Floristic and Distributional Account of the Common Crustose Coralline Algae on Guam[1]

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Abstract.—A collection of crustose coralline algae from Guam, Mariana Islands, is described. Fifteen species from nine genera of Corallinaceae have been named. Specimens were taken from the reef flat and to depths of 40 m. Their distribution is discussed along with possible environmental factors that are thought to affect distribution. The following species are reported for the first time from Guam: *Sporolithon schmidtii, Mesophyllum erubescens, M. mesomorphum, Lithothamnium asperulum, Fosliella farinosa, Lithoporella melobesioides, L. pacifica, Neogoniolithon conicum,* and *N. pacificum.* Due to its ecological role in cementing the reef margin, its wide distributional range, and its general abundance, *Porolithon onkodes* was felt to be the most important single species. Other species which were abundant were *Lithophyllum moluccense* and *Hydrolithon reinboldii.* Keys are given for the genera and appropriate species.

Introduction

The crustose coralline algae, family Corallinaceae, have been recognized for the important contribution they make to the composition of coral reefs as building and cementing agents. Our knowledge of this group is still limited because of the difficulty in identifying them. The two objectives of this paper are to present a floristic account of the common crustose coralline algae found on the reefs of Guam, Mariana Islands, and to describe their distributional patterns on selected reefs.

Some previous floristic work on the crustose coralline algae of Guam was done by Johnson (1964). He dealt primarily with fossil algae, but did describe eight species of living crustose corallines collected from Guam reefs. Johnson (1957) also worked on Saipan, Mariana Islands, 176 km north of Guam, where he described seven species of living algae in addition to numerous fossil species. In the remainder of Micronesia, floristic work has been carried out in the Marshall Islands. Taylor

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(1950) at Bikini, and Dawson at Enewetak (1957) and the southern Marshalls (1956) reported a total of 10 species, but neither had attempted to do a thorough study of the group. Lee (1967) intensively studied two reef flat genera, *Porolithon* and *Neogoniolithon*, at Rongelap, working with the growth forms of selected species.

In the tropical western Pacific, Dawson (1954) reported on the marine algae from Viet Nam and included eight species of calcareous coralline algae. Wormersley and Bailey (1970) reported on 12 species from the Solomon Islands.

From the tropical eastern Pacific, Dawson (1960) did a comprehensive study of the crustose Corallinaceae of Mexico. Littler (1973 a, 1973 b) named six species of crustose corallines in his work at Hawaii.

The Siboga Expedition resulted in an extensive collection of crustose coralline algae from the Malay Archipelago which were identified or named by Foslie (1904). Foslie worked extensively with the crustose Corallinaceae, describing many species and establishing the basis for their current classification system. Under the editorship of H. Printz, a monograph of Foslie's work (1929) was published after his death. Recently, Adey (1970) examined Foslie's collections and some species were redefined in terms of modern systematics.

Masaki (1968) dealt with species from Japan, but provided a useful key to some genera and described some species that were found on Guam. Adey and Macintyre (1973) have natural and working keys to all the living genera of crustose coralline algae. In addition, a thorough review of the literature has been provided by Littler (1972).

Materials and Methods

Specimens of crustose coralline algae examined in this study were collected by reef walking, snorkeling or scuba, and were preserved by placing in 10% formalin and seawater, or by air drying. For microtechnique work preserved specimens were decalcified with 10% hydrochloric acid in seawater; fresh specimens were fixed in Susa's solution and decalcified with 5% trichloroacetic acid. Specimens were embedded in paraffin, and sectioned with a microtome (Sass, 1956). They were stained with tannic acid, ferric chloride, and safranin, Delafields haematoxylin or haematoxylin.

Adey (personal correspondence) indicated that crustose corallines of the same species have a similar pattern of cell sizes. Measurements are made of the diameter and length of the first 10 perithallium cells moving vertically down from the epithallium. The diameters and lengths are then plotted on separate graphs, and specimens of the same species should show a similar pattern when comparing these graphs. Most species named were graphed and compared with slides made from type specimens from the Foslie Herbarium. This is referred to in this text as "graphic comparison".

The classification system of Adey and Macintyre (1973) is used throughout this paper with the exception of the genus name *Sporolithon* rather than *Archaeolithothamnium*. The diameters and lengths of epithallium, perithallium, and hypothal-

lium cells were measured and recorded. Conceptacle measurements are given as height (the greatest distance from the top to the bottom of the chamber), inside diameter (the distance from one side to the other of a conceptacle chamber having a pore opening), and outside diameter (a rather subjective measurement from one side to the other of where the surface of the algae is pushed upward by the conceptacle chamber).

After the first author had completed his Master's thesis, he traveled to Hakodate, Japan where he collaborated with Dr. Masaki and Dr. Akioka to prepare this manuscript for publication. For this work, new specimens were collected and slides were made and examined to ensure correct identification (some name changes were necessary). Drs. Masaki and Akioka also made new photographs for use in this manuscript. Specimens numbered 1–255 were collected by the first author (GDG) or by Richard H. Randall (RHR), and are deposited in the Herbarium of the University of Guam Marine Laboratory. Specimens numbered 256–301 were taken to Japan. Along with the slides, they are deposited with Dr. Tomitaro Masaki at the Faculty of Fisheries of Hokkaido University in Japan.

FLORISTIC ACCOUNT

ARTIFICIAL KEY TO THE GENERA:

A. Sporangium borne in an individual conceptacle, conceptacles in rows in the perithallium ..... **Sporolithon**

A. Many sporangia in each conceptacle, conceptacles scattered throughout the perithallium ..... B

B. Sporangial conceptacles multipored C

B. Sporangial conceptacles single pored ..... D

C. Hypothallium coaxial ..... **Mesophyllum**

C. Hypothallium not coaxial ..... **Lithothamnium**

D. Secondary pits present between perithallium cells ..... **Lithophyllum**

D. Secondary pits absent, cell fusions present between perithallium cells ..... E

E. Heterocysts absent in perithallium ..... **Lithoporella**

E. Heterocysts present in perithallium ..... F

F. Thallus one cell layer thick except around the conceptacles .. **Fosliella**

F. Thallus more than one cell layer thick ..... G

G. Heterocysts in horizontal rows ..... **Porolithon**

G. Heterocysts not in horizontal rows ..... H

H. Hypothallium one cell layer thick; heterocysts occurring singly ..... **Hydrolithon**

H. Hypothallium more than one cell layer thick, usually coaxial; heterocysts occurring in vertical rows, singly, or grouped horizontally with 1–2 perithallium cells in between ..... **Neogoniolithon**

Subfamily **Melobesioideae** (J. Aresch.) Mason

Genus **Sporolithon** Heydrich, 1897a

Sporolithon schmidtii (Foslie) Gordon, Masaki, and Akioka.

Pl. I, figs. 1–4.

Archaeolithothamnium schmidtii Foslie, 1901a: 16; Foslie, 1904: 43, pl. VIII, figs. 16–17; Foslie, 1929: 28, pl. XLIV, figs. 15–17.

DESCRIPTION: Thallus growing as smooth crust, free or loosely attached at margins; older portions developing small rounded excrescences, usually simple, occasionally branching once or twice, 1–7 mm high, 2–7 mm diam.; color varies with exposure to sunlight, exposed portions faded greenish yellow, yellowish brown or tan, shaded portions dark brown or red; forms nodules up to 6 cm diam; hypothallium single layered, cells palisade, subrectangular, 24–30 μ long, 14–19 μ diam, or parallel to substratum, subquadrate to subrectangular (23) 30–35 (41) μ long, 20–29 μ diam; perithallium cells subquadrate or ovoid, 12–15 μ diam. or subrectangular 12–20 μ long, 10–15 μ diam; epithallium 3 cells thick, cells subrectangular, 3–8 μ long, 9–12 μ diam; perithallium commonly with fusions of 2–3 cells; sporangial conceptacles composed of sori in rows, 62–85 μ high, 25–44 μ diam; spores 36–64 μ long, 20–31 wide.

HABITAT: It is found on the outer and inner reef flat encrusting the bottom substratum. Patches of it are usually large (10–20 cm in diameter), but few in number. Like *Hydrolithon reinboldii*, it has excrescences, but the thallus is very smooth and lacks conceptacles and its color is quite different. Often it is partially buried by sand and other sediment, but this does not seem to cause an adverse effect. It does result in the color of one organism being highly variable, the buried part being a dark purple or red-brown color, while that exposed to the direct sunlight fades to a cream or pale green color. There is usually a transition area where the color is a gradation of those mentioned above. *Sporolithon schmidtii* has also been found forming nodules on the submarine terrace in 7 m of water.

SPECIMENS EXAMINED: GDG 216, outer reef flat, 0.1 m, Marine Lab, Pago Bay, VII–18–74; GDG 241, submarine terrace, 7 m, S. of Facpi Point, VIII–1–74; GDG 256, inner reef flat, 0.1 m, Adelupe Point, Asan Bay, VI–29–75; RHR 317B–1, submarine terrace, 7 m, S. of Facpi Point, XI–15–73.

COMMENTS: Because of its many excrescences, this specimen was originally thought to be *Sporolithon erythraeum*, but its sori are smaller and perithallium cells larger than this species. A graphic comparison of their perithallium cells showed them to be quite different. It compares well with Foslie's description of *Archaeolithothamnium schmidtii*, as did a graphic comparison of their perithallium cells.

Plate I

Figs. 1–4. *Sporolithon schmidtii* (Foslie) Gordon, Masaki and Akioka.

Figs. 5–8. *Mesophyllum erubescens* Foslie.

Fig. 1. Part of vertical section of perithallium and epithallium (3 cells thick) ×450.

Fig. 2. Part of vertical section of one cell thick hypothallium and perithallium ×220.

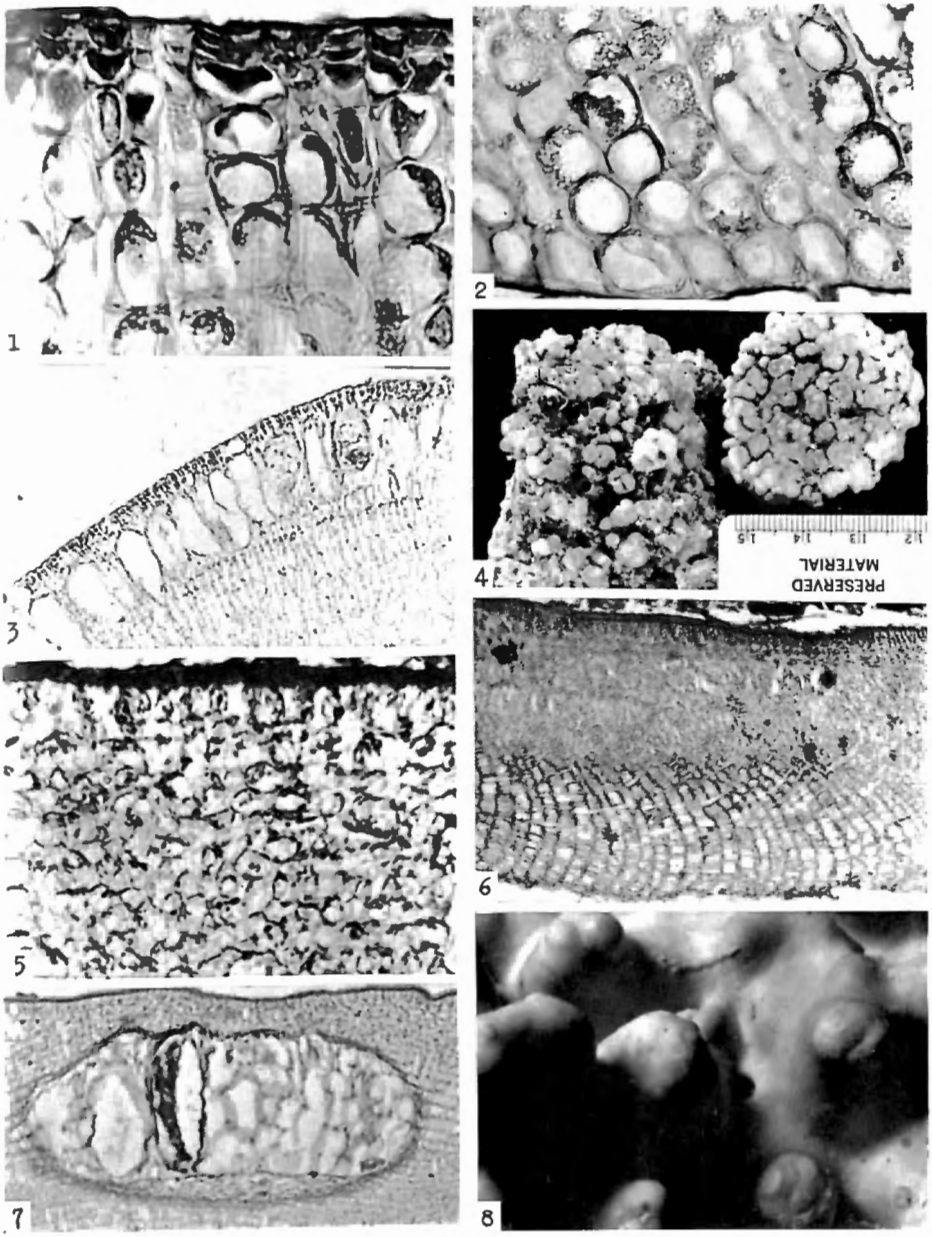


Fig. 3. Part of vertical section showing sporangial conceptacles composed of sori in a row. Scale: (100 μ).
Fig. 4. Habit of plant encrusting reef substratum and having numerous excrescences.
Fig. 5. Part of vertical section of perithallium and epithallium $\times 490$.
Fig. 6. Vertical section showing coaxial hypothallium and perithallium $\times 115$.
Fig. 7. Evacuated tetrasporangial conceptacle $\times 115$.
Fig. 8. Surface detail of excrescences having multipored conceptacles. Scale: (2 mm).

Genus **Mesophyllum** Lemoine, 1928

Key to species:

A. Thallus encrusting and forming short excrescences..... *M. erubescens*
A. Thallus many thin plates of varied shape..... *M. mesomorphum*

Mesophyllum erubescens (Foslie) Lemoine, 1928: 252.

Pl. I, figs. 5–8.

Lithothamnium erubescens Foslie, 1901b: 4; Foslie, 1901c: 3; Foslie, 1904: 31, figs. 15–17, pl. 3, figs. 1–25; Foslie, 1929: 40, pl. XV, figs. 1–25.

DESCRIPTION: Thallus firmly attached to substratum, growing as a smooth crust, often free or loosely attached at margins; older thallus developing many knobby excrescences usually branching 2–4 times, irregular at base, very round at tips, up to 15 mm high, 1–5 mm at tips; sometimes forming nodules up to 3 cm in diameter; color purple, pale cream spots common, especially at tips; hypothallium coaxial, 63–300 μ thick, cells subrectangular, 6–19 μ long, 4–10 μ diam., curving upward into perithallium; perithallium having staining bodies in outermost layers of cells, cells subquadrate, 4–7 μ diam., sometimes subrectangular 5–7 μ long, 3–8 μ diam; cells of epithallium subrectangular, 2–4 μ long, 3–7 μ diam.; sporangial conceptacles convex, 405–551 μ outside diam., 336–510 μ inside diam., 135–308 μ high; sporangia tetrasporic, 126–195 μ long, 32–72 μ diam.

HABITAT: It has been found on the submarine terrace in 7 m of water, but was most abundant on the submarine slope along the leeward northern coast. In this area between 20 and 35 m, *M. erubescens* is quite abundant. Its short branches and its purplish color with pale spots make it conspicuous and it appears to be the most abundant crustose coralline species in this area. On the windward side by the Marine Laboratory, this species was not seen.

SPECIMENS EXAMINED: GDG 152, submarine slope, 40 m, off Tanguisson Power Plant, Tanguisson Point, V–29–74; GDG 238, submarine terrace, 7 m, S. of Facpi Point, VIII–1–74; GDG 283, submarine slope, 27 m, off Tanguisson Power Plant, Tanguisson Point, VII–2–75.

COMMENTS: This specimen is closest in appearance to *M. erubescens* Foslie *f. americana.*

Mesophyllum mesomorphum (Foslie) Adey, 1970: 25.

Pl. II, figs. 1–3.

Lithothamnium mesomorphum Foslie, 1901d: 5; Foslie and Howe, 1906: 129, pl. 80, fig. 2, pl. 90, fig. 2; Lemoine, in Borgesen, 1917: 155; Howe, 1920: 584; Foslie, 1929: 43; Taylor, 1960: 382.

DESCRIPTION: Thallus forming many thin overlapping crusts adhering weakly to the substratum and to each other, crusts often plate-like, sometimes forming tubes, thin, 63–336 μ thick; color pink, dark red, purple; hypothallium coaxial, curving upward and downward, cells subrectangular, 9–18 μ long, 4–10 μ diam.; perithallium layered, ovoid or subquadrate 4–6 μ diam., cells subrectangular, 3–9 μ long, 2–6 μ diam.; epithallium single layered, cells subrectangular or subtriangular, 4–6 μ long,

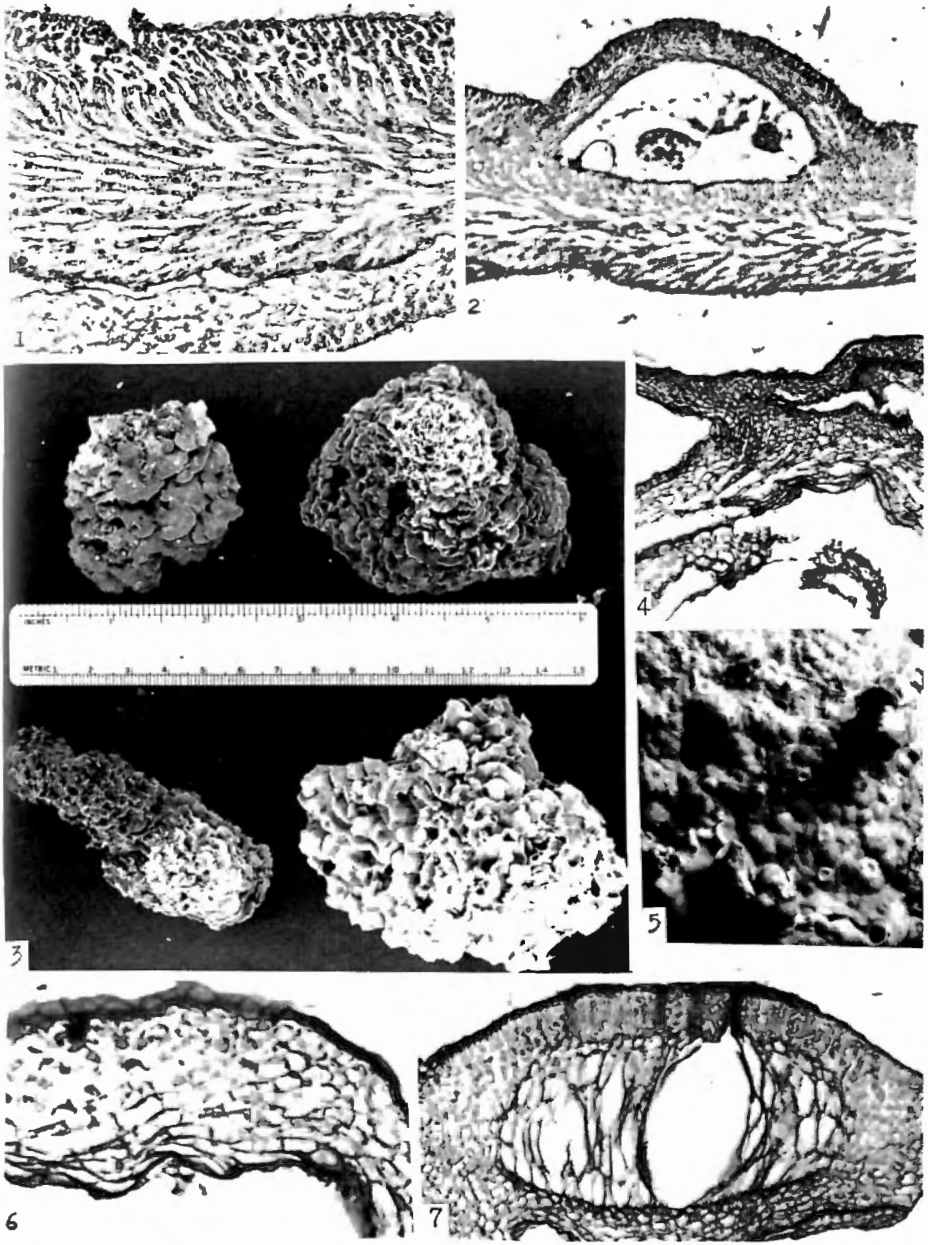


Plate II

Figs. 1–3. *Mesophyllum mesomorphum* (Foslie) Adey.
Figs. 4–7. *Lithothamnium asperulum* Foslie.
Fig. 1. Vertical section of hypothallium and perithallium ×185.
Fig. 2. Tetrasporangial conceptacle ×105.
Fig. 3. Habit of plants having many thin crusts.
Fig. 4. Vertical section of hypothallium and perithallium ×90.
Fig. 5. Habit of plant having large promient conceptacles. Scale (2 mm).
Fig. 6. Vertical section of hypothallium and perithallium ×465.
Fig. 7. Empty tetrasporangial conceptacle ×220.

6–8 μ diam.; fusions occurring between adjacent cell rows of hypothallium and perithallium, weakly developed perithallium sometimes occurring on lower side of thallus, perithallium and hypothallium having staining bodies; sporangial conceptacles slightly convex, 389 μ outside diam., 260–350 μ inside diam., 130–190 μ high; sporangium tetrasporic ca. 100 μ long, 40 μ diam.

HABITAT: It is very conspicuous when found growing in clumps. It commonly has a rose-like appearance although other growth forms are also found. It can be found growing under large rocks on the reef flat where the light intensity is low. It grows in exposed situations only in deeper (30 m) water.

SPECIMENS EXAMINED: GDG 123, reef flat, 0.1 m, Marine Lab, Pago Bay, V–6–74; GDG 293, reef flat, 0.1 m, Marine Lab., Pago Bay, VII–3–75.

COMMENTS: Asexual conceptacles have been difficult to find in the collected specimens, but its growth form is quite distinctive. Graphic comparison between it and a type specimen of *M. mesomorphum* show good agreement, and the hypothalliums are very similar in appearance.

Genus **Lithothamnium** Philippi, 1837

Lithothamnium asperulum Foslie, 1907a: 6; Foslie, 1929: 39, pl. I, figs. 4–6. Pl. II, figs. 4–7.

Lithothamnium repandum Foslie, 1906: 5.

DESCRIPTION: Thallus crustaceous, adhering firmly to substratum, thin, 50–130 μ thick; color purple; hypothallium 10–40 μ thick, composed of 3–7 layers of cells, cells subrectangular, 6–14 μ long, 4–8 μ diam., curving upward into perithallium; perithallium layered, sometimes cells fusing, upper layers distinctly subquadrate and smaller, graduating into subrectangular and larger cells in lower layers, subquadrate, 2–16 μ diam., subrectangular, 2–8 μ long, 2–8 μ diam., cells of epithallium subrectangular, 2–4 μ long, 5–6 μ diam.; sporangial conceptacles convex, 339–446 μ outside diam., 134–281 μ inside diam., 78–140 μ high; sporangia bisporic, 47–86 μ long, 29–44 μ diam.

HABITAT: It has only been found in *Acropora* thickets on the reef flat. It is found growing near the base of the coral where the coral is dead and the light intensity appears to be low. Other crustose corallines are sometimes present, but *L. asperulum* can be distinguished by its purple color and its distinctive conceptacle shape (see Pl. II).

SPECIMENS EXAMINED: GDG 96, reef flat, 0.5 m, off Coral Reef Enterprises, Asan Bay, II–6–74; GDG 254, reef flat, 0.4 m, E. of Cabras Island, Piti Bay, VIII–7–74; GDG 262, reef flat, 0.4 m, E. of Cabras Island, Piti Bay, VI–29–75.

COMMENTS: This specimen is also close to *L. sejunctum*. Slides and pieces of type specimens of *L. asperulum* and *L. sejunctum* were compared along with photographs of them. A graphic comparison was done using slides made from the two type specimens and this species. It was then decided that this species was *L. asperulum* and not *L. sejunctum*.

Subfamily **Mastophoroideae** (Svedelius) Setchell
Genus **Fosliella** Howe, 1920

Fosliella farinosa (Lamx.) Howe, 1920: 587; Taylor, 1937: 270; Taylor, 1942: 91; Taylor, 1950: 132; Dawson, 1954: 425, fig. 37c; Dawson, 1956: 49; Dawson, 1960: 30, pl. 21, fig. 1, pl. 22, fig. 1; Masaki and Tokida, 1960: 39, pl. 1, figs. 4–5, pl. 2, figs. 8–12, pls. 6–7; Masaki, 1968: 21.

Pl. III, figs. 1–4.

Melobesia farinosa Lamouroux, 1816: 315; Lemoine, 1952: 102, fig. 64, pl. XXI, 1–2.

DESCRIPTION: Thallus crustose, very thin; epiphytic on other plants; color pink; thallus monostromatic, cells 12–23 μ long, 6–14 μ diam.; heterocysts occurring singly, subrectangular, 18–28 μ long, 14–19 μ diam.; sporangial conceptacles convex, 100–150 μ diam., 44–77$\frac{1}{2}\mu$ high; sporangia tetrasporic, 34–58 μ long, 22–41 μ diam.
HABITAT: It is a common epiphyte of shallow water plants such as *Enhalus acoroides, Sargassum cristaefolium*, and *Padina tenuis.*
SPECIMENS EXAMINED: GDG 89, epiphytic on *Enhalus acoroides*, reef flat, 0.2 m, near Pago River, Pago Bay, III–17–74; GDG 265, epiphytic on *Enhalus acoroides* on reef flat, 0.2 m, Adelupe Pt., E. Asan Bay, VI–29–75; GDG 294, epiphytic on *Padina tenuis*, reef flat, 0.1 m, in front of Marine Lab, Pago Bay, VII–3–75; GDG 295, epiphytic on *Sargassum cristaefolium*, 0.1 m, in front of Marine Lab, Pago Bay, VII–3–75.
COMMENTS: The sporangial conceptacles of the above specimens are smaller than is usually given for *F. farinosa. Melobesia farinosa* var. *solmsiana* is described by Lemoine (1952) as having smaller sporangial conceptacles 110–125 μ diameter, and this description matches our specimens very well.

Genus **Hydrolithon** Foslie, 1909

Hydrolithon reinboldii (W. v. Bosse and Foslie) Foslie, 1909: 55; Dawson, 1954: 425, fig. 37b; Dawson, 1960: 28, pl. 20, figs. 1–2, pl. 21, fig. 2; Desikachary and Ganesan, 1966: 83, figs. 10, 12.

Pl. III, figs. 5–6, Pl. IV, figs. 1–3.

Lithophyllum cerebelloides Heydrich, 1901a: 405.

Lithophyllum reinboldii Foslie, 1900a: 466, pl. XXIV, fig. 4; W. v. Bosse and Foslie, *in* Foslie, 1901b: 5.

Goniolithon reinboldii (W. v. Bosse and Foslie) Foslie, 1904: 49, fig. 21, pl. 10, figs. 1–6; Foslie, 1929: 31, pl. LII, figs. 1–6; Johnson, 1957: 231, pl. 59, fig. 5; Johnson, 1964: 26, pl. 13, figs. 5–6, pl. 15, figs. 4–6.

DESCRIPTION: Entire thallus adhering firmly to substratum, individual crusts up to 2 mm thick, overlapping crusts up to 4 mm thick; forming excrescences, simple often crowded and anastomosing, size variable up to 10 mm high and 10 mm diameter; color usually pale to dark blue, sometimes brown, purple or cream; hypothallium single layered, cells palisade, 14–26 μ long, 9–15 μ diam., or cells parallel

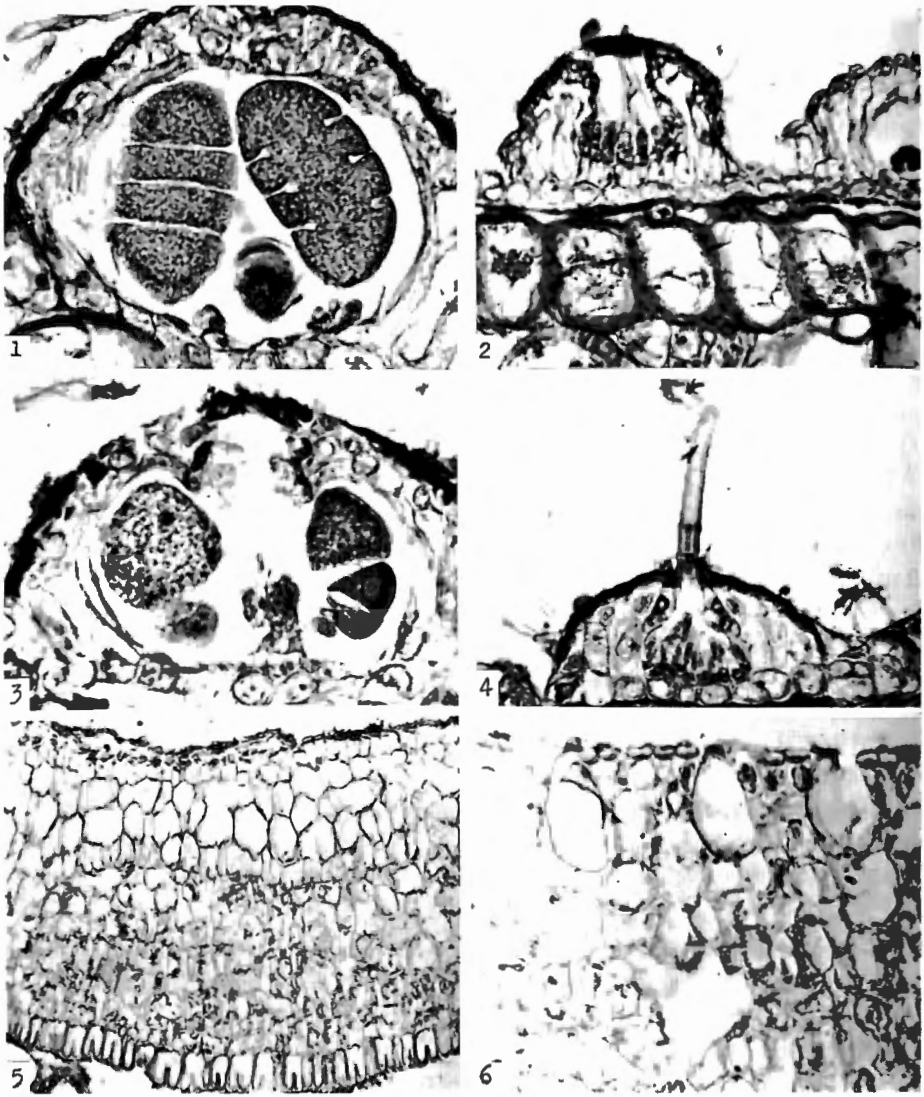


Plate III

Figs. 1–4. *Fosliella farinosa* (Lamx.) Howe.
Fig. 5–6. *Hydrolithon reinboldii* (W. v. Bosse and Foslie) Foslie.
Fig. 1. Tetrasporangial conceptacle ×435.
Fig. 2. Procarpic conceptacle ×355.
Fig. 3. Cystocarpic conceptacle ×355.
Fig. 4. Spermatangial conceptacle ×355.
F]g. 5. Vertical section of hypothallium one cell layer thick, perithallium and epithallium ×175.
Fig. 6. Part of vertical section of perithallium and epithallium having three large heterocyst cells at the thallus surface ×355.

to substrate, subquadrate, 8–16 μ diam., or subrectangular, 11–28 μ long, 8–20 μ diam.; perithallium distinctly irregular, cells subquadrate or ovoid, 6–12 μ diam., subrectangular, 6–22 μ long, 4–18 μ diam.; epithallium single layered, cells subrectangular, 3–10 μ long, 6–8 μ diam.; heterocysts prominent, scattered singly throughout perithallium, subrectangular, 19–44 μ long, 10–26 μ diam.; sporangial conceptacles ovoid, 160–252 μ inside diam., 115–180 μ high; sporangia bisporic, 62–97 μ long, 40–48 μ diam.

HABITAT: It dominates the shallow outer reef flat areas where it inhabits the small, shallow (often less than 10 cm deep) pools. It seems to be adapted to withstand the high temperatures encountered in the pools at low tide. It commonly encrusts pebbles and small rocks, as well as the reef substrate. Its blue-purple color and rounded excrescences distinguish it from any other crustose coralline on the reef flat. It is not as abundant in the moat areas, perhaps because the predominantly sandy bottom offers little suitable substratum for growth; it is found on rubble in the moat areas. It sometimes forms nodules found on the shallow (7 m deep) submarine terrace.

SPECIMENS EXAMINED: GDG 15, reef flat, 0.5 m, Marine lab, Pago Bay, X–18–73; GDG 242, submarine terrace, 7 m, S. of Facpi Pt., VIII–1–74; GDG 258, reef flat, 0.2 m, off Coral Reef Enterprises, Adelupe Pt., E. Asan Bay, VI–29–75.

Genus **Lithoporella** Foslie, 1909

Key to species:

A. Thallus encrusting, each crust tightly overlapping each other... *L. melobesioides*
A. Thallus encrusting, crusts loosely overlapping each other..... *L. pacifica*

Lithoporella melobesioides (Fosl.) Foslie, 1909: 59; Masaki, 1968: 55, pl. 38, pl. 79, figs. 2–4.

Pl. IV, figs. 4–5, Pl. V, fig. 1.

Mastophora melobesioides Foslie, 1903: 24–25; Foslie, 1904: 73, figs. 30–32; Foslie, 1929: 48, pl. LXXIII, figs. 1–4.

DESCRIPTION: Thallus crustaceous, adhering tightly to substratum, tightly overlapping, forming crusts up to 2 mm thick, new growth forming small fan-shaped patterns on thallus surface; color, after collected, pale pink to purple; thallus one cell thick, cells subquadrate, 14–21 μ diam., or subrectangular 14–28 μ long 12–23 μ diam.; cover cells triangular or subrectangular, 3–8 μ high, 8–19 μ diam.; cell fusions sometimes occurring; sporangial conceptacles conical, 900–1062 μ outside diam., 486–689 μ inside diam.; sporangium tetrasporic, 104 μ long, 70 μ diam.

HABITAT: It formed thin crusts which adhered tightly to each other. Close examination revealed fan-shaped patterns on the thallus surface which probably represented new overlapping growth. It was found at depths of 13 and 40 m.

SPECIMENS EXAMINED: GDG 31E, submarine terrace, 13 m, Marine Lab, Pago Bay, XII–10–73; GDG 156, submarine slope, 40 m, off Tanguisson Power Plant, Tanguisson Pt., V–29–74; GDG 169B, submarine slope, 40 m, Uruno Pt.,

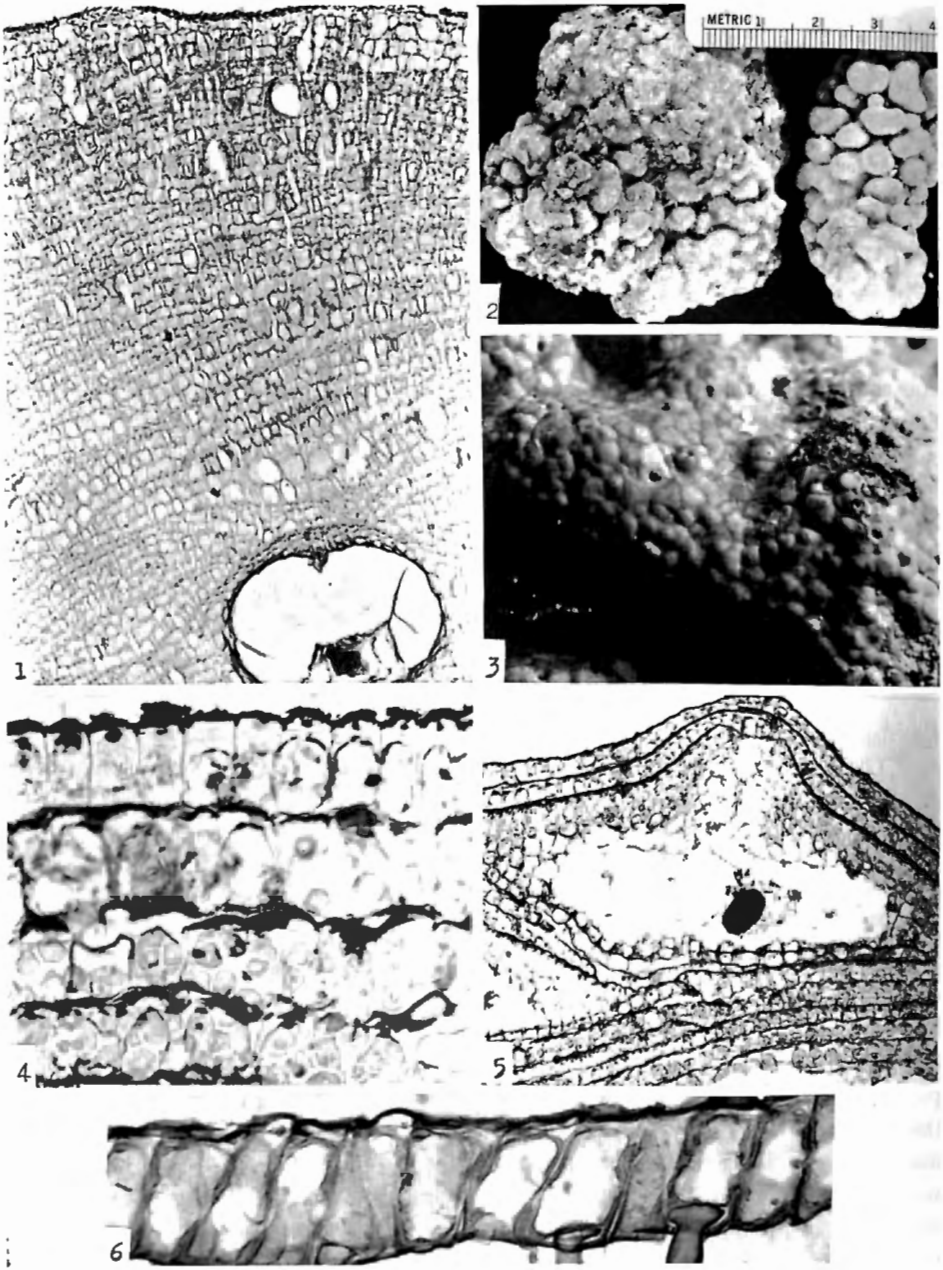


Plate IV

Figs. 1–3. *Hydrolithon reinboldii* (W. v. Bosse and Foslie) Foslie.
Figs. 4–5. *Lithoporella melobesioides* (Foslie) Foslie.
Fig. 6. *Lithoporella pacifica* (Heydrich) Foslie.
Fig. 1. Part of vertical section of perithallium and epithallium with buried conceptacle ×115.

VI–3–74; GDG 285, submarine slope, 34 m, off Tanguisson Power Plant, Tanguisson Pt., VII–2–75.

Lithoporella pacifica (Heydr.) Foslie, 1909: 59; Dawson, 1954: 428, fig. 40b.
Pl. IV, fig. 6, Pl. V, figs. 2–5.
Melobesia pacifica Heydrich, 1901b: 529.

DESCRIPTION: Thallus encrusting and forming loosely overlapping thin plates, adhering loosely to substratum; color pink to dark red; thallus one cell thick, often palisade, cells quadralinear or subrectangular, 28–52 μ long, 14–33 μ diam.; cover cells subrectangular, 5–11 μ long, 16–21 μ diam.; cell fusions, 2–3 cells, very common; sporangial conceptacles conical, 697–1002 μ outside diam., 486–608 μ inside diam., 239–348 μ high; sporangia tetrasporic, 160–193 μ long, 80–100 μ diam.
HABITAT: This very fragile species can be found along the reef front growing under corals and in other situations of reduced light where the force of the waves is absent or minimal. Its growth form is characteristic. It forms thin crusts which loosely adhere to each other and possesses large single pored conceptacles. It has a pink color and has only been found in the area of the reef front 2–4 m deep.
SPECIMENS EXAMINED: GDG 62, reef front, 2 m, Marine Lab, Pago Bay, I–15–74; GDG 231, reef front, 3–4 m, off Tanguisson Power Plant, Tanguisson Pt., VII–22–74.
COMMENTS: Measurements for this specimen are smaller than those given by Foslie, but photographs of the type specimen agree well with the species above.

Genus **Neogoniolithon** Setchell and Mason, 1943

Key to species:

A. Thallus encrusting and forming short branches ..... *N. frutescens*
A. Thallus encrusting only, no branches ..... B
B. Heterocysts occurring singly ..... *N. pacificum*
B. Heterocysts occurring in vertical or horizontal rows C
C. Heterocysts found in vertical columns of 5–18 cells ..... *N. fosliei*
C. Heterocysts found in horizontal rows of 3–7 cells separated by 1–2 rows of perithallium cells ..... *N. conicum*

Neogoniolithon conicum (Dawson) Gordon, Masaki, and Akioka.
Pl. V, figs. 6–8, Pl. VI, fig. 1.
Hydrolithon conicum Dawson, 1960: 27, pl. 19, figs. 1–3.

DESCRIPTION: Thallus crustaceous, adhering tightly to substratum, up to 860 μ

Fig. 2. Habit of nodules with excrescences.
Fig. 3. Surface detail of excrescences with small one pore conceptacles. Scale (2 mm)
Fig. 4. Vertical section of overlapping layers of thallus, each layer is one cell thick ×380.
Fig. 5. Tetrasporangial conceptacle ×90.
Fig. 6. Vertical section of thallus, one cell layer thick ×380.

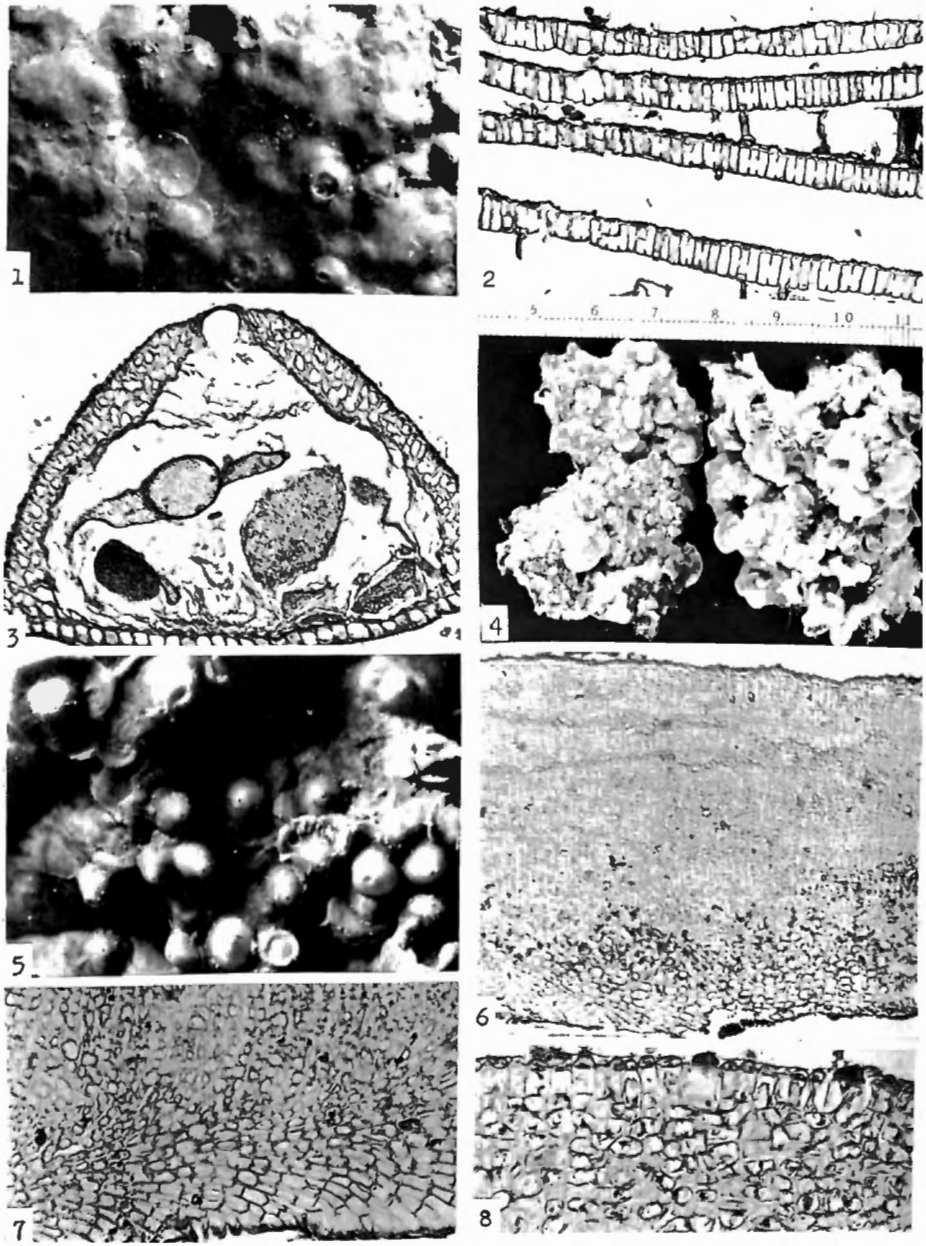


Plate V

Fig. 1. *Lithoporella melobesioides* (Foslie) Foslie.
Figs. 2–5. *Lithoporella pacifica* (Heydrich) Foslie.
Figs. 6–8. *Neogoniolithon conicum* (Dawson) Gordon, Masaki and Akioka.
Fig. 1. Surface detail showing the fan-shaped areas of new thallic growth. Scale: (2 mm).
Fig. 2. Vertical section of overlapping layers of thallus ×95.

thick, margins somewhat lobed; surface minutely speckled due to groups of heterocysts; color cream, pink, purple or wine; hypothallium coaxial, 60–130 μ wide, cells subrectangular, 8–18 μ long, 6–10 μ diam.; perithallium in layers, cells subquadrate, 4–8 μ diam., or subrectangular, 4–12 μ long, 4–10 μ diam.; epithallium one cell layer, cells subtriangular or subrectangular, 3–4 μ long, 5–7 μ diam.; cell fusions between adjacent cells in perithallium and hypothallium; heterocysts usually in horizontal clusters, 3–7 cells wide, separated by 1 or 2 rows of perithallium cells, subquadrate, 14–20 μ long, 13–20 μ diam.; sporangial conceptacles conical, 446–632 μ outside diam., 290–395 μ inside diam., 104–144 μ high; sporangia tetrasporic, found throughout floor of conceptacle, 62–86 μ long, 20–40 μ diam.

HABITAT: It was found encrusting dead coral and substratum in lagoon, 1 m deep.

SPECIMENS EXAMINED: GDG 269, lagoon, 1 m, near E. barrier reef Cocos Lagoon, VI–30–75.

COMMENTS: In Dawson's description of this species he describes a hypothallium 100–200 μ thick, but the genus *Hydrolithon* is characterized by having a hypothallium 1 cell layer thick. The genus *Porolithon* has heterocysts in horizontal clusters, but does not have perithallium cells between the heterocysts as Dawson describes. Our specimens closely match Dawson's description of the heterocyst clusters, and our broad hypothallium is coaxial as is found in some species of *Neogoniolithon*. Its epithallium is also characteristic of this genus being usually subtriangular, broader at the base than at the top. Our conceptacle measurements also agree with Dawson's. Examination of a holotype of Dawson's species confirmed that ours is the same as his, but it is a member of the genus *Neogoniolithon*, not *Hydrolithon*.

Neogoniolithon fosliei (Heydrich) Setchell and Mason, 1943: 90, pl. 9, figs. 1–5; Lemoine, 1965: 7, 13.

Pl. VI, figs. 2–5, Pl. VII, fig. 1.

Goniolithon fosliei (Heydr.) Foslie, 1900a: 470; Foslie, 1901e: 8; Foslie, 1904: 46, pl. 9, figs. 1–5; Foslie, 1929: 39, pl. XLVI, figs. 1–5; Johnson, 1964:25.

Lithothamnium fosliei Heydrich, 1897a: 58.

Lithophyllum fosliei Heydrich, 1897b: 410; Lemoine, 1911: 142, fig. 71.

DESCRIPTION: Thallus encrusting, adhering tightly to substratum, individual crusts up to 1.5 mm thick, overlapping crusts up to 5 mm thick; surface smooth often with prominent conical conceptacles; in field epithallium cells often flaking off in thin sheets; color pale blue or grey; hypothallium coaxial, cells subrectangular, 19–39 μ long, 11–17 μ diam., hypothallium curving upward quickly to form perithallium; perithallium layered, cells subquadrate, 10–14 μ diam., or subrectan-

Fig. 3. Tetrasporangial conceptacle ×95.
Fig. 4. Habit of plants having many thin crusts with large promient conceptacles.
Fig. 5. Surface detail of conceptacles. Scale: (2 mm).
Fig. 6. Vertical section of hypothallium, perithallium and epithallium ×95.
Fig. 7. Part of vertical section of hypothallium and perithallium ×185.
Fig. 8. Part of vertical section of perithallium and epithallium × 185.

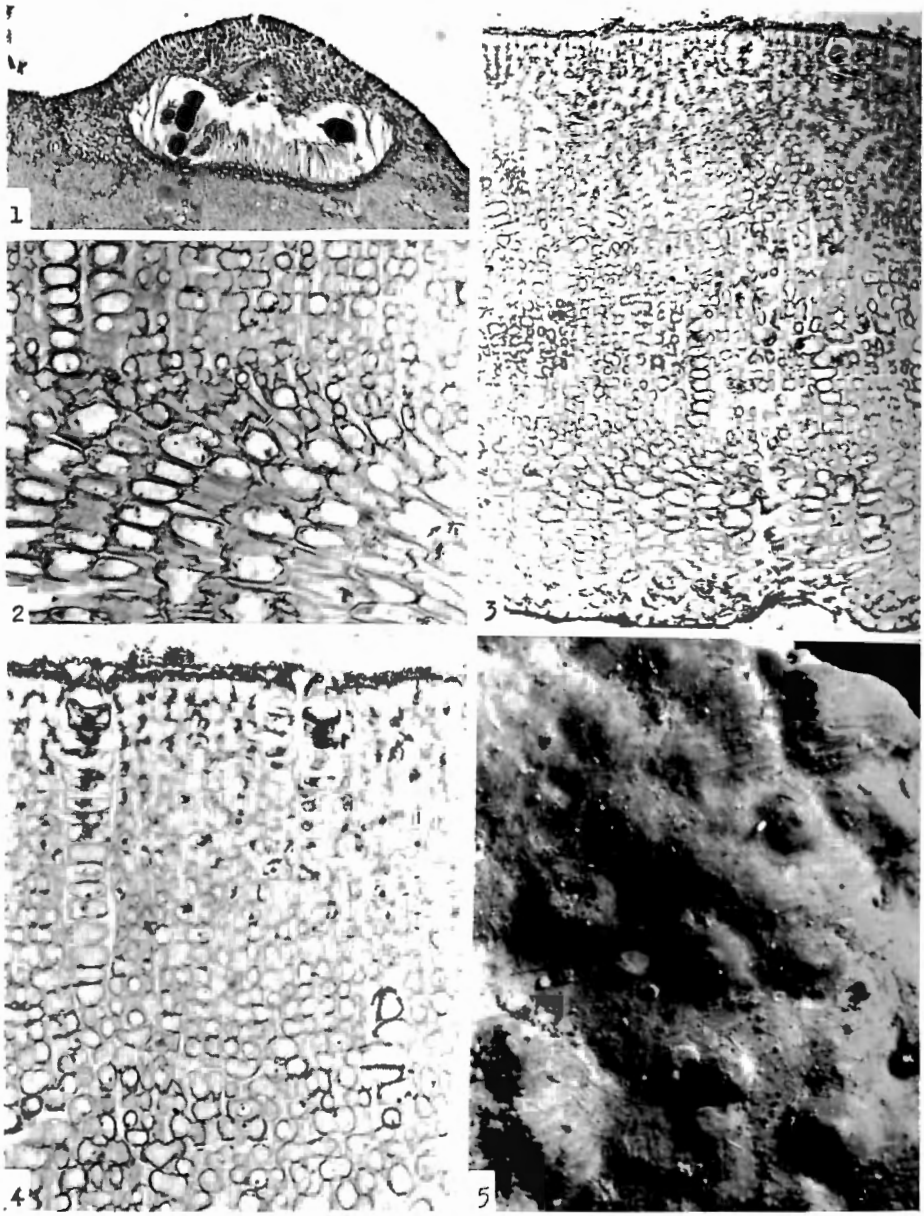


Plate VI

Fig. 1. *Neogoniolithon conicum* (Dawson) Gordon, Masaki and Akioka.
Figs. 2–5. *Neogoniolithon foslieii* (Heydrich) Setchell and Mason.
Fig. 1. Tetrasporangial conceptacle ×95.
Fig. 2. Part of vertical section of hypothallium and perithallium ×185.
Fig. 3. Vertical section of hypothallium, perithallium and epithallium ×95.
Fig. 4. Part of vertical section of perithallium, epithallium and vertical row of heterocyst cells ×185.
Fig. 5. Surface detail of plant with large conical conceptacles. Scale: (2 mm).

gular 7–20 μ long, 6–14 μ diam.; epithallium a single layer, cells subtriangular, 4–6 μ long, 10–13 μ diam.; fusions of 2 or 3 cells common between adjacent rows of hypothallium and perithallium; heterocysts in long vertical columns, subrectangular, 5–18 cells per column, 10–20 μ long, 22–31 μ diam.; sporangial conceptacles conical, 1224–2275 μ outside diam., 819–1167 μ inside diam., 148–351 μ high, sporangia tetrasporic, standing on entire surface of conceptacle floor, 142–158 μ long, 60–74 μ diam.

HABITAT: The pale blue or grey color of this species, and its large conical conceptacles make it very distinctive. It can be found encrusting inner or outer reef flats provided there is solid substratum and standing water at low tides. Nowhere on the reef flat is it abundant, and it is more commonly seen in deeper water. It has been found to depths of 35 m, and was found in greatest abundance in a shallow (5–13 m) terrace area that normally lacks any surf. Usually it is found in patches 10 to 20 cm or more in diameter, and it characteristically has a loose outer layer of epithallium cells which are sloughed off in the field.

SPECIMENS EXAMINED: GDG 86, reef flat, 1.5 m, NE of Pago River, Pago Bay, III–17–74; GDG 156, submarine slope, 37 m, leeward side of Cocos Lagoon, VI–30–74; GDG 233, submarine terrace, 7 m, SW side of Anae Island, VIII–1–74; GDG 259, reef flat, 0.1 m, off Adelupe Pt., E. Asan Bay, VI–29–75.

Neogoniolithon frutescens (Foslie) Setchell and Mason, 1943: 91; Lemoine, 1965: 7, 13; Lee, 1967: 986, pls. 2, 3.

Pl. VII, figs. 2–4, Pl. VIII, figs. 1–3.

Goniolithon frutescens Foslie, 1900a: 468, pl. 35, figs. 5–6; Foslie, 1900b: 9; Foslie, 1904: 53, pl. 10, figs. 7–13; Foslie, 1907b: 18; Foslie, 1907c: 186; Foslie, 1929: 30, Pl. XLVIII, figs. 1–14, Pl. LII, fig. 16; Taylor, 1950: 123, pls. 58–60; Johnson, 1964: 25.

DESCRIPTION: Thallus encrusting at margins, adhering tightly to substratum, older portions forming many short slender branches, up to 20 mm high, 1–3 mm diameter, branching simple or subdichotomous; color pink to cream; hypothallium coaxial, cells subrectangular, 15–31 μ long, 8–13 μ diam.; cells of perithallium subquadrate, 10–13 μ diam., or subrectangular, 7–24 μ long, 7–15 μ diam.; cells of epithallium subtriangular, 4–11 μ long, 7–15 μ diam.; cell fusions common between adjacent cell rows in hypothallium and perithallium; heterocysts single, sometimes 2–4 in short vertical rows, subrectangular, 30–51 μ long, 20–30 μ diam.; sporangial conceptacles usually at tips of branches, conical, 462–676 μ diam., 210–376 μ high; sporangia tetrasporic, standing on entire surface of conceptacle floor, 125–160 μ long, 72–73 μ diam.

HABITAT: It is distributed on the inner and outer reef flat, but grows more abundantly on the inner reef flat. It is found on areas having a strong current where it grows on *Acropora* fragments and other available substrata. The 2–3 cm long branches often radiate from all sides of the fragments. This appears to make it well adapted for a habitat where the strong current constantly moves the sand about and

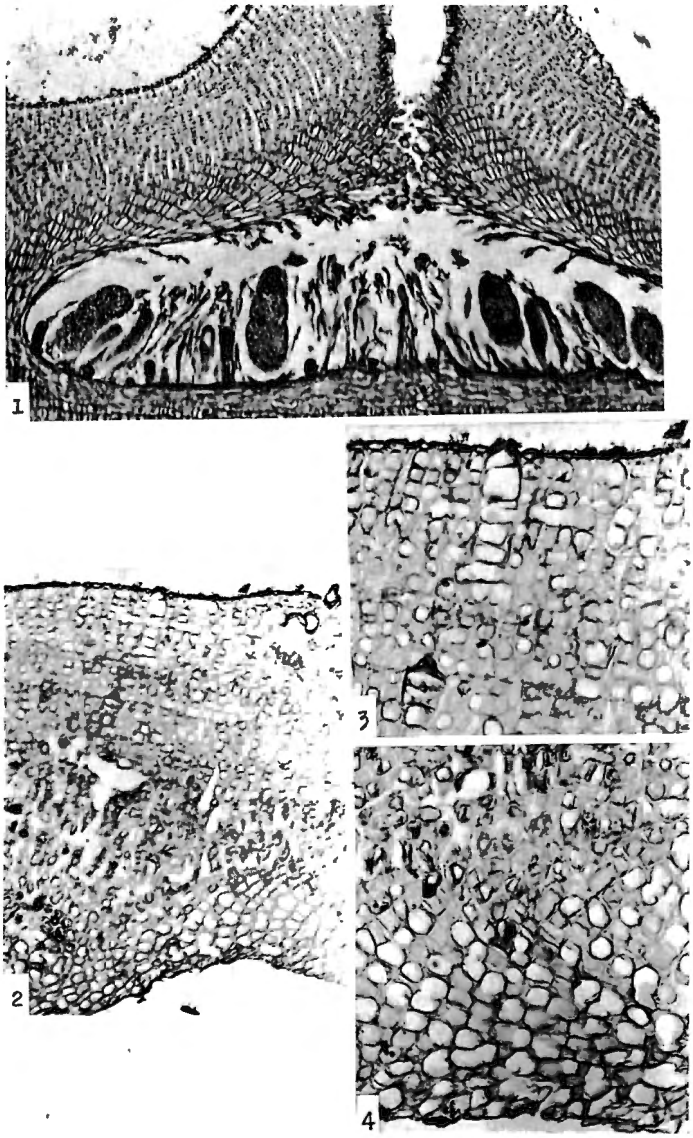
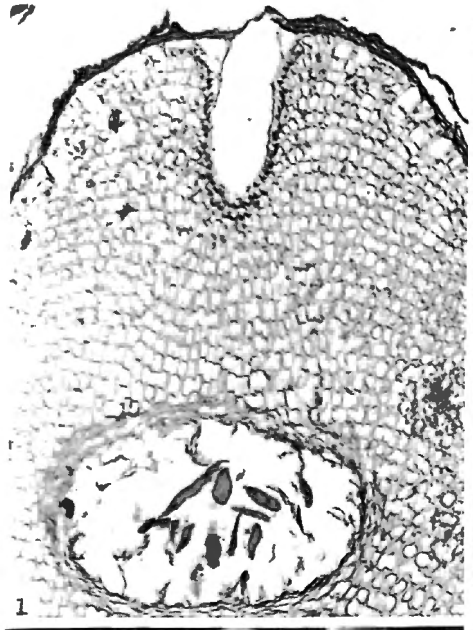
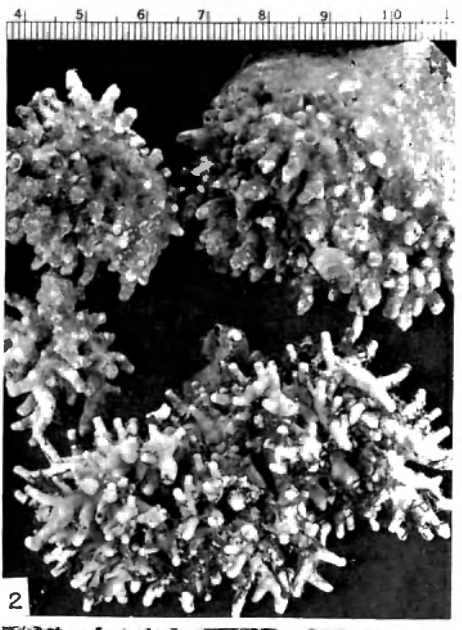


Plate VII

Fig. 1. *Neogoniolithon fosliei* (Heydrich) Foslie.
Figs. 2–4. *Neogoniolithon frutescens* (Foslie) Setchell and Mason.
Fig. 1. Tetrasporangial conceptacle ×90.
Fig. 2. Vertical section of hypothallium, perithallium and epithallium ×90.
Fig. 3. Part of vertical section of perithallium, epithallium and a short vertical row of heterocyst cells ×185.
Fig. 4. Part of vertical section of hypothallium and perithallium ×185.





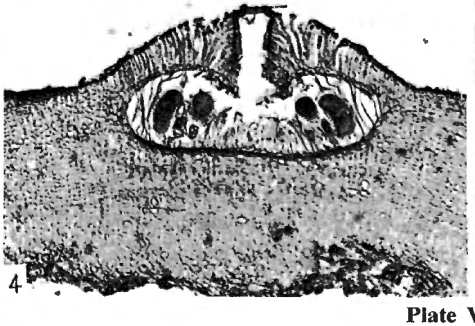


Plate VIII

Figs. 1–3. *Neogoniolithon frutescens* (Foslie) Setchell and Mason.
Figs. 4–5. *Neogoniolithon pacificum* (Foslie) Setchell and Mason.
Fig. 1. Tetrasporangial conceptacle with pore opening ×90.
Fig. 2. Habit of plants, the lower plant is a nodule with radiating branches, the others are encrusting reef substrate.
Fig. 3. Surface detail of branches with single pored conceptacles at their tips. Scale: (2 mm).
Fig. 4. Tetrasporangial conceptacle with pore opening ×95.
Fig. 5. Vertical section of hypothallium, perithallium and epithallium ×185.

could easily bury an encrusting species. Often, specimens are found partially buried in the sand, but superficially they appear healthy. If it is adapted to this type of habitat, this perhaps explains why its conceptacles are usually found at the tips of the branches. It is commonly pink in color but can be cream or purple, reflecting high or diminished light intensity.

SPECIMENS EXAMINED: GDG 129, inner reef flat, 0.3 m, Hilton Beach, Tumon Bay, V–15–74; GDG 192, patch reef, 1 m, Saipan lagoon, Saipan, Mariana Islands, VI–8–74; GDG 221, inner reef flat, 0.1 m, off Coral Reef Enterprises, E. Asan Bay, VII–14–74; GDG 257, inner reef flat, 0.1 m, off Adelupe Pt., E. Asan Bay, VI–29–75.

Neogoniolithon pacificum (Foslie) Setchell and Mason 1943: 90.
Pl. VIII, figs. 4–5.
Goniolithon pacificum Foslie, 1908: 6.
Goniolithon notarisii f. *pacificum* Foslie, 1907 b: 12.

DESCRIPTION: Thallus encrusting, adhering tightly to substratum, thickness variable, 75–820 μ; color pale pink to cream; hypothallium coaxial, cells subrectangular, 17–44 μ long, 8–18 μ diam.; perithallium layered, cells ovoid or subquadrate, 8–13 μ diam., or subrectangular, 6–22 μ long, 6–14 μ diam.; cells of epithallium subtriangular, 3–8 μ long, 10–15 μ diam.; cell fusions between adjacent cell rows in hypothallium and perithallium; sporangial conceptacles conical, 840–1342 μ outside diam., 458–658 inside diam., 104–273 μ high; sporangia tetrasporic, scattered throughout floor of conceptacle, 68–142 μ long, 34–70 μ diam.

HABITAT: It was found encrusting the tips of dead *Pocillopora* in the lagoon 2 m deep, and growing exposed at 40 m.

SPECIMENS EXAMINED: GDG 111A, lagoon, 2 m, Cocos Lagoon, IV–27–74; GDG 163, submarine slope, 40 m, Uruno Pt. VI–3–74; GDG 268, lagoon, 1 m, Cocos Lagoon, VI—30—75.

Porolithon onkodes (Heydrich) Foslie, 1909: 38; Lemoine, 1911: 160; Taylor, 1950: 125, pl. 9, figs. 61–63; Johnson, 1957: 232–233, pl. 55, figs. 6–7, pl. 59, fig. 6; Dawson, 1959: 4; Johnson, 1964: 23–24; Lemoine, 1965: 6; Lemoine, 1966: 10, figs. 5–6, pl. figs. B, C, D; Lee, 1967: 991, pl. 4, 5.
Pl. IX, figs. 1–4.
Lithothamnium onkodes (Heydr.) Heydrich, 1897c: 6, pl. 1, figs. a–b.
Lithophyllum onkodes (Heydr.) Heydrich, 1897b: 410; Foslie, 1900b: 8; Heydrich, 1901b: 533; Foslie, 1904: 57, pl. 11, figs. 5–10; Foslie, 1906: 25; Foslie, 1929: 36, pl. LXVII, figs. 1–8.
Lithophyllum (*Porolithon*) *onkodes* (Heydrich); Foslie, 1907b: 29.

DESCRIPTION: Thallus encrusting, smooth, adhering tightly to substratum, margins sometimes more loose, thick, 1.5 mm or more, often overlapping; surface having speckled or pox-like appearance from heterocyst clusters; hypothallium 40–140 μ thick, cells subrectangular, 8–28 μ long, 6–17 μ diam.; cells of perithallium subquadrate, 4–10 μ diam., or subrectangular 4–12 μ long, 3–12 μ diam.; epithal-

lium single layered, cells subtriangular or mostly subrectangular, 2–6 μ long, 4–9 μ diam.; fusions common between adjacent cell rows in hypothallium and perithallium; heterocysts in horizontal plates or clusters, 6–11 cells wide in vertical section, subrectangular, 10–33 μ long, 7–19 μ diam.; tetrasporangial conceptacles sometimes flat, usually slightly convex, 260–315 μ outside diam., 130–315 μ inside diam., 76–175 μ high; sporangia tetrasporic, 48–70 μ long, 26–38 μ diam.

HABITAT: It is commonly associated with the reef margin where it is the dominant organism. It is also found on the inner and outer reef flats. It seems to prefer standing dead *Acropora* or other elevated or exposed substratum of the inner reef flat where it can receive good water circulation. It will encrust small rocks and substratum of the outer reef flat but is not as abundant in this area. It can also be found on the submarine terrace. It is quite abundant to depths of 7 m and is found to depths of 14 m. It normally has a pink color although yellow-brown forms are found on the reef margin, and it can become a darker purple color if shaded. It often seems covered with a "pox," due to the clusters of heterocysts.

SPECIMENS EXAMINED: GDG 2, submarine terrace, 10 m, Marine Lab, Pago Bay, X–17–73; GDG 13, intake channel, 0.5 m. Marine Lab, Pago Bay, X–19–73; GDG 28, wave washed benches, supratidal, Marine Lab, Pago Bay, XI–2–73; GDG 61, reef margin, intertidal, Marine Lab, Pago Bay, I–15–74; GDG 278, reef margin, 1 m, Double Reef, VII–2–75.

Subfamily **Lithophylloideae** Setchell
Genus **Lithophyllum** Philippi, 1837

Key to species:

A. Branches never pointed at tips, tending to be fused and rounded, sometimes nearly cylindrical, other times broad and flat; conceptacles 240–373 μ diam. ..... *L. kotschyanum*

A. Branches more pointed at tips; conceptacles 145–290 μ diam. .... *L. moluccense*

Lithophyllum kotschyanum (Unger) Foslie, 1909: 34; Foslie, 1929: 35, pl. LXV, figs. 1–13; Johnson, 1957: 230, pl. 57, fig. 1, pl. 58, fig. 1; Johnson, 1964: 21, pl. 14, fig. 1–2, pl. 15, fig. 3.

Pl. IX, figs. 5–6, Pl. X, figs. 1–2.

DESCRIPTION: Thallus stoutly branching, forming dense heads up to 11 cm high, 18 cm wide, branches along edges tending to become broad and flat, more commonly rounded, fusing often near tips, tips of branches usually rounded 2–4 mm or broad, 1–3 mm thick, 4–10 mm wide, never pointed, branching subdichotomously; color pink if exposed, more commonly purple; structure of branches consisting of massive medullary hypothallium, cells subrectangular, in central portion 13–28 μ long, 8–13 μ diam.; perithallium layered, cells usually subquadrate, 6–12 μ diam., sometimes subrectangular, 5–20 μ long, 5–11 μ diam.; epithallium single layered, cells subrectangular, 2–5 μ long, 5–7 μ diam.; secondary pits between adjoining cells of medullary hypothallium and perithallium; sporangial conceptacles occasionally convex, commonly slightly convex, born along sides of branches, 350–500 μ outside diam., 240–373 μ inside diam., 80–130 μ high, central portion raised having ascending hairs;

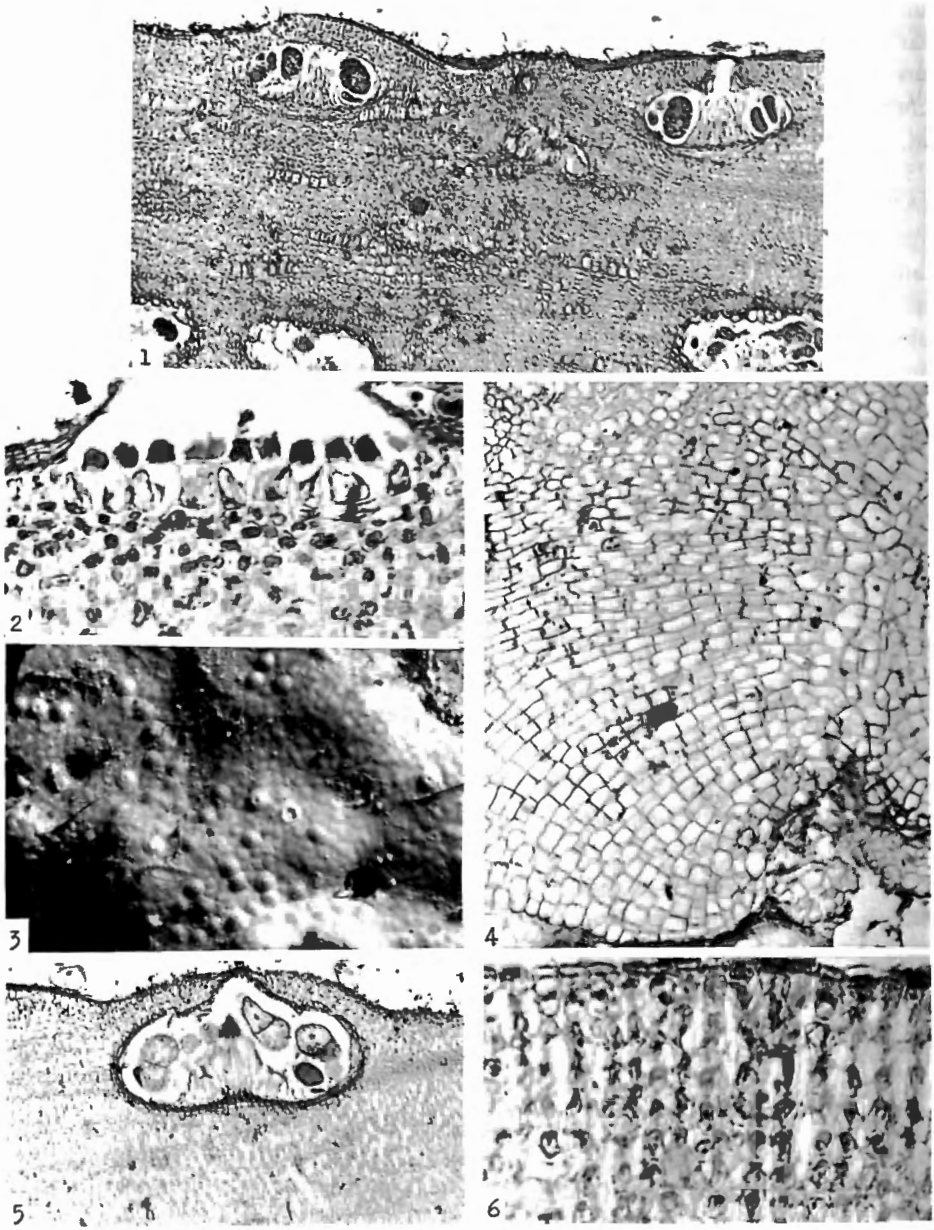


Plate IX

Figs. 1–4. *Porolithon onkodes* Foslie.
Figs. 5–6. *Lithophyllum kotschyanum* (Unger) Foslie.
Fig. 1. Part of vertical section of perithallium and epithallium with tetrasporangial conceptacles and horizontal rows of heterocyst cells ×95.
Fig. 2. Part of vertical section of perithallium with a horizontal row of heterocyst cells ×365.
Fig. 3. Surface detail of plant with single pored conceptacles. Scale: (2 mm).
Fig. 4. Part of vertical section of hypothallium and perithallium ×180.
Fig. 5. Part of vertical section of perithallium with tetrasporangial conceptacle and pore opening ×90.
Fig. 6. Part of vertical section of perithallium and epithallium ×360.

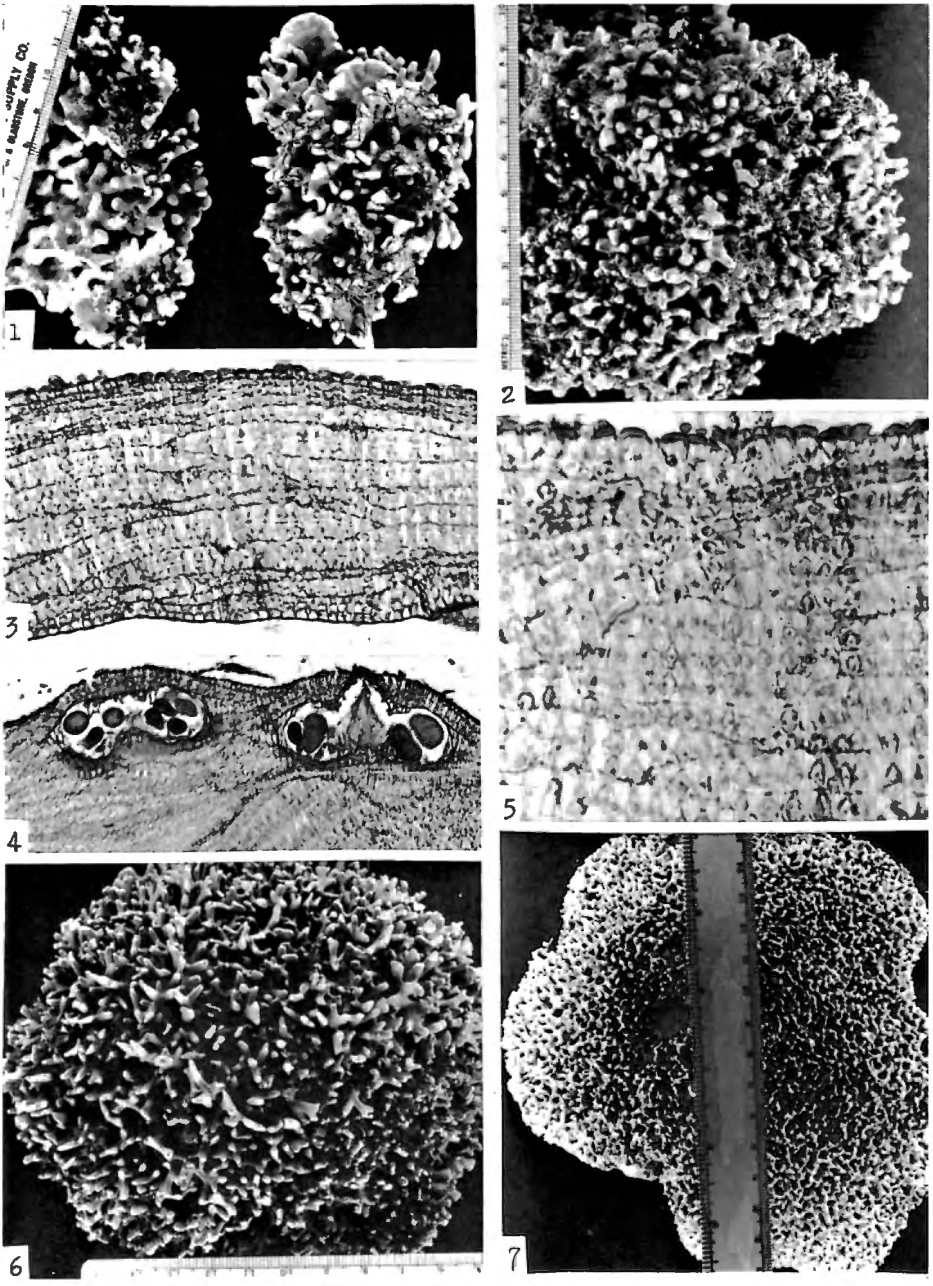


Plate X

Figs. 1–2. *Lithophyllum kotschyanum* (Unger) Foslie.
Figs. 3–7. *Lithophyllum moluccense* Foslie.
Fig. 1. Habit of plants growing and branching in one plane.
Fig. 2. Habit of plant growing in a dense head.
Fig. 3. Vertical section of hypothallium, perithallium and epithallium ×190.
Fig. 4. Tetrasporangial conceptacles ×95.
Fig. 5. Part of vertical section of perithallium and epithallium ×385.
Fig. 6. Habit of plant from a reef front having moderate surf.
Fig. 7. Habit of plant from windward reef margin.

sporangia bisporic, 67–76 μ long, 30–50 μ diam., located around periphery of conceptacle cavity.

HABITAT: It has only been found on the leeward side of the island, and usually in protected areas that receive little surf. On Guam it has been found only along the reef front. On Saipan it was found growing in 27 m of water, and so should not be considered to be found only in shallow water. Its branches are rounded and commonly flattened.

SPECIMENS EXAMINED: GDG 161, reef front, 3 m, Nimitz Beach, Agat Bay, V–30–74; GDG 176, patch reef, 3 m, Saipan lagoon, Saipan, Mariana Islands, VI–6–74; GDG 197, submerged patch reef, 23 m, Saipan lagoon, Saipan, Mariana Islands, VI–8–74; GDG 291, reef front, 0.5 m, Nimitz Beach, Agat Bay, VII–3–75.

Lithophyllum moluccense Foslie, 1900c: 16; Foslie, 1901e: 24; Foslie, 1904: 67, pl. 12, figs. 2–13; Foslie, 1929: 36, pl. LV, figs. 14–21; Johnson, 1957: 230, pl. 54, figs. 2–5; Johnson, 1964: 21, pl. 13, figs. 1, 3.
Pl. X, figs. 3–7, Pl. XI, fig. 1.
Lithothamnium pygmaeum Heydrich, 1897c: 3.
Goniolithon pygmaeum Foslie, 1898: 8.
Lithophyllum torquescens Foslie, 1901d: 11.

DESCRIPTION: Thallus originally crustaceous, quickly branching extensively, growth forms highly variable, sometimes forming dense heads up to 10 cm high, 15 cm wide, other times spreading and loosely branching, lower branches fusing, fusing infrequent near tips, tips pointed or somewhat rounded, branches 1–4 cm or more high, near base 2–4 mm diam., near tips 1–2 mm diam., or broad, 1 mm thick, 2–4 mm wide, branching subdichotomously; color pink if exposed, purple if shaded; structure of branches consisting of broad coaxial medullary hypothallium, cells alternating in length, one long and one or occasionally two short, cells quadrate or subrectangular, long cells 30–52 μ long, 6–17 μ diam., short cells 6–24 μ long, 6–11 μ diam.; perithallium layered, cells usually subquadrate 4–7 μ diam., or subrectangular, 4–23 μ long, 4–11 μ diam.; epithallium single layered, cells subtriangular or subrectangular, 3–4 μ long, 6–10 μ diam.; sporangial conceptacles on sides of branches, convex, 325–446 μ outside diam., 145–290 μ inside diam., 66–96 μ high, central portion raised having ascending hairs; sporangia tetrasporic 44–57 μ long, 26–31 μ diam.; sporangia bisporic, 45–58 μ long, 30–34 μ diam., located around periphery of conceptacle cavity.

HABITAT: The branching species *Lithophyllum moluccense* is found on areas of the reef which retain water at low tide, being usually most abundant on the inner reef flat. It grows most luxuriantly in the area of the reef margin and reef front, although it is found growing to depths of 30 m. It is also abundant on the windward reef margin where it is densely branched and the individual specimens are quite solid. Protected from waves, it is loosely branched and the individual branches break off quite easily. The tips of reef flat and deeper water specimens are usually pointed in contrast to specimens found on the reef margin and reef front.

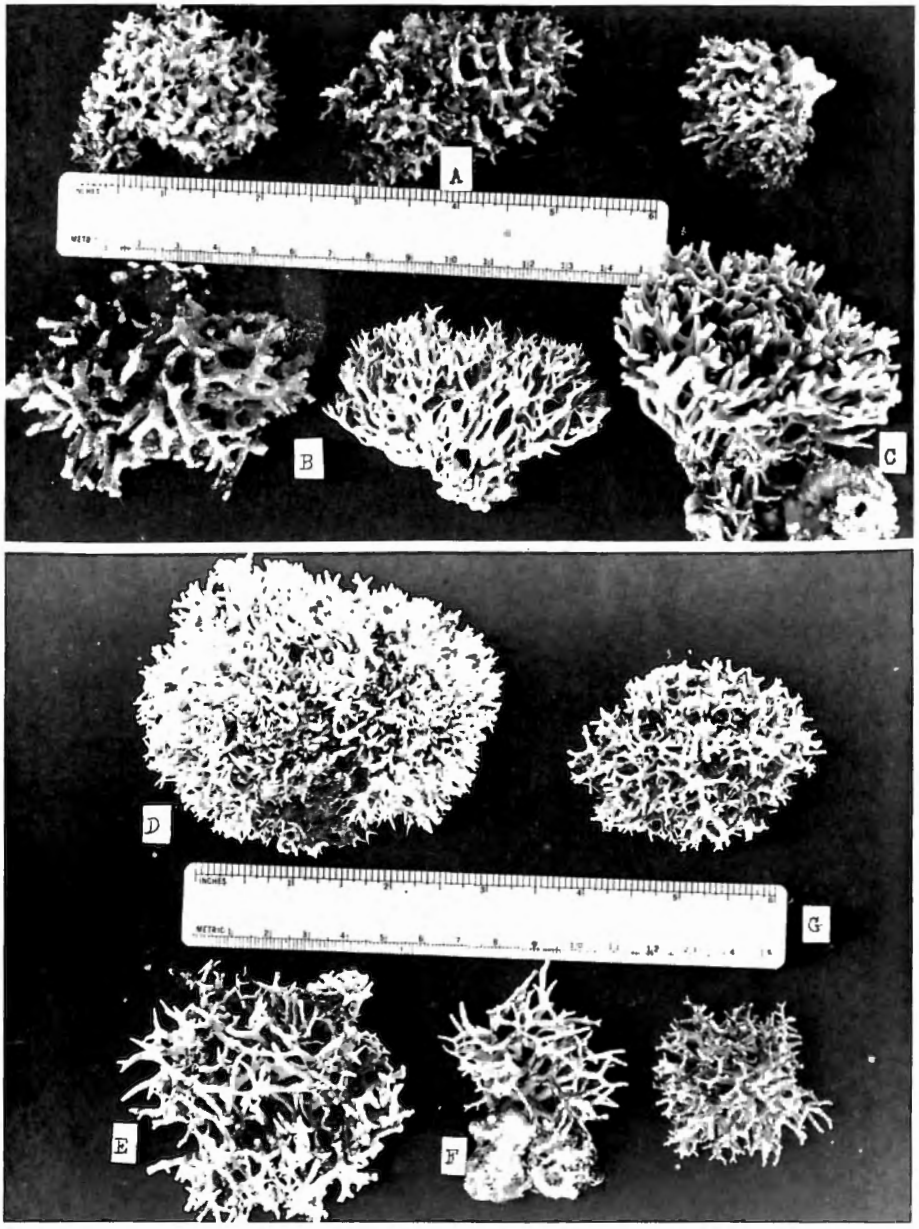


Plate XI

Fig. 1. *Lithophyllum moluccense* Foslie.

Fig. 1A. Habit of plants taken from reef front area close to reef margin.
Fig. 1B. Habit of plants taken from seaward edge of windward reef flat.
Fig. 1C. Habit of plant taken from reef front having light surf.
Fig. 1D. Habit of plant taken from reef flat.
Fig. 1E. Habit of plant taken from reef flat.
Fig. 1F. Habit of plant taken from submarine terrace, 30 m deep.
Fig. 1G. Habit of plants taken from submarine terrace, 7 m deep, where they formed nodules.

SPECIMENS EXAMINED: GDG 33, submarine slope, 14 m, Marine Lab, Pago Bay, XII–10–73; GDG 83, reef flat, 1.5 m, NE of Pago Bay, III–17–74; GDG 94, reef flat, 0.7 m, Piti Bay, III–21–74; GDG 98, reef front, 2 m, Marine Lab, Pago Bay, III–25–74; GDG 122, reef margin, 0.1 m, Marine Lab, Pago Bay, V–6–74; GDG 155, submarine slope, 37 m, off Tanguisson Power Plant, Tanguisson Pt., V–29–74; GDG 230, reef front, 3 m, off Tanguisson Power Plant, Tanguisson Pt., VII–22–74; GDG 235, submarine terrace, 7 m, 200 m SE of Anae Island, VIII–1–74; GDG 236, reef front, 3 m, 200 m SE of Anae Island, VIII–1–74; GDG 237, submarine terrace, 7 m, Facpi Pt., VIII–1–74; GDG 257, reef front, 2 m, E. of Cabras Island, Piti Bay, VIII–7–74; GDG 277, reef front, 1 m, Double Reef, VII–2–75.

COMMENTS: A number of highly variable growth forms have been grouped under this species. The growth forms can be divided into two groups; one tends to be pointed at the tips, while the tips of the second group are more blunt. The authors feel that this is due to their location on the reef with respect to waves. All the specimens from the reef margin and reef front tend to be blunt at the tips, while reef flat, deep water, and specimens from sheltered areas tend to be pointed.

In examining these specimens (see Plates X and XI) one can see overlapping characteristics from one to the other. For this reason, and because they lack any distinct differences in cell or conceptacle sizes, they have all been considered as one species. *L. kotschyanum* is the only other branching *Lithophyllum* found on Guam, but it was not considered a reasonable species for any of these types. Its conceptacle size is larger, its medullary hypothallium cells in the branches are very different, and specimens of *L. kotschyanum* can be found growing in the same habitats as *L. moluccense*, but with growth forms that are completely different. Perhaps with further intensive collecting and careful comparison of the conceptacle sizes and types of growth, this group could be separated into different species. This is not considered feasible at present.

Discussion

Although 15 species of crustose corallines have been named in this paper, the total number of species on Guam may be nearly double this amount. No specimens were collected below a depth of 40 m. Collections from a depth of 20–40 m were limited in numbers. The length of time spent collecting at this depth is only about 20 minutes for one dive. One must work quickly and there is little time to explore vast areas looking for new or different specimens, so probably some species were not collected. Likewise specimens found in very specialized habitats, e. g. estuarine conditions, areas of turbidity, caves, or wave-washed benches, may not have been collected. In addition to the named species, seven new species representing four genera, *Porolithon* (1 species), *Sporolithon* (2 species), *Hydrolithon* (3 species), and *Neogoniolithon* (1 species) were found but have not yet been named.

There are at least seven species of coralline algae that can be found on the reef flats of Guam (Table 1) and which can usually be distinguished in the field. They

are *Sporolithon schmidtii, Lithothamnium asperulum, Hydrolithon reinboldii, Lithophyllum moluccense, Neogoniolithon fosliei, N. frutescens,* and *Porolithon onkodes.* In addition, *Mesophyllum mesomorphum* can be found on the reef flats in very specialized habitats (under large rocks), but is typically a deep water species. The above species

Table 1. Zonational occurrence of species of crustose Corallinaceae based on collection data and field observations.

	inner reef flat	outer reef flat	reef margin	reef front	submarine terrace (to 20 m)	submarine slope (to 40 m)	Cocos Lagoon	wave washed benches
Sporolithon schmidtii	×	×			×			
Fosliella farinosa	×	×						
Hydrolithon reinboldii	×	×			×		×	×
Lithophyllum moluccense	×	×	×	×	×	×	×	
L. kotschyanum				×		×		
Lithoporella melobesioides					×	×		
L. pacifica				×	×			
Lithothamnium asperulum	×						×	
Mesophyllum erubescens					×	×		
M. mesomorphum		×				×		
Neogoniolithon conicum							×	
N. fosliei	×	×	×	×	×	×	×	
N. frutescens	×	×						
N. pacificum						×	×	
Porolithon onkodes	×	×	×	×	×		×	×

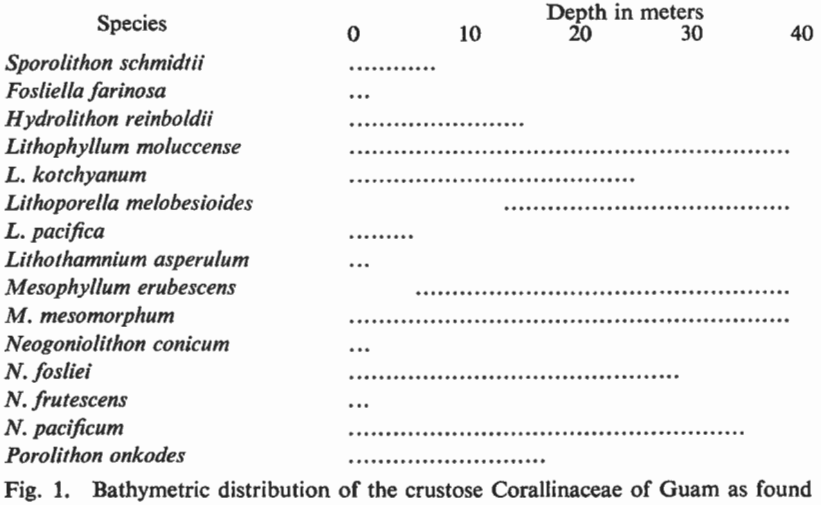


Fig. 1. Bathymetric distribution of the crustose Corallinaceae of Guam as found by the authors.

are usually most dominant in a specific habitat on the reef flat, although not necessarily limited to that habitat. All of these species were found beyond the reef margin in deeper water (Fig. 1) with the exception of *N. frutescens* and *L. asperulum.*

Of the 15 species of crustose coralline algae reported, the number of predominant species on the Guam reefs is low. *Porolithon onkodes* would seem to be the most important single species because of its ecological role in cementing the reef margin, and its rather wide distributional range from the reef flat to the submarine terrace (14 m). Although its ecological role may not be as important as *P. onkodes*; *Lithophyllum moluccense* is also very abundant, and is found over an even wider range of distribution from reef flats to depths of 30 m. *Hydrolithon reinboldii* is also abundant, especially on the reef flat, but it was found as deep as 17 m on the submarine terrace. *Neogoniolithon frutescens* and *Sporolithon schmidtii* are common reef flat species. Except for localized areas, *Neogoniolithon fosliei* was never abundant, but it is commonly found on the reef flat and submarine terrace and to as deep as 33 m. At least in certain areas on the submarine slope (20–30 m), *Mesophyllum erubescens* is the only dominant crustose coralline which can be identified in the field.

Because the genus *Neogoniolithon* has four species named from Guam, it would appear to be the dominant genus. The existence of seven new, unnamed species plus the probable existence of other species not collected makes this conclusion tentative. *Neogoniolithon* probably does have the greatest number of commonly found species on Guam.

The variability of habitat found on reef flats complicates algal distribution because light intensity seems to be one of the controlling factors involved. Thus species can be found growing under rocks and in holes on the reef flat or in shallow water which are growing exposed in deeper water. *Mesophyllum mesomorphum* illustrates this fact well, as did some other species collected but not yet named.

During extensive observing and collecting in the field, the first author has noticed that branching species exhibit a wide range of growth forms. It is thought that these forms are due to environmental conditions. Wave action is one important cause as has been discussed for *Lithophyllum moluccense.* Other apparent factors are the substratum and the microhabitat where the specimen is found, especially as it effects the growth of the alga towards the sunlight. Because of these observations only species names have been given for the branching algae. It is thought that the many forms of branching algae named by Foslie in his works are more likely the result of environmental differences, not genetic ones.

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