

FLORISTIC AND DISTRIBUTIONAL ACCOUNT OF THE

COMMON CRUSTACEAN CORALINE

ALGAE OF GUAM

A thesis submitted in partial fulfillment  
of the requirements for the degree of

MASTER OF SCIENCE  
in  
BIOLOGY

University of Guam  
1974

AN ABSTRACT OF THE THESIS OF Gregory L. Gordon for the Master of  
Science Degree in Biology presented August 26, 1974.

Title: Floristic and Distributional Account of the Common Crustose  
Coralline Algae on Guam

Approved:

Roy T. Tsuda  
ROY T. TSUDA, Chairman, Thesis Committee

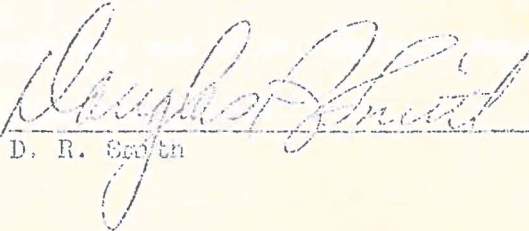
The common crustose coralline algae on Guam were collected from the reef flats and to depths of 40 meters. Specimens were decalcified, embedded in paraffin, microtomed, stained, and examined under a microscope. Twenty seven species are described. Porolithon onkodes Foslie and Hydrolithon reinholdii (Weber van Bosse and Foslie) Foslie are the two species found in greatest abundance over the widest range of habitats. The two dominant genera, Lithophyllum and Neoschistolithon, have five and six species, respectively.

James A. McLaughlin  
James A. McLaughlin  
Director, University of Guam


TO THE GRADUATE SCHOOL:

The members of the Committee approve the thesis of Gregory D.  
Gordon presented August 26, 1974.

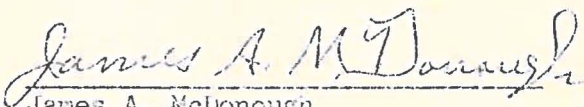
  
\_\_\_\_\_  
R. T. Tsuda, Chairman

  
\_\_\_\_\_  
D. R. Srofn

  
\_\_\_\_\_  
J. A. Marsh, Jr.

  
\_\_\_\_\_  
C. Carlson

ACCEPTED:

  
\_\_\_\_\_  
James A. McDonough  
Dean of the Graduate School

## ACKNOWLEDGEMENTS

I would like to acknowledge the following people: Bill FitzGerald for the photography; Dr. Walter H. Adey for answering certain questions through correspondence; Richard H. Randall and Dr. Mark M. Littler for the valuable knowledge given during our discussions. Special thanks to Maura Hechact for her help and support; and to Dr. Tomitaro Masaki for his willingness to confirm questionable species.



TABLE OF CONTENTS

	PAGE
ACKNOWLEDGMENTS . . . . .	ii
LIST OF TABLES . . . . .	iv
LIST OF FIGURES . . . . .	v
LIST OF PLATES . . . . .	vi
INTRODUCTION . . . . .	1
MATERIALS AND METHODS . . . . .	3
FLORISTIC ACCOUNT . . . . .	5
DISTRIBUTION . . . . .	33
CONCLUSIONS . . . . .	41
LITERATURE CITED . . . . .	42
PLATES . . . . .	44

LIST OF TABLES

TABLE	PAGE
1. Zonal occurrences of species of crustose Corallinales based on collection data and field observations . . . . .	35-36



LIST OF PLATES

PLATE		PAGE
I.	Fig. 1. <u>Archaeolithothamnium erythraeum</u> (Rothpl.) Foslie. Habit of plant encrusting reef substrate with excrescences (GDG 216) . . . . .	44
	Fig. 2. <u>Archaeolithothamnium erythraeum</u> (Rothpl.) Foslie. Habit of nodules; specimen at right is split in half (left, GDG 241, right, GDG 48). . . . .	44
II.	Fig. 1. <u>Archaeolithothamnium erythraeum</u> (Rothpl.) Foslie. Vertical section of a row of conceptacles in perithallus (GDG 48) . . . . .	45
III.	Fig. 1. <u>Archaeolithothamnium</u> sp. 1. Vertical section of rows of evacuated conceptacles in perithallus (GDG 157) . . . . .	46
	Fig. 2. <u>Archaeolithothamnium</u> sp. 2. Vertical section of rows of evacuated conceptacles in perithallus (GDG 116). . . . .	46
IV.	Fig. 1. <u>Leptophytum</u> sp. Habit of plant having large prominent conceptacles (GDG 254) . . . . .	47
	Fig. 2. <u>Leptophytum</u> sp. Vertical section of conceptacle with bispores; two mucilagenous plugs (mp) can be seen in conceptacle roof (GDG 96). . . . .	47
V.	Fig. 1. <u>Leptophytum</u> sp. Vertical section of conceptacle with bispores and thallus (GDG 96) . . . . .	48
	Fig. 2. <u>Leptophytum</u> sp. Vertical section of perithallus and hypothallus (GDG 96) . . . . .	48

- VI. Fig. 1. Mesophyllum cf. erubescens (Foslie)  
Lemoine. Surface detail of  
excrescences having multipored  
conceptacles at tips (GDG 238) . . . 49
- VII. Fig. 1. Mesophyllum cf. erubescens (Foslie)  
Lemoine. Vertical section of  
conceptacle with spore (GDG 152) . . . 50
- Fig. 2. Mesophyllum cf. erubescens (Foslie)  
Lemoine. Vertical section of  
coaxial hypothallus (GDG 152) . . . 50
- VIII. Fig. 1. Fosliella farinosa (Lamx.) Howe.  
Vertical section of four hetero-  
cysts with projecting hairs; also  
part of a conceptacle with  
tetraspore (GDG 89) . . . . . 51
- Fig. 2. Fosliella farinosa (Lamx.) Howe.  
Vertical section of conceptacle  
with tetraspore (GDG 89) . . . . . 51
- IX. Fig. 1. Fosliella lejosidis (Rosanoff) Howe.  
Vertical section of conceptacle  
with two tetraspores (GDG 126) . . . 52
- X. Fig. 1. Hydrolithon reinboldii (W. v. Bosse  
and Foslie) Foslie. Habit of  
nodule with excrescences (GDG 242) . . . 53
- Fig. 2. Hydrolithon reinboldii (W. v. Bosse  
and Foslie) Foslie. Surface  
detail of excrescences with small  
one pore conceptacles (GDG 242) . . . 53
- XI. Fig. 1. Hydrolithon reinboldii (W. v. Bosse  
and Foslie) Foslie. Vertical  
section of perithallus having  
heterocyst with projecting  
hair (GDG 15) . . . . . 54
- Fig. 2. Hydrolithon reinboldii (W. v. Bosse  
and Foslie) Foslie. Vertical  
section showing the irregular cell  
structure of the perithallus, an  
evacuated conceptacle, and the  
hypothallus (hy) one cell layer  
thick (GDG 15) . . . . . 54



- XII. Fig. 1. Lithonorella melobasioides Foslie.  
Surface detail showing the  
fan-shaped areas of new thallic  
growth (GDG 156) . . . . . 55
- Fig. 2. Lithonorella melobasioides Foslie.  
Vertical section of the one cell  
layer thick hypothallus with  
epithallus on top (GDG 169B) . . . . . 55
- XIII. Fig. 1. Lithonorella pacifica (Heydr.) Foslie.  
Habit of plant having many thin  
crusts with large prominent  
conceptacles (GDG 231) . . . . . 56
- Fig. 2. Lithonorella pacifica (Heydr.) Foslie.  
Surface detail of conceptacles  
and thin crusts (GDG 231) . . . . . 56
- XIV. Fig. 1. Lithonorella pacifica (Heydr.) Foslie.  
Vertical section of conceptacle  
chamber and hypothallus (GDG 62) . . . . . 57
- XV. Fig. 1. Neogoniolithon fosliei (Heydr.)  
Setchell and Mason. Surface  
detail of plant with large conical  
conceptacles (GDG 233) . . . . . 58
- Fig. 2. Neogoniolithon fosliei (Heydr.)  
Setchell and Mason. Vertical  
section of heterocysts in vertical  
columns in the perithallus (GDG 86) . . . . . 58
- XVI. Fig. 1. Neogoniolithon frutescens (Foslie)  
Setchell and Mason. Habit of  
plant, specimen at right is a  
nodule with branches radiating  
from all sides, other specimens  
are encrusted with branches (left,  
GDG 221; right, GDG 192) . . . . . 59
- Fig. 2. Neogoniolithon frutescens (Foslie)  
Setchell and Mason. Surface  
detail of branches with single  
pored conceptacles at their tips  
(GDG 192) . . . . . 59

- XVII. Fig. 1. Neogoniolithon frutescens (Foslie)  
Setchell and Mason. Vertical  
section of perithallus with  
heterocysts (h) (GDG 129) . . . . . 60
- XVIII. Fig. 1. Neogoniolithon myricosporum (Foslie)  
Setchell and Mason. Surface  
detail of plant with single pored  
conceptacles (GDG 111A) . . . . . 61
- Fig. 2. Neogoniolithon myricosporum (Foslie)  
Setchell and Mason. Vertical  
section of conceptacle with  
tetraspore (GDG 111A) . . . . . 61
- XIX. Fig. 1. Neogoniolithon sp. 1. Surface detail  
of plant with single pored  
conceptacles (GDG 11) . . . . . 62
- Fig. 2. Neogoniolithon sp. 1. Vertical section  
of tetrasporangial conceptacle and  
perithallus with short vertical  
columns of heterocysts (GDG 153B) . . . . . 62
- XX. Fig. 1. Neogoniolithon sp. 2. Surface detail  
of encrusting plant with single  
pored conceptacle (GDG 115) . . . . . 63
- Fig. 2. Neogoniolithon sp. 2. Habit of plant  
encrusting and with excrescences  
(left, GDG 118; right, GDG 117) . . . . . 63
- XXI. Fig. 1. Neogoniolithon sp. 2. Vertical section  
of evacuated conceptacle (GDG 115) . . . . . 64
- Fig. 2. Neogoniolithon sp. 2. Vertical section  
of perithallus with heterocysts (h)  
(GDG 115) . . . . . 64
- XXII. Fig. 1. Neogoniolithon sp. 2. Vertical section  
of perithallus with heterocysts  
and coaxial hypothallus (GDG 115) . . . . . 65
- Fig. 2. Neogoniolithon sp. 3. Vertical section  
of conceptacle with tetraspore  
(GDG 153A) . . . . . 65

- XXIII. Fig. 1. Porolithon onkodes Foslie. Surface detail of single pored conceptacles (GDG 13) . . . . . 66
- Fig. 2. Porolithon onkodes Foslie. Vertical section of conceptacle with tetraspores (GDG 13) . . . . . 66
- XXIV. Fig. 1. Porolithon onkodes Foslie. Vertical section of perithallus having many heterocyst plates (hp) lying in horizontal rows (GDG 28) . . . . . 67
- Fig. 2. Porolithon onkodes Foslie. Vertical section of heterocyst plate lying on surface of perithallus; some short heterocyst hairs can be seen (GDG 61) . . . . . 67
- XXV. Fig. 1. Porolithon sp. Surface detail of plant with many single pored conceptacles, some are faded white (GDG 80) . . . . . 68
- Fig. 2. Porolithon sp. Vertical section of conceptacle with tetraspores (GDG 10) . . . . . 68
- XXVI. Fig. 1. Porolithon sp. Vertical section of perithallus with a heterocyst plate (GDG 10) . . . . . 69
- XXVII. Fig. 1. Pseudolithophyllum sp. 1. Habit of plants having many thin crusts (GDG 123) . . . . . 70
- XXVIII. Fig. 1. Pseudolithophyllum sp. 1. Surface detail of plant (GDG 123) . . . . . 71
- XXIX. Fig. 1. Pseudolithophyllum sp. 2. Vertical section of conceptacle (GDG 119) . . . . . 72
- XXX. Fig. 1. Pseudolithophyllum sp. 3. Vertical section of two evacuated conceptacles (GDG 114) . . . . . 73



- XXX. Fig. 2. Pseudolithophyllum sp. 3. Vertical section of perithallus and multilayered hypothallus (GDG 114) . . . . . 73
- XXXI. Fig. 1. Lithophyllum kotschyannum (Unger) Fosl. Habit of plant (GDG 161) . . . . . 74
- Fig. 2. Lithophyllum kotschyannum (Unger) Fosl. Habit of plant growing and branching in one plane (left, GDG 176; right, GDG 197) . . . . . 74
- XXXII. Fig. 1. Lithophyllum kotschyannum (Unger) Fosl. Vertical section of conceptacles (GDG 161) . . . . . 75
- Fig. 2. Lithophyllum kotschyannum (Unger) Fosl. Vertical section of coaxial hypothallus (GDG 161) . . . . . 75
- XXXIII. Fig. 1. Lithophyllum moluccense Fosl. Habit of plant from windward reef margin (GDG 122) . . . . . 76
- Fig. 2. Lithophyllum moluccense Fosl. Habit of plant from reef front having moderate surf (GDG 251) . . . . . 76
- XXXIV. Fig. 1. Lithophyllum moluccense Fosl. Habit of plants; specimens A from reef front area close to reef margin; specimens B from seaward edge of windward reef flat; specimen C from reef front having light surf (A, GDG 230; B, GDG 209; C, GDG 236) . . . . . 77
- XXXV. Fig. 1. Lithophyllum moluccense Fosl. Habit of plants; specimens A and B from reef flat; specimen C from reef terrace 30 m deep; specimen D grew as nodules on the reef terrace 7 m deep; (A, GDG 83; B, GDG 84; C, GDG 155; D, GDG 237) . . . . . 78

- XXXVI. Fig. 1. Lithophyllum moluccense Foslie. Habit of plant; specimen from sheltered submarine terrace, 7 m deep (GDG 235) . . . . . 79
- XXXVII. Fig. 1. Lithophyllum moluccense Foslie. Vertical section of tetrasporangial conceptacle (GDG 98) . . . . . 80
- Fig. 2. Lithophyllum moluccense Foslie. Vertical section of coaxial hypothallus (GDG 33) . . . . . 80
- XXXVIII. Fig. 1. Lithophyllum cf. okamurai Foslie. Vertical section of conceptacle (GDG 75) . . . . . 81
- XXXIX. Fig. 1. Lithophyllum cf. trichotum (Heydr.) Lemoine. Vertical section of conceptacle (GDG 131B) . . . . . 82
- Fig. 2. Lithophyllum cf. trichotum (Heydr.) Lemoine. Vertical section of perithallus having secondary pits (sp) between cells (GDG 131B) . . . . . 82
- XL. Fig. 1. Lithophyllum cf. yendoi Foslie. Vertical section of conceptacle (GDG 41) . . . . . 83



## 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 in 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 (1950) at Bikini, and Dawson at Eniwetok (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 (1973a, 1973b) 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 primarily with temperate species, but provides a key to the genera that is applicable to the tropics. 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

The crustose corallines were either killed and fixed in 10% formalin in seawater, or were air dried. Decalcification was done using 10% hydrochloric acid in seawater. The methods of Sass (1958) were used for embedding in paraffin and sectioning with a microtome. Staining was done with tannic acid, ferric chloride and safranin, or Delafield's haematoxylin. It was later learned (M. Livtler, personal communication) that hydrochloric acid may cause slight distortion and shrinkage of the cells. Perenyi's solution is a better decalcifying agent as used by Masaki (1968).

Shallow water specimens and epiphytes were collected by reef walking and snorkeling. Specimens from deeper water to a depth of 40 m were collected by SCUBA diving.

The following data are reported for each species where possible and applicable: the depth (at M.L.L.W.) at which it grows, light intensity, tolerance to desiccation and high water temperatures, type of substrate, and qualitative estimate of water turbulence. Some of the crustose corallines exhibit different forms in response to environmental conditions. These forms are described and the possible environmental factors involved are discussed. Keys to the genera and species of the crustose Corallinaceae of Guam are presented.

Much of the habitat data is to be found in that portion of the paper on distribution. There are species which lack sufficient data



to be discussed properly, however, and for these the habitat data have been included with their description.

The classification system of Adey and Macintyre (1973) was used throughout this paper. To describe the species, measurements have been given as width by height ( $\mu$ ) or width by length ( $\mu$ ). Height is used for all conceptacle measurements and is the distance from the top to the bottom of the conceptacle chamber. Height is also used for describing the top-to-bottom distance in vertical section of all epithallus cells and the heterocyst cells of Neogoniolithon, the reason being that in these instances, the width is commonly equal to or greater than the height. In all measurements given as width by length, the length is commonly equal to or greater than the width. Specimens were collected by the author (SDG) or by Richard H. Randall (RHR). All specimens and prepared slides are deposited in the herbarium of the University of Guam Marine Laboratory.

## FLORISTIC ACCOUNT

Artificial Key to the Genera  
(Adapted from Adey and Macintyre, 1973)

- A. Sporangium borne in individual conceptacle, conceptacles in rows in the perithallus. Archaeolithothamnium
- A. Many sporangia borne in each conceptacle, conceptacles scattered throughout the perithallus. B.
- B. Sporangial conceptacles multipored. C.
- C. Hypothallus coaxial. Mesophyllum
- C. Hypothallus not coaxial. Leptophyllum
- B. Sporangial conceptacles single pored. D.
- D. Secondary pits present between perithallic cells. Lithophyllum
- D. Secondary pits absent, cell fusion often present between perithallic cells. E.
- E. Heterocysts present in perithallus. 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. Hypothallus one cell layer thick,  
heterocysts occurring singly.

Hydroclithon

- H. Hypothallus more than one cell layer  
thick, usually coaxial; heterocysts  
occurring in vertical rows or singly.

Neogonioliton

- E. Heterocysts absent. I.

- I. Thallus one cell layer thick  
except around conceptacles, cells  
large, greater than 10  $\mu$  wide.

Lithocorella

- I. Thallus composed of multilayered  
hypothallus and perithallus,  
cells small, less than 10  $\mu$  wide.

Pseudolithophyllum

Subfamily Melobesioidae (J. Aresch.) Mason

Genus Archaeolithothamnium Rothpeltz, 1891

Key to Species:

A. Thallus having excrescences, conceptacles 62-85  $\mu$  high.

A. erythraeum

A. Thallus lacking excrescences, conceptacles usually greater than 85  $\mu$  high. B.

B. Conceptacles 77-110  $\mu$  high.

Archaeolithothamnium sp. 1

B. Conceptacles 145-190  $\mu$  high.

Archaeolithothamnium sp. 2

Archaeolithothamnium erythraeum (Rothpl.) Foslie, 1900a; Foslie, 1904:38, pl. 5, 6.

Pl. I, fig. 1-2; Pl. II, fig. 1

Sporolithon ptychoides Heydrich, 1897a:67.

Description: Thallus smooth, encrusting but having knobby appearance from many small rounded excrescences 2-7 mm diameter, 1-7 mm high.

Color varies with exposure to sunlight; exposed portions faded, greenish yellow, yellowish brown or tan color; shaded portions dark red or purple. Forms nodules up to 6 cm in diameter. Meristematic cells of epithallus 5-6  $\mu$  wide, 9-10  $\mu$  long; perithallus cells 4-11  $\mu$  wide, 8-28  $\mu$  long; hypothallus 3-6 cells thick, 7-10  $\mu$  wide, 12-22  $\mu$  long. Conceptacles 25-44  $\mu$  wide, 62-85  $\mu$  high; spores 20-31  $\mu$  wide, 36-64  $\mu$  long.

Habitat: It was commonly encrusting reef substrate on inner or outer reef flats where it is often partially covered with sand and loose sediments. It was also found forming nodules on the submarine terrace in 7 m of water.

Specimens examined: GDG 41, reef flat, 0.1 m, Ipan Beach, Togoche, XII-26-73; GDG 73, reef flat, 0.1 m, Marine Lab, Pago Bay, III-26-74; GDG 100, reef flat, 0.2 m, Marine Lab, Pago Bay, VI-10-74; GDG 121, lagoon, 2 m, Cocos Lagoon, IV-27-74; 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; RHR 317B-1, submarine terrace, 7 m, S. of Facpi Point, XI-15-73.

Archaeolithothamnium sp. 1

Pl. III, fig. 1

Description: Thallus smooth encrusting with no excrescences; red-brown color. Perithallic cells square shaped, 4-11  $\mu$  wide, 6-11  $\mu$  long; hypothallus growing parallel to the surface, 3-6 cells thick, 6-11  $\mu$  wide, 8-19  $\mu$  long. Conceptacles 83-105  $\mu$  wide, 145-190  $\mu$  high.

Habitat: It was only found on the submarine terrace, 40 m deep.

Specimen examined: GDG 157, submarine terrace, 40 m, leeward ocean reef, Cocos Lagoon, V-30-74.

Remarks: The color of the thallus and its much larger conceptacles distinguish this species from the two other species of Archaeolithothamnium. Like Archaeolithothamnium sp. 2, it lacks the distinctive excrescences of A. erythraeum.



Archaeolithothamnium sp. 2

Pl. III, fig. 2

Description: Thallus smooth, encrusting; no excrescences. Color variable, burgundy to pink to greenish pink to pinkish green. Perithallus 4-9  $\mu$  wide, 6-11  $\mu$  long; hypothallus lying parallel to surface, 3-6 cells thick, 6-10  $\mu$  wide, 9-23  $\mu$  long. Conceptacles 33-44  $\mu$  wide, 77-110  $\mu$  high.

Habitat: The specimen was growing on substrate beneath soft corals, in a lagoon, 1-2 m deep.

Specimen examined: GDG 116, lagoon, 1-2 m, Cocos Lagoon, IV-27-74.

Remarks: Although found in shallow water, it lacks the excrescences of Archaeolithothamnium erythraeum. Its color is also different and its conceptacles larger.

Genus Leptophytum Adey, 1966Leptophytum sp.

Pl. IV, fig. 1-2; Pl. V, fig 1-2

Description: Encrusting, purple color. Perithallus cells usually square, 3-6  $\mu$  wide, 2-8  $\mu$  high; hypothallus 2-4 cells thick, 3-6  $\mu$  wide, 7-12  $\mu$  long. Conceptacles 110-185  $\mu$  wide, 55-88  $\mu$  high; only bispores seen, (24)29-34  $\mu$  wide, 47-84  $\mu$  long.

Habitat: It was growing in reduced light at the base of dead

Acropora, in Acropora beds on the reef flats.

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.

Remarks: This species has very prominent conceptacles, and all the cells of the perithallus are small. To the author's knowledge this genus has not been previously reported from the tropics, and it has been placed here with some hesitation.

Genus Mesophyllum Lemoine, 1928

Mesophyllum cf. erubescens (Foslie) Lemoine, 1928:252.

Pl. VI, fig. 1; Pl. VII, fig. 1-2

Lithothamnium erubescens Foslie, 1900b:9-10; Foslie, 1904:31, fig. 15-17, pl. 3, fig. 1-25.

Description: Encrusting and forming short rounded branching excrescences. Color purple, often a pale cream color at tips of excrescences where the multipored conceptacles are located. Excrescences branching once or rarely twice, growing up to 10 mm high, 1-5 mm in diameter. Epithallus 6-7  $\mu$  wide, 3-4  $\mu$  high; perithallus 3-8  $\mu$  wide, 5-7  $\mu$  long; hypothallus coaxial, 8-10  $\mu$  wide, 13-19  $\mu$  long. Conceptacles 450-510  $\mu$  wide, 170-200  $\mu$  high; tetraspores 39-62  $\mu$  wide, 170-195  $\mu$  long.

Habitat: The specimens were found growing exposed, 7-40 m deep. In 7 m of water, it was forming nodules up to 3 cm in diameter.

Specimens examined: GDG 152, submarine terrace, 40 m, off Tanguisson Power Plant, Tanguisson Point, V-29-74; GDG 238, submarine terrace,



Remarks: Although not forming branches as densely as those specimens pictured in Foslie's (1904) paper, his description agrees fairly well with the author's specimens.

Subfamily Mastophoroideae (Svedelius) Setchell

Genus Fosliella Howe, 1920

Key to Species:

- |                                     |                     |
|-------------------------------------|---------------------|
| A. Conceptacles 55-101 $\mu$ wide.  | <u>F. lejolisii</u> |
| A. Conceptacles 100-150 $\mu$ wide. | <u>F. farinosa</u>  |

Fosliella farinosa (Lamx) Howe, 1920:587; Taylor, 1950:132; Dawson, 1954:425, fig. 37c; Dawson, 1956:49; Dawson, 1960:30, pl. 21, fig. 1; pl. 22, fig. 1; Masaki, 1968:21.

Pl. VIII, fig. 1-2

Melobesia farinosa Lamouroux, 1816:315.

Description: Pink color, forming thin crusts, growing epiphytically on Enhalus acoroides. Thallus monostromatic, hypothallus vertically and horizontally elongate. Hypothallus 6-14  $\mu$  wide, 12-23  $\mu$  long; heterocysts occurring singly, 14-19  $\mu$  wide, 18-26  $\mu$  long. Conceptacles 100-150  $\mu$  wide, 44-77  $\mu$  high; tetraspores 22-41  $\mu$  wide, 34-58  $\mu$  long.

Specimen examined: GDG 89, epiphytic on Enhalus acoroides, reef flat, 0.2 m, near Pago River, Pago Bay, III-17-74.

Fosliella lejolisii (Rosanoff) Howe, 1920:588; Masaki, 1968:23,  
pl. XII, XLIX, & L.

Pl. IX, fig. 1.

Melobesia lejolisii Rosanoff, 1866:62.

Heterolenia lejolisii (Rosanoff) Foslie, 1909:56; Dawson, 1960:55,  
pl. 50, figs. 4-6.

Description: Pink color, growing epiphytically on Sargassum cristae-  
folium on the reef flat. Perithallic cells 3-4 cells thick around  
conceptacles, 6-7  $\mu$  wide, 6-8  $\mu$  long; thallus commonly monostromatic,  
basal cells oriented vertically or horizontally, 7-9  $\mu$  wide, 7-11  $\mu$   
high; heterocysts occurring singly, 8-12  $\mu$  wide, 10-25  $\mu$  high.  
Conceptacles 55-101  $\mu$  wide, 28-47  $\mu$  high; tetraspores 12-28  $\mu$  wide,  
22-47  $\mu$  long.

Specimen examined: GDG 126, epiphytic on Sargassum cristae-  
folium, reef margin, 0.1 m, Marine Lab, Pago Bay, V-6-74.

Genus Hydrolithon Foslie, 1909

Key to Species:

- |                                     |                      |
|-------------------------------------|----------------------|
| A. Conceptacles 160-250 $\mu$ wide. | <u>H. reinboldii</u> |
| A. Conceptacles 275-365 $\mu$ wide. | <u>H.</u> sp.        |

Hydrolithon reinboldii (W. v. Bosse and Foslie) Foslie, 1909:55;

Dawson, 1954:425, fig. 37b; Dawson, 1960:28, pl. 20, fig. 1-2,  
pl. 21, fig. 2.

Pl. X, fig. 1-2; Pl. XI, fig. 1-2

Lithophyllum reinboldii W. v. Bosse and Foslie, in Foslie  
1901a. Goniolithon reinboldii (W. v. Bosse and Foslie)  
Foslie, 1904:49, fig. 21, pl. 10, fig. 1-6; Johnson, 1957:231,  
pl. 59, fig. 5; Johnson, 1964:26, pl. 13, fig. 5-6, pl. 15,  
fig. 4-6.

Description: Encrusting, excrescences of variable size up to 10 mm high and 10 mm diameter; sometimes forming nodules with excrescences which radiate from center, 3-8 mm diameter, 10-13 mm long. Commonly pale to dark blue, also brown or purple. At times having long ostiole arising from conceptacles. Epithallus 6-8  $\mu$  wide, 3-10  $\mu$  high; perithallus 4-18  $\mu$  wide, 8-22  $\mu$  long; hypothallus 5-20  $\mu$  wide, 11-28  $\mu$  long; heterocysts occurring singly, 10-24  $\mu$  wide, 19-44  $\mu$  long. Conceptacles measuring 160-250  $\mu$  wide, 115-165  $\mu$  high; distinct tetraspores not seen; bispores and degenerate tetraspores (?) present measuring 28-66  $\mu$  wide, 53-109  $\mu$  long.

Habitat: It was found on the reef flat and submarine terrace to depths of 17 m. It is most abundant in the small shallow pools of the outer reef flat where it encrusts the reef substrate or more frequently the small stones to give a nodular appearance.

Specimens examined: GDG 8, submarine terrace, 17 m, Marine Lab, Pago Bay, X-17-73; GDG 15, reef flat, 0.5 m, Marine Lab, Pago Bay, X-18-73; RHR 317B-1, submarine terrace, 7-17 m, S. of Facpi Point, XI-15-73; GDG 242, submarine terrace, 7 m S. of Facpi Point, VIII-1-74.



Remarks: Although many conceptacles were present in vertical sections, tetraspores were never found. Many conceptacles had what appeared to be old, partially decomposed spores, but it was never possible to determine if they had been tetraspores. Bisporos were definitely seen. Specimens collected in May, 1970 were found to have long ostioles protruding from the conceptacle. These had not been noted previously when collecting was done, and probably were broken off soon after they were formed. Their possible significance is not yet known. In vertical sections, the perithallic cells are arranged in a very irregular manner that is distinctive of this species.

Hydrolithon sp.

Description: Encrusting, having a pink color at surface; deep water specimens had purple color in field. Epithallus 3-6  $\mu$  wide, 6-11  $\mu$  high; perithallus 3-8  $\mu$  wide, (4)6-13  $\mu$  long; hypothallus single layer vertically or horizontally oriented 7-19  $\mu$  wide, 7-24  $\mu$  high; heterocysts occurring singly, 9-15  $\mu$  wide, 19-33  $\mu$  high. Conceptacles 275-365  $\mu$  wide, 110-175  $\mu$  high.

Habitat: It was found on the reef margin but growing on the underside of a densely branching Lithophyllum moluccense.

Specimens collected: GDG 122A, reef margin, 0.1 m, Marine Lab, Pago Bay, V-6-74; GDG 151A, submarine terrace, 40 m, off Tanguisson Power Plant, Tanguisson Point, V-29-74; GDG 153D, submarine terrace, 40 m, off Tanguisson Power Plant, Tanguisson Point, V-29-74; GDG 157, submarine terrace, 37 m, leeward barrier reef, Cocos Lagoon, V-30-74.



Remarks: It lacks the excrescences distinctive of H. rainboldii, and its conceptacles are larger.

Genus Lithoporella Foslie, 1909

Key to Species:

- A. Thallus encrusting, crusts loosely overlapping each other; conceptacles 375-500  $\mu$  wide. L. pacifica
- A. Thallus encrusting, each crust tightly overlapping each other; conceptacles 475-612  $\mu$  wide. L. melobesioides

Lithoporella melobesioides Foslie, 1909:58; Masaki, 1968:55,

pl. XXXVIII, pl. LXXXIX, fig. 2-4.

Pl. XII, fig. 1-2

Description: Thin, encrusting, pink or purple color with large conceptacles. Thallus composed of tightly overlapping layers of the large hypothallic cells. Individual layers composed of a hypothallic and an epithallic cell. Epithallic 8-14  $\mu$  wide, 3-6  $\mu$  high; hypothallic 10-20  $\mu$  wide, 17-34  $\mu$  long, vertically and horizontally elongate. Thallus becoming more than two cells thick around the conceptacles. Conceptacles 475-612  $\mu$  wide, 200-315  $\mu$  high.

Habitat: It formed thin crusts at 13 and 42 m.

Specimens examined: GDG 31E, submarine terrace, 13 m, Marine Lab, Pago Bay, XII-10-73; GDG 156, submarine terrace, 40 m, off Tanguisson Power Plant, Tanguisson Point, V-29-74; GDG 169B, submarine terrace, 40 m, Uruno Point, VI-3-74.

Remarks: Although not easily recognized in the field, one can see distinctive fan-shaped layers of new growth on the thallus surface under a low power binocular scope.

Lithoporella pacifica (Heydr.) Foslie, 1909:59; Dawson, 1954:428,  
fig. 40b.

Pl. XIII, fig. 1-2; Pl. XIV, fig. 1

Melobesia pacifica Heydrich, 1901:529

Description: Encrusting and forming thin plates, color pink to dark red, large conical conceptacles. Epithallus 7-21  $\mu$  wide, 6-11  $\mu$  high; perithallus 11-21  $\mu$  wide, 21-26  $\mu$  long; hypothallus 22-33  $\mu$  wide, 36-52  $\mu$  long. Perithallus only around conceptacles, thallus normally consisting of monostromatic hypothallus with epithallus. Conceptacles 375-500  $\mu$  wide, 180-325  $\mu$  high.

Habitat: It was growing under the spurs along the reef front, 2 m deep and under corals along the reef front.

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 Point, VII-22-74.

Remarks: The loosely attached thin pink crust and large conceptacles distinguish this species from all others.

Genus Neogoniolithon Setchell and Mason, 1943

Key to Species:

A. Thallus encrusting.

B.

- C. Heterocysts in vertical columns of 5-18 cells; conceptacles 819-988  $\mu$  wide. N. fosliei
- C. Heterocysts occurring singly; conceptacles 300-480  $\mu$  wide. Neogoniolithon sp. 2
- B. Hypothallus not coaxial. D.
- D. Heterocysts in vertical columns of 1-7 cells; conceptacles 80-260  $\mu$  wide. Neogoniolithon sp. 1
- D. Heterocysts occurring singly. Conceptacles 450-640  $\mu$  wide. N. myriocarpum
- A. Thallus branching. E.
- E. Branches short, less than 1 cm. Neogoniolithon sp. 3
- E. Branches longer than 1 cm. N. frutescens

Neogoniolithon fosliei (Heydr.) Setchell and Mason, 1943:90.

Pl. XV, fig. 1-2

Goniolithon fosliei (Heydr.) Foslie, 1904:46; Johnson, 1964:25.

Lithothamnium fosliei Heydrich, 1897a:58.

Lithophyllum fosliei Heydrich, 1897b:410.

Description: Thallus forming large pale blue or grey patches, often has large conspicuous conceptacles. In the field the epithallus often is seen flaking off in thin sheets. Perithallus with many fusions of 2-3 cells, 6-13  $\mu$  wide, 9-20  $\mu$  long; coaxial hypothallus 11-17  $\mu$  wide, 19-39  $\mu$  long; heterocysts in vertical columns 5-18 per column, 24-31  $\mu$  wide, 11-20  $\mu$  high. Conceptacles 819-988  $\mu$  wide, 295-351  $\mu$  high.



Habitat: This species can be found encrusting reef substrate on the reef flats and to depths of 37 m.

Specimens examined: GDG 7, submarine terrace, 17 m, Marine Lab, Pago Bay, X-17-73; GDG 86, reef flat, 1.5 m NE of Pago River, Pago Bay, III-17-74; GDG 158, submarine terrace, 37 m, leeward side of Cocos Lagoon, VI-30-74; GDG 233, submarine terrace, 7 m, SW side of Anae Island, VIII-1-74.

Neogoniolithon frutescens (Foslie) Setchell and Mason, 1943:91.

Pl. XVI, fig. 1-2; Pl. XVII, fig. 1

Goniolithon frutescens Foslie, 1900c:9; Foslie, 1904:53, pl. 10, figs. 10-11; Taylor, 1950:123, pl. 58-60; Johnson, 1957:231, pl. 59, fig. 4, pl. 60, fig. 3; Johnson, 1964:25; Lee, 1967:988, pl. 2, 3.

Description: Encrusting with short slender branches, at times forming nodules with the branches radiating out in all directions from a central point. Pink to cream color, commonly having conceptacles borne at tips of the branches. Epithallus 7-15  $\mu$  wide, 4-11  $\mu$  high; perithallus cells often fused, 9-14  $\mu$  wide, 8-24  $\mu$  long; coaxial hypothallus 8-13  $\mu$  wide, 15-31  $\mu$  long; heterocysts found singly or occasionally in short vertical rows of 2-4 cells, 23-30  $\mu$  wide, 31-50  $\mu$  high. Conceptacles 490-676  $\mu$  wide, 210-376  $\mu$  high; tetraspores 72-73  $\mu$  diameter, 125-160  $\mu$  long.

Habitat: It was growing on reef flats, commonly in areas having strong currents. It was also common in areas having silty conditions or sandy bottoms, 0.1-1 m deep.



Specimens collected: 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, 0.2 m, off Coral Reef Enterprises, Asan Bay, VII-14-74.

Neogoniolithon myriocarpum (Foslie) Setchell and Mason, 1943:90;

Dawson, 1954:428, fig. 39b; Womersley and Bailey, 1970:311.

Pl. XVIII, fig. 1-2

Lithothamnion myriocarpum Foslie, 1897:19.

Goniolithon myriocarpum Foslie, 1904:45, pl. 9, figs. 6, 7.

Description: Encrusting, cream color in shallow water, pink to purple in deep water. Perithallic cells commonly fused. Epithallus 10-13  $\mu$  wide, 3-7  $\mu$  high; perithallus 7-14  $\mu$  wide, 8-22  $\mu$  long; hypothallus not coaxial, 1-6 cells thick, 8-18  $\mu$  wide, 17-30  $\mu$  long; heterocysts occurring singly, 18-23  $\mu$  wide, 33-37  $\mu$  long. Conceptacles 450-640  $\mu$  wide, 155-236  $\mu$  high; tetraspore (?) 37  $\mu$  wide, 80  $\mu$  long.

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 terrace, 40 m, Uruno Point, VI-3-74.

Neogoniolithon sp. 1

Pl. XIX, fig. 1-2

Description: Encrusting substrate, dark red to reddish brown color. Epithallus 9-10  $\mu$  wide, 8-10  $\mu$  high; perithallus 3-7  $\mu$  wide, 4-9  $\mu$  long; hypothallus horizontally elongate, not coaxial, 5-9 cells thick

6-14  $\mu$  wide, 11-28  $\mu$  long; heterocysts in vertical columns of 1-7 cells  
7-11  $\mu$  wide, 6-13  $\mu$  high. Conceptacles 80-260  $\mu$  wide, 64-125  $\mu$  high;  
tetraspores 18-31  $\mu$  wide, 45-69  $\mu$  long.

Habitat: All but one were found on the reef flat under rocks and substrate so that they never received direct sunlight, 0.1-0.5 m deep.

One specimen was found growing exposed at 40 m.

Specimens examined: GDG 11, reef flat, 0.5 m, intake channel, Marine Lab, Pago Bay, II-26-74; GDC 153B, submarine terrace, 40 m, off Tanguisson Power Plant, Tanguisson Point, V-29-74.

Remarks: This species has heterocysts in short vertical columns, but lacks a coaxial hypothallus. These characteristics together with its smaller conceptacles distinguish it from any of the other species in the genus.

Neogoniolithon sp. 2

Pl. XX, fig. 1-2; Pl. XXI, fig. 1-2; Pl. XXII, fig. 1

Description: Encrusting and sometimes forming excrescences; color varies with light intensity, cream to pink to dark red. Perithallus 3-13  $\mu$  wide, 3-17  $\mu$  long; hypothallus usually coaxial 6-13  $\mu$  wide, 8-33  $\mu$  long; heterocysts occurring singly, 8-21  $\mu$  wide, 4-37  $\mu$  high. Conceptacles 300-480  $\mu$  wide, 110-240  $\mu$  high; tetraspores 21-61  $\mu$  wide, 63-120  $\mu$  long.

Habitat: Range of distribution is highly variable but reduced light intensity is a common denominator of all locations. It was found

along the reef spurs, on the reef flat on the underside of rocks, in a lagoon under soft corals, and in 40 m of water.

Specimens examined: GDG 36, submarine terrace, 7 m, Marine Lab, Pago Bay, XII-10-73; GDG 64, base of reef spurs, 2.5 m, Marine Lab, Pago Bay, I-15-74; GDG 115, lagoon, 2 m, Cocos Lagoon, IV-27-74; GDG 118, lagoon, 2m, Cocos Lagoon, IV-27-74; GDG 117, lagoon, 2 m, Cocos Lagoon, IV-24-74; GDG 169C, submarine terrace, 40 m, Urunc Point, VI-3-74.

Remarks: Heterocysts were only found occurring singly on the surface. It is separated from the other species of Neogeniolithon on the basis of its conceptacle size.

Neogeniolithon sp. 3

Pl. XXII, fig. 2

Description: Encrusting and having short rounded branches, branching once, occasionally twice. Pale to dark pink color. Having single pored conceptacles, but slightly raised and not conspicuous. Cell fusions of hypothallic and perithallic cells. Epithallus 3-6  $\mu$  wide, 3-6  $\mu$  high; perithallus 4-8  $\mu$  wide, 6-11  $\mu$  long; hypothallus coaxial, 6-8  $\mu$  wide, 11-18  $\mu$  long; heterocysts 13-31  $\mu$  wide, 17-33  $\mu$  long, are scattered singly throughout perithallus. Conceptacles 260-370  $\mu$  wide, 110-150  $\mu$  high; tetraspore 83  $\mu$  wide, 120  $\mu$  long.

Habitat: It was found growing exposed at 40 m.

Specimens examined: GDG 153A, submarine terrace, 40 m, off Tanguisson Power Plant, Tanguisson Point, V-29-74; GDG 166A, submarine terrace,



Remarks: Its short branches and conceptacle size separate it from the other species of Neogoniolithon.

Genus Porolithon Foslie, 1909

Key to Species:

A. Heterocysts in plates of 6-11 cells; conceptacles 130-315  $\mu$  wide.

P. onkodes

A. Heterocysts in plates of 2-5 cells; conceptacles 110-150  $\mu$  wide.

Porolithon sp.

Porolithon onkodes Foslie, 1909:57; Taylor, 1950:125, pl. 9,

fig. 61-63; Johnson, 1957:232-233, pl. 55, fig. 6-7, pl. 59,

fig. 6; Johnson, 1964:23-24; Lee, 1967:991, pl. 4, 5.

Pl. XXIII, fig. 1-2, Pl. XXIV, fig. 1-2

Lithothamnium onkodes Heydrich, 1897c:6.

Lithophyllum onkodes (Heydr.) Heydrich, 1897b:410.

Lithophyllum (subgenus Porolithon) onkodes (Heydr.)

Heydrich; Foslie, 1906:25.

Description: Thallus crustose. Color variable: purple, light to dark brown, orangish brown, pinkish orange, yellow or red, pink, reddish pink, and red; purple and pink forms predominate. The heterocyst plates give a distinctive pox-like appearance to the thallus surface when fresh. Usually having many small conceptacles.

Epithallus 6-9  $\mu$  wide, 2-6  $\mu$  high; perithallus 3-12  $\mu$  wide, 4-12  $\mu$  long; hypothallus 6-17  $\mu$  wide, 9-27  $\mu$  long; heterocysts in horizontal plates of 6-11 cells, 7-19  $\mu$  wide, 10-33  $\mu$  long. Conceptacles oval to subreiniform, 130-315  $\mu$  wide, 83-175  $\mu$  high; tetraspores 15-37  $\mu$



Habitat: This species grows most abundantly on the reef margin, but is also found encrusting raised substrate on the reef flats. On the submarine terrace it has been found to depths of 13 m.

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 31A, submarine terrace, 13 m Marine Lab, Pago Bay, XI-10-73; GDG 63, reef margin, intertidal, Marine Lab, Pago Bay, I-15-74.

Porolithon sp.

Pl. XXV, fig. 1-2; Pl. XXVI, fig. 1.

Description: Encrusting, purple, having small conceptacles, Epi-thallus 3-7  $\mu$  wide, 3-6  $\mu$  high; perithallus 4-7  $\mu$  wide, 4-12  $\mu$  long; hypothallus 6-10  $\mu$  wide, 6-17  $\mu$  long; heterocysts in plates of 2-5 cells, 8-9  $\mu$  wide, 13-20  $\mu$  long. Conceptacles 135-145  $\mu$  wide, 99-125  $\mu$  high; tetraspores 28-37  $\mu$  wide, 39-58  $\mu$  long.

Habitat: It was found on rocks along rocky near-shore areas. Often it withstands prolonged exposure to sun during low tides with little adverse effect.

Specimens examined: GDG 10, inner reef flat, intertidal, Marine Lab, Pago Bay, X-19-73; GDG 80, inner reef flat, 0.1 m, S. side of Ylig Bay, III-10-74; GDG 226, inner reef flat, 0.1 m, S. side of Ylig Bay, IV-14-74.

Remarks: This species is a characteristic purple color in contrast

having a thinner thallus, smaller conceptacles, fewer heterocysts in the heterocyst plates, and a slightly smaller cell size. It is found only in a very restricted habitat.

Genus Pseudolithophyllum Lemoine, 1913

The three species found are characterized by their thin thallus composed of a multi-layered hypothallus having a loose cell structure, and a perithallus as thick as the hypothallus. Both the hypothallic and perithallic cells are quite small. There is some hesitation about placing them in this genus because it is considered to be primarily an antarctic genus.

Key to Species:

- A. Thallus encrusting and forming thin plate-like crusts; conceptacles 260-350  $\mu$  wide. Pseudolithophyllum sp. 1
- A. Thallus encrusting only, not forming plate-like crusts.
- B.
- B. Conceptacles 350-598  $\mu$  wide. Pseudolithophyllum sp. 2
- B. Conceptacles 180-210  $\mu$  wide. Pseudolithophyllum sp. 3

Pseudolithophyllum sp. 1

Pl. XXVII, fig. 1; Pl. XXVIII, fig. 1

Description: Encrusting and forming thin plate-like crusts. Dark red to purple color. Also forming a continuous series of bright pink plates giving a rose-like appearance, the plates corresponding to the flower petals. Small (10 cm) to massive (over 50 cm). Conceptacles rather inconspicuous on the plates. Hypothallus 4-6 cells thick, as thick as the perithallus. Perithallic cells 2-6  $\mu$  wide,

3-9  $\mu$  long; hypothallus not coaxial, horizontally elongate, 4-8  $\mu$  wide, 9-18  $\mu$  long. Conceptacles 260-350  $\mu$  wide, 130-190  $\mu$  high; tetraspore (?) 40  $\mu$  wide, 100  $\mu$  long.

Habitat: It was found on the reef flat, but only in dense shade under rocks or shaded pools. It was growing exposed at 40 m.

Specimens examined: GDG 27A, wave washed benches, 0.2 m, Marine Lab, Pago Bay, XII-2-73; GDG 123, reef flat, 0.1 m, Marine Lab, Pago Bay, V-6-74; GDG 153C, submarine terrace, off Tanguisson Power Plant, Tanguisson Point, V-29-74.

Remarks: The many thin plates rising up from the substrate distinguish this species from Pseudolithophyllum sp. 2 and sp. 3, and from any other species on Guam.

Pseudolithophyllum sp. 2

Pl. XXIX, fig. 1

Description: Encrusting, cream to pink color, having many conical conceptacles. Perithallus 3-4  $\mu$  wide, 4-7  $\mu$  long; hypothallus 4-6 cells thick, as thick as the perithallus, not coaxial, horizontally elongate, 3-6  $\mu$  wide, 8-13  $\mu$  long. Conceptacles 390-598  $\mu$  wide, 175-275  $\mu$  high.

Habitat: It was growing on shaded substrate at the base of soft corals in the lagoon 2 m deep.

Specimen examined: GDG 119, lagoon, 2 m, Cocos Lagoon, IV-27-74.



Remarks: This is an encrusting species; its color and larger conceptacle size distinguish it from Pseudolithophyllum sp. 3.

Pseudolithophyllum sp. 3

Pl. XXX, fig. 1-2

Description: Encrusting having distinct pale green color. Perithallus 4-7  $\mu$  wide, 4-7  $\mu$  long; hypothallus 4-6 cells thick, as thick as the perithallus, not coaxial, cells horizontally elongate, 2-8  $\mu$  wide, 6-18  $\mu$  long. Conceptacles 180-210  $\mu$  wide, 75-110  $\mu$  high.

Habitat: It was growing on shaded substrate at the base of soft corals in the lagoon 2 m deep.

Specimen examined: GDG 114, lagoon, 2 m, Cocos Lagoon, IV-27-74.

Remarks: The small conceptacle size and pale green color distinguish this species from the other species in the genus.

Subfamily Lithophylloideae Setchell.

Genus Lithophyllum Philippi, 1837

Key to Species:

A. Thallus encrusting, with no excrescences nor branches.

L. cf. yendoi

A. Thallus encrusting and forming branches or excrescences.

B.

B. Thallus forming excrescences, no branches.

L. cf. okanauri

B. Thallus forming branches, no excrescences.



C. Thallus forming short branches; conceptacles 315-405  $\mu$  wide. L. cf. trichotum

C. Thallus forming extensive branches; conceptacles 145-310  $\mu$  wide. D.

D. Branches never pointed at tips, tending to be fused and rounded sometimes nearly cylindrical, other times broad and flat; conceptacles 250-310  $\mu$  wide.

L. kotschyanum

D. Branches more pointed at tips; conceptacles 145-270  $\mu$  wide. L. moluccense

Lithophyllum kotschyanum (Unger) Foslie, 1909:34; Johnson, 1957:230, pl. 57, fig. 1, pl. 58, fig. 1; Johnson, 1964:21, pl. 14, fig. 1-2, pl. 15, fig. 3.

Pl. XXXI, fig. 1-2; Pl. XXXII, fig. 1-2

Lithophyllum madagascarense Heydrich, 1902:473.

Description: Stoutly branched, branches often branching only in one plane, fusing at the base, and tending to do so at the tips. Color pink if growing exposed, more commonly purple. Epithallus 6-9  $\mu$  wide, 3-6  $\mu$  long; perithallus 4-11  $\mu$  wide, 7-28  $\mu$  long; hypothallus 8-12  $\mu$  wide, 13-20  $\mu$  long. Conceptacles 250-310  $\mu$  wide, 80-130  $\mu$  long.

Habitat: It was growing in areas not receiving heavy surf along the reef front to a depth of 4 m. It was found in 23 m of water on Saipan.

Specimens examined: GDG 25, reef front, 3 m, Double Reef, XI-15-73; GDG 161, reef front, 0-4 m, Mimitz 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.

Lithophyllum moluccense Foslie, 1901b:24; Foslie, 1904:67, pl. 12; Johnson, 1957:230, pl. 54, fig. 2-5; Johnson, 1964:21, pl. 13, fig. 1, 3.

Pl. XXXIII, fig. 1-2; Pl. XXIV, fig. 1, Pl. XXXV, fig. 1;

Pl. XXXVI, fig. 1; Pl. XXXVII, fig. 1-2

Description: Thallus strongly branching. Pink to red to purple depending upon light intensity. Epithallus 7-9  $\mu$  wide, 6-9  $\mu$  high; perithallus 6-11  $\mu$  wide, 8-23  $\mu$  long; hypothallus coaxial with alternating rows of one long and one or two short cells, long cells 6-17  $\mu$  wide and 33-52  $\mu$  long, short cells 6-11  $\mu$  wide, 6-24  $\mu$  long. Conceptacles borne on sides of branches, 145-195  $\mu$  wide, 43-96  $\mu$  high; tetraspores 13-26  $\mu$  wide, 30-57  $\mu$  long.

Specimens examined: GDG 1, submarine terrace, 10 m, Marine Lab, Pago Bay, X-17-73; GDG 22, submarine terrace, 27 m, Marine Lab, Pago Bay, X-19-73; GDG 83, reef flat, 1.5 m, NE of Pago River, 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 209, reef flat, 0.1 m, Marine Lab, Pago Bay, VI-24-74; GDG 235, submarine terrace 7 m, 200 m SW of Anae Island, VIII-1-74; GDG 236, reef front, 3 m, 200 m

SW of Anac Island, VIII-1-74; GDG 241, reef front, 2 m; E of Cabras Island, Piti Bay, VIII-7-74.

Remarks: 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 author feels 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 Pls. XXXVII-XL) 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. kotschyranum is the only other branching Lithophyllum found on Guam, but it was not considered a reasonable species for any of these types. There are two reasons, its conceptacle size is larger, and specimens of L. kotschyranum can be found growing in the same habitats as some of these algae, 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.



Lithophyllum cf. okamuri Foslie, 1900d:4; Foslie, 1904:59, pl. 11, figs. 13-19; Dawson, 1954:427, fig. 39a; Masaki, 1964:35, pl. LXII, fig. 6.

Pl. XXXVIII, fig. 1

Description: Encrusting with a warty appearance due to excrescences 1-2 mm in diameter and 1-2 mm high. Color varies with exposure, yellow-green in light, burgandy where shaded. Perithallus 3-13  $\mu$  wide, 7-30  $\mu$  long; hypothallus 1-8 cells thick, 7-11  $\mu$  wide, 10-22  $\mu$  long. Conceptacles 89-140  $\mu$  wide, 88-110  $\mu$  high; tetraspores 19-28  $\mu$  wide, 47-60  $\mu$  long.

Habitat: Encrusting substrate and rocks on outer reef flat where water still remains at low tide, 0.1 m deep.

Specimen examined: GDG 75, outer reef flat, 0.1 m, Marine Lab, Pago Bay, II-26-74.

Remarks: The author has some hesitation in assigning this species here because the conceptacles tend to be smaller than those reported by Dawson (1954) and Masaki (1968).

Lithophyllum cf. trichotum (Heydr.) Lemoine, 1929:45; Dawson, 1944:267, pl. 55, fig. 2, pl. 58, figs. 1, 4-6, pl. 60; Dawson, 1954:426, fig. 38d; Dawson, 1960:51; pl. 44, fig. 2-3, pl. 45, fig. 1-2, pl. 46.

Pl. XXXIX, fig. 1-2

Lithothamnion trichotum Heydrich, 1901:538

Neogoniolithon trichotum (Heydr.) Setchell & Mason, 1943:92.

Description: Encrusting and forming short branches, pinkish cream color. Epithallus 7-9  $\mu$  wide, 2-3  $\mu$  high; perithallus 7-10  $\mu$  wide, 4-12  $\mu$  long; hypothallus horizontally oriented, 1-2 cells thick in encrusting portion of thallus, 7-12  $\mu$  wide, 8-23  $\mu$  long. Conceptacles 315-405  $\mu$  wide, 100-125  $\mu$  high.

Habitat: Encrusting the tips of dead Acropora on the reef flat, 0.5 m deep.

Specimen examined: GDG 131B, reef flat, 0.5 m, Hilton Beach area, Tumon Bay, V-15-74.

Remarks: The specimen agrees fairly well in conceptacle size and the manner of branching with Dawson's (1954) specimens. There is some hesitation because these characteristics are not in good agreement with his 1944 specimens.

Lithophyllum cf. yendoii Foslie, 1900e:20; 1904:61, pl. 11, figs. 1-4; Masaki, 1968:41, pl. XXIV, fig. 1 & 6, XXV, pl. LXV, figs. 3-6, pl. LXVI.

Pl. XL, fig. 1

Description: Encrusting, color orange-brown where exposed, purple where shaded. Epithallus 3-6  $\mu$  wide, 5-8  $\mu$  long; perithallus 3-13  $\mu$  wide, 7-30  $\mu$  long; hypothallus often palisade and having fused cells, 5-22  $\mu$  wide, 15-31  $\mu$  long. Conceptacles reniform, 156-253  $\mu$  wide, 78-105  $\mu$  high; tetraspores 18-37  $\mu$  wide, 41-69  $\mu$  long.

Habitat: Found in pools of wave washed benches, 0.1 m deep.

Specimens examined: GDG 29, wave washed bench, 0.1 m. Marine Lab, Pago Bay, XII-27-73; GDG 14, intake channel on reef flat, 0.5 m, Marine Lab, Pago Bay, X-19-73.

Remarks: The conceptacle size agrees well with Masaki's (1968) specimens, but there is some discrepancy because other characteristics seem to be different.



## DISTRIBUTION

Distribution of the crustose Corallinaceae is highly variable from species to species. Some are found from the reef flats to water 40 m in depth, while others are quite restricted in their distribution (Fig. 1). The variability of habitat found on the reef flats further complicates the situation since light intensity seems to be one controlling factor in algal distribution. Species found under rocks and in holes on the reef flat and shallow water are found similarly growing exposed in deeper water.

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 Archaeolithothamnium erythraeum, Hydroolithon reinboldii, Lithophyllum moluccense, Necgoniolithon fosliei, N. frutescens, Porolithon onkodes, and Porolithon sp. In addition, Pseudolithophyllum sp. 1 can be found in very specialized habitats (under large rocks), but is typically a deep water species. All of these species have also been found beyond the reef margin in deeper water with the exception of N. frutescens. These various species are usually most dominant in a specific habitat on the reef flat, although not necessarily limited to that habitat. In terms of overall distribution on the reef flat, H. reinboldii and P. onkodes are probably the most abundant over the widest range of habitats.

On the reef flat, Porolithon sp. 1 can often be found growing intertidally near shore. It is purple in color and grows on rocks and hard substrate in exposed situations. It can also be found on

Species	Depth in Meters				
	0	10	20	30	40
<u>Archaeolithothamnium erythraeum</u>	-----				
<u>A. sp. 1</u>					---
<u>A. sp. 2</u>	---				
<u>Fosliella farinosa</u>	---				
<u>F. lejolisii</u>	---				
<u>Hydrolithon reinboldii</u>	-----				
<u>H. sp.</u>	-----				
<u>Leptophytum sp.</u>	---				
<u>Lithophyllum moluccense</u>	-----				
<u>L. kotchyanum</u>	-----				
<u>L. cf. okamuri</u>	---				
<u>L. cf. trichotum</u>	---				
<u>L. cf. yendoi</u>	---				
<u>Lithoporella melobesoides</u>		-----			
<u>L. pacifica</u>	-----				
<u>Mesophyllum cf. erubescens</u>		-----			
<u>Neogeniolithon fosliei</u>	-----				
<u>N. frutescens</u>	---				
<u>N. myriocarpum</u>	-----				
<u>N. sp. 1</u>	-----				
<u>N. sp. 2</u>	-----				
<u>N. sp. 3</u>					-----
<u>Pseudolithophyllum sp. 1</u>	-----				
<u>P. sp. 2</u>	---				
<u>P. sp. 3</u>	---				

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

Table 1. Zonational occurrences 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 terrace (20-40 m.)	Cocos Lagoon wave washed benches
<u>Archaeolithothamnium erythraeum</u>	X	X			X		
<u>A. sp. 1</u>						X	
<u>A. sp. 2</u>							X
<u>Fosliella farinosa</u>	X						
<u>F. lejolisii</u>	X	X					
<u>Hydrolithon reinboldii</u>	X	X			X		X
<u>H. sp.</u>			X			X	
<u>Leptophytum sp.</u>	X						X
<u>Lithophyllum moluccense</u>	X	X	X	X	X	X	X
<u>L. kotschyannum</u>				X		X	
<u>L. cf. okamurai</u>	X						
<u>L. cf. trichotum</u>		X					
<u>L. cf. yendoii</u>							X
<u>Lithoporella melobesoides</u>					X	X	
<u>L. pacifica</u>				X	X		



Table 1. Continued.

	inner reef flat	outer reef flat	reef margin	reef front	submarine terrace (to 20 m)	submarine terrace (20-40 m)	Cocos Lagoon wave washed benches
<u>Mesophyllum erubescens</u>					X	X	
<u>Neogoniolithon fosliei</u>	X	X		X	X	X	X
<u>N. frutescens</u>	X	X					
<u>N. myriocarpum</u>						X	X
<u>N. sp. 1</u>		X				X	
<u>N. sp. 2</u>		X		X	X	X	X
<u>N. sp. 3</u>						X	
<u>Porolithon onkodes</u>	X	X	X	X	X		X X
<u>P. sp. 1</u>	X						
<u>Pseudolithophyllum sp. 1</u>		X				X	
<u>P. sp. 2</u>							X
<u>P. sp. 3</u>							X

undercut ledges and rocks where it is not as exposed to direct sunlight. It seems to be uniquely adapted to withstand partial desiccation and high temperatures. Although P. onkodes has often been noted for its similar ability in this regard, it is usually washed intermittently by waves and if this does not happen it can die (Littler, 1973a). Porolithon sp. 1 is normally exposed for four hours or more during the summer low tides. Algae receiving direct sunlight die, but if partially shaded by overhanging rock, much of the thallus lives. In exposed areas, other filamentous algae will often overgrow it, thus retaining moisture and offering shade from direct sunlight, allowing it to survive until the low tides occur during the nights. At this time, Porolithon sp. re-establishes itself and the filamentous algae disappear. Desiccation seems to be the critical factor. If the thallus surface is not totally dried out, then the alga survives.

Hydrolithon reinboldii 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 substrate for growth; it is found on rubble in the moat areas. H. reinboldii is also found on the shallow (17 m deep) submarine terrace.

Archaeolithothamnium erythraeum is found on the outer and inner reef flat encrusting the bottom substrate. Patches of it are usually

large (10-20 cm in diameter), but few in number. Like H. 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. A. erythraeum has also been found as nodules in 7 m of water.

Neogoniclithon frutescens is distributed on the inner and outer reef flat, but grows more abundantly on the inner reef flat. It is found on reef substrate in areas having high sedimentation and also on sandy bottom areas having a strong current where it grows on Acropora fragments and other available substrate. 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 could easily bury an encrusting species. Often, specimens are found partially buried in the sand, but superficially they appear healthy. If N. frutescens has adapted for this type of habitat, it 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.

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. The variability of growth forms of



in the area of the 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.

The pale blue or grey color of Neogoniolithon foslii, and its large conical conceptacles make it very distinctive. It can be found encrusting inner or outer reef flats provided there is solid substrate 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 terrace (5-13 m) area that normally lacks any surf. Usually it is found in patches 10 to 20 cm or more in diameter, and characteristically has a loose outer layer of epithallic cells which are sloughed off in the field.

Porolithon onkodes is commonly associated with the reef margin where it is the dominant organism. P. onkodes is also found on the inner and outer reef flats. It seems to prefer standing Acropora or other elevated or exposed substrate of the inner reef flat where it can receive good water circulation. It will encrust small rocks and substrate 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.

Pseudolithophyllum sp. 1 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.

Many of the algae from deeper water are encrusting, and only in sectioning do their individual characteristics appear. With increasing water depth, color usually becomes meaningless in the field in trying to identify species. The following species usually have characteristic growth forms in the field which make identification possible.

The very fragile Lithoporella pacifica can be found along the reef front growing under corals and in other situations of reduced light. 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. L. melopesoides has been found in deeper water up to 40 m. It forms thin crusts which adhere tightly to each other.

Lithophyllum kotschyannum 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 only a shallow water species. Its branches are rounded and commonly flattened.

## CONCLUSIONS

Although 27 species of crustose coralline algae have been found on Guam, the number of species that seem to predominate 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 distribution range from the reef flat to the submarine terrace (14 m). Hydrolithon reinboldii, Neogoniolithon frutescens, and Archaeolithothamnium erythracum are most abundant on the reef flat. On the submarine terrace above 30 m, Neogoniolithon foşliei and Lithophyllum moluccense along with P. onkodes and H. reinboldii are the most common species.

In terms of the number of different species found on Guam, Archaeolithothamnium, Lithophyllum, Neogoniolithon, and Pseudolithophyllum are the dominant genera. Porolithon is considered a tropical genus (Adey and Macintyre, 1973), but only two species were found on Guam. Taylor's (1950) work at Bikini, where five species were found, would indicate that Porolithon also constitutes an important genus elsewhere in the Pacific in terms of numbers of species.



## LITERATURE CITED

- Adey, W. H. 1966. The genera Lithothamnium, Leptophytum (nov. gen.) and Phymatolithon in the Gulf of Maine. *Hydrobiologia* 27:321-370.
- \_\_\_\_\_. 1970. A revision of the Foslie crustose coralline herbarium. *K. Norske Vidensk. Selsk. Skr.* 1970(1):1-46.
- Adey, W. H., and I. G. Macintyre. 1973. Crustose coralline algae: A re-evaluation in the Geological Sciences. *Geol. Soc. Amer. Bul.* 84:883-904.
- Dawson, E. Y. 1944. The marine algae of the Gulf of California. *A. Hancock Pac. Exped.* 3(10):139-454.
- \_\_\_\_\_. 1954. Marine plants in the vicinity of Nha Trang, Viet Nam. *Pac. Sci.* 8(4):372-470.
- \_\_\_\_\_. 1956. Some marine algae of the southern Marshall Islands. *Pac. Sci.* 10(1):25-66.
- \_\_\_\_\_. 1957. An annotated list of marine algae from Eniwetok Atoll. *Pac. Sci.* 11(1):92-132.
- \_\_\_\_\_. 1960. Marine red algae of Pacific Mexico. Part 3. Cryptoneemiales Corallinaceae Subf. Melobesiodeae. *Pac. Nat.* 2(1):1-125.
- Foslie, M. H. 1897. On some Lithothamnium. *K. Norske Vidensk. Selsk. Skr.* 1897(1):1-20.
- \_\_\_\_\_. 1900a. The Lithothamnium of the Maldives and Laccadives. p. 460-471, pls. 24-25. In J. S. Gardner (ed.), *The Fauna and Geography of the Maldivian and Laccadive Archipelagoes*. Cambridge.
- \_\_\_\_\_. 1900b. New or critical calcareous algae. *K. Norske Vidensk. Selsk. Skr.* 1899(5):1-34.
- \_\_\_\_\_. 1900c. Calcareous algae from Funafuti. *K. Norske Vidensk. Selsk. Skr.* 1900(1):1-12.
- \_\_\_\_\_. 1900d. Five new calcareous algae. *K. Norske Vidensk. Selsk. Skr.* 1900(3):1-6.
- \_\_\_\_\_. 1900e. Revised systematical survey of the Melobesiaceae. *K. Norske Vidensk. Selsk. Skr.* 1900(5):1-22.

- Foslie, M. H. 1901a. Three new Lithothamnium. Kgl. Norske Vidensk. Selsk. Skr. 1901(1):1-5.
- \_\_\_\_\_. 1901b. New Melobesiaceae. K. Norske Vidensk. Selsk. Skr. 1900(6):1-24.
- \_\_\_\_\_. 1904. Lithothamnionaceae, Melobesiaceae, Mastophoraceae. In A. Weber van Bosse and H. Foslie, The Corallinaceae of the Siboga-Expedition. 61:10-77. E. J. Brill, Leiden.
- \_\_\_\_\_. 1906. Algologiske Notiser. II. K. Norske Vidensk. Selsk. Skr. 1906(2):3-28.
- \_\_\_\_\_. 1909. Algologiske Notiser. VI. K. Norske Vidensk. Selsk. Skr. 1909(2):1-63.
- \_\_\_\_\_. 1929. Contributions to a monograph of the Lithothamnium, edited by H. Printz. Kongelige Norske Videnskabers Museet. Trondheim. 66 p.
- Heydrich, F. 1897a. Corallinaceae, insbesondere Melobesiaceae. Ber. Deutsch Bot. Ges. 15:34-70, text-figs. 1-3, pl. 3.
- \_\_\_\_\_. 1897b. Melobesiaceae. Ber. Deutsch Bot. Ges. 15:403-420.
- \_\_\_\_\_. 1897c. Neue Kalkalgen von Deutsch-Neu-Guinea. Bibliothec. Bot. 7(41):1-11, pl. 1.
- \_\_\_\_\_. 1901. Die Lithothamnien des Museum d'Histoire Naturelle in Paris. Bot. Jahrb. (Engler) 28:529-545.
- \_\_\_\_\_. 1902. Sur quelques nouvelles Mélobésiées du Muséum de Paris. Mus. Hist. Nat. Paris, Bull. 8:473-476.
- Howe, M. A. 1920. Class 2. Algae. p. 553-618. In W. L. Britton and C. F. Millspagh, the Bahama Flora. vii + 695 p. Published by the authors, New York.
- Johnson, J. H. 1957. Geology of Saipan, Mariana Islands. Part 3. Calcareous algae. U. S. Geol. Surv. Prof. Pap. 280-E:209-246.
- \_\_\_\_\_. 1964. Fossil and recent calcareous algae from Guam. U. S. Geol. Surv. Prof. Pap. 403-C:1-40.
- Lamouroux, J. V. 1816. Histoire des polypiers coralligènes flexibles..lxxxiv + 559 p., 19 pls. F. Poisson, Caen.
- Lee, R. K. S. 1967. Taxonomy and distribution of the melobesioid algae on Rongelap Atoll, Marshall Islands. Can. J. Bot. 45:985-1001.
- Lemoine, M. 1913. Mélobésiées, IIe Exp. Ant. Française. 1908-1910. Paris, Masson. 67 p.

- Lemoine, M. 1928. Un nouveau genre de Mélobésiées: Mesophyllum.  
Bull. Soc. Bot. Fr. 4:251-254.
- \_\_\_\_\_. 1929. Les Corallinacees de l'Archipel des Galapagos et  
du Golfe de Panama. Mus. Hist. Nat. Paris, Arch. 6(4):37-88.
- Littler, M. M. 1972. The crustose Corallinaceae. Oceanogr. Mar.  
Bio. Ann. Rev. 10:311-347.
- \_\_\_\_\_. 1973a. The population and community structure of  
Hawaiian fringing-reef crustose Corallinaceae (Rhodophyta,  
Cryptonemiales). J. Exp. Mar. Biol. Ecol. 11:103-120.
- \_\_\_\_\_. 1973b. The distribution, abundance, and communities  
of deepwater Hawaiian crustose Corallinaceae (Rhodophyta,  
Cryptonemiales). Pac. Sci. 27(3):281-289.
- Masaki, T. 1968. Studies on the Melobesiodideae of Japan. Mem.  
Fac. Fish., Hokkaido Univ. 16:1-80.
- Philippi, R. H. 1837. Beweis, dass die Nulliporen Pflanzen sind.  
p. 387-388. In A. F. A. Wiegmann (ed.), Archiv. für Natur-  
geschichte. 3rd Set, 1.
- Rosanoff, S. 1866. Recherches anatomiques sur les Mélobésiées  
(Hapalidium, Melobesia, Lithophyllum et Lithothamnium). Mem.  
Soc. Imp. Sci. Nat. Math. Cherbourg 12:1-112.
- Rothpletz, A. 1891. Fossile Kalkalgen aus den Familien der  
Codiaceen and Corallinaceen. Deutsch Geol. Gesell. Zeitschr.  
2:295-322.
- Sass, J. E. 1958. Botanical Microtechnique. The Iowa State  
College Press, Ames, Iowa. x + 228 p.
- Setchell, W. A., and L. R. Mason. 1943. Goniolithon and Neogonio-  
lithon: Two genera of crustaceous coralline algae. Proc.  
Natl. Acad. Sci., U. S. A. 29:87-92.
- Taylor, W. R. 1950. Plants of Bikini and other northern Marshall  
Islands. Univ. of Mich. Press, Ann Arbor. xv + 227 p., 79 pls.
- Wormersley, H. B. S., and A. Bailey. 1970. Marine algae of the  
Solomon Islands. Phil. Trans. R. Soc. Lon., Ser. B.  
259:257-352.



## PLATE I



Fig. 1. Archaeolithothamnium erythraeum (Rothpl.) Foslie.  
Habit of plant encrusting reef substrate with  
excrecences (GDG 216).

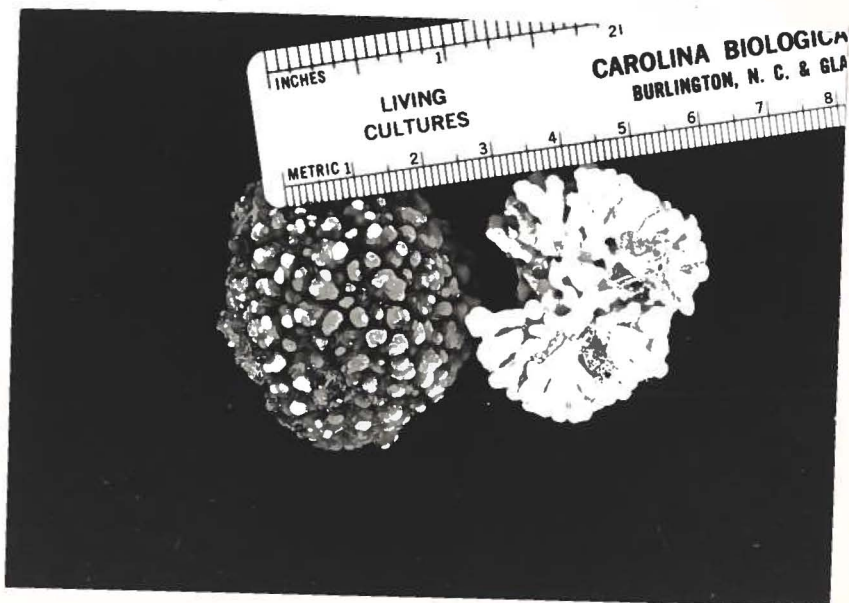


Fig. 2. Archaeolithothamnium erythraeum (Rothpl.) Foslie.  
Habit of nodules; specimen at right is split in  
half (left, GDG 241, right, GDG 48).

## PLATE II

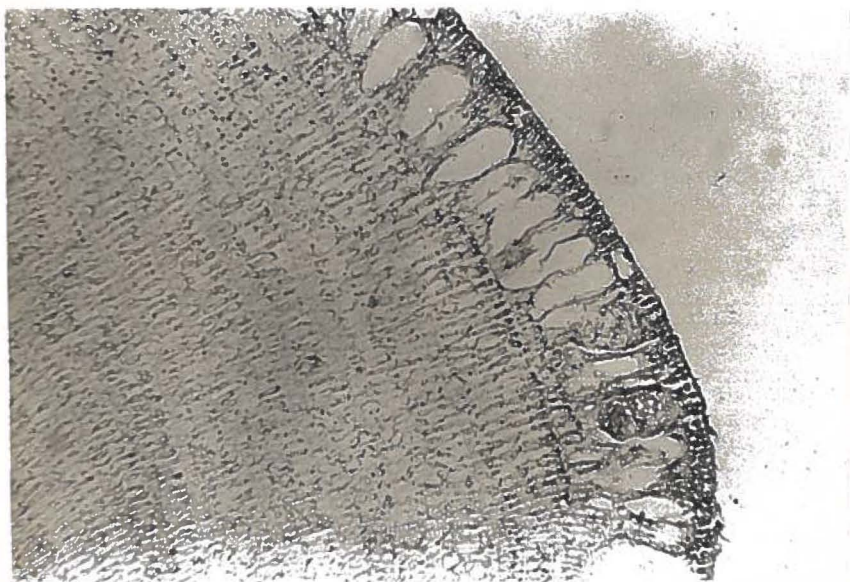


Fig. 1. Archaeolithothamnium erythaeum (Rothpl.) Foslie.  
Vertical section of a row of conceptacles in  
perithallus (GDG 48). Scale:  $\frac{\text{---}}{100 \mu}$ .

## PLATE III



Fig. 1. Archaeolithothamnium sp. 1. Vertical section of rows of evacuated conceptacles in perithallus (GDG 157). Scale:  $\frac{\text{---}}{100 \mu}$ .

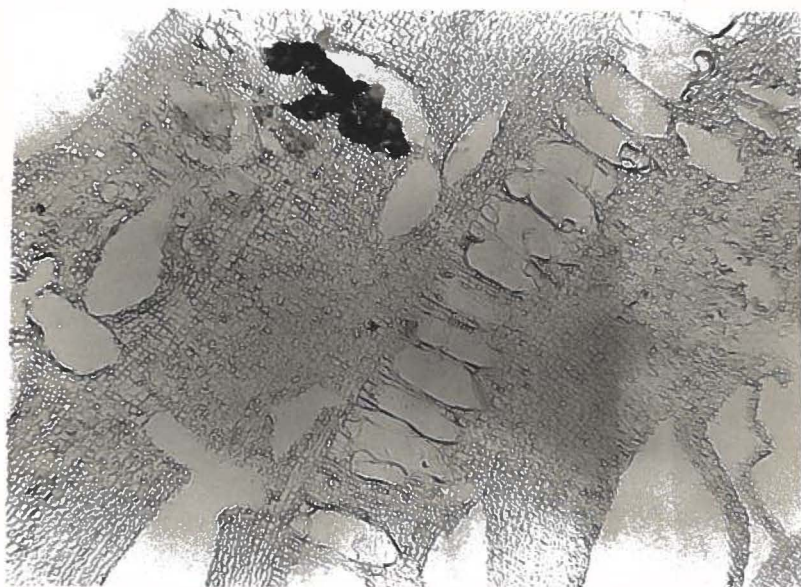


Fig. 2. Archaeolithothamnium sp. 2. Vertical section of rows of evacuated conceptacles in perithallus (GDG 116). Scale:  $\frac{\text{---}}{100 \mu}$ .



## PLATE IV

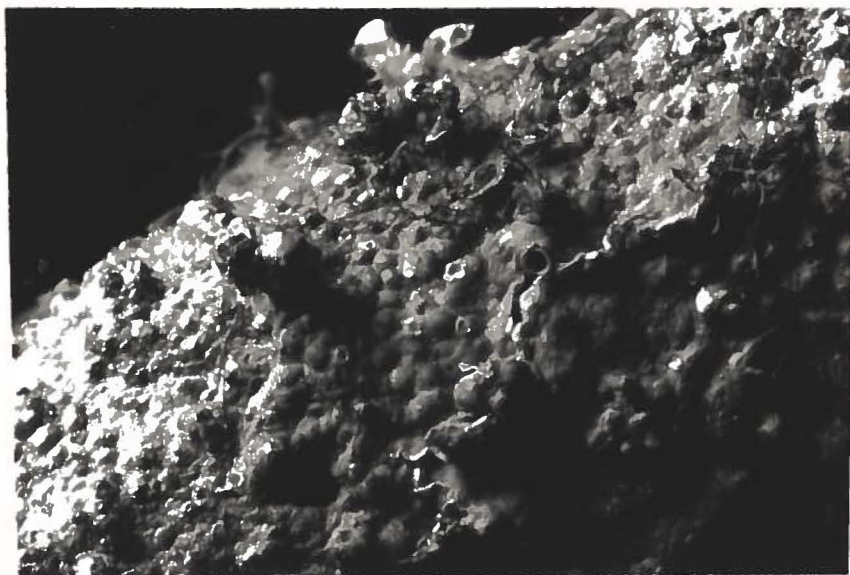


Fig. 1. Leptophytum sp. Habit of plant having large prominent conceptacles (GDG 254),  
Scale: /———/.  
2 mm



Fig. 2. Leptophytum sp. Vertical section of conceptacle with bispores; two mucilaginous plugs (mp) can be seen in conceptacle roof (GDG 96). Scale: /———/.  
14 $\mu$

PLATE V



Fig. 1, Leptophytum sp. Vertical section of conceptacle with bispores and thallus (GDG 96). Scale:  $\frac{\quad}{100\mu}$ .



Fig. 2, Leptophytum sp. Vertical section of perithallus and hypothallus (GDG 96). Scale:  $\frac{\quad}{24\mu}$ .

## PLATE VI



Fig. 1. Mesophyllum cf. erubescens (Foslie) Lemoine.  
Surface detail of excrecences having multipored  
conceptacles at tips (GDG 238). Scale:  $\frac{\text{---}}{2 \text{ mm}}$ .



## PLATE VII

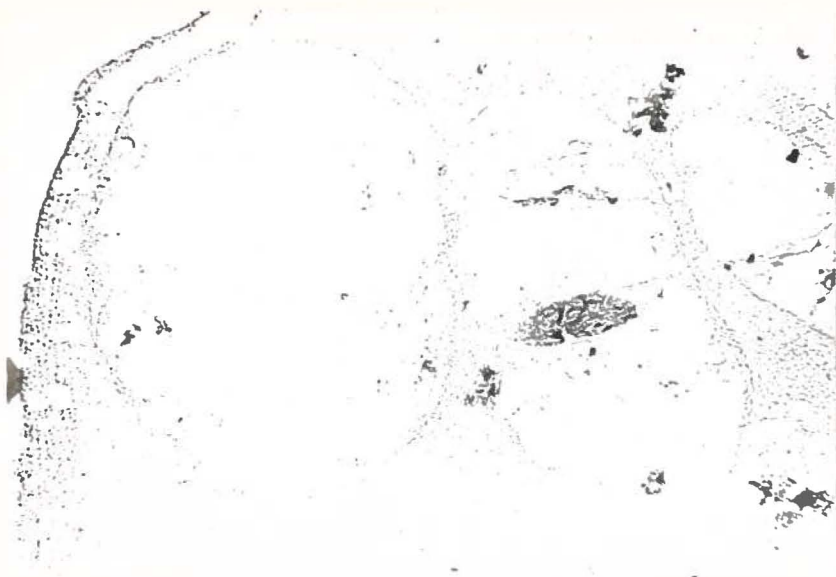


Fig. 1. Mesophyllum cf. erubescens (Foslie) Lemoine.  
Vertical section of conceptacle with spore (GDG 152).  
Scale: /100 μ/.

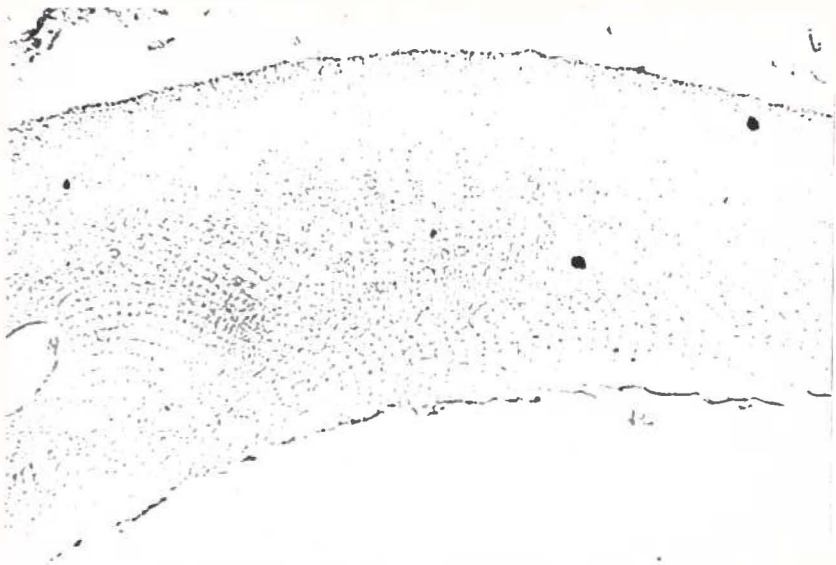


Fig. 2. Mesophyllum cf. erubescens (Foslie) Lemoine.  
Vertical section of coaxial hypothallus (GDG 152).  
Scale: /100 μ/.

## PLATE VIII



Fig. 1. Fosliella farinosa (Lamx.) Howe. Vertical section of four heterocysts with projecting hairs; also part of a conceptacle with tetraspore (GDG 89). Scale:  $\frac{\quad}{14 \mu}$ .

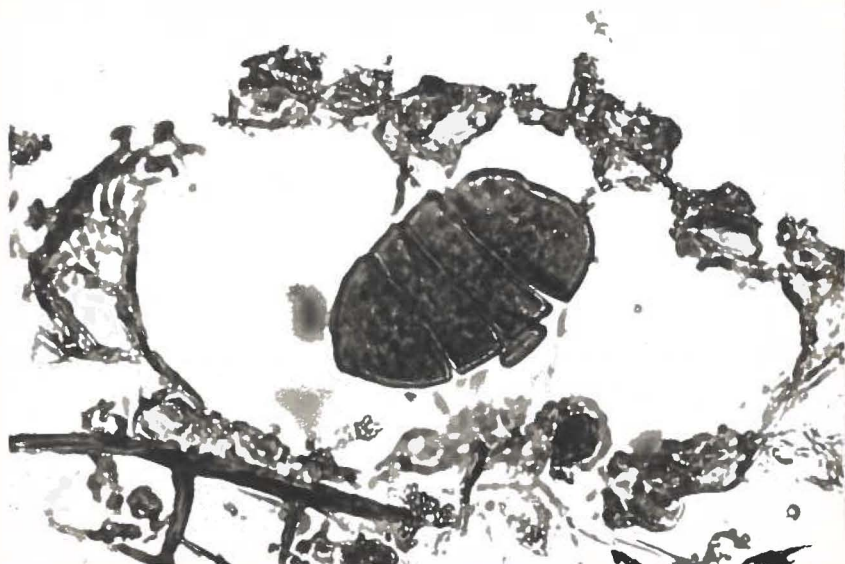


Fig. 2. Fosliella farinosa (Lamx.) Howe. Vertical section of conceptacle with tetraspore (GDG 89). Scale:  $\frac{\quad}{14 \mu}$ .

## PLATE IX



Fig. 1. Foslarella lejolisii (Rosanoff) Howe, Vertical section of conceptacle with two tetraspores (GDG 126). Scale:  $\frac{14 \mu}{/}$ .



## PLATE X

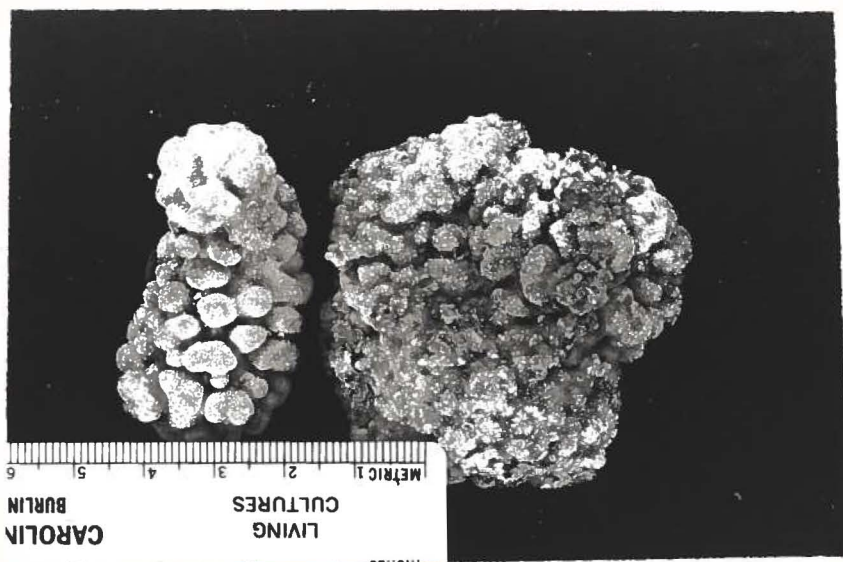


Fig. 1. Hydrolithon reinboldii (W. v. Bosse and Foslie) Foslie. Habit of nodule with excrescences (GDG 242).

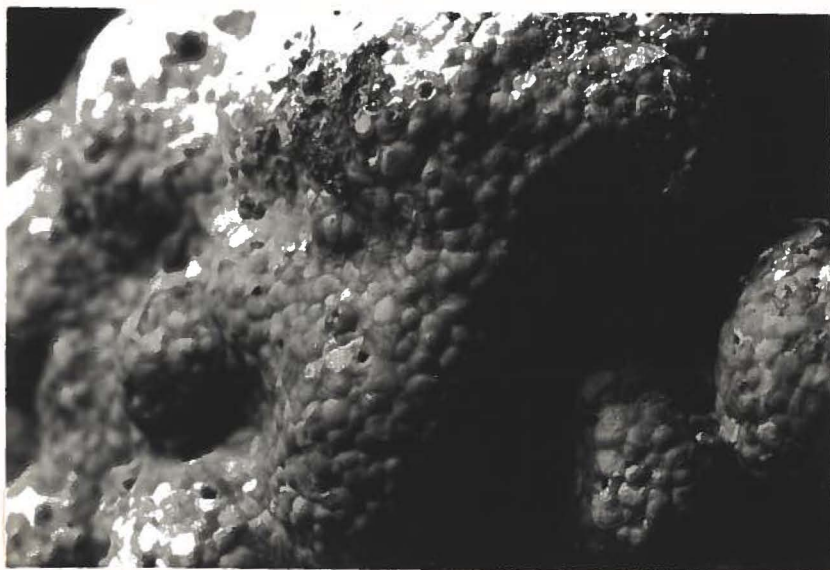


Fig. 2. Hydrolithon reinboldii (W. v. Bosse and Foslie) Foslie, Surface detail of excrescences with small one pore conceptacles (GDG 242). Scale:  $\frac{\quad}{2}$  mm

## PLATE XI



Fig. 1. Hydrolithon reinboldii (W. v. Bosse and Foslie) Foslie. Vertical section of perithallus having heterocyst with projecting hair (GDG 15).  
Scale:  $\frac{\quad}{14 \mu}$ .

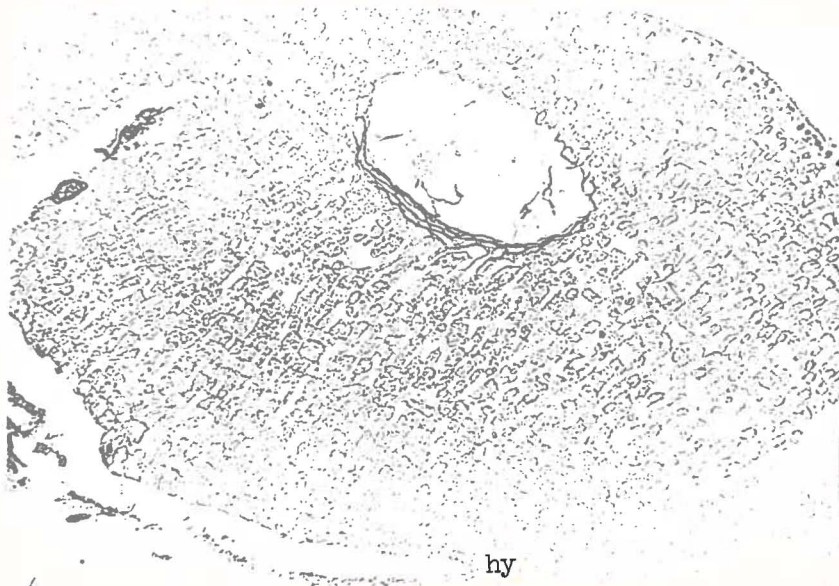


Fig. 2. Hydrolithon reinboldii (W. v. Bosse and Foslie) Foslie. Vertical section showing the irregular cell structure of the perithallus, an evacuated conceptacle, and the hypothallus (hy) one cell layer thick (GDG 15).

## PLATE XII



Fig. 1. Lithoporella melobesioides Foslie. Surface detail showing the fan-shaped areas of new thallic growth (GDG 156). Scale:  $\frac{\quad}{2 \text{ mm}}$ .



Fig. 2. Lithoporella melobesioides Foslie. Vertical section of the one cell layer thick hypothallus with epithallus on top (GDG 169B). Scale:  $\frac{\quad}{14 \mu}$ .



## PLATE XIII



Fig. 1. Lithoporella pacifica (Heydr,) Foslie. Habit of plant having many thin crusts with large prominent conceptacles (GDG 231).

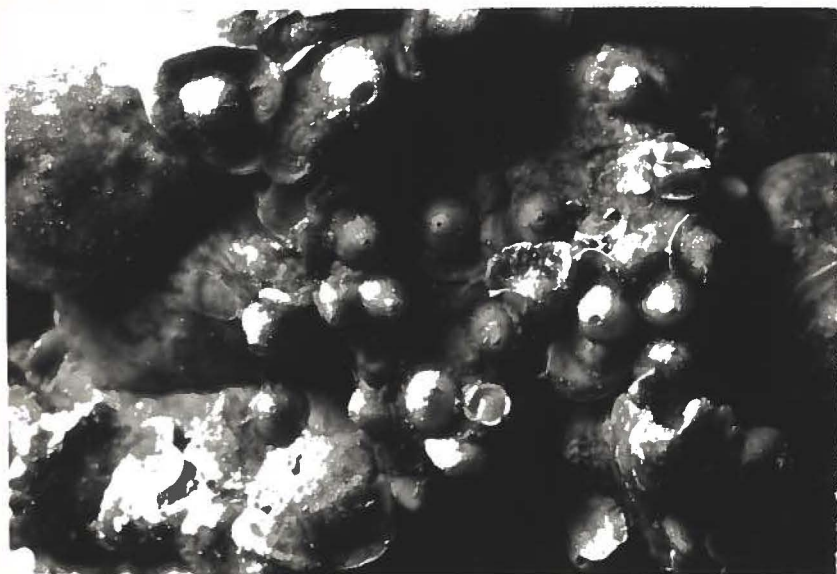


Fig. 2. Lithoporella pacifica (Heydr,) Foslie, Surface detail of conceptacles and thin crusts (GDG 231). Scale:  $\frac{1}{2}$  mm.

## PLATE XIV

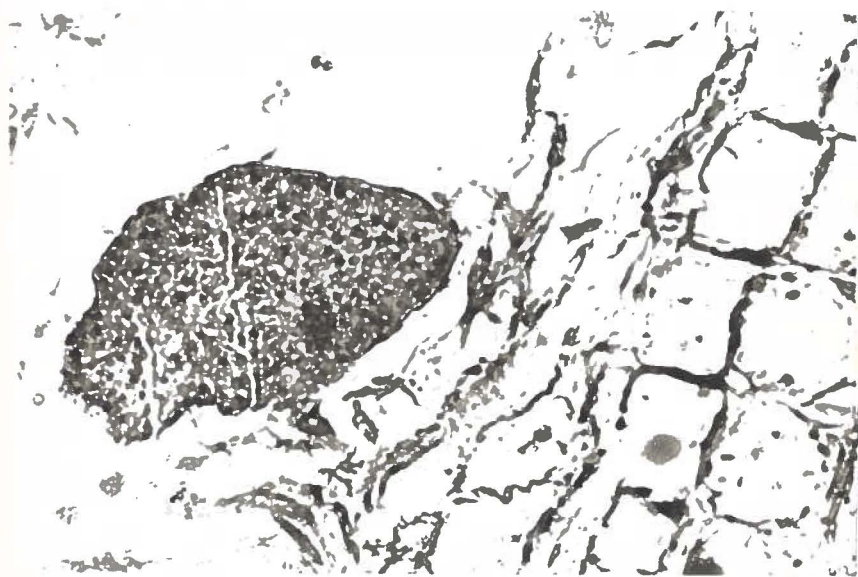


Fig. 1, Lithoporella pacifica (Heydr.) Foslie. Vertical section of conceptacle chamber and hypothallus (GDG 62). Scale:  $\frac{\quad}{14 \mu}$ .

## PLATE XV

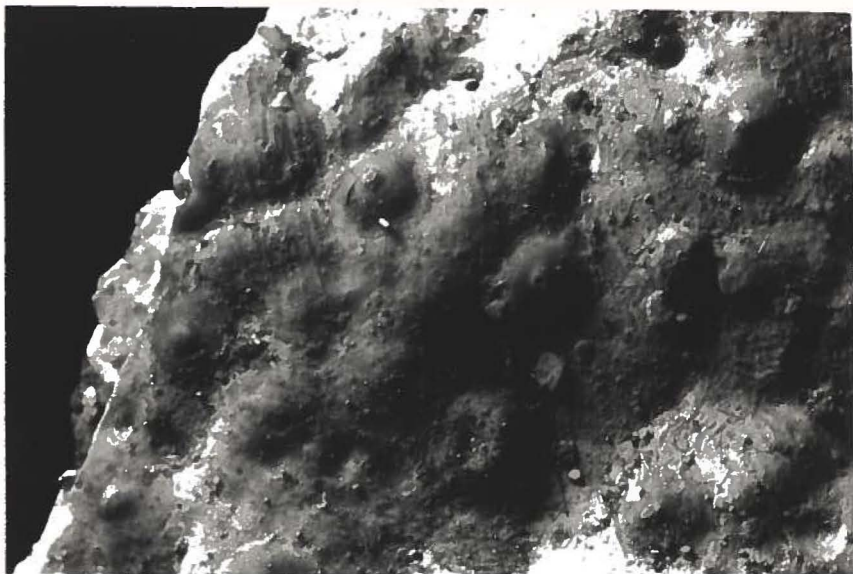


Fig. 1. Neogoniolithon fosliei (Heydr.) Setchell and Mason.  
Surface detail of plant with large conical conceptacles  
(GDG 233). Scale:  $\frac{\text{---}}{2 \text{ mm}}$ .

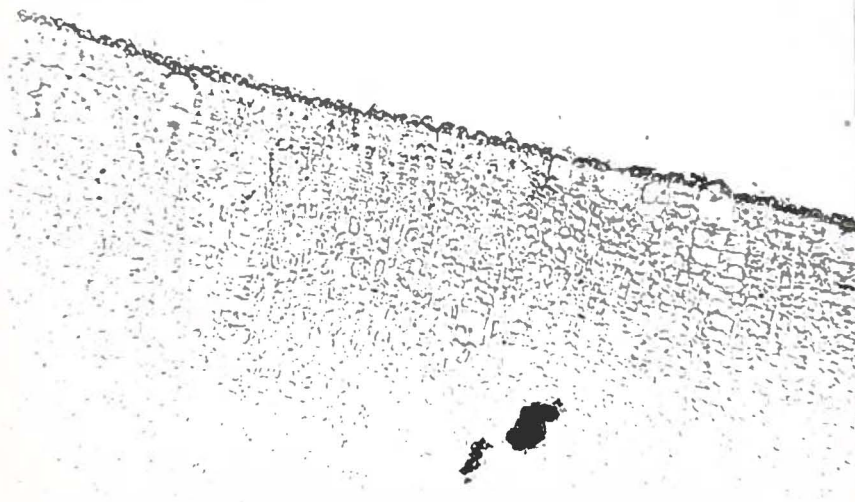


Fig. 2. Neogoniolithon fosliei (Heydr.) Setchell and Mason,  
Vertical section of heterocysts in vertical columns  
in the perithallus (GDG 86). Scale:  $\frac{\text{---}}{100 \mu}$ .



## PLATE XVI

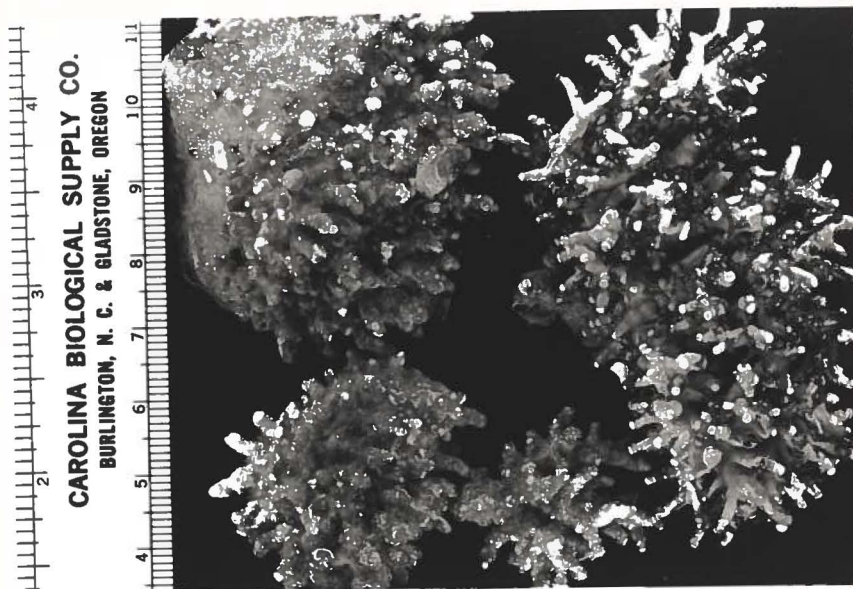


Fig. 1. Neogoniolithon frutescens (Foslie) Setchell and Mason. Habit of plant, specimen at right is a nodule with branches radiating from all sides, other specimens are encrusted with branches (left, GDG 221; right, GDG 192).

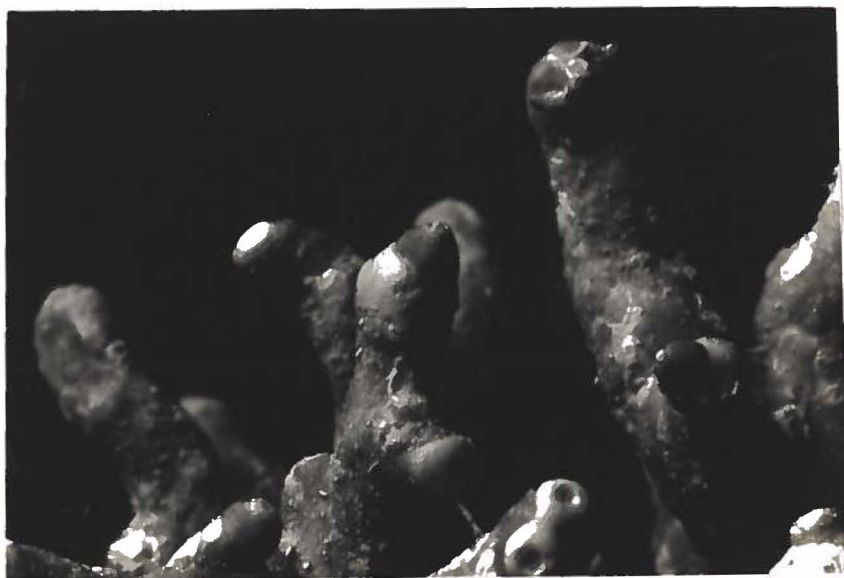


Fig. 2. Neogoniolithon frutescens (Foslie) Setchell and Mason. Surface detail of branches with single pored conceptacles at their tips (GDG 192). Scale:  $\frac{\text{---}}{2 \text{ mm}}$ .

## PLATE XVII

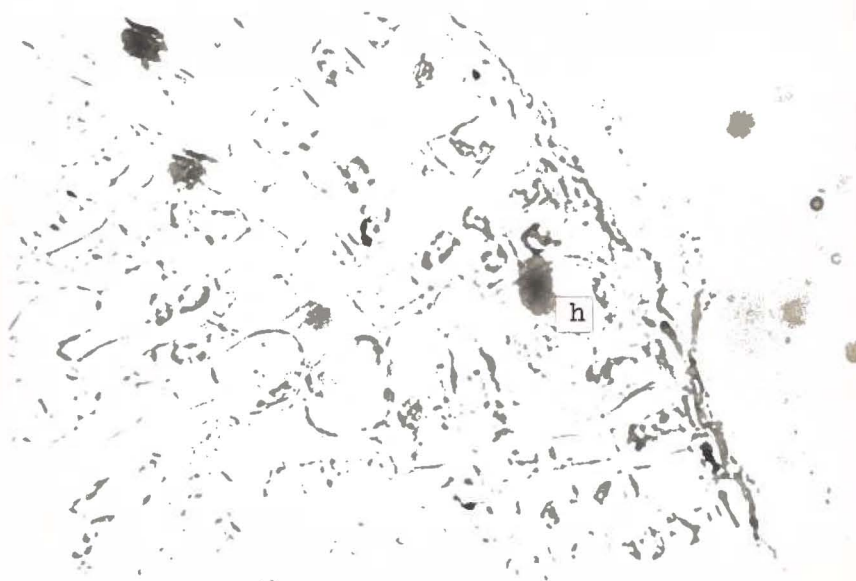


Fig. 1. Neogoniolithon frutescens (Foslie) Setchell and Mason.  
Vertical section of perithallus with heterocysts (h)  
(GDG 129). Scale: /14  $\mu$  /.

## PLATE XVIII

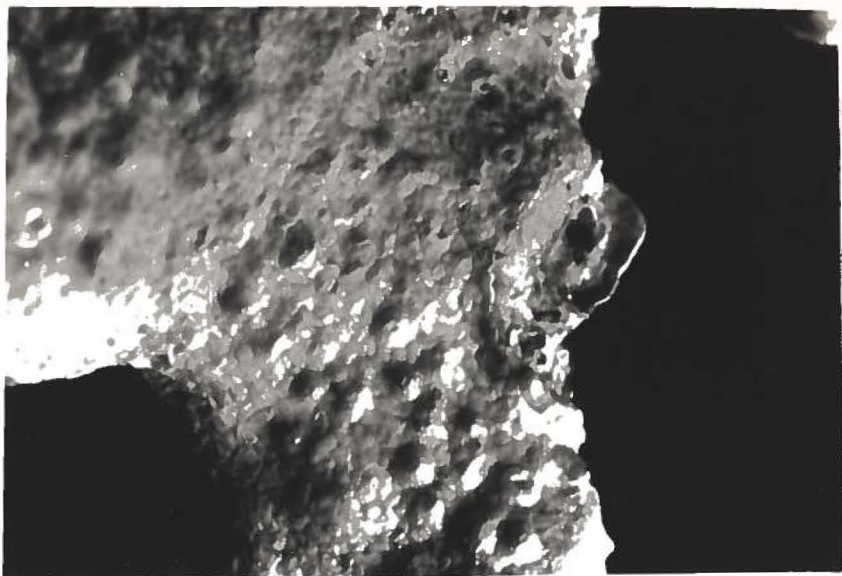


Fig. 1. Neogoniolithon myriocarpum (Foslie) Setchell and Mason.  
Surface detail of plant with single pored conceptacles  
(GDG 111A). Scale: /———/.  
2 mm

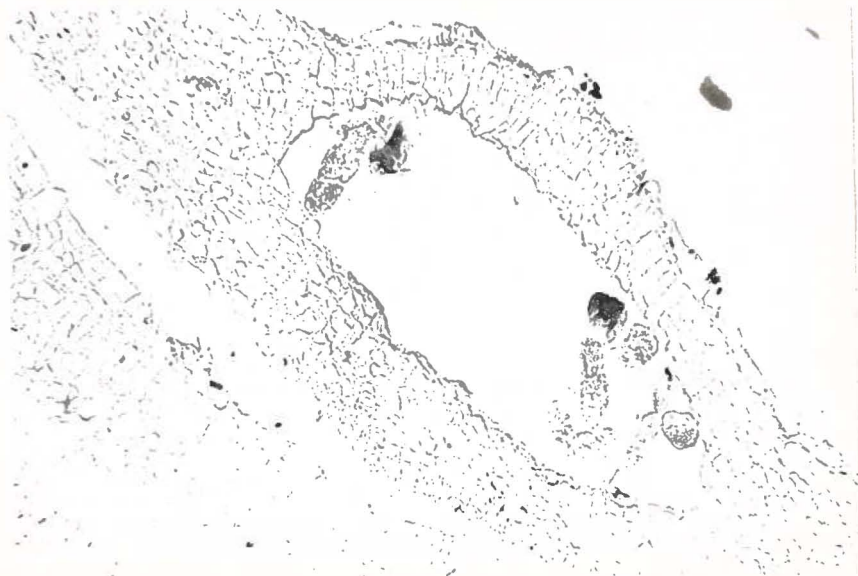


Fig. 2. Neogoniolithon myriocarpum (Foslie) Setchell and Mason.  
Vertical section of conceptacle with tetraspore  
(GDG 111A). Scale: /———/.  
100  $\mu$



## PLATE XIX

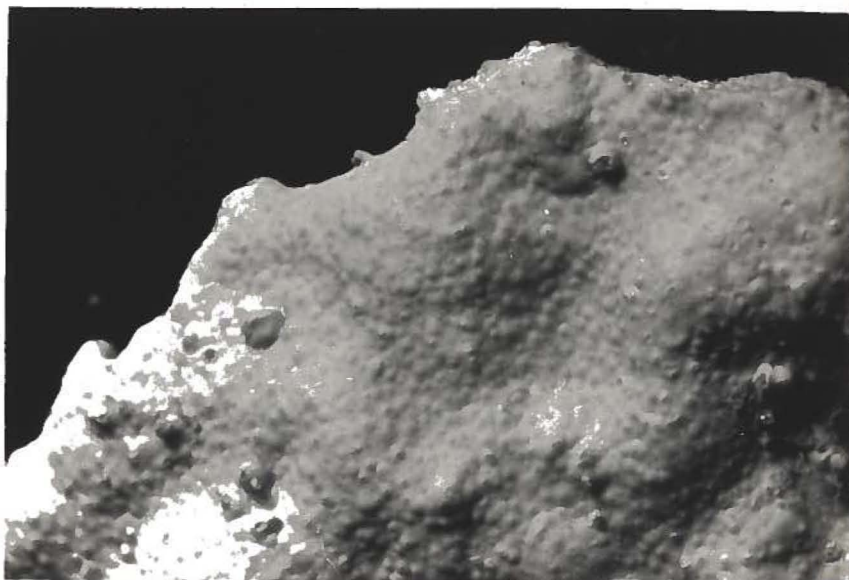


Fig. 1. Neogoniolithon sp. 1. Surface detail of plant with single pored conceptacles (GDG 11). Scale:  $\frac{\text{---}}{2 \text{ mm}}$ .

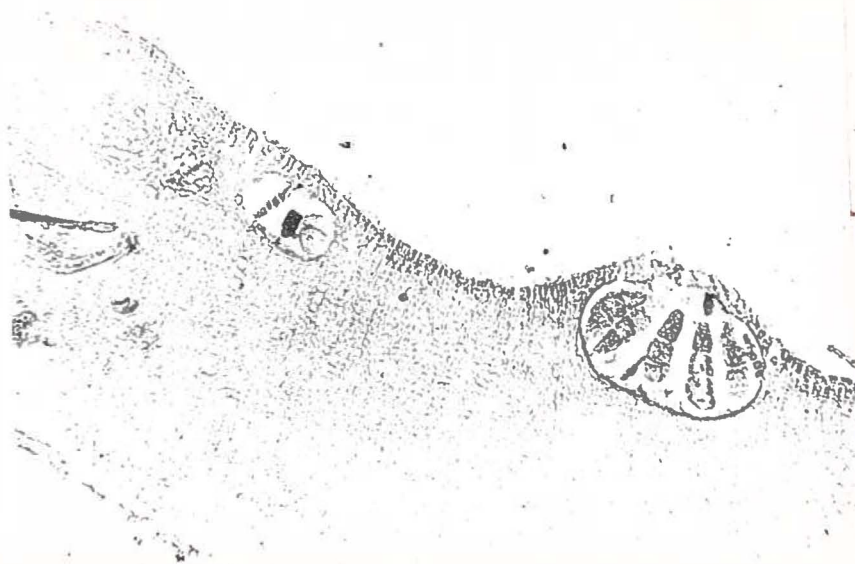


Fig. 2. Neogoniolithon sp. 1. Vertical section of tetrasporangial conceptacle and perithallus with short vertical columns of heterocysts (GDG 153B). Scale:  $\frac{\text{---}}{100 \mu}$ .

## PLATE XX



Fig. 1. Neogoniolithon sp. 2. Surface detail of encrusting plant with single pored conceptacles (GDG 115), Scale:  $\frac{\text{---}}{2 \text{ mm}}$ ,

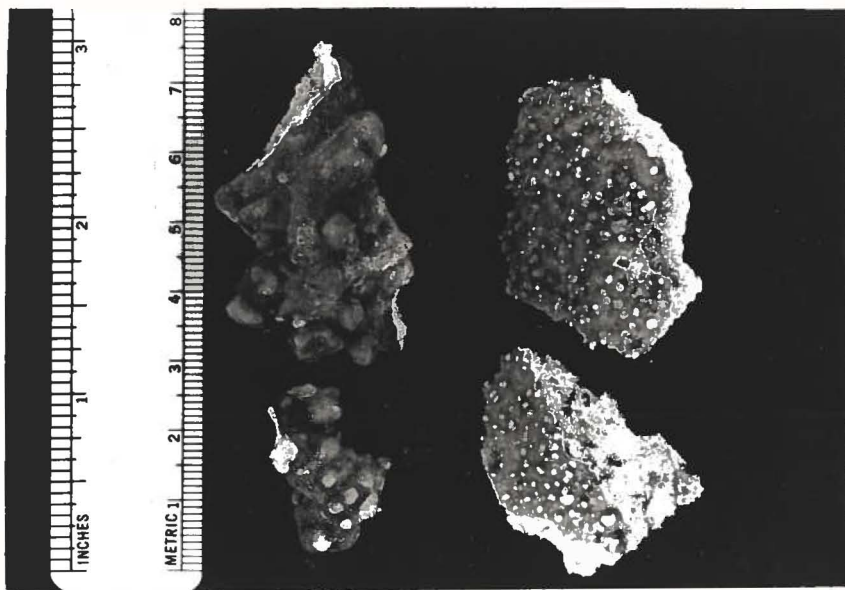


Fig. 2. Neogoniolithon sp. 2, Habit of plant encrusting and with excrescences (left, GDG 118; right, GDG 117).

## PLATE XXI



Fig. 1. Neogoniolithon sp. 2, Vertical section of evacuated conceptacle (GDG 115). Scale:  $\frac{\quad}{100 \mu}$ .



Fig. 2. Neogoniolithon sp. 2, Vertical section of perithallus with heterocysts (h) (GDG 115). Scale:  $\frac{\quad}{14 \mu}$ .



## PLATE XXII

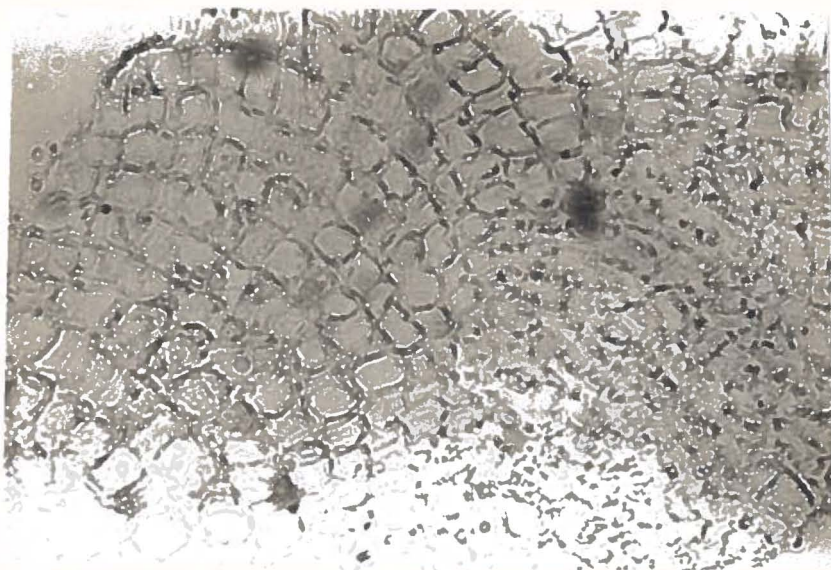


Fig. 1. Neogoniolithon sp. 2. Vertical section of perithallus with heterocysts and coaxial hypothallus (GDG 115). Scale:  $\frac{\quad}{14 \mu}$  /.

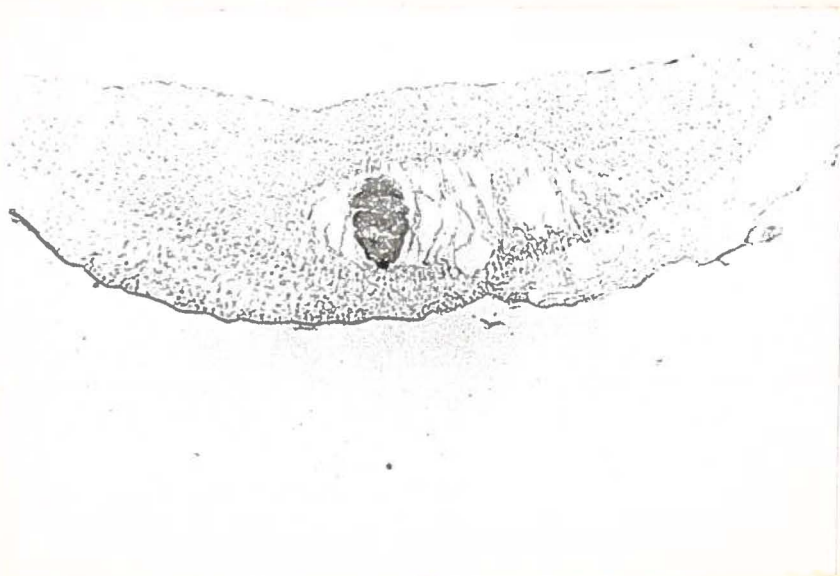


Fig. 2. Neogoniolithon sp. 3. Vertical section of conceptacle with tetraspore (GDG 153A). Scale:  $\frac{\quad}{100 \mu}$  /.

## PLATE XXIII

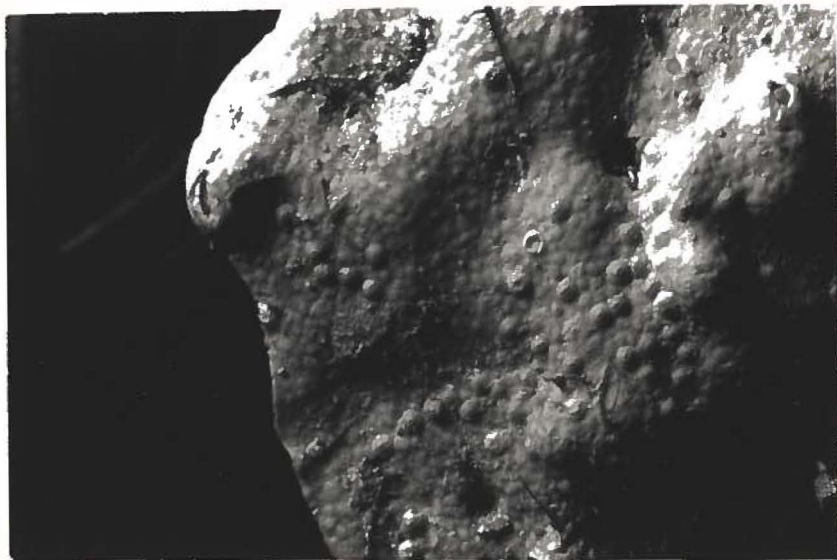


Fig. 1. Porolithon onkodes Foslie. Surface detail of single pored conceptacles (GDG 13). Scale:  $\frac{\quad}{2 \text{ mm}}$  /.



Fig. 2. Porolithon onkodes Foslie. Vertical section of conceptacle with tetraspores (GDG 13). Scale:  $\frac{\quad}{100 \mu}$  /.

## PLATE XXIV



Fig. 1. Porolithon onkodes Foslie, Vertical section of perithallus having many heterocysts plates (hp) lying in horizontal rows (GDG 28). Scale:  $\frac{\quad}{100 \mu}$ .



Fig. 2. Porolithon onkodes Foslie, Vertical section of heterocyst plate lying on surface of perithallus; some short heterocyst hairs can be seen (GDG 61). Scale:  $\frac{\quad}{14 \mu}$ .



## PLATE XXV

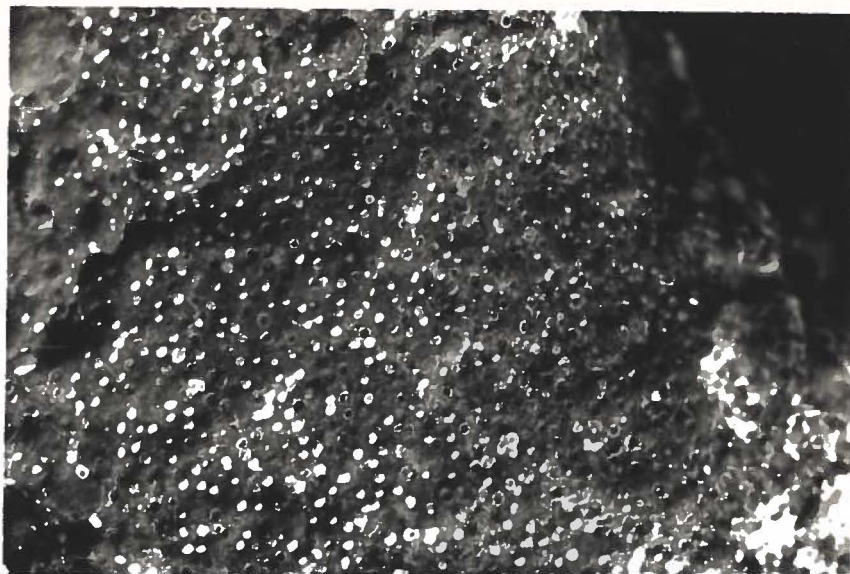


Fig. 1. Porolithon sp. Surface detail of plant with many single pored conceptacles, some are faded white (GDG 80). Scale:  $\frac{\quad}{2 \text{ mm}}$ .



Fig. 2. Porolithon sp. Vertical section of conceptacle with tetraspores (GDG 10), Scale:  $\frac{\quad}{100 \mu}$ .

## PLATE XXVI



Fig. 1. Porolithon sp. Vertical section of perithallus with a heterocyst plate (GDG 10). Scale:  $\frac{14}{\mu}$ .

## PLATE XXVII

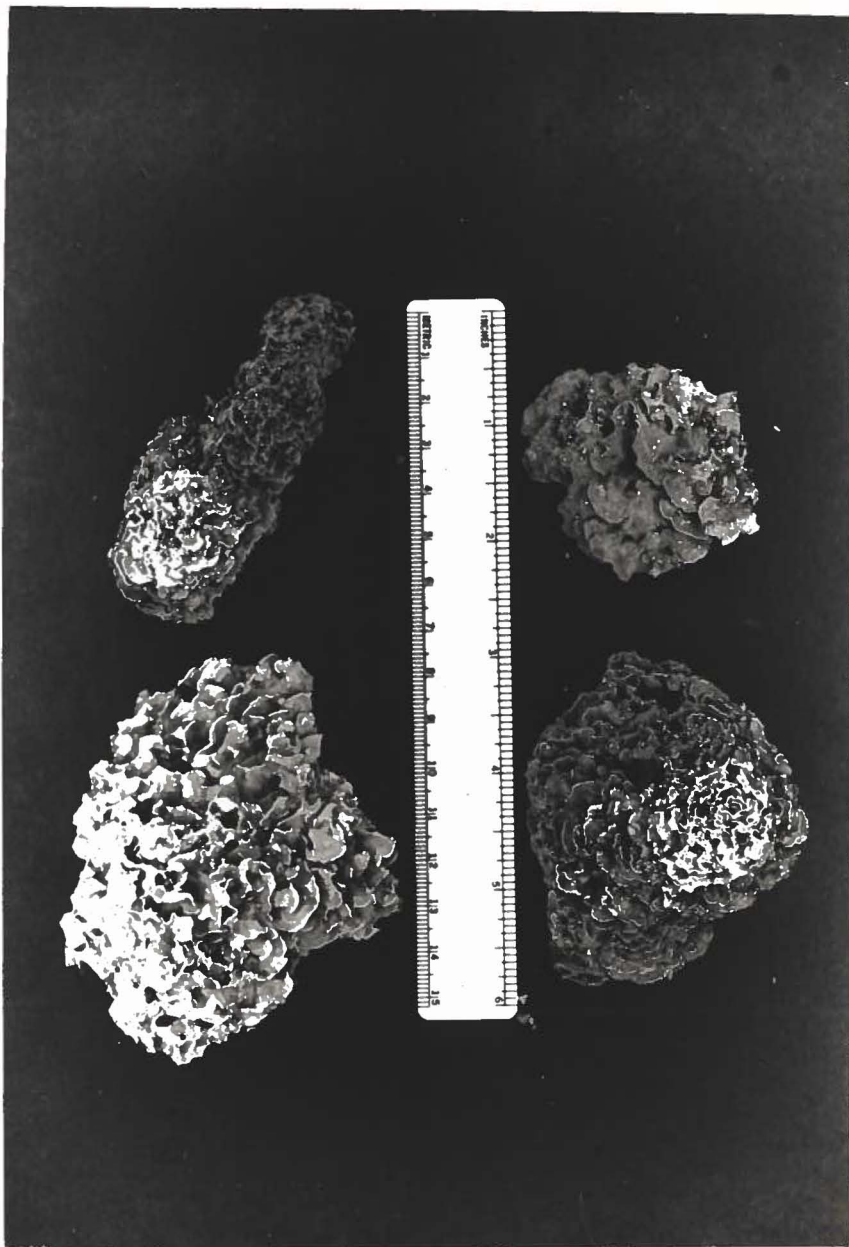


Fig. 1. Pseudolithophyllum sp. 1, Habit of plants having many thin crusts (GDG 123).



## PLATE XXVIII

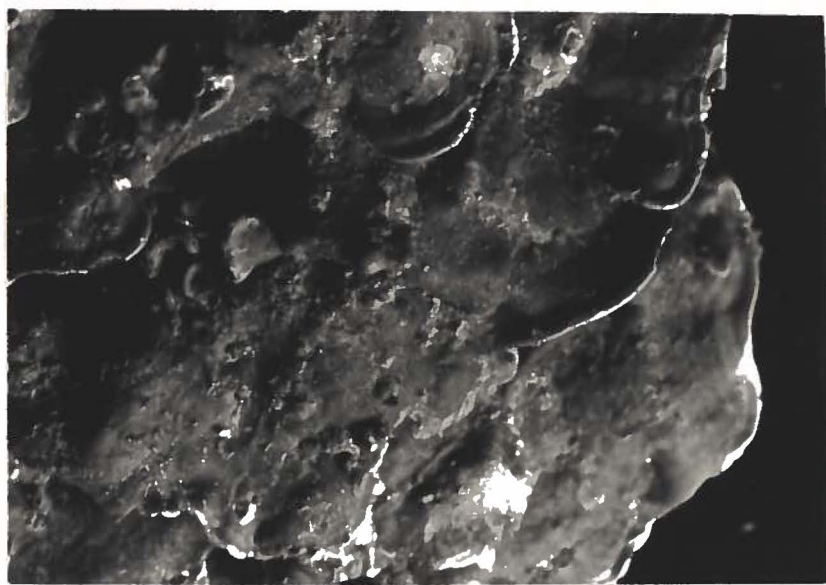


Fig. 1. Pseudolithophyllum sp. 1. Surface detail of plant  
(GDG 123). Scale:  $\frac{1}{2}$  mm /.

## PLATE XXIX



Fig. 1, Pseudolithophyllum sp. 2. Vertical section of conceptacle (GDG 119). Scale:  $\frac{\quad}{100 \mu}$ .

## PLATE XXX



Fig. 1, Pseudolithophyllum sp. 3, Vertical section of two evacuated conceptacles (GDG 114). Scale:  $\frac{\quad}{100 \mu}$ .

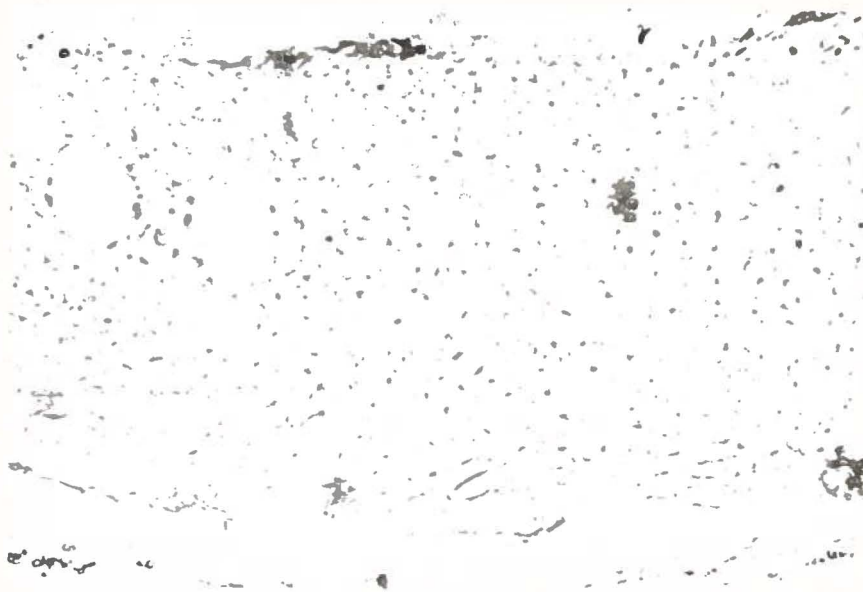


Fig. 2, Pseudolithophyllum sp. 3, Vertical section of perithallus and multilayered hypothallus (GDG 114). Scale:  $\frac{\quad}{14 \mu}$ .



## PLATE XXXI

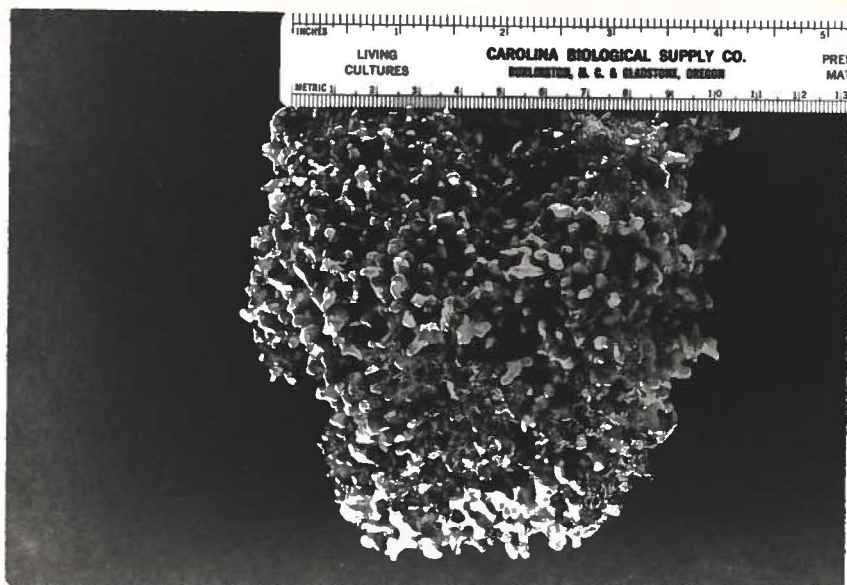


Fig. 1. Lithophyllum kotschyannum (Unger) Foslie, Habit of plant (GDG 161),

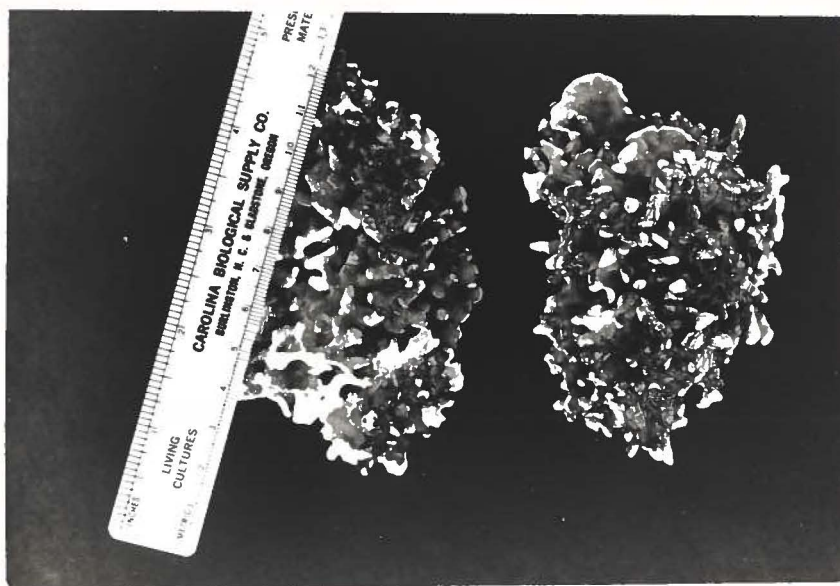


Fig. 2. Lithophyllum kotschyannum (Unger) Foslie, Habit of plant growing and branching in one plane (left, GDG 176; right, GDG 197).

## PLATE XXXII



Fig. 1. Lithophyllum kotschyanum (Unger) Foslie. Vertical section of conceptacles (GDG 161). Scale:  $\frac{\quad}{100 \mu}$ .

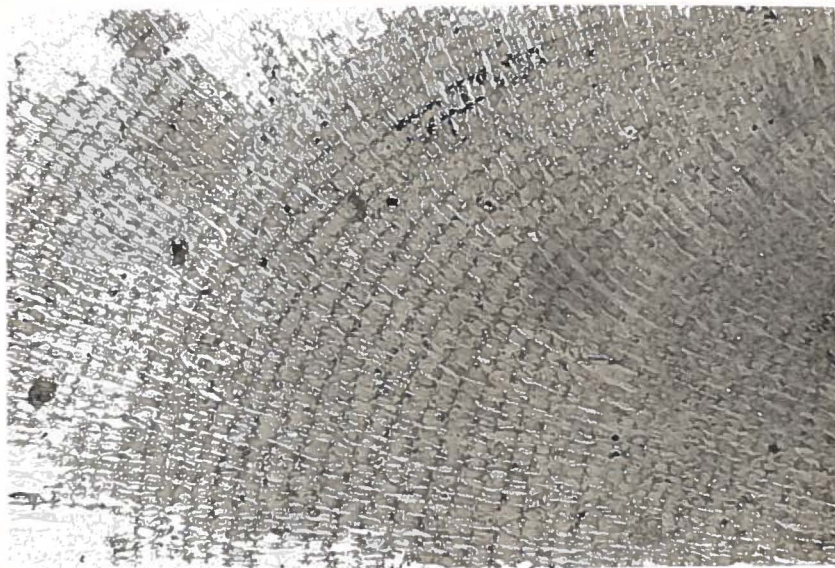


Fig. 2. Lithophyllum kotschyanum (Unger) Foslie. Vertical section of coaxial hypothallus (GDG 161). Scale:  $\frac{\quad}{100 \mu}$ .



## PLATE XXXIII

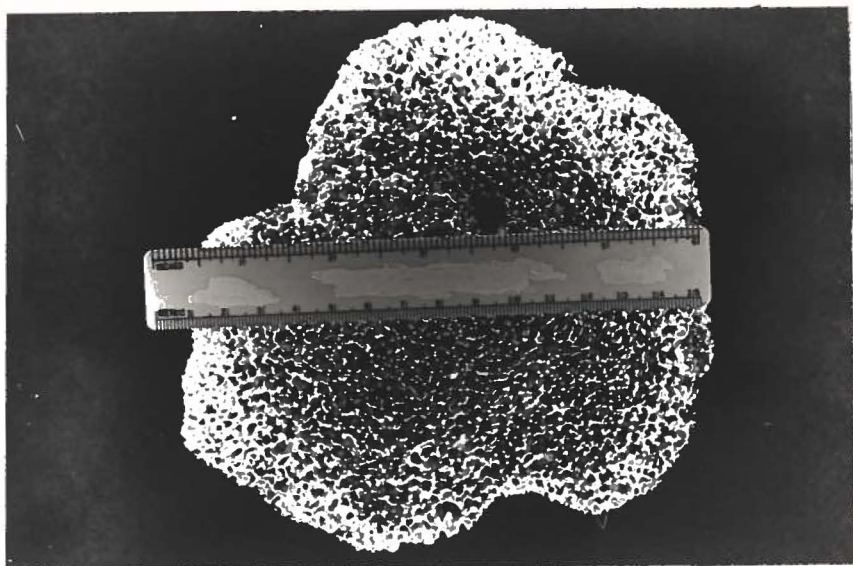


Fig. 1. Lithophyllum moluccense Foslie. Habit of plant from windward reef margin (GDG 122),

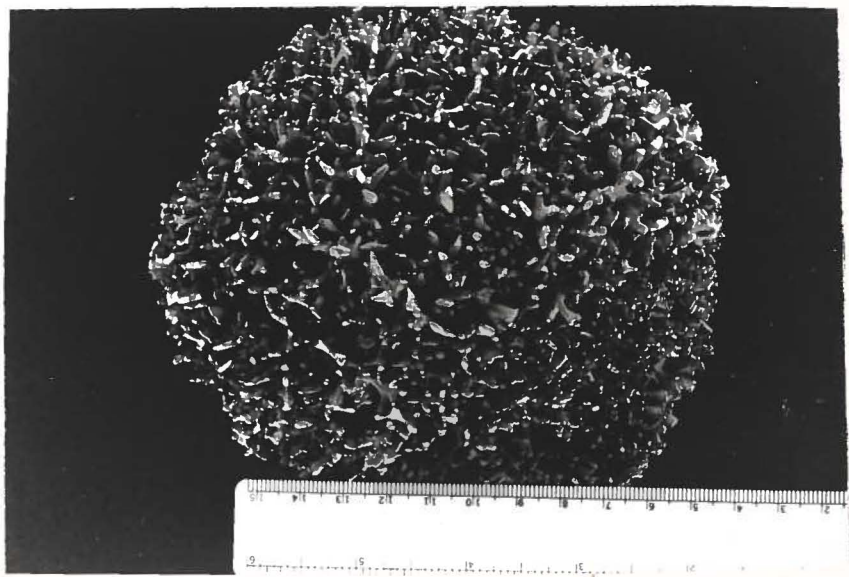


Fig. 2. Lithophyllum moluccense Foslie. Habit of plant from reef front having moderate surf (GDG 251),



## PLATE XXXIV

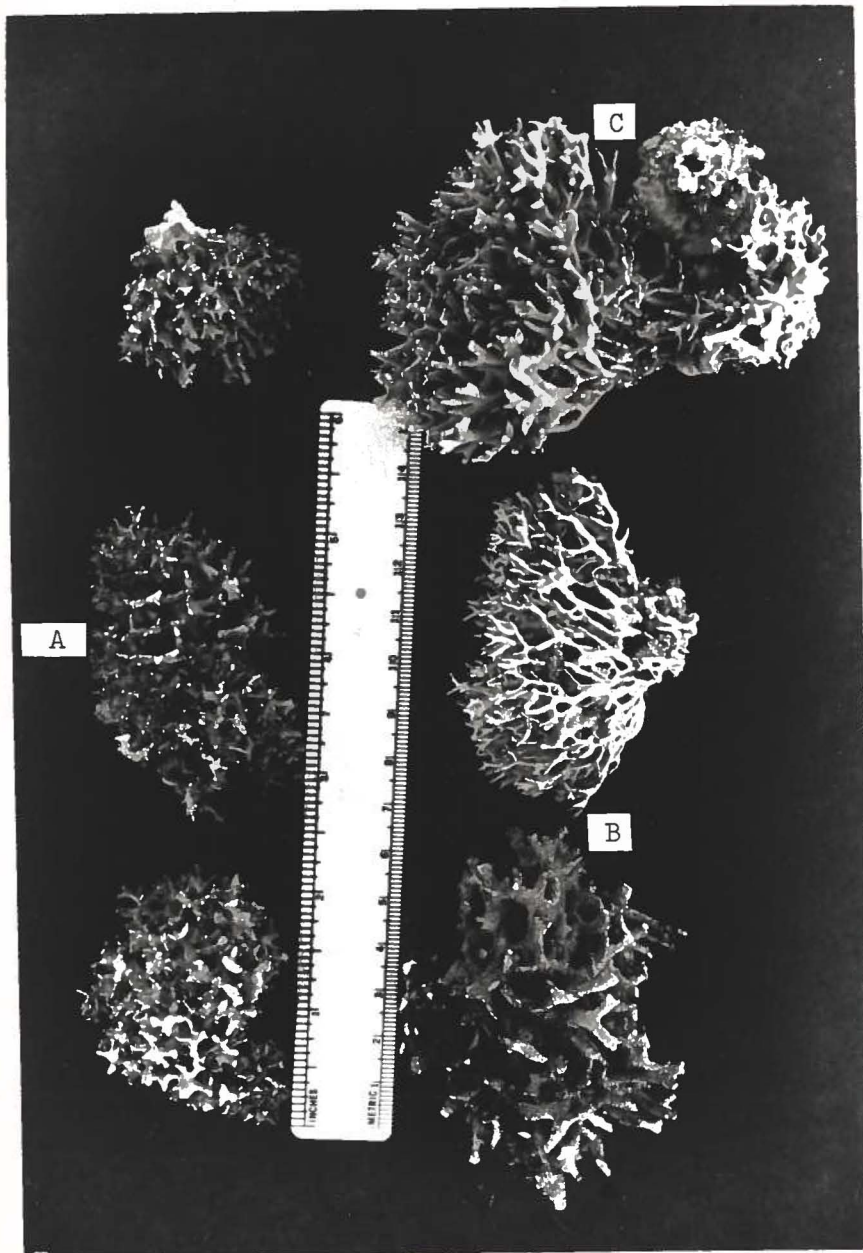


Fig. 1. Lithophyllum moluccense Foslje, Habit of plants; specimens A from reef front area close to reef margin; specimens B from seaward edge of windward reef flat; specimen C from reef front having light surf (A, GDG

## PLATE XXXV

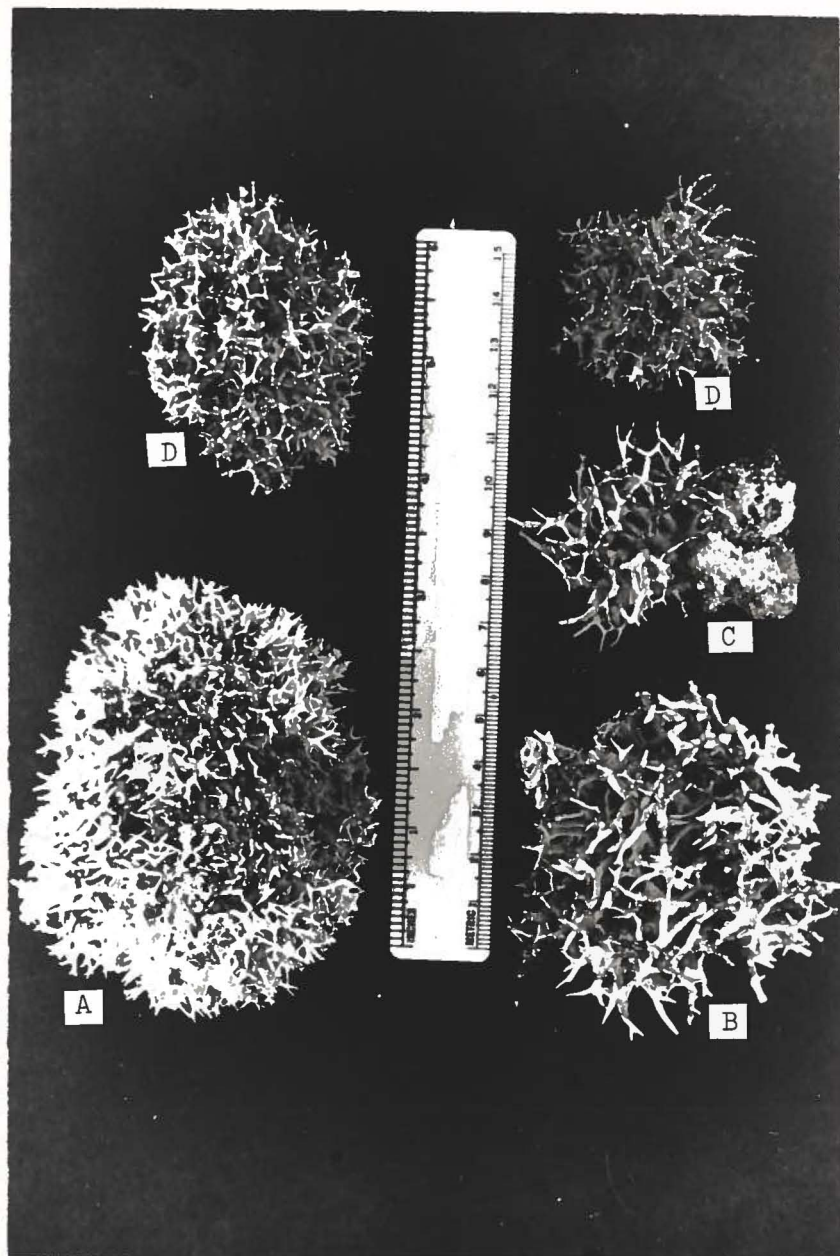


Fig. 1. *Lithophyllum moluccense* Foslie, Habit of plants; specimens A and B from reef flat; specimen C from reef terrace 30 m deep; specimen D grew as nodules on the reef terrace 7 m deep; (A, GDG 83; B, GDG 84; C, GDG 155; D, GDG 237)

## PLATE XXXVI

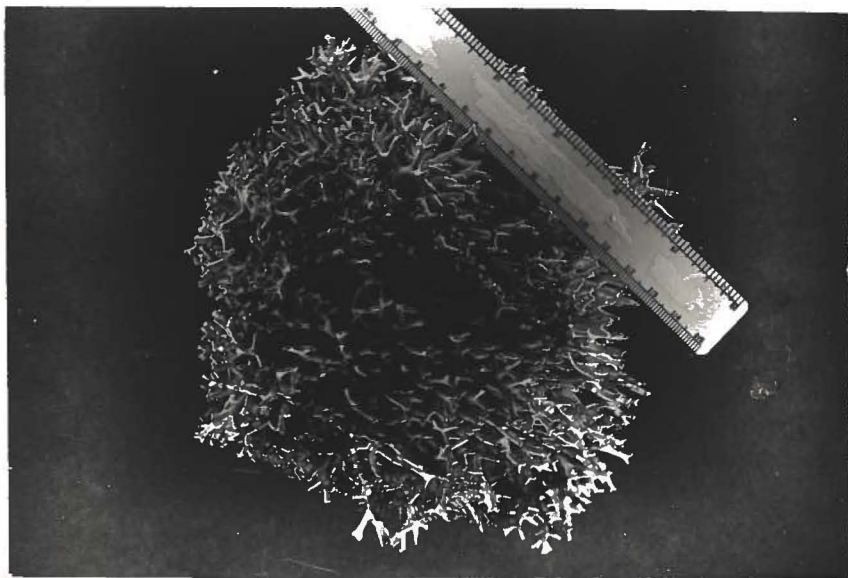


Fig. 1. Lithophyllum moluccense Foslie. Habit of plant; specimen from sheltered submarine terrace, 7 m deep (GDG 235).



## PLATE XXXVII



Fig. 1. Lithophyllum moluccense Foslie. Vertical section of tetrasporangial conceptacle (GDG 98). Scale:  $\frac{\quad}{100 \mu}$ .

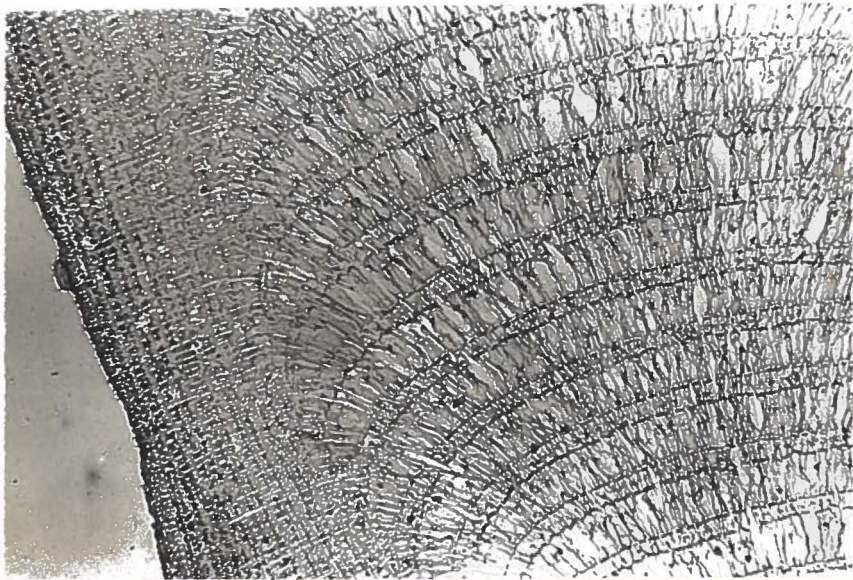


Fig. 2. Lithophyllum moluccense Foslie. Vertical section of coaxial hypothallus (GDG 33). Scale:  $\frac{\quad}{100 \mu}$ .

## PLATE XXXVIII

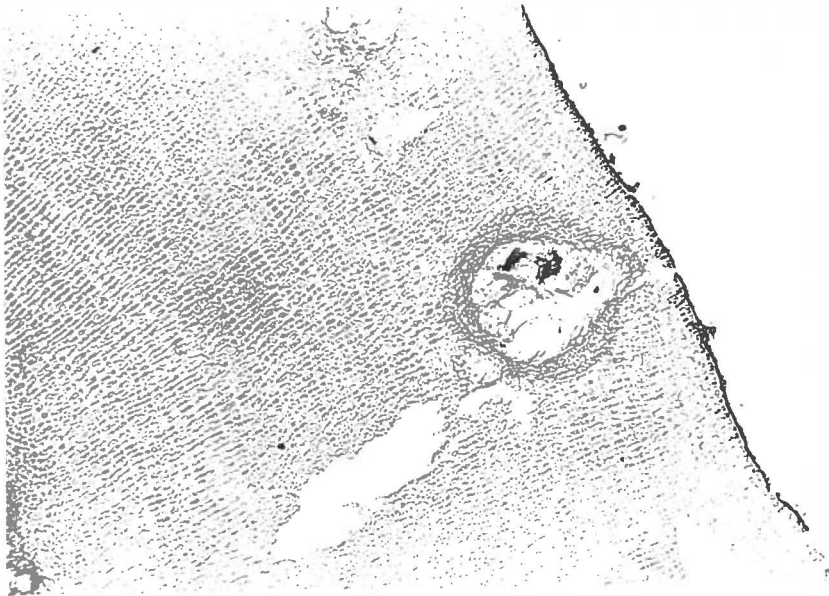


Fig. 1. Lithophyllum cf. okamuri Foslie. Vertical section of conceptacle (GDG 75). Scale: / $\frac{\quad}{100 \mu}$ /.



## PLATE XXXIX

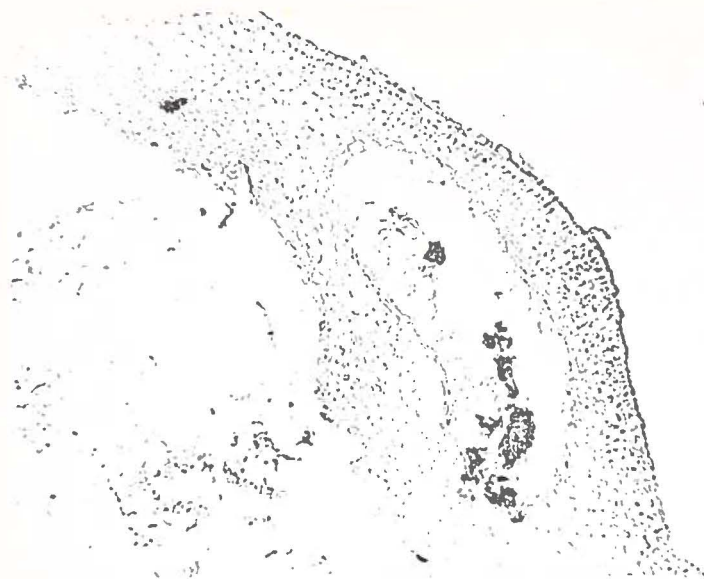


Fig. 1. Lithophyllum cf. trichotum (Heydr.) Lemoine.  
Vertical section of conceptacle (GDG 131B),  
Scale:  $\frac{\quad}{100 \mu}$ .

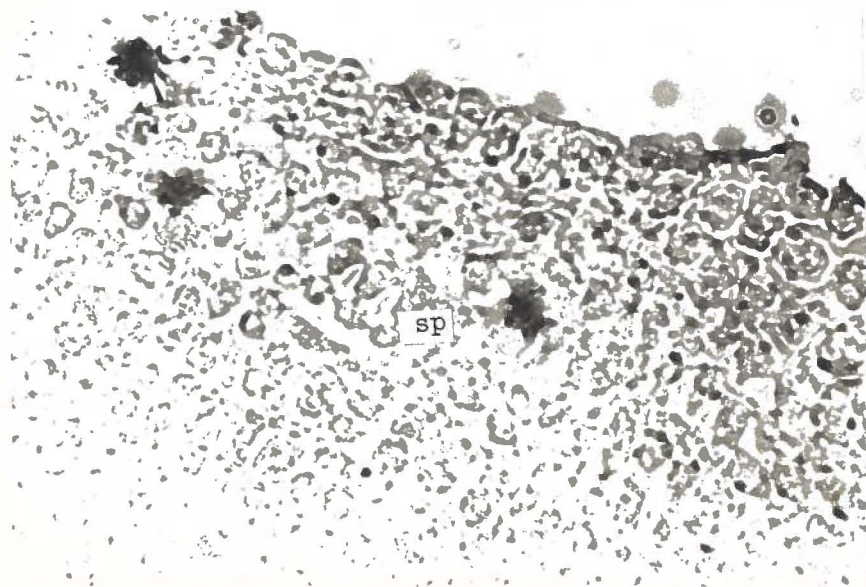


Fig. 2. Lithophyllum cf. trichotum (Heydr.) Lemoine,  
Vertical section of perithallus having secondary  
pits (sp) between cells (GDG 131B), Scale:  $\frac{\quad}{14 \mu}$ .



## PLATE XL



Fig. 1. Lithophyllum cf. yendoi Foslie, Vertical section of conceptacle (GDG 41). Scale:  $\frac{\quad}{100 \mu}$ .