

Eocene Algae from
Ishigaki-shima
Ryūkyū-rettō

GEOLOGICAL SURVEY PROFESSIONAL PAPER 399-C



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By J. HARLAN JOHNSON

GEOLOGY AND PALEONTOLOGY OF ISHIGAKI-SHIMA, RYŪKYŪ-RETTŌ

GEOLOGICAL SURVEY PROFESSIONAL PAPER 399-C

*Descriptions of six new species from
exceptionally well preserved specimens
of Eocene limestone*



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GEOLOGY AND PALEONTOLOGY OF ISHIGAKI-SHIMA, RYŪKYŪ-RETTŌ

EOCENE ALGAE FROM ISHIGAKI-SHIMA, RYŪKYŪ-RETTŌ

By J. HARLAN JOHNSON

ABSTRACT

Well-preserved calcareous algae occur abundantly in some of the Eocene limestone at Ishigaki-shima, Ryūkyū-rettō. Most of the algae observed were red crustose corallines, but a few articulated corallines were also present. The green algae were represented by only a few fragments of *Halimeda*. With the exception of a few endemic species, the algae belong to a widely distributed Eocene flora that extended from the western Mediterranean region, across southern Asia, the East Indies, and much of the tropical Pacific.

Recognized were 6 species of *Archaeolithothamnium*, 10 species of *Lithothamnium*, 5 species of *Mesophyllum*, 3 species of *Lithophyllum*, 2 of *Lithoporella*, 1 of *Dermatolithon*, 3 of *Corallina*, 1 of *Jania*, and 1 of *Amphiroa*.

Described as new are: *Archaeolithothamnium fosteri*, *Lithothamnium ishigakiensis*, *Mesophyllum ishigakiensis*, *Mesophyllum ryukyensis*, *Lithoporella minus* and *Jania mayei*.

INTRODUCTION

Calcareous algae occur abundantly in the Eocene limestone of the Miyara formation on Ishigaki-shima, Ryūkyū-rettō, and many are exceptionally well preserved. An unusually large number of the specimens collected contained conceptacles and sporangia. As a result, the study of the collections was exceptionally rewarding.

This study is based on several hundred thin sections and a score or so of specimens. Most of the slides were 2 by 2 inches or larger.

Most of the algae observed belong to the crustose corallines. Articulated corallines were relatively rare. Green algae were unusually scarce; only a few *Halimeda* segments were noted.

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THE ALGAL FLORA

The flora, although containing several endemic species, consists mainly of species belonging to a widely

distributed Eocene flora that extended from the western Mediterranean region across southern Asia, the East Indies, and much of the tropical Pacific. It will be noted that many of the named species were originally founded on material from France, Spain, Italy, and Algeria. Most of them are known from previous collections made at Bikini, Saipan, and Guam in the Pacific.

LOCALITY DATA FOR THE EOCENE ALGAE

Locations of sample localities are shown in figure 1.

- F-49 Limestone from remnants that crop out in a near-sea-level valley 0.5 km north of Ō-saki on the Yarabu Peninsula.
- F-50 Limestone from hillside 0.6 km north of Ō-saki on the Yarabu Peninsula.
- F-51 Limestone overlying schist unconformably at about 1 km north of Ō-saki on the Yarabu Peninsula.
- F-80 Isolated limestone block at road junction on the east side of the Miyara-gawa along the coastal road 1 km north-east of Miyara.
- F-81 North of Inoda 0.5 km.
- F-83 North of Ibaruma 1.2 km. Erosional remnants of gray shaly appearing limestone.
- F-84 Northwest of Miyara 1.4 km. Chert pebble conglomeratic limestone that grades into light-gray limestone without pebbles.
- F-85 Limestone from near fault 1.6 km northwest of Miyara.
- F-95 2.7 km north of Hirae.
- F-163 Thin bed of limestone interbedded in shale exposed in streambed 1.3 km northwest of Ō-saki, Yarabu Peninsula.
- F-176 Limestone remnants 0.3 km east of Dacho-zaki on the Hirakubo Peninsula.
- M-97 Bluff 1.4 km northeast of Miyara.
- M-106 1.8 km north of Miyara.
- M-121 Large remnant slabs of limestone on ridge of volcanic breccia 0.6 km northeast of Hoshino.
- M-236 Northern limestone knob 0.9 km northwest of Hoshino.
- M-239 North slope of central limestone knob 0.5 km northwest of Hoshino.
- M-240 Base of limestone section on north face of southern limestone knob 0.4 km west of Hoshino.
- M-247 1.5 km north of Miyara.
- M-248 0.4 km northwest of Miyara.
- M-286 2.2 km north-northeast of Hirae.

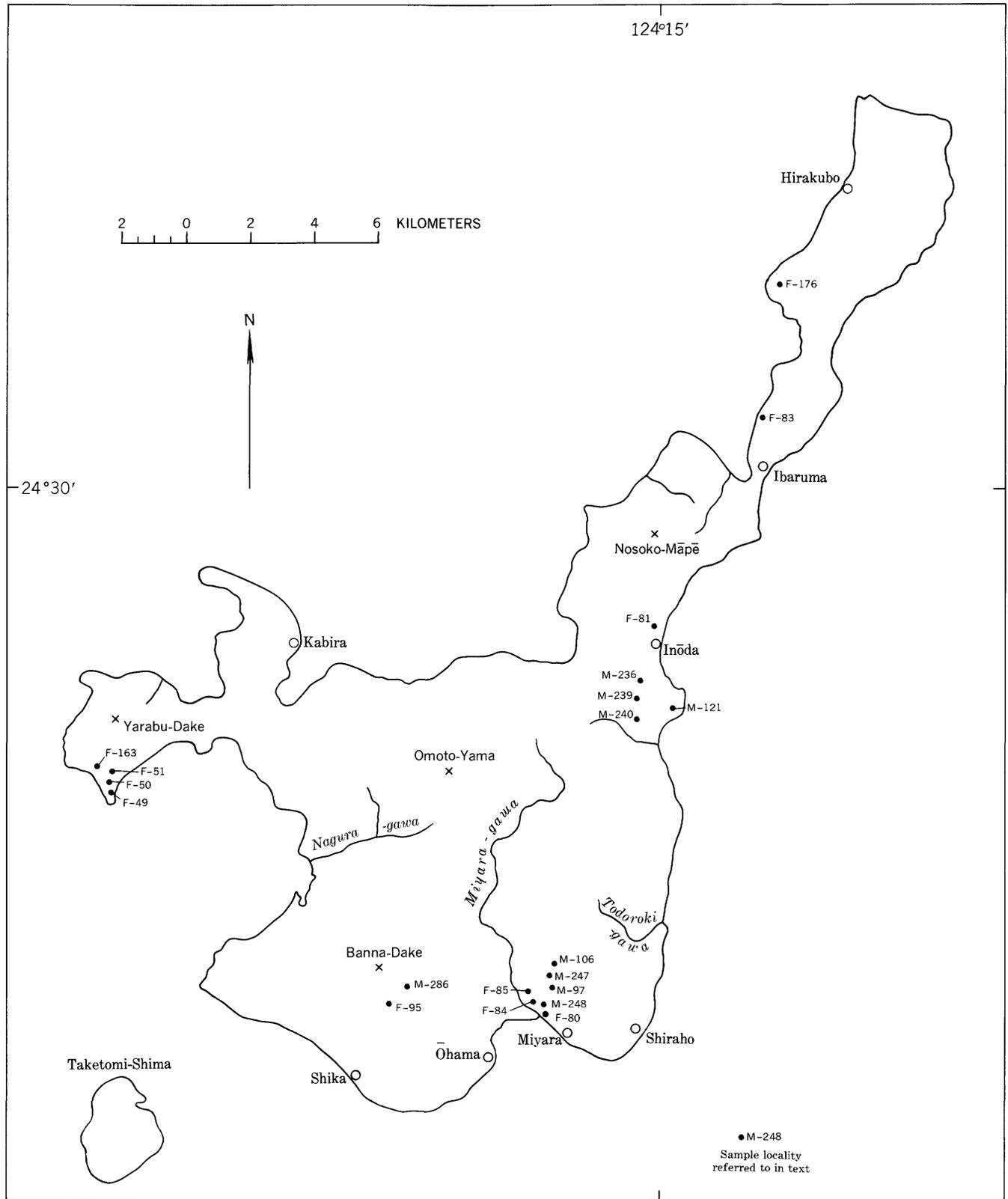


FIGURE 1.—Map of Ishigaki-shima showing Eocene algae localities.

ECOLOGICAL INTERPRETATIONS

The flora grew in clear warm shallow marine waters that were rich in lime and had good circulation. The large number of branching forms suggests depths not greater than 60 feet, possibly considerably less.

SYSTEMATIC DESCRIPTIONS

RHODOPHYTA (red algae)

Family **CORALLINACEAE** (coralline algae)

Subfamily **MELOBESIOIDEAE** (crustose corallines)

Genus **ARCHAEOLITHOTHAMNIUM** Rothpletz, 1891

Like other genera of the crustose corallines, this genus has a tissue containing both a hypothallus and a perithallus. The hypothallus consists of curved rows of

cells. Commonly it is thinner than the perithallus. The characteristic feature of the genus is that the sporangia are not collected into conceptacles but occur isolated or in layers or lenses in the perithallic tissue.

Structurally this is the most primitive genus of coralline algae that is still found in Recent seas. It reached its greatest development during the Late Cretaceous and Eocene time. It appears to have always lived in warm shallow marine waters.

In the collections from Ishigaki-shima, *Archaeolithothamnium* is represented by numerous specimens of six species. Table 1 shows their characteristic features and observed distribution.

TABLE 1.—Measurements, in microns, and distribution of Eocene species of *Archaeolithothamnium*

[From random sections]

Species	Hypothallic cells		Perithallic cells		Sporangia		Growth habit	Locality
	Length	Width	Length	Width	Diameter	Height		
<i>Archaeolithothamnium chamorrosum</i> Johnson	11-14	7-13	9-14	9-11	26-41	46-48	Crustose	F-49.
<i>fosteri</i> Johnson, n. sp.	16-38	8-14	9-28	6-15	34-68	41-95	Crust with knobs	F-49, 50, 80, 163; M-239, 240.
cf. <i>A. liberum</i> Lemoine	12-24	7-11	10-24	9-15	22-49	44-76	Nodular crust with mammillae	M-240.
<i>nummuliticum</i> (Gümbel) Rothpletz	14-41	9-15	11-32	8-18	35-72	57-130	Crust with branches	F-49, 50, 163; M-239, 240, 247.
cf. <i>A. parisiense</i> Lemoine	12-24	7-13	10-24	6-16	35-65	57-93	do.	F-49; M-239, 240.
cf. <i>A. affine</i> Howe	11-23	9-11	9-20	7-12	32-36	41-58	Long slender branches	F-49, 50; M-239, 240.

***Archaeolithothamnium chamarrosum* Johnson**

Archaeolithothamnium chamorrosum Johnson, 1957, p. 217, pl. 39, figs. 3, 6.

Description.—Thallus crustose, 350 μ –450 μ thick. Tissue quite regular with suggestions of growth zones. Hypothallus thin to moderately developed, consisting of curved rows of cells that measure 11 μ –14 μ by 7 μ –13 μ . Perithallic tissue formed of regular layers of rectangular cells, 9 μ –14 μ by 9 μ –11 μ . Sporangia oval to nearly spherical, 46 μ –48 μ high and 26 μ –41 μ in diameter.

Remarks.—This species resembles the material described from Saipan except for slightly shorter hypothallic cells. Only two specimens were recognized in the collection from Ishigaki-shima.

Locality: F-49.

***Archaeolithothamnium fosteri* Johnson, n. sp.**

Plate 1, figures 1-6

Description.—Thallus forms a crust that may develop rounded knobs or short stubby branches. Hypothallus normally poorly developed or absent. When present, it consists of several curved rows of cells. Cells measure 16 μ –38 μ long and 8 μ –14 μ wide. Perithallic tissue fairly regular but horizontal partitions are poorly developed in much of the tissue. Cells 9 μ –28 μ by 6 μ –15 μ . Sporangia ovoid to rectangular, commonly rather closely packed in regular layers or lenses. Sporangia 41 μ –95 μ high, and 34 μ –68 μ in diameter. Detailed dimensions are given in table 2.

TABLE 2.—Measurements, in microns, of *Archaeolithothamnium fosteri* Johnson, n. sp.

Slide	Hypothallic cells		Perithallic cells		Sporangia	
	Length	Width	Length	Width	Diameter	Height
IS-F-49 (1)	21-38	11-14	11-24	9-12	63-68	81-92
IS-F-50			17-25	7-12	42-50	66-83
IS-F-80 (2)	16-19	8-14	11-16	9-14	34-50	79-95
IS-F-163 (2)			13-20	6-11	38-52	63-81
IS-F-163 (4)	14-24	8-12	9-16	9-13	38-41	63-75
2532			11-25	10-15	36-44	41-65
IS-M-239 B			13-23	7-11	36-68	58-92
IS-M-240 C			11-28	9-12	44-54	47-93

Remarks.—This species suggests *A. aschersoni* Schwager and *A. lugeoni* Pfender but differs from them in having appreciably longer perithallic cells and sporangia with a much greater size range. It is named for H. L. Foster who collected many of the specimens. This species is the most abundantly represented *Archaeolithothamnium* in the collection from Ishigaki-shima.

Localities: F-49, 50, 80, 163; M-239, 240.

Figured specimen: Holotype, slide IS-F-49 (1).

***Archaeolithothamnium nummuliticum* (Gümbel) Rothpletz**

Plate 2, figures 1-3

Archaeolithothamnium nummuliticum (Gümbel).

(Gümbel) Rothpletz, 1891.

Lemoine, 1927, p. 547, fig. 1.

Airoldi, 1932, p. 61, pl. 9, fig. 1.

Lemoine, 1939, p. 56.

Description.—This species characteristically forms a crust from which develop short unramified branches. Several thalli may grow superimposed. Hypothallus thin but quite distinct, consisting of curved rows of cells. Cells 14μ – 41μ by 9μ – 15μ . Perithallus fairly regular, with cells in rows with distinct transverse partitions between the rows. Cells 11μ – 32μ by 8μ – 18μ . Sporangia numerous, ovoid to rectangular, or often quite irregular, in rows or layers, size 57μ – 130μ high and 35μ – 72μ in diameter. Detailed dimensions are given in table 3.

TABLE 3.—Measurements, in microns, of *Archaeolithothamnium nummuliticum* (Gümbel) Rothpletz

Slide	Hypothallic cells		Perithallic cells		Sporangia	
	Length	Width	Length	Width	Diameter	Height
F-49(1)-----	24-28	9-14	14-27	9-13	54-63	100-115
F-49L(2)-----	-----	-----	11-21	10-14	45-72	57-99
F-49L(5)-----	-----	-----	11-18	10-15	37-70	73-100
F-50(2)-----	-----	-----	12-14	13-18	34-50	95-130
F-51(2)-----	14-19	11-15	14-18	10-15	45-63	79-105
F-163(1)-----	-----	-----	13-24	8-14	35-59	75-97
F-163(4)-----	-----	-----	20-28	9-13	36-42	73-85
F-163(4)-----	-----	-----	18-32	9-13	40-58	107-130
M-239(2)-----	-----	-----	11-15	9-11	58-72	81-114
M-240(3)-----	-----	-----	11-23	8-12	49-57	65-98
M-240C-----	30-41	9-11	15-29	9-12	56-77	61-114
M-240C-----	-----	-----	10-18	8-11	48-67	77-110
M-240C-----	-----	-----	11-18	8-11	50-55	73-103
M-247C-----	-----	-----	11-12	9-11	62-86	104-118

Remarks.—The Ishigaki material closely resembles the typical forms. This species is very widely distributed geographically; it has been reported from the West Indies, North Africa, southern Europe, the near East, southern Asia, and the East Indies. The species has considerable geologic range, extending from the Upper Cretaceous (Santonian-Campanian) through the Paleocene and Eocene into the lower part of the Oligocene. This species is one of the most common species in the collections from Ishigaki-shima.

Localities: F-49, 50, 51, 163; M-239, 240, 247.

Figured specimens: F-51-55(2); F-163(1); M-240-56C.

***Archaeolithothamnium cf. A. parisiense* (Gümbel) Lemoine**

Plate 2, figure 4

Lithothamnium parisiense Gümbel, 1871, p. 32, pl. 8 a-b.

Archaeolithothamnium parisiense (Gümbel) Lemoine, 1923, p. 63-64, pl. 6, figs. 1 a-c, 2.

Description.—The thallus forms a crust from which develop mammillae and in adult stage, short branches. The hypothallus is only slightly developed, consisting of curved rows of cells that measures 12μ – 24μ by 7μ – 13μ . Cells of the marginal perithallus measured 10μ – 15μ by 9μ – 16μ . The perithallus of the crusts and the tissue of the short branches shows an arrangement into nearly regular layers of cells. The cells measure 10μ –

24μ by 6μ – 15μ . Sporangia irregular, rounded to ovoid, commonly in rather irregular layers or lenses. A few specimens show them in fairly regular rows, size 57μ – 93μ high and 35μ – 65μ in diameter.

Remarks.—The specimens from Ishigaki-shima closely resemble the material described by Lemoine (1923) from the Paris Basin. The cells fall within the same size range but do not reach the maximum lengths and widths given by Lemoine. This species closely resembles the form described as *A. cf. A. liberum* Lemoine described from Saipan in size of cells and sporangia but differs in developing short cylindrical branches instead of mammillae. Relatively rare in the collections from Ishigaki-shima.

Localities: F-49; M-239, and 240.

Figured specimen: F-49-55L(4).

***Archaeolithothamnium cf. A. liberum* Lemoine**

Archaeolithothamnium liberum Lemoine, 1939, p. 61, pl. 1, fig. 14; p. 62, fig. 26.

Archaeolithothamnium cf. A. liberum Lemoine. Johnson, 1957, p. 219, pl. 39, figs. 1-2.

Description.—Thallus crustose to nodular with mammillae, apparently growing unattached. Hypothallus poorly developed, consisting of only a few curved threads of cells. The cells measure 12μ – 24μ by 7μ – 11μ . Perithallus quite regular, of rectangular cells 10μ – 24μ by 9μ – 15μ . Sporangia ovoid 44μ – 76μ high and 22μ – 49μ in diameter. They are numerous in well-defined layers and lenses.

Remarks.—This is the same species that was described under this name from Saipan. It is closely related to *A. cf. A. parisiense* Lemoine. It is relatively rare in the collections from Ishigaki-shima.

Locality: M-240.

***Archaeolithothamnium cf. A. affine* Howe**

Archaeolithothamnium affine Howe, 1919, p. 11, pl. 4, fig. 1; pl. 5, figs. 1, 2.

Lemoine, 1939, p. 60, pl. 2, fig. 8, text fig. 25, p. 62.

Description.—A strongly branching form developing long, relatively slender branches, 2.5–3.3 mm in diameter. The tissue shows definite growth zones. The branches are differentiated into a medullary hypothallus and a perithallus. Cells of medullary hypothallus 11μ – 23μ long and 9μ – 11μ wide. Marginal perithallus cells 9μ – 20μ by 7μ – 12μ . Sporangia 41μ – 58μ high and 32μ – 36μ in diameter. Detailed dimensions are given in table 4.

Remarks.—This closely resembles the widely distributed late Eocene and early Oligocene species in growth habit, cell size, and dimensions of sporangia.

Locality: F-49, 50; M-239, 240.

TABLE 4.—Measurements, in microns, of *Archaeolithothamnium* cf. *A. affine*

Slide	Hypothallic cells		Perithallic cells		Sporangia	
	Length	Width	Length	Width	Diameter	Height
F-49L(2).....	11-18	10-12	10-12	10-12	34-44	39-50
F 50.....	16-23	9-11	9-10	9-11	32-36	41-52
M-239B(4).....	-----	-----	10-20	7-11	33-47	49-76
M-240A.....	-----	-----	9-18	7-12	28-41	49-65
M-240A(2).....	-----	-----	9-18	8-12	29-33	37-59

Genus *Lithothamnium* Philippi, 1837

The tissue of *Lithothamnium* normally is differentiated into a hypothallus and a perithallus. The

hypothallus commonly is formed of curved rows of cells. Basically the perithallus is formed of vertical threads of cells. The horizontal partitions of adjoining threads may or may not be at the same levels. Conceptacles of sporangia have many apertures for the escape of spores.

The plants develop a number of growth forms, varying from simple thin crusts to strongly branching forms.

The Eocene species from Ishigaki-shima and their characteristic features are shown in table 5.

TABLE 5.—Measurements, in microns, and distribution of Eocene species of *Lithothamnium* [From random sections]

Species	Hypothallic cells		Perithallic cells		Conceptacles		Growth habit	Locality
	Length	Width	Length	Width	Diameter	Height		
<i>Lithothamnium</i> cf. <i>L. abrardi</i> Lemoine.....	13-30	9-18	9-18	9-12	225-265	110	Thin, irregular crust.	F-50
<i>crispithallus</i> Johnson.....	16-28	7-11	7-10	6-8	359	108	Thin crust.	M-247
<i>cymbicrusta</i> Johnson.....	14-24	8-14	9-14	7-12	360-450	90-180	Thin irregular crust.	F-85, 163
<i>ishigakiensis</i> Johnson, n. sp.....	11-25	6-13	7-15	6-12	450-810	88-296	Crust with protuberances.	F-49, 50, 83, 163
cf. <i>L. moreti</i> Lemoine.....	14-27	6-14	6-13	6-11	150-385	85-175	Thin crusts.	F-49, 50, 80, 163
cf. <i>L. tagpochaense</i> Johnson.....	12-23	8-10	9-15	8-12	210-290	78-100	do.....	F-84, 163
cf. <i>L. bofilli</i> Lemoine.....	12-24	9-11	6-15	6-12	530-579	168-176	Crusts with branches.	F-83
<i>faurai</i> Lemoine.....	16-27	9-11	9-18	9-13	220-475	80-200	Strongly branching.	F-49, 83; M-286
<i>marianae</i> Johnson.....	-----	-----	9-15	7-11	246-465	116-176	do.....	M-239
cf. <i>L. andrusovi</i> Lemoine.....	12-20	8-11	7-11	7-10	-----	-----	Thin crust.	M-247

Lithothamnium cf. *L. abrardi* Lemoine

Lithothamnium abrardi Lemoine, 1934, p. 274, fig. 3.

Lithothamnium cf. *L. abrardi* Lemoine. Johnson, 1957, p. 221, pl. 41, figs. 6-7; pl. 42, figs. 1, 5.

Description.—Thallus thin and irregular with a well-developed hypothallus and perithallus. Hypothallus 150 μ –300 μ thick, formed of curved rows of cells measuring 13 μ –30 μ long and 9 μ –18 μ wide. Perithallus moderately regular with well-defined vertical rows of cells and fairly regular horizontal partitions. Perithallic cells measure 9 μ –18 μ by 9 μ –12 μ . Conceptacles small, about 225 μ by 265 μ in diameter and 110 μ high. Sporangia in a conceptacle 65 μ –67 μ high and 11 μ –12 μ in diameter.

Remarks.—This appears to belong to the same species described by the writer as *L. cf. L. abrardi* Lemoine from the Eocene of Saipan. It approximates the type material from the Mediterranean region but has slightly larger perithallic cells. The conceptacles of the European specimens are not known.

Age: Eocene.

Locality: F-50.

Specimen: IS-F-50.

Lithothamnium cf. *L. andrusovi* Lemoine

Plate 2, figure 5

Lithothamnium andrusovi Lemoine, 1934, p. 274, fig. 2.

Lithothamnium cf. *L. andrusovi* Lemoine, 1939, p. 67.

Description.—Thallus consists of a very thin crust

(300 μ –350 μ thick) with a thick hypothallus and a thin perithallus. Hypothallus of curved rows of rectangular cells (170 μ –290 μ thick). Cells are relatively narrow with a considerable range in length. They measure 12 μ –23 μ by 8 μ –11 μ . Perithallus thin (80 μ –90 μ) with fairly regular tissue, cells measure 7 μ –11 μ by 7 μ –10 μ . No conceptacles present.

Remarks.—This closely resembles the species described by Lemoine from Hungary and Algeria, with its thick hypothallus of rectangular cells and small perithallic cells. The cell measurements of the specimens from Ishigaki-shima are almost the same except that the maximum attained by the hypothallic cells is not so great.

Locality: M-247.

Figured specimen: IS-M-247-56B.

Lithothamnium cf. *L. bofilli* Lemoine

Plate 4, figures 1, 2

Lithothamnium bofilli Lemoine, 1928b, p. 92–107, 20 text figs. 1939, p. 70–71.

Description.—Thallus forms a thin crust from which develop projections or branches. Hypothallus 76 μ –175 μ thick, with cells 12 μ –24 μ by 9 μ –11 μ with curved rows of cells or a plumose structure. Perithallus quite regular, with a tendency to horizontal layering of cells. Cells 6 μ –15 μ by 6 μ –12 μ . Conceptacles 530 μ –579 μ in diameter and 168 μ –176 μ high. One shows sporangia 35 μ –62 μ high and 18 μ –40 μ in diameter.

Remarks.—This closely resembles Lemoine's *L. bofilli* from Spain and Algeria, except that it does not seem to develop such long spines.

Locality: F-83.

Figured specimens: F-83-55(2)L.

***Lithothamnium crispithallus* Johnson**

Lithothamnium crispithallus Johnson, 1957, p. 223, pl. 42, figs. 6-8.

Description.—Thallus develops a thin probably unattached crust, with distinct but thin hypothallus and perithallus. Hypothallic cells 16μ - 28μ by 7μ - 11μ . Perithallic cells 7μ - 12μ by 6μ - 11μ . Conceptacles flat, diameter 282μ - 359μ , height 99μ - 108μ .

Remarks.—This is similar to the form described from Saipan except that the hypothallic cells are longer.

Locality: M-247.

***Lithothamnium cymbicrusta* Johnson**

Lithothamnium cymbicrusta Johnson, 1957, p. 224, pl. 40, figs. 1, 6, 7; pl. 41, fig. 8.

Description.—Thallus develops a thin irregular crust 200μ - 500μ thick. Hypothallus well developed, consisting of rows of cells that curve gently from the center toward the top and the bottom. Hypothallic cells 14μ - 24μ by 8μ - 14μ . Secondary hypothallic tissue with slightly shorter cells were observed on several specimens developing scar tissue. Perithallic tissue fairly regular, cells 9μ - 14μ by 7μ - 12μ . Conceptacles 360μ - 450μ in diameter and 90μ - 180μ high. Sporangia observed in several of the conceptacles, measuring 80μ - 82μ high and 18μ - 25μ in diameter.

Remarks.—The specimens from Ishigaki-shima agree with the type material from Saipan in all respects except that in some specimens from Ishigaki-shima the hypothallic cells attain a greater length.

Age: Eocene.

Locality: F-163, 85.

Specimens: IS-F-163-55(4), IS-F-85-55(2).

***Lithothamnium faurai* Lemoine**

Plate 4, figures 3, 4

Lithothamnium faurai Lemoine, 1927, v. 6, p. 545-551, 6 text figs. 1928b, p. 97, fig. 8.
1939, p. 74, text figs. 36-37, p. 79.

Description.—Thallus develops strong branches with growth zones that are not conspicuous. Cells of branches 9μ - 18μ by 8μ - 13μ . Several examples of secondary hypothallus developed as scar tissue have cells 16μ - 27μ by 9μ - 11μ . Conceptacles abundant, 220μ - 475μ in diameter and 88μ - 200μ high. Detailed dimensions are given in table 6.

Remarks.—The specimens from Ishigaki-shima fit the the material described by Lemoine from Spain and Algeria.

TABLE 6.—Measurements, in microns, of *Lithothamnium faurai* Lemoine

Slide	Hypothallic cells		Perithallic cells		Conceptacles	
	Length	Width	Length	Width	Diameter	Height
2532.....	16-20	7-9	9-16	7-11	440-467	88-99
F-83-55L.....	18-27	9-11	9-17	8-13	220-470	118-220
2538.....	.....	.....	11-14	8-11	335-440	112-145
2536.....	.....	.....	11-18	8-11	211-338	88-144
2530.....	.....	.....	10-18	9-13	308	132
M-286-56.....	.....	.....	11-18	10-13	415	264
F-49-55(5).....	.....	.....	11-17	9-11	407	234

This species closely resembles *L. marianae* Johnson from Saipan, differing slightly in cell dimensions but mainly in having poorly defined growth zones whereas *L. marianae* has well-defined lenticular growth zones. Also the horizontal alinement of cells is poor in *L. faurai* and pronounced in *L. marianae*.

Localities: F-49, 83; M-286.

Figured specimens: 2532, F-83-55 L, 2538.

***Lithothamnium ishigakiensis* Johnson, n. sp.**

Plate 3, figures 1, 2

Description.—Thallus develops as a thin sheet or irregular mass. Several may grow connected or superimposed to form an irregular crust, a nodular mass, or an irregular plate with long warty protuberances that externally suggest branches. Each thallus consists of a well-developed hypothallus, commonly 100μ - 175μ thick, consisting of curved rows of cells. The perithallus is thin, consisting of regularly arranged rows of cells. Conceptacles abundant, large, flat topped, and the roof is pierced by many apertures. Cell and conceptacle measurements for eight specimens are given in table 7.

TABLE 7.—Measurements, in microns, of *Lithothamnium ishigakiensis* Johnson, n. sp.

Slide	Hypothallic cells		Perithallic cells		Conceptacles	
	Length	Width	Length	Width	Diameter	Height
IS-F-49-55L(4).....	15-25	6-11	10-15	8-11	396-687	88-176
IS-F-50-55L.....	11-15	8-11	7-11	6-10	630	176
IS-F-83-55(4).....	14-24	8-10	11-14	9-12	810	195
IS-F-83-55L(5).....	13-16	6-8	10-13	8-12	792	194
IS-F-83-55L(5).....	14-20	7-11	10-13	7-10	453-675	123-176
IS-F-83-55(3).....	11-18	8-12	12-14	9-11	450-670	180-200
IS-F-163-55(1).....	.....	.....	7-9	7-10	726	296
2532.....	11-20	8-13	9-15	8-11	669	132

The large range in size of conceptacles probably is largely the result of the accidental position of the section that might be through the center or might be near the edge. The larger figures are probably the closest to the true diameter.

Remarks.—This species differs considerably from any previously described Eocene *Lithothamnium* known to the author. The peculiar growth forms resulting from the combined growth of numerous thalli, the large

size of the conceptacles, the well-developed but thin hypothallus and perithallus, and the cell size are considered to be distinctive features of the species.

Ishijima, 1954, described a species, *L. boninensis*, that has unusually large conceptacles, but it differs in size of cells, growth habit, and in having a poorly developed hypothallus and a very thick perithallus.

Age: Eocene.

Localities: F-49, 50, 83, 163.

Figured specimens: Holotype, IS F-83-55(4); also figured, IS F-83-55(3), IS F-163-55(1).

Lithothamnium marianae Johnson

Lithothamnium marianae Johnson, 1957, p. 226, pl. 41, figs. 1-3.

Description.—A strongly branching form. Branches show pronounced growth zones and a well-defined tendency for a horizontal as well as a vertical alignment of the cells. Cells measure 9μ – 15μ by 7μ – 11μ . Conceptacles 247μ – 465μ in diameter and 116μ – 176μ high. Sporangia present, at least 21μ – 48μ high.

Remarks: Similar to the material described from Saipan.

Locality: M-239.

Lithothamnium cf. L. moreti Lemoine

Plate 3, figure 3

Lithothamnium moreti Lemoine, 1927, p. 547, fig. 2.

Johnson, 1957, p. 225, pl. 38, fig. 7.

Description.—Thallus thin, encrusting. Several may grow superimposed. Thallus thin, normally about 100μ – 200μ . It consists of curved rows of cells. The perithallus is well defined but shows a considerable variation of thickness in different specimens. Conceptacles common. The dimensional data for five specimens are given in table 8.

TABLE 8.—Measurements, in microns, of *Lithothamnium* cf. *L. moreti* Lemoine

Slide	Hypothallic cells		Perithallic cells		Conceptacles	
	Length	Width	Length	Width	Diameter	Height
IS-F-80-55(2).....	14-23	7-9	7-9	7-9	200-235	85-95
IS-F-163-55(3).....	15-27	6-11	6-13	7-8	198	65
IS-F-163-55(2).....	15-20	8-9	7-10	6-7	195-256	112-158
IS-F-49.....	16-23	9-13	9-13	8-10	285-290	100-170
IS-F-50(2).....	16-21	10-14	7-10	7-11	385	175

Remarks.—This form is common in the slides from Ishigaki-shima. The growth habit, cell dimensions, and conceptacle size are similar to the material described from Saipan by this author and from the Mediterranean region by Lemoine. The material from Ishigaki-shima, however, differs in having slightly larger perithallic cells and by having a better developed hypothallus.

Age: Eocene.

Localities: F-49, 50, 80, 163.

Figured specimens: IS-F-80-55(2), IS-F-163-55.

Lithothamnium cf. L. tagpotchaense Johnson

Lithothamnium tagpotchaense Johnson, 1957, p. 223, pl. 37, fig. 7; pl. 39, fig. 7.

Description.—Thallus forms a thin irregular sheet. Hypothallus and perithallus thin. Hypothallus 50μ – 150μ thick, consisting of curved rows of cells. Cells 12μ – 23μ by 8μ – 11μ . Perithallus with well-defined vertical rows of cells. Cells 9μ – 15μ by 8μ – 12μ . Conceptacles 210μ – 290μ in diameter and 78μ – 100μ high. Some of the conceptacles show sporangia 60μ – 67μ high and 23μ in diameter.

Remarks.—In appearance and growth habit the Ishigaki-shima specimens closely resemble the type *L. tagpotchaense* Johnson from Saipan. The conceptacles are about the same size. There is a slight difference, however, in the size of the perithallic cells. It also closely resembles *L. grahamsi* Johnson and Stewart but differs in character of hypothallus and in having a much thinner perithallus.

Age: Eocene.

Localities: F-84, 163.

Genus MESOPHYLLUM Lemoine, 1928

This genus is intermediate between *Lithothamnium* and *Lithophyllum* structurally. It has tissue similar to *Lithophyllum* and conceptacles that have many apertures like those of *Lithothamnium*. It includes both crustose and branching species. In most species the tissue shows pronounced irregular growth zones.

The genus has a known range extending from the Eocene to the Recent. In the Ishigaki collections it is abundantly represented by numerous specimens belonging to a few species.

The detailed dimensions and locality data for the Ishigaki species are shown in table 9.

Mesophyllum ishigakiensis Johnson, n. sp.

Plate 5, figure 4

Description.—The plant forms large, very irregular crusts that have wide rounded protuberances. The hypothallus and perithallus are strongly differentiated. The hypothallus is very irregular, being thin in some places and then thickening rapidly. Thickness ranges from 150μ to more than 600μ . It may develop a plumose structure. Where thin it consists of strongly curved rows of cells; where thick it consists of many rows of cells which curve from the center toward the top and bottom. Hypothallic cells 16μ – 25μ by 10μ – 13μ . Detailed dimensions are given in table 10.

TABLE 9.—Measurements, in microns, and distribution of Eocene species of Mesophyllum

[Based on slices in thin sections]

Species	Hypothallic cells		Perithallic cells		Conceptacles		Growth habit	Locality
	Length	Width	Length	Width	Diameter	Height		
<i>Mesophyllum ishigakiensis</i> Johnson, n. sp.-----	16-25	10-13	10-17 9-11	11-12 8-9	250-425	135-160	Crusts with rounded protuberances. . .	F-49, 50
<i>ryukyuensis</i> Johnson, n. sp.-----	12-22	8-12	8-18	6-12	250-325		Crusts with branches or knobs.-----	F-49, 50, 81, 83, 163
<i>vaughanii</i> (Howe) Lemoine-----	9-22	7-13	9-19	6-19	176-528	117-170	Crusts with branches.-----	F-51, 81, 83, 163, 176; M-121, 239, 240
sp. A.-----	13-20	9-12	11-18	9-10			Long, slender branches.-----	F-176
sp. B.-----			9-21	11-18	1056	298	Crust with protuberances.-----	M-239, 286

TABLE 10.—Measurements, in microns, of *Mesophyllum ishigakiensis* Johnson, n. sp.

Slide	Hypothallic cells		Perithallic cells		Conceptacles	
	Length	Width	Length	Width	Diameter	Height
F-50.-----	16-25	10-13	10-15	9-12	250-400	125-150
F-50.-----			9-16	9-12	275-425	135-160
F-49(1).-----	21-27	10-14	13-14	10-14	189-370	112-125

The perithallus is thick and irregular. At the base it is fairly regular with thin growth zones of layers of cells, but above it becomes very irregular, appearing to be composed of small lenticular growth zones. Conceptacles are numerous and add to the irregularity of the tissue. The growth zones commonly contain longer cells in the lower layers than in the upper ones. Cells in the lower layers are 10 μ -17 μ by 11 μ -12 μ , middle layers 11 μ -12 μ by 11 μ -12 μ , upper layers 9 μ -11 μ by 8 μ -9 μ . Conceptacles small, very numerous, and crowded with sporangia. Diameter of conceptacles 250 μ -425 μ , height 135 μ -160 μ . Sporangia 45 μ -78 μ high and 14 μ -45 μ in diameter.

Remarks.—The growth form, very irregular tissue, and small high conceptacles make this species quite distinctive.

The cell dimensions and size of conceptacles fall within the range of those attributed to *M. vaughanii* (Howe) Lemoine, but in the latter the crust is insignificant and the branches and spines are more characteristic. Although the tissue of *M. vaughanii* is zoned also, the zones are larger and the tissue more regular.

M. ishigakiensis differs from *M. ryukyuensis* Johnson by having a much more irregular perithallic tissue and by lack of branches.

Localities: F-49, 50.

Figured specimen: Holotype, F-50(1).

***Mesophyllum ryukyuensis* Johnson, n. sp.**

Plate 5, figures 1-3; plate 7, figure 6

Description.—Thallus forms a crust from which develop short flat-topped knobs or branches. The basal hypothallus is thin but well defined. It consists of curved rows of cells. Cells measure 12 μ -22 μ long and

8 μ -12 μ wide. Numerous specimens show a secondary hypothallus developed as a scar tissue. The tissue of the branches shows growth zones; these are shaped like an inverted saucer. Commonly the zones contain 6-14 layers of cells. In many of the lower layers the cells are longer than in the upper layers. Cell dimensions range from 8 μ to 18 μ long by 6 μ to 12 μ . They average about 9 μ -13 μ by 8 μ -11 μ . Conceptacles numerous with diameters as much as 325 μ . Many contain sporangia. These show lengths as much as 75 μ and diameters as much as 35 μ .

The dimensional data for a number of specimens are given in table 11.

TABLE 11.—Measurements, in microns, of *Mesophyllum ryukyuensis* Johnson, n. sp.

Slide	Hypothallic cells		Perithallic cells		Conceptacles	
	Length	Width	Length	Width	Diameter	Height
IS F-49-55L.-----	12-22	8-10	9-16	9-12	264-323	61-85
IS 50.-----			9-14	8-10	210-310	100-120
IS F-81-55.-----			10-12	9-12	290-310	128-180
IS F-83-55(1).-----	13-17	7-9	12-15	8-10	250-270	90-108
IS F-83-55(2).-----	12-17	9-11	12-17	9-11	190-250	90-100
IS F-83-55(3).-----			9-18	9-11	280-290	100-110
IS F-163-55(2).-----			9-15	9-10	270	108
IS F-163-55(3).-----			8-12	6-8	191-275	98-127
IS F-163-55(4).-----			10-13	8-9	133-165	81-112
IS F-163-55(5).-----			9-11	7-9	184-191	84-92
2530.-----	17-24	8-11	9-15	9-11	153-244	61-79
2534.-----	13-14	6-10	11-15	8-11	176-245	65-75

Remarks.—This is the species most abundantly represented in the Eocene slides studied from Ishigaki-shima. It rather closely resembles *M. pfenderae* Lemoine but has smaller cells and considerably smaller conceptacles. It approaches *M. ishigakiensis* Johnson but differs in having a more regular tissue and by developing branches.

Localities: F-49, 50, 81, 83, 163; M-239.

Figured specimen: Holotype, IS-F-49-55 L(1); also figured, IS-F-49-55 L(4).

***Mesophyllum vaughanii* (Howe) Lemoine**

Plate 3, figure 4; plate 6, figures 4, 5, 6

Lithothamnium vaughani Howe, 1918, p. 6-7, pls. 7, 8.

Mesophyllum vaughanii (Howe) Lemoine, 1939, p. 89-90, pl. 1.

Description.—Thallus forms a crust from which develop numerous short branches or spines as much as 5 mm long and 3 mm wide. The tissue of the branches is strongly zoned and is composed of lenticular masses of cells, each lens being formed of layers of cells. In some of these layers the cells are of equal length, in others the lower layers contain longer cells than the upper ones. Cells measure 9μ – 19μ by 6μ – 19μ . Some of the thicker branches have a fairly well defined outer or marginal perithallus, others do not.

There is a small but well-defined basal hypothallus to the crust, consisting of curved cell rows. Cells 14μ – 27μ by 9μ – 13μ . Some of the specimens studied show strips of secondary hypothallic tissue that apparently developed as scar tissue. Conceptacles are abundant and pierced by numerous pores. Conceptacle diameters are as much as 528μ . Some specimens show traces of the sporangia.

Dimensional data for 14 specimens are given in table 12.

TABLE 12.—Measurements, in microns, of *Mesophyllum vaughanii* (Howe) Lemoine

Slide	Basal hypothallic cells		Cells of branches		Conceptacles	
	Length	Width	Length	Width	Diameter	Height
F-51(1).....	14-26	9-13	14-19	11-15	525	125
F-51(2).....	12-18	9-12	13-20	7-11	320-430	150-170
F-81(1).....	-----	-----	10-12	9-12	290-310	128-180
F-83(1).....	13-17	7-9	12-15	8-10	250-289	90-108
F-83(1).....	15-19	7-10	9-15	7-10	220-383	88-100
F-163(4).....	-----	-----	8-11	9-16	338-504	117-139
F-176(2).....	9-17	5-10	11-18	7-10	202-228	66-77
M-97(1).....	-----	-----	10-12	6-11	370-396	185-198
M-121(1).....	19-27	7-11	13-19	9-12	202-396	202-220
M-121(1).....	26-35	9-11	11-25	9-13	204-414	132-147
M-239D(3).....	-----	-----	12-25	8-13	312-528	130-149
M-239A(1)L.....	14-28	9-11	10-19	7-12	264-506	84-194
M-240C.....	-----	-----	11-17	6-10	176-440	114-159
M-247A.....	-----	-----	9-15	9-11	396-508	119-132
M-247A.....	-----	-----	10-19	8-11	191-330	101-132
M-247A.....	-----	-----	9-14	7-10	189-341	118-132
M-247A.....	14-28	9-13	9-19	6-16	528	-----

Remarks.—This is the most common species of algae found in the collections from Ishigaki-shima. It suggests *M. pfenderae* Lemoine but has smaller cells and conceptacles. It approaches *M. ishigakiensis* Johnson in cell size but differs in having a more regular tissue, larger conceptacles, and by developing branches. It is close to *M. ryukyensis* Johnson but differs in having a tissue with more pronounced growth zones and in developing long, slender branches.

Localities: F-51, 81, 83, 163, 176; M-121, 239, 240, 247.

Figured specimens: F-83-55(4); M-240-56C, and F-163-55(4).

Mesophyllum sp. A

Plate 6, figure 1

Description.—Develops long, slender branches. These are composed of a thick medullary hypothallus

and a narrow marginal perithallus. The hypothallus shows numerous growth zones, each about 10 layers of cells thick, composed of cells measuring 13μ – 20μ by 9μ – 12μ . The marginal perithallus contains cells 11μ – 18μ by 9μ – 10μ . No conceptacles observed.

Remarks.—The long, slender spinelike branches and the cell dimensions of this form differ from any described Eocene species. With only a few infertile branches available for study however, it does not seem desirable to give it a specific name.

Locality: F-176.

Figured specimen: IS-F-176-55(2).

Mesophyllum sp. B

Plate 4, figure 5

Description.—Thallus develops a crust with small protuberances or mammillae. Hypothallus moderately developed; cells 18μ – 25μ by 9μ – 12μ . Perithallic tissue fairly regular, with cells 9μ – 21μ by 9μ – 18μ . Conceptacle chamber $1,056\mu$ – $1,320\mu$ by 298μ – 310μ .

Remarks.—Represented by two fragments but of interest because of its unusually large conceptacle.

Locality: M-239 and 286.

Figured specimen: M-286-56(1).

Genus LITHOPHYLLUM Philippi, 1837

This genus has the tissue differentiated into hypothallus and perithallus. Most of the species have a coaxial basal hypothallus but some have a hypothallus consisting of a few irregular or curved threads of cells. The perithallus is regular, showing layers of cells. Branching species have a well-developed coaxial medullary hypothallus, surrounded by a thinner marginal perithallus. The tetrasporangia are collected into conceptacles having a single large aperture in the roof.

For some reason *Lithophyllum* is not abundant in the Eocene rocks from Ishigaki-shima. Only three species were observed.

Lithophyllum cf. L. ovatum (Capeder) Lemoine

Lithothamnium ovatum Capeder, 1900, p. 177, pl. 6, figs. 5 a, b.

Lithophyllum ovatum (Capeder) Lemoine, 1926, p. 245-246, fig. 3.

Airoldi, 1932, p. 70, pl. 10 [1933].

Johnson, 1957, p. 228, pl. 45, figs. 4, 8.

Description.—Thallus forms a thin crust. Several may grow superimposed. Hypothallus is thin (44μ – 98μ thick), and coaxial, having cells 12μ – 24μ by 7μ – 12μ . Perithallus is 250μ – 600μ thick, of regular cell rows. Cells are 6μ – 13μ by 6μ – 11μ . Conceptacle chambers 176μ – 365μ in diameter and 58μ – 84μ high.

Remarks.—This species closely resembles the species described by Lemoine (1926) from Italy except that the

hypothallic cells are shorter. It is similar to the material from Saipan which was attributed to that species.

Localities: F-49, 163; M-247, 248.

Lithophyllum cf. *L. pfenderae* Lemoine

Plate 6, figures 2, 3

Description.—Small slender branches, possibly developing from a thin crust. Tissue shows growth zones. Tissue of branches of layers of cells is 9μ – 18μ by 7μ – 11μ . Thin growths of hypothallic tissue over conceptacles have cells 20μ – 31μ by 7μ – 11μ . Conceptacles are 176μ – 552μ in diameter, highly arched, having a single large long-necked aperture.

Remarks.—The growth habit and size of cells and conceptacles closely resemble those given by Lemoine (1928b, p. 99) for *L. pfenderae* from Catalonia, Spain. The branches, however, are a little smaller and the maximum length of cells is less.

Localities: M-239, 240, 247; F-83.

Figured specimens: M-239B(3), and 240A(2).

Lithophyllum sp. D

Plate 7, figure 7

Description.—Thallus forms an irregular crust, a millimeter or more thick, composed of a thin poorly developed hypothallus ($50\mu\pm$) and a thick perithallus. Perithallic tissue shows irregular growth zones, and cells are 9μ – 18μ by 9μ – 13μ . Conceptacles are small— 132μ – 215μ in diameter and 50μ – 77μ high and have a long thick aperture.

Remarks.—This form is quite different in cell size, character of tissue, and conceptacle size from any hitherto described Eocene *Lithophyllum*. It is represented, however, by only a single specimen that cuts the hypothallus obliquely and thus is considered inadequate for giving it a specific name.

Locality: M-236.

Figured specimen: IS-M-236-56L.

Genus *Lithoporella* Foslíe, 1909

The thallus of *Lithoporella* is composed of a single layer of large cells that are elongated vertically and slightly obliquely. (They contain the longest cells found among the crustose corallines, although some of the articulated corallines have cells equally long. Conceptacles have a single large roof pore. The plants form thin, often circular crusts growing on other plants, coral, Foraminifera shells, pebbles, and other firm objects.

Specimens belonging to this genus are found in the Ishigaki collection but for some reason are not nearly as common as in most of the Eocene collections studied from the Pacific area.

Lithoporella melobesioides

Mastophora (Lithoporella) melobesioides Foslíe. Weber van Bosse and Foslíe, 1904, p. 73–77, figs. 30–32.

Melobesia (Lithoporella) melobesioides Foslíe. Lemoine, 1939, p. 108–110, figs. 78–79.

Lithoporella melobesioides (Foslíe) Foslíe. Lignac-Grutterink, 1943, p. 292–293, pl. 2, fig. 8.

Lithoporella (Melobesia) melobesioides (Foslíe) Foslíe. Johnson and Ferris, 1949, p. 196–197, pl. 37, figs. 4–5; pl. 39, fig. 2.

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

Johnson, 1957, p. 234, pl. 37, fig. 5; pl. 43, figs. 1, 2; pl. 49, fig. 4; pl. 56, fig. 6.

Description.—Thallus thin, consisting of a single layer of long narrow cells 81μ – 92μ long and 15μ – 18μ wide. No conceptacles are present.

Remarks.—This ubiquitous species with very long cells is surprisingly scarce in the collections from Ishigaki-shima. All the specimens were infertile.

Age: Eocene.

Locality: F-95.

***Lithoporella minus* Johnson n. sp.**

Plate 2, figure 6

Description.—Thalli small and very thin, consisting of a single layer of vertically elongated cells. Cell dimensions, in microns:

24μ – 27μ by 15μ – 18μ

21μ – 24μ by 11μ – 16μ

22μ – 26μ by 11μ – 14μ

22μ – 25μ by 11μ – 15μ

Conceptacle chambers average 135μ in diameter and 65μ high.

Remarks.—Superficially this looks very similar to *Melobesia? cuboides* Johnson from the Eocene of Saipan. The cells, however, are elongated vertically and slightly obliquely instead of horizontally, and the cells are longer and narrower.

Age: Eocene.

Locality: F-84.

Figured specimen: Holotype, IS-F-84-55(1).

Genus *DERMATOLITHON* Foslíe, 1899

The thallus forms a thin crust that is circular or irregular in outline. These grow on other algae, coral, shells, and other objects. Thalli may grow on one another. The hypothallus consists of one or two layers of cells that are vertically and obliquely elongated. Perithallus contains only a few layers of nearly cubic cells. Conceptacles slightly to strongly convex, the roof pierced by a single aperture. Only a few specimens of a single species were observed in the slides.

Dermatolithon nitida Johnson

Dermatolithon nitida Johnson, 1957, p. 235, pl. 57, figs. 2, 3.

Description.—Thallus is thin and encrusting. Hypothallus consists of a single layer of vertically elongated cells 42μ – 63μ by 11μ – 19μ . Perithallus formed of a few layers of nearly cubic cells 20μ – 32μ by 16μ – 21μ . No conceptacles present.

Remarks.—This is similar to the species described from the Eocene of Saipan.

Locality: M-239.

Subfamily CORALLINOIDEAE (articulated corallines)

Genus CORALLINA Linnaeus, 1758

The plants are bushy clusters of segmented stems that branch at close intervals, ordinarily in a plane. Segments mainly clavate or flattened cylindrically, quite variable in size and shape. Segments mainly of hypothallic tissue, composed of lenticular layers of long narrow cells. Marginal perithallus is weakly developed. Conceptacles are lateral or terminal.

Corallina cf. C. coosmanni Lemoine

Plate 7, figures 4, 5

Description.—Flattened segments of a frond. Segments consist of curved layers of long narrow cells that measure 58μ – 121μ long and 5μ – 12μ wide at middle of cell layers. Several specimens show the nodes formed of a single layer of very long cells, 246μ – 264μ long and 8μ – 11μ wide. No conceptacles were observed. The detailed measurements of eight specimens are given in table 13.

Remarks.—These specimens fit very closely Lemoine's species from the lower Miocene of Martinique (Lemoine, 1917) and the material attributed to that species by Lignac-Grutterink (1943) from the Eocene of the Malaysian archipelago.

Localities: M-121, 239, 247, 248.

Figured specimens, slides: M-121-56 L, M-248-56C(2).

TABLE 13.—Measurements, in microns, of specimens of *Corallina coosmanni* Lemoine

Slide	Size segments	Number of layers of cells in segments	Cell size		Node		Marginal cells
			Length	Width	Length	Width	
M-121-56L.....	1012×572	17	62-83	7-12	264	467	-----
	1056×572	18	53-90	7-10	-----	-----	-----
M-239B(4).....	660×462	8	75-121	8-11	-----	-----	8-10×8-9
M-239D(3).....	924×294	14	62-91	5-10	-----	-----	-----
M-247B.....	660×440	8	86-109	8-11	-----	-----	9-11×9-11
M-247B.....	860×500	12	62-101	6-11	300	396	-----
M-247B.....	528×247	8	58-79	7-9	-----	-----	-----
M-248C(2).....	1452×704	21	60-84	8-12	-----	-----	-----

Corallina matansa Johnson

Corallina matansa Johnson, 1957, p. 238-239, pl. 44, figs. 3, 4.

Description.—Segments flattened, sharply tapering, 1-1.4 mm long. Hypothallic cells in center of layers 47μ – 78μ long.

Remarks.—Represented by a number of abraded segments which appear to belong to the same species described from Saipan.

Localities: M-97, 106, 121.

Corallina prisca Johnson

Corallina prisca Johnson, 1947, p. 239-240, pl. 37, fig. 4; pl. 40, fig. 10; pl. 44, figs. 1, 2, 7-11.

1961, p. 907-950, pls. 267-280, figs. 288-289.

Description.—Fronds composed of slender nearly cylindrical segments. Hypothallic cells 80μ – 110μ by 6μ – 10μ . Perithallic cells 10μ – 28μ by 8μ – 15μ .

Remarks.—These are the same species originally described from Saipan and later found in the Eocene limestone of many of the Pacific Islands.

Localities: F-84, 95.

Genus JANIA Lamouroux, 1812

The plants consist of bushy masses of slender dichotomously branching fronds. Each frond is a series of slender segments formed of tiers of medullary hypothallic cells surrounded by a very narrow marginal perithallus. Commonly this is only one layer thick with small rectangular cells. The cells of the hypothallus tend to be wider in proportion to their length than in most genera of the articulated corallines. Many of the hypothallic cells are wedge shaped, wider at the top than at the bottom; and the boundary between the layers of cells is irregular.

One plant, a new species, is described.

Jania mayei Johnson, n. sp.

Plate 7, figures 1, 2

Description.—Long, slender nearly cylindrical segments composed of layers of cells. Irregular boundaries between the cell layers. Cells measure 19μ – 34μ by 8μ – 11 (14) μ . Marginal cells 9μ – 14μ by 7μ – 9μ . Dimensions of four specimens are given in table 14.

Remarks.—This species has considerably smaller cells than any previously described Eocene species and tends to develop long segments.

This is based on many broken segments, so the total length and number of tiers of cells in segment is greater

than the observed figures. Named for Harold May who collected most of the material.

Localities: F-176; M-239, 248.

Figured specimens: Holotype, M-248-C; also figured, F-176-55L.

TABLE 14.—*Measurements, in microns, of Jania mayei Johnson, n. sp.*

Slide	Size of segment	Tiers of cells in a segment	Cells of tiers		Marginal cells	
			Length	Width	Length	Width
M-248C	1012×156	36+	19-28	9-11	9-14	8-9
F-176	704×139	24+	26-35	9-12	9-12	7-8
M-239B(4)	507×102	18+	26-34	8-11	-----	-----
M-248(2)	1474×130	59+	22-33	9-14	-----	-----

Genus AMPHIROA Lamouroux, 1812

The plants form tufts or clusters of segmented fronds that branch dichotomously or trichotomously at regular intervals. Conceptacles are lateral. The segments are cylindrical to flattened or are flattened but thicker at the center than at the margins. The medullary hypothallus is well developed and formed of gently arched tiers of cells. In many of the Recent species one or more tiers of long cells regularly alternate with single tiers of short cells. The marginal perithallus is moderately to well developed.

The genus is represented by only a few badly worn segments in the slides of Eocene material from Ishigaki-shima.

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PLATES 1-7

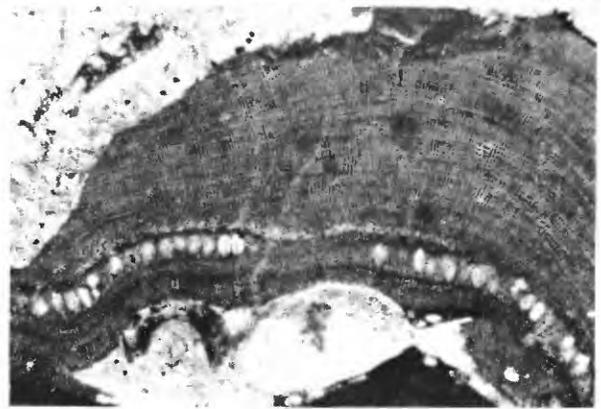
PLATE 1

FIGURES 1-6. *Archaeolithothamnium fosteri* Johnson, n. sp. (p. C3).

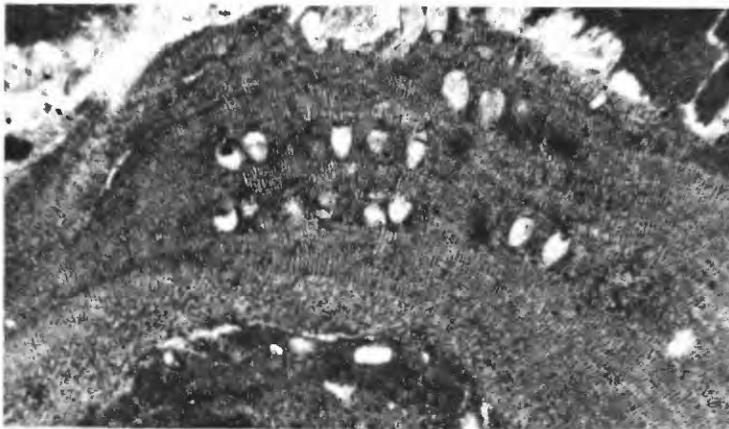
1. A crustose mass with a well-developed hypothallus and perithallus and several layers of sporangia ($\times 50$). USGS loc. D962, holotype specimen A788a.
2. Another area of the same ($\times 50$).
3. Vertical section of another crust ($\times 50$). USGS loc. D969 [F-163(4)], specimen A824.
4. Nearly vertical section of another crust ($\times 50$). USGS loc. D962 [F-49], specimen A789.
5. Section through a rounded mass ($\times 50$). USGS loc. D962, specimen A789.
6. Detail of a thick crust ($\times 100$) showing perithallic tissue, suggestions of growth zones, and several layers of sporangia. USGS loc. D969, specimen A825.



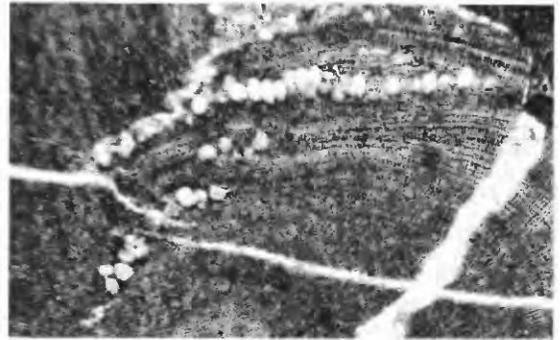
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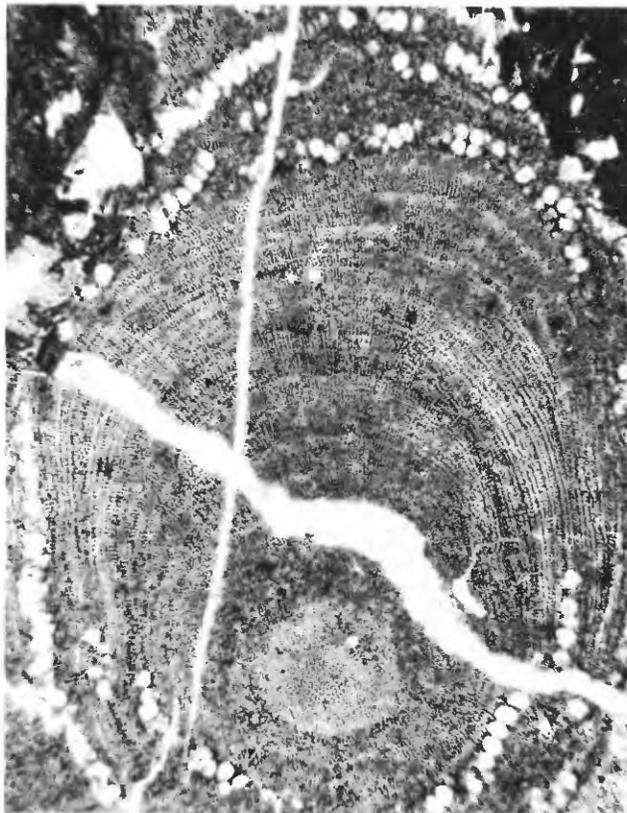
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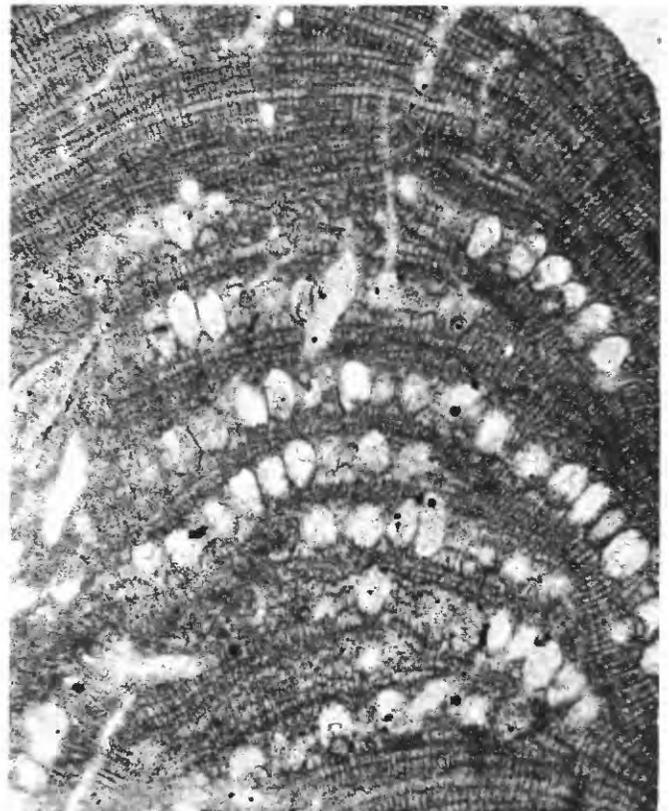
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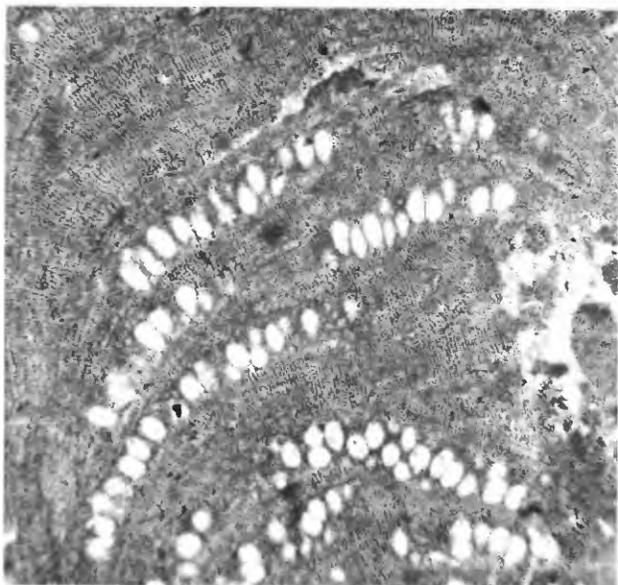
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6

PLATE 2

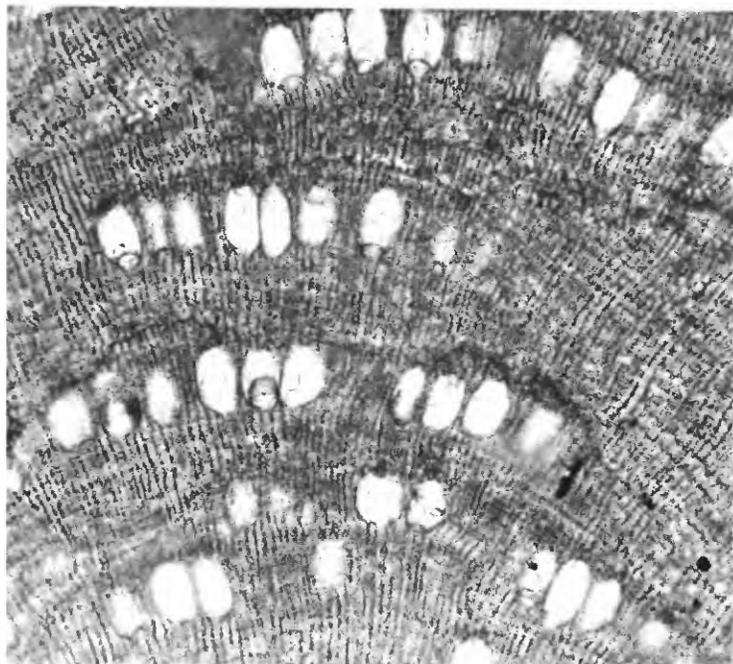
- FIGURES 1-3. *Archaeolithothamnium nummuliticum* (Gümbel) Rothpletz (p. C3).
1. A slightly oblique section of the tissue showing numerous sporangia ($\times 40$), M-240-56C.
 2. Detail of tissue and sporangia ($\times 100$), F-163(1).
 3. Section of a small knob or branch with several layers of sporangia ($\times 50$), F-51-55(2).
4. *Archaeolithothamnium* cf. *A. parisiense* Gümbel Lemoine (p. C4).
Section of a branch ($\times 40$) showing tissue and several layers of sporangia, F-49-55L(4).
5. *Lithothamnium* cf. *L. andrusovi* Lemoine. (p. C5).
Section showing detail ($\times 40$), M-247-56B.
6. *Lithoporella minus* Johnson, n. sp. (p. C10).
Several superimposed thalli ($\times 100$), F-84-55(1).



1



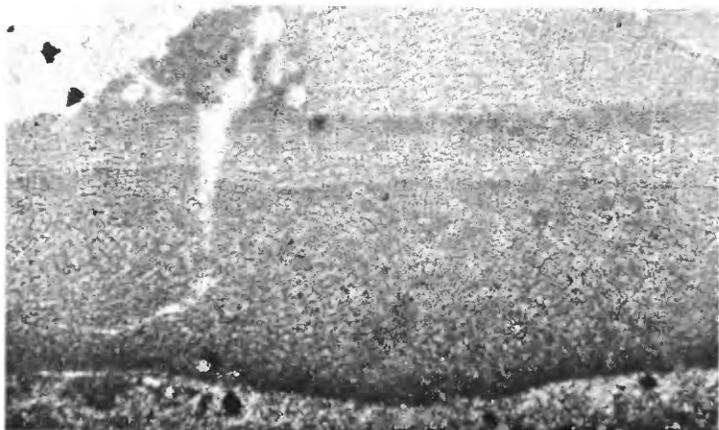
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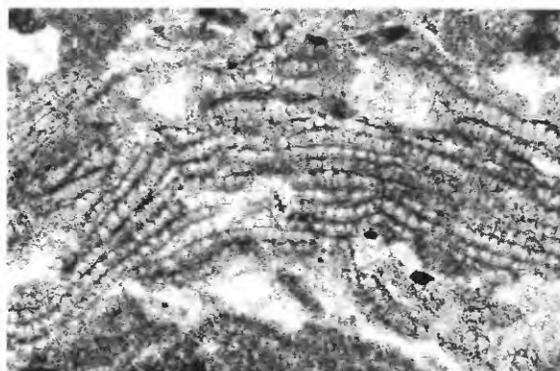
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6

PLATE 3

FIGURES 1, 2. *Lithothamnium ishigakiensis* Johnson, n. sp. (p. C6).

1. Several crusts each showing a hypothallus and perithallus. A large conceptacle chamber on top shows numerous apertures for the escape of spores ($\times 50$). Holotype F-83-55.
2. Detail of tissue and a large conceptacle chamber ($\times 100$) with indications of multiple apertures, F-83-55.
3. *Lithothamnium* cf. *L. moreti* Lemoine. (p. C7).
Section ($\times 100$) through several thin crusts. The upper one contains a conceptacle chamber with sporangia (somewhat recrystallized), F-163-55.
4. *Mesophyllum vaughanii* (Howe) Lemoine. (p. C8).
Section through a colony showing tissue and numerous conceptacle chambers ($\times 50$), F-163-55.



1



3



4



2

LITHOTHAMNIUM AND MESOPHYLLUM

PLATE 4

FIGURES 1, 2. *Lithothamnium* cf. *L. bofilli* Lemoine (p. C5).

1. A section ($\times 100$) showing hypothallus, perithallus, and a conceptacle filled with sporangia, F-83(2).

2. Section of a crust with well-developed hypothallus, a perithallus, and conceptacle chamber with numerous apertures ($\times 100$), F-83(2)L.

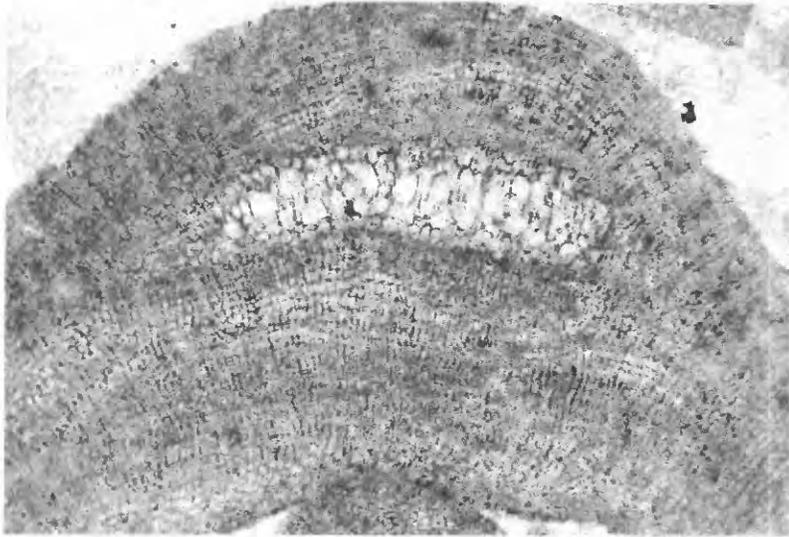
3, 4. *Lithothamnium faurii* Lemoine (p. C6).

Detail of tissue and a conceptacle chamber at top. Below it is another chamber partly covered by a secondary hypothallus which developed as scar tissue ($\times 100$), F-49.

Section of a branch ($\times 40$).

5. *Mesophyllum* sp. B (p. C9).

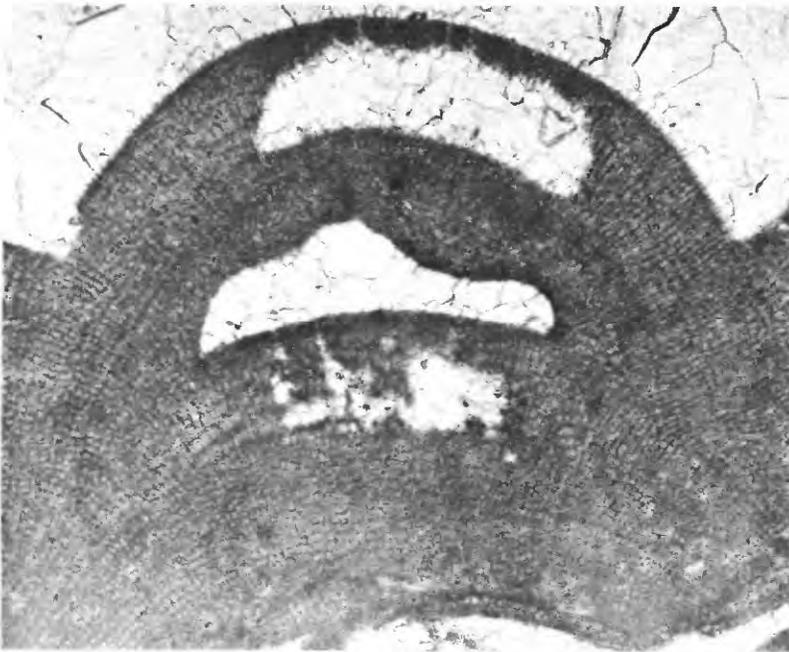
Details of a worn and worm-bored specimen ($\times 100$), M-286-56.



1



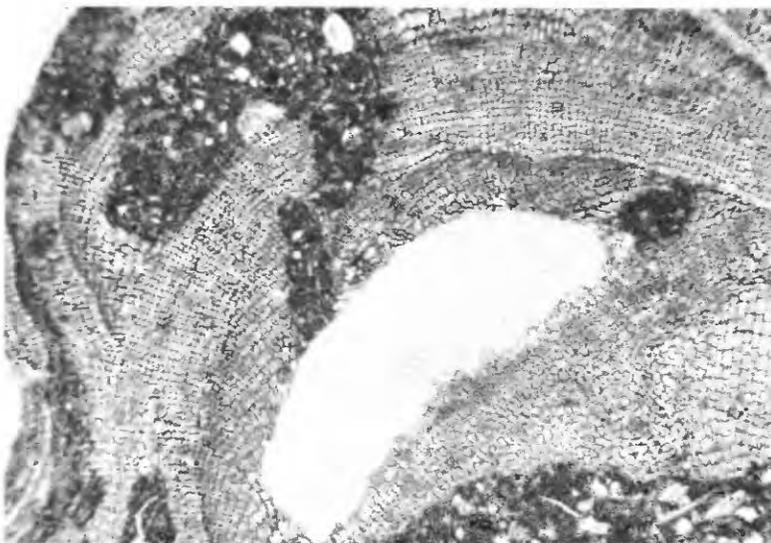
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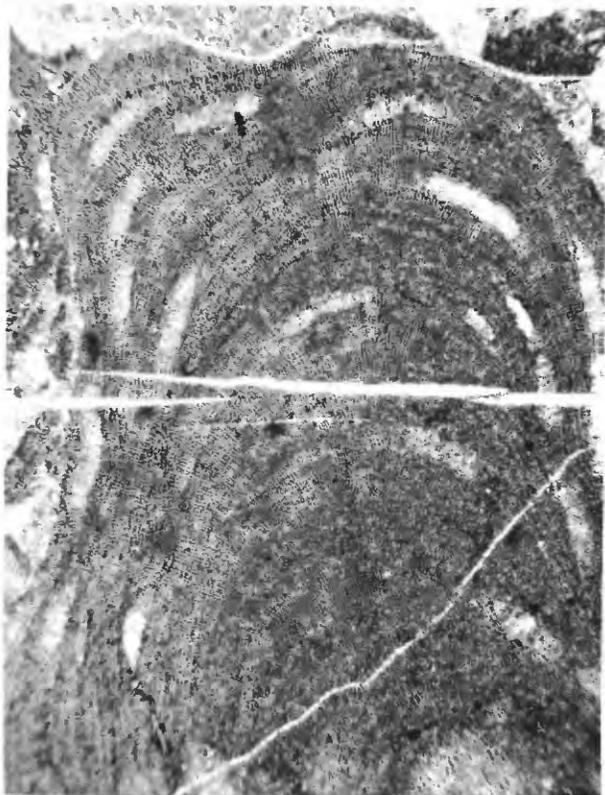


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PLATE 5

FIGURES 1-3. *Mesophyllum ryukyuensis* Johnson, n. sp. (p. C8).

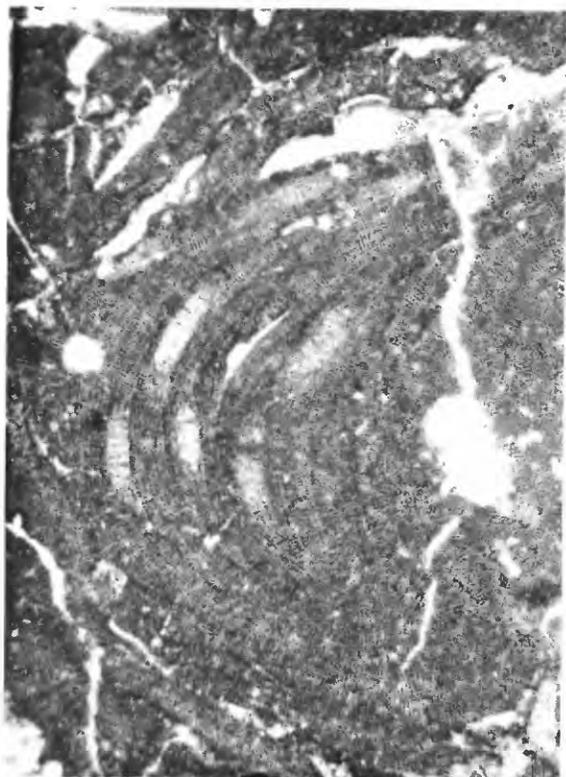
1. Section of a branch ($\times 40$). USGS loc. D962 [F-49], holotype specimen A787a.
2. Detail of the same ($\times 100$) showing tissue and conceptacles filled with sporangia.
3. Section of a small knob ($\times 50$). USGS loc. D962, specimen A826.
4. *Mesophyllum ishigakiensis* Johnson, n. sp. (p. C7).
Slightly oblique section of a branch ($\times 50$) showing the numerous irregular growth zones and conceptacles filled with sporangia. USGS loc. D962, specimen A789b.



1



2



3

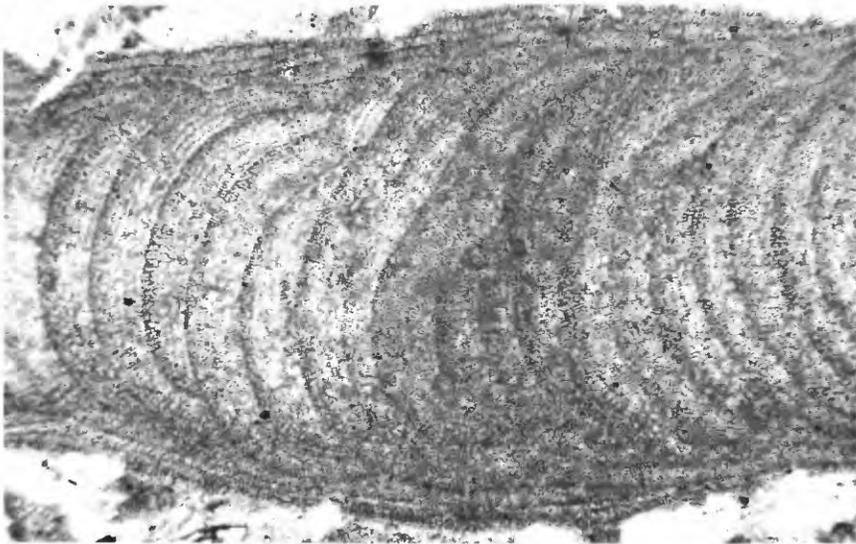


4

MESOPHYLLUM

PLATE 6

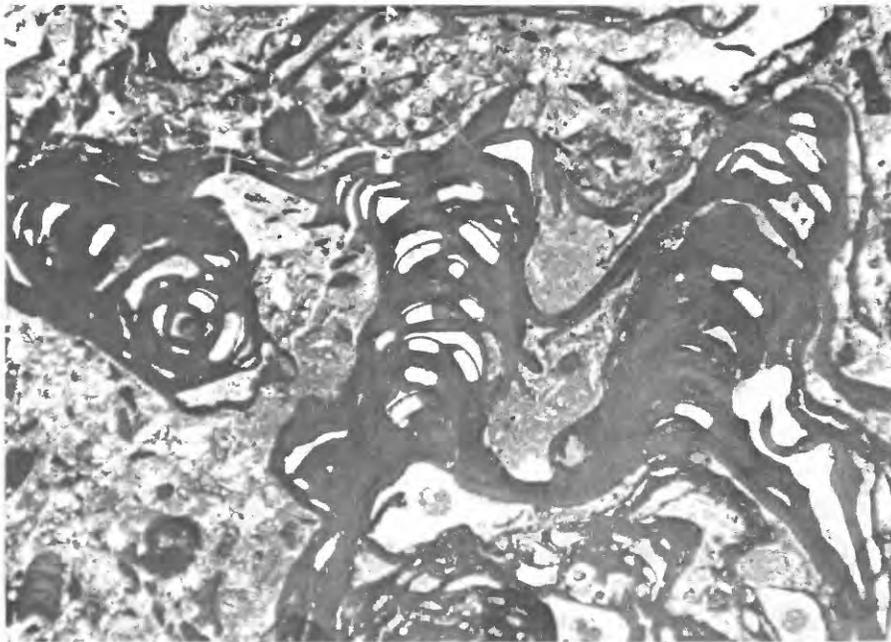
- FIGURE 1. *Mesophyllum* species A (p. C9).
Section of a branch showing the growth zones ($\times 50$), F-176(2).
- 2, 3. *Lithophyllum* cf. *L. pfenderae* Lemoine (p. C10).
2. A small growth showing tissue and conceptacle chambers with a single large long-necked aperture ($\times 50$) M-240A(2).
3. A similar smaller growth ($\times 50$), M-239D(3).
- 4-6. *Mesophyllum vaughanii* (Howe) Lemoine (p. C8).
4. Several branches arising from a thin crust ($\times 9$), F-83.
5. A nearly complete branch showing tissue and multiple apertured conceptacles ($\times 40$), F-83(4).
6. Detail of a fragment of a branch with conceptacle chambers ($\times 50$) M-240C.



1



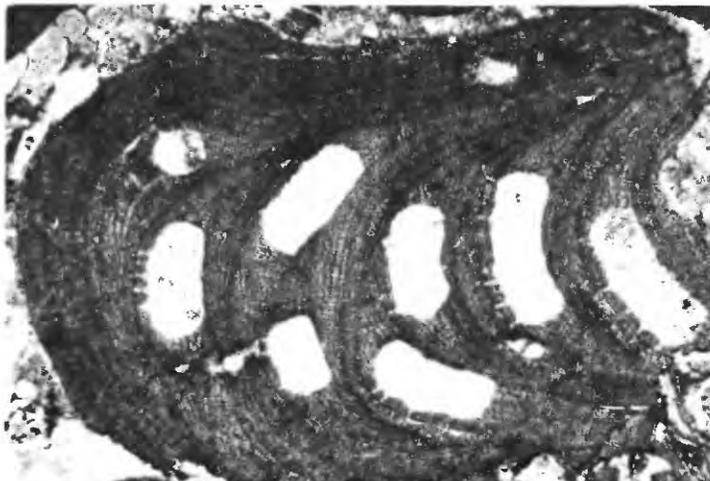
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PLATE 7

FIGURES 1, 2. *Jania mayei* Johnson n. sp. (p. C11).

1. A nearly complete segment ($\times 100$), F-176.

2. A larger segment (the type) ($\times 100$), M-248-56C.

3. *Lithothamnium* cf. *L. bofilli* Lemoine (p. C5).

A thin crust with well-developed hypothallus, perithallus, and a conceptacle chamber ($\times 50$), M-286.

4, 5. *Corallina* cf. *C. cossmanni* Lemoine (p. C11).

4. Two segments with connecting node ($\times 40$), M-121.

5. Several segments ($\times 50$), M-248C(2).

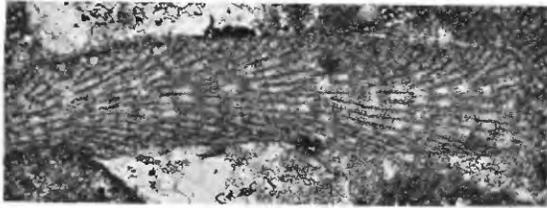
6. *Mesophyllum ryukyuensis* Johnson, n. sp. (p. C8).

Section of a branch, shows the growth zones and conceptacles with sporangia ($\times 50$), F-49(4).

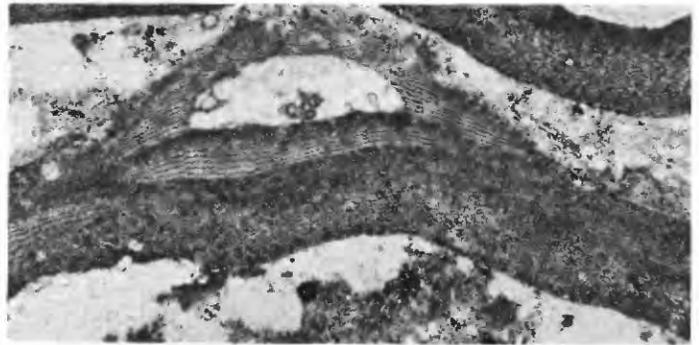
7. *Lithophyllum* sp. D (p. C10).

A crust with conceptacle chambers ($\times 50$), M-236-65L.

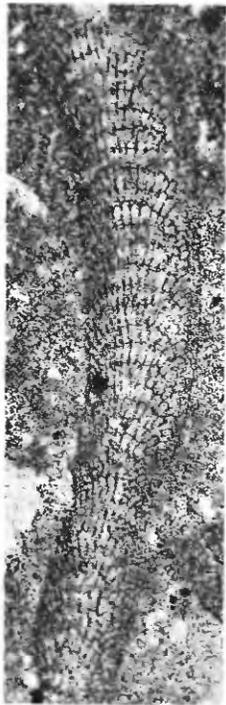




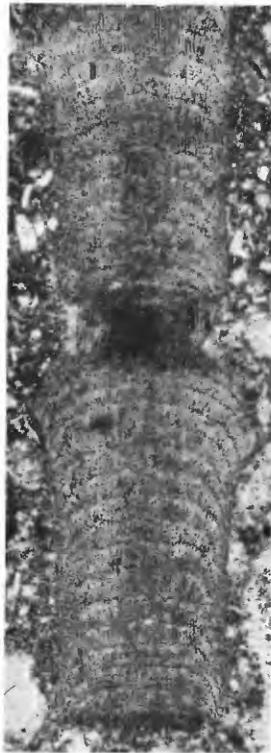
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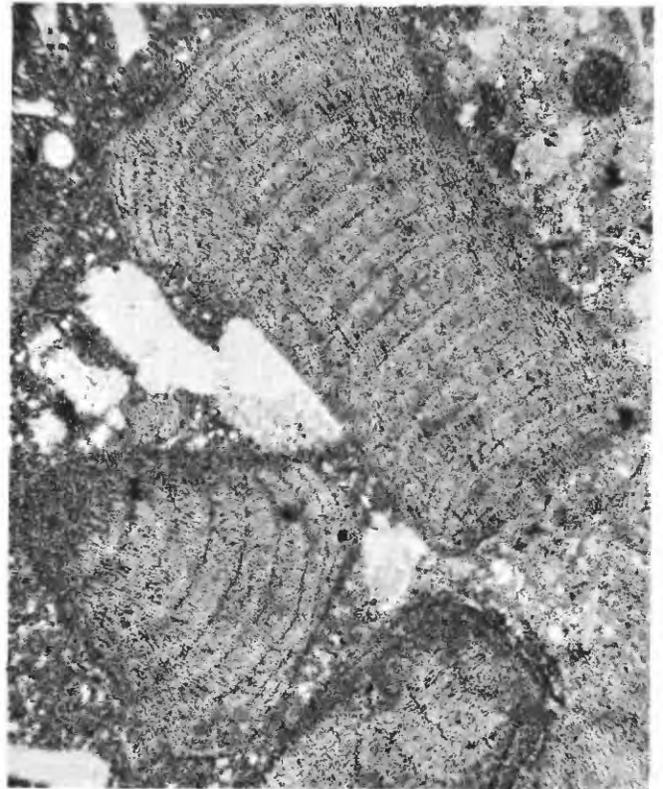
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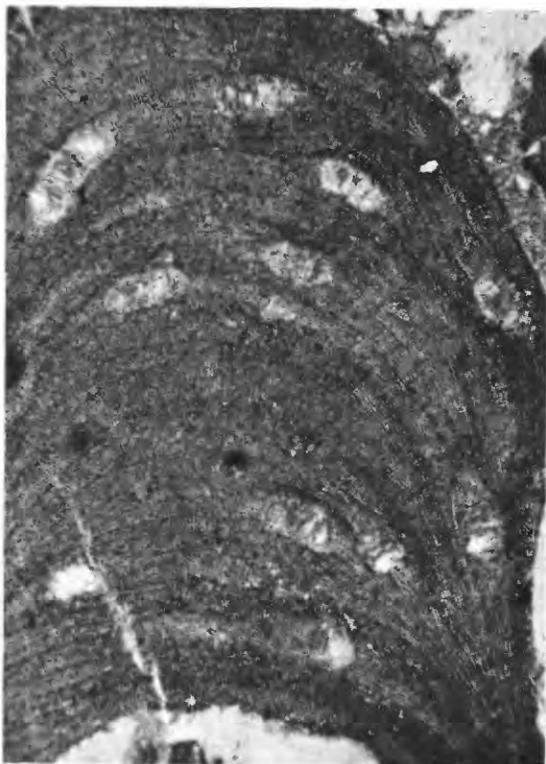
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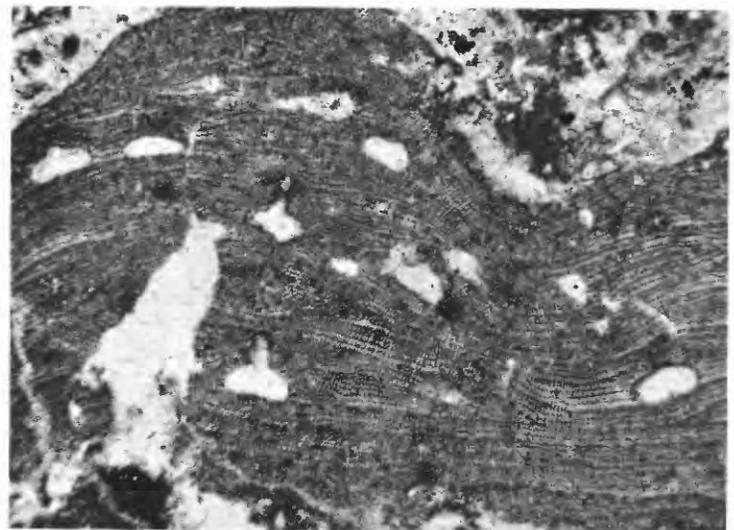
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