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On the Calcareous Algae from the Nanatsugama Sandstone of the Nishisonogi Peninsula, Nagasaki Prefecture

By

Wataru ISHIJIMA

Geological Laboratory, St. Paul's (Rikkyo) University, Tokyo 171

Introduction

The Nishisonogi Group composed of late Oligocene marine sediments is widely distributed in the western part of the Nishisonogi Peninsula, Nagasaki Prefecture. From old times this group has been investigated by many people from various viewpoints and a number of field reports and academic papers have been published. In 1964 Mr. Eiji INOUE of the Geological Survey of Japan discussed in detail the group's regional variation in lithofacies and fossil occurrence. Mainly on the basis of lithofacies, he divided the lower part of the group into six members, namely, Itanoura Sandstone, Fukushima Sandstone, Nanatsugama Sandstone, Kamashikiyama Tuff, Kamashikiyama Alternation and Yobikonohama Sandstone, in ascending order. He correlated these members with those of the standard division in the Sakito-Oshima district. The Nanatsugama Sandstone is correlated with the Tokuman Sandstone of the Sakito-Oshima district. In 1956 the present writer described a few calcareous algae from the Tokuman Sandstone, samples of which had been provided by Dr. Mitsuo NODA. In 1979, by the courtesy of Prof. KAMADA of Nagasaki University, the writer has had an opportunity of visiting the type locality of the Nanatsugama Sandstone, which has enabled him to observe the mode of occurrence of algal fossils as well as to collect a large quantity of samples for re-examination of the algal fossils. In carrying out the present study, the writer has received valuable advice and assistance from Prof. KAMADA of Nagasaki University and the members of the Nagasaki Chigaku Kai. In taking photographs of the specimens, Dr. Mitsuo HASHIMOTO of the National Science Museum has rendered a great help to the writer. To all these persons the writer's deep sense of gratitude is extended.

Occurrence

The major part of the Nanatsugama Sandstone is a calcareous, campact and hard, bluish gray or greenish gray, fine- to medium-grained massive sandstone. The algae facies in which calcareous algae are concentrated is developed best near the Kochi River in the village of Nanatsugama (Fig. 1). Because of this facies, the sandstone is exceedingly calcareous, and grades into sandy limestone or limestone which formed

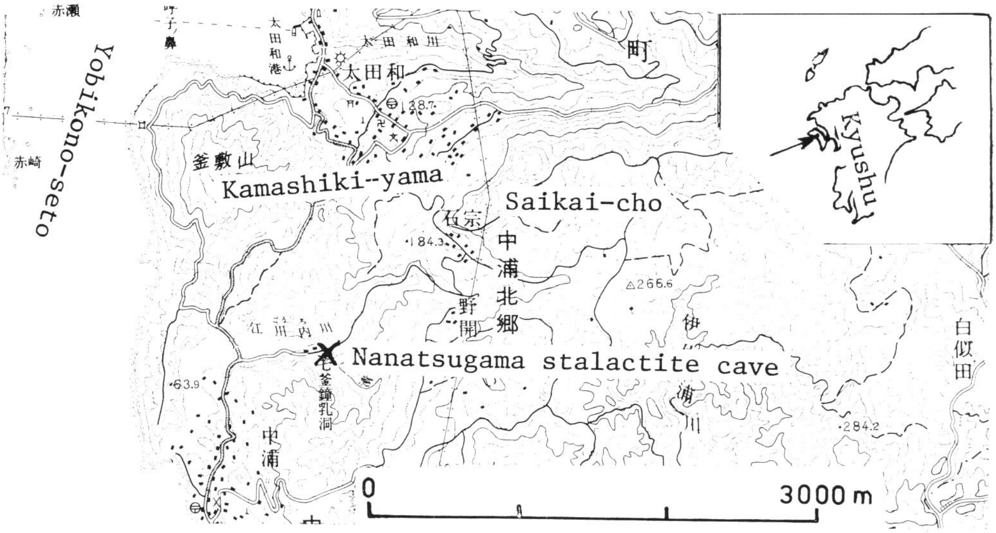

Fig. 1. Map showing the fossil locality. (The map used is a 1: 50,000 topographic map "Sasebo, South" published by the Geographical Survey Institute.)

the Nanatsugama cave, the one and only limestone cave in Nagasaki Prefecture. Almost all calcareous algae in this sandstone are crustose corallines, and no other fossils are discerned with the naked eye. The rock may be defined as a well-preserved calcareous algal sandstone (Plate 1). The mode of occurrence is characteristic in that the fossils, even their external forms, are in a good state of preservation and their dense aggregate is quite partial. These features suggest that the fossils were derived from the calcareous algal reef which might have existed near by (possibly the present limestone cave itself). The algal assemblage differs little from the one reported from the Tokuman Sandstone. It is composed predominantly of crustose corallines, among which *Lithothamnium* and well-preserved *Lithoporella* are conspicuous. Articulated corallines are barely discerned with only a few fragments of *Corallina*. *Peyssonellia* belonging to Squamariaceae has been found newly.

Description

Archeolithothamnium ROTHPLETZ, 1891

The most destinctive feature of the genus is the fact that the sporangia are not collected into conceptacles but are isolated in the tissue as individuals, or more commonly in rows, lenses, or layers. They may be packed closely together, or may be separated from one another by thin segments of tissue. The tissue is very similar to that of *Lithothamnium* in most cases, and sections of infertile tissue cannot always be separated, particularly if the specimens are smaller or poorly preserved. It reached its greatest development during the Eocene. All Recent species are confined to tropical and subtropical marine waters, and apparently fossil species had similar restrictions. It appears to be most common in depth from to 60 meters.

Archeolithothamnium lugeoni PFENDER

Pl. 2, fig. 1

Archeolithothamnium lugeoni PFENDER, 1926, p. 324, pls. 9, 12. — LEMOINE, 1939, p. 52, — JOHNSON and TAFUR, 1952, p. 537, pl. 62, figs. 1, 4. — ISHIJIMA, 1956, p. 3, pl. 1, fig. 1; pl. 2, figs. 1, 2. — JOHNSON, 1966, p. 263, pl. 1, fig. 2.

A crustose form which may develop nodular masses but not true branches, composed of a number of superimposed thalli. Hypothallus poorly developed, formed of curved rows of cells 7–10 μ and 4–8 μ. Perithallus tissue quite regular, but with vertical partitions of th cell threads much more prominent than the cross partitions. Measurements of cells of central area; 10 μ–15 μ by 8–10 μ. Sporangia abundant, oval to egg-shaped, in regular rows, 80 μ in height and 50–60 μ in diameter.

Remarks. —There are several Paleogene *Archeolithothamnium* having cells and sporangia in the same size range. The material studied consists entirely of fragments of crusts. In appearance, structure, measurements and growth habits they closely fit JOHNSON and TAFUR's descriptions based on material from Eocene of Peru.

Lithothamnium nodai ISHIJIMA

Pl. 3, figs. 3, 4; Pl. 4, fig. 1

Lithothamnium nodai ISHIJIMA, ISHIJIMA, 1956, p. 3, pl. 1, fig. 1; pl. 2, fig. 3.

Thallus encrusting, forms thin crusts, usually less than half a centimeter thick, composed of irregular rows of cells and with conceptacles irregular disposed through the tissue. Hypothallus poorly developed, consisting of a few layers of irregular rectangular cells which measure 8–18 μ by 6–10 μ. Perithallus formed of fairly regular rows of fine subquadrate cells 10 to 12 μ in dimension. In most specimens vertical partitions better defined than the horizontal. Conceptacles fairly flattened elliptical in form, rather crowded, 150–160 μ long and 75–80 μ wide.

Remarks.—In general appearance, the nearest known fossil species is *Lithothamnium leptum* JOHNSON and FERRIS from the Miocene of the Lau Island in eastern Fiji but it differs from *L. leptum* in having much smaller cells forming the perithallus and smaller conceptacles.

The one specimen observed agrees in all respects with the type material from the Oligocene Tokuman Sandstone.

Genus *Mesophyllum* LEMOINE, 1928

This genus was established in 1928 by Mme. LEMOINE in France with the type species of *Mesophyllum lichenoides* (ELLIS), which show characters intermediate between *Lithothamnium* and *Lithophyllum*. It has tissue similar to *Lithophyllum*, but the large, many apertured conceptacles are like those of *Lithothamnium*. In most species the tissue shows strong growth zones.

The genus includes both encrusting and branching species. Its known geologic range is from the Eocene to the present.

Mesophyllum sp.

Pl. 2, fig. 2

Thallus of long, slender branches with pronounced growth zones, each zone consisting of regular arched rows of cells, 5–7 rows to a zone.

Cells rectangular, 10–15 μ by 8–10 μ. No conceptacles observed.

Remarks. —Based on the nature of the cell layers alone, the species described is considered to be a *Mesophyllum*. However, this is uncertain in the absence of knowledge of the conceptacles.

Peyssonelia antiqua JOHNSON

Pl. 3, figs. 1, 2

Peyssonilia antiqua JOHNSON, JOHNSON, 1964, p. 214, pl. 1, fig. 2, — DENIZOT and MASSIEUX, 1965, p. 96–102, pls. 1, 2. — JOHNSON and KASKA, 1965, p. 12–13, pls. 1, 2. — MASTRORILLI, 1968, p. 141, — 145, pl. 1, fig. 1, text-fig. 1.

Thallus develops a thin crust, 303–350 μ thick, irregular in shape. Hypothallus consisting of 3–4 layers of large rectangular cells, 20–40 μ high and 15–20 μ wide. Perithallus is formed of short vertical threads rectangular to subquadrate cells with the largest at the base and gradually diminishing in height toward the thallus surface. They measure 8–10 μ wide, 3–5 μ in the upper rows. At the top is a dermal layer of one or two layers of fine flat cells.

Remarks.—Represented by only a few specimens, mostly small fragments. In growth habit, general appearance, nature of hypothallus, perithallus, as well as dimensions of their cells, they fit the description of *Peyssonelia antiqua*.

Non-calcareous forms of this family are distributed in the intertidal and sub-intertidal zones of mostly tropical to subtropical regions, though some are found in the polar regions also. Their thallus is very thin and simple in structure. It adheres to crustose corallines or some other solid things. Taxonomic study of these forms is still insufficient, and the living genera hitherto known are only three, *Peyssonnelia*, *Cruoriella* and *Ethelia*, but there are not a few scholars who refuse to accept *Cruoriella*. *Peyssonnelia* and *Cruoriella* cannot be distinguished by structure alone (NOZAWA, 1972). In the case of fossils, therefore, it would be appropriate to treat them together as *Peyssonnelia* for the time being. Fossil *Peyssonnelia* and *Ethelia* are represented only by one species each so far.

Genus *Lithoporella* FOSLIE, 1909

Thallus irregularly crustose as lichens, almost membraneous and less calcareous than other forms of the family Melobesiae, consisting of one or several layers of cells. Cells equal in size and similar in form and superposed continuously in succeeding layers. No differentiation of the thallus into hypothallus and perithallus being seen.

Conceptacle of sporangia either superficial or deeply embedded in tissue bearing one opening on roof.

In regard to the taxonomic position of *Lithoporella*, there is still much discussion as to the classification. In the course of his study on the fossil algae from various localities, the writer noticed that some special types of the fossil forms which are considered to be included in the category of the genus *Lithoporella* although they bear thick layers of cells which are uniform in shape as well as in size from the base of the thallus to the top, moreover neither differentiation, nor undulation are observed in the cell-layers.

Lithoporella melobesioides (Foslie) Foslie

Pl. 4, figs. 1–3

Mastophora (*Lithoporella*) *melobesioides* Foslie. Weber van Bosse and Foslie, 1904, 61, p. 73–75, figs. 30–32.

Lithoporella melobesioides (Foslie) Foslie, 1909, p. 58, 59. Howe, 1918, p. 11. Howe, 1919, p. 16–19, pl. 6.

Mastophora melobesioides Foslie, Pfender, 1926, p. 327–328, pl. 15.

Melobesia (*Lithoporella*) *melobesioides* Foslie. Lemoine, 1927. p. 550. Lemoine, 1928, p. 104. Lemoine, 1938, p. 123, (Apr. 4, 1938). Lemoine, 1939, p. 108–110, fig. 79. Conti, 1950. pp. 1–156.

Lithoporella melobesioides (Foslie) Foslie. Lignac-Gruttirink, 1943, p. 292, pl. 2, fig. 8.

Lithoporella (*Melobesia*) *melobesioides* (Foslie) Foslie. Johnson and Ferris, 1949, p. 196, pl. 39, figs. 1–2.

Lithoporella melobesioides (Foslie) Foslie. Johnson and Ferris, 1950, p. 18, pl. 8, fig. A.

Melobesia (*Lithoporella*) *melobesioides* Foslie. Conti, 1950, 4, p. 130.

Lithoporella melobesioides (Foslie) Foslie. Johnson and Tafur, 1952, p. 541–542, pl. 62, fig. 2, pl. 64, fig. 1. Ishijima, 1954, p. 47–48, pl. 45, figs. 1–6, pl. 46, fig. 1. Johnson, 1954, p. 542–543, pl. 197, figs. 2–3. Johnson, 1957, p. 234, pl. 37, fig. 5, pl. 43, figs. 1, 2, pl. 49, fig. 4, pl. 56, fig. 6. Johnson, 1961, p. 936. Johnson, 1962, p. 163–164, pl. III, fig. 3. Johnson, 1964, p. 10. Johnson and Kaska, 1965, p. 50, pl. 44, fig. 3. Ishijima, 1956, p. 5, pl. 1, fig. 5, pl. 2, fig. 4. Ishijima, 1967, p. 95–101. Ishijima, 1978, p. 177–178, pl. 26, fig. 2. Mastrorilli, 1967, v. 5, 2, 376–377. Tav. XXXIX, fig. 5.

Thallus very thin crust formed of single layer of small cells with rounded corners; cells square or slightly elongated horizontally thin section. They grow on other calcareous algae, coral, shell, another hard objects. Commonly several thalli superimposed to form thin crusts or nodular masses. Cell walls are relatively thick. Cells 10–13 μ by 10–20 μ. Conceptacles abundant, small with a single aperture in the roof, 110–160 μ in diameter and 70–100 μ in height.

Remarks: Judging from the shape of cell having somewhat roundish corners, and from the arrangement and measurements of cells, this species agrees with the one described by Johnson (1957) as *Melobesia* (?) *cuboides*. The specimen reported by Johnson lacked conceptacles, but the present specimen shows numerous conceptacles with a single aperture, so it evidently belongs to *Lithoporella*.

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Explanation of Plates

Locality: Nanatsugama-go, Saikai-cho, Nishisonogi-gun, Nagasaki Prefecture.
Horizon: Nanatsugama Sandstone Formation of the Nishisonogi Group.

Plate 1

(natural size)

Polished surface of calcareous sandstone showing the characteristic appearance of the calcareous algae (white masses) bearing rock. NSM PP 15633

Plate 2

(All $\times 50$)

Fig. 1. *Archeolithothamnium lugeoni* PFENDER. A nearly vertical section.
Fig. 2. *Mesophyllum* sp. Section of a branch showing the growth zones.

Plate 3

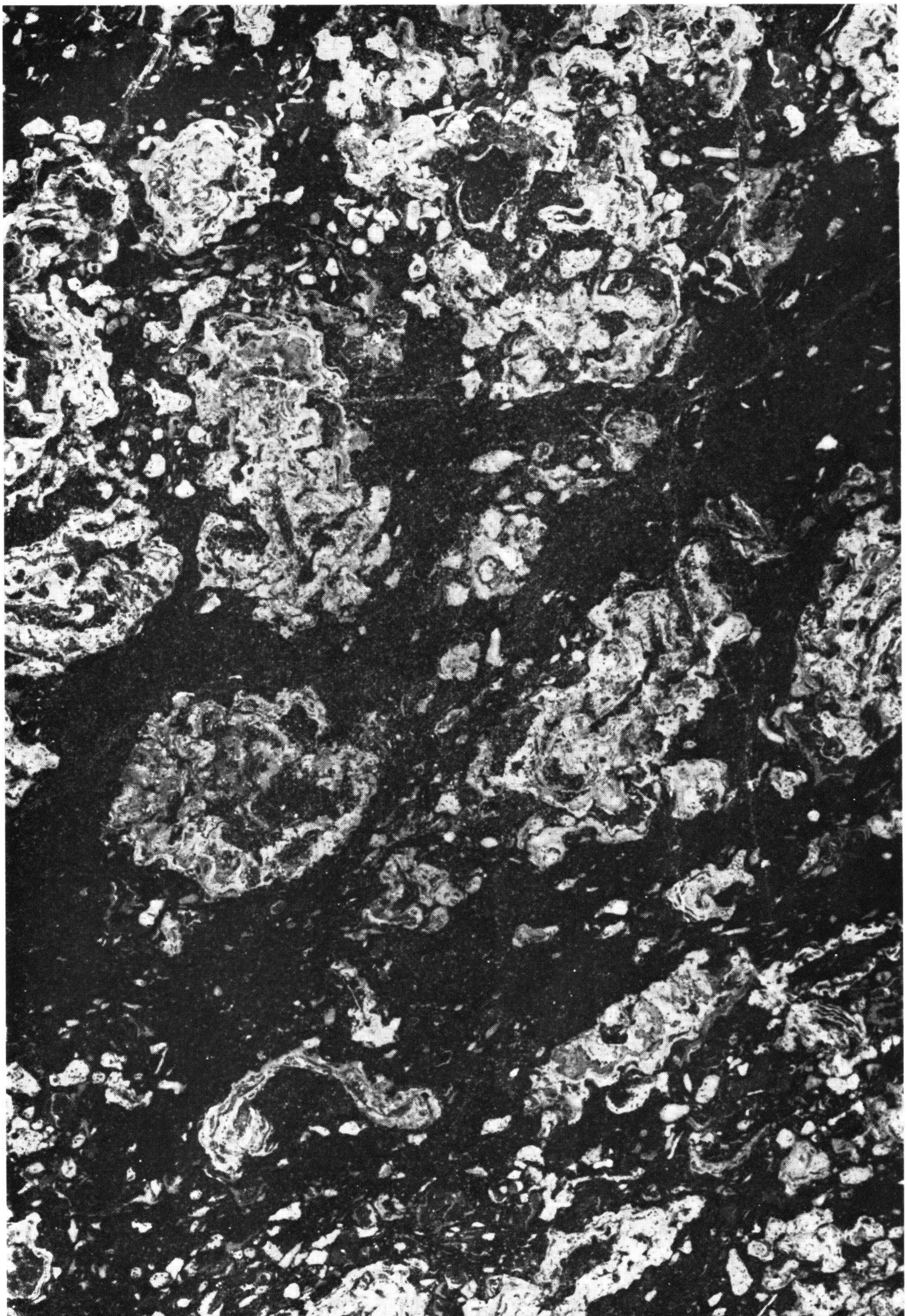
(All $\times 50$)

Figs. 1, 2. *Peyssonelia antiqua* JOHNSON.
Figs. 3, 4. *Lithothamnium nodai* ISHIJIMA. Section of thin crust showing hypothallus, perithallus and several conceptacles.

Plate 4

(All $\times 50$)

Figs. 1–3. *Lithoporella melobesioides* FOSLIE. Superimposed thalli form a thin crust.



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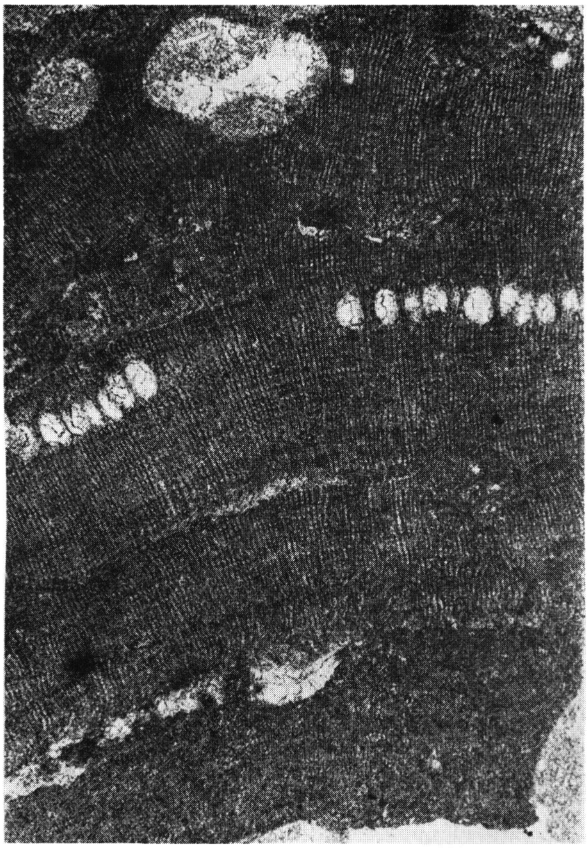

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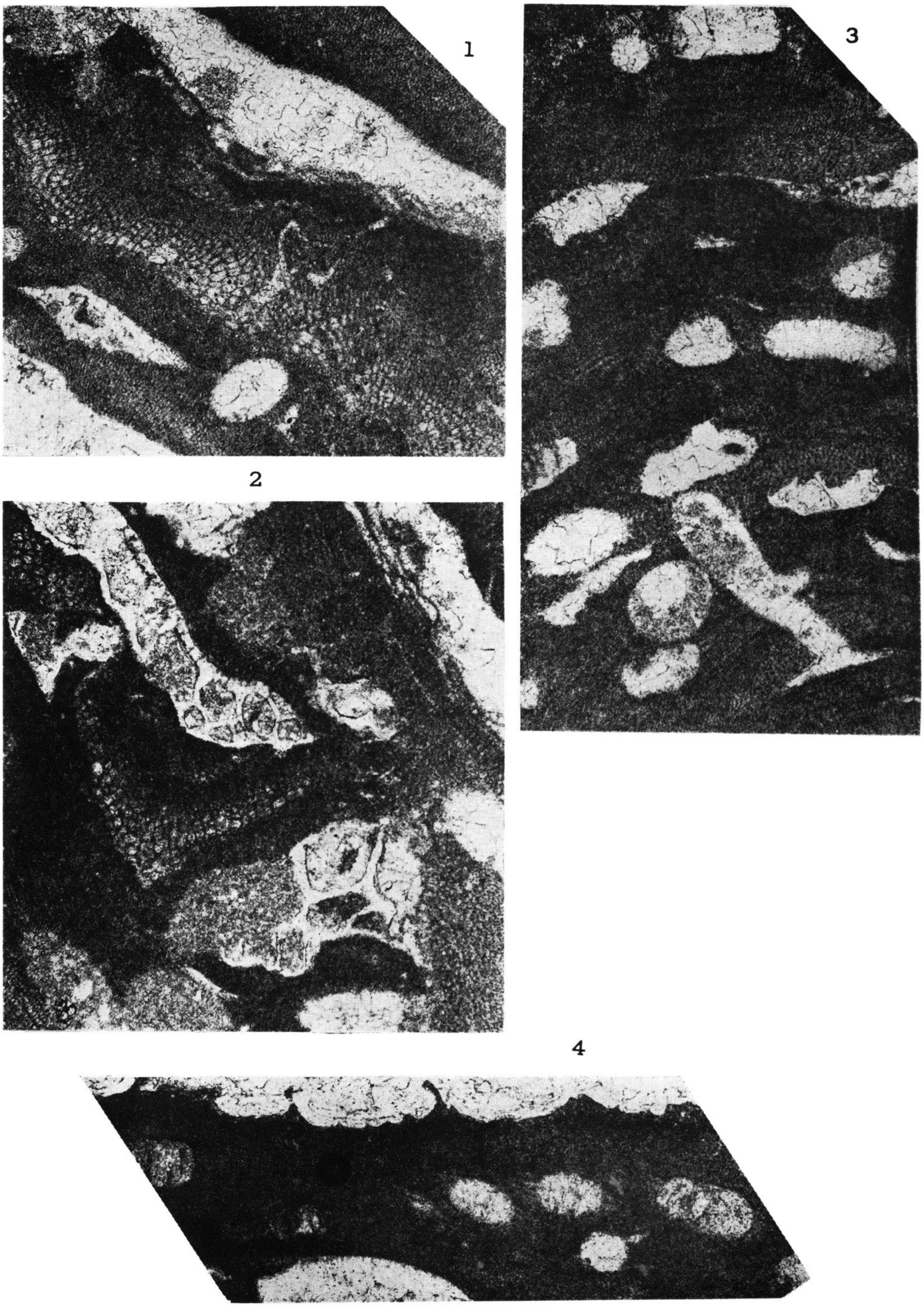
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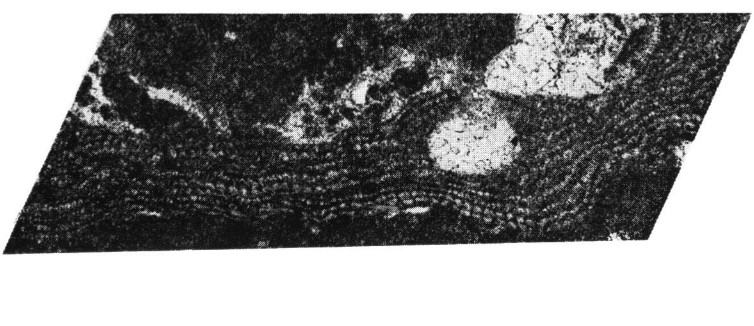

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