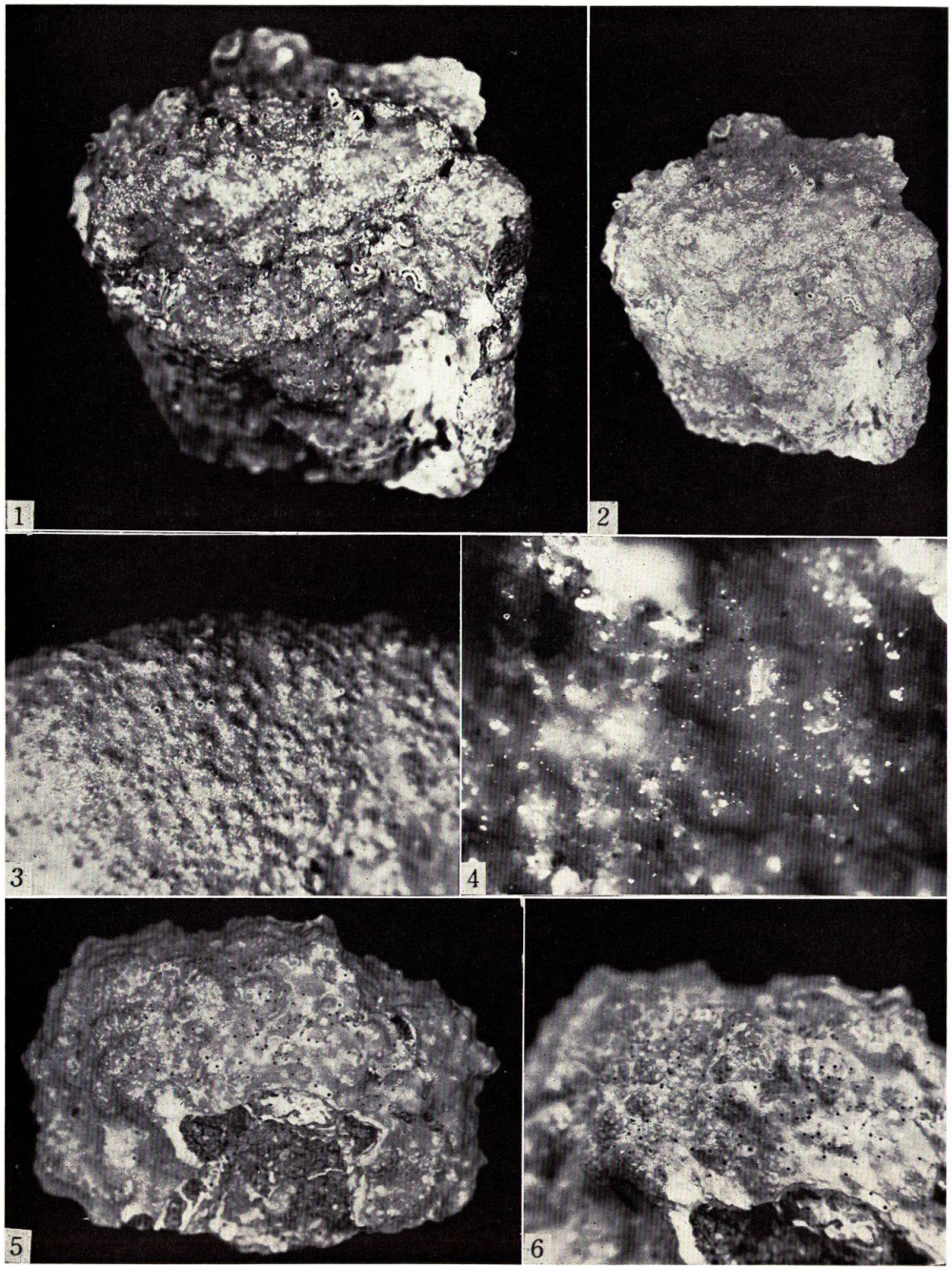

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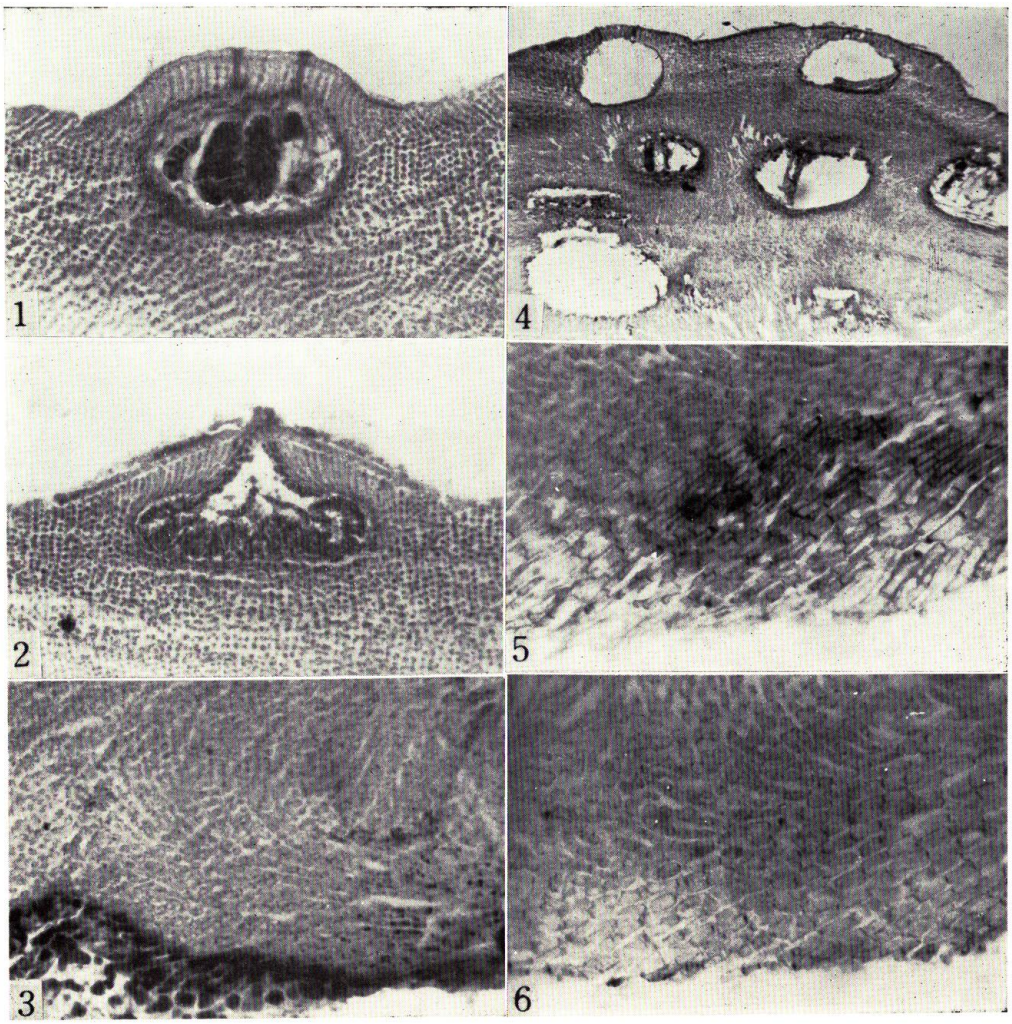

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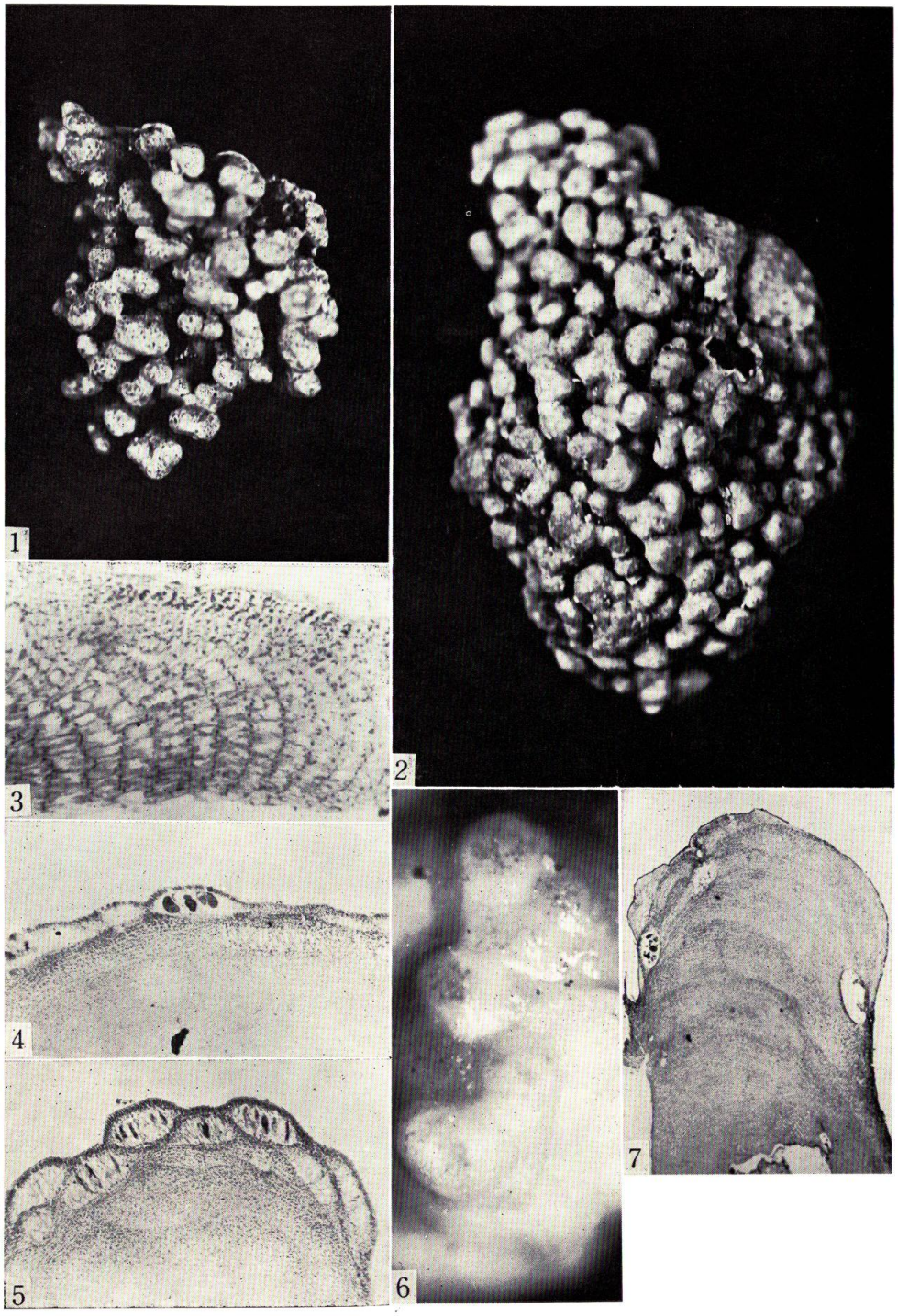

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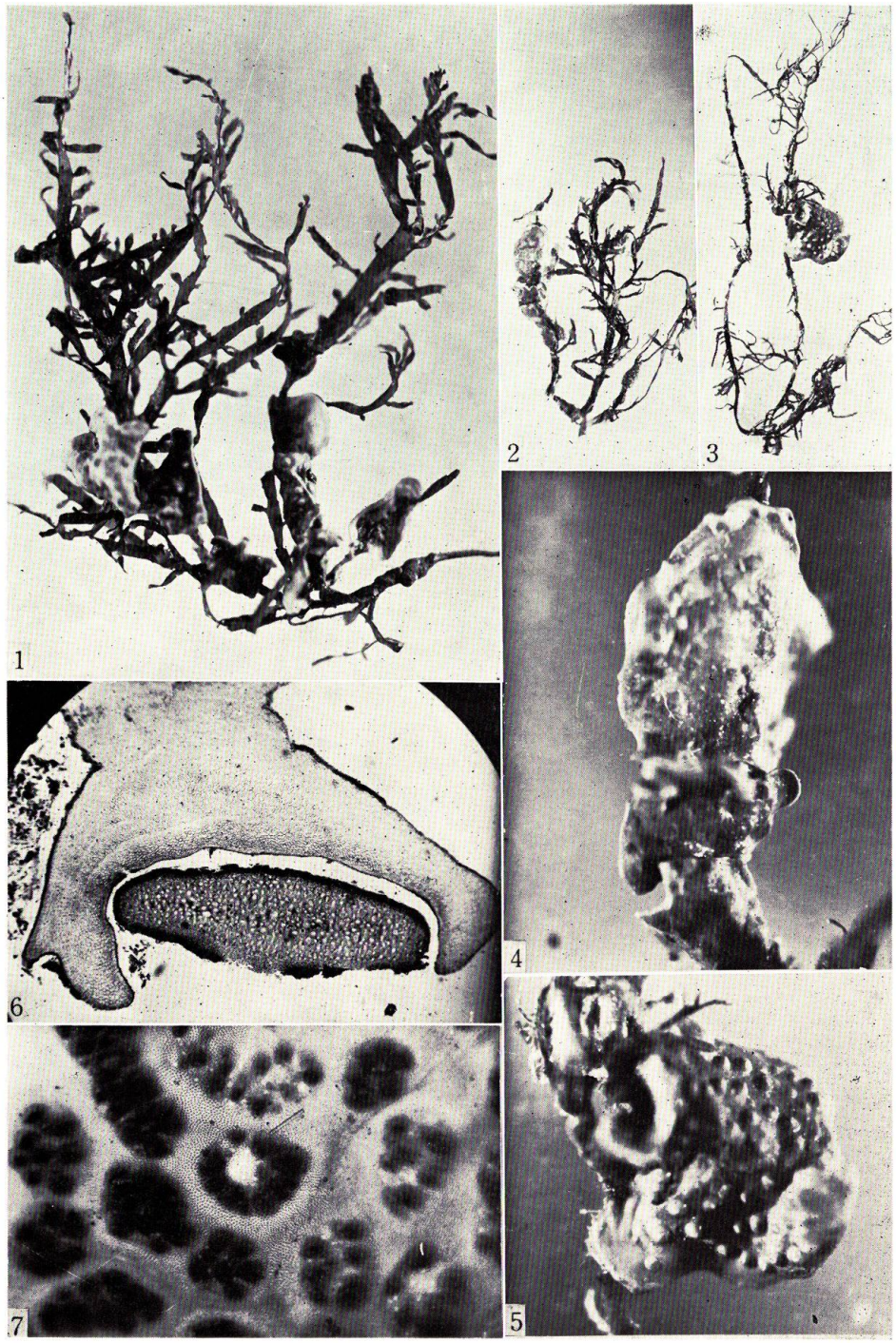

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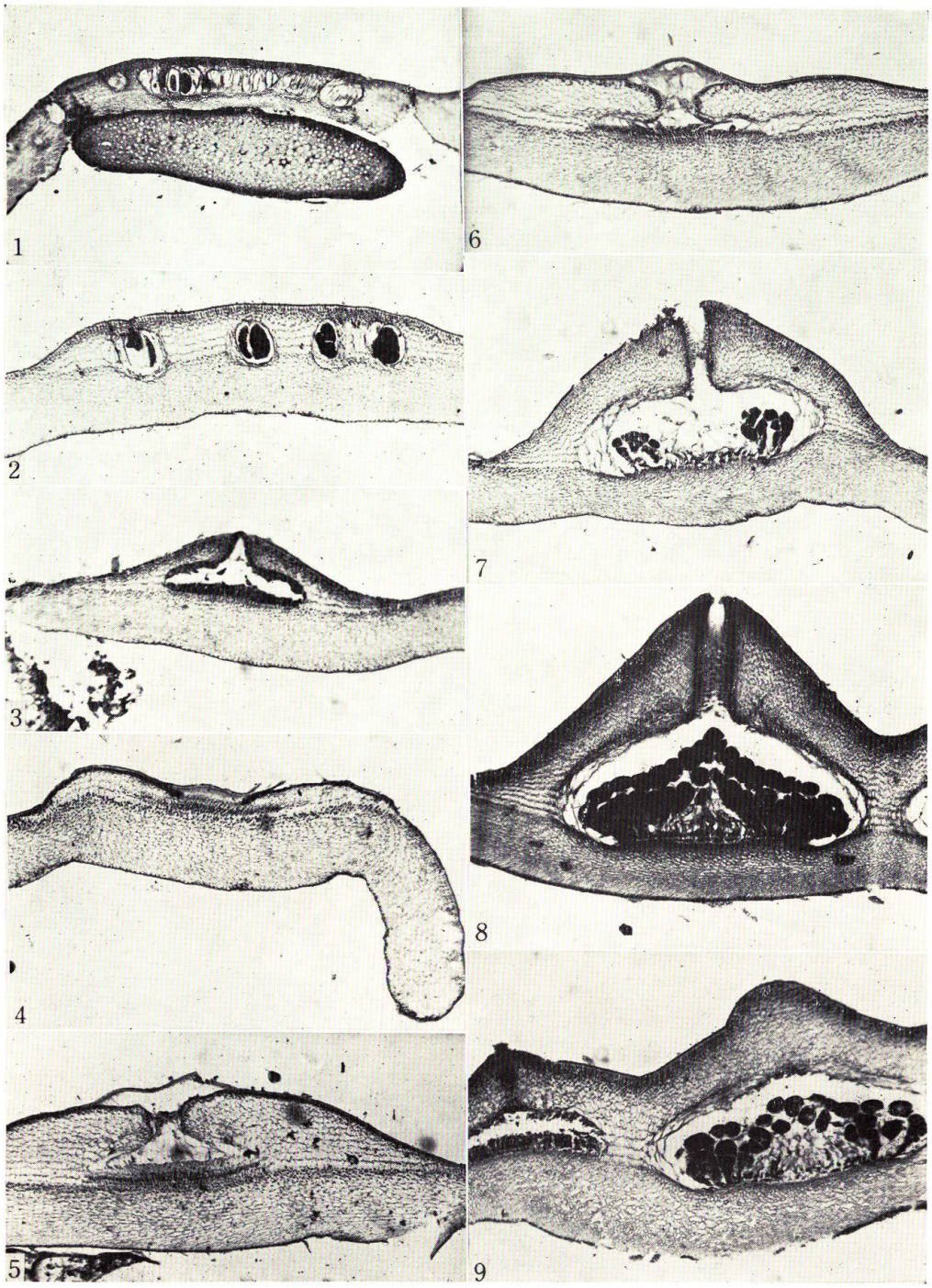

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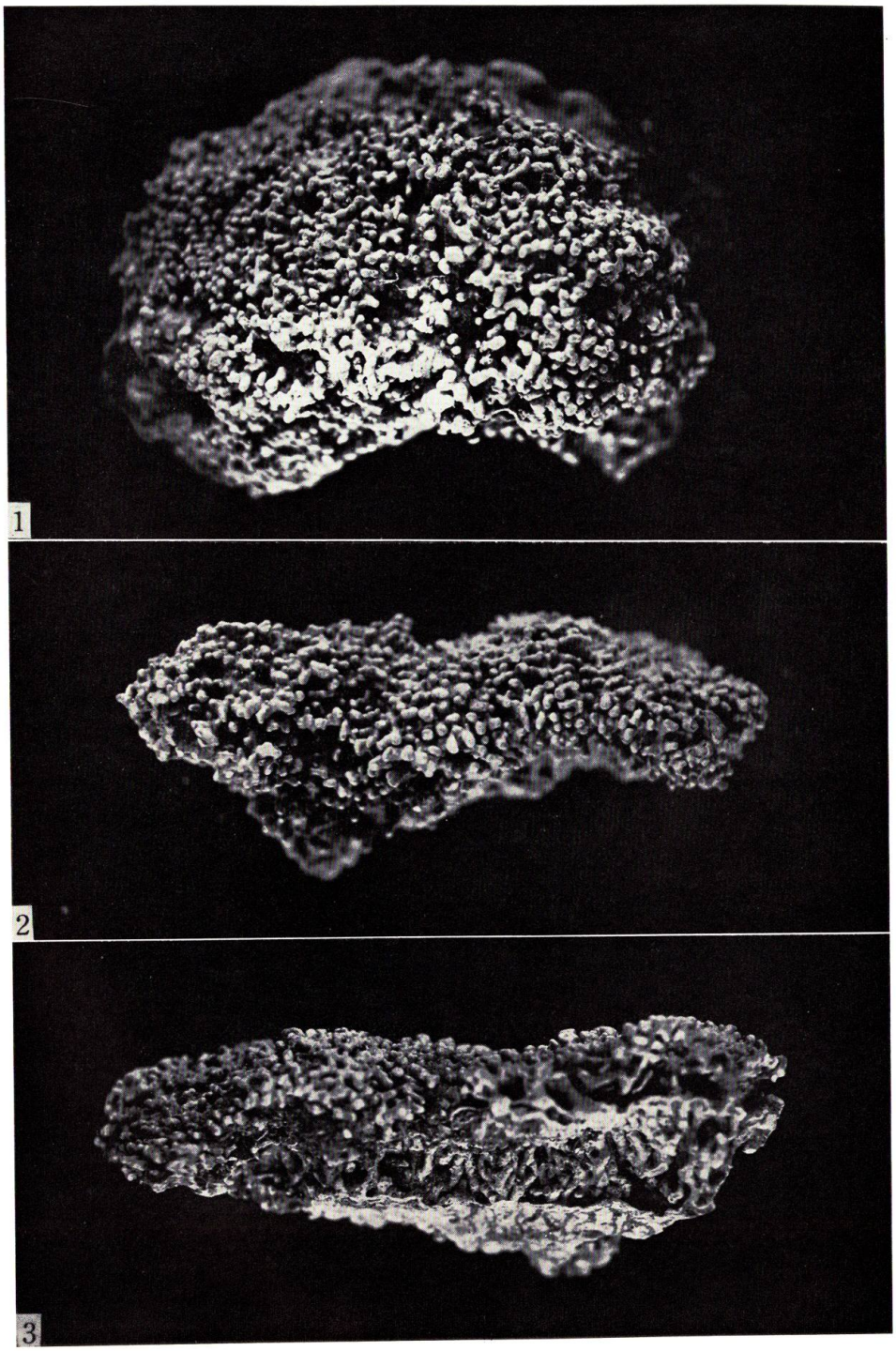

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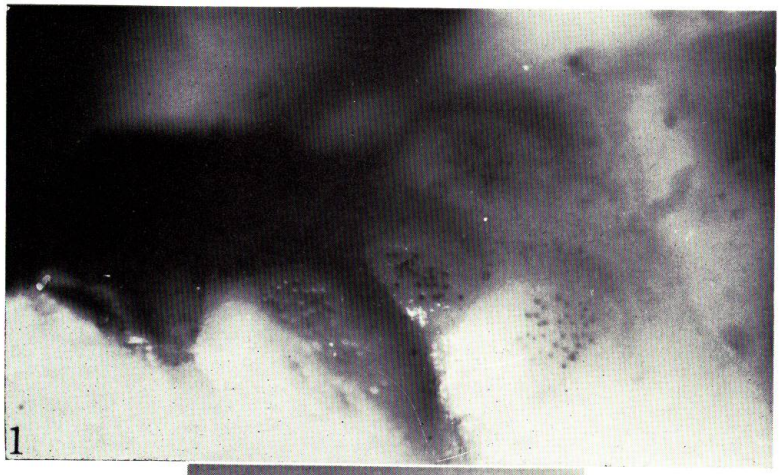
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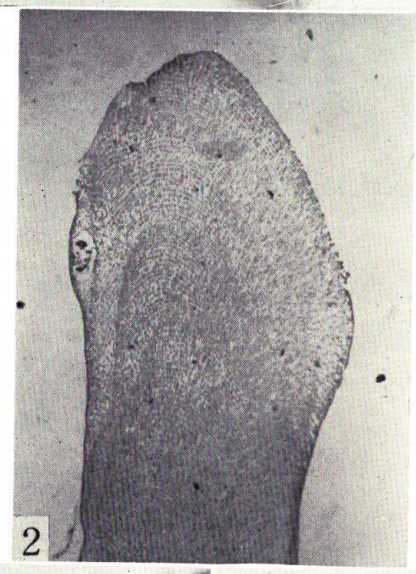
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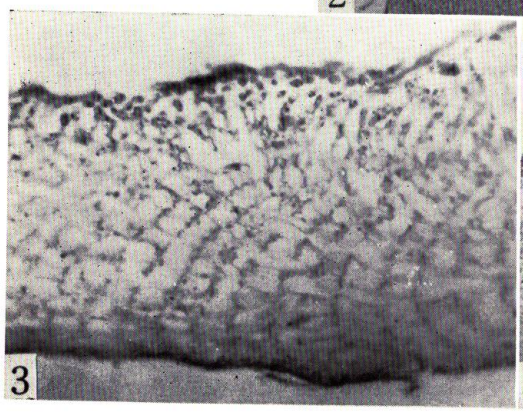
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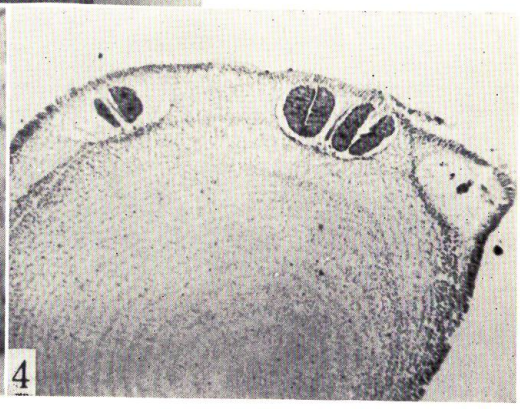
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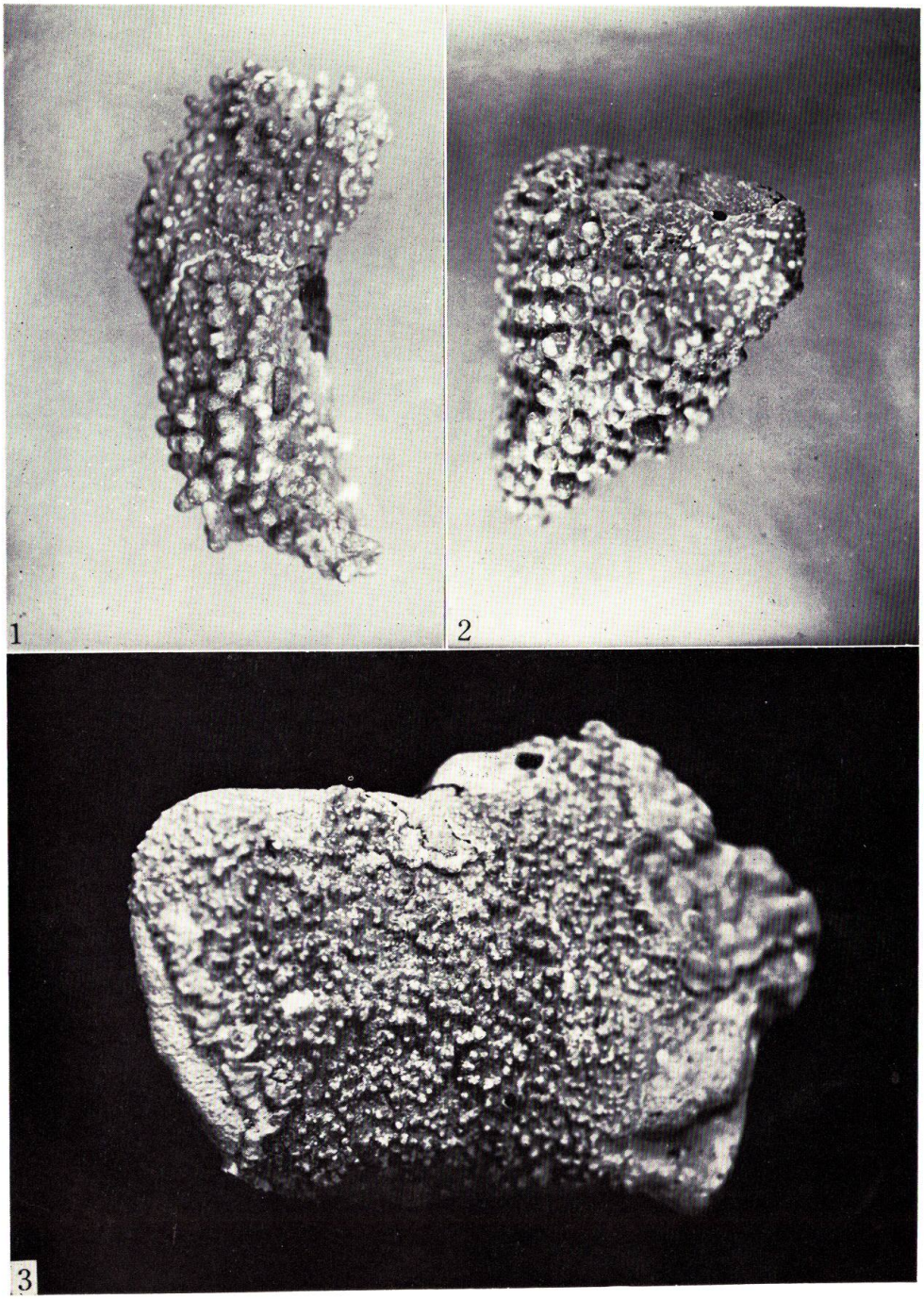

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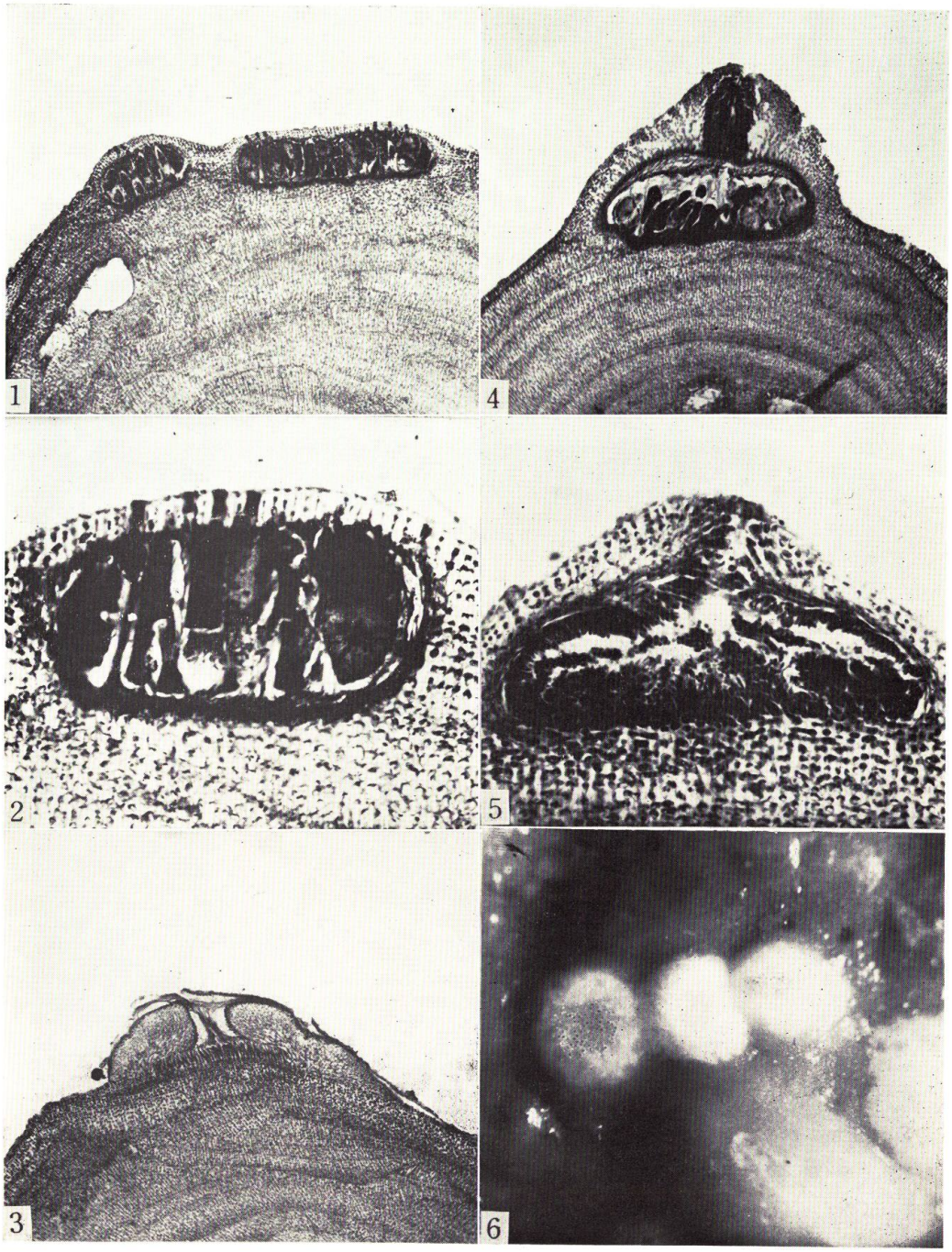

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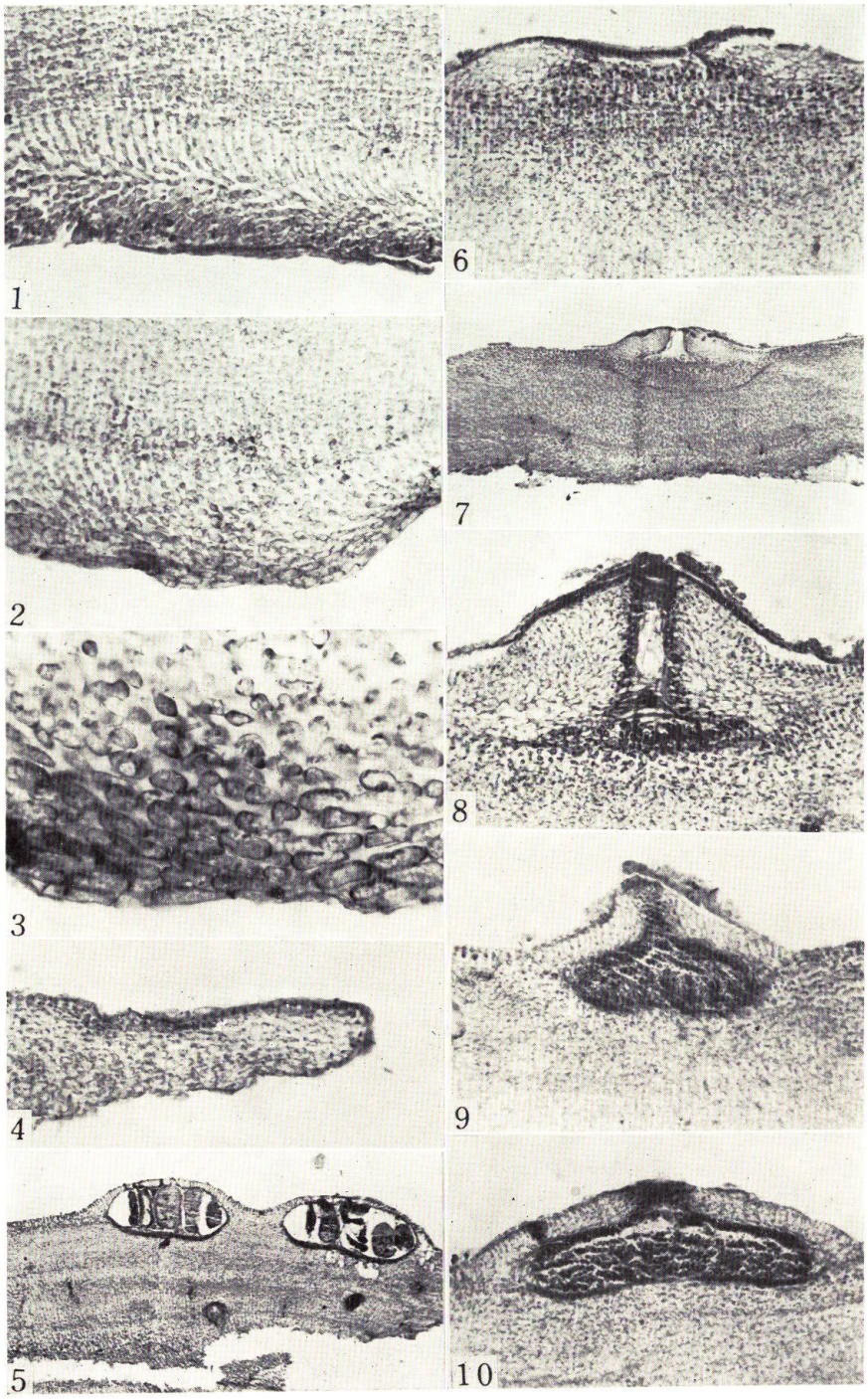

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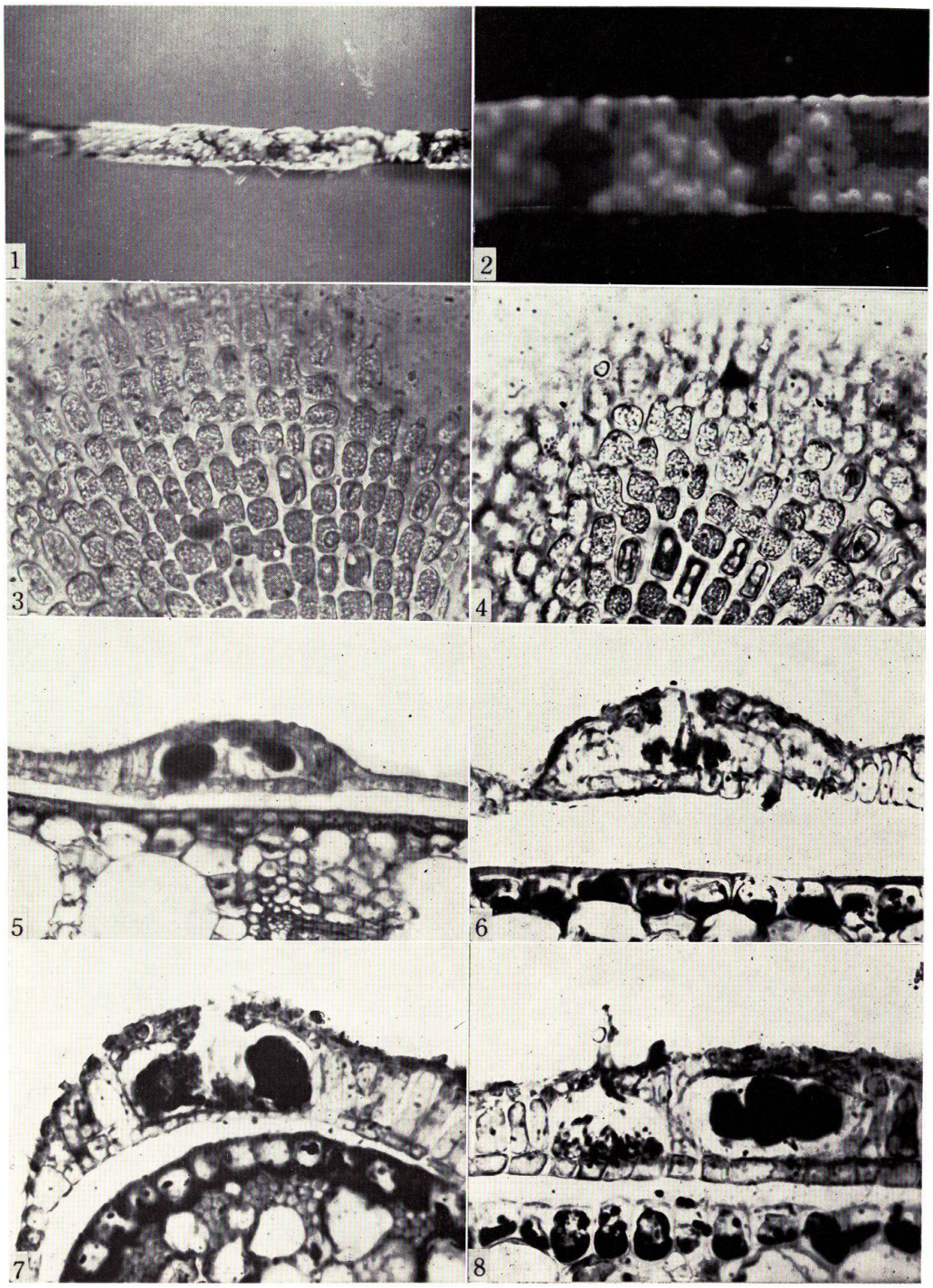

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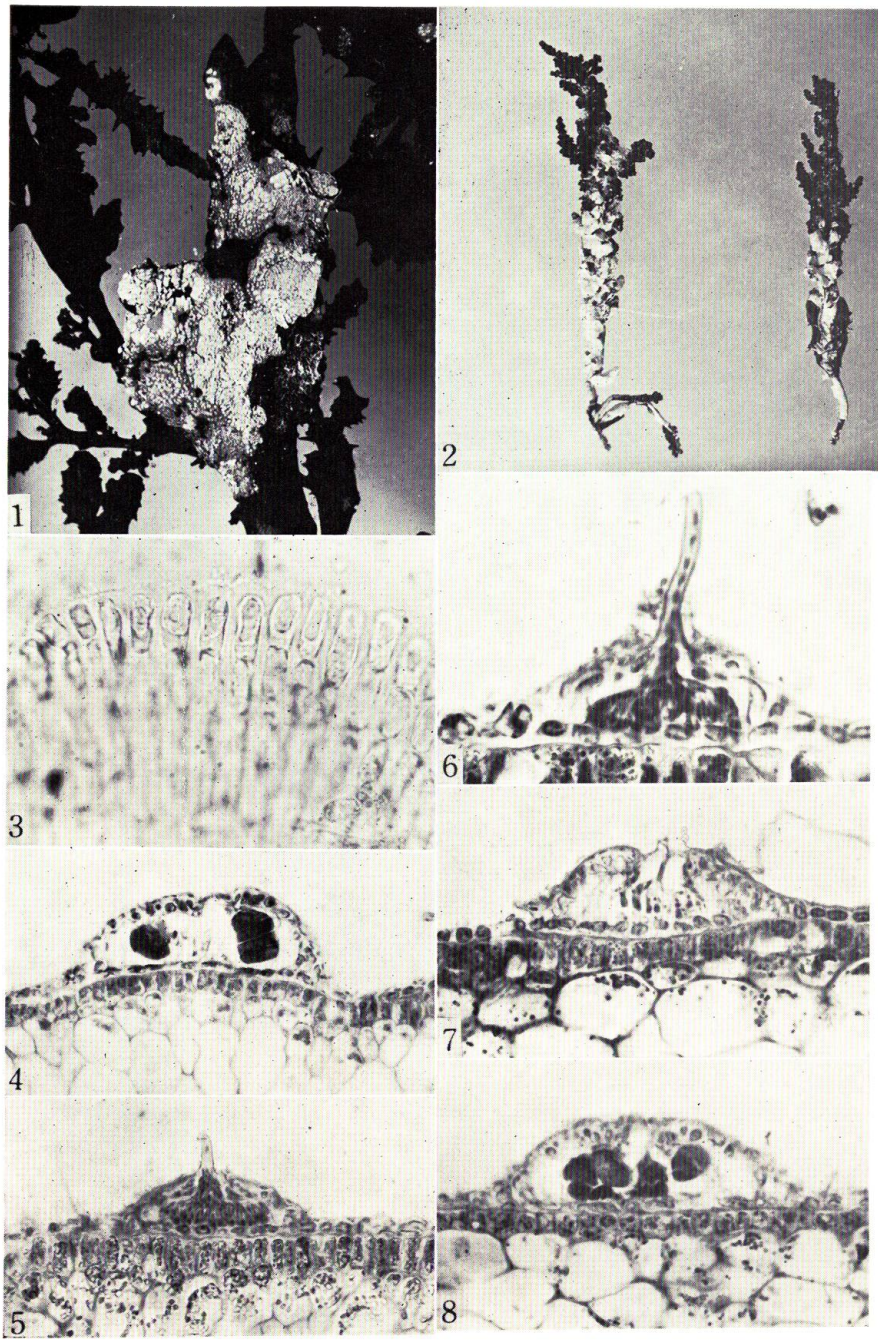

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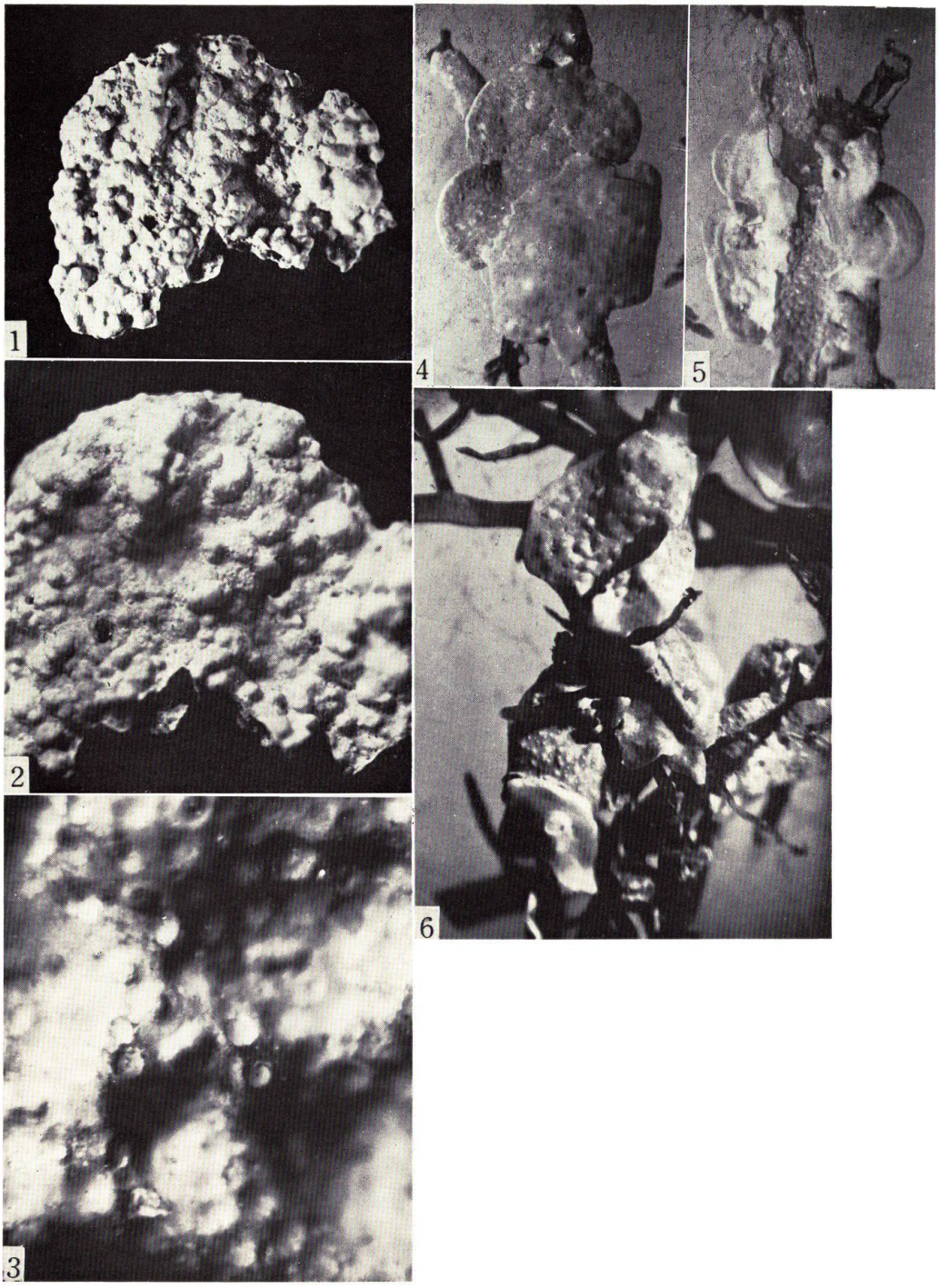

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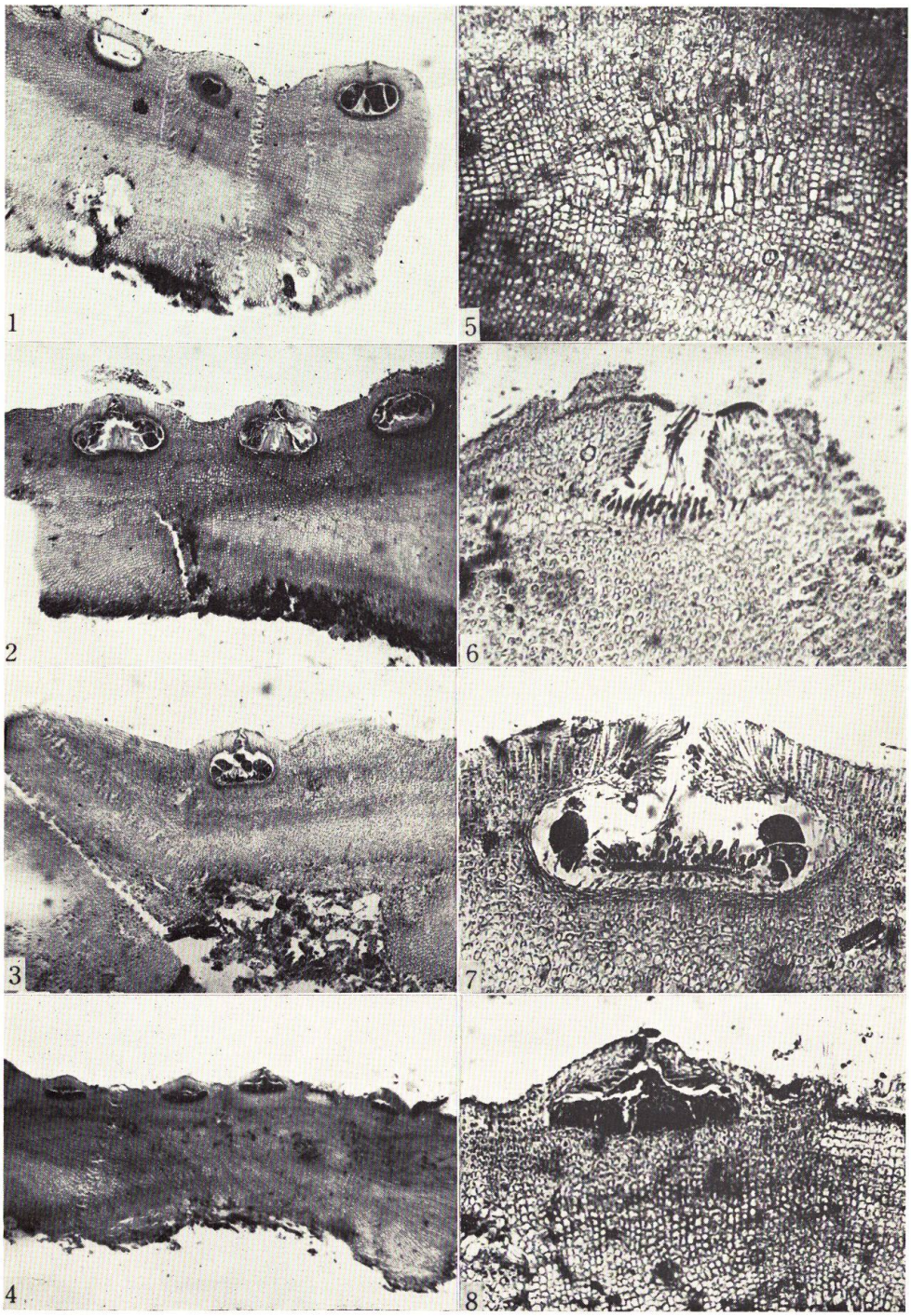

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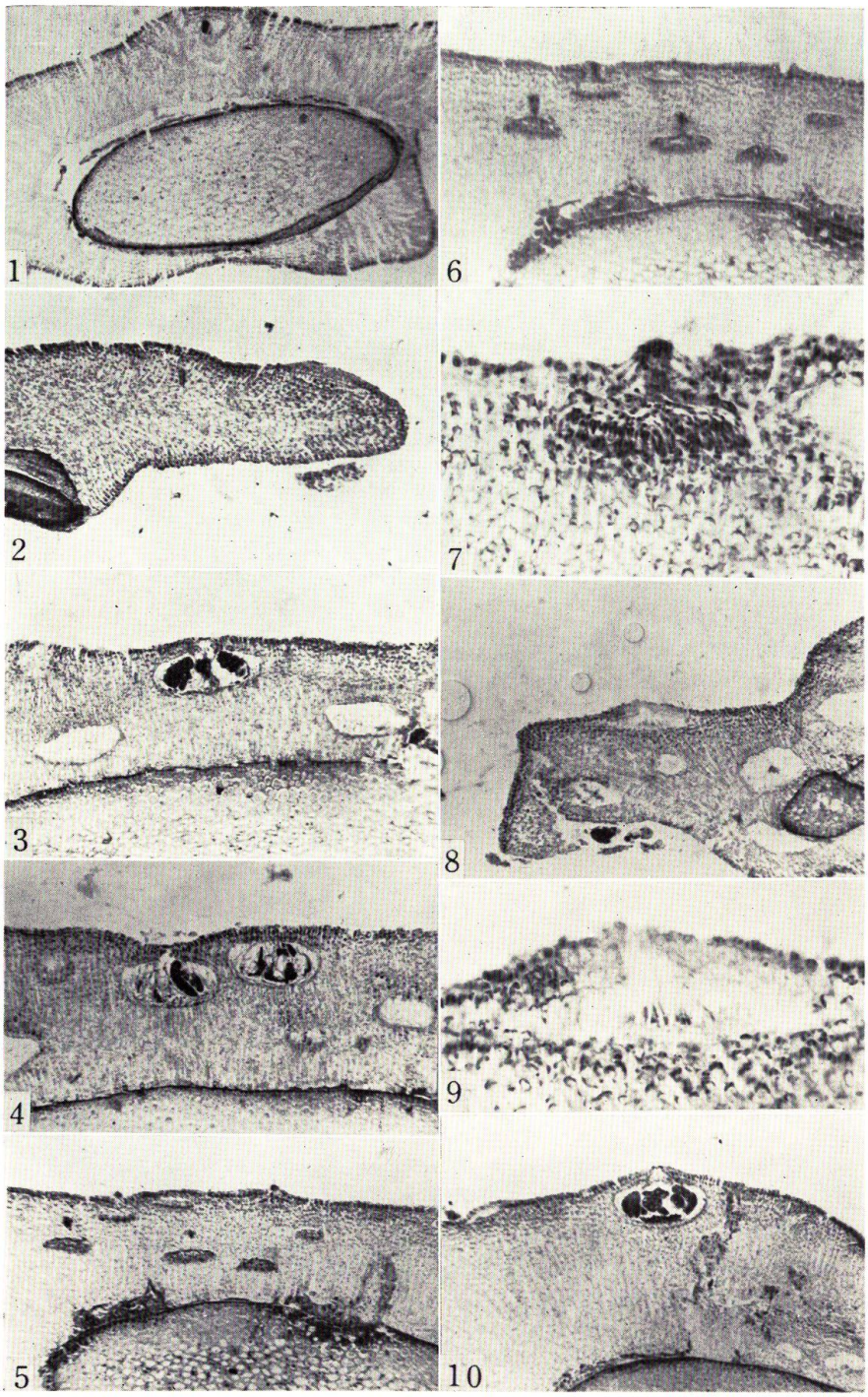

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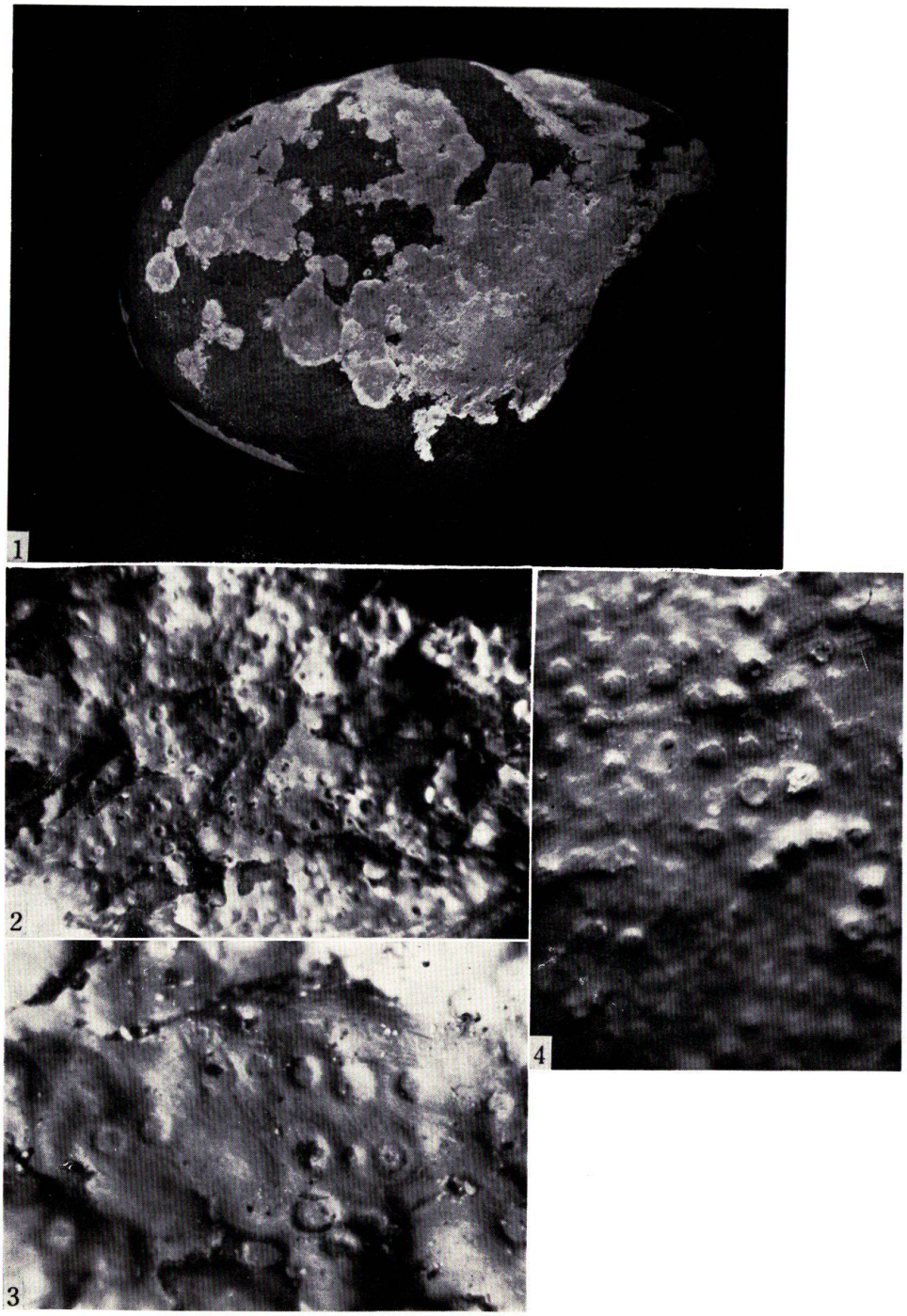

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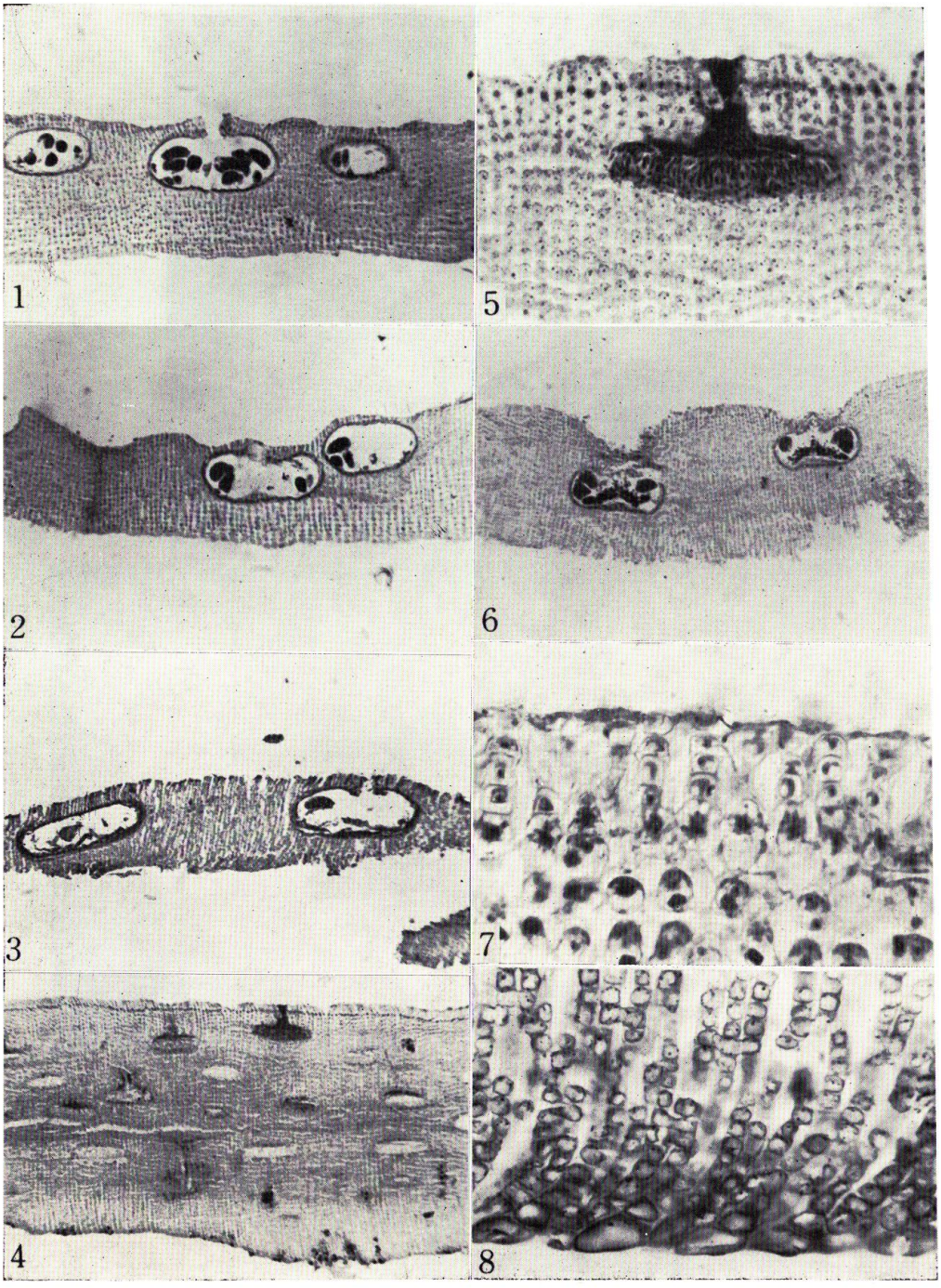

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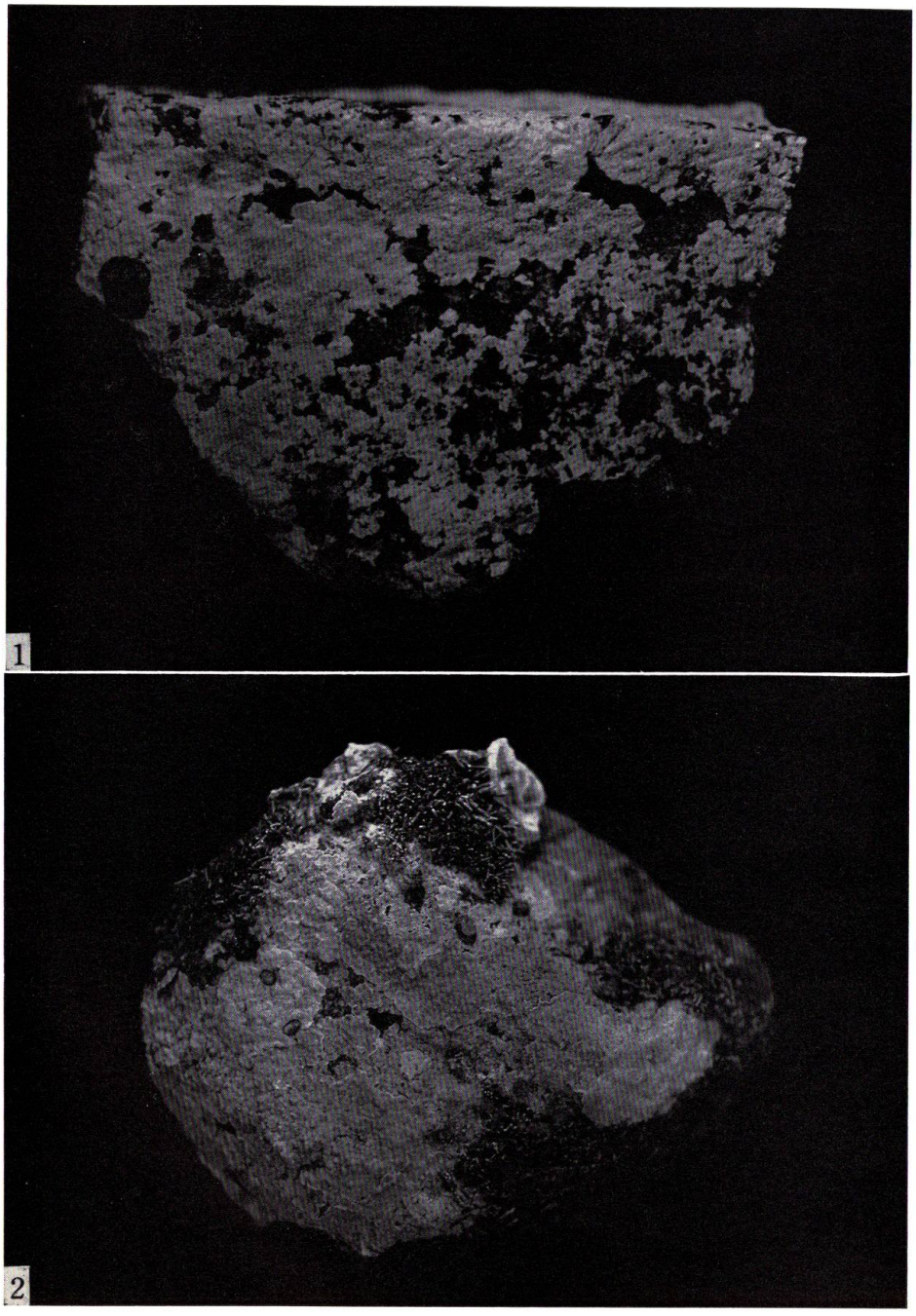

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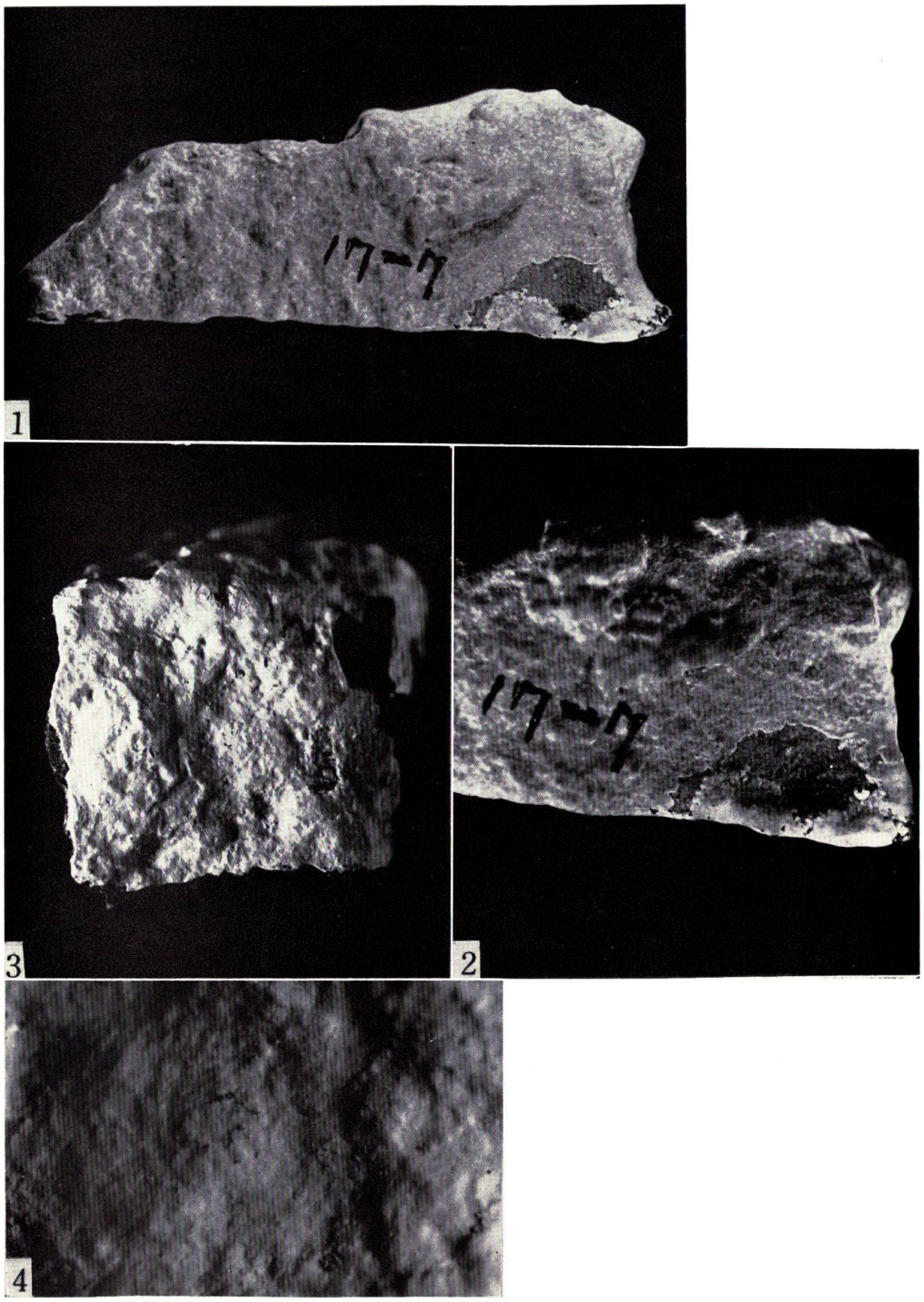

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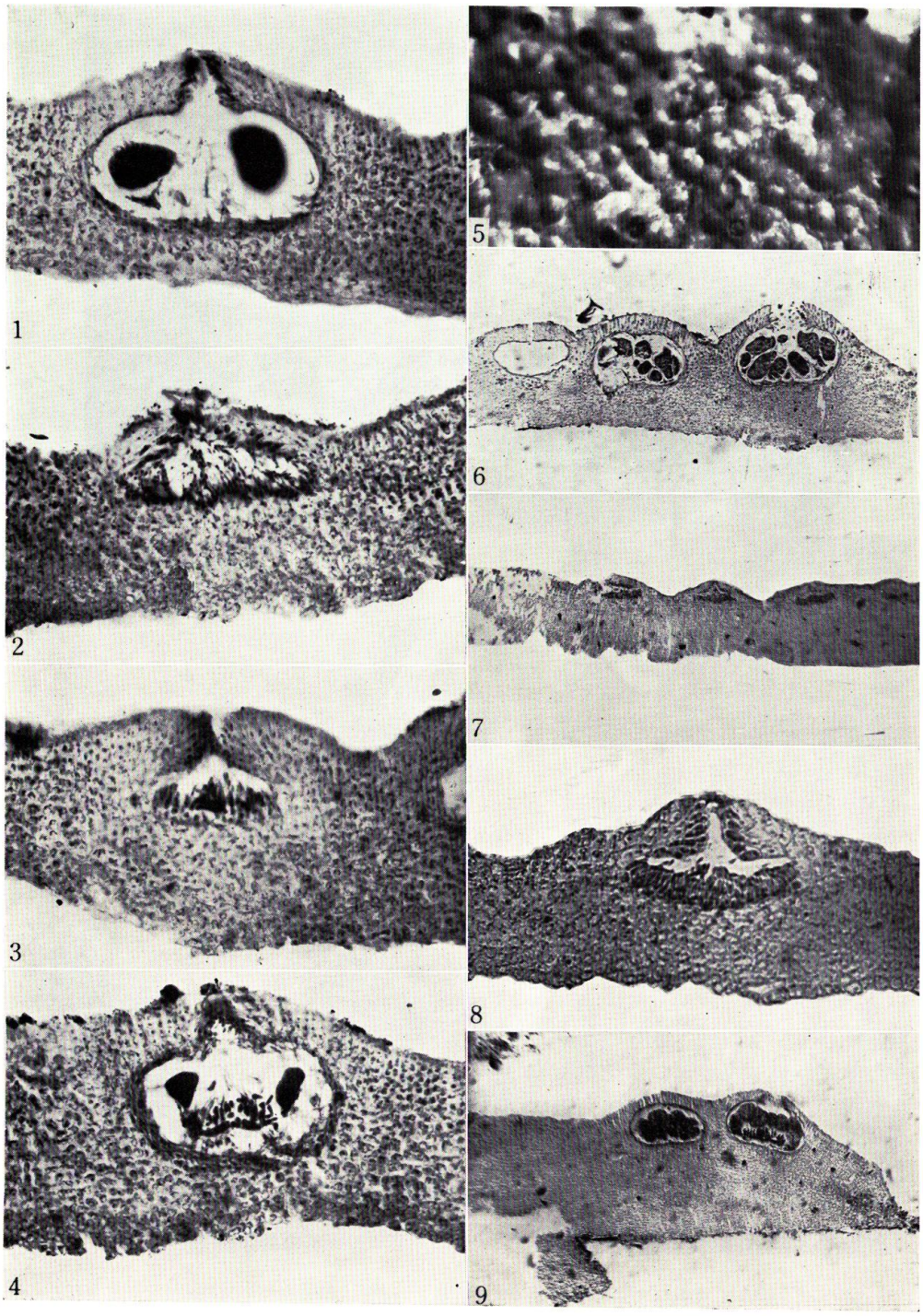

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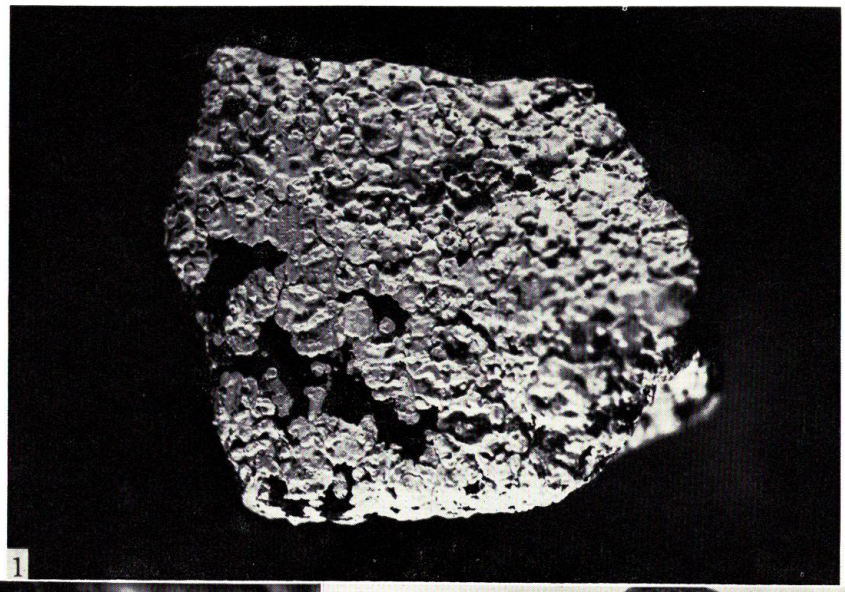
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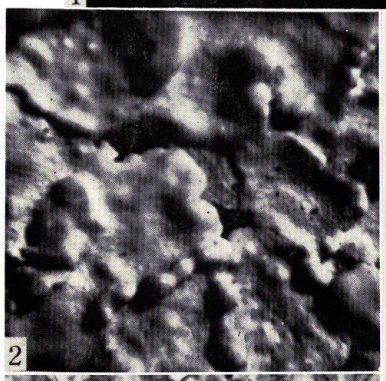
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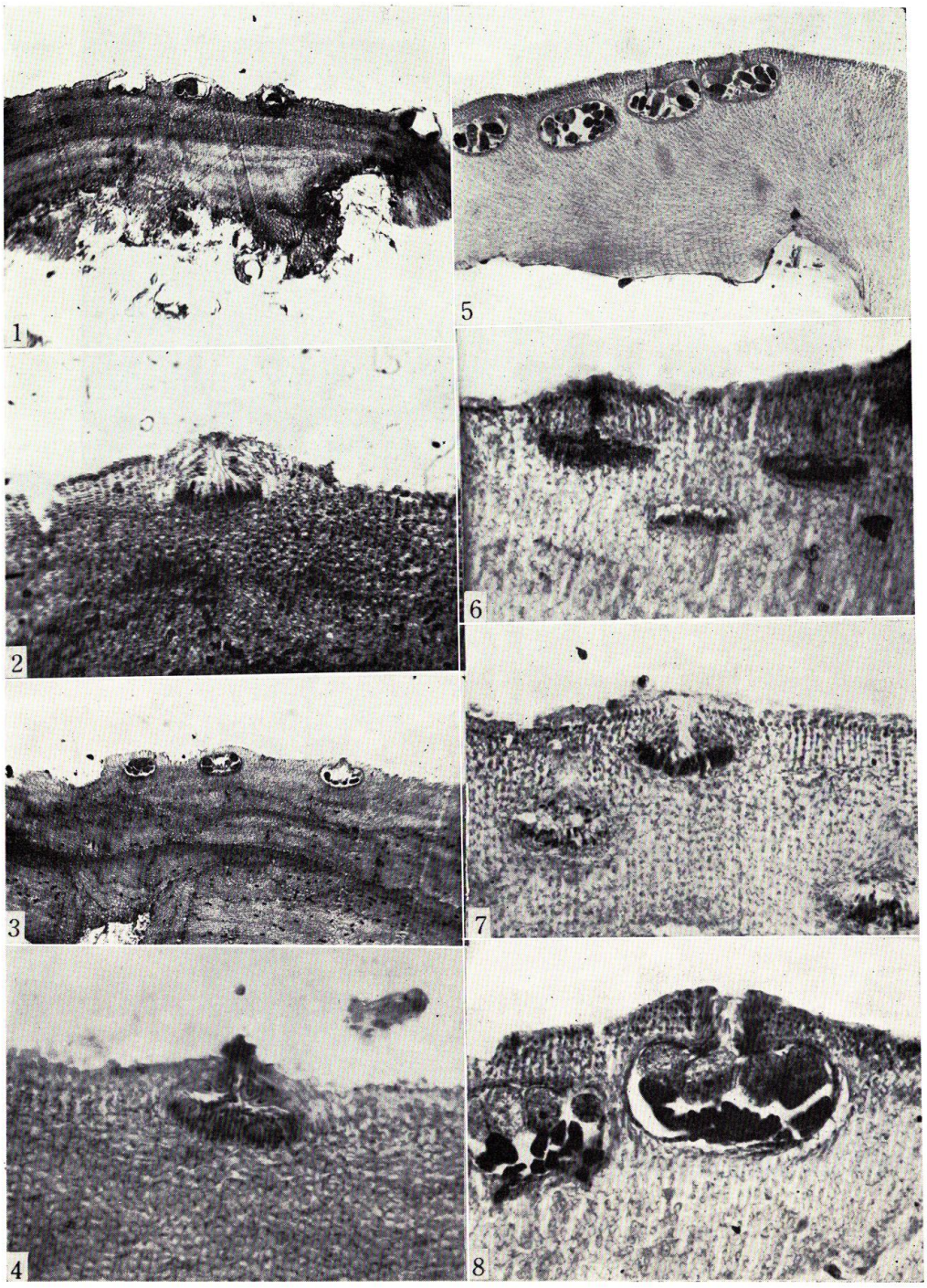

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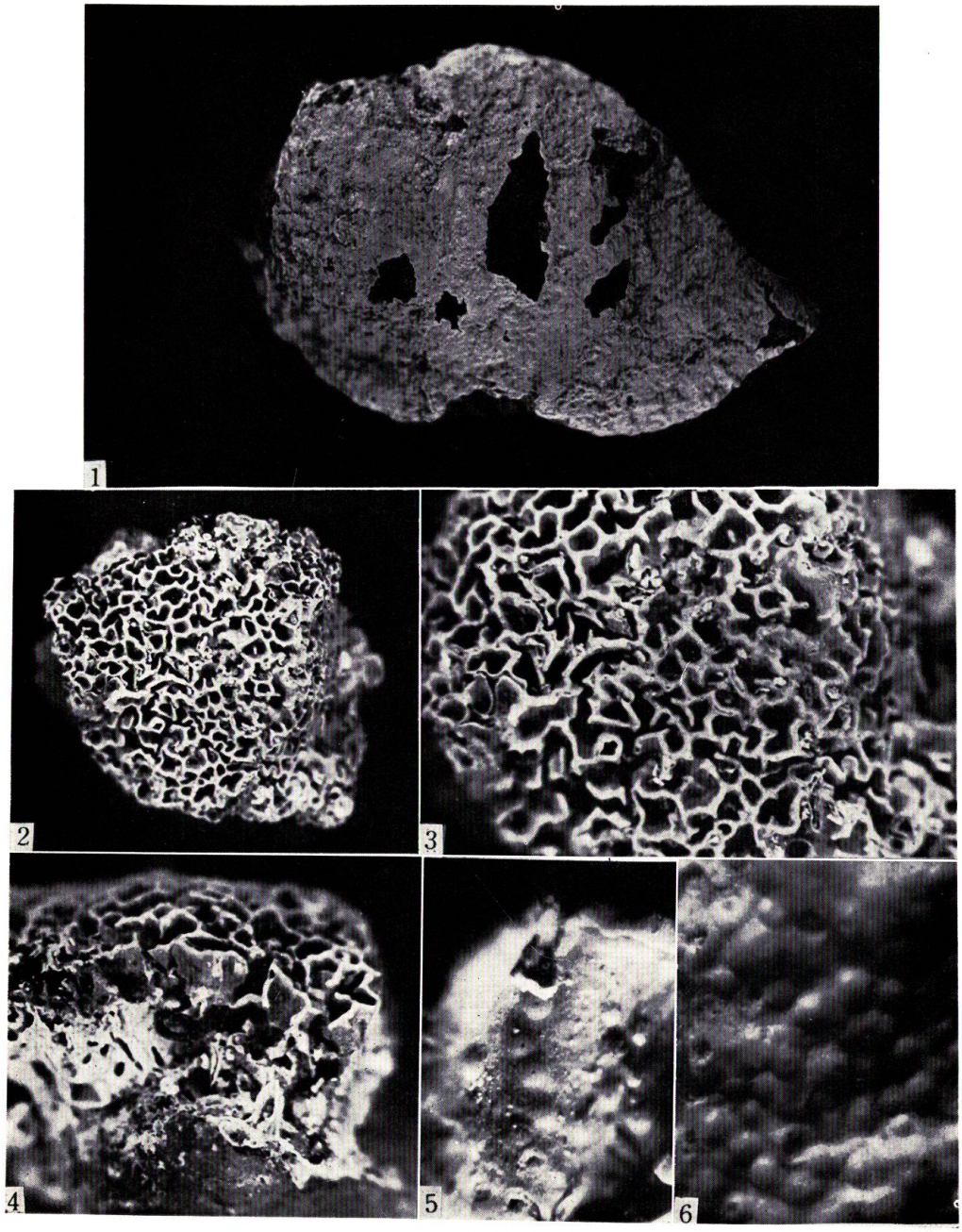

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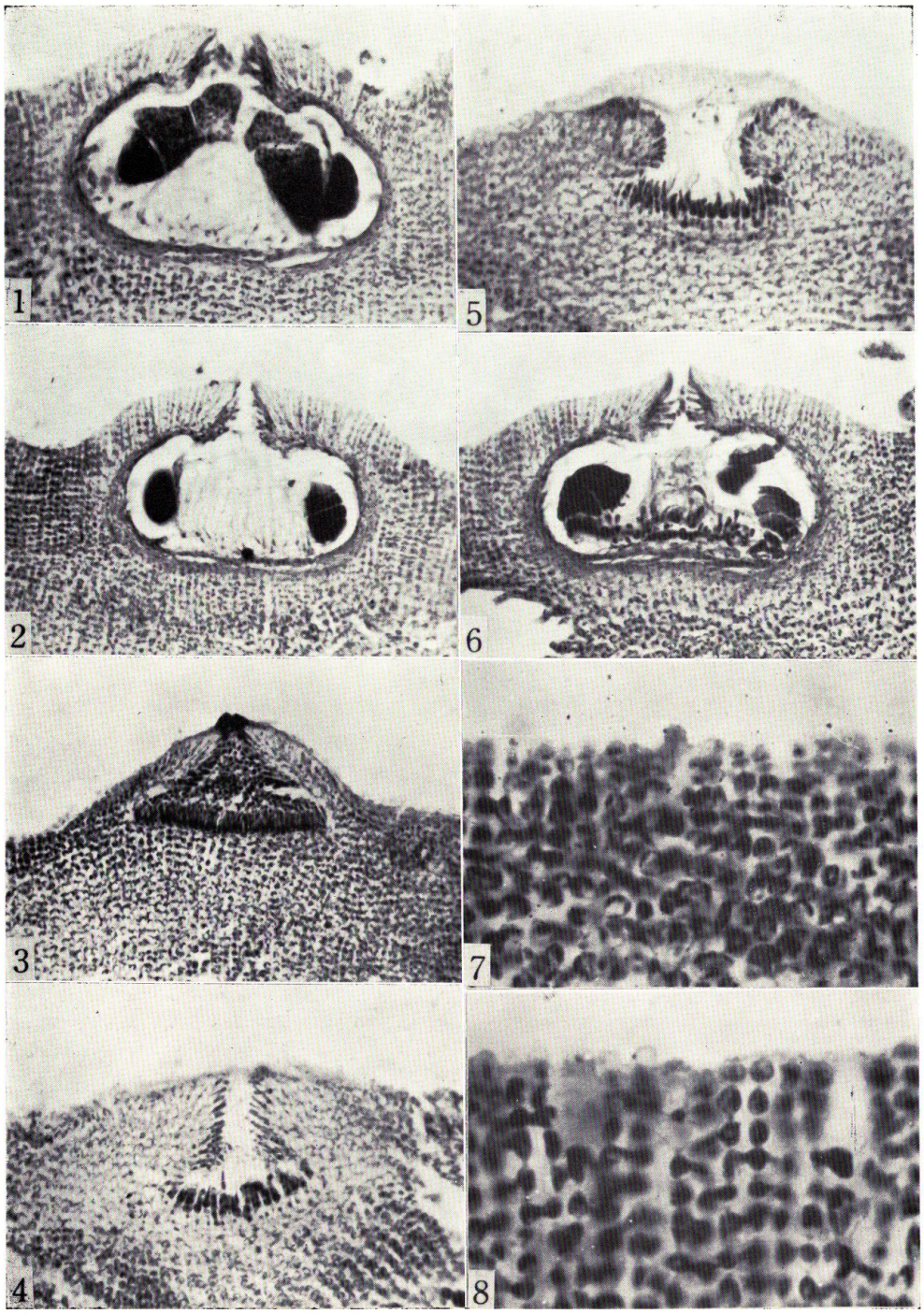

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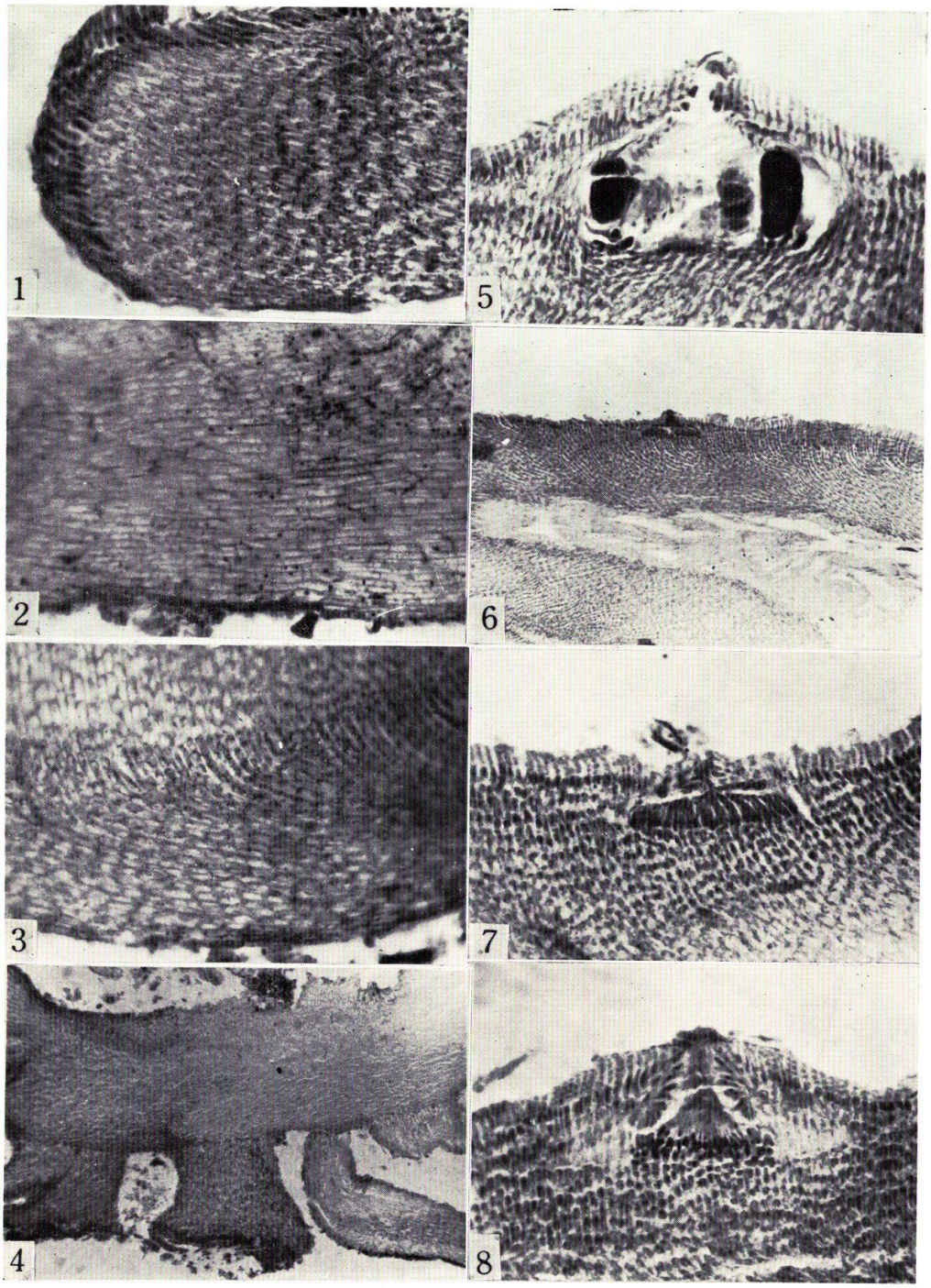

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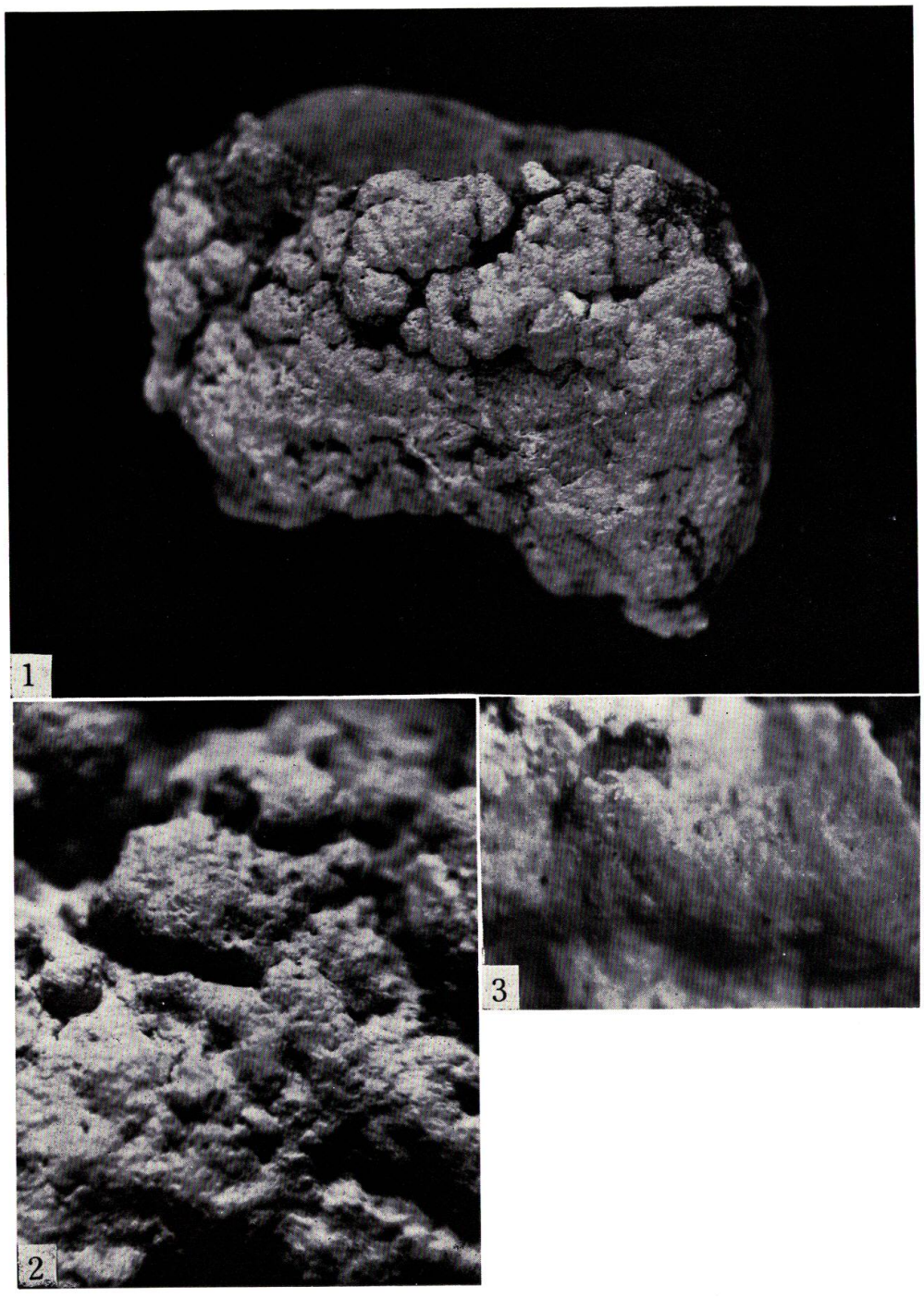

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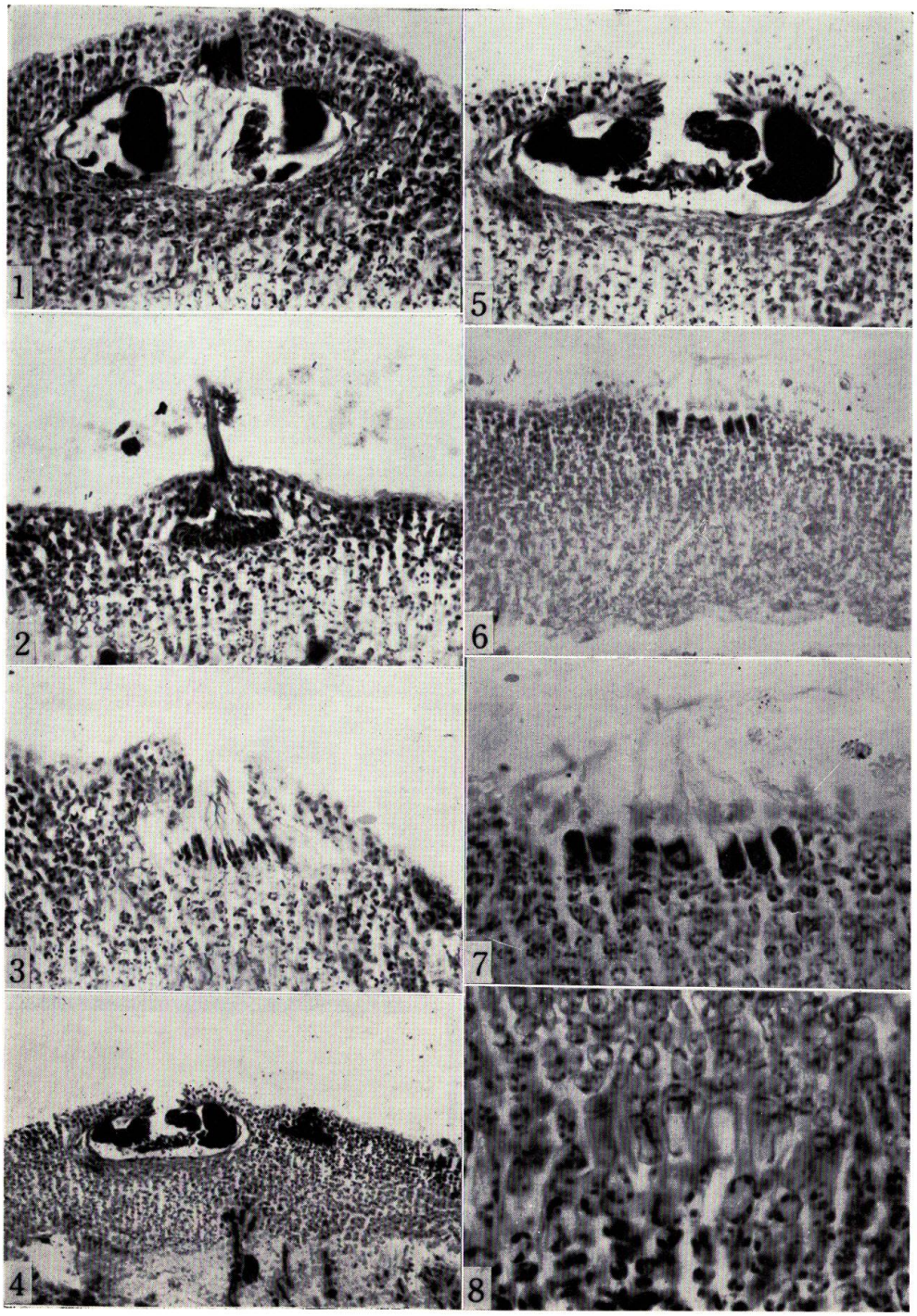

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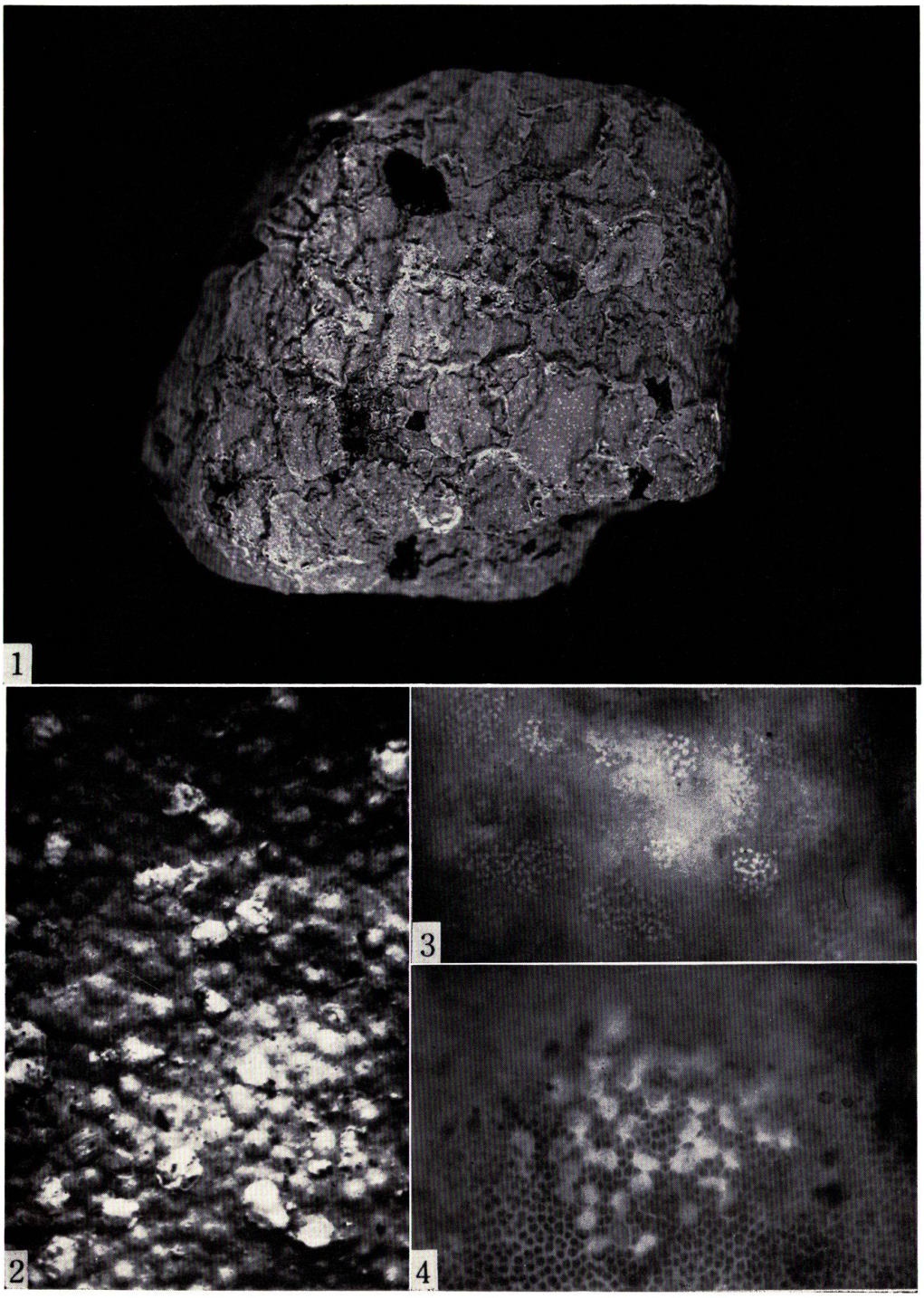

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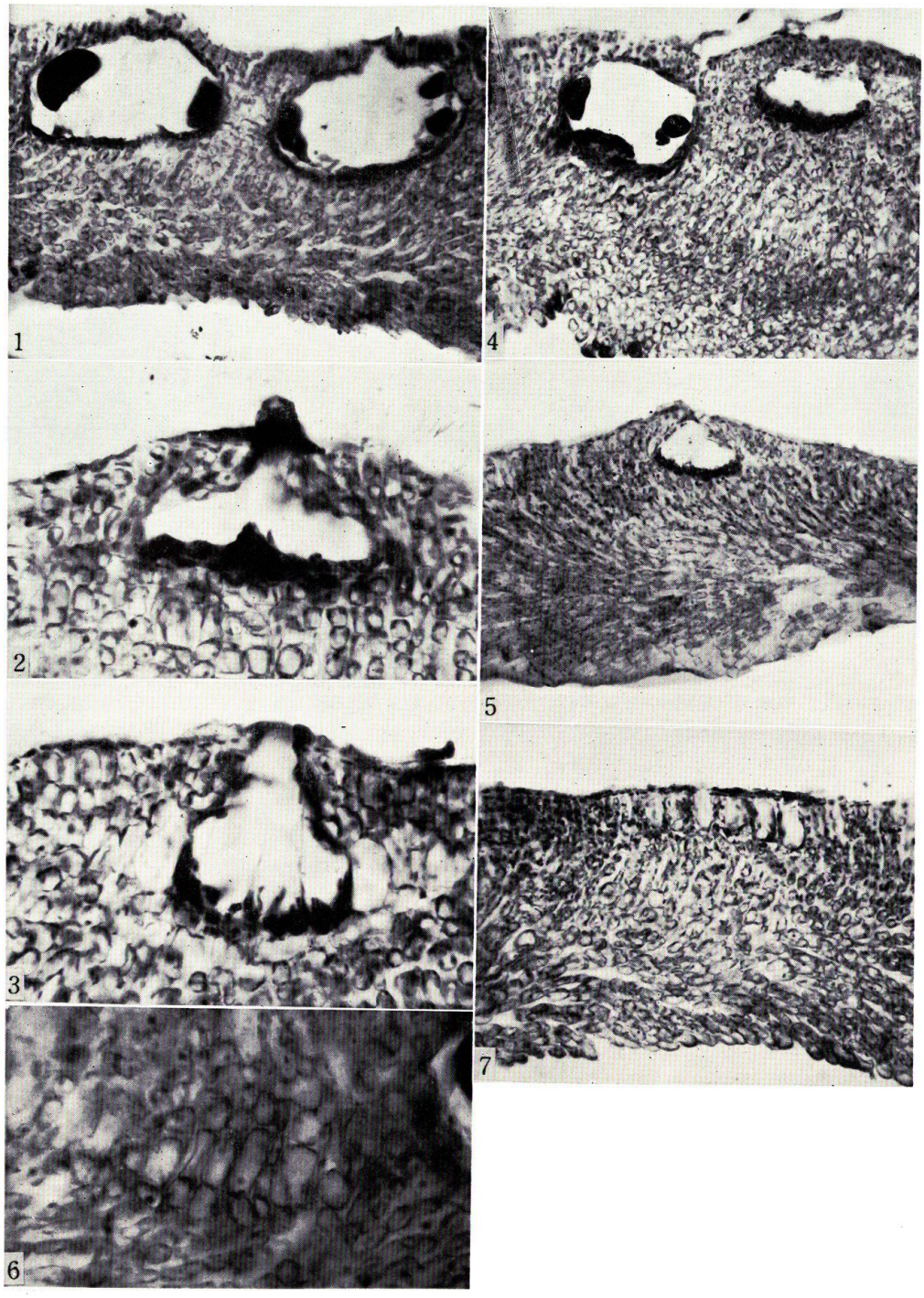

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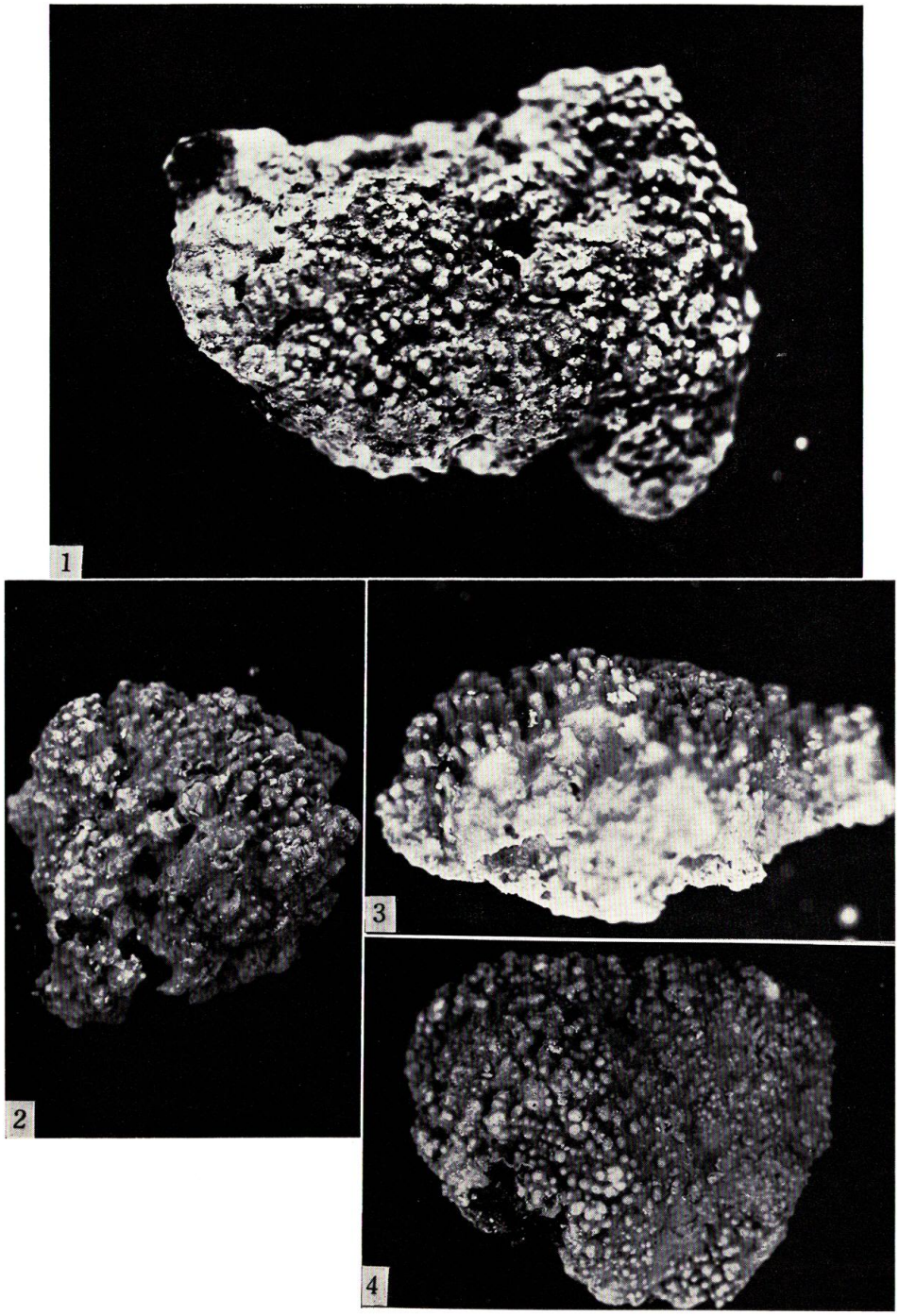

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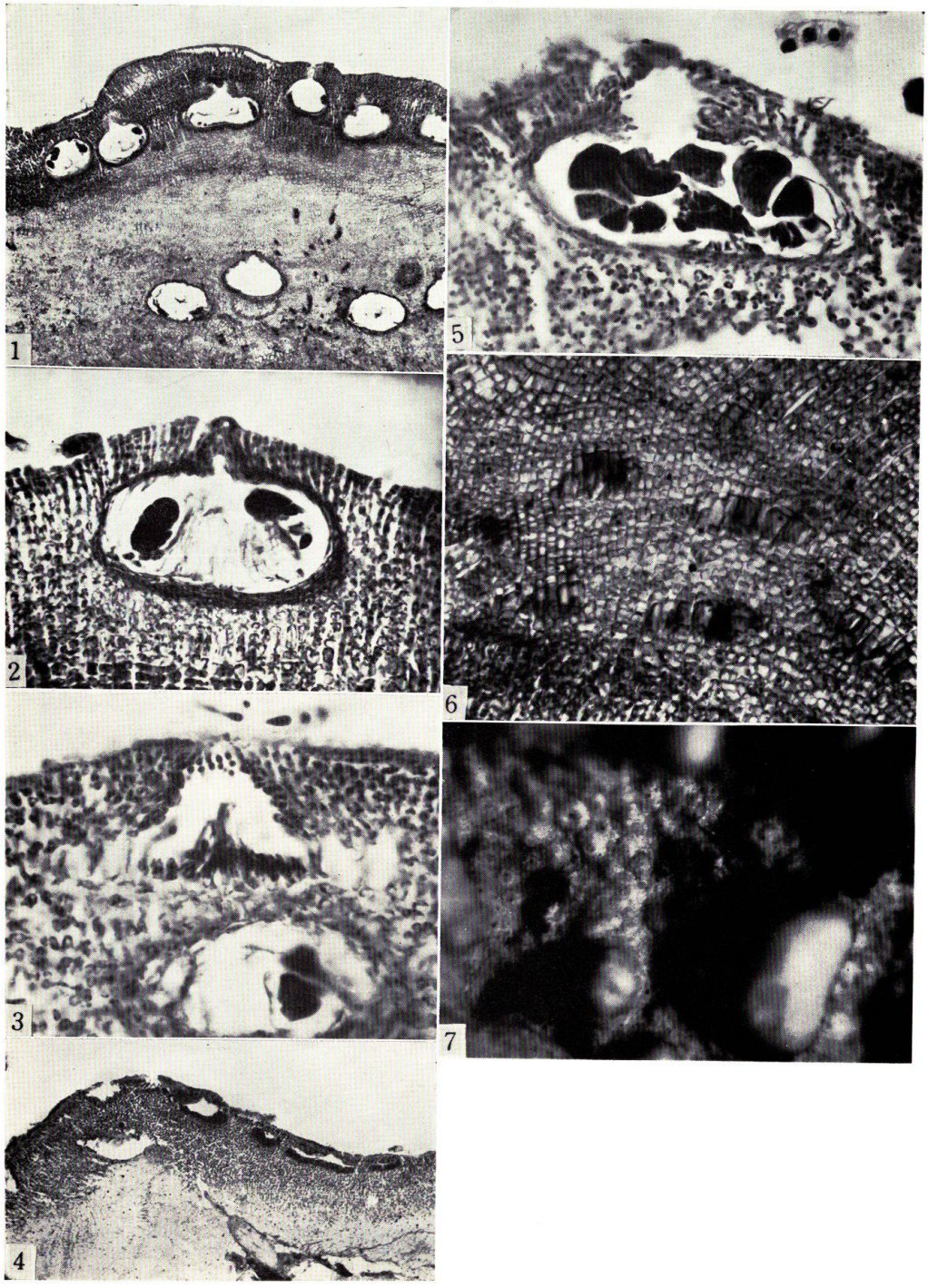

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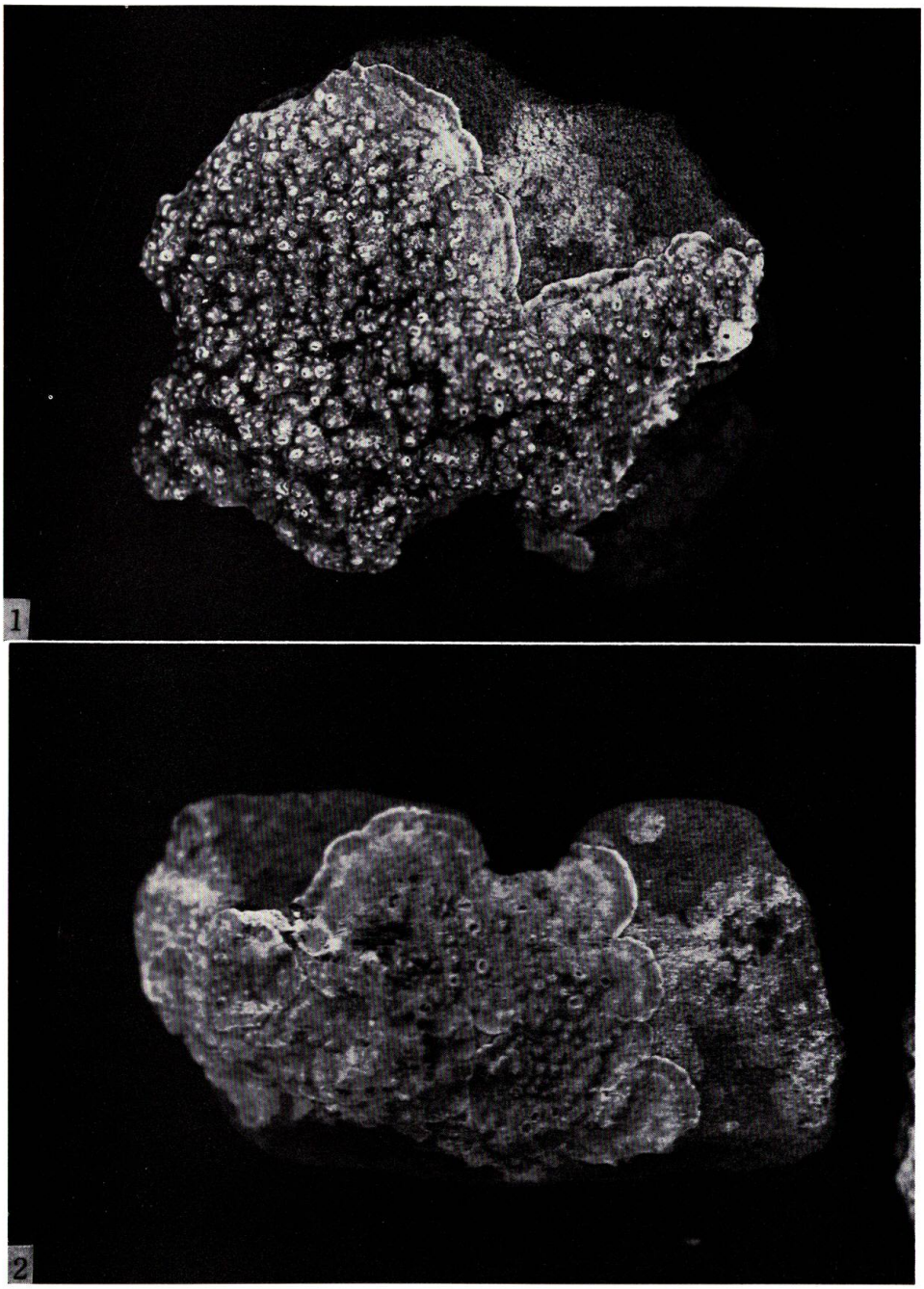

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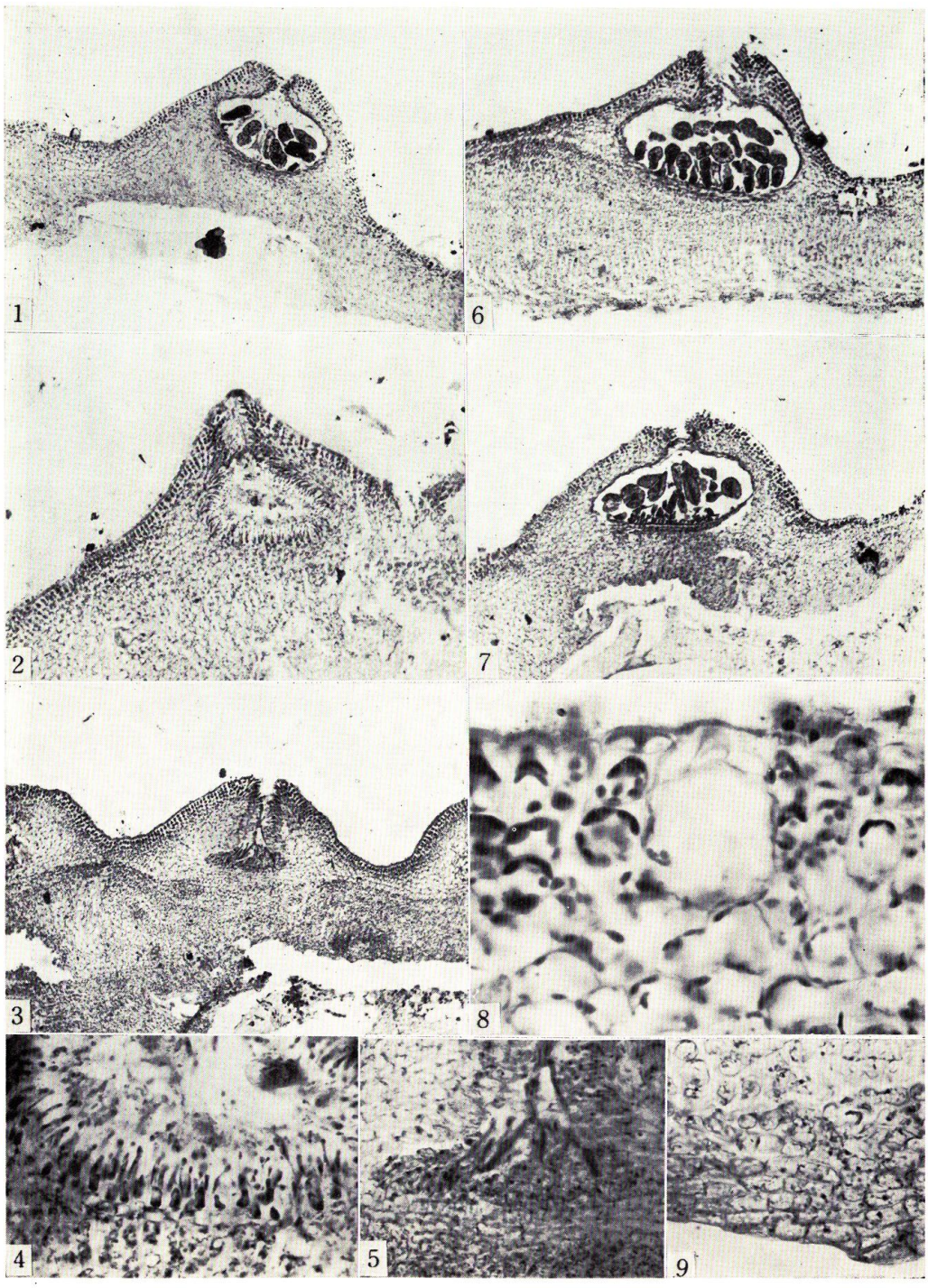

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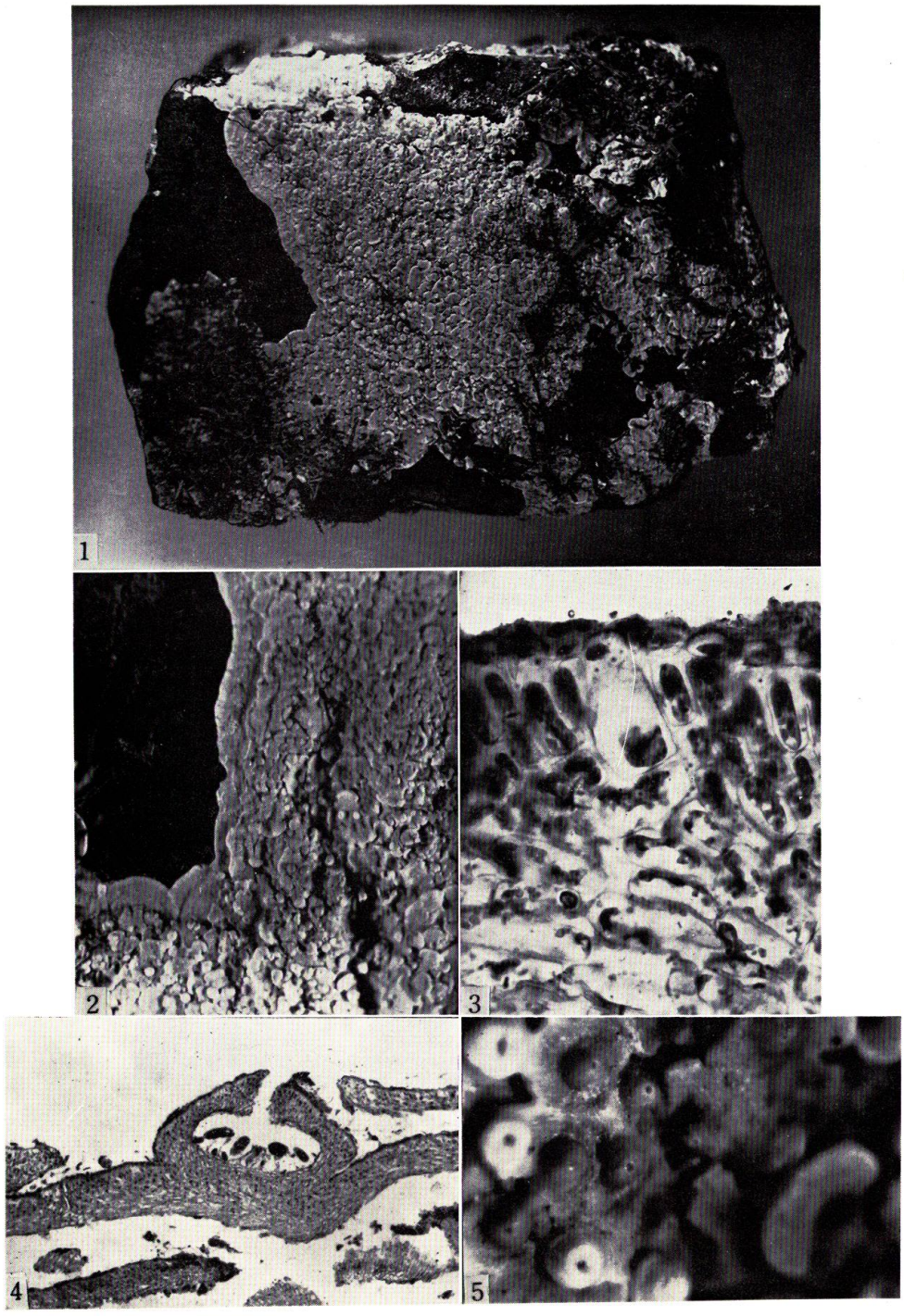

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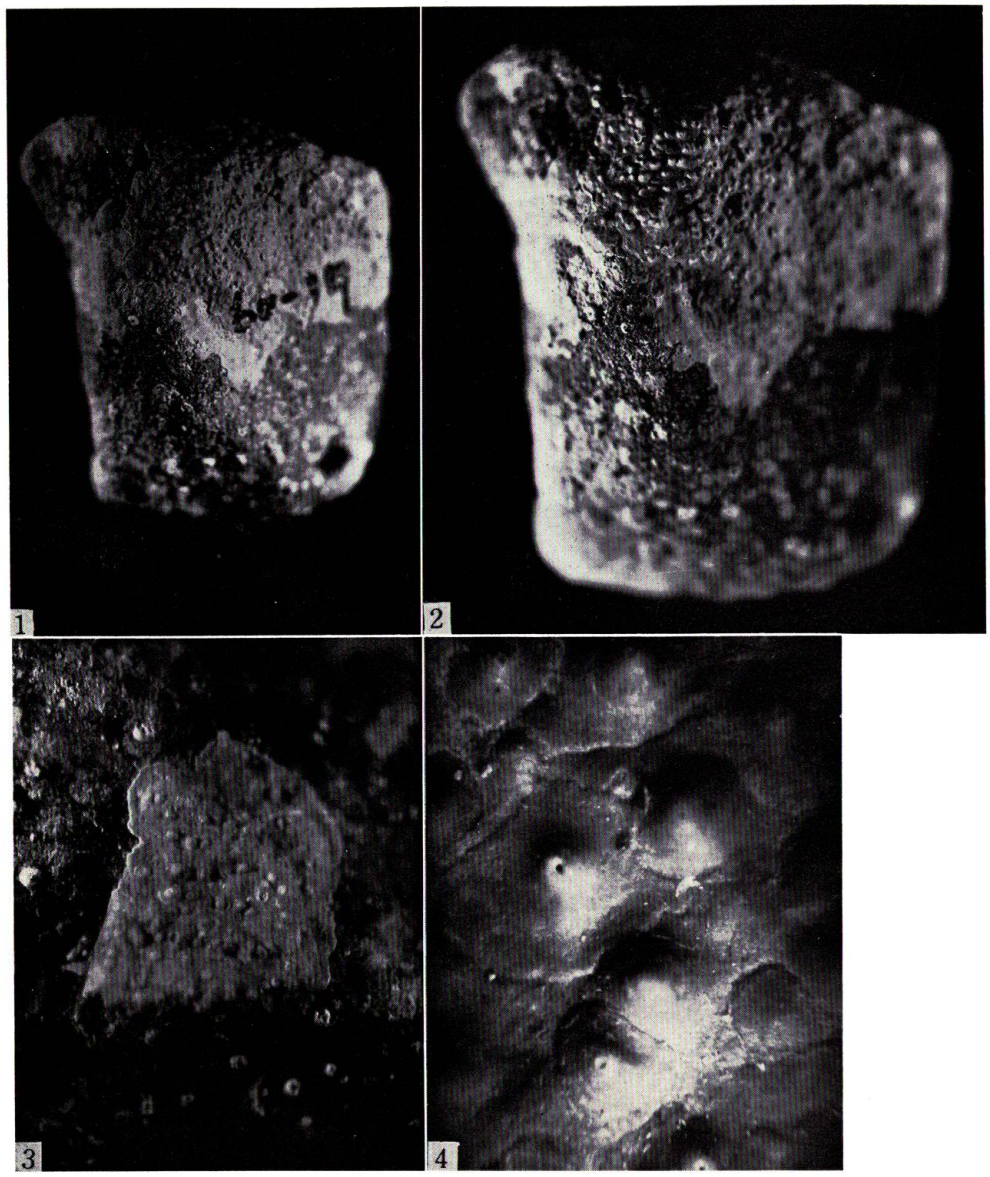

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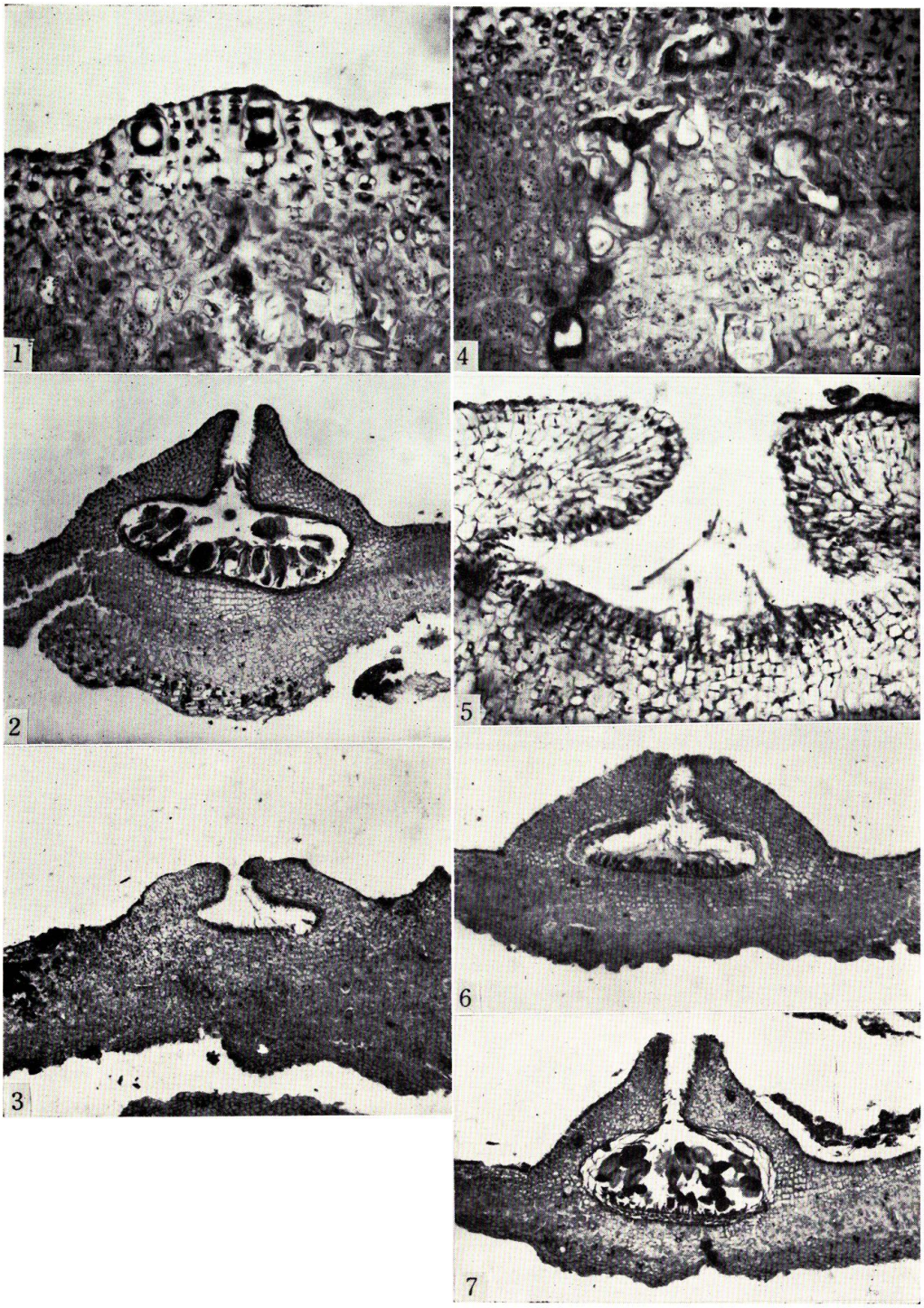

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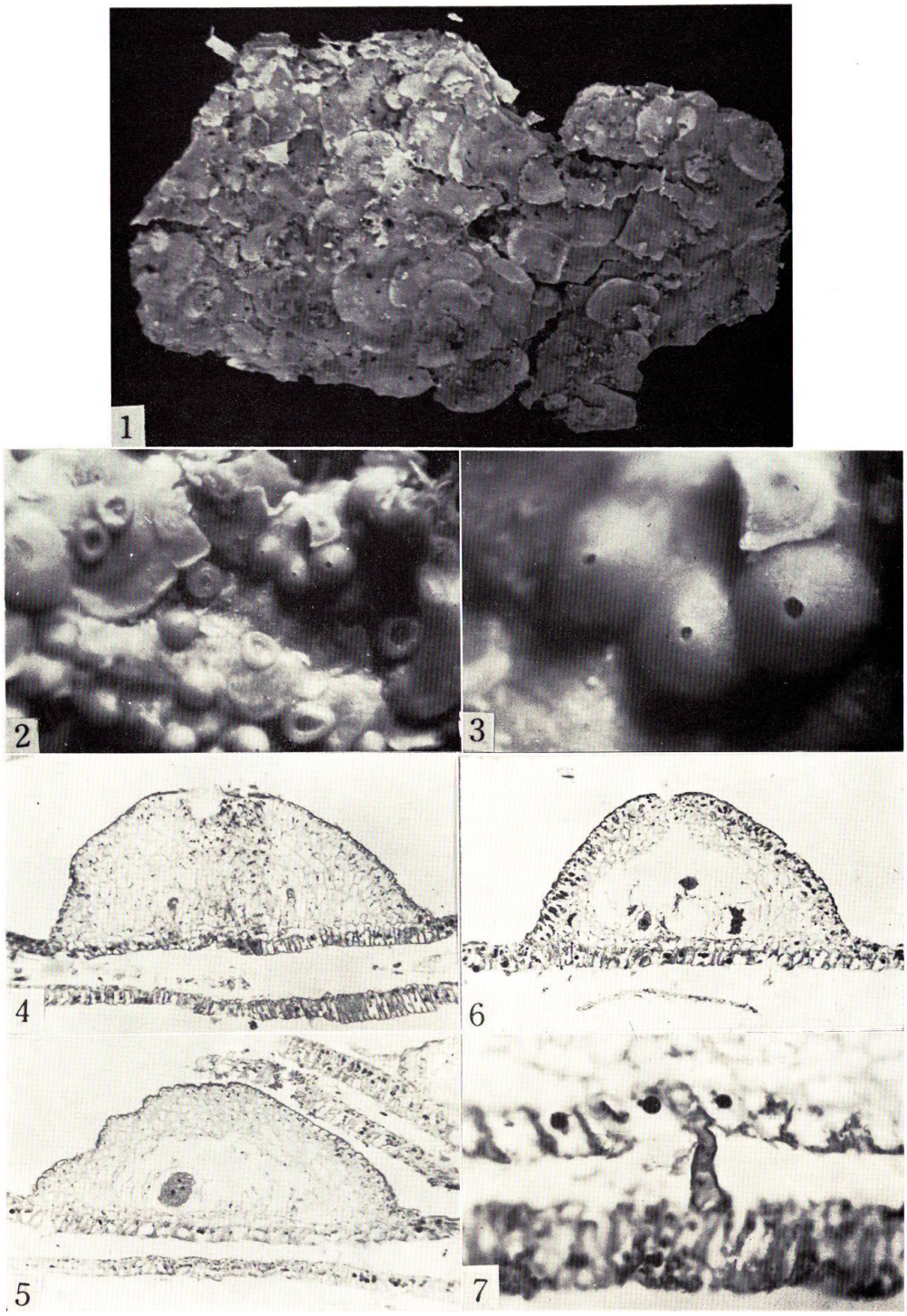

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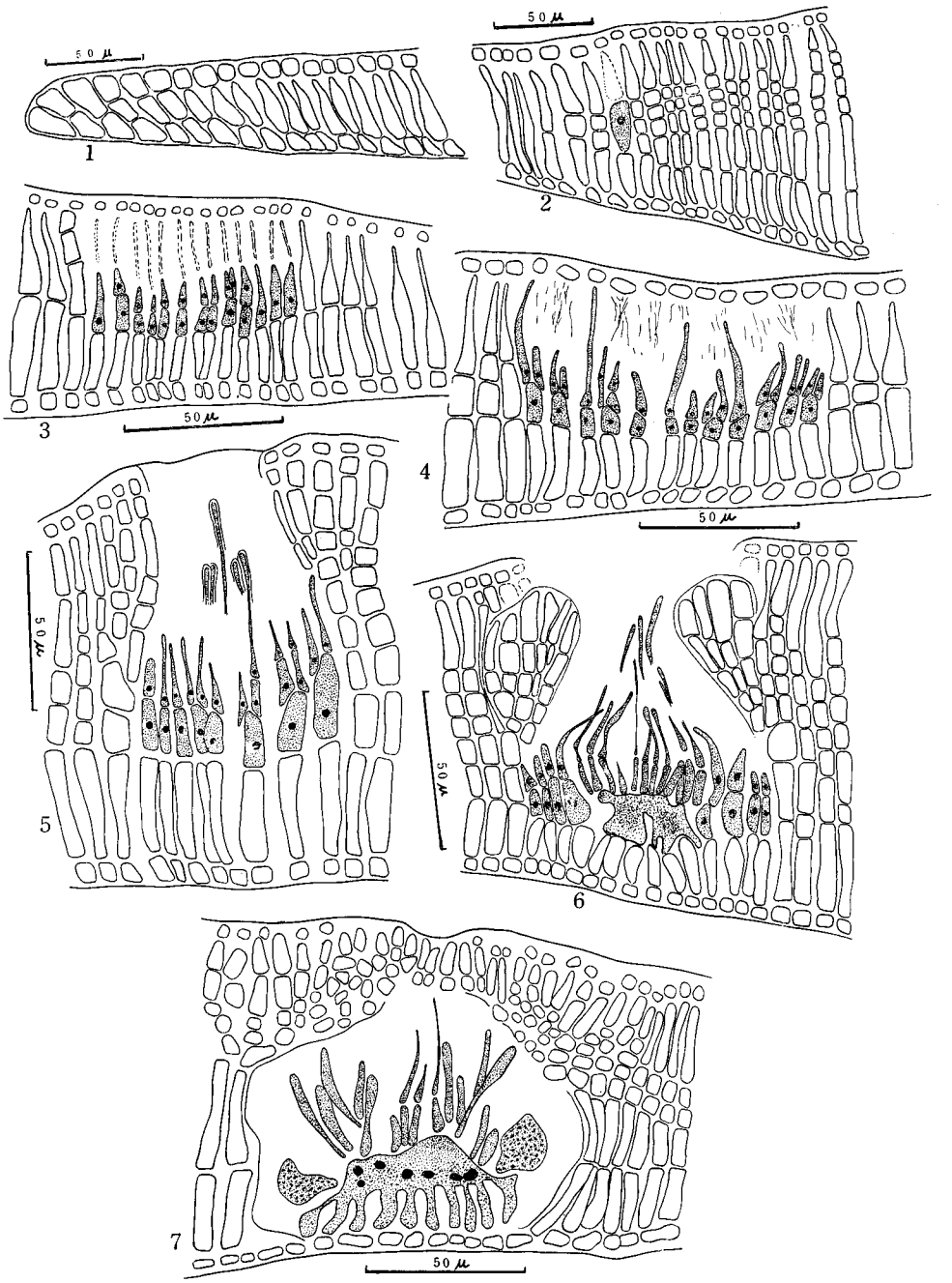

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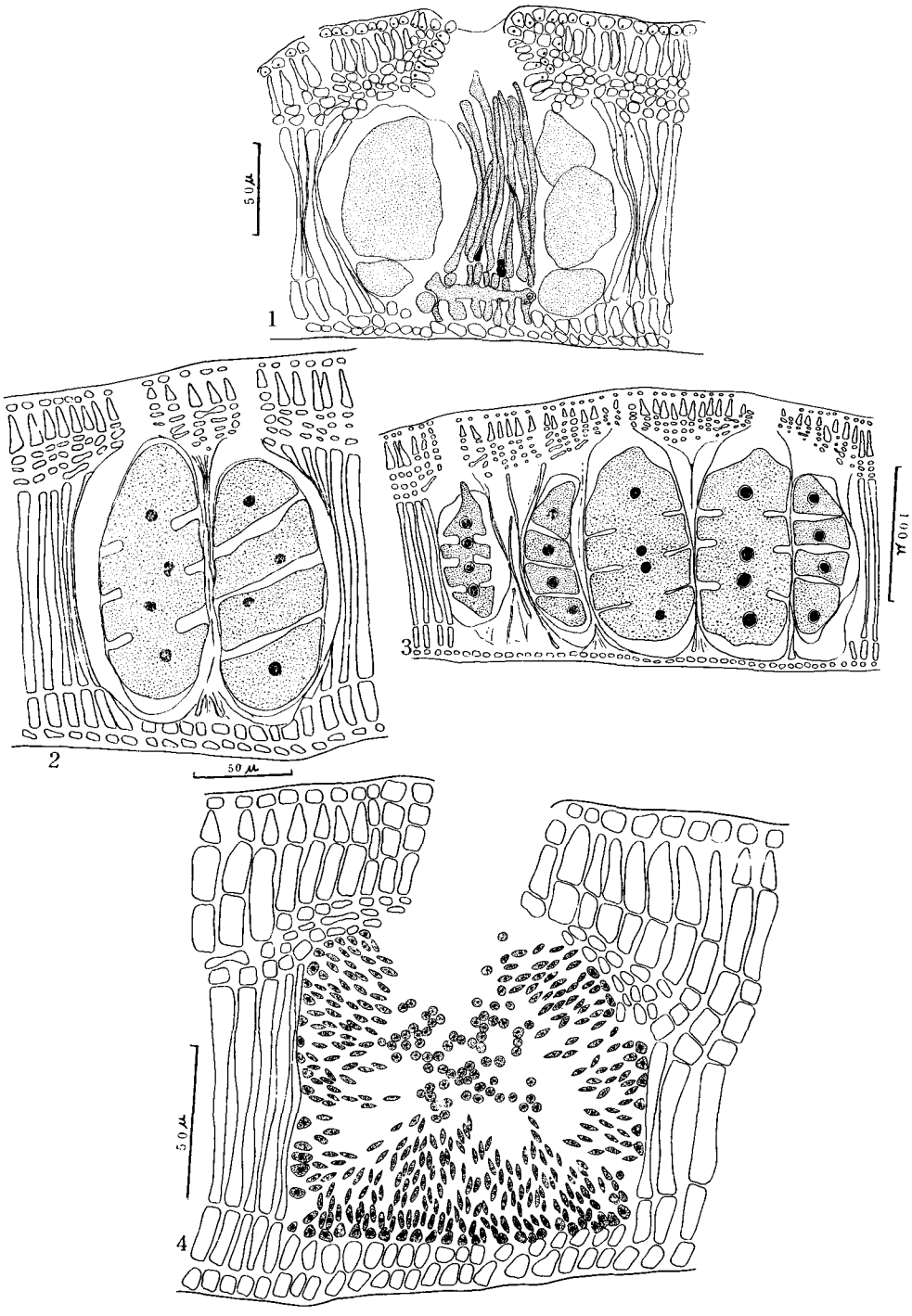

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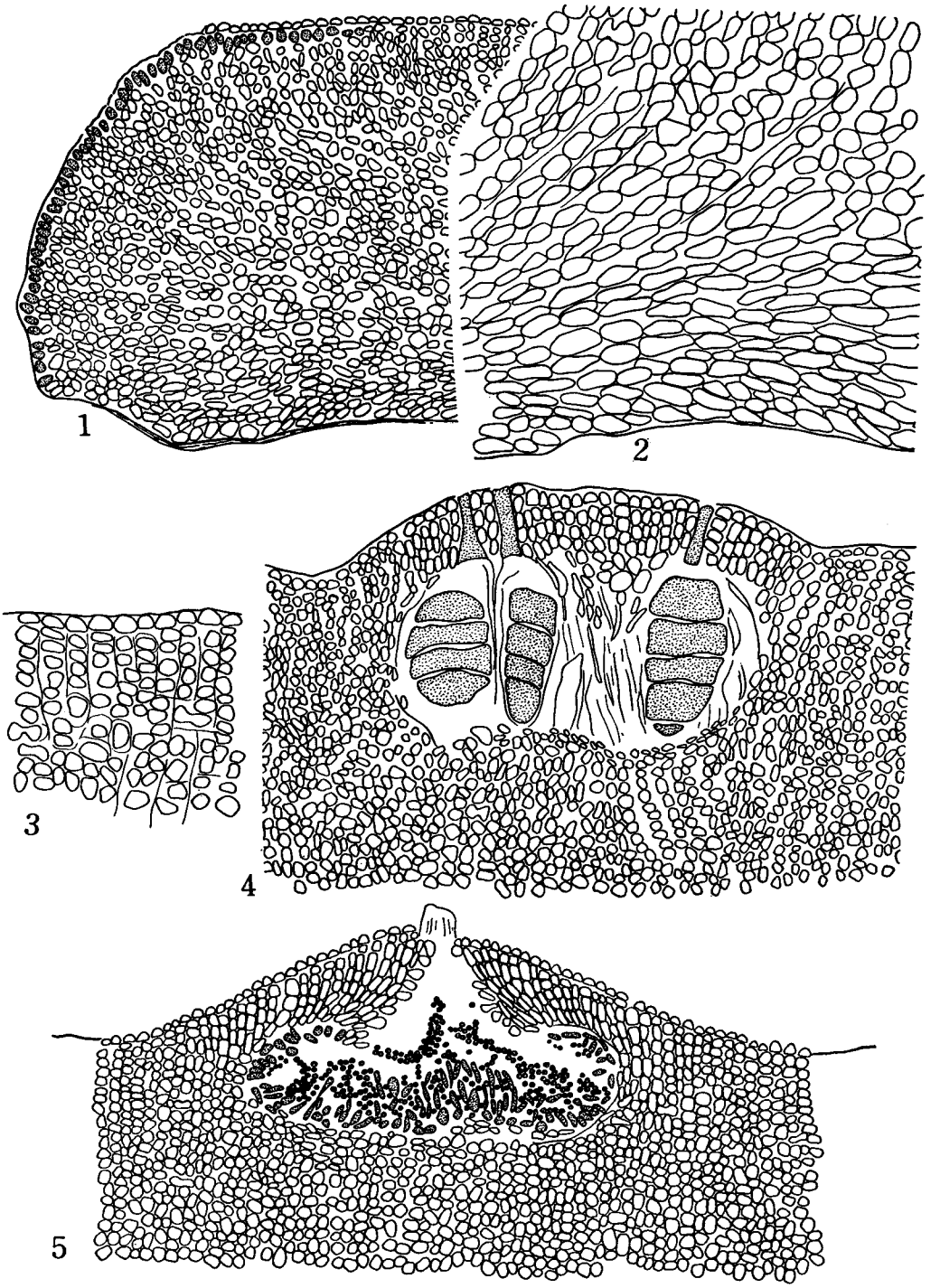

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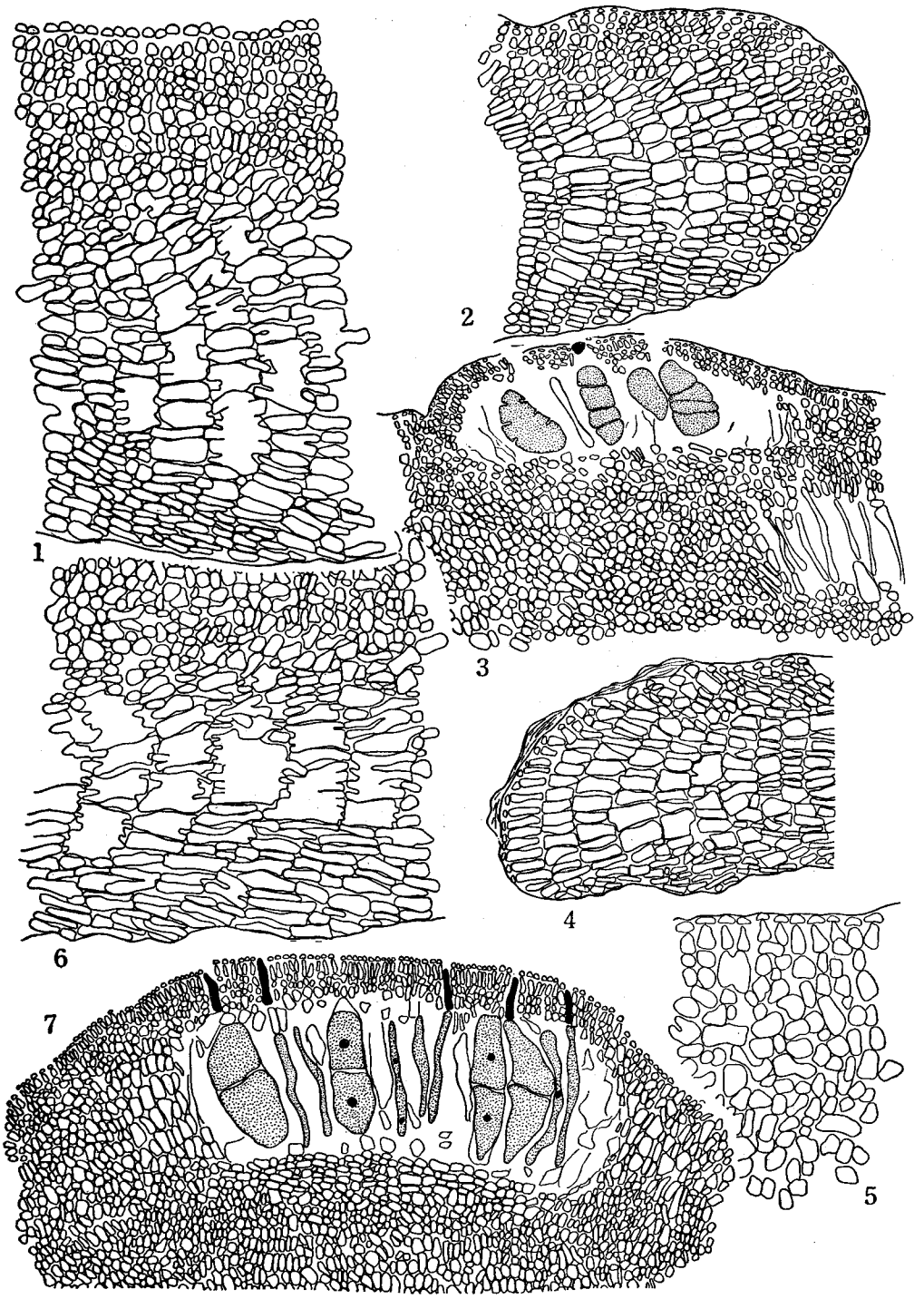

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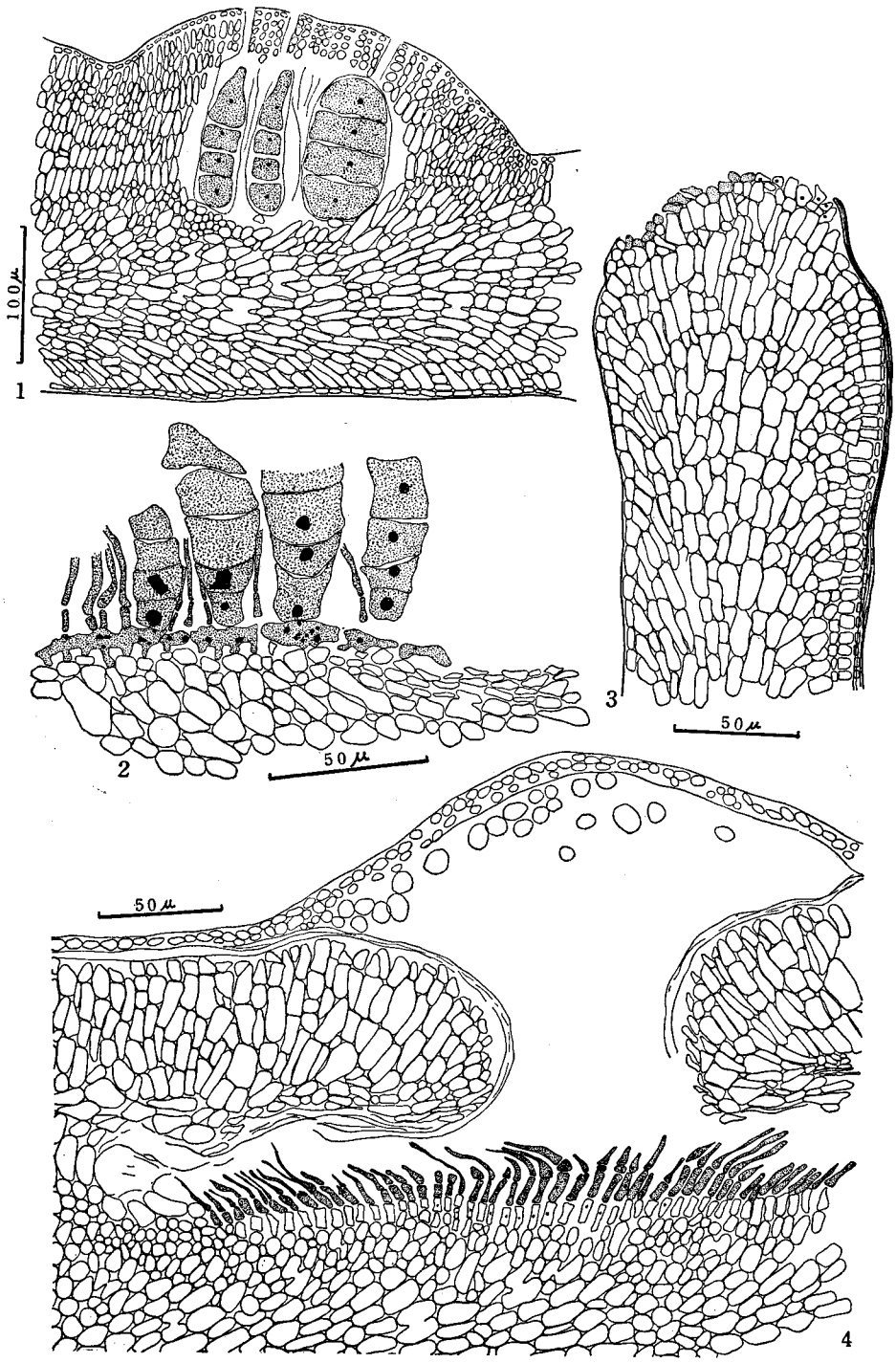

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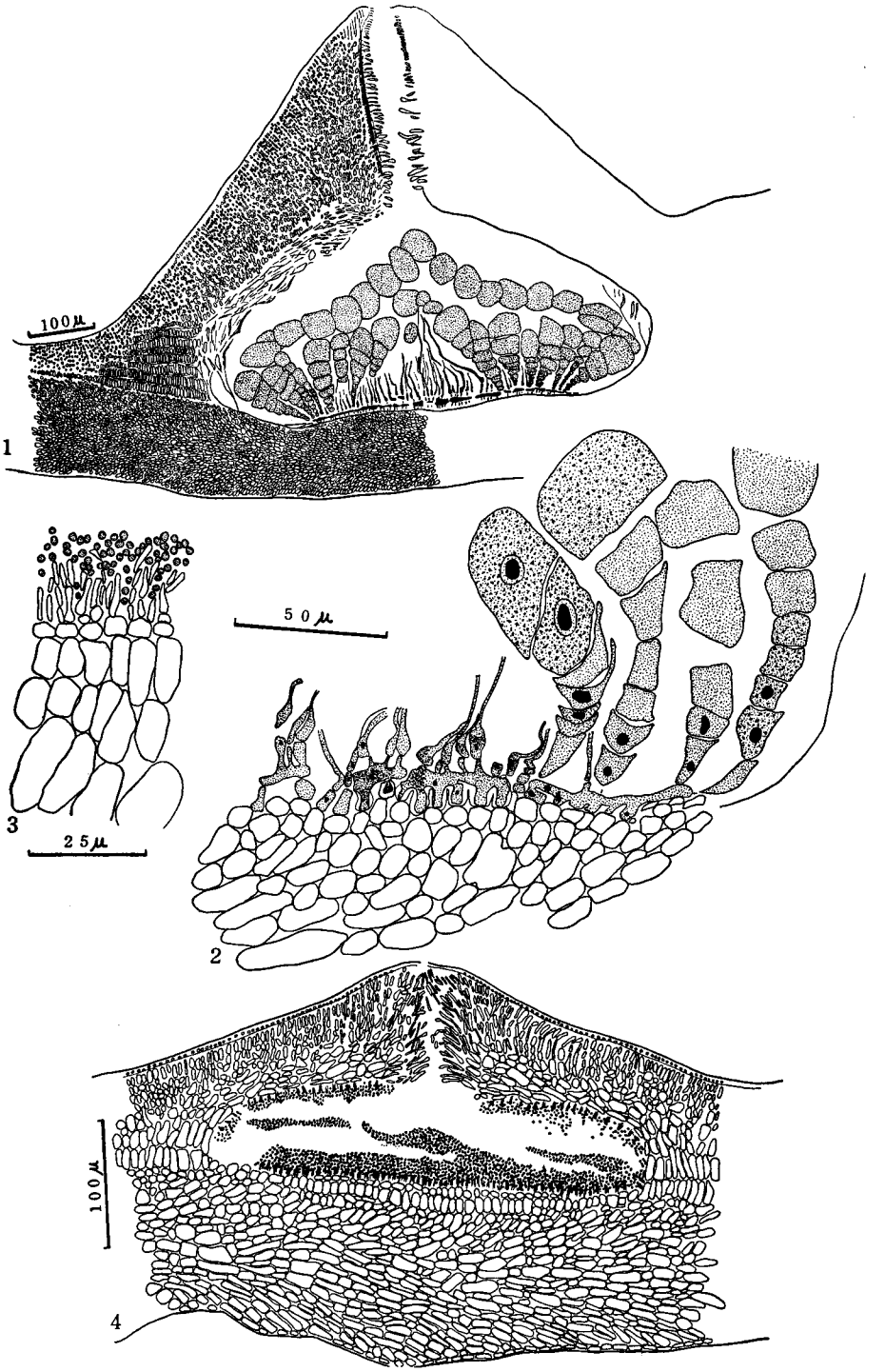

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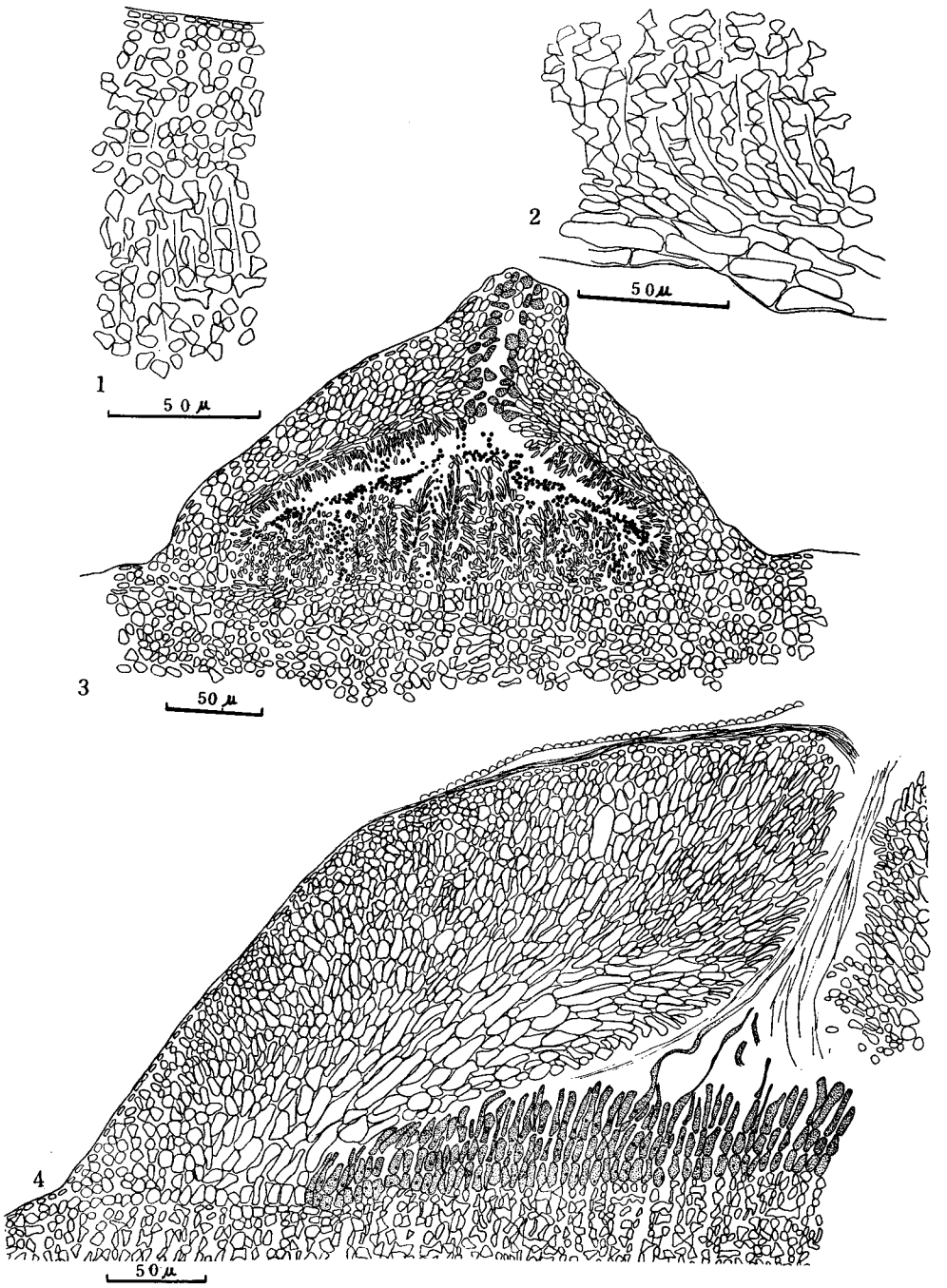

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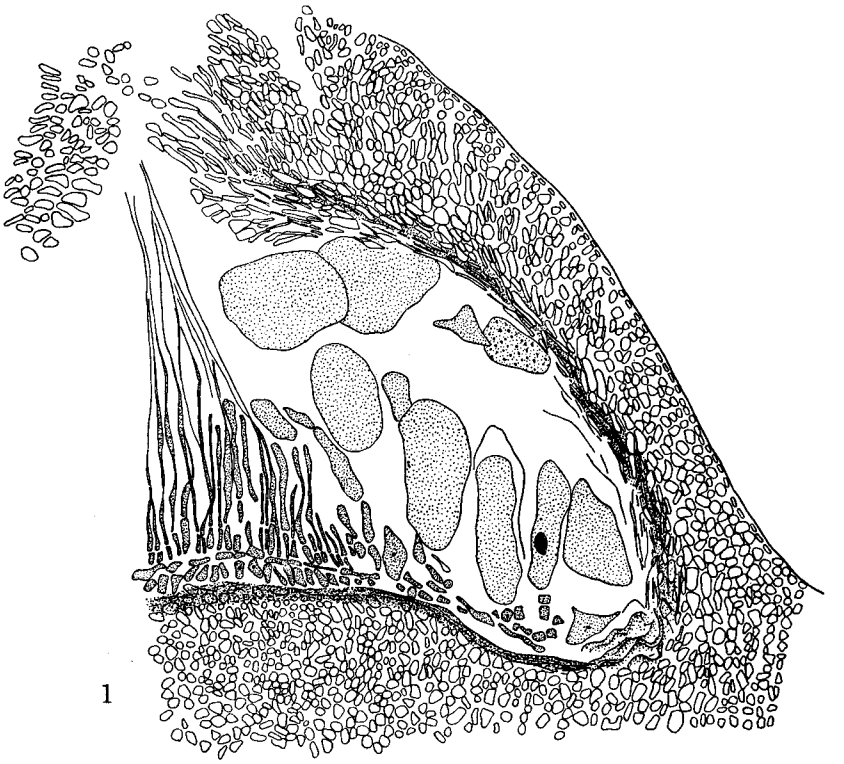

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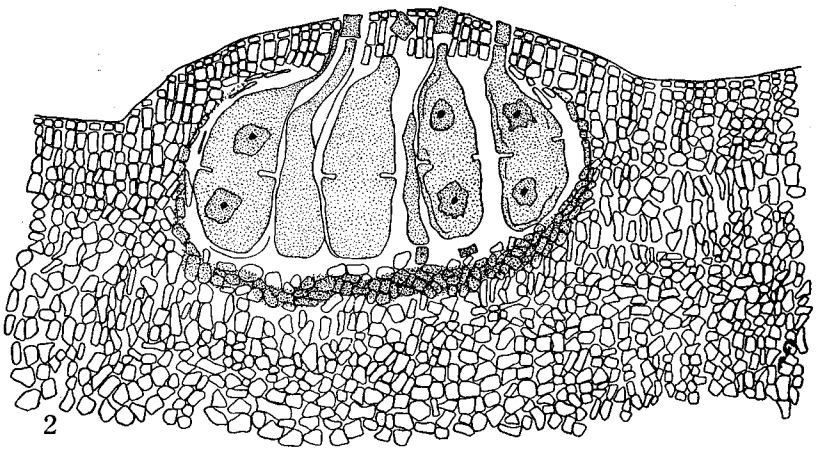

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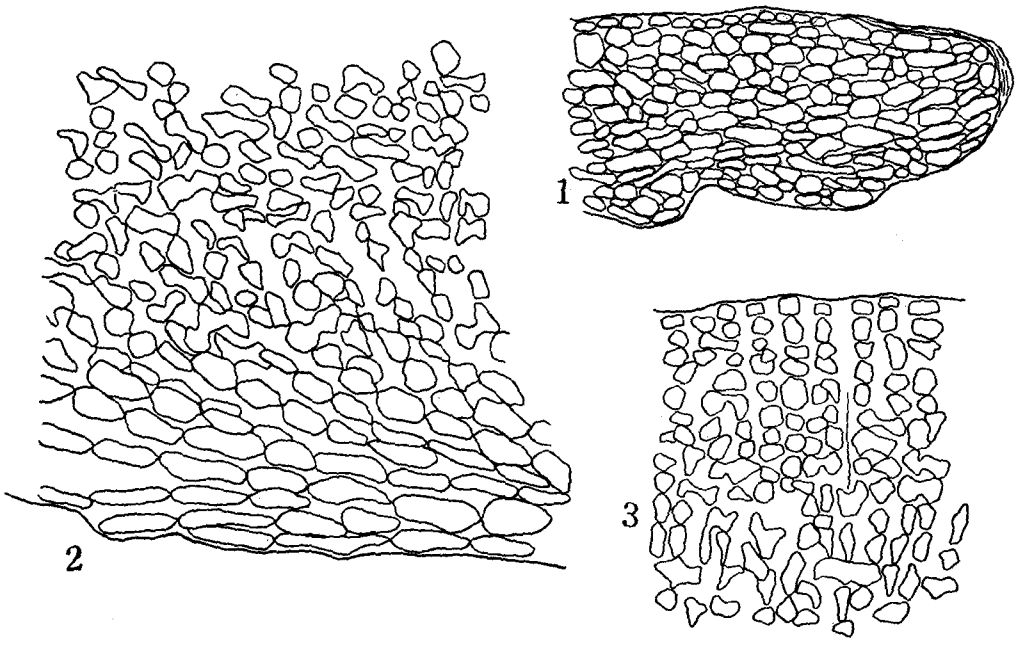
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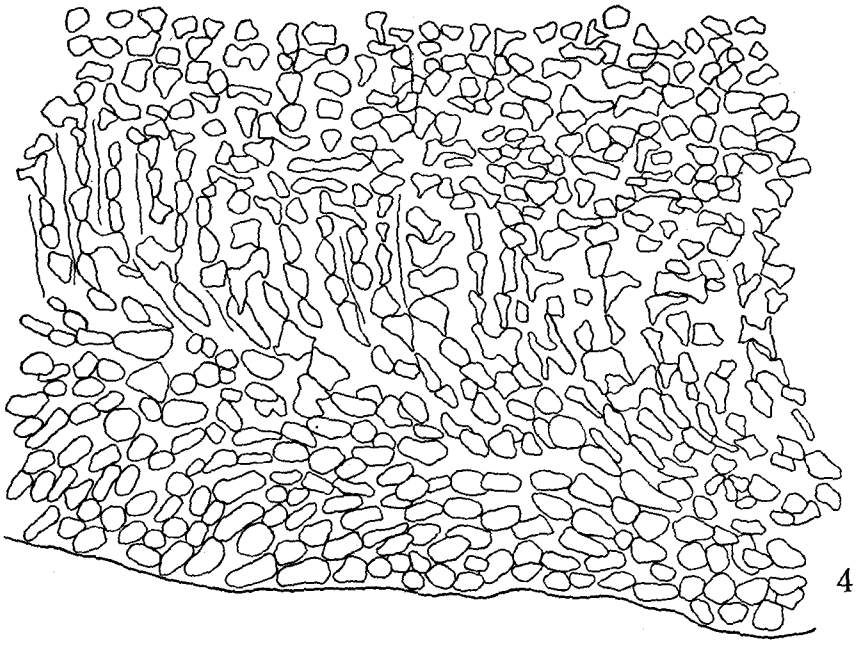
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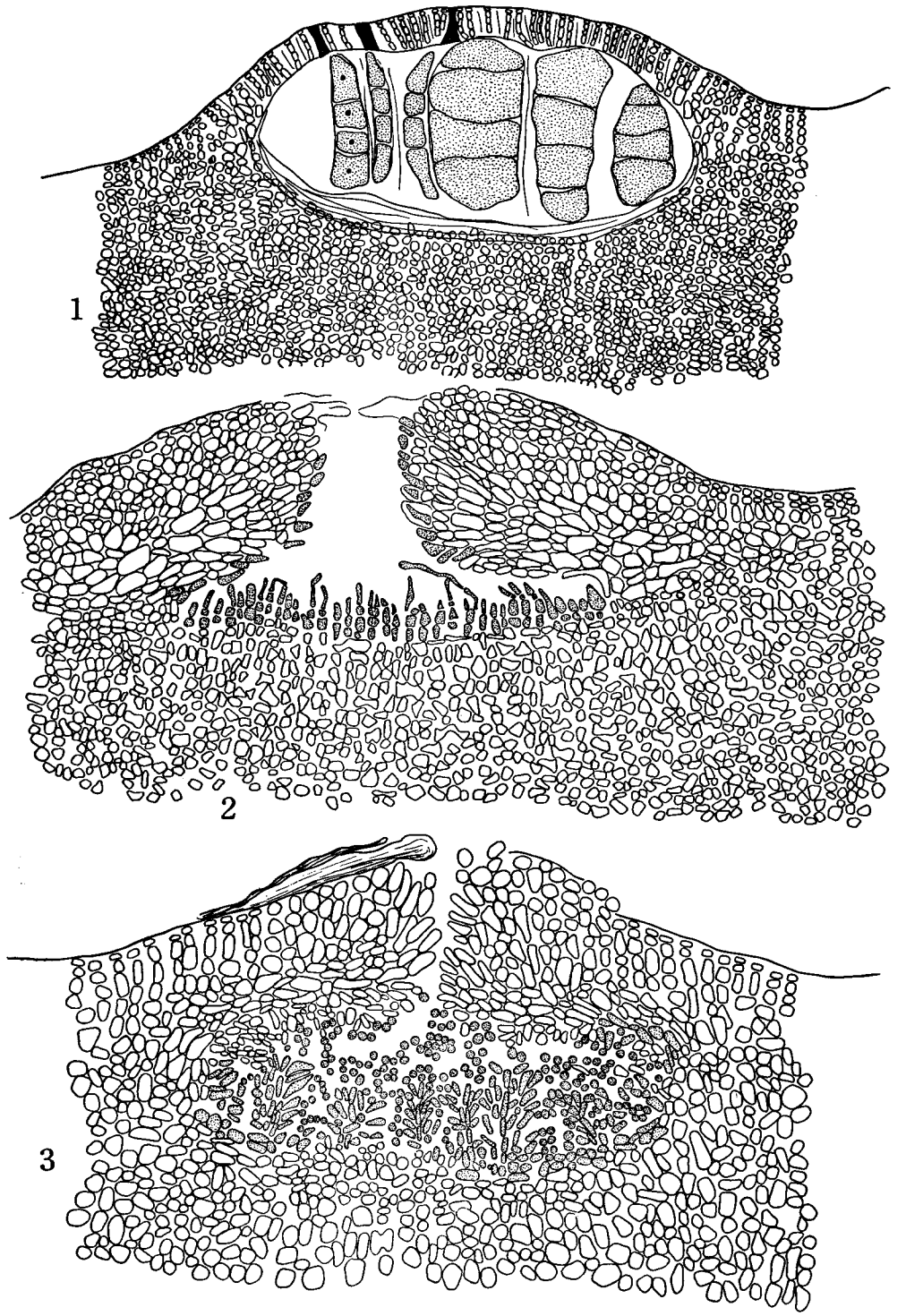

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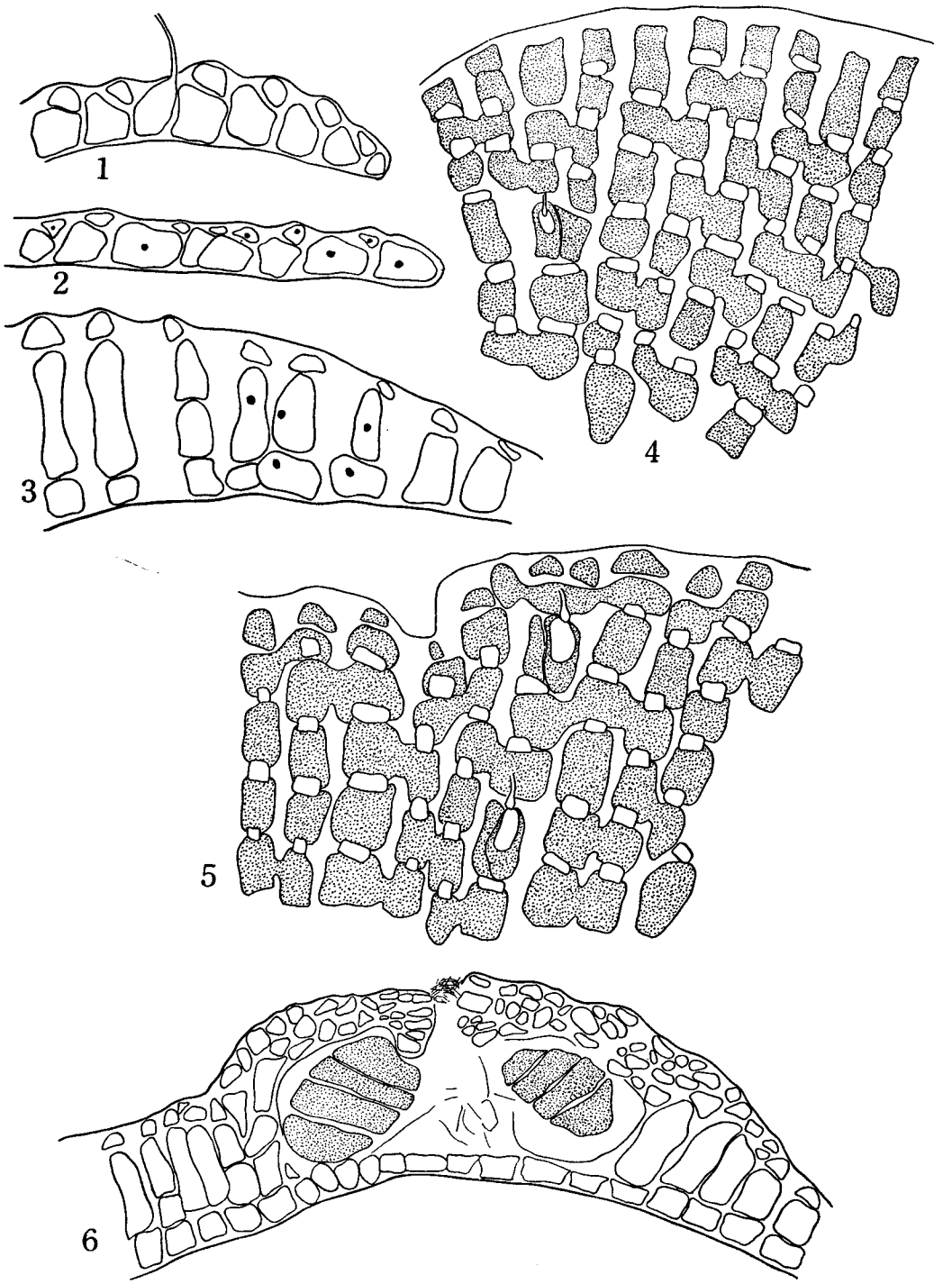

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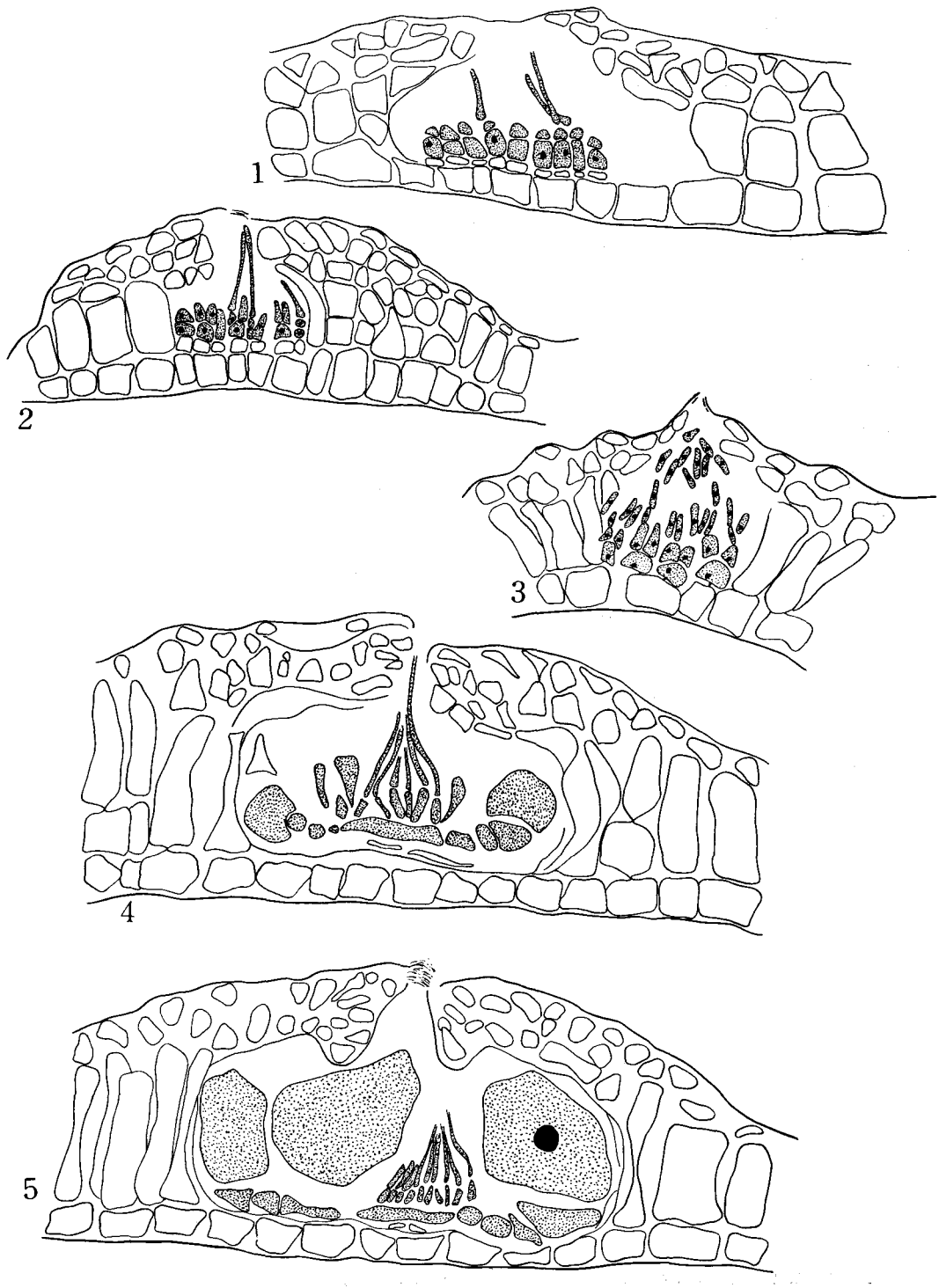

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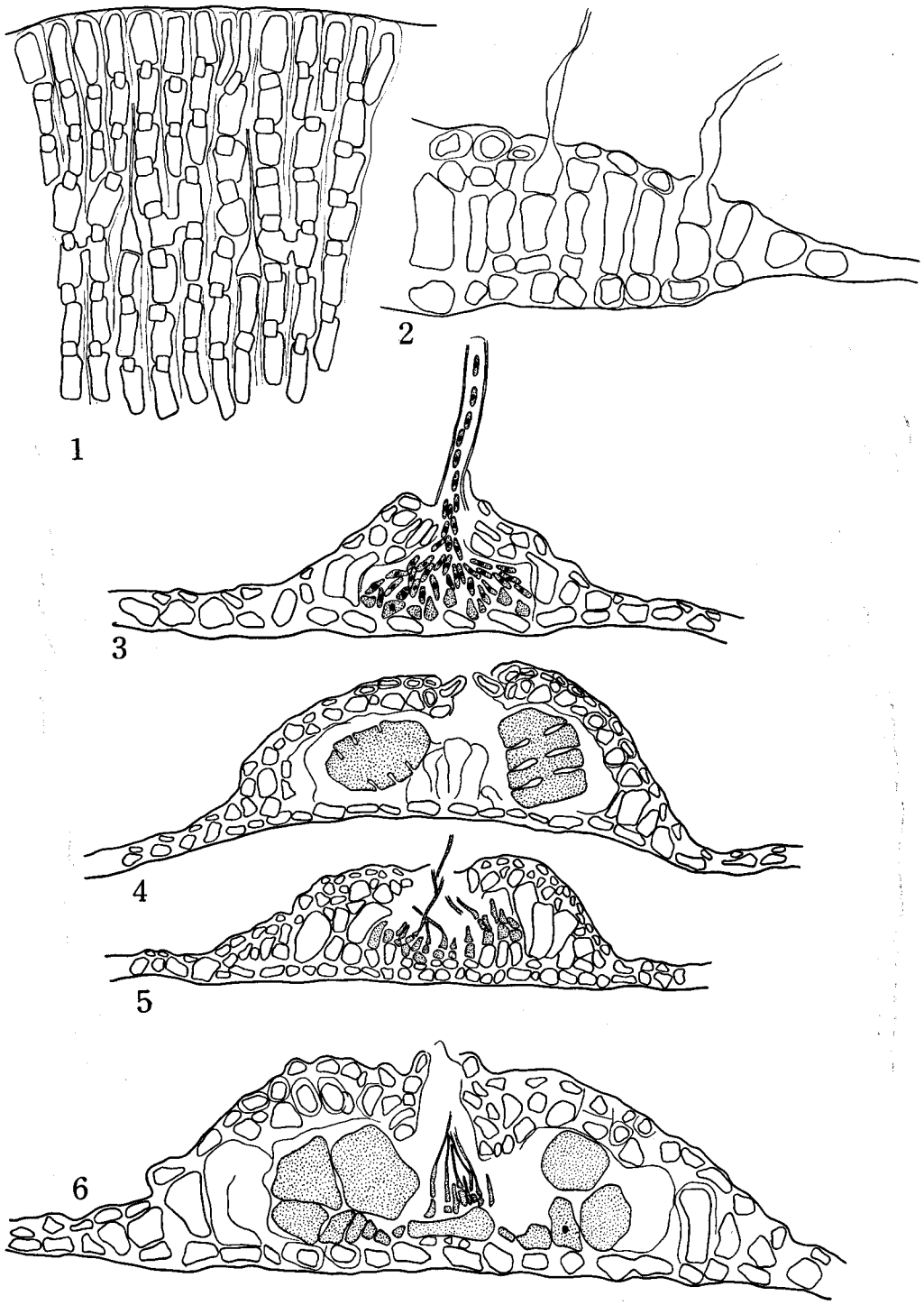

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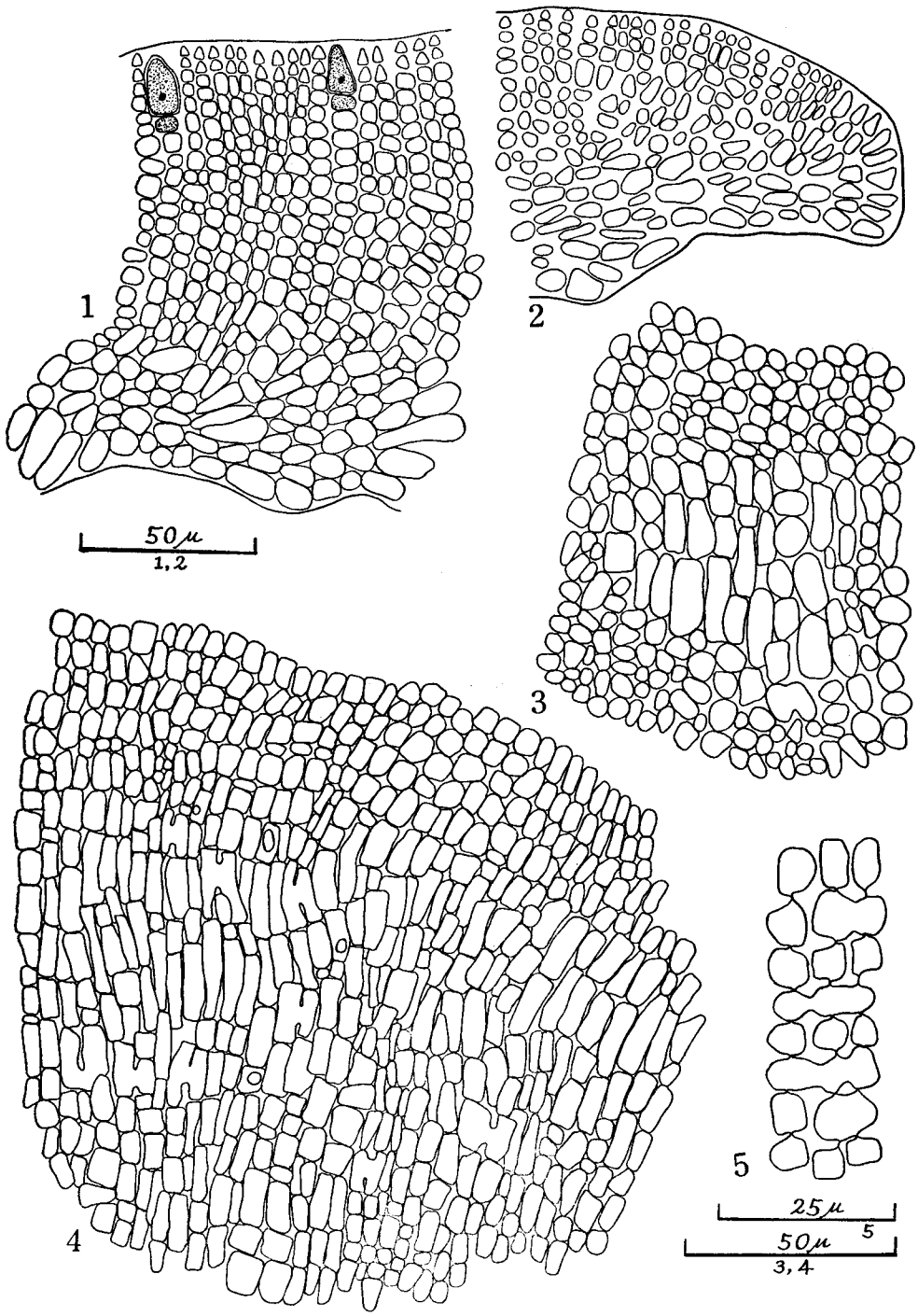

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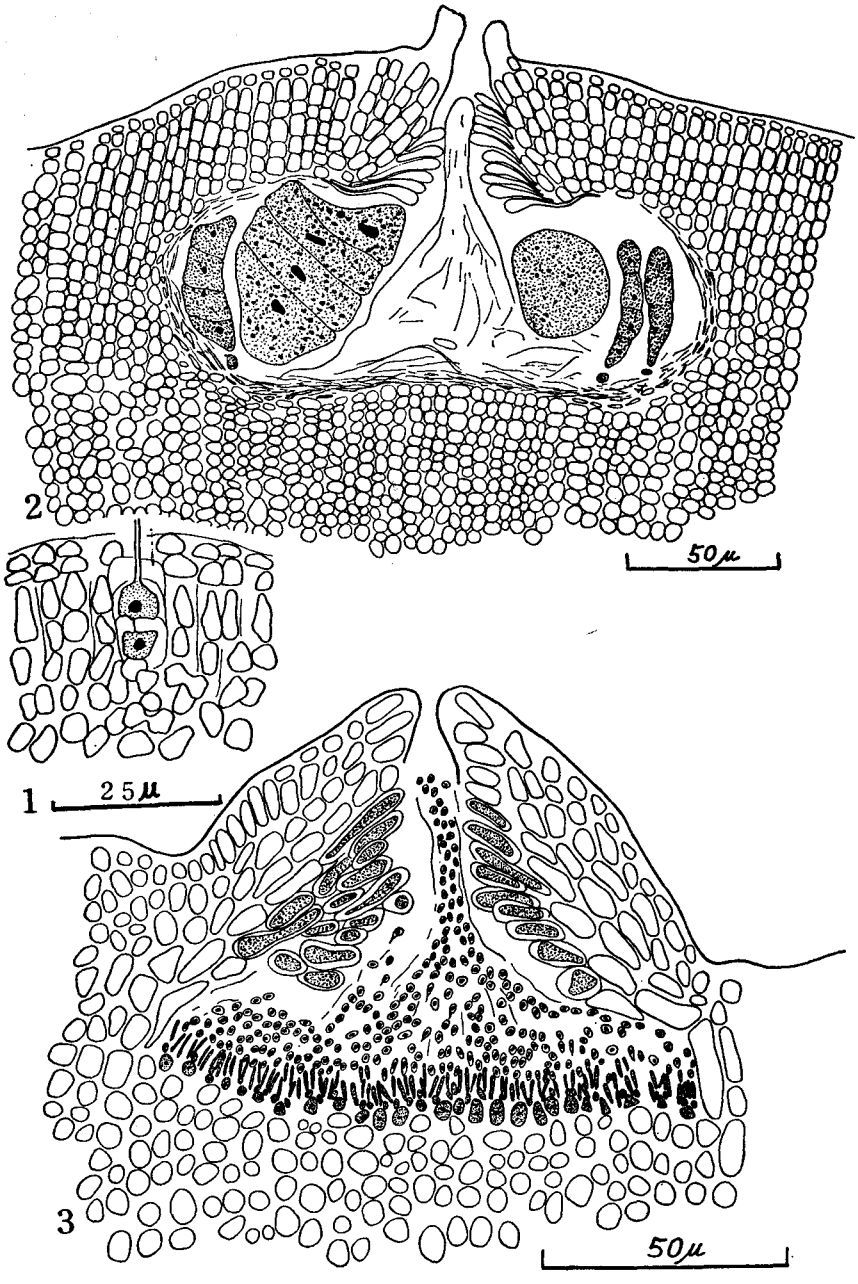

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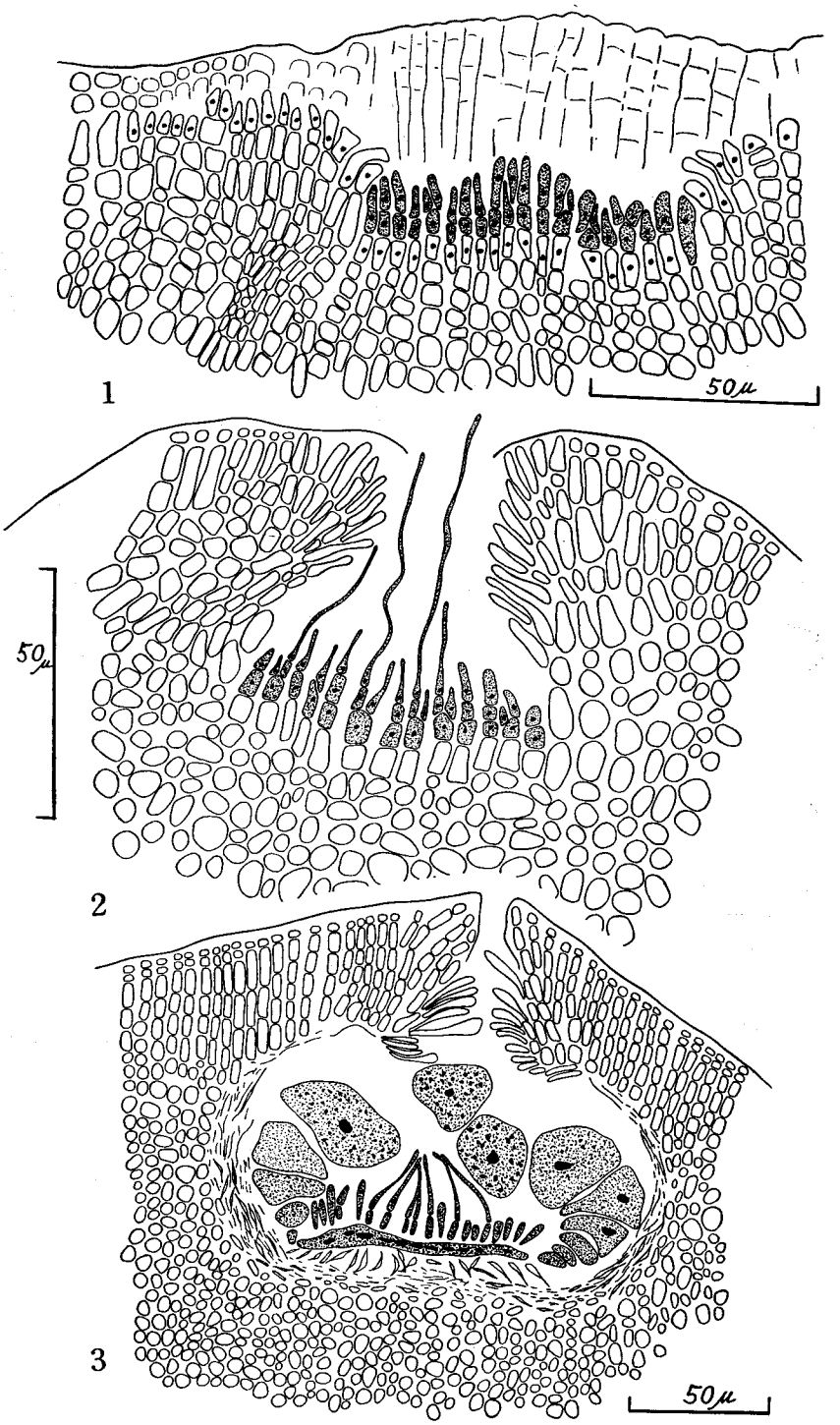

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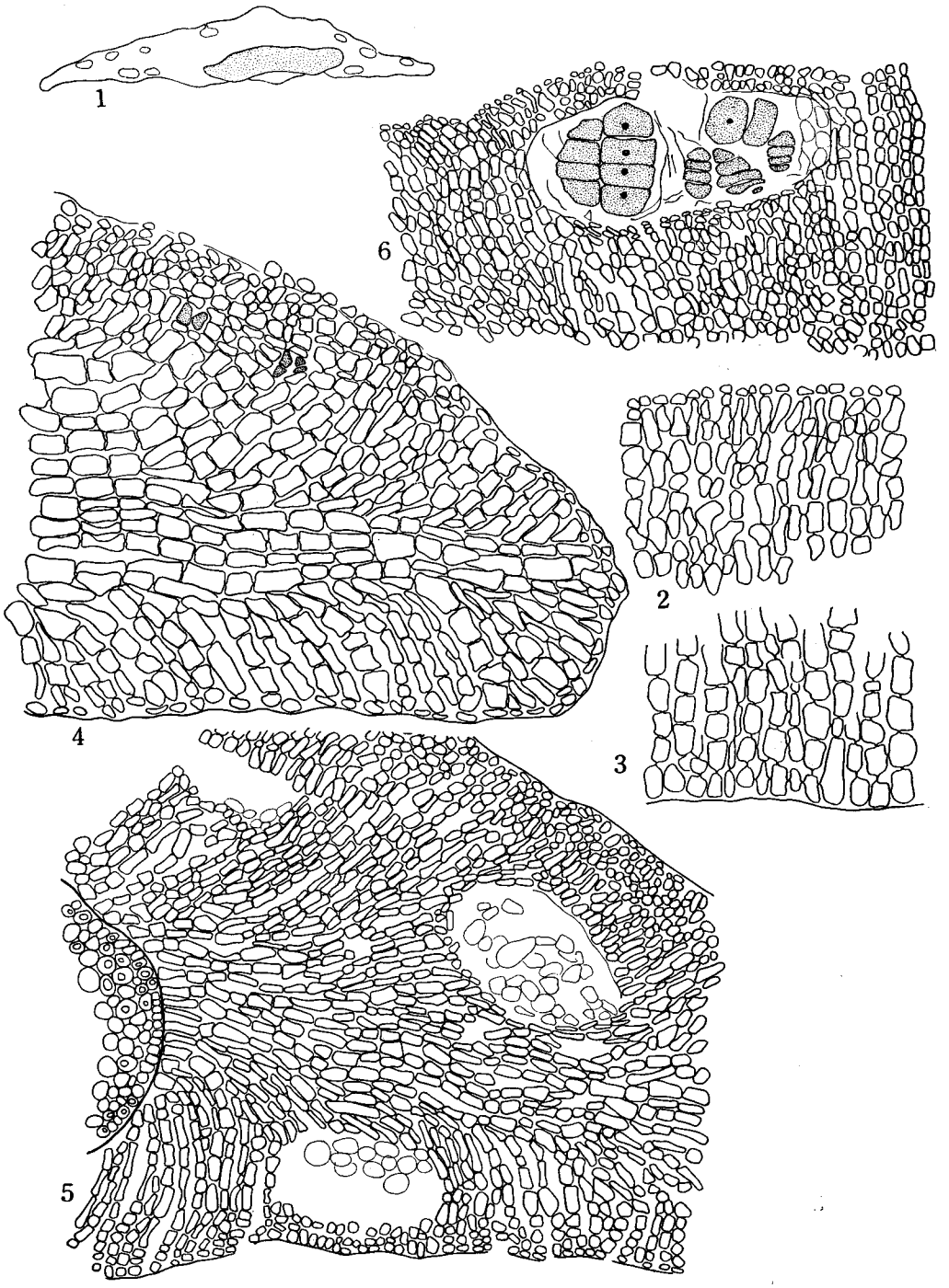

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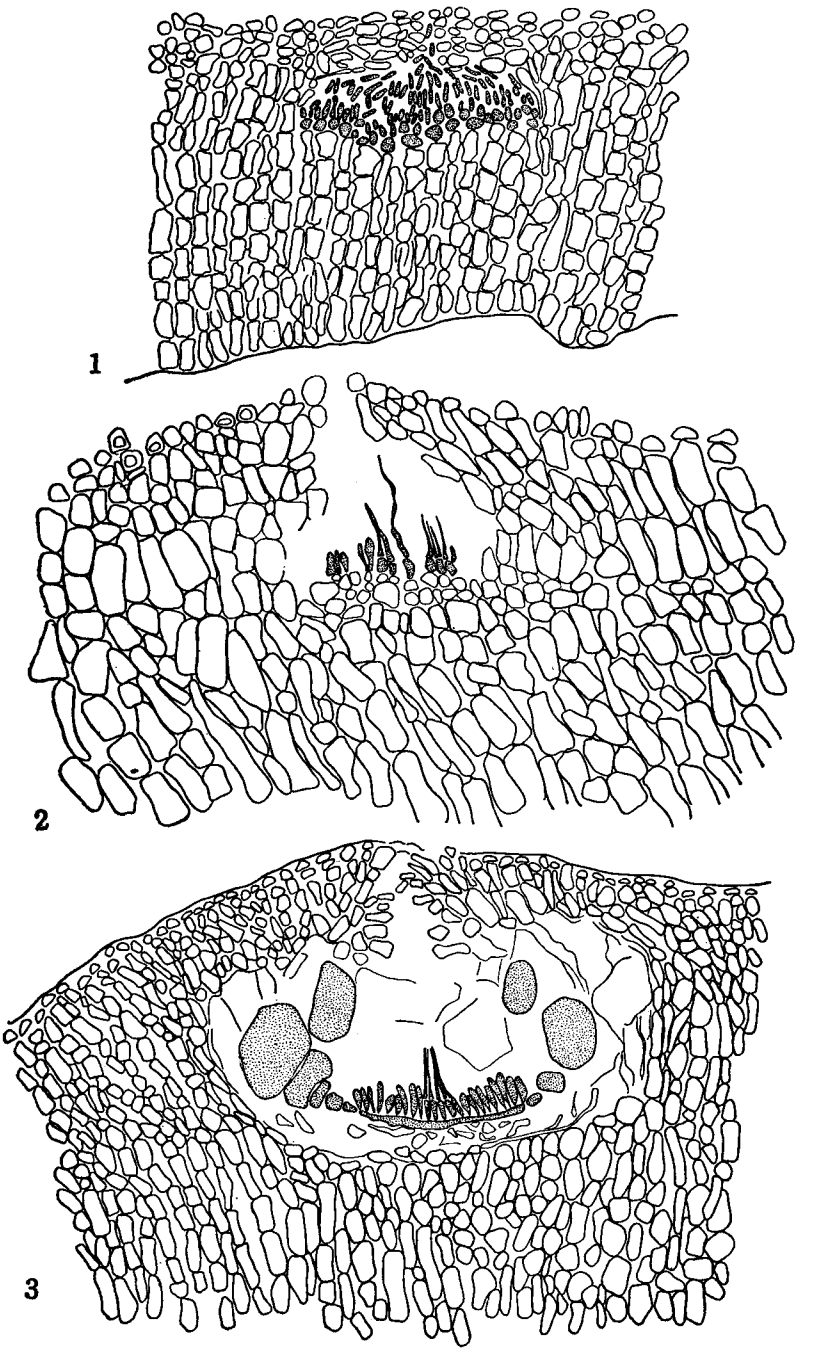

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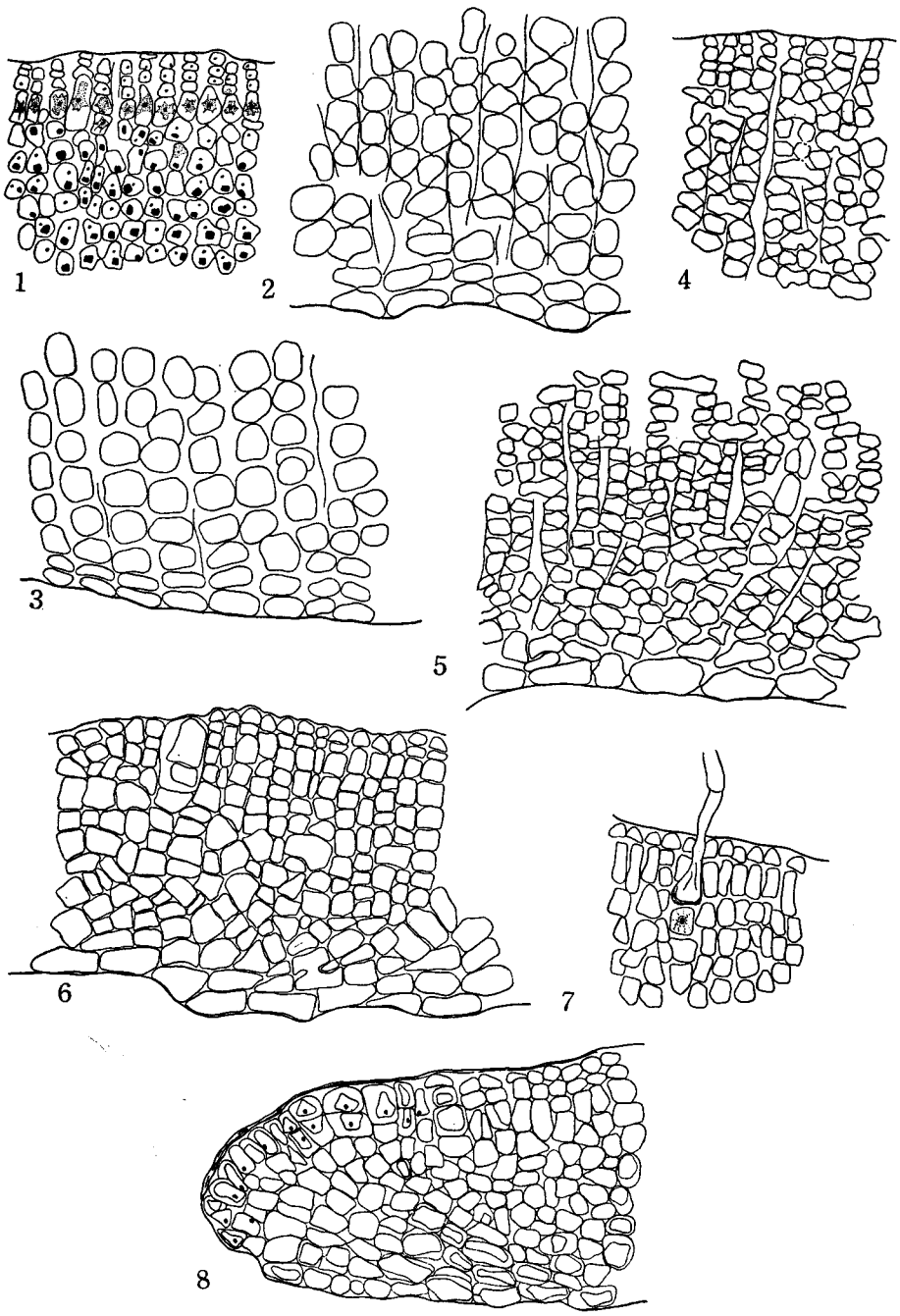

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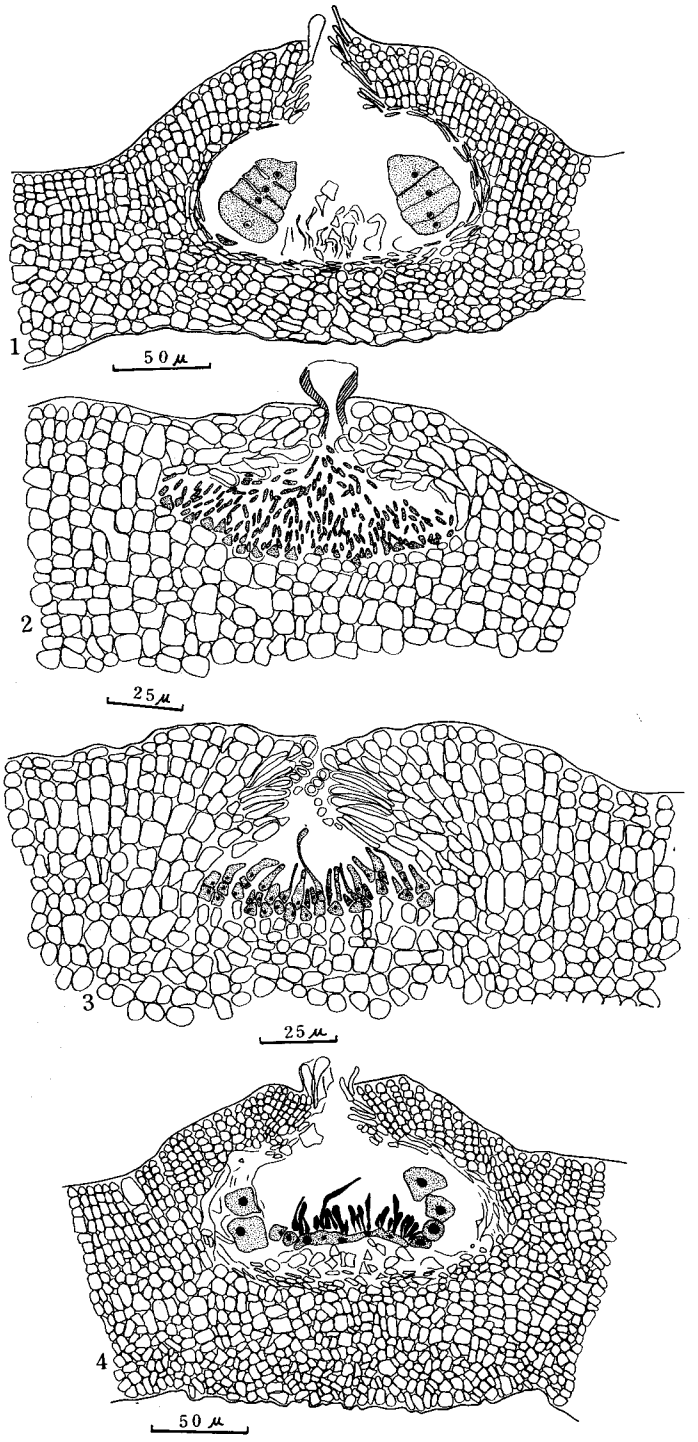

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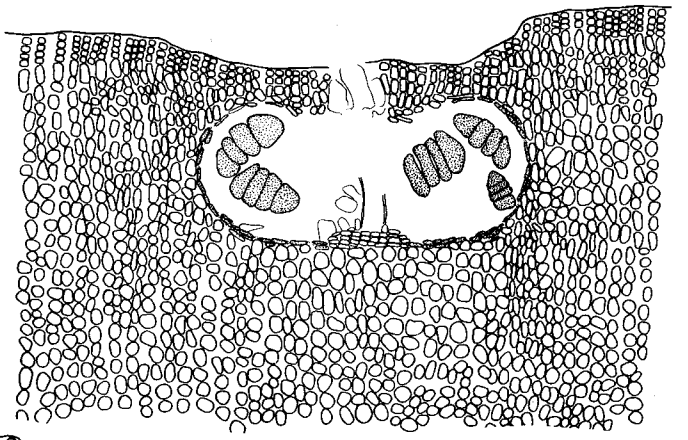

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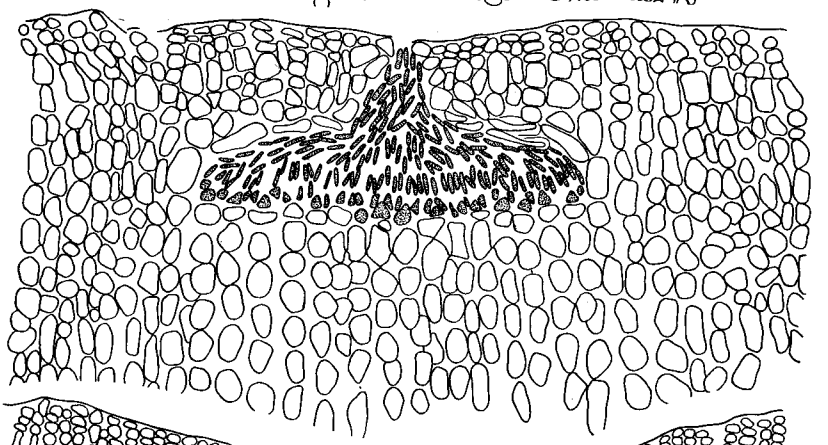

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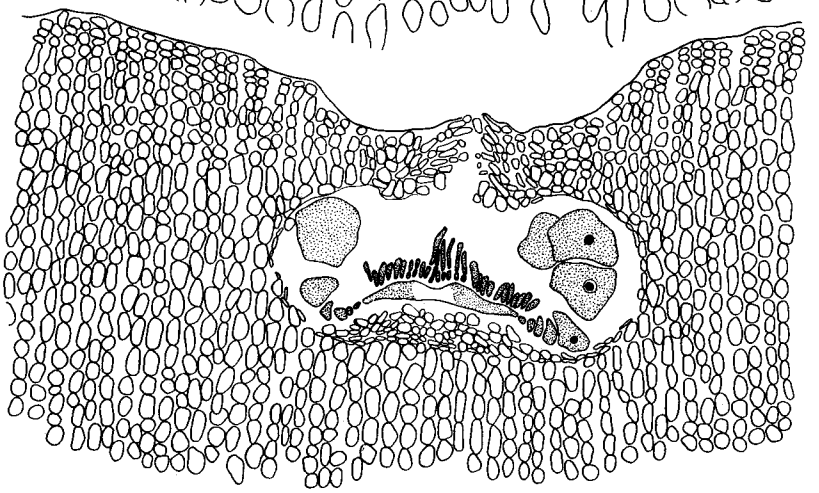

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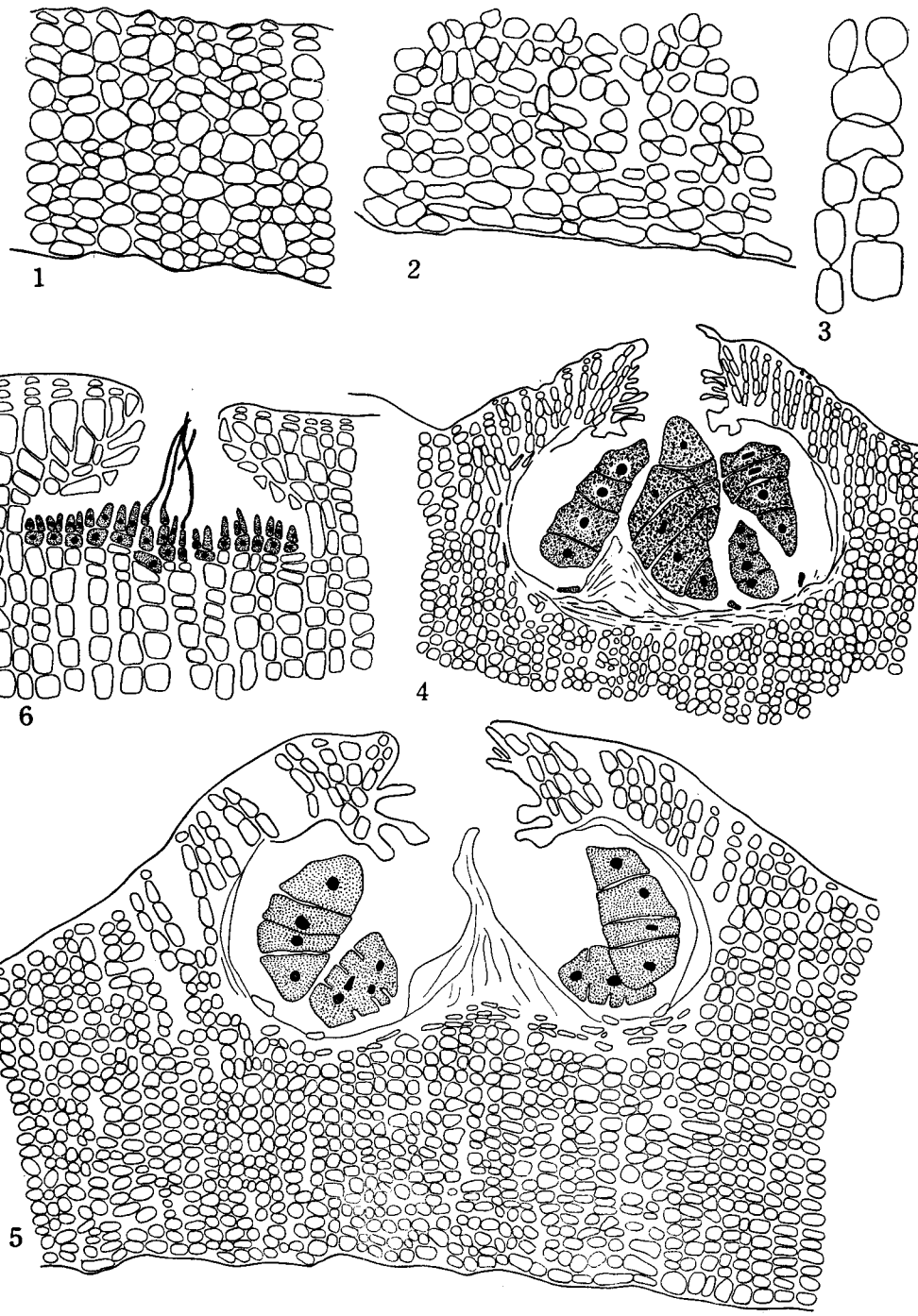

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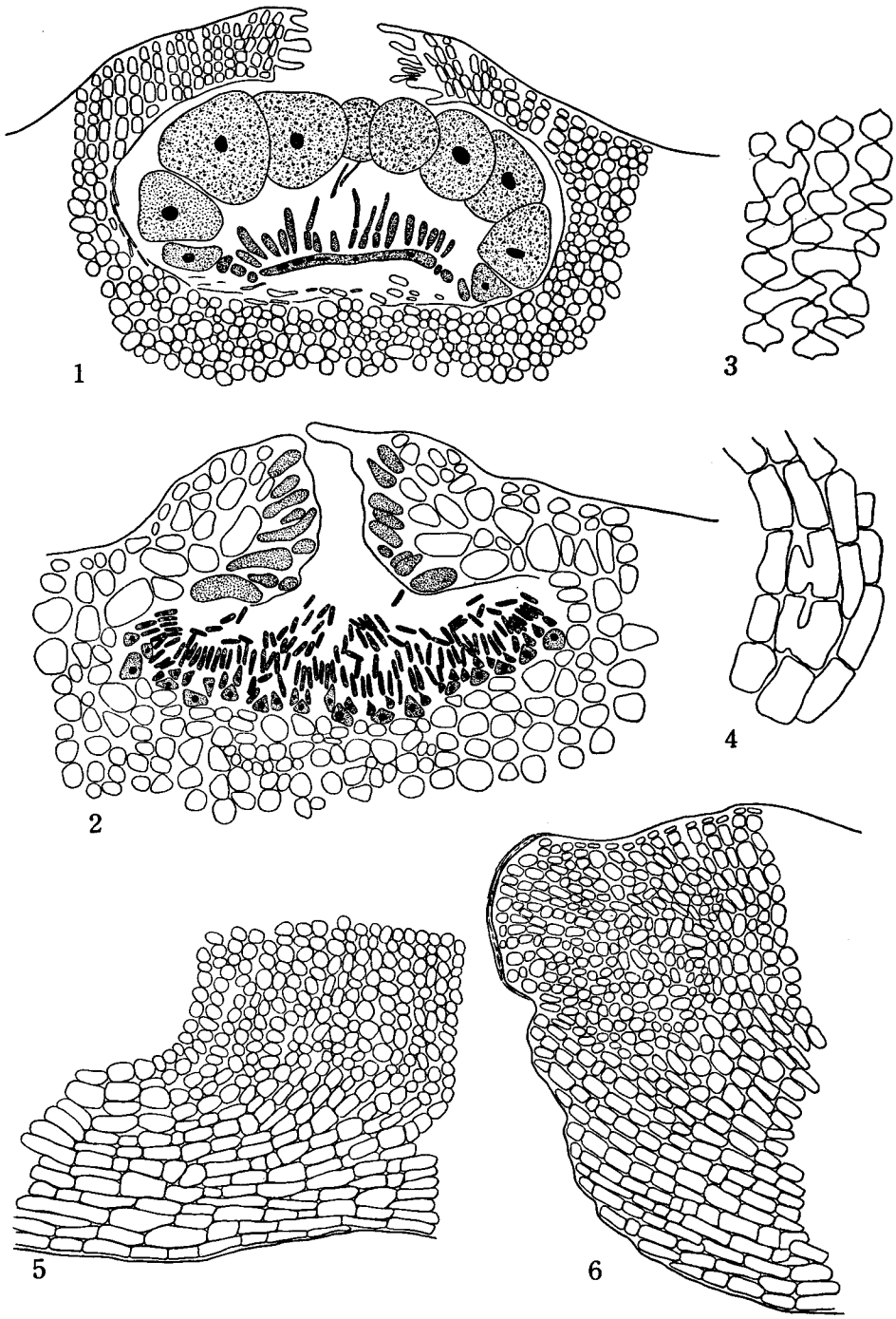

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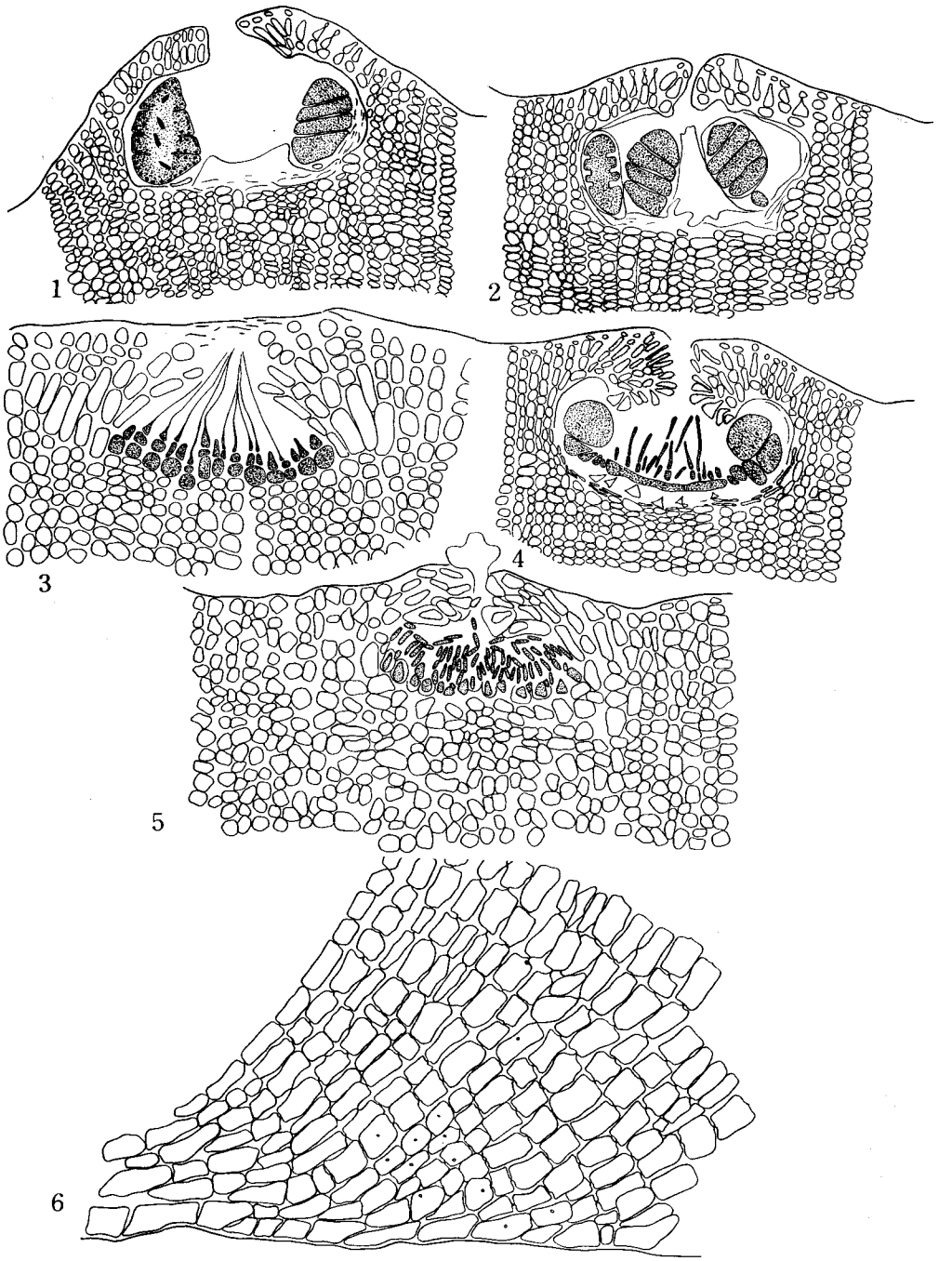

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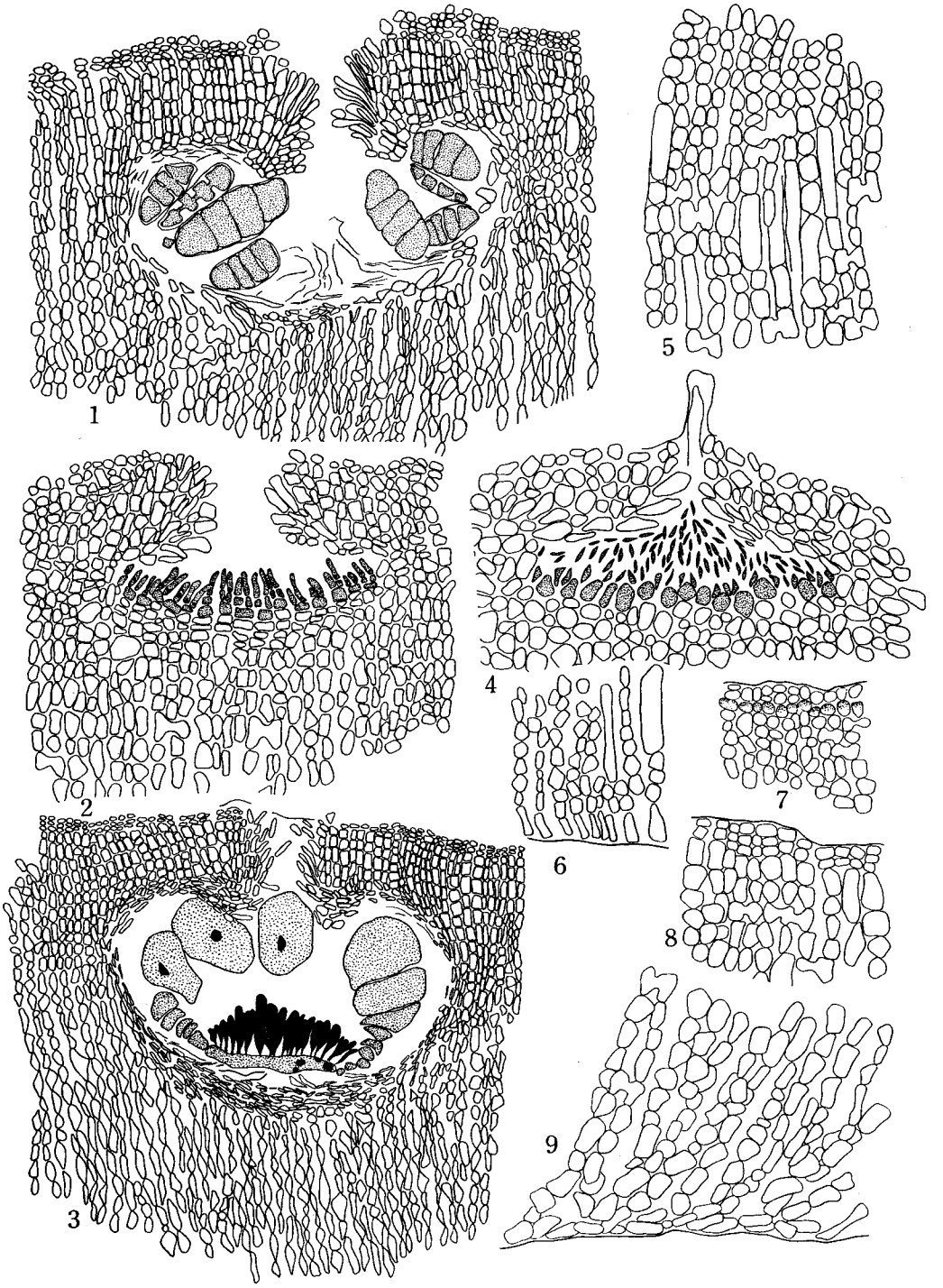

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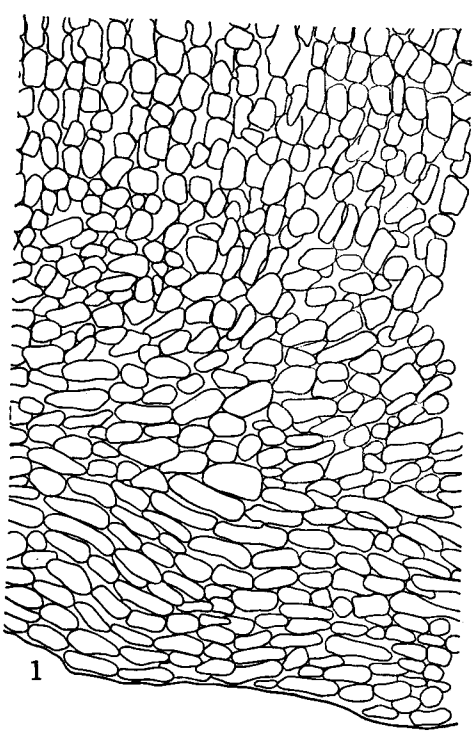

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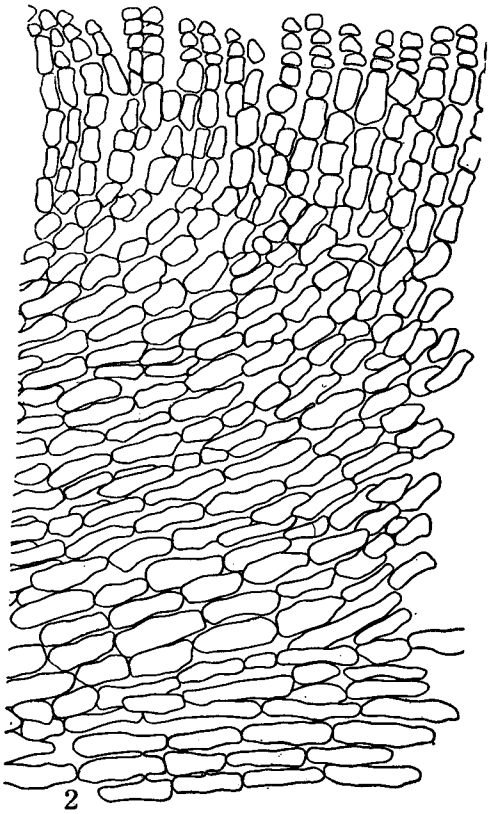

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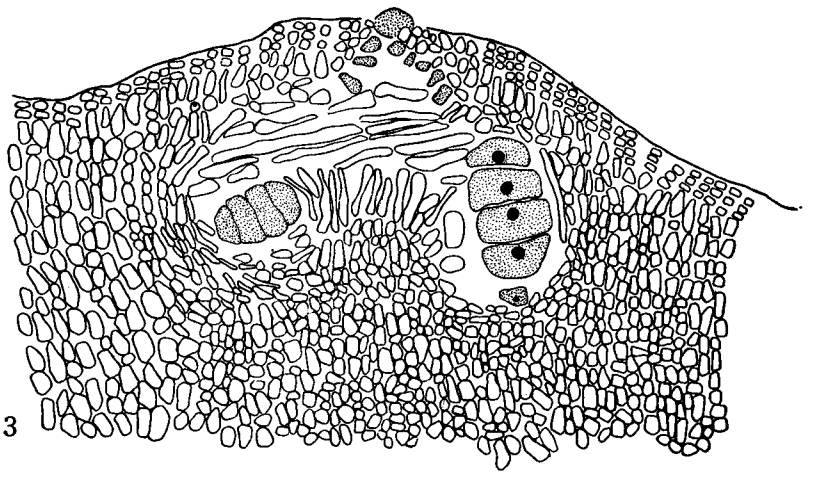

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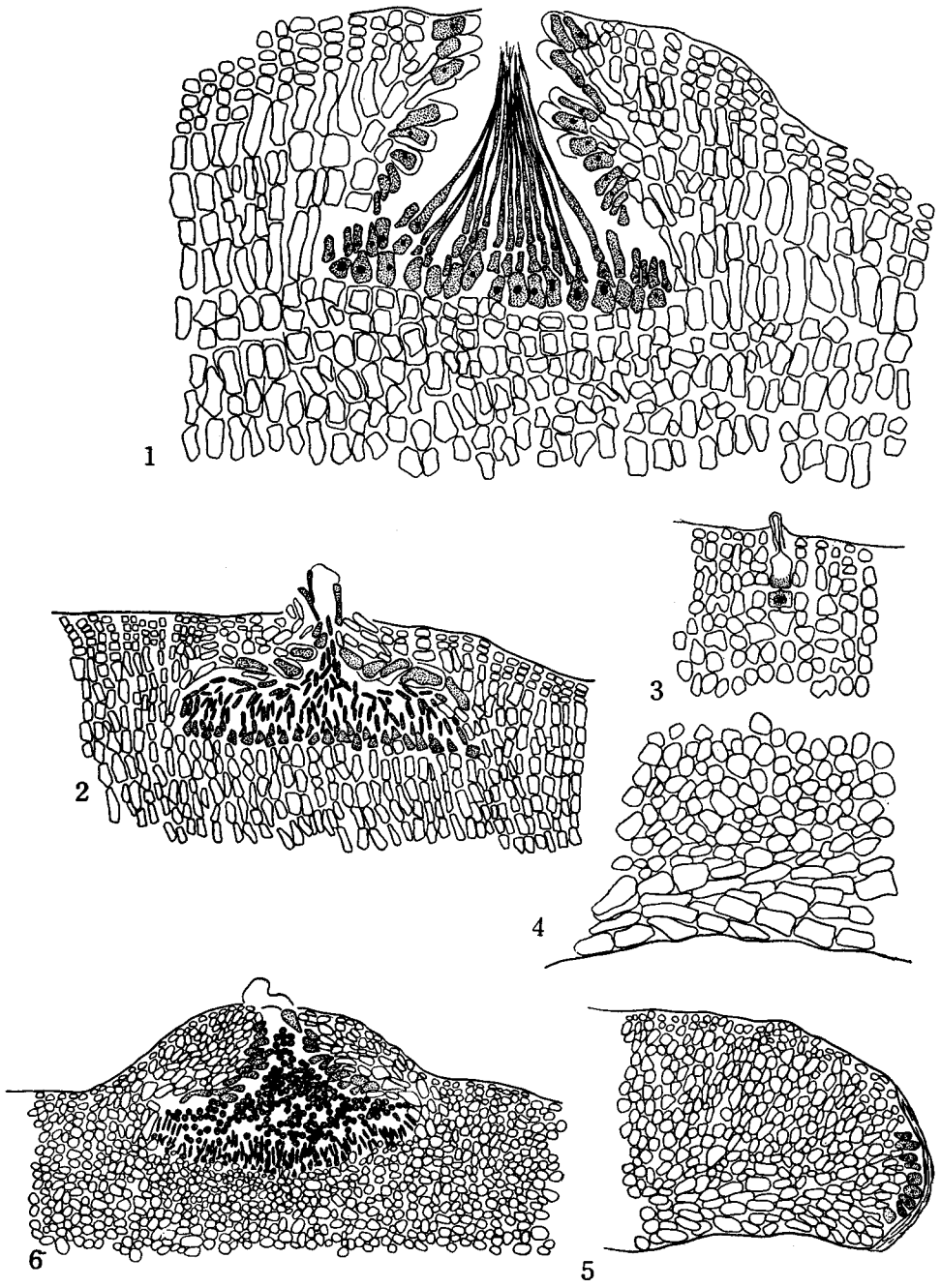

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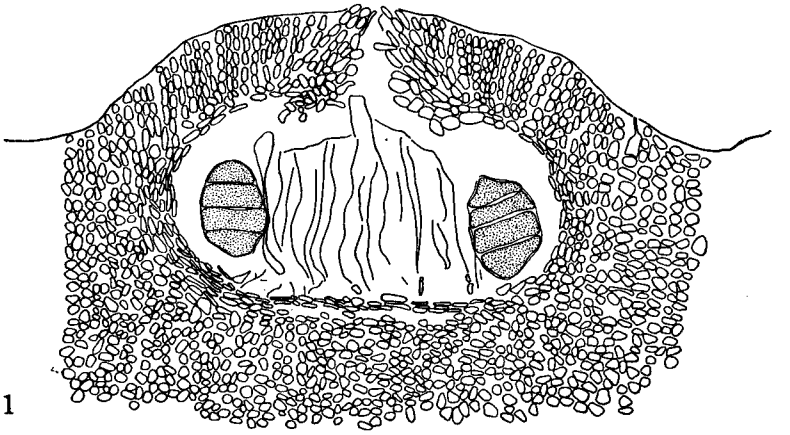

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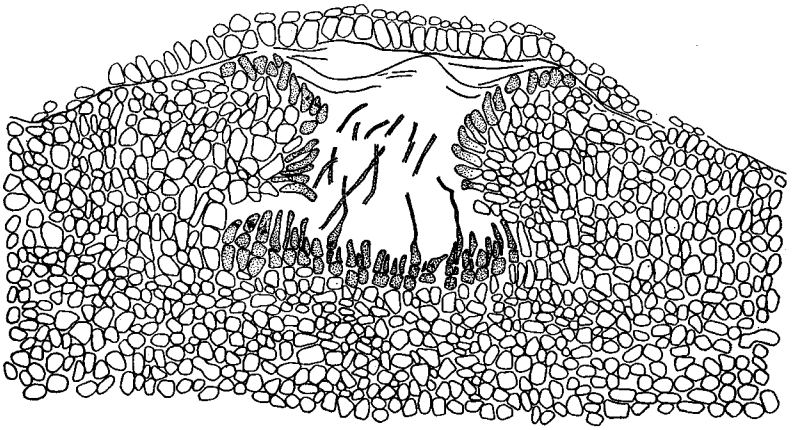

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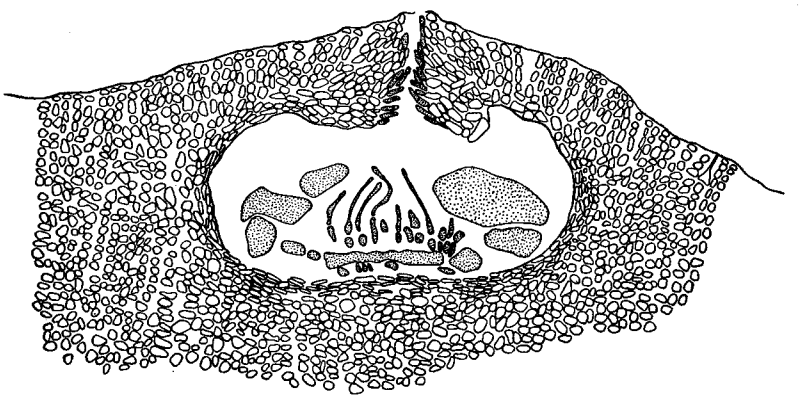

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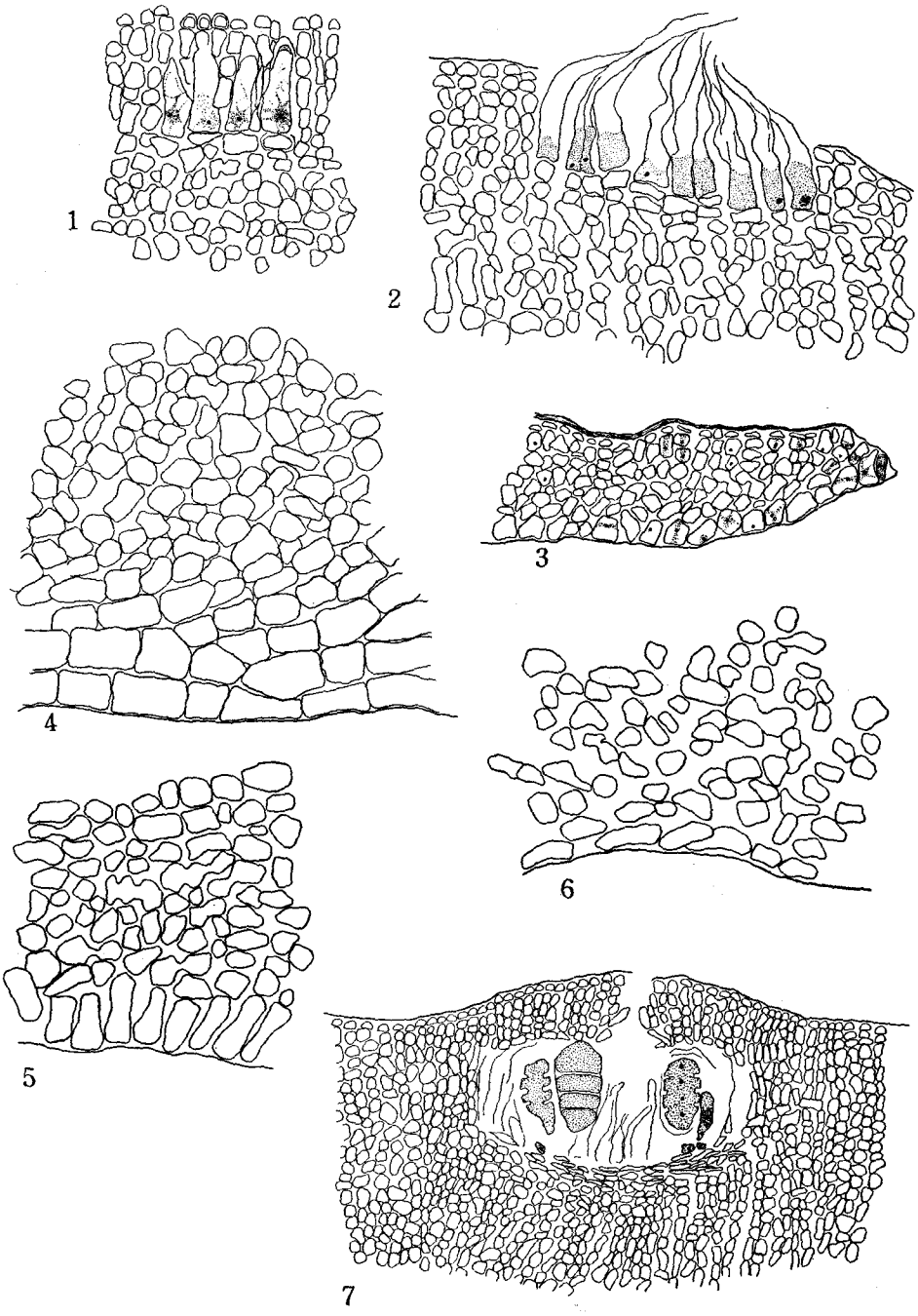

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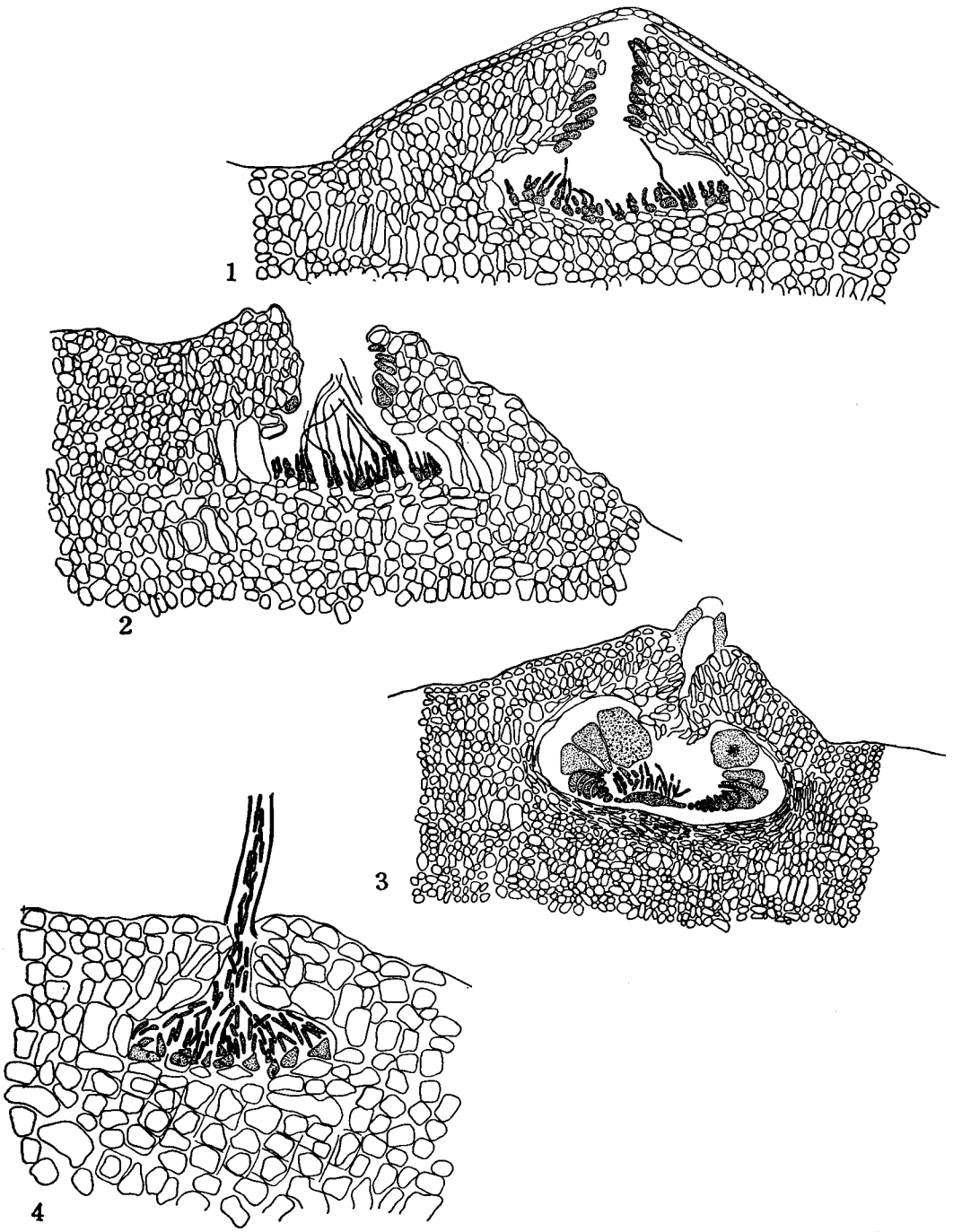

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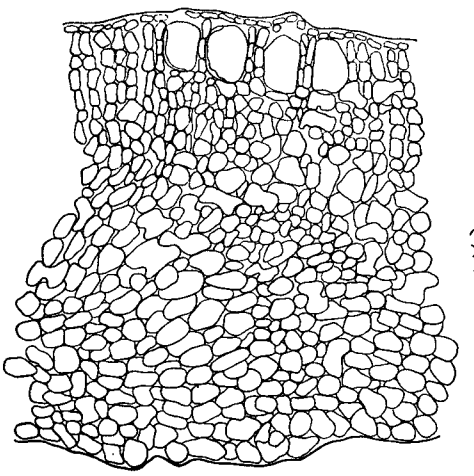

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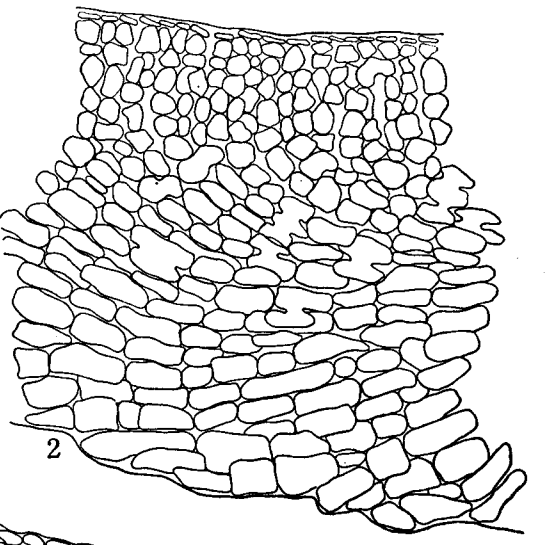

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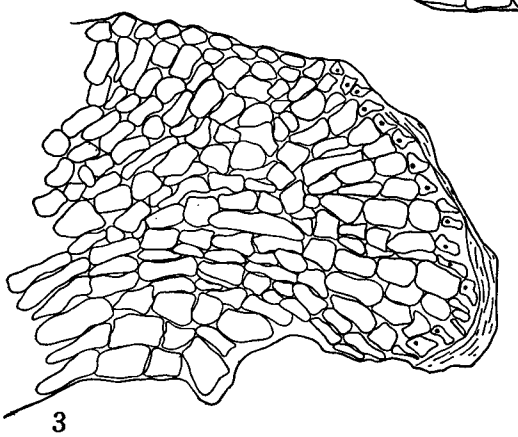

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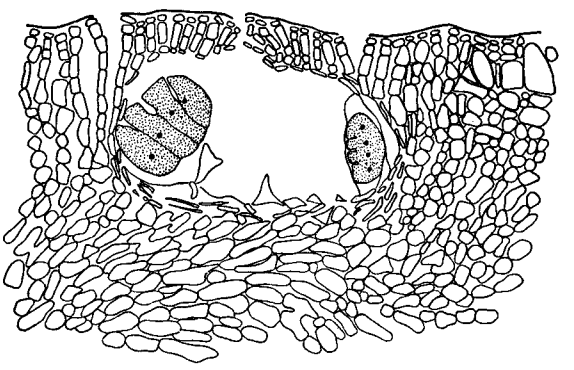

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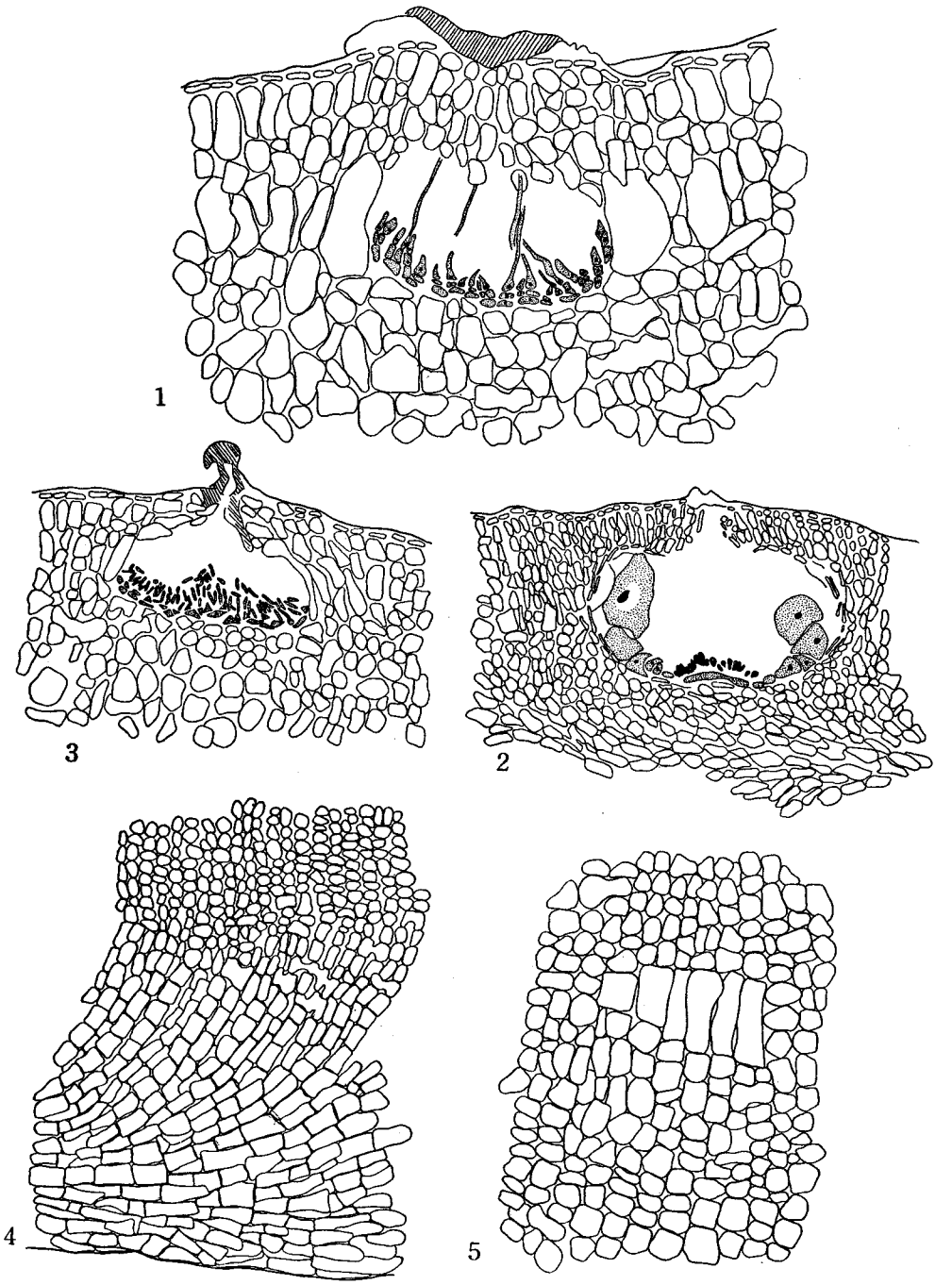

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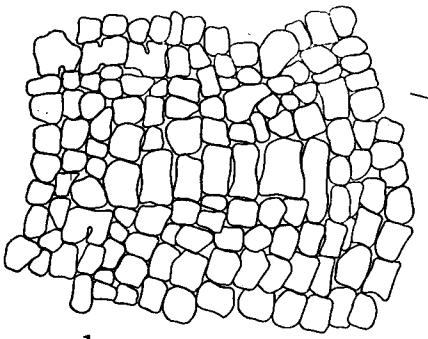

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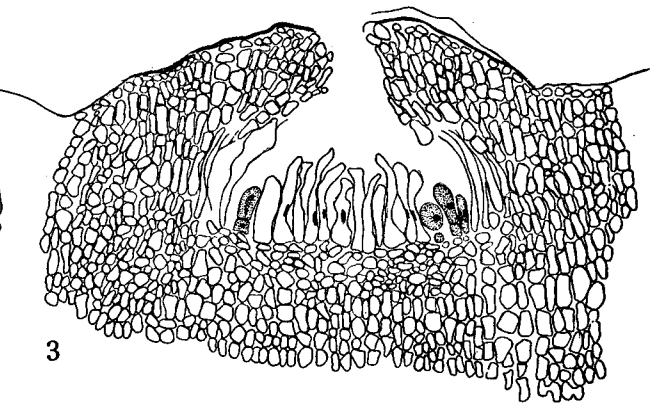

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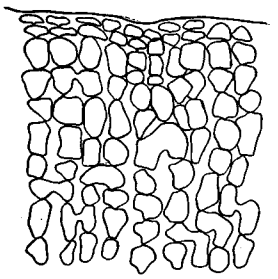

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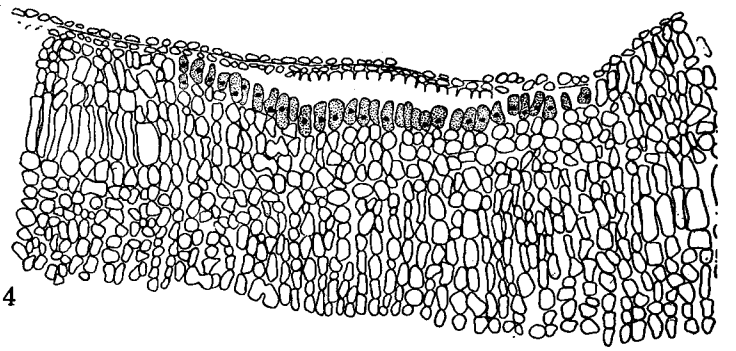

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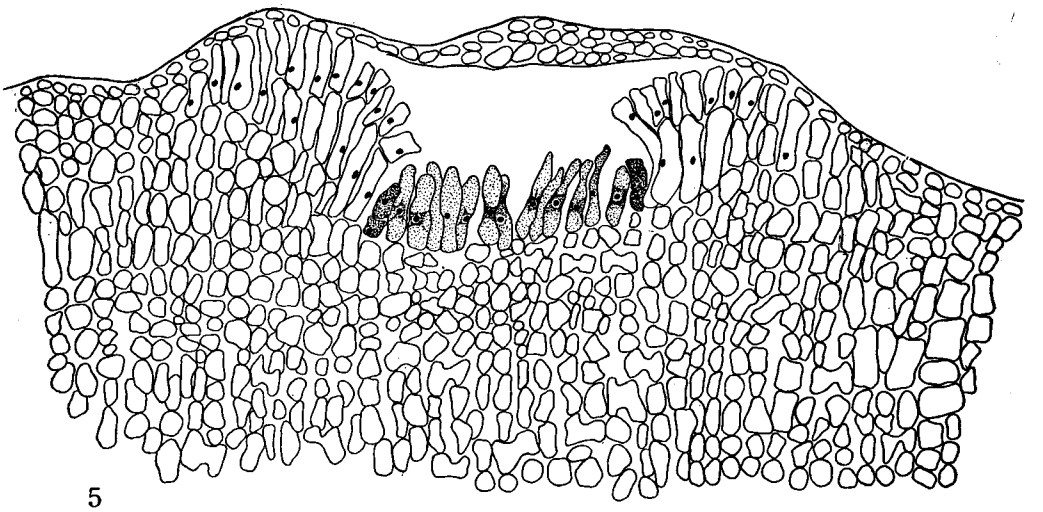

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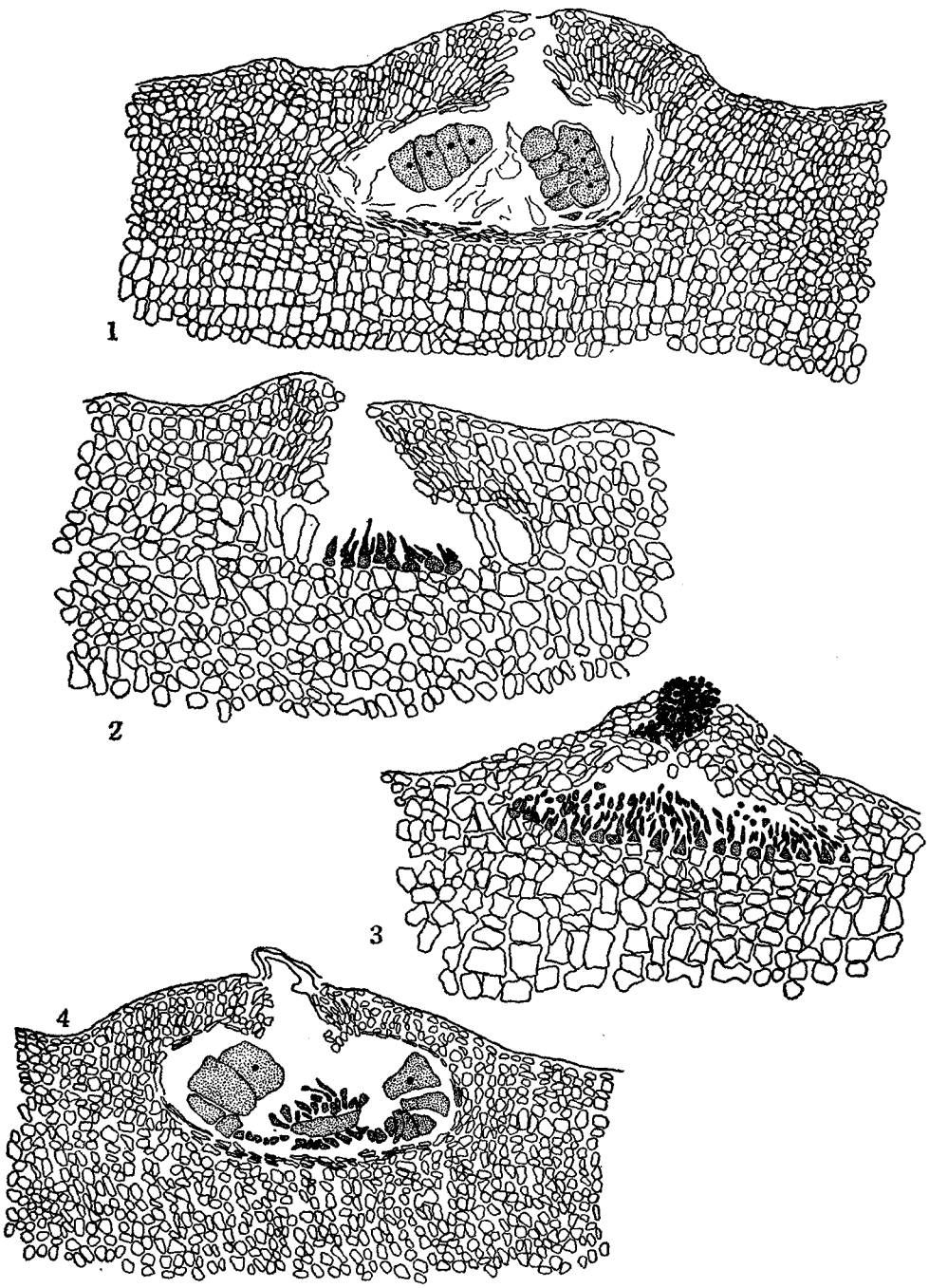

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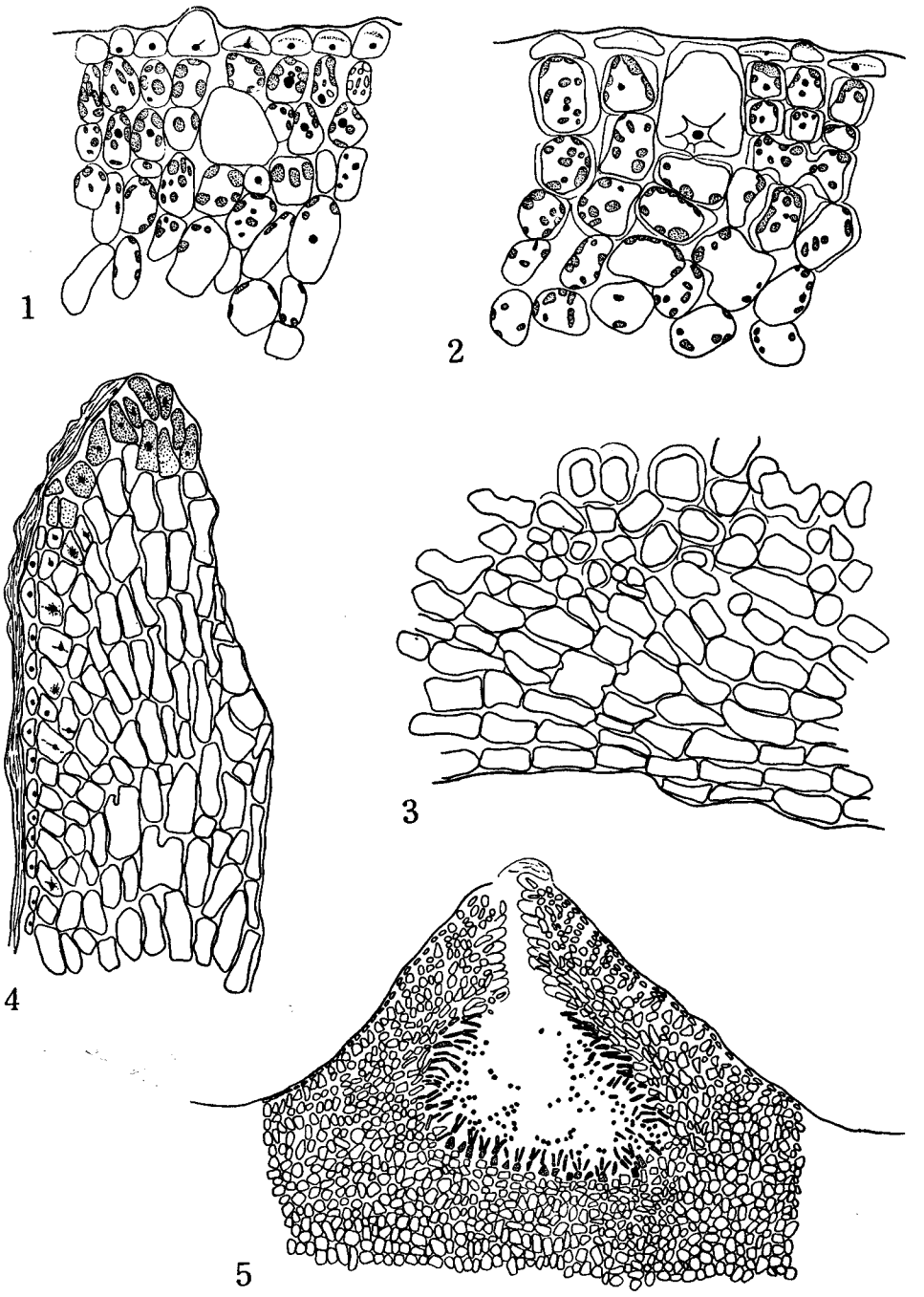

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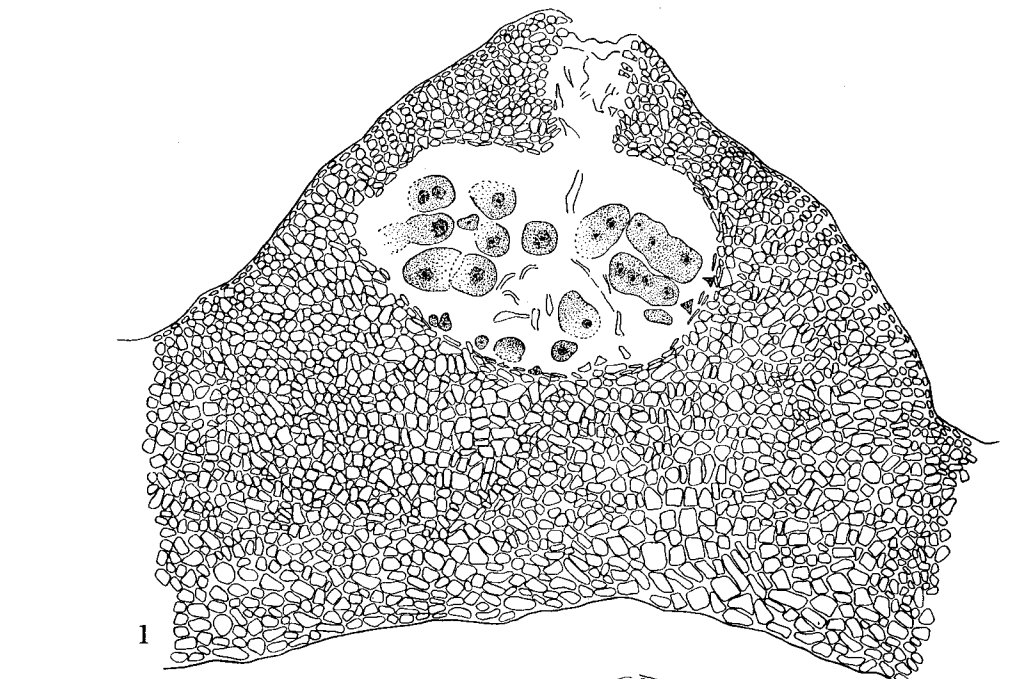

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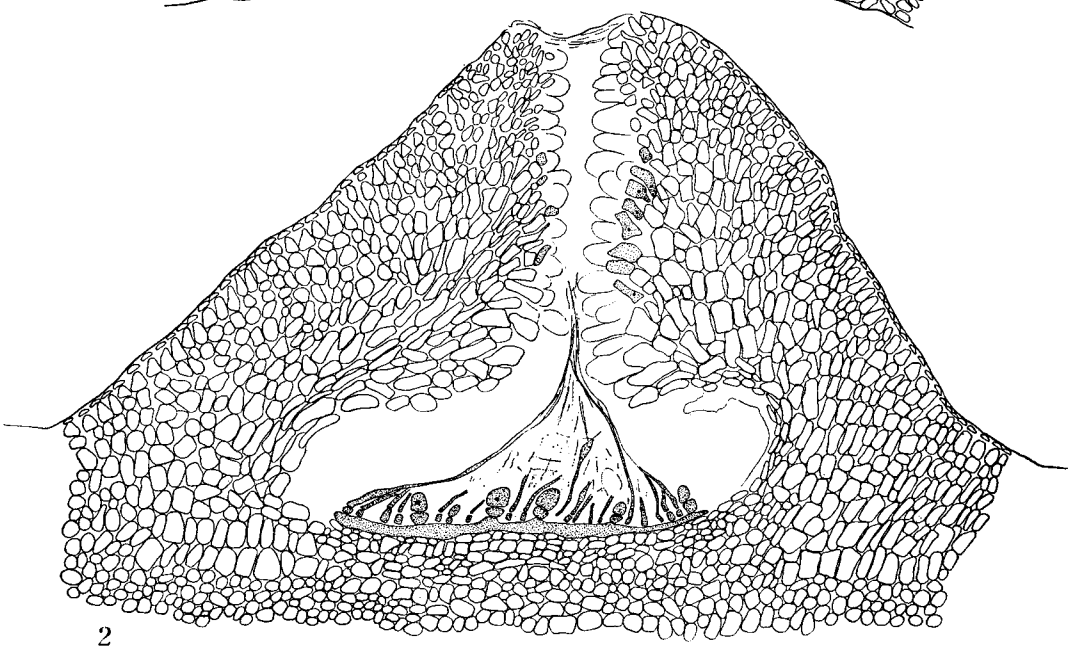

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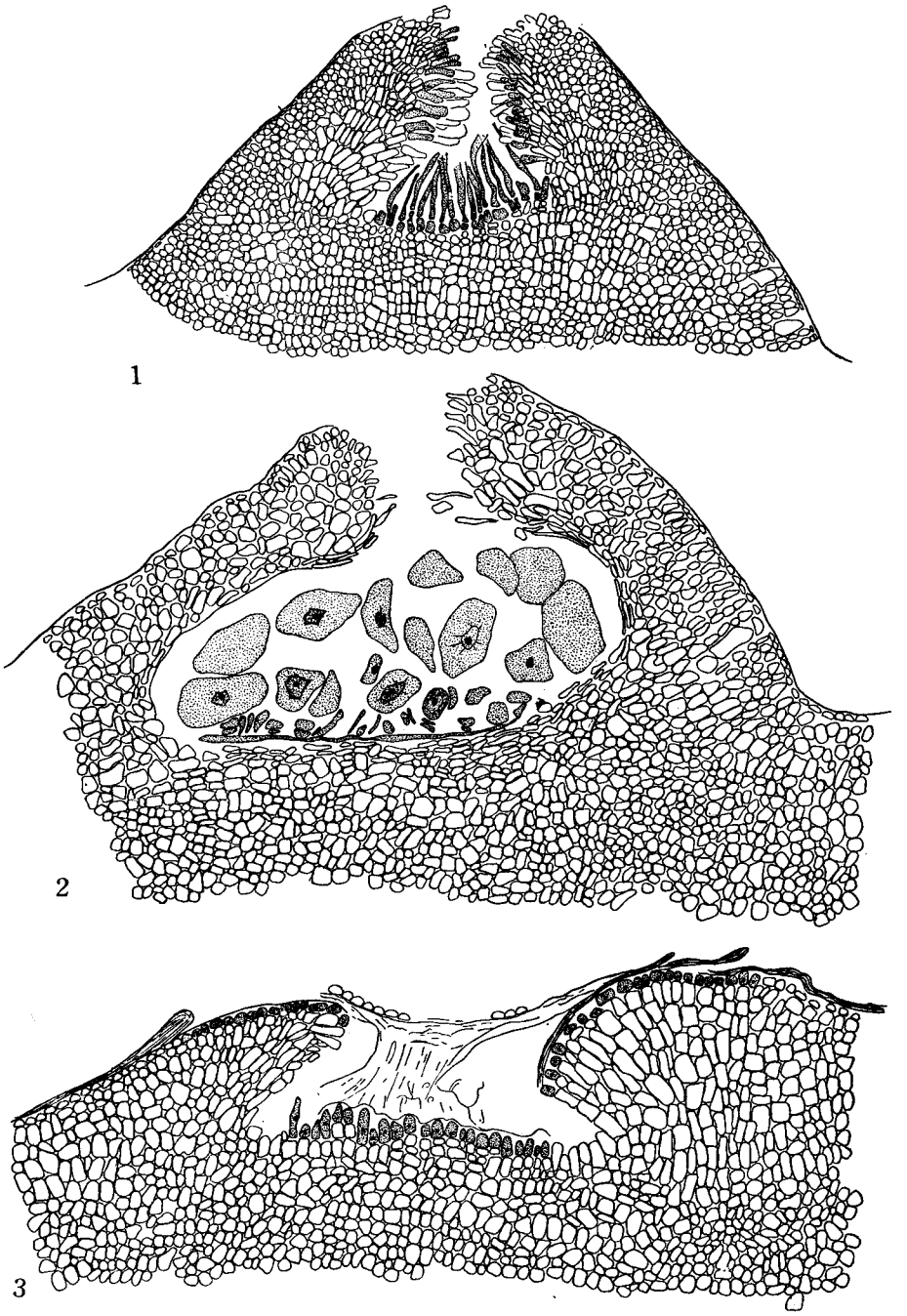

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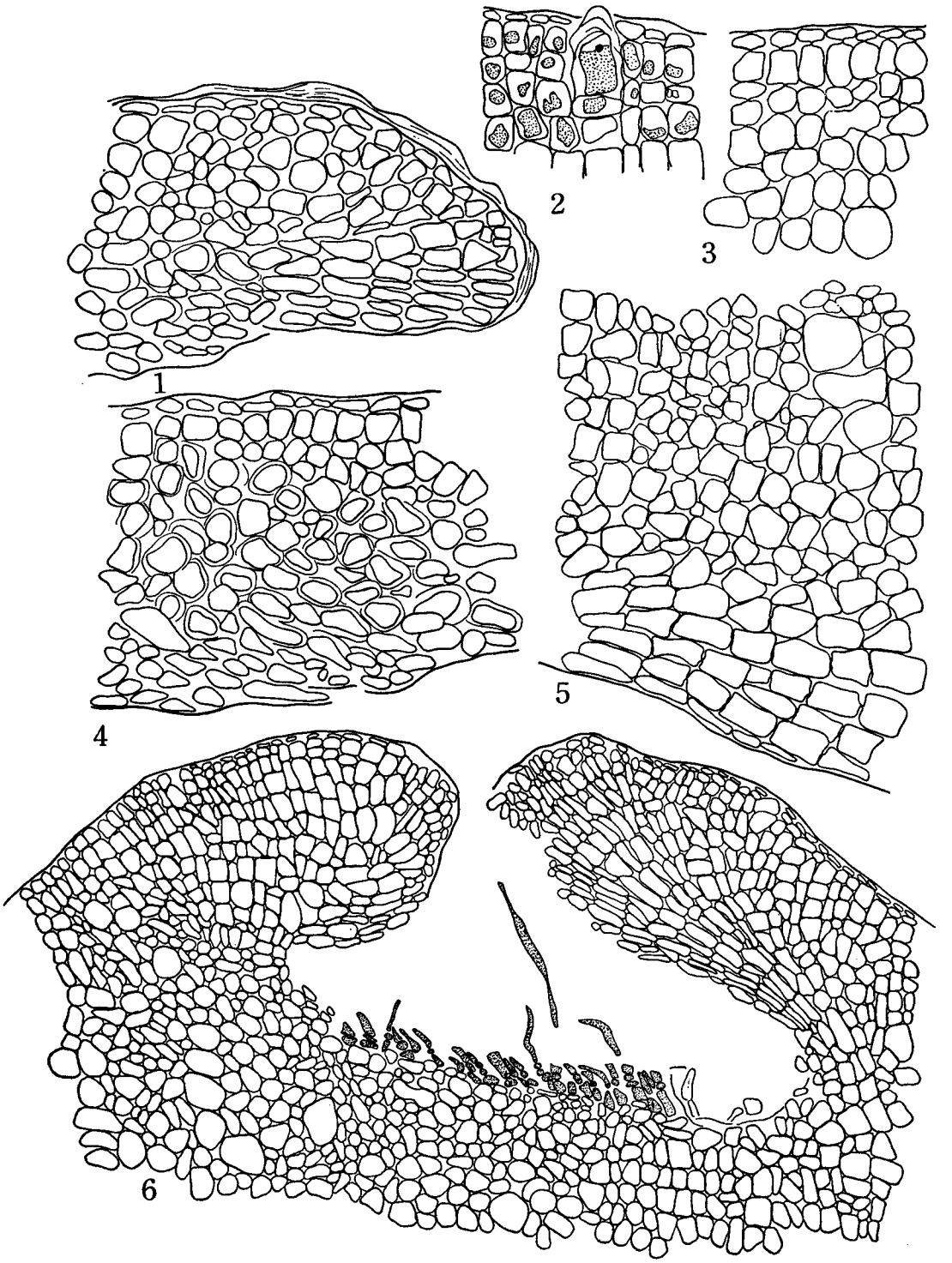

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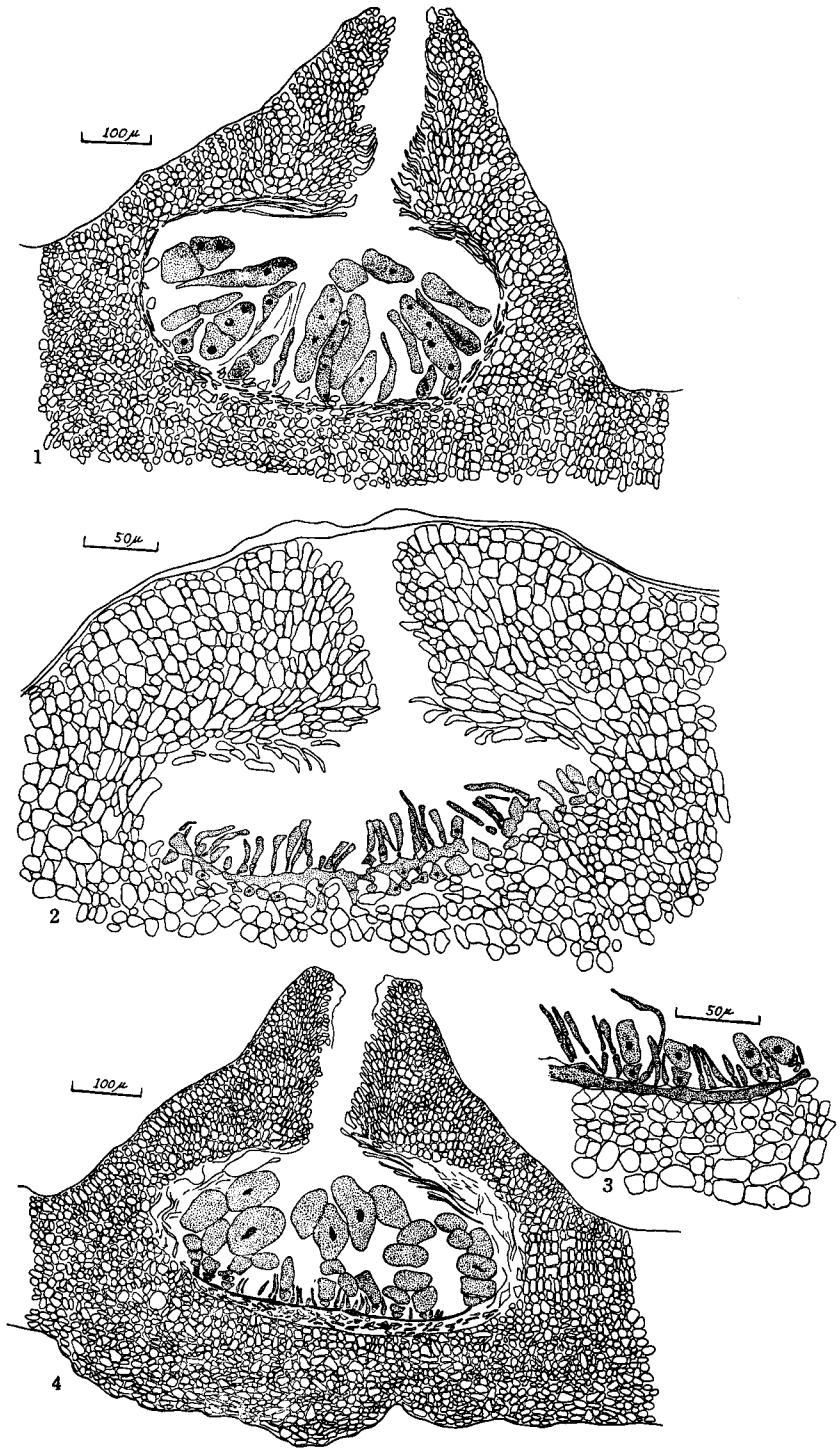

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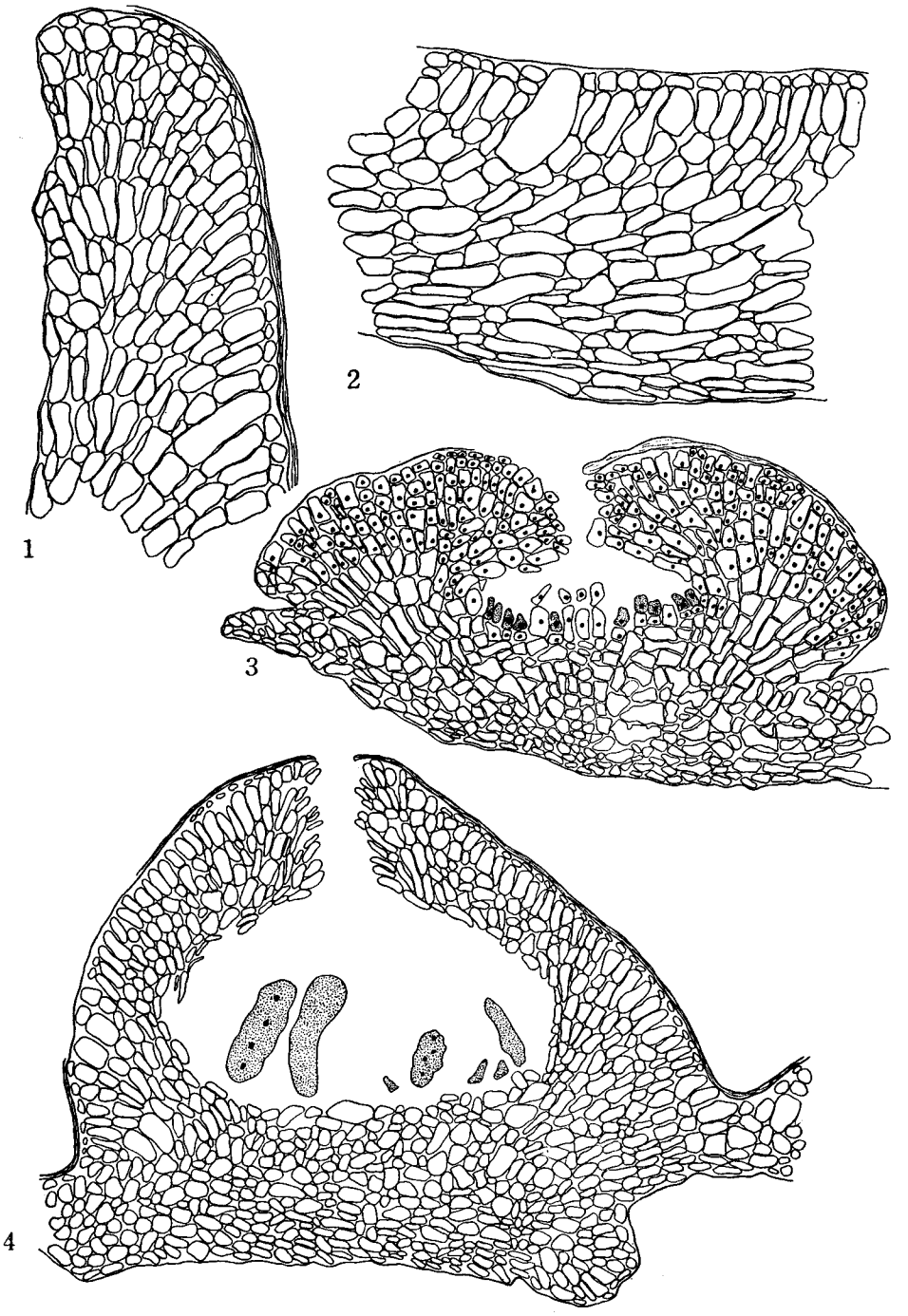

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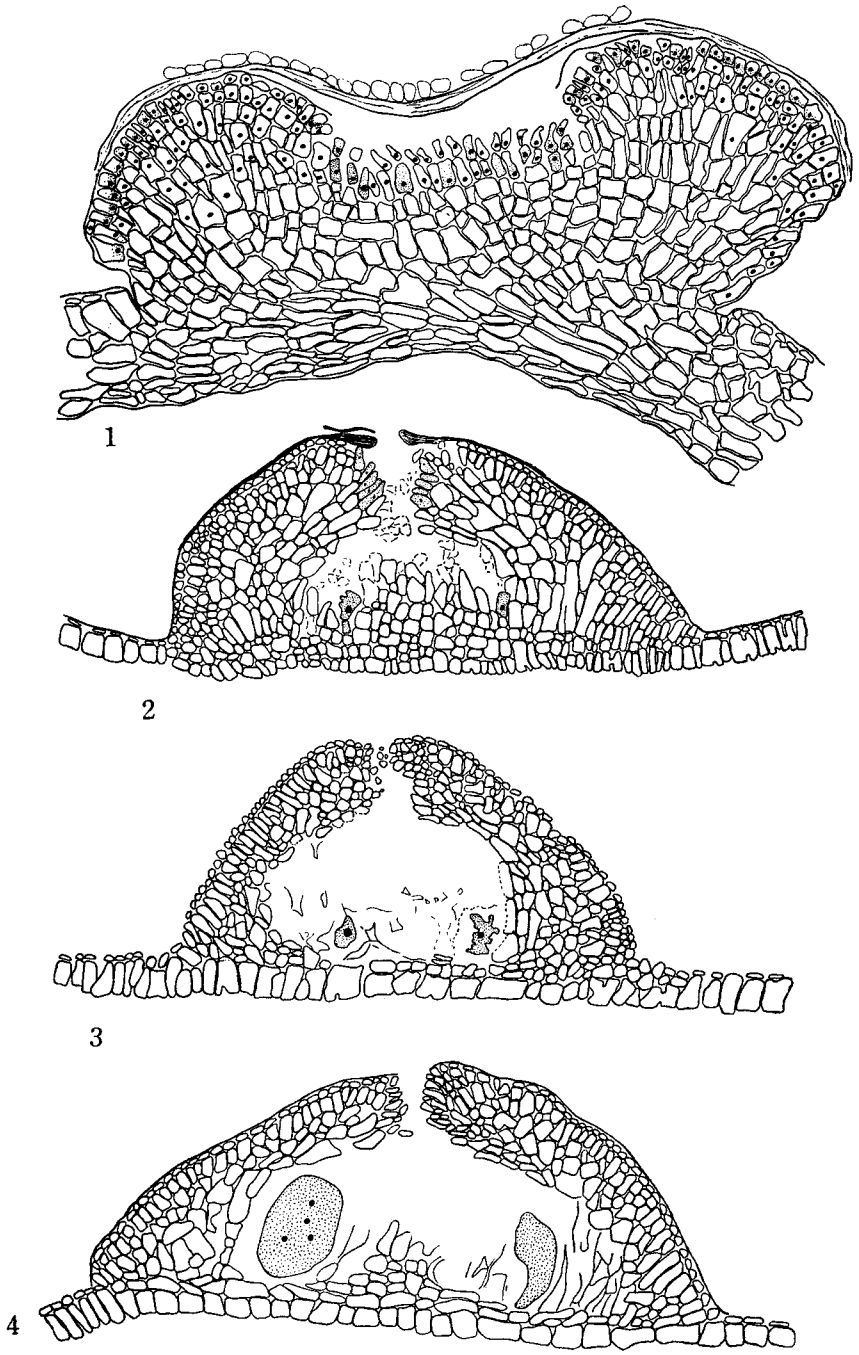

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