Recent Corals of the Marshall Islands

Bikini and Nearby Atolls, Part 2, Oceanography (Biologic)

GEOLOGICAL SURVEY PROFESSIONAL PAPER 260–I

Recent Corals of the Marshall Islands

By JOHN W. WELLS

Bikini and Nearby Atolls, Part 2, Oceanography (Biologic)

GEOLOGICAL SURVEY PROFESSIONAL PAPER 260-I

An ecologic and taxonomic analysis of living reef- and non-reef-building corals at Bikini and other Marshall Islands atolls

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1954

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price $5.50 (paper cover)

CONTENTS

ILLUSTRATIONS

[Plates 94-185 follow index, plates 186, 187 in pocket]

TABLES

BIKINI AND NEARBY ATOLLS, MARSHALL ISLANDS

RECENT CORALS OF THE MARSHALL ISLANDS

By JOHN W. WELLS

ABSTRACT

This is an ecologic and taxonomic analysis of the living corals, both hermatypic (reef-building) and ahermatypic (non-reef-building), of this region, especially of Bikini Atoll, where large collections have been made. The general aspects of the distribution of hermatypic corals in the Indo-Pacific are summarized with a table and a map showing the geographic distribution of 77 genera; the map also shows the relation between isothermal and isopangeneric lines. The Marshall Islands coral fauna includes 240 species and varieties (22 new) representing 52 genera (1 new) of hermatypic scleractinian corals, 15 species and varieties (3 new) representing 10 genera (1 new) of ahermatypic forms, and 11 species representing 6 genera of nonscleractinian corals.

A zonal analysis of the corals from Bikini Atoll is presented. The windward seaward reefs show, in order from the shore outward, the following zonation: *Porites lutea* zone, *Heliopora* zone, *Acropora palifera* zone, *A. digitifera* zone, and *A. cuneata* zone, which is immediately behind or on the algal ridge at the reef edge. Associated species are listed, and variations to leeward are described. From the algal reef ridge downward to a depth of 10 fathoms, corals are known to grow, but specimens cannot be recovered and are practically unknown. On the seaward slope below 10 fathoms, are found successively the *Echinophyllia* zone to 50 fathoms; the *Leptoseris* zone from 50 to 80 fathoms, the lowest depth of hermatypic coral growth; and the ahermatypic *Sclerhelia-Dendrophyllia* zone below 80 fathoms.

In the lagoon, two types of reefs are found: those to windward, which resemble seaward reefs in their coral associations, and those to leeward, representing a distinct facies, the *Porites andrewsi* zone. From the deeper waters of the lagoon to the floor there is a zone of *Acropora formosa*, which is divisible into two subzones, that of *A. reticulata* between 3 and 15 fathoms and that of *A. rayneri* from 15 fathoms downward. With their luxuriant coral growth, the coral knolls are of special interest.

Comparisons are made between the Bikini Atoll reefs and reefs in the Marshall Islands and elsewhere in the Pacific, where the general zonation of windward seaward reefs is found to hold.

The taxonomic section deals with 223 species systematically, with data on variation, coloration, and ecologic and geographic distribution. All new species are fully described and figured; and many old species, previously inadequately known iconographically, are figured anew on 92 plates including 528 photographic figures. A number of these figures show coral associations.

INTRODUCTION

PREVIOUS WORK

On July 31, 1815, the *Rurik*, under the command of Otto von Kotzebue, sailed from St. Petersburg on a three years' voyage of discovery in the Pacific. Adelbert Chamisso, the naturalist of this expedition, made the first scientific observations on the atolls of the Marshall Islands, which were visited by the *Rurik* in 1817. Large natural history collections were made, and among them were the first corals to be collected from this region. Only two of these, however, seem to have been described (Chamisso and Eysenhardt, 1821): *Caryophyllia glabrescens* Chamisso and Eysenhardt (= *Euphyllia glabrescens*) and *Tubipora musica* Linnaeus.

A. E. Verrill (1864) described two new species from Ebon (Boston) Atoll in the Ralik Chain of the Marshall Islands: *Stylaster elegans* and *Distichopora nitida* (= *D. violacea*). In 1867 he added *Paracyathus ebonensis*.

The next addition to this little group of species came as a result of Doederlein's (1902) great study of the genus *Fungia*, in which six varieties of three species of *Fungia* from the Marshall Islands, especially Jaluit Atoll, were described.

In January 1900 when the U. S. Fish Commission Steamer *Albatross* visited the Marshall Islands under the charge of Alexander Agassiz, a number of corals were collected and later deposited in the U. S. National Museum, where some were later identified by Dr. T. Wayland Vaughan. No record of these, however, has been published until the present.

Many years later, in 1931, a large collection of corals and photographs of other specimens from the then Japanese Mandate Islands was sent by Prof. H. Hattori to Dr. Vaughan from the Biological Laboratory, Imperial Palace, Tokyo. The writer was at the Scripps Institution of Oceanography at the time, and Dr. Vaughan suggested that an acquaintance with

Recent corals could have no better beginning than an attempt to identify this material, which included nearly 175 species, many of them from Jaluit Atoll. Fortunately for the writer, no list was published of these corals, for many of his original identifications have proved to have been erroneous. The Jaluit Atoll material is incorporated into the present report.

The only other work involving Marshall Islands corals is that of Yabe, Sugiyama, and Eguchi (1936 and 1941), who published the first two parts of a monograph, "Recent reef-building corals from Japan and the South Sea Islands under the Japanese mandate," in which many species of the atolls from some of the Marshall Islands (Nugol, Eniwetok, Kwajalein, Wotje, Jaluit, Namotik [Namorik],[1] Ailuk, and Pokak [Taongi] Atolls) are listed and figured. This sumptuously illustrated work is incomplete, for part of the acroporid and the poritid corals are not included. The work is most valuable for the beautiful photographic figures, among the finest yet made for corals; but few of the species are described or discussed, and no ecological information whatever is given.

COLLECTIONS OF 1946–47

Early in 1946 in connection with the atomic bomb tests of that year (Operation Crossroads), the U. S. Geological Survey undertook field studies of the geology of several of the atolls of the Marshall Islands, especially Bikini Atoll, under direction of Harry S. Ladd. During the course of this work, covering a period of about 6 months, large collections of Recent corals from the surface reefs and lagoons, with abundant data on situation and location, were made. This work was done principally by H. S. Ladd and J. I. Tracey, but many other participants in the Operation collected and donated specimens. The writer was asked in June 1946 to undertake the study of the coral collections, which were then in transit to the United States for eventual deposit in the U. S. National Museum.

During the rest of 1946 and into 1947, the writer carried out the work of identification, when free from other duties, and considered it as primarily a museum and laboratory problem that was aided by excellent field data. However, with the organization of the Bikini Scientific Resurvey in May 1947, the writer was given the opportunity of going to Bikini Atoll to make further collections and study the living corals. Seven weeks were spent at Bikini, where the distribution of corals on the reefs was studied and additions to the earlier collections were made on a large scale. Observations were also made at Rongerik Atoll. As an incidental part of the field season, 2 days were spent at Johnston Island, where a hasty but apparently fairly complete set of coral specimens was obtained with the view to the broader problems of distribution of reef corals in the Pacific.

Two important increments to the collections resulted from parallel investigations in 1946 and 1947. One was from the extensive program of bottom sampling carried out by K. O. Emery in 1946 at Bikini, Eniwetok, Rongelap, and Rongerik Lagoons. Mr. Emery spent much time separating corals from his thousands of samples and forwarded them to the writer. The other increment to the collections was from the dredgings made in the lagoon and especially down the seaward slope of Bikini by Mr. R. Dana Russell in 1947. This was the most extensive operation yet undertaken in this poorly known life-zone of Pacific Atolls. Messrs. Emery and Russell's material added to the rather large amount dredged by Messrs. Ladd and Tracey and gives a fairly comprehensive picture of the distribution of corals in Bikini Lagoon.

In the summer of 1948 the writer was able to spend several weeks in London working with the large coral collections at the British Museum (Natural History), among which are many of the types of Quelch, Brook, Bernard, Gardiner, and others. Without this access to typical material, the naming of the many *Acroporae* would have been most unsatisfactory. As others have found, the identification of such protean genera as *Acropora*, *Montipora*, and *Porites*, on the basis of the literature, especially where adequate figures are lacking, is nearly impossible.

Further, the writer has had constant access to the great coral collections of the U. S. National Museum, where are deposited most of the types of Dana, Vaughan, and Hoffmeister, as well as a few of Verrill's.

COLLECTIONS OF 1950

In the summer of 1950 the writer participated in an expedition to Arno Atoll, in the southern part of the Marshall Islands, sponsored by the Pacific Science Board of the National Research Council. Large collections of reef corals were made by the writer and Dr. R. W. Hiatt, of the University of Hawaii. Although a report on the Arno Atoll reefs has been published (Wells, 1952), the study of the corals is not yet completed. In the present paper the Arno corals are listed in table 2, but further notes on them will be published later.

ACKNOWLEDGMENTS

The writer is greatly obligated to many people for aid in the many phases of this work, and the mere mention of all who collected corals, directly or indirectly for this

[1] Where geographic name used by an author differs from that used by the U. S. Board on Geographic Names, the Board's name, in brackets, follows the name used by the author.

report alone would make a long list. The writer trusts that those who are not named here will understand that their assistance is not unappreciated. The field work of Harry S. Ladd, J. I. Tracey, R. Dana Russell, and K. O. Emery has already been alluded to. To the first three and to J. Harlan Johnson, with all of whom the writer was associated in the field, is due special acknowledgment of their material assistance.

For his many courtesies and giving of unlimited access to these coral collections, thanks are expressed to Dr. Harald A. Rehder, of the Division of Mollusks, U. S. National Museum, under whose wing are the recent coral collections. Similar acknowledgment is made to the authorities of the British Museum (Natural History), and especially to Capt. A. Knyvett Totton, for access to collections.

Previously it was mentioned that the collections of corals from the former Japanese Mandate Islands were accompanied by a number of photographs of specimens. Prof. H. Hattori, of the Biological Laboratory, Imperial Palace, Tokyo, has kindly permitted reproduction of some of these photographs in the plates accompanying this report.

Nor must the writer fail to pay tribute here to that leader of coral studies for half a century, the late Dr. T. Wayland Vaughan, whose counsel and interest in all phases of research on corals provided constant stimulus. It is a pleasure to point out here the lasting soundness of his systematic work on the Indo-Pacific corals. His thorough revision of many of the genera and species has stood up firmly with the acquisition of new material and provided a sound base for further work by succeeding workers such as Matthai, Hoffmeister, Umbgrove, Boschma, Yabe, Sugiyama, and Eguchi, and the writer.

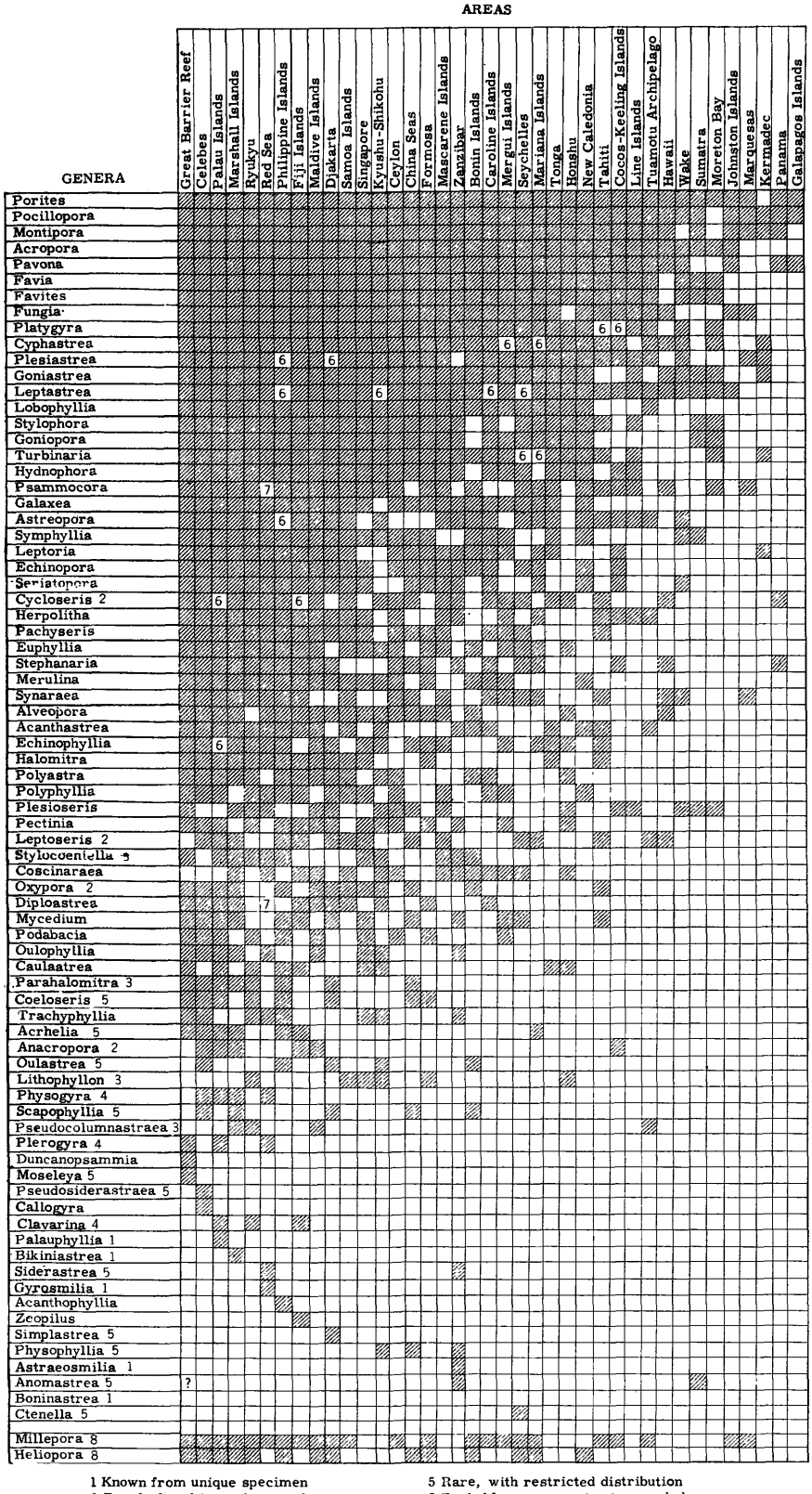
GENERAL ASPECTS OF DISTRIBUTION OF HERMATYPIC CORALS IN THE INDO-PACIFIC

In order to present a general picture of the distribution of the genera of reef-building corals in the tropical Indo-Pacific, table 1 has been compiled to show the occurrence of the 77 genera and subgenera of scleractinians and 2 important nonscleractinians in 39 areas. These areas have been selected on the bases of geographical situation and completeness of records. For some years the writer has compiled an index of records of genera and species of all Recent corals from published sources and his own studies of large collections. It is believed to be quite accurate so far as it goes; but there are, of course, many other localities or areas from which corals have been recorded or described; but except for those listed, the records are obviously incomplete and not taken into account. Deficiencies in knowledge of distribution yet remaining are emphasized by the map (pl. 186). The genera occurring in the Persian Gulf, where reefs are known to exist, are scarcely known at all; the corals of the Caroline and Mariana Islands are incompletely collected; the region eastward from New Guinea is almost unknown scleractinically, and the western and northwestern coasts of Australia and southwestern side of the Sumatra-Java-Flores arc are hardly touched. Records from some of the areas are more or less new: the genera occurring in Moreton Bay, Queensland, are taken from a list of species prepared by Dr. Dorothy Hill, University of Queensland, who has kindly permitted its use; the list from Johnston Island is based upon a collection made by the writer in 1947; and additional material from Dr. C. H. Edmondson, of the Bishop Museum, who also has lent material from Wake, Palmyra, Washington, and Christmas (P. O.) Islands (the last three in the Line Islands). The reef coral fauna of the Tuamotu Archipelago has been greatly augmented by study of the collection made at Raroia Atoll by Dr. Norman D. Newell, of Columbia University, in the summer of 1952. The list of genera occurring in the Mariana Islands is based upon a large collection recently made at Saipan and Guam by P. E. Cloud, Jr., of the U. S. Geological Survey.

The location of the areas listed on table 1 are shown on the map (pl. 186), on which are also drawn isothermal and isopangeneric lines. The table and map indicate that many genera are widely distributed, while many others apparently have a restricted geographical range, a broad generalization true for all organic groups. Among those with a restricted geographical range are some genera that are extremely rare, that is, known from a single specimen. The following are these rare genera, which are not at present significant and are not further considered: *Palauphyllia*, *Bikiniastrea*, *Zocpilus*, *Simplastrea*, *Gyrosmilia*, *Boninastrea*, and *Astraecsmilia*. Others which are rare but which the few available records indicate have a wide distribution are: *Physogyra*, *Plerogyra*, and *Clavarina*. Still others, although evidently widely distributed, rarely live in the shallow waters of surface reefs but usually in lagoons and down seaward slopes, which are as yet incompletely explored in most of the areas: *Cycloseris*, *Leptoseris*, *Oxypora*, *Anacropora*, and *Acanthophyllia*. There have been misinterpretations of a few genera such as *Lithophyllon*, which includes some specimens commonly referred to *Podabacia*, and *Parahalomitra*, which includes some forms previously placed in *Halomitra*. None of these genera are yet well enough known from an ecological standpoint to require further attention in this broad review.

One small group, however, includes genera which are

TABLE 1.—*Distribution of Indo-Pacific hermatypic coral genera and subgenera.*



1 Known from unique specimen
2 Rarely found in surface reefs
3 Probably more widely distributed
4 Rare but probably more widely distributed
5 Rare, with restricted distribution
6 Probably occurs; not yet recorded
7 Only in Gulf of Aden
8 Important hermatypic nonscleractinians; data incomplete

known only from a few localities, where they seem to be abundant: *Coeloseris, Acrhelia, Oulastrea, Caulastrea, Scapophyllia, Siderastrea, Physophyllia, Duncanopsammia, Moseleya, Ctenella, Anomastrea,* and *Pseudosiderastrea.* These would seem to be important in distinguishing subfaunae in the overall Indo-Pacific coral fauna, but this seems possible only in a few limited areas.

As is well known, the areal pattern of occurrence of hermatypic corals is closely controlled by the pattern of the minimum temperature isotherms as shown on the map. The greatest number of genera occur within the limits of the 25-degree isotherm and especially close to the 28-degree line. A notable exception is the northerly shift of the 40–50 isopangeneric lines from the Philippines toward Japan and carrying well into the 15-degree isotherm, assuredly the effect of the strong Kuroshio Current, which may replenish genera not ordinarily found outside of the higher temperature area by transportation of planulae from the areas of vigorous growth.

There is no striking variation in generic composition within the central strip of maximum variety nor in directions radiating from it. Only two genera are peculiar to the westernmost section of the Indo-Pacific: *Ctenella* and *Siderastrea,* which is evidently a relic genus of the old Tethyan Tertiary coral fauna in the Indo-Pacific, although it is still very widespread in the tropical Atlantic. The tropical western Pacific and the Malay Archipelago region has a few: *Oulastrea, Scapophyllia, Coeloseris, Acrhelia, Caulastrea, Physophyllia, Moseleya, Duncanopsammia,* and *Pseudosiderastrea.* Some of the provincially distributed genera are: *Anomastrea* along the east African coast southward from Zanzibar; *Moseleya* and *Duncanopsammia* in northern Australia, *Pseudosiderastrea* in the central region of the Malay Archipelago, and *Physophyllia* in the South and East China Seas-Japanese area. These minor provincialisms, however, leave vast areas apparently uncharacterized by any special generic types, although this may be modified as further collecting brings to light more data on some of the genera now known from unique specimens.

There is very little, if any, distinct variation in composition in directions radiating from the rich central strip, except that as peripheral areas are approached, genera drop out. But in all peripheral areas the same genera drop out in the same sequence, and the remaining peripheral faunas are of the same composition and include only genera also found more centrally. The only exception to this is the appearance of *Anomastrea* in the peripheral Natal-Zanzibar section.

In summary, the Indo-Pacific hermatypic coral fauna, so far as its composition on the generic level is concerned, is remarkably homogeneous. Its variations are principally radial gradients under temperature gradient controls, and there is no generic difference between a fauna from one extreme geographical situation and one from another within the same temperature range.

The vertical distribution of hermatypic corals has for some time been known to be controlled by two factors, depth of penetration of light rays necessary for the growth of symbiotic zooxanthellae and the depth to which vigorous water movements extend. The first determines the lower limit of reef-coral growth and probably has no appreciable effect on faunal composition, but the latter involves faunal changes. Certain genera and species of other genera normally occur in relatively quiet water at some distance below the surface, as *Leptoseris, Oxypora, Cycloseris, Anacropora,* and special species of *Acropora.* The presence of these permits the recognition of a deepwater facies of the normal surface reef fauna. Areal variations within this facies, however, cannot be analyzed at present because of lack of data; but from what little is known in such areas as the Hawaiian Islands, Marshall Islands, East and South China Seas, and the Maldive Islands, it appears to vary no more and in the same fashion as the surface reef fauna.

MARSHALL ISLANDS CORAL FAUNA

A list of all corals now known to occur in the Marshall Islands is given in table 2, and the following tabulation is developed from that list:

Scleractinians:	
Hermatypic genera and subgenera	(1 new) 52
Hermatypic species and varieties	(22 new) 240
New species, surface reefs	7
New species, lagoon and slope	15
Ahermatypic genera	(1 new) 10
Ahermatypic species and varieties	(3 new) 15
Nonscleractinians:	
Genera	6
Species and varieties	11
Total, genera and subgenera	(2 new) 68
Total, species and varieties	(25 new) 266

The number of genera and species of ahermatypic forms is small, because dredgings outside and down seaward slopes of atolls have been relatively few and to a depth of only 800 feet. Any analysis of these forms is impractical. The distribution of the nonscleractinian corals is not well worked out, and they will not be further discussed, although the occurrence of *Millepora* and *Heliopora* is indicated on tables 1 and 2.

293438—54——2

TABLE 2.—*Hermatypic and ahermatypic corals known from the Marshall Islands. Genera are listed in taxonomic order; species are alphabetized under genera. Species marked by an asterisk (*) are not discussed in the systematic section.*

	Atolls													
	Bikini	Rongelap	Rongerik	Eniwetok	Jaluit	Nugol	Kwajalein	Arno	Wotje	Namotik [Namorik]	Aliuk	Pokak [Taongi]	Ebon	Likiep
Family Astrocoeniidae														
Stylocoeniella armata (Ehrenberg)	×							×						
Family Thamnasteriidae														
Psammocora explanatula van der Horst	×													
nierstraszi van der Horst	×							×						
(*Stephanaria*) *togianensis* Umbgrove					×									
(*Plesioseris*) *haimeana* Milne-Edwards and Haime	×							×						
(*Plesioseris*) *superficialis* Gardiner*								×						
Family Pocilloporidae														
Stylophora mordax (Dana)	×		×	×	×			×	×		×	×		
pistillata (Esper)	×							×						
Seriatopora angulata Klunzinger	×			×	×	×		×	×		×	×		
hystrix Dana	×		×	×	×			×				×		
Pocillopora brevicornis Lamarck	×													
damicornis (Linnaeus)	×		×		×		×	×	×		×			
danae Verrill	×							×						
elegans Dana	×	×	×	×				×						
eydouxi Milne-Edwards and Haime	×		×					×						
ligulata Dana	×							×						
meandrina nobilis Verrill	×							×						
setchelli Hoffmeister	×			×					×					
sp. cf. *P. solida* Quelch*								×						
verrucosa (Ellis and Solander)	×	×	×	×	×			×	×		×	×		
Madracis sp	×													
Family Acroporidae														
Acropora abrotanoides (Lamarck)	×													
acuminata Verrill	×		×	×				×						
arbuscula (Dana)	×													
brevicollis (Brook)*								×						
conferta (Quelch)	×			×	×									
conigera (Dana)*								×						
corymbosa (Lamarck)	×		×	×	×			×						
cuneata (Dana)	×		×					×						
cymbicyathus (Brook)	×		×	×				×						
danai (Milne-Edwards and Haime)		×												
delicatula (Brook)	×													
diffusa Verrill*								×						
digitifera (Dana)	×							×						
disticha (Brook)*								×						
diversa (Brook)	×			×				×						
echinata (Dana)	×		×	×	×			×						
formosa (Dana)	×	×		×				×						
hebes (Dana)				×				×						
humilis (Dana)	×		×	×	×			×						
hyacinthus (Dana)	×			×	×			×						
hystrix (Dana)	×							×						
implicata (Dana)	×													
inermis (Brook)		×												
kenti (Brook)					×									
microphthalma Verrill	×				×			×						
nana (Studer)*								×						
nasuta (Dana)	×			×				×						
nasuta crassilabia (Brook)	×													
nobilis (Dana)	×													

TABLE 2.—*Hermatypic and ahermatypic corals known from the Marshall Islands. Genera are listed in taxonomic order; species are alphabetized under genera. Species marked by an asterisk (*) are not discussed in the systematic section.*—Continued

	Atolls													
	Bikini	Rongelap	Rongerik	Enlwetok	Jaluit	Nugol	Kwajalein	Arno	Wotje	Namotik [Namorik]	Ailuk	Pokak [Taongi]	Ebon	Likiep
Family Acroporidae—Continued														
Acropora —Continued														
palifera (Lamarck)	×	×	×	×	×	×		×						
palmerae Wells, n. sp	×			×				×						
paniculata Verrill	×													
polymorpha (Brook)	×													
procumbens (Brook)*								×						
prostrata (Dana)	×													
pulchra (Brook)*								×						
rambleri (Bassett-Smith)	×													
ramiculosa (Dana)	×													
rayneri (Brook)	×			×										
reticulata (Brook)	×				×			×						
rosaria (Dana)	×													
rotumana (Gardiner)	×		×	×				×						
spicifera (Dana)	×													
squarrosa (Ehrenberg)	×	×	×					×						
striata Verrill	×		×	×				×						
surculosa (Dana)	×	×						×						
syringodes (Brook)	×	×			×			×						
tenella (Brook)	×													
tenuis (Dana)*								×						
teres Verrill	×			×										
teres distans Wells, n. var		×												
tizardi (Brook)	×							×						
tubicinaria (Dana)	×							×						
valida (Dana)	×							×						
variabiiis (Klunzinger)	×	×												
vaughani Wells, n. sp	×	×												
virgata (Dana)	×													
Astreopora sp. cf. *A. gracilis* Bernard	×									×				
listeri Bernard	×													
myriophthalma (Lamarck)	×		×	×	×	×		×	×			×		
ocellata Bernard	×						×				×			
profunda Verrill*										×				
punctifera Verrill*						×								
suggesta Wells, n. sp	×													
tabulata Wells, n. sp	×													
Montipora cactus Bernard*								×						
caliculata (Dana)	×	×						×						
circumvallata (Ehrenberg)*								×						
colei Wells n. sp	×													
sp. cf. *M. complanata* (Lamarck)	×													
composita Crossland	×													
conicula Wells, n. sp	×													
danae Milne-Edwards and Haime	×													
ehrenbergii Verrill	×													
etschneri Vaughan	×													
floweri Wells, n. sp														
foveolata (Dana)	×	×						×						
gaimardi Bernard*								×						
granulata Bernard	×							×						
granulosa Bernard	×													
hoffmeisteri Wells, n. sp	×							×						

TABLE 2.—*Hermatypic and ahermatypic corals known from the Marshall Islands. Genera are listed in taxonomic order; species are alphabetized under genera. Species marked by an asterisk (*) are not discussed in the systematic section.*—Continued

	Atolls													
	Bikini	Rongelap	Rongerik	Enlwetok	Jaluit	Nugol	Kwajalein	Arno	Wotje	Namotik [Namorik]	Ailuk	Pokak [Taongi]	Ebon	Likiep
Family Acroporidae—Continued														
Montipora—Continued														
informis Bernard*								×						
marshallensis Wells n. sp	×							×						
minuta Bernard	×													
sp. cf. *M. myriophthalma* Bernard	×													
sp. cf. *M. pallida* Bernard	×													
patula Verrill*								×						
socialis Bernard	×	×		×										
sp. cf. *M. solanderi* Bernard*								×						
sp. cf. *M. studeri* Vaughan	×													
subtilis Bernard	×													
tuberculosa (Lamarck)	×							×						
turgescens Bernard	×													
venosa (Ehrenberg)	×			×				×						
verrilli Vaughan	×							×						
verrucosa (Lamarck)	×							×						
Anacropora forbesi Ridley	×	×												
gracilis Quelch	×													
reptans Bernard	×							×						
Family Agariciidae														
Pavona clavus (Dana)	×				×			×		×	×			
danai (Milne-Edwards and Haime)					×									
divaricata Lamarck*					×									
frondifera Lamarck					×									
minor Brueggemann					×			×						
minuta Wells, n. sp	×													
praetorta (Dana)					×	×		×						×
varians Verrill	×	×			×	×		×			×			
(*Pseudocolumnastraea*) *pollicata* Wells, n. sp	×							×						
(*Polyastra*) *obtusata* (Quelch)*								×						
(*Polyastra*) *planulata* (Dana)*								×						
(*Polyastra*) *venosa* Ehrenberg*								×						
(*Polyastra*) *venosa arbuscula* Umbgrove*								×						
Leptoseris gardineri van der Horst	×													
hawaiiensis Vaughan	×													
incrustans (Quelch)	×							×						
mycetoseroides Wells, n. sp	×													
papyracea (Dana)	×												×	
scabra Vaughan	×													
solida (Quelch)	×													
Pachyseris rugosa (Lamarck)					×									
speciosa (Dana)	×													
Family Siderastreidae														
Coscinaraea columna (Dana)	×							×						
ostreaeformis van der Horst	×													
Family Fungiidae														
Cycloseris distorta (Michelin)	×													
fragilis (Alcock)	×													
hexagonalis Milne-Edwards and Haime	×			×										
patelliformis (Boschma)	×													
vaughani (Boschma)	×													

TABLE 2.—*Hermatypic and ahermatypic corals known from the Marshall Islands. Genera are listed in taxonomic order; species are alphabetized under genera. Species marked by an asterisk (*) are not discussed in the systematic section.*—Continued

	Atolls													
	Bikini	Rongelap	Rongerik	Eniwetok	Jaluit	Nugol	Kwajalein	Arno	Wotje	Namotik [Namorik]	Ailuk	Pokak [Taongi]	Ebon	Likiep
Family Fungiidae—Continued														
Fungia concinna Verrill *								×						
concinna serrulata Verrill	×	×												
echinata (Pallas)					×									
fungites agariciformis Lamarck *								×						
fungites confertifolia Dana *								×						
fungites dentata Dana	×	×			×									
fungites haimei Verrill	×	×			×			×						
fungites incisa Doederlein		×												
fungites stylifera Doederlein	×				×									
paumotuensis Stutchbury *								×	×	×				
repanda Dana *											×			
scutaria Lamarck	×	×	×	×	×			×			×	×		
Herpolitha limax (Esper)	×	×			×			×						
Halomitra philippinensis Studer					×			×						
Parahalomitra dentata (Quelch)	×													
robusta (Quelch)	×				×									
Family Poritidae														
Goniopora sp. cf. *G. gracilis* (Bassett-Smith)					×									
muscosa Wells, n. sp	×													
pulvinula Wells, n. sp	×													
somaliensis Vaughan	×													
traceyi Wells, n. sp	×													
Porites andrewsi Vaughan	×		×					×						
australiensis Vaughan	×	×			×			×						
fragosa Dana	×													
lichen Dana	×		×					×						
lobata Dana	×		×					×						
lutea Milne-Edwards and Haime	×	×		×	×			×						
matthaii Wells, n. sp					×									
murrayensis Vaughan	×													
studeri	×													
superfusa Gardiner	×	×						×						
(*Synaraea*) *hawaiiensis* Vaughan	×													
(*Synaraea*) *horizontalata* Hoffmeister		×												
(*Synaraea iwayamaensis* Eguchi					×									
(*Synaraea*) *monticulosa* (Dana)					×			×						
Alveopora allingi Hoffmeister		×												
fijiensis Hoffmeister *								×						
ocellata Wells, n. sp	×													
Family Faviidae														
Bikiniastrea laddi Wells, n. gen., n. sp	×													
Favia favus (Forskaal)	×							×						
helianthoides Wells, n. sp	×													
pallida (Dana)	×		×	×	×	×		×						
rotumana (Gardiner)	×													
speciosa (Dana)	×				×	×		×	×	×	×	×		
stelligera (Dana)	×			×	×			×						
valenciennesii (Milne-Edwards and Haime)	×		×											
Favites abdita (Ellis and Solander)	×							×						
flexuosa (Dana)	×													
halicora (Ehrenberg)*								×						
virens (Dana)	×		×											

TABLE 2.—*Hermatypic and ahermatypic corals known from the Marshall Islands. Genera are listed in taxonomic order; species are alphabetized under genera. Species marked by an asterisk (*) are not discussed in the systematic section.*—Continued

	Atolls													
	Bikini	Rongelap	Rongerik	Eniwetok	Jaluit	Nugol	Kwajalein	Arno	Wotje	Namotik [Namorik]	Ailuk	Pokak [Taongi]	Ebon	Likiep
Family Faviidae—Continued														
Plesiastrea lilli Wells, n. sp	×													
russelli Wells, n. sp	×													
versipora (Lamarck)	×							×						
Goniastrea pectinata (Ehrenberg)	×				×			×						
retiformis (Lamarck)	×		×	×	×			×			×			
Oulophyllia crispa (Lamarck)	×				×			×						
Platygyra rustica (Dana)	×	×	×	×	×	×		×			×			
sinensis (Milne-Edwards and Haime)			×					×						
Leptoria gracilis (Dana)*							×	×			×	×		
phrygia (Ellis and Solander)*				×					×					
Hydnophora exesa (Pallas)*								×						
microconos (Lamarck)	×	×		×				×	×			×		
rigida (Dana)	×			×				×						
Merulina ampliata (Ellis and Solander)*						×		×						
Scapophyllia cylindrica Milne-Edwards and Haime*								×						
Leptastrea purpurea (Dana)	×							×			×			
transversa (Klunzinger)*								×						
Cyphastrea chalcidicum (Forskaal)	×				×	×								
serailia (Forskaal)	×			×				×		×	×			
Echinopora lamellosa (Esper)	×				×	×		×		×		×		
Diploastrea heliopora (Lamarck)	×													
Family Rhizangiidae														
Culicia rubeola (Quoy and Gaimard)	×													
Family Oculinidae														
Sclerhelia alcocki Wells, n. sp	×													
Galaxea fascicularis (Linnaeus)*					×						×			
Acrhelia horrescens (Dana)					×			×						
Family Mussidae														
Lobophyllia hemprichii (Ehrenberg)	×													
corymbosa (Forskaal)	×							×						
costata (Dana)	×							×			×	×		
Symphyllia nobilis (Dana)	×	×	×	×					×			×		
recta (Dana)*								×						
Acanthastrea echinata (Dana)*	×							×						
Family Pectiniidae														
Echinophyllia aspera (Ellis and Solander)	×	×						×						
Oxypora lacera (Verrill)	×													
Mycedium elephantotus (Pallas)*								×						
Family Caryophylliidae														
Caryophyllia rugosa Moseley	×													
Paracyathus parvulus Gardiner	×													
ebonensis Verrill*													×	
Deltocyathus italicus (Michelotti)	×													
Desmophyllum sp. cf. *D. crista-galli* Milne-Edwards and Haime	×													
delicatum Yabe and Eguchi	×													
Dactylotrochus cervicornis (Moseley), n. gen	×													
Euphyllia glabrescens (Chamisso and Eysenhardt)	×		×							×				
Physogyra lichtensteini (Milne-Edwards and Haime)					×									

TABLE 2.—*Hermatypic and ahermatypic corals known from the Marshall Islands. Genera are listed in taxonomic order; species are alphabetized under genera. Species marked by an asterisk (*) are not discussed in the systematic section.*—Continued

	Atolls													
	Bikini	Rongelap	Rongerik	Eniwetok	Jaluit	Nugol	Kwajalein	Arno	Wotje	Namotik [Namorik]	Ailuk	Pokak [Taongi]	Ebon	Likiep
Family Dendrophylliidae														
Turbinaria crater (Pallas)	×													
irregularis Bernard	×				×									
mesenterina (Lamarck)	×													
sp. cf. *T. sinensis* Verrill	×													
sp. cf. *T. stellulata* (Lamarck)	×													
tayamai Yabe and Sugiyama*					×									
sp. cf. *T. veluta* Bernard	×													
Dendrophyllia fistula (Alcock)	×													
florentula van der Horst	×													
n. sp.?	×													
Rhizopsammia chamissoi Wells, n. sp	×													
minuta bikiniensis Wells, n. var	×													
Family Tubiporidae														
Tubipora musica (Linnaeus)	×		×	×				×						
Family Helioporidae														
Heliopora coerulea (Pallas)	×	×	×	×				×						
Family Milleporidae														
Millepora exaesa Forskaal	×	×												
platyphylla Hemprich and Ehrenberg	×		×	×				×						
tenera Boschma	×				×			×						
Family Stylasteridae														
Stylaster asper Kent	×							×						
elegans Verrill	×												×	
eximius Kent*								×						
Errina sp	×													
Distichopora violacea (Pallas)	×	×			×								×	×
fisheri Broch	×	×		×										

The Marshall Islands hermatypic scleractinian fauna is rich and varied, and only three other areas are known to have a greater number of genera: Celebes, 54; Great Barrier Reef, 54; and Palau Islands, 53. Several widely spread genera are not yet known from the Marshall Islands: *Pectinia*, *Podabacia*, *Polyphyllia*, *Caulastrea*, *Coeloseris*, and *Lithophyllon*. Some of these are almost certain to be found by future collectors. It should be remembered that the only part of the Marshall Islands where corals have been really intensively collected is at Bikini Atoll, in the northern part of the group. At Jaluit Atoll, in the southern part, the occurrence of several genera not found at Bikini, such as *Stephanaria*, *Halomitra*, *Merulina* (Nugol Atoll), *Acrhelia*, *Galaxea*, and *Physogyra*, suggests that similarly intensive collecting will find some of the missing corals. Similarly, the seemingly smaller variety in the Caroline Islands to the west of the Marshall Islands and in the same temperature control belt assuredly reflects incompleteness of collection rather than a diminished fauna. Few genera that are truly typical of the rich central strip are missing in the Marshall Islands, as will be seen by reference to table 1.

The total of 211 hermatypic scleractinian species is large. Comparisons of numbers of species, even in the well-collected areas, however, are not especially significant at this time because of poor data on the species of many genera (especially *Acropora*, *Montipora*, *Porites*, *Goniopora*, and other taxonomically difficult genera) and because many areas have had extensive collecting only on the surface reefs. Some idea of the comparative number of species has been given by Vaughan and Wells (1943, p. 77–82) and need not be recapitulated.

If only surface reef species of the Marshall Islands are counted, the total species drops to about 150, which is still a large number, especially when it is remembered that most of these occur at Bikini Atoll. If the Marshall Islands could be thoroughly searched, the total surface reef species would be nearer 200. But the net figure of

150 known species compares well with the total known species from the following localities: Palau Islands, 150; the Philippines, 155 known but probably higher; Teluk Djakarta, 117, fairly complete collections; Ryukyu Islands, 134; Great Barrier Reef, probably about 200; and Fiji Islands, about 150.

Within the Marshall Islands there are a few minor variations in the reef fauna from one atoll to another, although collections are still insufficient from sites other than Bikini to perceive any pattern. No frondose or ramose species of *Pavona* occur at Bikini, but five such forms are known from Jaluit and other atolls, and such forms are very common elsewhere in the Pacific. *Fungia echinata* has been found at Jaluit Atoll but not at Bikini. This is a very widespread species-group of *Fungia* from the Red Sea east to Tahiti and north to the Ryukyu Islands. Notable, too, is the absence in the Marshall Islands of the *actiniformis* group of *Fungia* while ramose species of *Montipora* are very rare.

ZONAL ANALYSIS OF THE CORAL FAUNA

The scleractinian-alcyonarian-hydrozoan stony coral associations of the reefs and deeper waters are divisible at Bikini Atoll on the basis of local differences into zones, as outlined in plate 187. Details of the distribution of the species at Bikini Atoll are shown in table 3.

The term "zone" is used here to refer to an area where local ecologic differences are reflected in the species association and signalized by one or more dominant species. It is the same as the term "facies" used by Umbgrove (1940, p. 5) for "various combinations of special kinds of bottom and conditions for life, each with a corresponding fauna adapted to it."

SEAWARD REEF

The clearest zonation at Bikini Atoll is found on the windward seaward reefs, and that at Bikini island, which has been most thoroughly studied, will serve as an example. The length of the reef may be divided into a set of bands or zones parallel to the long curving axis of the island (pl. 94). The situation is somewhat similar to that described for Yonge Reef, of the Outer Barrier series, of the Great Barrier Reef, by Stephenson and others (1931, p. 32, 83). These zones, beginning with the outermost, at the reef edge are: *Acropora cuneata* zone, *A. digitifera* zone, *A. palifera* α zone, *Heliopora coerulea* zone, and *Porites lutea* zone.

Acropora cuneata *zone.*—The *Acropora cuneata* zone includes the region of the *Lithothamnion* or algal ridge, a structure developed on the windward margins of seaward reefs in many parts of the tropical Pacific. It is highest (1 or 2 feet above water at low tide) at the seaward edge with a comparatively gentle slope inward to the reef flat. The boundary of this zone of highly agitated water and the *Acropora digitifera* zone to landward is not distinct, and the two merge imperceptibly. The distinctive species here is *Acropora cuneata*, which has a roughly circular, expanded, encrusting base from which arise vertical plates oriented roughly parallel to the direction of water movement (pl. 101, fig. 3). Associated, but less abundant, are *A. digitifera*, *A. humilis* γ (pl. 100, fig. 1), *A. rotumana*, *A. humilis* α (in protected places), and *A. surculosa*. *A. palmerae* forms very large encrustations especially at sites between islands (pl. 100, fig. 4), where the algal ridge is low and slopes gently seaward as well as lagoonward. *Porites* is represented almost exclusively by patches of *P. lichen* (pl. 165, fig. 3), and *P. lobata* occurs occasionally in encrusting patches. *Montipora* is represented by *M. elschneri*. Other species are *Plesiastrea versipora; Coscinaraea columna*, in cavities; and *Favia stelligera*.

Pocillopora is best represented in this zone (pl. 95, fig. 2) and is the only important branching scleractinian growing in the dash of the surf on the ridge. It is represented by a number of species: *P. ligulata*, *P. damicornis*, *P. setchelli*, *P. verrucosa*, *P. eydouxi*, *P. danae*, and *P. elegans*. Equally abundant here is the hydrozoan *Millepora platyphylla*, which rarely occurs elsewhere.

A special ecologic niche in this zone is provided by the deeper parts of the surge channels and their cavernlike ramifications ("room-and-pillar structure"), in which the water oscillates constantly and strongly but is not agitated, except at the outer ends. Here grow luxuriantly on the illuminated sides of the passages down to a depth of about 20 feet a number of species less commonly found elsewhere: *Coscinaraea columna* (greatest development), *Turbinaria* sp. aff. *T. veluta*, *Heliopora coerulea* γ, *Acropora nasuta*, *A. surculosa*, *A. variabilis*, *A. rosaria* (rare), *Pavona clavus*, *Stylophora mordax*, and *Plesiastrea lilli*. The edges of the deeper channels are bordered by patches of brilliant red-violet *Montipora caliculata* and yellow-green *Porites superfusa*.

This zone diminishes in development on the leeward reefs, where a prominent algal ridge is not developed and the reef margin assumes the character of the lagoon reefs. Some of the characteristic lagoon-reef species occur here, as instanced by the reef near the sheltered western end of Enirik island, south side of Bikini Atoll. Here the reef slopes gently from the shore outwards to a depth of 6–8 feet at the reef margin and then drops abruptly down to the 10-fathom terrace. Notable is the absence of *Acropora cuneata* and *A. palmerae*, scarcity of *Pocillopora*, and presence of *A. reticulata*, *A. acuminata*, *A. nasuta*, and other lagoon reef types.

Acropora digitifera *zone.*—The *Acropora digitifera* zone is the band between the inner part of the *Litho-*

thamnion or algal ridge (*A. cuneata* zone) and the *A. palifera* α zone. It is not as clearly defined as the zones to landward. It includes a part of the reef flat, which bears microatolls of varied composition ("mixed microatolls") and size, growing on the rocky surface in depths from 1 to 2 feet to awash at ordinary low tide. This is the region of greatest variety of corals on the seaward, surface-reef flats, although most of its surface is actually bare of coral colonies. Scattered on its surface are firmly cemented, encrusting, nodular, and stunted ramose colonies and microatolls from a few inches to many feet across. The larger microatolls (pl. 95, fig. 3) are formed by the growth of several adjoining colonies, often of different species, with secondary development on their dead parts of yet different species; and their flat, rotten tops provide a substratum for still other forms. Calcareous algae are an important element of these structures. They are uncommon and usually absent on the flat between the mixed microatolls and grow best on or near their tops, where circulation of water from the here enfeebled surf is greatest.

The distinctive coral of this zone is *Acropora digitifera*, with its slender finger-sized branches and bright, fluorescent-green or grayish polyps. Associated common species are *Pocillopora danae*, large clumps; *Acropora humilis* α; *A. nasuta; A. tubicinaria*, very common; *Astreopora myriophthalma; Porites lobata; P. lichen*, encrusting surface of flat; *Favia pallida; Favites valenciennesi, F. virens; Leptastrea purpurea;* and *Cyphastrea serailia*, encrusting surface of flat. Less abundant are: *Acropora humilis* γ; *A. acuminata*, occasional loose pieces; *Coscinaraea columna*, small patches; *Pavona varians; Favia helianthoides; Echinopora lamellosa; Plesiastrea versipora; Euphyllia glabrescens*, only one or two seen in this zone; *Lobophyllia costata*, infrequent but large hemispherical heads; *Goniastrea retiformis; G. pectinata; Favia favus; F. stelligera; Platygyra rustica*, large colonies; *Stylophora pistillata; Fungia scutaria*, loose on tops of microatolls; and *Turbinaria* sp. cf. *T. stellulata*.

In places, as between Eniairo and Rochikarai islands and at Bikini Atoll, *Tubipora musica* is very common in the seaward part of this zone where it passes into the *Acropora cuneata* zone.

Acropora palifera α *zone.*—The *Acropora palifera* zone includes the reef flat proper, as defined by Tracey and others (1948, p. 867). It is not sharply delimited from the *A. digitifera* zone or the *Heliopora* zone. In the seaward part, a band 50 to 300 feet wide is occupied almost exclusively by *A. palifera* α. It is covered by about 1 foot of water but deepens to landward. Near the outer margin of the *Heliopora* zone where the water is 2 to 3 feet deep at low tide, there are scattered clumps or microatolls of *A. palifera* α mingled among *Helioporae*.

In the shallower water in the outer part of this zone, small nodules and microatolls of *Porites lobata, Favia favus, F. pallida, Favites abdita,* and *Cyphastrea serailia* become fairly abundant; and in places where the flat is otherwise nearly barren and composed of bare rock a few inches below low water level, these are about the only corals.

The microatolls of *A. palifera* α are not so large as those of *Heliopora*, rarely being more than 10 feet across; nor are they so compact. The thick branches of *A. palifera* α are interlaced but with spaces several inches across everywhere, and the rottenness of the inner parts makes them crumble when one tries to climb atop them. The surface, sides, and nooks and crannies make these microatolls a haven for small encrusting and lightly branching corals, especially *Stylocoeniella armata*, which can almost always be found forming small patches in the well-shaded recesses of the clumps. Many other species are also found on the clumps: *Acropora microphthalma; A. humilis* α; *A. delicatula; A. striata; Astreopora listeri; A. ocellata; Porites lichen; P.* (*Synaraea*) *hawaiiensis*, in dark cavities; and *Stylophora pistillata*.

Heliopora coerulea *zone.*—The depth of water over the flat in this zone is 1 to 4 feet at low tide, and the width of the zone ranges from 100 to 500 feet. Over this area are innumerable colonies of *Heliopora coerulea* rising from the rocky surface of the reef flat in the form of microatolls from a few feet to as much as a hundred feet across, often laterally coalescing to form a continuous surface at low tide over which one can walk. The pools or passages between the colonies are covered on the bottom by a thin veneer of sand and coral fragments on which few if any corals are found.

Corals other than *Heliopora* are not numerous in this zone. The most common of the other corals are *Stylophora pistillata* and and *Seriatopora hystrix*, both of which are relatively scarce elsewhere on the surface reefs. These grow as tufts on the sides of the *Helioporae*, but here and there isolated colonies arise from boulders or dead coral pieces. Small colonies of *Porites lutea* and *Cyphastrea serailia* are also occasionally found.

At the west end of Namu island, Bikini Atoll, the development of this zone is remarkable. Enormous microatolls of *Heliopora* up to an acre in extent rise from 3 to 12 feet of water. The tops are compact, form a firm platform at low tide level, and are cut by steep-sided channels. In these channels, shallow surface pools, crevices, and the deeper passages between the microatolls, a rich variety of corals grows: *Goniastrea retiformis; G. pectinata; Euphyllia glabrescens.*

very rare; *Oulophyllia crispa*, large coralla; *Acanthastrea hemprichii; Fungia scutaria* (pl. 95, fig. 1); *F. fungites dentata*, in deep channels; *F. concinna serrulata; Lobophyllia corymbosa*, rare; *Pavona varians*, encrusting branches of *Heliopora; Porites lutea*, microatolls on surface of *Helioporae; P. lichen; P. andrewsi*, large thickets in channels; *Turbinaria irregularis*, and *Acropora acuminata*. Except for the last species, *Acropora* is very rare, and no colonies of *Pocillopora* were seen.

On the south side of Enirik island, south side of Bikini Atoll, the seaward reef is much narrower at Bikini island, but the *Heliopora* zone is extensively developed with a much greater variety of associated species: *Acropora squarrosa*, abundant; *Fungia scutaria*, between *Helioporae; Stylocoeniella armata*, in dark cavities; *Pocillopora danae; P. verrucosa*; *Acropora tubicinaria; A. nasuta, A. variabilis, A. palifera*, occasional; *Psammocora nierstraszi*, encrusting *Helioporae; Montipora ehrenbergii*, encrusting *Helioporae; Porites superfusa*, and *P. lichen*. The larger variety of species, especially those of *Acropora*, is probably due to the proximity of the reef margin, where the water is more agitated.

Porites lutea *zone*.—Adjacent to the beach in shallow water less than a foot in depth at ordinary low tide is a strip a few feet wide where both the yellow and purplish-brown variants of *Porites lutea* are the only corals, and indeed almost the only living form, except for scattered still-living loose pieces of corals rolled in from farther out. The colonies are small irregular nodules or microatolls up to several feet across, firmly cemented to the smooth rock platform which is elsewhere covered by a thin coating of sand and coral fragments (pl. 165, fig. 2). At a distance of 5 to 25 feet from the strand ine, this zone merges with the *Heliopora* zone.

ALGAL RIDGE TO THE TEN-FATHOM TERRACE

From the outer edge of the algal ridge or reef margin down the cliffed (leeward) or buttressed (windward) slope toward the 10-fathom terrace lies the mare incognitum of the reefs. The only data on this region are from glimpses obtained through face masks while swimming off the algal ridge, a dangerous and inefficient proceeding, and from air photographs. Use of diving or dredging equipment is impossible owing to the heavy surf. From air photographs and limited direct observation, "algal spurs and grooves" have been described by Tracey and others (1948, p. 872, figs. 5, 8) as descending to about 10 fathoms to a preexisting surface. Algal growth is strongest on the tops of the spurs, and the grooves are veneered with fragmental debris. Apparently few corals grow in this zone. At any rate, as far as the eye can see, few can be seen on the spurs, and the grooves are relatively barren of either coral or algae. On the other hand, the presence of large boulders of coral colonies of much larger size than are now encountered on the reef flat or algal ridges suggests that corals do grow profusely in the lower part of this zone and from time to time are torn loose and worked across the flat. The species are all reef-flat types, although one or two species at Bikini are known only from dead and worn specimens.

SEAWARD SLOPE

Beyond the 10-fathom terrace lies the seaward slope which extends uniformly with an average slope of 25° (Emery, 1948, p. 856) to 200 fathoms, beyond which data on corals are lacking at present. From a depth of about 10 fathoms downward, the bottom lies far enough outward from the surface reef margin to permit the use of dredging equipment with little risk when ship or boat is operated by experienced seamen. In 1947 under the direction of R. Dana Russell (Bikini Scientific Resurvey), corals were recovered in hauls off the eastern, southern, and northwestern sides of Bikini Atoll. This represents, of course, the merest scratching of a very large area, and the amount of material procured is trifling compared with collections made on the surface reefs and in the lagoon. Nevertheless, the collection is larger than any previously obtained in this part of the Pacific and adds immensely to our knowledge of the bathymetric distribution of reef corals. It contains a number of new species characteristic of these little known depths, and comparisons can now be made with the few sites in other areas where similar collections have been made—Hawaii (Vaughan, 1907), Maldive Islands (Gardiner, 1903), and Funafuti Atoll (Gardiner, 1898b).

In dealing with the dredging depths, some of which were "long hauls" owing to rough submarine terrain, with variations of as much as 32 fathoms, only the minimum depth of each haul has been used in analyzing the distribution of the corals.

Although the data are admittedly slender, three zones may tentatively be recognized: (1) *Echinophyllia* zone, 10 to 50 fathoms; (2) *Leptoseris* zone, 50 to 80 fathoms; and (3) *Sclerhelia-Dendrophyllia* zone, below 80 fathoms. Of these, the first is the lowest zone into which surface reef species extend and grow with any degree of strength. In the lower part of the zone, below 30 to 40 fathoms, there is a noticeable decrease in kind, individuals, and size of these forms. The second zone, that of *Leptoseris*, is marked by special species or a facies which differs from those of the surface reef forms but is not truly ahermatypic This is the bathymetric faunal zone recognized first by Gardiner (1903) in the Maldive Islands between 25 and 40 fathoms and later in the Hawaiian Islands by Vaughan

(1907) at the same depths. At Bikini Atoll this zone appears to be developed at a somewhat greater depth.

Echinophyllia *zone.*—This includes the seaward-slope coral zone between 10 and 50 fathoms, where *Echinophyllia aspera* and its ally *Oxypora lacera* occur in abundance. These species are not found on the surface reefs nor in the lagoon at Bikini Atoll, although a specimen of the former was collected from a reef-flat pool at Rongelap Atoll. Other species in this zone are (1) species occurring also on the surface reefs, (2) forms peculiar to this zone, and (3) forms found also at corresponding depths in the lagoon.

In the first group are such forms as *Stylocoeniella armata, Pocillopora elegans, P. damicornis, Montipora verrilli, Porites (Synaraea) hawaiiensis, Favia stelligera, F. helianthoides, Favites flexuosa, Goniastrea pectinata, Heliopora coerulea,* and *Distichopora violacea.* Most of these occur in the upper part of the zone (10–20 fathoms) and in general are those forms which are more tolerant of varied ecologic conditions.

As would be expected in material from a relatively unexplored environment, a few new species were found: *Pavona (Pseudocolumnastraea) pollicata, Plesiastrea russelli, Astreopora suggesta, Montipora colei, Goniopora pulvinula,* and *Alveopora ocellata.* Other species at Bikini Atoll found only in this zone, in addition to *Echinophyllia aspera* and *Oxypora lacera,* are *Madracis* sp., *Acropora syringodes, Psammocora (Plesioseris) haimeana, P. explanatula, Cycloseris vaughani, Parahalomitra robusta, P. dentata, Porites fragosa, P. studeri, Pachyseris speciosa, Favia speciosa, Hydnophora microconos, Stylaster elegans,* and *Millepora tenera.* Some of these extend a short distance beyond 50 fathoms into the *Leptoseris* zone (see table 3).

In addition to the forms listed above, there are a number of species which also occur in the lagoon at Bikini Atoll below the surface reefs, notably species of *Acropora.*

TABLE 4.—*Distribution of species in Bikini Lagoon and down the seaward slope*

Species	Lagoon (in fathoms)	Seaward slope (in fathoms)
Acropora rayneri	17–23	12–44
rambleri	22–30	25–44
reticulata	6–14	21–25
vaughani	4–22	21–25
Astreopora tabulata	14–20	20–75
Montipora marshallensis	30	25–44
verrucosa	22	25–44
Leptoseris incrustans	8–23	12–48
Leptoseris? mycetoseroides	8–23	12–44

Acropora formosa, so abundant in the lagoon at all depths, was not found on the seaward slope. Nor are *Seriatopora* or *Stylophora* represented here.

Leptoseris *zone.*—The *Leptoseris* zone, which lies between 50 and 80 fathoms, is transitional between the overlying *Echinophyllia* zone, in which hermatypic corals are most abundant on the seaward slope, and the underlying *Sclerhelia-Dendrophyllia* zone below 80 fathoms, in which there are only ahermatypic or deep sea corals.

In the upper part of the zone are found species straggling down from the *Echinophyllia* zone: *Astreopora suggesta, A. tabulata, Echinophyllia aspera, Pachyseris speciosa, Goniopora pulvinula, Acropora syringodes,* and *Montipora colei. Cycloseris vaughani, Parahalomitra dentata* occur in the lower part of the *Echinophyllia* zone and extend well down into the *Leptoseris* zone.

The commonest coral on this zone is *Leptoseris,* a non-surface-reef coral. Species of this genus found in every haul from this zone were *L. hawaiiensis, L. papyracea, L. scabra,* and *L. solida.* Other hermatypic types found only in this zone are *Montipora granulosa, Coscinaraea ostreaeformis,* and *Goniopora muscosa,* but all colonies are small and evidently rather widely spaced on the slope, and the entire zone is clearly below the depth of optimum growth.

Ahermatypic forms of this zone are *Caryophyllia rugosa, Paracyathus parvulus, Desmophyllum crista-galli, Rhizopsammia minuta,* and *Dactylotrochus cervicornis.*

Sclerhelia-Dendrophyllia *zone.*—Records thus far of Bikini Atoll corals from depths greater than 80 fathoms are confined to four hauls (locations 104, 108, 112, 118) between 97 and 133 fathoms. From these there are a new species of *Sclerhelia (S. alcocki)* and two species of *Dendrophyllia (D. florentula, D. fistula).* Further dredgings down the slope would certainly add greatly to these.

LAGOON

The lagoon of Bikini Atoll is about 23 miles long in an east-west direction and about 12 miles wide, comprising more than 200 square miles. The bottom of the lagoon, 160 to 200 feet below the surface, is a relatively level floor from which coral knolls rise abruptly to within 25 to 50 feet of the surface. Within the encircling belt of islands and seaward reefs the bottom slopes gently down to a 10-fathom terrace, believed to be the same as that encountered on the seaward slope, and thence downward steeply to the lagoon floor. The areas of coral growth in this whole area may be divided into the lagoon reefs, the slope to the 10-fathom terrace, the lagoon floor, and the coral knolls.

Lagoon reefs.—The surface reefs facing the lagoon develop in two distinct environments: (1) The relatively

protected windward side of the atoll, which is behind the islands and reef of that side, and (2) on the relatively exposed inside of the leeward part of the atoll. At Bikini, as well as in other large atolls, the fetch of the wind across the lagoon is a matter of 10 to 20 miles from east to west; and a surf is developed around the west inner side of the atoll, producing conditions similar to those found on leeward seaward reefs.

Windward lagoon reefs.—The reef on the south side of Namu island, Bikini Atoll, is an example of a lagoon reef that resembles seaward reefs (pl. 95, fig. 4). There is a marginal algal zone, not forming, however, a ridge. The growth of corals is much richer than on leeward lagoon reefs. Species of *Acropora* are dominant, especially *A. nasuta, A. rotumana* (profuse around edges of pools and reentrants), and *A. acuminata.* The common species of *Acropora* of the outer parts of windward seaward reefs, such as *A. cuneata, A. humilis* γ, and *A. digitifera,* are not found. Similarly, *Porites superfusa,* very common on windward seaward reefs, is only occasionally met with. On the other hand, *Stylophora mordax,* found only in sheltered spots on windward reefs, is very abundant; and *Heliopora coerulea,* while not forming a distinct zone, is found scatteringly out to the margin of the reef.

Leeward lagoon reefs (Porites andrewsi *zone*).—Two examples will serve to illustrate reefs in this environment, where the ramose *Porites, P. andrewsi,* is characteristic:

The luxuriant reef on the south side of Latoback island, on the north side of Rongerik Atoll, extends from the beach outward 300–500 feet on a gentle slope in depths from 2 to 18 feet and consists of patches of coral that rise close to the surface. There is no distinctive reef margin or algal zone, calcareous algae being uncommon and insignificant. Heads of *Porites lutea, P. andrewsi,* and *Platygyra rustica,* 20 feet across and 8 or more feet high, are common. Smaller but nevertheless large colonies of *Lobophyllia, Pavona clavus, Stylophora mordax,* and *Favites virens* are also common. Between these large heads, on their tops and sides, are many other species, which form much larger colonies than on seaward surface reefs: *Acropora humilis* α; *A. palifera* $\alpha \rightarrow \beta$; *A. acuminata; A. cymbicyathus; A. nasuta; Pocillopora eydouxi,* below 8 feet; *Montipora verrucosa,* not found on surface reefs at Bikini Atoll; *M. ehrenbergi; M. venosa. Fungia fungites* and *F. scutaria* are relatively common; *Favia* and *Heliopora* are not. Down the slope in deeper water, *Acropora reticulata* can be seen growing in depths of 20 feet or more on the nearly vertical sides of great heads. The writer obtained, during a few hours' visit, at least 34 species growing here within an area of about 2 acres.

The lagoon reef off the west side of Bikini island, at the east end of Bikini Atoll, is like the one just described in form and composition, but is not in a flourishing condition; indeed, it seems to be dying. Large colonies are dead and largely covered with soft algae; living colonies are small and scattered. This end of the lagoon is strongly affected by swells that enter through Enyu Channel, and the water is often turbid. Judging by the large size of the dead and dying coral colonies, the reef formerly was a flourishing one; and the change in conditions has been fairly recent. *Porites lutea, Acropora cymbicyathus, A. nastua,* and *A. striata* are common in addition to the characteristic *Porites andrewsi,* and there are occasional small colonies of *A. humilis* α and *A. squarrosa. Heliopora coerulea* forma β occurs in places, as well as *Astreopora myriophthalma. Pocillopora meandrina nobilis, P. damicornis,* and *Stylophora mordax* are rare, and neither *Favia* nor *Favites* were found.

Lagoon terrace and floor (Acropora formosa *zone*).—The Bikini Lagoon has been fairly well explored by dredging, bottom sampling, and diving. Corals have been recorded from 63 stations, and while the discussion below is based upon this area for the most part, less intensive studies of other Marshall Islands lagoons confirm the broad zonation.

Everywhere in the lagoon downward from about 4 or 5 fathoms to the floor at 27–30 fathoms, *Acropora formosa* is seemingly abundant, in places forming dense thickets which are shown in a striking underwater photograph taken by K. O. Emery (1954, pl. 24, fig. 3). *A. formosa,* however, does not occur at corresponding depths on the seaward slope either at Bikini, or at Eniwetok or Rongelap Atolls. Several other species of *Acropora, A. echinata, A. arbuscala, A. nobilis, A. teres,* and *A. palifera* β, are similarly distributed or restricted, but they are much less abundant. Other species seemingly restricted to this broad zone are *Anacropora gracilis; Montipora danae; M. socialis,* on surface reefs, however, at Eniwetok and Rongelap Atolls; *M. umbgrovei; Cycloseris patelliformis;* and *Rhizopsammia chamissoi.* Within this zone, two subzones are distinguishable: *Acropora reticulata* subzone and *A. rayneri* subzone.

Acropora reticulata *subzone.*—The *Acropora reticulata* subzone extends from a depth of 3–5 fathoms in the lower part of the lagoon reefs downward across the 10-fathom lagoon terrace and a short distance down the slope toward the lagoon floor to a depth of about 15 fathoms which includes the upper parts of the coral knolls. Ths subzone is marked by the abundance of the handsome, delicate, vasiform *Acropora reticulata.* Many of the surface reef species are found here (see table 3) in addition to a number of seemingly exclusive species such as: *Acropora implicata, Montipora hoff-*

meisteri, Pavona minuta, Fungia fungites stylifera, F. concinna serrulata, Goniopora somaliensis, and *Porites murrayensis.*

Coral knolls.—The coral knolls which rise from the floor of the lagoon into this zone are of special interest, for they bear a marvellously luxuriant coral assemblage on and around their summits. Some idea of this is gained from Emery's photograph near the top of a knoll in 10 fathoms (Emery, 1954, pl. 23). The writer was able to study briefly the top of a knoll (loc. 49) in 6 fathoms by diving gear. The top, covering perhaps half an acre, is uneven and composed of solid coral rock, with frequent pockets filled with sand, and covered by a profusion of immense branching and massive coral colonies, among which one could walk on sandy paths as in a garden, or climb upon the less fragile ones. At this depth the filtering of the longer wavelength light rays is evident, and the brilliant violet polyps appear blue. The water is clear and gently oscillating, even less agitated than on sheltered surface reefs; and corals, especially branching types, achieve a perfection of form and size not seen elsewhere. The striking size of the colonies makes even large surface reef masses, except in sheltered sites, where wave action is subdued, seem puny in comparison. The outstanding branching corals are *Acropora reticulata,* which forms great fragile brackets and vasiform colonies higher than one's head and 5 to 15 feet across, and *A. palifera* β, which resembles some cacti. Less common are *A. formosa, A. hyacinthus,* and *A. arbuscula. A. nasuta, A. cymbicyathus,* and *A. humilis* α form huge corymbose masses. *Pocillopora eydouxi* (pl. 99, fig. 1) reaches a size remarkable for this genus. *Pavona clavus* forms large columniform or reniform masses. *Porites australiensis* and *P. murrayensis* occur as huge hemispherical, ridged bosses. Calcareous algae are a minor element and grow as small nodular masses here and there. But soft corals (alcyonarians), which are usually absent from seaward reefs and scarce on lagoon reefs, are common. The general assemblage is a modified leeward lagoon reef, living under optimum conditions in somewhat deeper water. The comparable situation on seaward reefs is probably the mare incognitum of the outer reef slope downwards from the algal ridge.

Dredgings down the sides of coral knolls below 10 fathoms indicate that the surface reef species diminish in number and are succeeded by special types, as on the seaward slope. The upper part of a coral knoll, therefore, lies in the *A. reticulata* subzone and its lower or basal section is in the *A. rayneri* subzone.

Acropora rayneri *subzone.*—A subzone from about 15 fathoms down to the floor of the lagoon is characterized by the deepwater *Acropora rayneri* and its close relative *A. rambleri,* both of which also occur in a similar environment down the seaward slope. Most of the surface reef species do not grow in this subzone, and those which do persist are small colonies found in the upper part of the zone. Species confined to this region at Bikini Atoll are listed in table 3. Most common are *Seriatopora angulata, Montipora conicula, Cycloseris hexagonalis, Montipora marshallensis, Astreopora tabulata, Stylaster asper, Leptoseris incrustans, L. gardineri,* and *L.? mycetoseroides.* Several of these also occur in similar or greater depths on the seaward slope.

COMPARISON WITH OTHER REEFS

Comparisons here will be confined to the distribution of the coral faunas on reefs comparable to the seaward windward reefs, especially those characterized by the development of an algal ridge. Many details of the physical structure of the reefs of the Marshall Islands and comparison with others in the Pacific will be found in other chapters of Geological Survey Professional Paper 260.

Of the many Pacific area reefs and reef coral faunas described, only a few have been studied from the standpoint of coral distribution or zonation. And for the present purpose, a series of sections (fig. 119, *A–G*), based upon references indicated in each case (original for Bikini and Arno Atolls and Johnston Island), has been compiled and presented on a uniform scale. In some cases the zonation is the writer's interpretation.

WINDWARD REEFS WITH ALGAL RIDGES

Arno Atoll.—In the summer of 1950, the writer spent 8 weeks studying the reefs of Arno Atoll, Marshall Islands, about 500 miles southeast of Bikini Atoll in the southern part of the Marshall Islands (Wells, 1952). Here the windward seaward reef (fig. 119*G*) ranges from 150 to 425 yards in width. Coral growth is much weaker than at most places on the corresponding Bikini reef. Indeed, much of the reef flat is a barren and somewhat irregular, smooth rock surface. The algal ridge is well developed; immediately behind it occasional colonies of *Acropora cuneata* and other species of this zone are found, especially *Favites,* in the shallow, straight surge channels. Inward from this, the only coral is an occasional encrusting patch of bright-green *Porites lichen.* At ordinary low tide the inner half of the rock flat is exposed to the air for a couple of hours. Much of the inner flat is covered to the sand beach by a thin veneer of angular, corroded rubble. Calcareous algae seem to be the main factor in windward surface reef development at Arno Atoll.

Funafuti Atoll.—The reef of Funafuti Atoll, Ellice Islands, (fig. 119*E*), the atoll nearest the Marshall Islands, where the coral association has been described, is like that at Arno Atoll in many respects. It is much

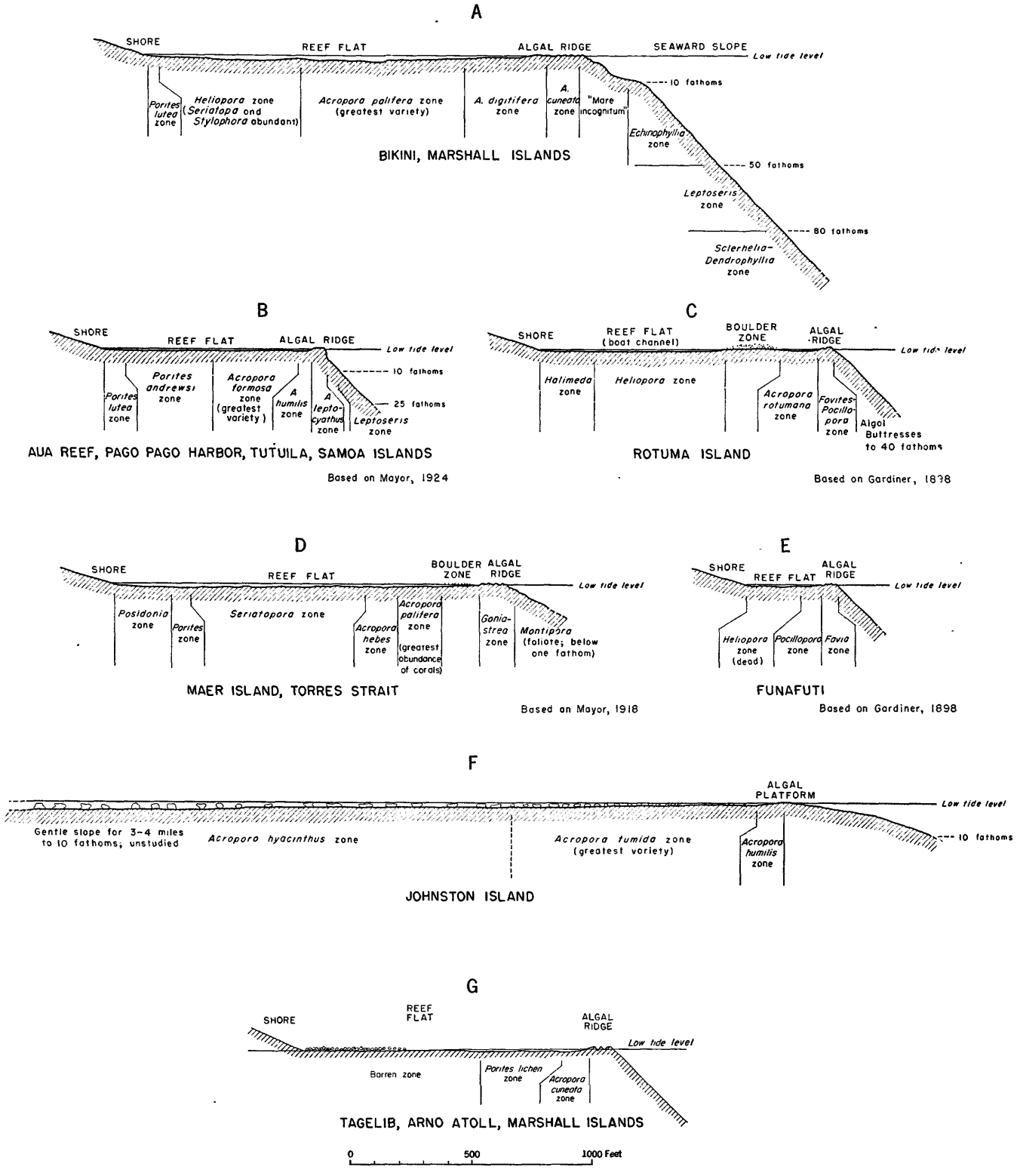


FIGURE 119.—Cross sections of windward reefs with algal ridges.

narrower and no *Heliopora* zone is developed, although its place formerly was in what is now the "rough zone" and inner reef flat (Finckh, 1940, pl. 17). *Acropora* is very rare on the surface reefs, and none has been found on the reef off Funafuti island (Gardiner, 1898, p. 428). The reef flat is in general barren of corals, as it is in places on the outer reefs to windward on Marshall Islands atolls. The main areas of coral growth are in pools near the algal ridge and on the algal ridge, but even here it is relatively unimportant. According to Finckh (1904, p. 130), there is little or no coral growing down the upper part of the seaward slope beyond the algal ridge. This area at Funafuti Atoll is primarily, then, an algal reef.

Rotuma Island.—The windward reef to the east of Rotuma Island, an isolated island midway between Funafuti Atoll and the Fiji Islands, described by Gardiner (1898, p. 441–443, fig. 4), is very similar to the Bikini Atoll reefs (fig. 119*C*). The inner reef flat has a broad *Heliopora* zone, with heads, or microatolls, 6 to 20 feet across, among which are large massive heads of other corals. Beyond this is a barren boulder zone, which is not found, or is only very feebly developed, at Bikini Atoll. The shallow flat following the boulder zone is dominated by *Acropora rotumana*, which, together with other corals, especially *Pocillopora* and faviids, cover about 25 percent of the surface. Few calcareous algae grow in this zone, which corresponds to the *A. digitifera* and inner *A. cuneata* zones at Bikini Atoll. The algal zone is well developed and carries only a sparse coral fauna (*Favites*, *Pocillopora*, *Stylophora*), which covers about 5 percent of the surface. Few corals occur on the upper part of the seaward slope, although algae flourish.

Samoa Islands.—The Aua reef (fig. 119*B*) in Pago Pago Harbor, Tutuila Island, was thoroughly analyzed by A. G. Mayor (1924, p. 1–25). It is situated in a more protected site than the open reefs at Bikini Atoll, Funafuti Atoll, and Rotuma Island; and the zonation and the coral fauna reflect this less agitated situation. *Heliopora* does not occur here, and the inner part of the reef flat is dominated by *Porites lutea* near shore and *P. andrewsi*, a ramose species, in the outer part. Beyond the inner part is a zone of abundance of *Acropora formosa*, a lagoon species in the Marshall Islands, with a large variety of species of other genera. Between this and the algal ridge is a narrow strip where *A. humilis* α abounds; the algal ridge is marked by *A. humilis* γ. Near the reef margin the delicate *A. hyacinthus* lives only in protected spots, but it becomes abundant, together with *Pocillopora*, down the steep seaward slope beyond the algal ridge in depths 2–5 fathoms below the influence of breakers.

Murray Islands.—Another reef studied by A. G. Mayor (1918) is the windward reef at Maer Island (fig. 119*D*), one of the Murray Islands, Queensland, Australia. Here the innermost part of the reef flat has a rich growth of the sea grass *Posidonia* but no corals. None of this grass was observed at Bikini or Arno Atolls. Next is a *Porites* zone of both massive and ramose species. In place of *Heliopora*, which is not reported from Maer Island, is *Seriatopora*, abundantly covering a broad zone. At Bikini Atoll *Seriatopora* is a poor second to *Heliopora* in many parts of this zone. The *Seriatopora* zone is transitional outwards into *Acropora* zones, first *A. hebes;* then in more agitated water near the reef margin, *A. palifera* with *A. plicata*. In the boulder zone are very few corals, and on the algal ridge the commonest genus is *Goniastrea*, rather than *Acropora* or *Pocillopora*. Down the seaward slope foliated species of *Montipora* are abundant.

Johnston Island.—In August 1947 the writer was able to study briefly some of the reefs of this crescent-shaped island southwest of the Hawaiian Islands. The windward part is about a mile wide, extending from the small sand islands out to a low algal platform. The island is a very small part of the entire reef and is merely incidental between windward and leeward reefs, which are actually continuous with a long, gentle slope downwards for 6 miles from the algal platform to the leeward 10-fathom line (fig. 119*F*). There is therefore no reef flat extending from shore outwards to the reef margin. Outward from the algal platform is a gentle seaward slope covered in its upper part by nodular, spongy, calcareous algae and few, if any, corals. The algal ridge is low; only a few inches are visible at low tide. The ridge is thoroughly cemented and relatively smooth inward from the rough area at the line of breakers. The few corals include small colonies of *Pocillopora; Montipora;* and *Porites*, found in crevices; and a crimson *Distichopora*, which grows in cavities away from light. The inner part of the algal platform is less even, with shallow channels and pools here and there, in which much stunted *Acropora humilis* γ is fairly abundant, together with *A. retusa*, *Montipora*, *Pocillopora*, and *Porites lobata*. This strip gradually deepens and passes into a zone about 350 yards wide, and up to 6 feet deep, thickly set with huge heads of *Porites lutea*, which form a basis for *Acropora tumida*, *Millepora tenera*, *Pocillopora eydouxi*, *Pavona*, and *Leptastrea*. Between the coral heads are narrow, tortuous, and often discontinuous, sand-floored channels, where *Fungia scutaria* is common. These channels are usually so narrow that at low tide one can wade across the zone by stepping from one coral head to another. This zone, which corresponds to the "Anchorage Coral Zone" at Yonge Reef, Outer Barrier (fig. 120*A*), grades into a belt of larger and more separated coral masses topped by

spreading colonies of *Acropora hyacinthus*. The colonies, with large boat-channels up to 12 feet deep, extend inward a distance of about 1,200 yards to the islands or into the leeward part of the reef with little change. Unfortunately the writer was able to observe the leeward part of the reef only from the air and air photographs. The coral heads, composition unknown, extend for several miles leeward, fewer and more widely separated as distance and water depth increase and finally dying out as depths approach 10 fathoms.

Summary.—The Aua reef and the windward reefs of Bikini, Arno, and Funafuti Atolls and Rotuma Island—all with algal ridges—show a similarity in structure and zonation of reef corals, which may be broadly summarized as follows:

Shoreward			Seaward (windward)
Reef flat			Algal ridge
Inner	Intermediate	Outer	
Porites	*Heliopora, Seriatopora*	*Acropora*	*Pocillopora, Acropora, Goniastrea*

Johnston Island reef has an algal ridge or platform, but its inner gradual slope to leeward and the ocean beyond give its inner parts a distinct ecological situation, which is very similar to Yonge Reef, such as might be produced were the leeward half of an atoll to be cut away. Here are combined in a single continuous reef tract the features of the windward reef, island, lagoon reef (or leeward reef) sites of an atoll.

WINDWARD REEFS WITHOUT ALGAL RIDGES

Yonge Reef.—Yonge Reef (fig. 120*A*), one of the reefs of the Outer Barrier, Australia, off Lizard Island, has been described by Stephenson, Stephenson, Tandy, and Spender (1931, p. 30–34, 82–86, fig. 5, pl. 17, fig. 2), Manton (1935, p. 303–307, pls. 14–16). The structure and ecology are different from reefs of the inner parts of the Great Barrier:

> * * * the complications presented by the occurrence of ramparts, mangroves, and a sandy reef-flat, do not exist. In their place the question of relationship of organisms to Pacific breakers becomes insistent.
>
> A primary feature of Yonge Reef is the heavy encrustation of nullipores. * * * all the zones from the Pacific to the boulder zone consist of solid rock swept clear of loose debris, and for the most part so generally encrusted with nullipores that the prevailing color of the substratum is a purplish pink. This is misleading, because the rock consists of coral and the nullipores are only a veneer, * * *
>
> (Stephenson and others, 1931, p. 83).

From this it appears that although algae are abundant here, an algal ridge similar to those of the reefs previously analyzed does not occur in spite of the favorable situation. The "outer ridge," whose structure is not clearly explained in the Great Barrier Reef Expedition reports, and the "outer moat," however, correspond to the algal ridge; and the area immediately behind it corresponds in structure and coral fauna, and like the Aua Reef ridge, constitutes a zone of flourishing *Acroporae: A. humilis* γ, *A. hyacinthus*, *A. decipiens*, and, according to Stephenson and others (1931, p. 83), *A. palifera*. This last, however, in this zone on Yonge Reef, is said (Stephenson and others, 1931, p. 83) to be "encrusting sheets yards wide"—quite unlike *A. palifera* in habit. The form is symbolically illustrated by Manton (1935, pl. 15) in a diagram showing coral growth in the outer moat. It suggests an *Acropora* with a very expanded, encrusting base and low proliferations, which may very well be *A. cuneata* or *A. plicata*. I have tentatively called this zone the *A. cuneata?* zone, reminiscent of the zone at Bikini Atoll.

Inside the outer moat and ridge is a reef flat area, called reef crests in the Great Barrier Reef Expedition reports, where *Acroporae* dominate, especially *A. humilis* γ, *A. hebes*, and *A. squamosa;* but colonies are low and stunted, and corals are a minor item on the bare rock surface.

The boulder zone which succeeds the reef flat is followed by the Anchorage Coral Zone—so-called because "* * * it resembles, both in structure and fauna, the reefs found in the anchorage at Low Islets." This region is illustrated by a photograph (Stephenson and Stephenson, 1931, pl. 24, fig. 1) and a diagram by Manton (1935, pl. 16). Both these figures leave little doubt that here *A. palifera* does occur in abundance, constituting an *A. palifera* zone. It is much like the *A. palifera* zone at Bikini Atoll with its mixed microatolls, except that *A. palifera* is less important as a substratum for other corals. There is an even greater resemblance to the corresponding zone of *A. tumida* at Johnston Island. As at Johnston Island, this zone passes gradually leeward into a zone of heads of coral rock and gigantic colonies, separated by sandy stretches with depths gradually increasing to 4–5 fathoms. Here the most prominent coral is again *A. hyacinthus*.

Low Islets.—Manton (1935, p. 297, traverse 3, pl. 8) analyzed the windward reef on the Low Islets, Australia, one of the island reefs of the innermost part of the Great Barrier Reef. This analysis is of interest because it gives some idea of the distribution of corals on the upper part of the seaward slope of a windward reef from sea level down to a depth of 16 feet—a glimpse into a small part of the mare incognitum of the upper

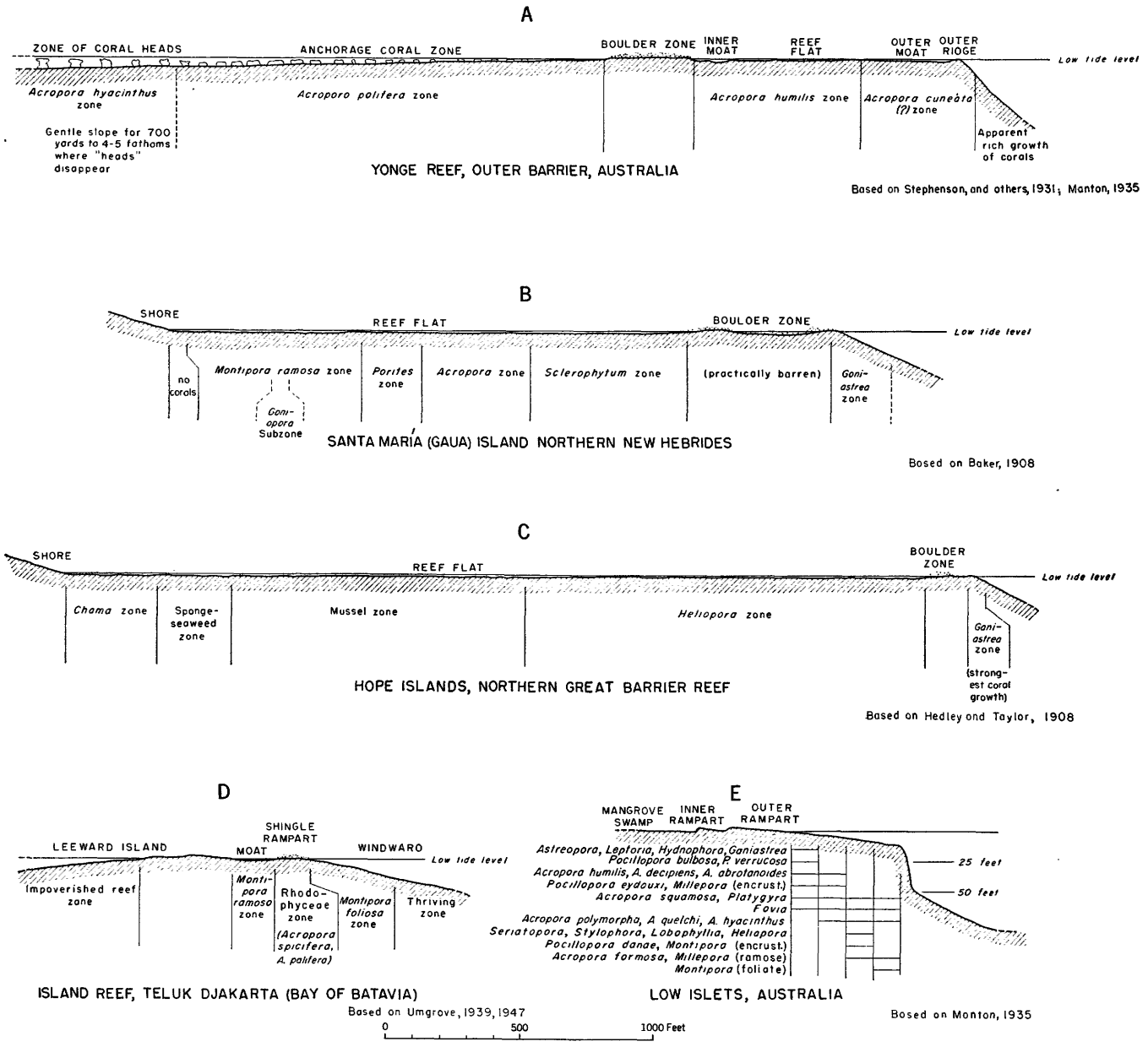


FIGURE 120.—Cross sections of windward reefs without algal ridges.

seaward slope zone. The occurrence of the various corals (fig. 120*E*) shows, as would be expected, a close adjustment of form to position with respect to the breakers at the surface.

Hope Islands.—This reef (fig. 120*C*) fringes the windward side of the Hope Islands, Australia, one of the islands of the Inner Barrier near Cooktown, and has been the subject of a traverse by Hedley and Taylor (1908). Corals do not grow or are very scarce over the inner half (about 600 yards) of the broad reef flat which comprises a *Chama* zone, sponge-seaweed zone, and a mussel zone. The outer half of the flat is dominated by *Heliopora* to the boulder zone, beyond which is a rocky rampart with *Goniastrea* and *Porites*. *Acropora* does not appear to be an important element on the surface part of the reef.

Santa María Island.—The windward reef of this island, in the Banks Islands, northern New Hebrides, was studied in some detail by Baker (1925). (See fig. 120*B*.) There is an outer *Goniastrea* zone, as at the Hope Islands, followed by a barren stretch with two boulder zones. Next is a wide stretch of reef flat with an abundance of *Sclerophytum*, associated with scattered colonies of *Porites*, *Seriatopora*, and *Pocillopora*. These,

with the alcyonarians, however, cover not more than 15 percent of the platform and include many species but relatively few colonies.

A richer stretch of flat, 35 percent covered by *Acropora*, with *Pocillopora*, *Porites*, and *Seriatopora*, succeeds the *Sclerophytum* zone and merges into a thinly settled zone (10 percent) of *Porites*, with *Heliopora*, *Montipora*, *Acropora*, and *Goniopora*. Algal nodules are abundant. Between this stretch and the narrow barren area next to the shore, there is a wide zone of abundant *Montipora ramosa*, associated with *Pavona*, *Pocillopora*, *Porites*, and *Psammocora*. This appears to be the region of the most luxuriant coral growth (85 percent covered by corals) and has in its midst a narrow strip, the *Goniopora* subzone. The richly developed *Montipora ramosa* zone is analogous to the zone of the same species on the island reefs in the Teluk Djakarta but more remote from the reef margin.

Teluk Djakarta (Bay of Batavia).—The island reefs of this Malay Archipelago area, which have been the object of much study by Umbgrove (1928, 1939, 1947), differ in many respects from those previously discussed. The reefs and cays are composed largely of fragmental coral material which has been assembled and sorted by the action of waves and currents, and the whole unconsolidated mass rests on a shallow mud floor. Sedimentation is heavy on the leeward sides, and coral growths there are weak. The main area of thriving reef growth is down the windward slope from the rampart for about three-quarters of the distance down to the mud floor (5–12 fathoms) of the bay (fig. 120*D*). In the warm, sandy-floored moat between the cay and rampart is an abundant growth of *Montipora ramosa*, a form characteristic of the inner reef flat zone at Santa María Island and the moats at Low Islets but representative of a growth form of the genus almost unknown on the Marshall Islands reefs. On the low shingle rampart Umbgrove distinguishes a "Rhodophyceae-facies," marked especially by the red alga, *Amphiroa*. In this turbulent zone *Acropora spicifera*, *A. palifera*, and, as Umbgrove points out, such forms as *Seriatopora* and *Heliopora*, which are not usually found in this situation, indicate an absence of the heavy surf of the open Pacific reefs. *Seriatopora* and *Heliopora* also occur with many other genera in the upper part of the slope, seaward from the shingle rampart in the *Montipora foliosa* zone, which is transitional to the thriving reef facies with its huge *Porites* heads and smaller colonies of other forms rising from the sandy bottom. The richness of speciation of this zone and its aspect are like that of some of the favorably situated lagoon reefs of the Marshall Islands, such as Latoback island, Rongerik Atoll, and the "zone of coral heads" of Johnston Island, where the variety of corals is much smaller, and Yonge Reef.

DEPTH OF GROWTH OF HERMATYPIC CORALS

A great deal of information has been accumulated on the relation of corals to depth of water. The general conclusions have been that most reef-building takes place in depths of 15 fathoms or less, that some forms extend to 25 fathoms, that a few live in as much as 40 fathoms, and that the maximum depth is reached at about 50 fathoms. Analysis of the vertical distribution of hermatypic corals at Bikini Atoll (see figs. 121 and 122) adds confirmatory data to these conclusions but also suggests that in some localities the extreme lower limit may extend to 85 fathoms.

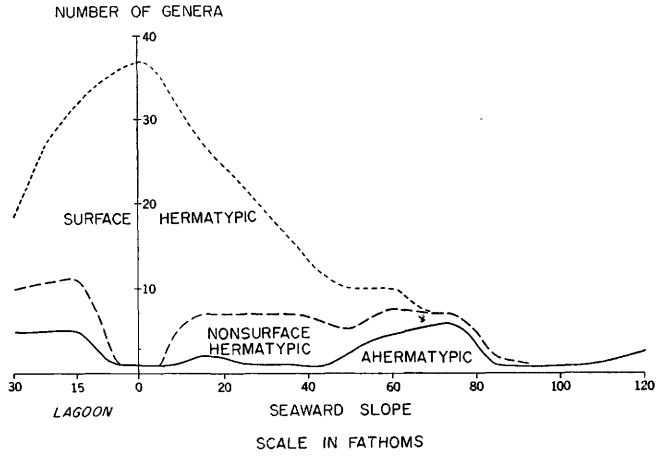


FIGURE 121.—Bathymetric distribution of genera at Bikini Atoll.

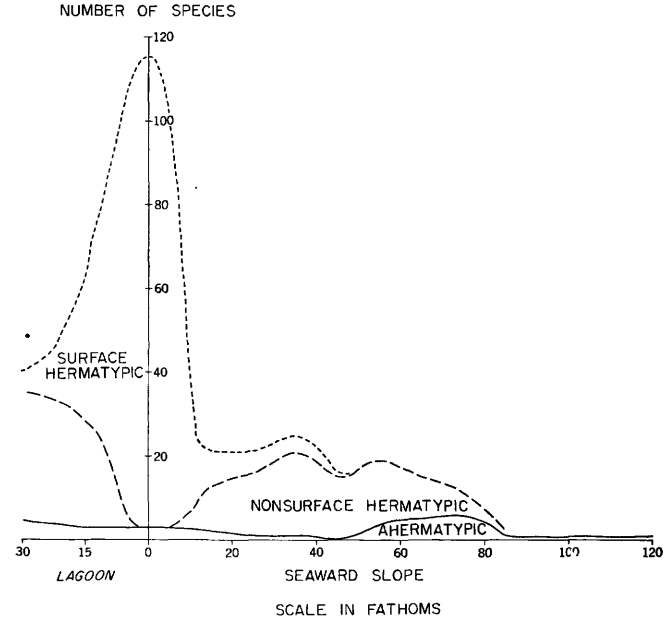


FIGURE 122.—Bathymetric distribution of species at Bikini Atoll.

Although these records are incomplete, three inferences are fairly certain: 1, The distribution of genera with depth is much the same in the lagoon as down the

seaward slope to the equivalent lagoon depths, but the number of species diminishes more rapidly down the seaward slope than into the depths of the lagoon; 2, there is no specific depth at which there is a sudden diminution in number of genera or species, although the number of species does drop very rapidly from the surface to about 15 fathoms, increases slightly again to about 35 fathoms, then declines steadily and slowly to none at 85 fathoms; and 3, the lower bathymetric limit for hermatypic corals is not imposed by the temperature gradient. The number of species between 10 and 40 fathoms is probably considerably greater than actually known, because of the incomplete sampling thus far possible in this depth range. Plate 187 shows the annual temperature ranges from the surface to 800 feet, derived from Robinson (1952). At 50 fathoms the temperature ranges between 26.5° and 27.5° C, well above the tolerable minimum for reef corals, but at this depth the number of reef corals is very small; at 80 fathoms, where the very last traces of reef corals are found, the temperature is 24.5°–25.5° C. The minimum endurable temperature of around 19° C is reached at about 95 fathoms, well inside the exclusively ahermatypic coral zone. On the other hand, curves of numbers of hermatypic species with increasing depth plotted against curves for light and radiant energy penetration show a very close correlation. Light or radiant energy is the principal factor controlling the depth of growth of mutually interdependent reef corals and their symbiotic zooxanthellae; temperature is the principal factor controlling their geographic distribution.

LOCALITIES OF CORAL MATERIAL FROM THE MARSHALL ISLANDS

Each of the stations in the Marshall Islands from which coral specimens were collected during the 1946–47 collecting seasons has been given a number. Details of these stations are given below. The numbers, to avoid constant repetitions of similar details, are in parentheses after the citation of localities in the systematic descriptions. Water depths are in fathoms, which has been abbreviated fms. Reference to material other than that recently collected is made by citing the collection or institution from which it was obtained or at which it was studied.

LOCATIONS OF SPECIMEN COLLECTIONS

USNM—U. S. National Museum: principally specimens collected on cruises of the U. S. Fisheries Steamer *Albatross* in 1899 and 1900.

BM—British Museum (Natural History).

Imp. Coll.—Biological Laboratory, Imperial Palace, Tokyo. Specimens and photographs.

HMCZ—Museum of Comparative Zoology, Harvard University.

COLLECTION STATIONS, 1946–47 SEASONS

Reef localities:

Bikini Atoll:

1. Enirik island, seaward reef near west end of island.
1a. Enirik island, seaward reef near west end of island, *Heliopora* zone.
2. Rukoji island, reef flat northwest side of island.
3. Chieerete island, seaward reef.
4. Ourukaen island, seaward reef, *Lithothamnion* ridge.
4a. Ourukaen island, seaward reef flat.
4b. Ourukaen island, seaward reef flat, above low water level.
4c. Ourukaen island, seaward reef, deep pool.
4d. Ourukaen island, lagoon side, algal-coral zone.
5. Bokororyuru island, seaward reef, south side of island, behind *Lithothamnion* ridge.
5a. Bokororyuru island, seaward reef, west side of island.
5b. Bokororyuru island, seaward reef, east side of island.
5c. Bokororyuru island, seaward reef, east side of island, in reef channel.
5d. Bokororyuru island, reef patch northwest of north end of island.
6. Bokororyuru island, seaward edge of lee side of atoll, about 3 miles northwest of island.
7. Namu island, seaward reef, northeast side of island.
7a. Namu island, seaward side, west end of island, broad *Heliopora* zone.
7b. Namu island, edge of lagoon reef, south side of island.
8. Yurochi island, pool in seaward reef, between Yurochi and Uorikku islands.
9. Aomoen island, seaward reef margin.
9a. Aomoen island, seaward reef flat.
10. Bikini island, seaward reef, margin midway between Bikini island and Aomoen island.
10a. Bikini island, seaward reef, off northwest end of island.
10b. Bikini island, seaward reef off center of island, *Lithothamnion* ridge.
10c. Bikini island, seaward reef off center of island, reef flat.
10d. Bikini island, seaward reef off center of island, caves in *Lithothamnion* ridge and flat.
10e. Bikini island, seaward reef off center of island, *Heliopora* zone.
10f. Bikini island, lagoon reef off center of island.
10g. Bikini island, seaward reef, midway between Bikini and Bokon islands: *Lithothamnion* ridge.
11. Eniairo and Rochikarai islands, seaward reef between islands, caves and pools in *Lithothamnion* ridge and reef flat.
12. Enyu island, seaward reef edge, 1,000 feet north of island.
12a. Enyu island, seaward reef, east side of island.

Eniwetok Atoll:

13. Rigili island.
14. Rujiyoru island, seaward reef.
15. Bogon island, seaward reef, *Heliopora* zone.

Reef localities—Continued
Eniwetok Atoll—Continued
16. Lidilbut island, seaward reef, 0.25 mile from shore.
16a. Lidilbut island, lagoon reef.
17. Bogen island, lagoon channel reef, west side of island.
Rongerik Atoll:
18. Bock island, seaward reef.
19. Eniwetak island, seaward reef.
20. Latoback island, seaward reef.
20a. Latoback island, lagoon reef.
Rongelap Atoll:
21. Arbar island.
22. Busch island, seaward reef.
22a. Busch island, lagoon reef, depth 2 fms.
23. Piganiyaroyaro island, seaward reef.
24. Naen island, east side in channel between *Heliopora* masses, depth, 1–2.5 fms.
24a. Mellu island, near reef edge, in pool under shelf, depth, 0.5 fm.
25. Lomuilal island, pools on seaward reef, depth, 1–3.5 fms.
27. Yugui island.
28. Burok island, leeward seaward reef.
29. Rongelap island, lagoon reef, north of village, 50 yards offshore: depth, 3 fms.
29a. Enybarbar island.

Lagoon localities:
Bikini Atoll:
30–36. 1946 dredgings:
30. Northeast part of lagoon, 22 fms.
31. Bikini island, 0.25–0.75 miles west of south end of island, 22 fms (haul 5).
32. Bikini island, west of south end of island, 28 fms (haul 6).
33. Bikini island, west of south end of island, 27 fms (haul 7).
34. Bikini island, 3–5 miles southwest of northwest end of island, 12 fms (haul 10).
35. Bikini island, southwest of northwest end of island, 18 fms (haul 11).
36. Bikini island, southwest of northwest end of island, 14 fms (haul 12).
37–38b. 1947 dredgings:
37. Side of coral knoll, 37′40″ N.–26′20″ E., 17–23 fms (haul 4).
37a. Side of coral knoll, same site, 7–14 fms (haul 5).
38. Side of coral knoll, 31′51″ N.–32′53″ E., 8–13 fms (haul 21).
38a. Side of coral knoll, same site, 8–23 fms (haul 22).
38b. Side of coral knoll, same site 5–12.5 fms (haul 23).
39–49. Other Material:
39. Aomoen island, south of island, 3 fms.
39a. Aomoen island, 0.75 miles south of island, 10 fms.
40. Namu island, south of island, 5 fms.
41. Yomyaran island, 1.5 miles west of island, 27 fms.
42. Bikini island, 0.5 mile west of island, 15 fms.
43. Lagoon, east center, 30 fms.
44. Lagoon, east end near Bikini island, 10 fms.
45. Near Bikini island, 4 fms.

Lagoon localities—Continued
Bikini Atoll—Continued
39–49. Other Material—Continued
46. Lagoon, west center, 30 fms.
47. Enyu Channel, 3 miles west of Enyu island, 8 fms.
48. Airukiiji island, northwest of island, 6 fms.
49. Coral knoll 1 mile north of Eninman island, 6 fms.
50–86. Specimens from botton samples, sample number and depth, in fathoms, as indicated, collected by K. O. Emery:
50. 36: 10.5 fms.
51. 39: 4 fms.
52. 91: 8.5 fms.
53. 97: 11.3 fms.
53a. 100: 24 fms.
54. 127: 11.5 fms.
55. 162: 14 fms.
56. 193: 10 fms.
57. 197: 22 fms.
58. 202: 20 fms.
59. 207: 16 fms.
60. 223: no depth.
60a. 270: 27 fms.
61. 338: 17 fms.
62. 390: 4 fms.
63. 397: 27.5 fms.
64. 413: 24.6 fms.
65. 421: 28 fms.
66. 442: 25 fms.
67. 505: 5–10 fms.
68. 522: no depth.
69. 523: no depth.
70. 524: 10.5 fms.
71. 527: no depth.
72. 531: about 25 fms.
73. 539: 14 fms.
74. 540: no depth.
75. 589: 30 fms (?).
76. 673: 32 fms.
77. 793: 26 fms.
78. 812: 13.3 fms.
79. 814: 22.7 fms.
80. 817: 24 fms.
81. 821: no depth.
82. 921: 25 fms.
83. 967: 10.7 fms.
84. 1055: 20.7 fms.
85. 1154: 27.7 fms.
86. 1158: 29.7 fms.

Eniwetok Atoll:
87. Rujiyoru island, 0.25 mile southeast of island, 7.5 fms.
88. Rigili Island, 0.25 mile northeast of island, 13 fms.
89. Eniwetok Island, 5 miles north of island, 15–20 fms.
90–92a. Specimens from bottom samples, sample number and depth, in fathoms, as indicated, collected by K. O. Emery:
90. 58: 28 fms.
91. 102: 26 fms.
92. 143: 30 fms.
92a. 243: 21 fms.

Lagoon localities—Continued
Rongerik Atoll:
93–94a. Specimens from bottom samples, sample number and depth, in fathoms, as indicated, collected by K. O. Emery:
93. 52: 17 fms.
94. 59: 16 fms.
94a. 44: 19 fms.
Rongelap Atoll:
95. Rigonman island, 1 mile off island, 17–20 fms.
96–101. Specimens from bottom samples, sample number and depth as indicated, collected by K. O. Emery:
96. 15: no depth.
96a. 26: no depth.
97. 161: no depth.
98. 203: no depth.
99. 235: no depth.
100. 275: no depth
101. 485: no depth.
Seaward slope localities:
Bikini Atoll:
102. Off Enyu Channel, 260 fms.
103. Enyu island, off south end of island, 12.5–17 fms (dredging 1).
104. Off Enirik island, 133 fms (dredging 2).
105. Off Airukiiji and Airukiraru islands, 33–125 fms (dredging 7).
106. Off Enirik island, 50–97 fms (dredging 9).
107. Off Enirik island, 33–48 fms (dredging 10).
108. Bikini island, off northwest end of island, 125–133 fms (dredging 11).
109. Bikini island, off northwest end of island, 58–90 fms (dredging 12).
110. Bikini island off northwest end of island, 25–44 fms (dredging 13).
112. Bikini island, off northwest end of island, 97–133 fms (dredging 14).
113. Off northwest side of atoll, 67–75 fms (dredging 18).
114. Off northwest side of atoll, 29–42 fms (dredging 19).
115. Off northwest side of atoll, 12.5–15 fms (dredging 20).
116. Off Enyu Channel, 67–75 fms (dredging 28).
117. Off Enyu Channel, 21–25 fms (dredging 29).
118. Off Enyu Channel, 117–121 fms (dredging 30).

SYSTEMATIC DESCRIPTIONS

The classification of the Scleractinia followed below is that developed by Vaughan and Wells (1943), with one or two changes. The figures in parentheses are the locality or station numbers. (See p. 407–409.)

The synonymies have been restricted. Where a published synonymy is reliable, it is indicated by the word "synonymy" in brackets, and only supplementary citations have been added.

Under Occurrences, those references which are cited by preceding the author's name with the word "*in*" refer to literature listed in the synonymy; those references in parentheses refer to publications listed under Literature Cited. Where a place name has been changed from that used by the cited author, the old name is followed by the new name, as used by the U. S. Board on Geographic Names, in brackets.

Class ANTHOZOA Ehrenberg, 1834
Subclass ZOANTHARIA de Blainville, 1830
Order SCLERACTINIA Bourne, 1900
Suborder ASTROCOENIIDA Vaughan and Wells, 1943
Family ASTROCOENIIDAE Koby, 1890
Subfamily ASTROCOENIINAE Felix, 1898
Genus STYLOCOENIELLA Yabe and Sugiyama, 1935

Stylocoeniella armata (Ehrenberg)

Plate 96, figures 1–4

Porites armata Ehrenberg, 1834, Corallenthiere des rothen Meeres, p. 119.
Stylophora armata (Ehrenberg). Milne-Edwards and Haime, 1850, Annales Sci. Nat., 3d ser., v. 13, p. 105.
Klunzinger, 1879, Korallthiere des rothen Meeres, pt. 2, p. 66, pl. 8, fig. 12.
Von Marenzeller, 1907, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., Band 80, p. 77.
Stylocoenia hanzawai Yabe and Sugiyama, 1933, Japanese Jour. Geology and Geography, v. 11, p. 11, pl. 2, figs. 1–4.
Astrocoenia hanzawai (Yabe and Sugiyama). Wells, 1935, Annals and Mag. Nat. History, 10th ser., v. 15, p. 343, pl. 15, figs. 1–3.
Stylocoeniella hanzawai Yabe and Sugiyama. Yabe and Sugiyama, 1935, Japanese Jour. Geology and Geography, v. 12, p. 105, pl. 15, figs. 1–6.
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ., Sci. Repts., 2d ser., special v. 1, p. 16, pl. 11, figs. 1–3.
Stylocoeniella armata (Ehrenberg). Wells, 1950, Raffles Mus. Bull. 22, p. 33.

This inconspicuous but widespread astrocoeniid is relatively common in practically all environments at Bikini Atoll. Colonies are usually small brown or green encrusting patches on the underside of larger corals. It is most abundant in the *Acropora palifera* zone on windward reef flats and can almost always be found by breaking open the rotten lower parts of clumps of this *Acropora* and searching in the darker recesses.

The polyps are very small, with nearly colorless or pale-brown columns, 12 brown tentacles, and peristome edges which are brilliant green or nearly colorless. The coralla from deeper water are bright green, owing to *Ostreobium* in the skeletal tissues. Prof. G. M. Smith, Stanford University, kindly made field identification of this algal genus for the writer.

A specimen (pl. 96, fig. 1) from locality 36 (14 fms) encrusts a dead *Acropora* and shows the beginnings of the apparently ramose habit exhibited by the specimen from Honshū figured by Yabe and Sugiyama (1935). There is much variation in the development of the intercalicular columns and peritheca; in some specimens columns are highly developed, in others, quite absent; in the specimens from deeper water, the calices are widely separated by spinous peritheca, and the columns, one to a corallite, stand close to the calyx

and in many cases arch over it. The columns are covered with minute, appressed spinules. In these deeper water colonies the calices are less open, and the second-cycle septa are longer, extending nearly to the columella, much less differentiated from the primaries. The innermost teeth of the primary septa are very prominent and stand up like a ring of pali around the columella. Specimens from the reef flats show gradation into this deeper water facies.

Occurrence.—Bikini Atoll: Enirik island (1a); Bokororyuru island (5a, 5c, 6); Aomoen island (9); Bikini island (10c—*A. palifera* zone, 10f); lagoon, 4–30 fms (31, 36, 37a, 43, 44, 51, 84); seaward slope, 13–17 fms (103). Rongerik Atoll: Lagoon, 16 fms (94). Red Sea (Ehrenberg's types); Zanzibar (on base of *Acropora*, HMCZ); Mauritius (HMCZ, labeled *Astrocoenia stylifera* Pourtalès); Cocos Keeling Islands, *in* Wells, 1950; Singapore, *in* Wells, 1935; Albany Pass, Torres Strait, *in* Wells, 1935; Palau Islands, *in* Yabe, Sugiyama, and Eguchi, 1936; Ponapé, Caroline Islands, *in* Yabe, Sugiyama, and Eguchi, 1936; Ryukyu Islands, *in* Yabe and Sugiyama, 1933 (type of *S. hanzawai*); Kyūshū and Honshū, *in* Yabe, Sugiyama, and Eguchi, 1936; Tahiti (Crossland, 1952).

Family THAMNASTERIIDAE Vaughan and Wells, 1943
Genus PSAMMOCORA Dana, 1846

Psammocora nierstraszi van der Horst, 1921

Plate 157, figures 7, 8

Psammocora nierstraszi van der Horst, 1921, *Siboga*-Expeditie Mon. 16b, p. 34, pl. 2, figs. 3, 4.

?Psammocora samoensis Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 46, pl. 5, figs. 3a–3c.

One specimen, a thick crust on branches of *Heliopora*, was collected. *P. nierstraszi* is related to *P. superficialis* Gardiner but has much smaller calices (1 mm) and is marked by the irregularly developed collines. *P. samoensis* Hoffmeister, from the Samoa Islands, is either the same as *P. nierstraszi* or very closely allied. Study of Hoffmeister's cotypes in the U. S. National Museum shows no differences in dimensions, septal number or arrangement, or in the columella. The only difference is that in *P. samoensis* the collines are more continuous with sharper crests.

The living corallum is reddish brown to reddish green.

Occurrence.—Bikini Atoll: Erik island (1a). Malay Archipelago: Sumbawa, 18 fms; Samoa Islands.

Psammocora explanatula van der Horst, 1922

Plate 157, figures 9, 10

Psammocora explanatula van der Horst, 1922, Linnean Soc. London Trans., 2d ser., Zool., v. 18, p. 426, pl. 32, figs. 7, 8.

One specimen, which fits van der Horst's excellent description very closely, was dredged. The only difference, and a minor one, is that the septocostae are frequently thickened and produced upwards into blunt lobes, expecially the six corresponding to the primary septa at the margin of the otherwise superficial calices.

Occurrence.—Bikini Atoll: seaward slope, 25–44 fms (110). Amirante Isles and Providence Island, Indian Ocean, 29–78 fms.

Subgenus STEPHANARIA Verrill, 1867

Psammocora (Stephanaria) togianensis Umbgrove, 1940

Plate 156, figures 6, 7

Psammocora togianensis Umbgrove, 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 299, pl. 29, fig. 3; pl. 30, fig. 1; pl. 31, figs. 3, 4.

Psammocora (Stephanaria) togianensis Umbgrove. Wells, 1950, Raffles Mus. Bull. 22, p. 43.

One specimen from Jaluit Atoll, identified from photographs, agrees with Umbgrove's analysis of this species, and his separation of it from *P. digitata* seems justified, although all of his criteria for discrimination may not hold. According to Umbgrove the calices are much smaller; and although he does not give any dimensions for either species, his figures show the calices of the holotype of *P. digitata* to be 3–4 mm and those of the holotype of *P. togianensis* a little more than 2 mm. The Jaluit specimen has calices ranging from 1.5 to 3 mm. The calices of *P. togianensis* are said to be deeper, and the Jaluit specimen shows mostly such deep fossettes, but basally they are practically superficial or flush. A more reliable distinction seems to be in the number of septa that reach the columella: rarely more than 6 or 7 in *P. digitata*, rarely less than 8 and often 12 in *P. togianensis*.

Another species concerned here is *P. exesa*. Dana's type of this species (USNM 189) seems to be a *Coscinaraea* close to *C. fossata*, further discussed on p. 446 but the specimen figured by Yabe, Sugiyama, and Eguchi (1936, p. 59, pl. 44, figs. 3, 4) may be a variant of *P. togianensis*.

Occurrence.—Jaluit Atoll (Imp. Coll. 45). Teluk Tomini, N. Celebes; Daitō-jima; Cocos-Keeling Islands; Saipan.

Subgenus PLESIOSERIS Duncan, 1884

Psammocora (Plesioseris) haimeana Milne-Edwards and Haime, 1851

Psammocora haimiana Milne-Edwards and Haime. Vaughan, 1918, Carnegie Inst. Washington Pub. 213, p. 141, pl. 59, figs. 2, 2a. [Synonymy.]

Psammocora haimeana Milne-Edwards and Haime. Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 52, pl. 10, fig. 3.

Psammocora haimiana Milne-Edwards and Haime. Matthai, 1948 [part], Royal Soc. London Philos. Trans., v. 233B, p. 87, pl. 9, fig. 40.

Psammocora (Plesioseris) haimeana Milne-Edwards and Haime. Wells, Raffles Mus. Bull. 22, p. 43.

Two small encrusting patches 15–25 mm broad were dredged from the seaward slope of Bikini Atoll.

Occurrence.—Bikini Atoll: seaward slope, 12.5–17 fms (103). Teluk Djakarta; Minicoy Island; Funafuti Atoll; Red Sea; Seychelles; Cocos-Keeling Islands; Tahiti.

Family POCILLOPORIDAE Gray, 1842
Genus STYLOPHORA Schweigger, 1819

Stylophora pistillata (Esper), 1797

Stylophora pistillata (Esper). Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 32, pl, 3, figs. 2, 3. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tōhuku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 15, pl. 3, fig. 1.
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 23.
Umbgrove, 1940, idem, p. 274.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, 170.3, p. 107, pl. 2, fig. 5.

This well-known and very widely distributed species occurs commonly on the windward flats in the *A. palifera* and *Heliopora* zones, where illuminated living colonies are nearly colorless, but the bases and shaded parts may grade to a deep chocolate. In the *Heliopora* zone *Seriatopora hystrix* and *Stylophora pistillata* are the commonest associates of *Heliopora*. It is very rare in the *A. digitifera* and *A. cuneata* zones, although occasional clumps occur in the comparative shelter of the surge channel caverns. It is not common on the lagoon reefs, and lagoonward from there it seems to occur only sporadically down to the lagoon floor at 25–30 fms.

Occurrence.—Bikini Atoll: Bikini island (10c, 10e); Enirik island (1); lagoon, 10–25 fms (44, 69, 82). Rongelap Atoll: lagoon (100). Generally in the Indo-Pacific from the Red Sea eastward to Samoa Islands.

Stylophora mordax (Dana), 1846

Plate 96, figure 5

Stylophora mordax (Dana). Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 15, pl. 3, fig. 2. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 23.

This seems to be much commoner in the Marshall Islands than *S. pistillata* and has been previously reported by Yabe, Sugiyama, and Eguchi. In the present collections there are 17 specimens, all normal compared with Vaughan's figures (1918, pl. 25, figs. 1, 1a) of Dana's type, except that the branches are not so strongly meandrine. Several specimens, evidently pieces from large broken heads that had fallen on their sides, show 3 or 4 new proliferating branchlets that rise from the prostrate parts.

S. mordax is rarely found associated with *S. pistillata*. On windward reefs it grows only in crevices and cavities in the reef flat and surge channel caves in which it flourishes. Living colonies are pale yellow brown. On lagoon reefs, such as at Latoback island, Rongerik Atoll, and Namu and Bikini islands, Bikini Atoll, it forms much larger heads.

Occurrence.—Bikini Atoll: Bokororyuru island (5a, 5d, 6); Ourukaen island (4); Bikini island (10f); lagoon, 3½–8 fms (39, 45, 47). Eniwetok Atoll: Bogon island (15), Lidilbut island (16a). Jaluit Atoll, Imp. Coll. 39, 24; Ailuk, Pokak [Toangi], Jaluit, Eniwetok, and Wotje Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Fiji Islands (Dana, 1846); Fanning Island (Vaughan, 1918); Mariana Islands, Caroline Islands, Palau Islands, Daitō-jima, Okino-tori-shima, *in* Yabe, Sugiyama, and Eguchi, 1936; Bay of Batavia [Teluk Djakarta], *in* Umbgrove, 1939.

Genus SERIATOPORA Lamarck, 1816

The taxonomy of the species of this genus is most unsatisfactory, as Umbgrove has pointed out. Probably less than 6 of the 20 or more described species are valid.

Seriatopora hystrix (Dana), 1846

Plate 96, figures 6, 7; plate 97, figures 1, 2

Seriatopora hystrix (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 12, pl. 1, figs. 1, 2. [Synonymy.]
?Seriatopora stellata Yabe, Sugiyama, and Eguchi, 1936, idem, p. 12, pl. 2, figs. 3, 4.
Seriatopora hystrix (Dana). Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 20. [Synonymy.]
Umbgrove, 1940, idem, deel 22, p. 272, pl. 21, figs. 1, 2, 5, 6.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 107.

This species is abundant in the *Heliopora* zone, less so on the lagoon reefs, and occurs down the slope into the lagoon. It is almost never seen in the outer zones of the reefs in agitated water. There is some variation in the development of the calicular margins and angle of branching. In most specimens the calices have prominent distal "hoods"; in others, hoods may be lacking, and the margins are flush. The specimen figured shows both of these conditions: most calices are hooded; but on two nearly horizontal branches, they are quite nonemergent, resembling *Stylophora*. Deeper water specimens, such as that figured, are laxly branched, and many branchlets are nearly at right angles, resembling *S. angulata* or *S. spinosa*, whereas those from shallow water on the reefs are compact tufts with branches tending to be subfasciculate with blunter but still rather acuminate tips.

Occurrence.—Bikini Atoll: Bikini island (10e); Aomoen island off pier; lagoon, 10–12 fms. (44, 70). Eniwetok Atoll: Bogen island (15). Rongerik Atoll: Latoback island (20a). Pokak [Taongi] *in* Yabe, Sugiuama, and Eguchi, 1936, as *S. stellata*. Jaluit Atoll, Imp. Coll. 33. Teluk Djakarta; Amboina; Pulau-pulau Penju; Murray Islands; Palau Islands; Mariana Islands; Formosa; Ryukyu Islands; Fiji Islands; Samoa Islands.

Seriatopora angulata Klunzinger, 1879

Plate 97, figures 3–7

Seriatopora sp. cf. *angulata* Klunzinger. Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 11, pl. 2, figs. 1, 2. [Synonymy.]

?Seriatopora cf. *S. caliendrum* Ehrenberg. Yabe, Sugiyama, and Eguchi, 1936, idem, p. 11, pl. 1, figs. 3, 4; pl. 7, fig. 3.

Seriatopora angulata Wells, 1950, Raffles Mus. Bull. 22, p. 33.

There seem to be two intergrading growth forms of this species in the Marshall Islands. One is the normal type from Eniwetok Lagoon, 15–20 fms, with spiky branchlets, showing the compressed branches or flattened areas between the hooded calicular series (pl. 97, fig. 4); the other, from Bikini Lagoon, 18–28 fms, is more diffuse, with lax, slender, rounded branches (pl. 97, figs. 3, 5), on which the calices are flush or very feebly salient, similar to the specimen figured by von Marenzeller (1906, pl. 29, fig. 110a). The specimen from Bikini Lagoon (loc. 35), 18 fms, intergrades with the normal forms found at the same depth at Eniwetok Atoll and the slender form type from Bikini Lagoon.

One specimen is doubtfully referred to *S. angulata*, a delicately branched specimen from 33–48 fms off Enirik island (loc. 107). It resembles very closely one of the specimens from Jaluit Atoll referred to *S. caliendrum* by Yabe, Sugiyama, and Eguchi (1936, pl. 1, fig. 5). The calices are more hooded than in *S. caliendrum*, and smaller and more distant, about 4 in 5 mm, contrasted with 5 or 6 in 5 mm in *S. angulata* and *S. hystrix*.

Occurrence.—Bikini Atoll: Normal forms: lagoon, 14–23 fms (37, 55); seaward slope, 12.5–17 fms (103); doubtful specimen, 33–48 fms (107). Lax, slender form: lagoon, 18–30 fms (32, 33, 34, 66, 84). Eniwetok Atoll: Normal forms, 5–20 fms (89, 72). Rongelap Atoll: Lax form: lagoon (96); Wotje, Ailuk, Nugol Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea type specimens: Indian Ocean; Palau Islands: Caroline Islands.

Genus POCILLOPORA Lamarck, 1816

Pocillopora damicornis (Linnaeus), 1758

Plate 99, figure 2

Pocillopora damicornis (Linnaeus). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 15, pl. 1, fig. 1. [Synonymy.]
Yabe, Sugiyama, and Eguchi 1936, Tōhoku Imp. Unit. Sci. Repts., 2d ser., special v. 1, p. 12, pl. 4, figs. 3, 4, 5.
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 21. [Synonymy.]
Umbgrove, 1940, idem, deel 22, p. 273.
Crossland, 1948, Natal Mus. Annals, v. 11, p. 183.
Wells, 1950, Raffles Mus. Bull. 22, p. 34.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 110.

Two specimens: one typical is from Namu island lagoon reef; the other, included here with some doubt, shows gradation towards *P. danae*.

A few pale yellow-brown specimens of *P. damicornis bulbosa* Ehrenberg were obtained from the lagoon reef at Latoback island, Rongerik Atoll. These specimens, which have straggly, finely divided branches and branchlets, are identical with the specimen figured by Yabe, Sugiyama, and Eguchi (1936, pl. 5, fig. 4) from the Palau Island. One colony of this variety was dredged alive from 33–48 fms on the seaward slope off Bikini Atoll (loc. 107).

P. damicornis caespitosa Dana is common on the algal ridge and in surge channels on the windward reef at Bikini island, where it forms small compact clumps in cavities, varying considerably in color from light brown and yellow brown to pale red brown and pale red violet.

Occurrence.—Bikini Atoll: Bikini island (10, 10a); Namu island (7b); Aomoen island (9); seaward slope, 33–48 fms (107). Rongerik Atoll: Latoback island (20a); Jaluit Atoll (Imp. Coll. 28); Kwajalein, Wotje, Jaluit, and Ailuk Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Eastern Indian Ocean eastward to Marshall Islands, and Hawaiian Islands.

Pocillopora danae Verrill, 1864

Pocillopora danae Verrill. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 77, pl. 22, figs. 1, 1a, 2. [Synonymy.]
Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 27, pl. 1, fig. 7. [Synonymy.]
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 110.

The species is very close to *P. verrucosa* and in nearly all reef environments at Bikini Atoll. The living colonies are usually brownish, pinkish brown, gray brown, or with violet tints. Specimens from the rough-water area of the surge channels are more compact, with closely set branches, whereas those growing on the reef flat or on lagoon reefs are taller and more open.

The specimens from Bikini island correspond closely with Verrill's type and specimens from the Murray Islands, described and figured by Vaughan. Three others, two from Bokororyuru island and one from Enirik island, are gradational towards *P. verrucosa*, with swollen verrucae and slightly compressed branches.

Occurrence.—Bikini Atoll. Bikini island (10a, 10f); Bokororyuru island (5); Enirik island (1); lagoon, 16 fms (59). Pulau-pulau Banda; Philippine Islands; Murray Islands, Australia; Tahiti; Fiji Islands.

Pocillopora verrucosa (Ellis and Solander), 1786

Plate 98, figures 5, 6

Pocillopora verrucosa (Ellis and Solander). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 77, pl. 23, figs. 1, 2, 2a. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tohoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 14, pl. 3, figs. 3, 4.
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 22.
Wells, 1950, Raffles Mus. Bull. 22, p. 34.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 111.

This is the commonest *Pocillopora* in the Marshall Islands. Fifteen specimens have been examined; most are typical, but a few grade towards *P. danae*. Those from reef margins and very shallow water are stunted, low, and prostrate, often with very compressed branches.

Occurrence.—Bikini Atoll: Bikini island (10b, 10f), Enyu island (12a), Ourukaen island (4, 4a, 4b), Bokororyuru island (5d, 6), Namu island (7), Aomoen island (9a). Eniwetok Atoll: Lidilbut island (16a). Rongerik Atoll: Bock island (18), Eniwetak island (19b). Rongelap Atoll: Busch island (22). Jaluit Atoll, Imp. Coll. 41; Wotje, Pokak [Taongi], and Ailuk Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Eastern Indian Ocean eastward to Hawaii.

Pocillopora elegans Dana, 1846

Plate 95, figure 2

Pocillopora elegans Dana. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 78, pl. 23, figs. 3, 4, 4a. [Synonymy.]
not *Pocillopora elegans* Thiel, 1932, Mus. royale historie nat. Belgique Mém., (hors sér.), v. 2, p. 24, pl. 2, fig. 1.
Pocillopora elegans Verrill. Wells, 1950, Raffles Mus. Bull. 22, p. 35.

Ten specimens of this species, which is closely allied to *P. verrucosa* and *P. meandrina*, were examined. The specimen from 6 to 8 fms in Enyu Channel is an exceptionally fine symmetrical subspherical head 17 cm high and 18 cm in diameter, arising from a stalk 3 cm thick. A living colony from the seaward reef on the north end of Enirik island was a strong red violet.

Occurrence.—Bikini Atoll: Ourukaen island (4); Enirik island (1a); Enyu Channel, 6–8 fms (47); seaward slope, 13–17 fms (103). Eniwetok Atoll: Bogon island (15), Lidilbut island (16). Rongerik Atoll: Bock island (18). Rongelap Atoll: Tufa island (21). Cocos-Keeling islands; Pulau-pulau Banda; Amboina; Ryukyu Islands; Fiji Islands; Samoa Islands.

293438—54——3

Pocillopora meandrina nobilis Verrill, 1864

Pocillopora meandrina nobilis Verrill. Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 98, pl. 14, figs. 3, 4; pl. 22, figs. 1, 2; pl. 23. [Synonymy.]
Dana. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 78.
Pocillopora elegans Dana Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 24, pl. 2, fig. 1.
Pocillopara meandrina nobilis (Verrill). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 14, pl. 4, fig. 1.

The only specimen of this handsome species seen was a large colony with stout branches at least 9 mm thick. The colony was brown where living, but most parts were dead.

Occurrence.—Bikini Atoll: Bikini island (10f). Namotik [Namorik] Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Pulau-pulau Banda northeastward to Hawaiian and Bonin Islands.

Pocillopora brevicornis Lamarck, 1816

Plate 98, figures 1, 2

Pocillopora brevicornis Lamarck. Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 17, pl. 1, fig. 2. [Synonymy.]

One specimen, a low, spreading, even-topped colony, fitting Hoffmeister's description and specimen, is identical with this species.

Occurrence.—Bikini Atoll: Ourukaen island (4). Malay Archipelago; Fiji Islands; Ceylon; Samoa Islands.

Pocillopora setchelli Hoffmeister, 1929

Pocillopora setchelli Hoffmeister, 1929, Wash. Acad. Sci. Jour., v. 19, p. 359, pl. 1, figs. 1, 2; pl. 2, fig. 1.
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 14, pl. 6, figs. 1–3.

This is a common species in the Marshall Islands. Twelve specimens, all seeming typical, were examined. In most specimens the verrucae are lacking over the tips of the fronds; they are smaller and less swollen than in *P. brevicornis*.

Occurrence.—Bikini Atoll: Bikini island (10a); Ourukaen island (4); lagoon, 4 fms (45). Eniwetok Atoll: Bogen island (17), Rigili island (13), Bogon island (15), Lidilbut island (16a). Wotje Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Tahiti (types); Caroline Islands; Bonin Islands; Kita-daitō-jima; Okino-tori-shima, *in* Yabe, Sugiyama, and Eguchi, 1936.

Pocillopora ligulata Dana, 1846

Plate 99, figures 3, 4.

Pocillopora ligulata Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 529, pl. 50, figs. 3, 3a.
Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 94, pl. 14, figs. 1, 1a; pl. 17, figs. 2, 2a; pls. 18–21.
Pocillopora sp. cf. *P. ligulata* Dana. Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 13, pl. 3, fig. 5; pl. 5, fig. 2.

A few colonies of this species are to be seen on the decadent lagoon reef at Bikini island and are relatively common in the surge channels on the windward reefs, where large colonies, light-brown to pale red-violet, with compressed, contorted flabellate branches, grow in strongly agitated water. At first glance they resemble lax colonies of *P. elegans*, but the calicular characters are different and the verrucae usually much appressed.

Occurrence.—Bikini Atoll: Bikini island (10, 10b, 10f). Hawaii, *in* Vaughan, 1907; Caroline and Palau Islands, *in* Yabe, Sugiyama, and Eguchi, 1936.

Pocillopora eydouxi Milne-Edwards and Haime, 1860

Plate 98, figures 3, 4; plate 99, figure 1

Pocillopora eydouxi Milne-Edwards and Haime. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 79, pl. 24, figs. 1, 2, 2a. [Synonymy.]

Pocillopora sp. cf. *P. eydouxi* Milne-Edwards and Haime. Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 13, pl. 2, fig. 5; pl. 4, fig. 2; pl. 6, figs. 4, 5; pl. 7, figs. 4–6.

Pocillopora sp. cf. *P. modumanensis* Vaughan. Yabe, Sugiyama, and Eguchi, 1936, idem, p. 13, pl. 5, fig. 1.

Pocillopora eydouxi Milne-Edwards and Haime. Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 22. [Synonymy.]

Umbgrove, 1940, idem, deel 22, p. 273, pl. 21, figs. 3, 4, 8.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 112, pl. 1, fig. 2.

?*Pocillopora modumanensis* Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 93, pl. 17, figs. 1, 1a.

This species lives on the reefs and in quiet water down to about 40 feet. One specimen, taken alive, was growing on the top of a coral knoll in Bikini Lagoon (loc. 49) at a depth of 6 fms. It is only a pale yellow-brown fragment of a large, perfect corallum 3 feet high. The calices and coenenchyme correspond very closely to Vaughan's description of specimens from Cocos-Keeling and Murray Islands. The verrucae are taller, more erect, and not so crowded as in previously described material, probably the effect of greater depth. Similar specimens were observed on the lagoon reef at Latoback island, Rongerik Atoll, growing at depths of 8 feet or more.

Occasional bright red-violet colonies, representing a shallow-water variant similar to Vaughan's specimens, are found on the seaward and lagoon reefs at Bikini Atoll. The branches are less flabellate and more divided and fingerlike.

One specimen, dredged on the seaward slope off Enyu island, is doubtfully placed here. It has been dead for some time and is more or less corroded, which makes the calicular characters almost completely indiscernible.

From photographs, two specimens from Jaluit Atoll are also identified with this species. The photographed colonies, which are composed of closely compacted, less foliose branches, probably represent the shallow-water facies.

Occurrence.—Bikini Atoll: Bikini island (10); Namu island (7); lagoon, 6 fms (49); also one fragment of a huge colony from beach at Eninman island. Rongerik Atoll: Latoback island (20a). Jaluit Atoll: (Imp. Coll. 1, 4); Jaluit, Nugol, Ailuk Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936; Cocos-Keeling Islands; Samoa Islands; Loyalty Islands; Funafuti Atoll; Rotuma Island; and probably Hawaiian Islands (*P. modumanensis*).

Genus MADRACIS Milne-Edwards and Haime, 1848

This genus is represented in the Indo-Pacific by several species from the Hawaiian Islands, Palau Islands, Bougainville Islands, eastern Indian Ocean, and the Red Sea, in depths of 24 to 294 fms.

Because the lone specimen described below represents only the early stage in the development of a ramose corallum, the characters of the calices are probably quite different from those on normal branches, and identification with one of the described species would be uncertain.

Madracis sp.

Plate 99, figure 5

One small colony of this genus was collected—a patch with a few corallites encrusting the underside of a bracket of *Oxypora lacera*. The polygonal calices are 2.0–2.5 mm in diameter, with the septa arranged 10/10. The larger septa are exsert with arched margins between the wall and axial space, and each bears a small palus on its inner end, its sides minutely but thickly spinulose. Columella is a stout central knob.

Occurrence.—Bikini Atoll: seaward slope, 25–44 fms (110).

Family ACROPORIDAE Verrill, 1902

Genus ACROPORA Oken, 1815

No less than 250 species of this protean genus have been described from the Indo-Pacific region. Many of these are probably synonyms, and many cannot be identified without recourse to the type specimens because of inadequate figures and descriptions. The collections from the Marshall Islands are remarkably rich in species of this genus, and 49 have been recognized. Pending Dr. Jan Verwey's long-promised revision of the genus, the writer has grouped the species according to his own concept of their interrelationships, but in a very loose and tentative manner.

Particularly important is the wide range of distribution of the material, especially at Bikini Atoll, where specimens were procured from all environments—on

the reefs, in the lagoon, and down the seaward slope to the lower limit of occurrence of the genus.

Nearly all of the Marshall Islands species have been figured, which adds materially to the iconography of *Acropora* well started by Brook (1893), Vaughan (1918), Hoffmeister (1925), and Crossland (1952). Several of Dana's types, heretofore unfigured photographically, have been included. Most of Dana's, Brook's, Vaughan's, and Hoffmeister's types and other specimens of species involved have been studied and compared.

Acropora acuminata Verrill, 1864

Plate 100, figure 2; plate 101, figures 1–6

Madrepora acuminata Verrill, 1864, Harvard Coll. Mus. Comp. Zoology Bull. 3, p. 40.
Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 38.
Madrepora nigra Brook 1892, Annals and Mag. Nat. History, 10th ser., v. 10, p. 459.
Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 45, pl. 27, fig. C.
Acropora acuminata Verrill. Verrill, 1902, Conn. Acad. Arts and Sci. Trans., v. 11, p. 260, pl. 36D, fig. 5; pl. 36E, fig. 2; pl. 36F, fig. 11.

Fourteen specimens represent this arborescent species, which is common on lagoon reefs and leeward reefs and occasionally occurs on windward reefs behind the algal ridge. Living colonies are yellow brown to brown, with white tips. Two specimens, one from the lagoon reef at Latoback island, Rongerik Atoll, and another from the windward reef, Bikini island (*A. digitifera* zone), were yellow brown but were a pale yellow green when the polyps were fully expanded. The corallum dries to a velvety black.

The specimens have few radial corallites attaining the diameter indicated by Verrill, 2.0 to 2.2 mm; but his figures show few as large as this. The septa are prominent in the radicals and easily seen by the unaided eye in cleaned specimens. The axials measure 2.0–2.5 mm, with thick walls and 1-3 mm exsert. The radials are often recurved, with flaring apertures.

Study of Brook's types of *A. nigra* (BM 89.9.24.92, 89.9.24.93) shows that the species is identical with *A. acuminata* in every detail, except that the axials are slightly smaller (1.5 mm). In both the Bikini and Tizard Bank specimens, the septa are better developed in the radials than in Verrill's specimens.

Occurrence.—Bikini Atoll: Bikini island (10b), Namu island (7b), Enirik island (1), Bokororyuru island (5a). Eniwetok Atoll: Bogen island (15). Rongerik Atoll: Latoback island (20a), Bock island (18). Kingsmill Group, Gilbert Group [Gilbert Islands], *in* Verrill, 1864; Tizard Bank, *in* Brook, 1893.

Acropora formosa (Dana), 1846

Plate 102, figures 1–9; plate 103, figures 1–5; plate 104, figure 4

Acropora formosa (Dana). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 55, pl. 8, figs. 1–3. [Synonymy.]
Hoffmeister, 1929, Wash Acad. Sci. Jour., v. 19, p. 363.
Wells, 1950, Raffles Mus. Bull. 22, p. 35.
Acropora laevis Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3. p. 230, pl. 45, figs. 1, 2.

This species seemingly is abundant in the Bikini Lagoon at depths below about 6 fathoms, and forms in places dense thickets (Emery, 1954, pl. 24, fig. 3).

I am following in part Hoffmeister's species treatment, by which he combined *A. formosa*, *A. brachiata*, and *A. gracilis*. He distinguished *A. brachiata* and *A. gracilis* as "varieties" in which the radials mostly have oblique apertures and which differ from each other only in the thickness of the branches—more than 12 mm in *A. brachiata*, less in *A. gracilis*. It is doubtful, however, if the distinction between these two forms can be maintained. In the material from Bikini Atoll there are many specimens of *A. formosa*, some representing parts of the same very large shrublike colony. The distal parts of the branches are *A. gracilis* by every criterion; the basal parts are *A. brachiata*, with stems up to 25 mm thick.

There are other variations in this species, principally in the development of the radial corallites. The "normal" type, exemplified by Dana's type (USNM 888) figured by Hoffmeister, shows thickly set, salient, spreading radials. The specimen from Eniwetok Lagoon, 7½ fms off Rujiyoru island (pl. 102, fig. 4), shows these characters well. The opposite extreme is the almost complete immersion of the radials, which are somewhat more widely spaced, with very dense, finely echinulate coenenchyme between them, as shown by the specimens from Bikini Lagoon, 18 fms (pl. 102, figs. 7, 8), and others. Taken separately these two forms would scarcely be called the same species, but there is complete intergradation, strikingly exhibited by the specimen from Bikini Lagoon, 14 fms (pl. 103, fig. 1). A main branch of this specimen has immersed radials, but a secondary branchlet shows thick, salient corallites and less compact coenenchyme.

Many specimens from Bikini Lagoon show salient radial corallites with very small apertures (pl. 103, figs. 4, 5). This type is completely gradational into "normal" *A. formosa*. Specimens from the coral knoll northwest of Enyu island (locs. 38a, 38b), Bikini Lagoon, show this gradation—from branches with all subimmersed, tiny radials to branches with spreading, *A. formosa*-sized, tubolabellate radials, many of them 4–5 mm long. When dried, these last specimens became black.

Rather than attempt to refer such variants to already amed varieties, I would prefer to use forma α for specimens with mostly salient radials and forma β for those with mostly immersed radials, and $\alpha \rightarrow \beta$ for intergrades.

The form does not seem to be a function of depth: forma α being represented at 15 stations in depths from 6 to 30 fms; forma β at 5 stations, 10–18 fms; and intergrades at 3 stations, 12–18 fms. The material is not conclusive as to whether the variations or formae are a matter of orientation, although the striking example referred to above suggests that it is not. Although there is a tendency for lower parts of branches of large colonies to assume forma β, the fragments from location 35, 18 fms, probably snapped from a large colony, suggest that in some cases forma β may be characteristic of entire colonies.

Living colonies on the coral knoll north of Eninman island, Bikini Lagoon, 6 fms (loc. 49), were tan; others, dredged from slightly greater depths, were pale lavender.

Specimens from 19 stations were examined; all, with one dubious exception, came from atoll lagoons. None was dredged on the seaward slopes.

Occurrence.—Bikini Atoll: Aomoen island (9) doubtfully this species; lagoon, 5–30 fms (35, 36, 37, 37a, 38a, 38b, 43, 44, 49, 52, 53, 69, 71, 74, 81, 82, 85). Eniwetok Atoll: lagoon (87). Rongelap Atoll: lagoon (101), and 12 fms (USNM). Fiji islands (Dana, 1846; Brook, 1893); Samoa Islands, *in* Hoffmeister, 1925; Amboina (Brook, 1893; Tahiti) *in* Hoffmeister, 1929; Carteret Harbor, New Ireland (Studer, 1878).

Acropora implicata (Dana), 1846

Plate 103, figures 6–8

Madrepora implicata Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 72. [Synonymy.]

The type of this species, which is in the U. S. National Museum (283), is figured on plate 103, figure 6. Two pieces from 4 fms in the Bikini Lagoon, south of Namu island, have been compared with it. The only difference is that in the Bikini Lagoon specimens the radials are slightly farther apart and the coenenchyme is denser. Except near the tips of the branches, all corallites are immersed, about 1 mm in diameter, with six short septa. The coenenchyme is coarsely vermiculate, the ridges bearing single rows of slightly flattened echinulations.

Occurrence.—Bikini Atoll: lagoon 4 fms (62). Fiji (Dana's type).

Acropora nobilis (Dana), 1846

Plate 104, figures 1, 2

Acropora nobilis (Dana). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 59, pl. 11, fig. 1. [Synonymy].

Two specimens from Bikini Lagoon are typical *A. nobilis* and are pieces from large, arborescent, openly branched colonies. The larger one (pl. 104, figs. 1, 2) has a maximum thickness of 20 mm. The arrangement and character of the radials are as described by Hoffmeister and by Verrill (1902). The larger piece was pale lavender when alive.

Occurrence.—Bikini Atoll: lagoon, 3½–14 fms (37a, 39). Samoa Islands; Singapore; Ceylon; Java.

Acropora polymorpha (Brook), 1891

Plate 105, figures 2–5

Acropora polymorpha (Brook). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 180, pl. 81, figs. 1–5. [Synonymy.]

Five specimens from the lagoon reef on Namu island, Bikini Atoll, correspond to Vaughan's specimens from Fanning Island (1918, pl. 81, figs. 1, 4). These and Vaughan's material agree very well with Brook's types (BM 42.11.28.1, 5, 6; 42.11.30.20, 25) from Malacca, except that the branches do not bear many proliferous branchlets.

In deeper, less agitated water the corallum of this species appears to develop slenderer branches, with denser, very finely echinulate coenenchyme and thicker radial corallite walls. A single specimen from 22 fms in Bikini Lagoon (pl. 105, figs. 2, 3), not certainly this species but unlike any of the other lagoon species of *Acroporae*, may represent an extreme in this direction of variation. The branches are slender, 5–8 mm thick, with branchlets more spreading, very dense coenenchyme, and tubular, contracted radials with greatly thickened walls and reduced apertures.

Occurrence.—Bikini Atoll: Namu island (7b); lagoon, 22 fms (31). Malacca (types); Fiji Islands (Dana's *M. abrotanoides*, 1846); Fanning Island, *in* Vaughan, 1918.

Acropora vaughani Wells, n. sp.

Plate 105, figure 1; plate 106, figures 1–8; plate 107, figures 2–6

Arborescent, with numerous long branches at 60°–90°, usually straightening or curving upwards. Main branches up to 25 mm; secondary branches 6–12 mm, tapering gently to apex; proliferous short branchlets about 6 mm in diameter, up to 20 mm long, nearly at right angles. Axial corallites 2.0–2.5 mm in diameter, aperture 1 mm, exsert 1–2 mm, thickwalled, rounded, with 12 septa, first cycle of which well developed, the second less so. Radial corallites relatively distant, about 3 mm apart, tending to be arranged in vertical rows the same distance apart, giving long slender branches a prismatic appearance. Diameter of radials 1.5 mm, with apertures 0.5–1.0 mm. Radials cylindrical, aperture oblique or normal, distally appressed with weak inner wall, spreading lower down. Distally

they are well developed, 2 mm exsert, but on most branches subimmersed. On thick branches nearly all, except for scattered proliferants, subimmersed with rims salient up to 1 mm so that they are prominent. Wholly immersed corallites scarce, even near bases of branches. Septa variously developed in radials; distally on some rapidly growing branches they are weak, the first cycle short and inconspicuous except for the directives, second cycle absent. In other cases the first cycle well developed. Lower down on the branches, where most of the radials are subimmersed, the second cycle is usually present, often highly developed so that 12 septa, with prominent directives, are seen. In general, the less protuberant the corallites, the smaller the aperture and the more developed the septa. The coenenchyme shows much variation—from coarsely porous and distally striate to dense echino-vermiculate lower down around subimmersed corallites. In the stoutly branched specimens from deep water, coenenchyme openly vermiculate with rows of flattened spines on the flattened ridges. The wall of protuberant corallites noncostate, thick, porous, and spinulose.

Holotype, USNM 44452; paratype, USNM 44453.

Growth form varies considerably from the shallow-water facies (pl. 107, figs. 2, 3) with more intricate branching and rows of salient corallites to the deeper water facies (pl. 106, figs. 1, 4; pl. 107, fig. 6) with thick main branches bearing a few stubby branchlets with subimmersed corallites. In spite of this variation specimens show complete intergradation and seeming response to local conditions of sedimentation and water movement. The essential characteristics of the species are the tendency of the radial corallites to be subimmersed but not wholly immersed except on some "under surfaces," giving an exophthalmic effect; two cycles of septa in the axials and six well-developed septa in the radials with the secondaries more often developed than not; and variable, but usually dense, vermiculate coenenchyme.

The shallow-water facies of *A. vaughani* bears considerable superficial resemblance to *A. horrida* (Dana), but in *A. horrida* the radials are more protuberant distally with very thin walls and only six septa, and the coenenchyme is coarsely reticular and porous. Plate 107, figure 1, shows the holotype specimen, USNM 291, of this species.

The branches with mostly subimmersed, ring-margined calices resemble *A. pharaonis arabica*, which is a deepwater facies of *A. pharaonis*, a Red Sea-Indian Ocean species; but in *A. arabica* the axials have only six septa, and the radials are smaller and closer with the septa scarcely developed. The protuberant corallites of *A. pharaonis* characteristically bear clusters of smaller, labellate corallites.

This species is apparently abundant in Bikini Lagoon, having been obtained at six stations, mostly in the form of fragments snapped from large bushlike colonies. One handsome specimen, a fragment of a main stem 25 mm in diameter with several secondary branches, which bear branchlets, was dredged on the seaward slope off Bikini Atoll.

Occurrence.—Bikini Atoll: lagoon, 4–22 fms (31, 34, 35, 36, 59, 62); seaward slope, 21–25 fms (117). Rongelap Atoll: lagoon, 12 fms (USNM).

Acropora virgata (Dana), 1846

Plate 108, figures 1–7

Madrepora virgata Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 40. [Synonymy.]

Dana's type of this species, USNM 290, is figured on plate 108, figure 4. It is laxly branched, with branches up to 10 mm thick, gently tapering. Axial corallites 1.5 mm with two cycles of septa; radials tubular with oblique aperture, closely set, about 0.75 mm in diameter, thin-walled, short (up to 1 mm), appressed at about 45° near tips, slightly spreading (at 60°) lower down. Six short septa in radials, directives longer. No immersed corallites. Coenenchyme coarse, striato-costulate near tips, finer lower down but not dense.

Five specimens from Bikini Atoll agree with the above brief description; the axials are slightly larger (1.75 mm) with the second septal cycle weak or absent; radials rarely completely immersed, with normal apertures.

This species resembles *A. formosa*, but the radials are less spreading with only one cycle of septa, and the coenenchyme is not dense.

Occurrence.—Bikini Atoll: Aomoen island (9); lagoon, 18 fms (35). Fiji Islands; Tahiti; Amboina; Tonga; New Hanover.

Acropora teres (Verrill), 1866

Plate 109, figures 1–7

Madrepora teres Verrill, 1866, Commun. Essex Inst. Proc., v. 5, p. 20. Brook 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 198. [Synonymy.]

Acropora teres (Verrill). Hoffmeister, 1925, Carnegie Inst. Wash., Pub. 343, p. 58, pl. 10, figs. 1a, 1b, 2a, 2b.

?Acropora teres (Verrill). Hoffmeister, 1924 [*in* Mayor], Carnegie Inst. Wash. Pub. 340, pl. 6, fig. 19.

Specimens from the lagoons at four stations in the Marshall Islands correspond very closely with Verrill's type (USNM 377), although there is much individual variation and none approaches the large colony referred to this species by Hoffmeister (Mayor, 1924, pl. 6, fig.

19), which may, however, be a geographical or ecological variant. The variations observed in the Marshall Islands material are in the spacing of the corallites and development of the septa. In most specimens the corallites are close-set (1 mm or so) with only the six primary septa (pl. 109, fig. 3). In a few, however, the corallites are distant 2.5–3.5 mm (pl. 109, fig. 5). In one specimen (pl. 109, figs. 6, 7), the calices are strongly sunken in the echinulo-vermiculate coenenchyme. Near the tips of the branches the corallites are emergent and appressed (pl. 109, fig. 2); elsewhere they are all immersed. Plate 109, figure 1, shows a splendid branch 72 cm long from a very large colony and represents what I consider the typical facies of this species.

Occurrence.—Bikini Atoll: lagoon, 10–26 fms (35, 39a, 59, 61, 63). Eniwetok Atoll: lagoon, 13 fms (88). Rongerik Atoll: lagoon, 17 fms (93). Rongelap Atoll: lagoon (101). Ousima, *in* Verrill, 1866; Tahiti (?), *in* Hoffmeister, 1925.

Acropora teres distans Wells, n. var.

Plate 110, figures 1–3

Branches terete, sparse, at 60°–90°, 5–7 mm thick. Axial corallites 2.5 mm, with 12 septa. Radials appressed, emergent near tips, a few protuberant, 1.0–1.5 mm, with elliptical aperture, outer wall thin, costate, inner wall weakly developed. Away from tips the radials all immersed, rarely less than 1 mm in diameter and 4 mm or more apart, with 2 cycles of septa, often incomplete in one or two systems, upper directive large. Coenenchyme scabrous-reticulate distally, denser and echinulo-vermiculate lower down.

This differs from *A. teres* s. s. in having a more persistent second cycle of septa in the radials, even distally, considerably larger and more distant corallites, and slenderer more terete branches. It is probably a geographical variant.

Holotype, USNM 44464.

Occurrence.—Rongelap Atoll: lagoon, 12 fms (USNM).

Acropora arbuscula (Dana), 1846

Plate 111, figures 1–3

Madrepora arbuscula Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 40. [Synonymy.]

Acropora arbuscula (Dana). Faustino, 1927, Philippine Dept. Agriculture and Nat. Resources, Bur. Sci. Mon. 22, p. 258, pl. 83.

Dana's type (USNM 296) has been refigured by Faustino; another photograph, showing more of the same specimen, is reproduced on plate 111, figure 1. Three specimens from Bikini Atoll are conspecific, although they have more spreading corallites that suggest an approach to *A. formosa*. The radials, which are slightly larger than in that species, have a more pronounced, elongate, upwardly curved lip. One specimen is subpalmate; the main branch subhorizontal, 6 cm wide, 1.5 cm thick, with distally proliferant, erect branches about 10 mm thick and with short conical branches on the palmate part. The specimen from the coral knoll north of Eninman island is a fragment from a huge arborescent colony 2 m in height with main stems up to 5 cm thick; the whole is tan when alive.

Occurrence.—Bikini Atoll: lagoon, 6–8 fms (47, 49) Sulu Sea; Singapore; Great Barrier Reef; Tizard Bank, *in* Brook, 1893.

Acropora abrotanoides (Lamarck), 1816

Plate 123, figures 1, 2

Madrepora abrotanoides Lamarck. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 56. [Synonymy.]

Acropora abrotanoides (Lamarck). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 166, pl. 68, figs. 1, 1a, 2.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 204.

Except for two dubious references, this species has been figured only by Vaughan, and the identification of one specimen from Bikini is based upon his specimens and Brook's description of Lamarck's type. It is subpalmate with short, blunt marginal branches; but otherwise it is not noticeably different.

Occurrence.—Bikini Atoll: lagoon, 6–8 fms (47). Tahiti; Great Barrier Reef; Murray Islands, Australia; Singapore.

Acropora danai (Milne-Edwards and Haime), 1860

Plate 111, figures 4–6

Madrepora danae Methy. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 57. [Synonymy.]

One specimen is referred to this rare species. It is a subpalmate frond 26.5 cm long, 3.5 cm thick at the broken-off lower end. Marginal branches short, subhorizontal, up to 2 cm thick, blunt. Axial corallites 2 mm in diameter; exsert 2–4 mm with 6 septa; the second cycle rudimentary or usually absent. Radials labellate, gutter-shaped, or tubonariform with incurved or dimidiate margins, spreading at about 45°, erect on broad surfaces; septa obsolete; directives only slightly developed. Some larger radials with buds; immersed radials scattered between close-set protuberant ones. On the under surface, no immersed calices, all being nariform and variously oriented. Walls of corallites striated distally; coenenchyme reticulate, moderately dense with scattered fine echinulations.

Dana's specimen of *M. deformis* (not *M. deformis* Michelin), the type of *A. danai*, is USNM 303 from Tahiti (pl. 111, fig. 6). It corresponds well with the preceding description but shows a subcaespitose rather than subpalmate growth form, not an important difference; the radials have a shorter lower lip and are more tubular.

A. danai differs greatly in all but form from *A. rotumana*; the radials are different in shape with a thinner outer lip, and the coenenchyme is less dense and echinulate.

Occurrence.—Rongelap Atoll: Tufa island (21). Tahiti.

Acropora rotumana (Gardiner), 1898

Plate 112, figures 1–3; plate 113, figures 4, 5

Madrepora rotumana Gardiner, 1898, Zool. Soc. London Proc., p. 258, pl. 23, fig. 2.
Acropora rotumana (Gardiner). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 69.

About 15 specimens of this species were obtained in the Marshall Islands. They show some individual variation in the size and shape of the radial corallites, but all are very close to Gardiner's and Hoffmeister's material. The radials have a more elongate aperture and appear more compressed than in Hoffmeister's specimens, but there is complete agreement on other characters such as growth form, axial corallites, character of coenenchyme, and septal arrangement. Young colonies are pedicellate with relatively slender branches that form a tuft. Later growth is lateral, with fusions, becoming palmate with erect, tapering, marginal branches and short, conical branches on the upper surface formed by interfusion of main branches.

One specimen from the lagoon reef at Latoback island, Rongerik Atoll, has radials with much thicker walls than seems normal but is otherwise not different.

A colony from a very shallow pool in rough water, on the windward reef margin north of Bikini island, has stubby and obtuse, rather than subacute or subterete, branchlets.

This species is very close indeed to *A. decipiens* in growth form and form and arrangement of the radial corallites. The axial corallites of *A. decipiens* are supposed to be larger, but measurements of Brook's specimens show that they are usually only 2 mm in diameter rather than 2.5–3.0 mm as stated by Brook. The only real difference seems to be in the well-developed septa in the radial corallites of *A. rotumana*.

A. rotumana is commonest in pools on lagoon reef margins in shallow water, with more or less exposure at low tide, when the brackets sometimes extend out from all sides so as nearly to fill the pools. A few colonies were found in similar sites on seaward reefs, and one was obtained from a depth of 4 fms in Bikini Lagoon on the margin of a lagoon reef. Living colonies are brown to ashy brown with pale tips.

Two small specimens from Rigili island, Eniwetok Atoll, seem to be pathologic, with radials which have very long outer lips or hoods curled in every direction (pl. 113, figs. 4, 5).

Occurrence.—Bikini Atoll: Enirik island (1); Ourukaen island (4, 4a); Namu island (7b); Bikini island (10); lagoon, 4 fms (45). Eniwetok Atoll: Rigili island (13); Lidilbut island (16a). Rongerik Atoll: Latoback island (20a). Rotuma Island, *in* Gardiner, 189°; Samoa islands, *in* Hoffmeister, 1925.

Acropora palmerae Wells, n. sp.

Plate 113, figures 1–3

Corallum encrusting, spreading by marginal budding over rocky surfaces with upper layer corresponding to topography of substratum, thin marginally, but 10 or even 20 mm thick centrally. In some cases irregular bosses with a few stumpy proliferations rise in the midst of colonies where there are topographic depressions or shelters from the surf, but these are scarcely true branches, nor are there shelflike expansions or marginal branchlets. No trace of axial corallites, even on the occasional proliferations, the tips of which are covered by corallites like those on the main surface but usually smaller. Corallites range from immersed to subtubular, mostly short, labellate, and spreading. Inner wall scarcely developed even on flat surfaces; the other wall striato-echinulate, curved toward the calyx and often forms a slightly thickened lip. Calicular aperture oblique, diameter from 1.0 to 1.25 mm. On the proliferations many corallites apt to be more protuberant, up to 3 mm. Septa weakly developed, appearing as ridges on the inner surface of the wall; those corresponding to the first cycle frequently slightly larger than the secondaries, with the directives in some cases reaching nearly halfway to the axis. Deep within the calyx the directives may join. Surface of coenenchyme delicately spongy in texture with regularly spaced, blunt, simple echinulations. Beneath the surface the coenenchyme dense, nearly solid in places.

Truly encrusting species of *Acropora* are almost unknown, and there is no other species of the genus, except possibly *A. monticulosa* Brueggemann (Brook, 1893, p. 130, pl. 14, fig. A: Rodriguez; Great Barrier Reef) which resembles this. *A. monticulosa* (figured type: BM 76.5.5.119), however, is marked by the presence over much of its surface of "stout, rounded, subconical prominences" (Brook, 1893), which bear thick-walled axial corallites 3 mm in diameter. *A. palmerae* has occasional irregular proliferations, but these bear no trace of axial corallites. Otherwise, the

two species are much alike, having the same kind of radial corallites, septa, and coenenchyme.

Colonies of *A. palmerae* are abundant on the algal ridge of the reef along the windward side of Bikini Atoll. These colonies are associated with *A. cuneata* where the ridge is highly developed opposite islands. But where the ridge is reduced to a gentle slope just awash at low tide, as between the islands, the colonies are immense—one measured approximately 2.5 by 8.5 m and easily possessed five million corallites. Living colonies are usually a rich ochre or yellow brown, but in places this grades into a dark purple brown.

A few colonies occur on lagoon reefs and one doubtful specimen is said to have come from a depth of 18 fms in Bikini Lagoon.

One specimen, from the windward reef south of Aomoen island, Bikini Atoll, may be a variant. The septa of the first cycle are prominent in the calices, highly developed, and extend nearly to the axis, whereas other specimens from the same reef show only weakly developed, ridgelike septa.

Holotype, USNM 44482; paratype, USNM 44480.

Occurrence.—Bikini Atoll: Bikini island (10a), holotype; Enyu island (12a); lagoon, 18 fms (doubtfully this species). Eniwetok Atoll: Lidilbut island (16, 16a), Bogen island (17).

Acropora delicatula (Brook), 1891

Plate 115, figures 1, 2

Madrepora delicatula Brook, 1891, Annals and Mag. Nat. History, v. 8, p. 461.
Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 109, pl. 28, figs. D, E.

Three specimens from Bikini Lagoon, wedge-shaped fragments from horizontal fronds of this delicate form, are typical and present no marked differences from Brook's holotype (BM 84.12.11.23) from the Solomon Islands, except that the branchlets of the under surface are more appressed instead of projecting at right angles and the axial corallites are slightly larger, as in Brook's specimen from the Great Barrier Reef. In the holotype the radials basally are immersed rather than projecting. The specimen from locality 37a was lavender with violet tips.

Two specimens from the *A. palifera* α zone on the Bikini island windward reef also belong here, although their growth form is not so clearly corymbose but loosely branching, which is perhaps due to their having grown in niches on the sides of *A. palifera* α microatolls. One, when alive, was a very pale brown, the other pale brown with pale violet tips.

This species is close to *A. tenuis* (Dana), but the axials and radials are decidedly smaller and less appressed.

Occurrence.—Bikini Atoll: Bikini island (10b); lagoon, 6.5–23 fms (31, 37, 37a). Solomon Islands; Port Denison, Australia.

Acropora conferta (Quelch), 1886

Plate 115, figures 3–5; plate 116, figures 1, 2

Madrepora conferta Quelch. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 108. [Synonymy.]

Two specimens from Bikini and Eniwetok Atolls, one a young colony, the other a large piece of a horizontal frond 35 cm across (pl. 115, figs. 3, 4, 5), are identical with Quelch's holotype (BM 85,2,1,12) from the Fiji Islands. Photographs of a fine specimen from Jaluit Atoll (pl. 116, figs. 1, 2) also show the typical form. There is some resemblance of the radials to *A. corymbosa*, but they are typically smaller and more spreading. Brook indicates 1.75 mm as the diameter of the axial corallites. My measurements of his specimens, which include Quelch's, show rarely over 1.25 mm. The Marshall Islands material also has the same small axials.

Occurrence.—Bikini Atoll: Bokororyuru island (5a). Eniwetok Atoll: Rigili island (13). Jaluit Atoll (Imp. Coll. 6). Fiji Islands; Tongatabu, Tonga; Amirante Isles, 10 fms; Great Barrier Reef; Torres Strait; Rodriguez (?).

Acropora corymbosa (Lamarck), 1816

Plate 116, figures 3–6; plate 117, figures 1, 2

Madrepora corymbosa Lamarck. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 97. [Synonymy.]
Acropora corymbosa (Lamarck). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 62, pl. 13, figs. 1a, 1b, 1c. [Synonymy.]
Hoffmeister, 1929, Wash. Acad. Sci. Jour., v. 19, p. 363.
Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 121, pl. 18, fig. 2; pl. 19, fig. 2.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 211.

This widely distributed species is represented by many specimens from the Marshall Islands. Further description would add little to the descriptions of Brook, von Marenzeller, Vaughan, and Hoffmeister. It is marked by the gutter-shaped, appressed radials with truncated lips. *A. pectinata* (Brook) is probably the same as *A. corymbosa*.

Nine compact colonies represent a local growth variant (pl. 117, figs. 1, 2) with stubby, short branchlets usually bearing more than one axial on their summits. This form occurs in shallow agitated water on reef flats or algal ridges, especially on the southwest side of Bikini Atoll.

The specimen figured on plate 116, figures 3, 4, seems at first glance to represent a distinct species but also is probably a rough-water adaptation consisting of short clusters of branchlets arising from an expanded encrusting base. It is identical with the lower parts of the more normal specimen of *A. corymbosa* shown on plate 116, figures 5, 6.

Occurrence.—Bikini Atoll: Normal form: Ourukaen island (4b); Enyu island (12a); lagoon, 3–18 fms (35, 39). Variant form: Ourukaen island (4, 4a, 4b, 6). Eniwetok Atoll: Normal and variant: Rigili island (13). Variant: Lidilbut island (16a). Rongerik Atoll: Normal: Latoback island (20a). Red Sea eastward to Tuamotu Archipelago.

Acropora surculosa (Dana), 1846

Plate 118, figures 1, 2; plate 119; figures 1–3

Madrepora surculosa Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 104. [Synonymy.]

Acropora surculosa (Dana). Verrill, 1902, Conn. Acad. Arts Sci. Trans., v. 11, p. 254.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 214, pl. 38, figs. 2–5.

One of Dana's types of this species (USNM 248) from the Fiji Islands is refigured here (pl. 119, fig. 3). Specimens from Bikini Atoll compare well with this specimen and Verrill's description. The radials are more spreading than in *A. corymbosa* but less than in *A. prostrata*, with septa scarcely developed, and open labellate to gutter-shaped, truncated apertures. *A. convexa* (Dana) is probably the same as *A. surculosa*.

From the point of numbers of colonies, this species is one of the most abundant Acropores on the algal ridge (*A. cuneata* zone), in surge channels, and on reef flats behind the ridge (*A. digitifera* zone). Living colonies are brown, ashy brown, and occasionally pale olive green and with violet tips. At Ourukaen island most of the colonies are gray brown with sage green polyps.

Occurrence.—Bikini Atoll: Namu island (7b); Eniairo and Rochikarai islands (11); Ourukaen island (4a); Bikini island (10b, 10c); lagoon, 4–8 fms (45, 47). Rongelap Atoll: Tufa island (21). Fiji Islands; Tahiti; Great Barrier Reef; "East Indies"; Mergui Islands.

Acropora prostrata (Dana), 1846

Plate 120; figures 1, 2

Madrepora prostrata Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 119. [Synonymy.]

Acropora prostrata (Dana). Faustino, 1927, Philippine Dept. Agriculture and Nat. Resources, Bur. Sci. Mon. 22, p. 271, pl. 88, figs. 1, 2.

A fine corymbose colony, 17 by 18 cm, is referred to this species and shows no important differences when compared with Dana's type (USNM 236), refigured by Faustino. The branchlets are shorter, and the axial corallites rarely reach a diameter of 2 mm. The radials are very spreading with a nearly horizontal lower lip. The lower lip is the main distinction from *A. surculosa*, in which the lip is about 45°. In *A. corymbosa* the lip is more gutter shaped and still more closely appressed.

A. prostrata is uncommon, and no colonies were found in 1947.

Occurrence.—Bikini Atoll: Bikini island (10b). Philippines; Fiji Islands; Great Barrier Reef.

Acropora spicifera (Dana), 1846

Plate 121, figures 1–3

Acropora spicifera (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 172, pl. 68, figs. 3, 3a, 3b. [Synonymy.]

Dana's specimens of this species are USNM 234, 235, and 244. Number 234, from Singapore, is closest to the five specimens from Bikini Atoll and also to Vaughan's specimen from the Cocos-Keeling Islands. These are all marked by the thickened outer lip of the radial corallites, while Dana's specimens 235 and 244 have thin-lipped radials.

There is a close similarity to *A. surculosa* except for the thickened lip of the radials in *A. spicifera*.

Occurrence.—Bikini Atoll: Bokororyuru island (6); Namu island (7b); Enyu island (12a); lagoon, 4 fms (45). Gulf of Aden eastward through the Indo-Pacific to Tongatabu, Tonga.

Acropora hyacinthus (Dana), 1846

Plate 118, figures 3, 4; plate 120, figures 3–5

Acropora hyacinthus (Dana). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 64, pl. 13, fig. 3; pl. 14, figs. 1a–1d. [Synonymy.]

Madrepora cytherea Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 441, pl. 32, fig. 3.

Madrepora armata Brook, 1892, Annals and Mag. Nat. History, v. 10, p. 452.

Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 100, pl. 10, figs. A, B.

Acropora diomedeae Vaughan, 1906, Harvard Coll. Mus. Comp. Zoology Bull., v. 50, p. 69, pl. 7, figs. 1, 1a; pl. 8, figs. 2, 3.

not *Acropora hyacinthus* (Dana). Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 123, pl. 16, fig. 2.

This species is not common in the Marshall Islands. Three specimens correspond both with Dana's type (USNM 246) and Hoffmeister's additional and better material, also in the U. S. National Museum. Two specimens are from the reef at Rigili island, Eniwetok Atoll (pl. 118, fig. 3); the others, from the lagoon reef at Namu island, Bikini Atoll, are like Dana's type—immature subflabellate colonies, with thicker branch-

lets and more crowded radials, probably the effect of more turbulent water. The specimens from deeper water, where the species is more abundant, are more openly flabellate with more delicate branchlets, tubular axial corallites, and less crowded, delicate, long-lipped radials (pl. 120, figs. 3, 4, 5). Hoffmeister's specimens are intermediate between these extremes and have moderately exsert axials and long-lipped, moderately crowded radials.

Large vasiform colonies of this species, pale tan with yellow tips when alive, were observed in 6 fms on the coral knoll north of Eninman Island, Bikini Atoll (loc. 49).

Hoffmeister's inclusion of *Madrepora arcuata* Brook in *A. hyacinthus* is confirmed by study of Brook's types (BM 62.1.27.4, 62.1.27.5; 75.10.2.9). The specimens from Tizard Bank, 9.5 fms, placed in *A. hyacinthus* by Brook (BM 89.9.24.90, 116; 93.4.7.97, 166), are probably *A. reticulata*, the radial corallites of which are much larger than in *A. hyacinthus*. It is quite likely that the species *A. hyacinthus*, *A. cytherea*, and even *A. reticulata* are all ecologic forms of the same species, the only real difference being the growth form: *A. hyacinthus* vasiform to spreading vasiform, in agitated water; *A. cytherea* spreading vasiform or flabellate with closely anastomosing horizontal branches, in gently agitated water; and *A. reticulata* flabelliform with loosely anastomosing branches, in deep or quiet water. *A. reticulata*, however, is provisionally retained here as a distinct species.

Occurrence.—Bikini Atoll: Namu island (7b); lagoon, 6–15 fms (37a, 49). Eniwetok Atoll: Rigili Island (13). Jaluit Atoll: lagoon reef (USNM). Fiji Islands; Samoa Islands, *in* Hoffmeister, 1925, and Brook, 1893 (*Madrepora arcuata*); Philippines.

Acropora reticulata (Brook), 1892

Plate 110, figures 4–6; plate 114, figures 1–6

Madrepora reticulata Brook, 1892, Annals and Mag. Nat. History, v. 10, p. 491.
Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 68, pl. 4, figs. A. B.
Madrepora hyacinthus Dana. Brook [in part], 1893, idem, p. 107.

Specimens of this species, showing intergradations from the typical form to Brook's variety *cuspidata* with its normally erect twigs or branchlets, were procured at several stations in Bikini Lagoon and on the seaward slope off Bikini Atoll. It is a common form in deep water, and huge vasiform and flabellate colonies were observed living at 6 fms on the coral knoll north of Eninman island, Bikini Lagoon. These colonies were a uniform pale gray-violet or with paler violet tips and were as much as 3 m broad, expanding from a pedicellate base to the height of a man.

The species also occurs, but sparingly, on the reefs in sheltered pools. On the seaward reef at the north end of Enirik island, where there is no algal ridge, it grows in deeper water down the seaward slope; and a few stunted and gnarled colonies were found on the upper reef surface in about 3 feet of water. These stunted colonies were of a brown violet with violet tips. The species was seen on the steep lagoon slope of the lagoon reef at Latoback island, Rongerik Atoll, beginning at 2½ to 3 fms.

The only notable difference between the Bikini Atoll specimens and Brook's types (BM 82.10.17.131, 135, 155, and 98.4.7.141) is that the axial corallites are rarely over 1.25 mm in diameter instead of 2 mm.

One specimen (pl. 114, figs. 5, 6), from the coral knoll north of Eninman island, is included here with some doubt. The horizontal branches are more closely or tightly anastomosed, and the erect branchlets have closer and proportionally more radials. It resembles very closely *A. spicifera* var. *sinensis* (Brook, 1893, p. 93; BM 89.9.24.118) from 6 fms, Tizard Bank, which is not *A. spicifera* and may not be *A. reticulata*. There is some resemblance to *A. hyacinthus*, but the radials in that species are more appressed with more prolonged-lanellate outer lips.

Occurrence.—Bikini Atoll: lagoon, 6–14 fms (36, 49, 59); Yurochi island (8); Enirik island (10); seaward slope, 21–25 fms (117). Jaluit Atoll: lagoon (*Albatross* Coll., 1900). Amirante Isles, 10 fms; Seychelles; Macclesfield Bank, 13 fms, *A. reticulata* var. *cuspidata* (Brook), 1893; Evans Shoal, Arafura Sea, 15 fms; Tizard Bank, 9.5 fms, *A. hyacinthus* Dana *in* Brook, 1893; Funafuti Atoll 35 to 45 fms, *M. reticularis* Gardiner, 1898.

Acropora striata Verrill, 1866

Plate 122, figures 1, 2

Madrepora striata Verrill, 1866, Essex Inst. Commun., v. 5, p. 24. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 178.
Acropora striata Verrill. Verrill 1902, Conn. Acad. Arts and Sci. Trans., v. 11, p. 251, pl. 36, figs. 4, 4a; pl. 36A, figs. 4, 4a; pl. 36F, fig. 7.

Nine specimens accord with Verrill's description and figures of this species, which is marked by the "thin flaring lips of the tubular corallites, which have regularly costulate, thin walls" (Verrill, 1902). The septa are unusually well developed, as Verrill pointed out. The growth form is shrubby, with a few main branches up to 15 mm thick, from which there sprout many short, slender, spreading branchlets—subbottle-

brush. In the two specimens from Eniwetok and Rongelap Atolls, the growth form is more compact, and the radials have less flaring and thicker lips. Two specimens from the *A. palifera* zone on the windward reef at Bikini island have slightly smaller corallites and were very pale brown with white tips when alive. *A. striata* may prove to be merely a shallow-water facies of the next species, *A. echinata*.

Occurrence.—Bikini Atoll: Bikini island (10c, 10f), Namu island (7b), Bokororyuru island (5a, doubtfully this species). Eniwetok Atoll: Rigili island. Rongelap Atoll: Lomuilal island (68), Busch island (22). Ousima, *in* Verrill, 1866.

Acropora echinata (Dana), 1846

Plate 135, figures 1–4; plate 136, figures 1–6

Madrepora echinata Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 185. [Synonymy.]

Acropora echinata (Dana). Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 158; pls. 49, 50.

Faustino, 1927, Philippine Dept. Agriculture and Nat. Resources, Bur. Sci. Mon. 22, p. 278, pl. 92.

?*Madrepora spinosa* Rehberg, 1892, Naturwiss. Ver. Hamburg Abh., Band 12, pl. 3, fig. 10. [No description or locality.]

Dana's type of this species, which has been refigured by both Vaughan and Faustino, is USNM 275 from the Fiji Islands. On it the lateral branchlets are 2–3 cm long with mostly elongate and appressed radial corallites with transverse or nasute apertures. The thin-walled radials are rarely over 1.25 mm in diameter, occasionally curved but with little decrease in diameter towards apertures. Some are immersed. Septa deep in the calices, usually only the directives developed; better developed in the immersed corallites. Coenenchyme coarsely striato-echinulate, becoming denser and more coarsely echinulate basically. Walls of radials costulate.

A number of specimens referable to this species were obtained in lagoons, and two specimens from Jaluit Atoll are represented by photographs. The specimens from Jaluit Atoll (pl. 135, figs. 3, 4; pl. 136, figs. 5, 6), depth unknown, and a young sprig from Bikini Lagoon (pl. 136, figs. 3, 4) are closest to the type specimen. The other specimens, mostly from between 5 and 10 fathoms, are more loosely branching with short, erect branchlets, on which the radials are nariform at first, then tubular and erect.

Occurrence.—Bikini Atoll: lagoon, 4–25 fms (35, 36, 42, 54, 62, 66, 68). Eniwetok Atoll: lagoon, 7.5 fms (87). Rongerik Atoll: lagoon, 19 fms (94a). Jaluit Atoll (Imp. Coll. 7, 10). Fiji Islands; Philippines, *in* Faustino, 1927; Samoa Islands; Australia.

Acropora tubicinaria (Dana), 1846

Plate 122, figures 3–5

Madrepora tubicinaria Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 139. [Synonymy.]

Acropora tubicinaria (Dana). Verrill, 1902, Conn. Acad. Arts and Sci. Trans., v. 11, p. 219.

This species is very common on the windward reef at Bikini island in the *A. digitifera* and *Heliopora* zones. Colonies are small caespitose clumps, tending to become flabellate. The distinctive characters are the lightness of the corallum, the large (2 mm), subtubular, spreading radials with flaring lips, and weakly developed septa. Axial corallites are 1.5–2.0 mm in diameter with six well-developed primary and six weak secondary septa. Dana's type (USNM 258) is refigured (pl. 122, fig. 5) here for comparison.

Closely related to *A. tubicinaria* is *A. tenuis* (Dana), which has more appressed radials with well-developed septa and slightly smaller axials. *A. striata* Verrill is also a related form, but the radials are more tubular with a nearly complete inner wall and well-developed septa and a less spreading growth form.

Occurrence.—Bikini Atoll: Bikini island (10c). Fiji Islands (Dana, 1846); Tahiti, *in* Verrill, 1902.

Acropora hebes (Dana), 1846

Plate 104, figure 3

Acropora hebes (Dana). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 57, pl. 9, figs. 3a, 3b. [Synonymy.]

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 217.

One specimen, a piece of a branch from a large laxly branched corallum, light blue when alive and growing in 2–4 feet of water among *Helioporae* on the outer reef at Bogen island, Eniwetok Atoll, is characteristic of this widespread species.

Careful search failed to reveal the presence of *A. hebes* at Bikini Atoll.

Occurrence.—Eniwetok Atoll: Bogen island (15); Arno Atoll. Fiji Islands; Samoa Islands; Great Barrier Reef.

Acropora kenti (Brook)

Plate 119, figures 4, 5

Madrepora kenti Brook, 1892, Annals and Mag. Nat. History, v. 10, p. 458.

Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 110, pl. 11, fig. B.

A complete horizontal corallum, 30 cm across, from Jaluit Atoll, agrees in all essential details with Brook's types (BM 93.6.8.202, 203) from the Great Barrier Reef. The species is marked especially by the large

appressed radials with flaring outer lips and well-developed septa.

Occurrence.—Jaluit Atoll (Imp. Coll. 8). Great Barrier Reef.

Acropora diversa (Brook), 1891

Plate 117, figures 3–6

Madrepora diversa Brook, 1891, Annals and Mag. Nat. History, v. 8, p. 461.
Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 141, pl. 16, fig. B.
Acropora otteri Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 229, pl. 43, figs. 1, 2; pl. 44, figs. 1, 2.

Six specimens are very close to Brook's holotype (BM 91.4.9.4), but the axial, radial corrallites, and branchlets are somewhat smaller. The stockier, stouter structure of the type may be due to the more turbulent environment than those from the Marshall Islands. There is some similarity to *A. effusa* (Dana) and *A. secale* (Studer), but there are only six septa in the axial corallites.

Occurrence.—Bikini Atoll: Bokororyuru island (5); Namu island (7b); lagoon, 4 fms (45). Eniwetok Atoll: Lidilbut island (16a). Diego Garcia; Torres Strait; Great Barrier Reef, *in* Crossland, 1952 (*A. otteri*).

Acropora paniculata Verrill, 1902

Plate 123, figures 5, 6

Acropora paniculata Verrill, 1902, Conn. Acad. Arts and Sci. Trans., v. 11, p. 259, pl. 36D, figs. 7, 10, 10a; pl. 36E, fig. 5.

Two specimens from Bokororyuru island, Bikini Atoll, agree closely with Verrill's description and figures. The unbleached coralla are bright yellow brown. The specimen figured is 15 cm high and 16 cm across at the broadest part near the top.

Occurrence.—Bikini Atoll: Bokororyuru island (5a). Fiji Islands or Tahiti.

Acropora ramiculosa (Dana), 1846

Plate 123, figures 3, 4

Madrepora ramiculosa Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 463, pl. 35, fig. 4.

Dana's type of this species is USNM 274. It is marked by its growth form: "* * * subfastigiate, close ramose, and very minutely subdivided into branchlets * * *," (Dana, 1846), the small branchlets being rarely more than 3 mm thick and 10–20 mm long, with main basal stalks up to 10 mm thick. Axial corallites 2 mm, exsert 2–3 mm, with 12 deep septa. Radial corallites about 1.25 mm, closely appressed, apertures horizontal, inner wall scarcely developed. Some radials, however, are slightly protuberant, subtubiform, with fairly thick outer walls, with 2 directives and 4 other septa of the first cycle well developed. Coenenchyme finely striato-echinulate, the echinulations prominent on striato-costae to calicular margins. Many immersed corallites on lower parts of branches, but none on the branchlets. The type measures 30 cm in diameter.

A small clump from the seaward reef on the lee side of Bikini Atoll is included in this species.

Occurrence.—Bikini Atoll: Bokororyuru island (6). Fiji Islands.

Acropora nasuta (Dana), 1846

Plate 113, figures 5, 6; plate 124, figures 1–3

Madrepora nasuta Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 73. [Synonymy.]
Acropora nasuta (Dana). Hoffmeister, 1929, Wash. Acad. Sci. Jour., v. 19, p. 364.
Verrill, 1902, Conn. Acad. Arts and Sci. Trans., v. 11, p. 257.

One of Dana's types of this species (USNM 260) is refigured here (pl. 124, fig. 1). As Hoffmeister has pointed out, there is little difference between *A. nasuta* and *A. cymbicyathus* (Brook). The variation in the radials and their septa affords no clean distinction, and Hoffmeister differentiates them mainly on the attitude of the radials, which spread as much as 90° in *A. nasuta* and are more appressed in *A. cymbicyathus*. I am following this separation, but the two species are very probably the same. Another species close to these is *A. rosacea* (Esper) (Brook, 1893, p. 84) which has radials with a better developed inner wall.

Many specimens from the Marshall Islands have been examined. *A. nasuta* and *A. cymbicyathus* are both common lagoon reef types and are often met with on seaward reefs in the less agitated water in pools and caves. Living colonies resemble *A. cymbicyathus* in color—brown with pale-violet tips, more rarely brown with white tips, or pale olive green with blue-violet tips.

The form of the colony is somewhat variable: on quiet lagoon reefs and in the lagoon, it is corymbose with close, slender, long, upright branchlets; on windward reefs in shallower more agitated water, it is subvasiform with horizontal expansions, and subarborescent on reef flats.

Occurrence.—Bikini Atoll: Enirik island (1); Namu island (7b); Bikini island (10c, 10f); Enyu island (12a); Eniairo and Rochikarai islands (11); lagoon, 3.5–6 fms (39, 49). Eniwetok Atoll: Lidilbut island (16). Rongerik Atoll: Latoback island (20a). Tahiti and Great Barrier Reef, *in* Brook, 1893.

Acropora nasuta crassilabia (Brook), 1893

Plate 124, figure 4

Madrepora nasuta var. *crassilabia* Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 74.
Acropora nasuta var. *crassilabia* Verrill, 1902, Conn. Acad. Arts and Sci. Trans., v. 11, p. 257.

Four specimens, in addition to the eight above placed in *A. nasuta* s. s., show the radials with dense thick walls and rounded margins characteristic of this variety.

Occurrence.—Bikini Atoll: Namu island (7b); lagoon, 8 fms (47). Fiji Islands; Tahiti, *in* Verrill, 1902.

Acropora cymbicyathus (Brook), 1893

Plate 124, figures 5–7

Madrepora cymbicyathus Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 86
Acropora cymbicyathus (Brook). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 63, pl. 13, figs. 2a, 2b.
Hoffmeister, 1925, idem, Pub. 340, pl. 21, fig. 36D; pl. 7, fig. 18.

Notes on the distinction between this species and *A. nasuta* are given on p. 424. Seven specimens from the Marshall Islands are typical. One is a fine large colony 35 cm broad, 15 cm high. Five other specimens from lagoon reefs have obtuse rather than tapering branches with thicker walled radial corallites which are larger and longer near the blunt tips than below. Many of the radials have very compressed calices with the aperture reduced to a long narrow slit.

Living colonies are reddish to greenish brown with tan, yellowish, or pale-violet tips. Two specimens which seem to be this species came from 6 fms on the coral knoll north of Eninman island, Bikini Atoll (loc. 49). Both are small compact tufts, probably young colonies, which were light brown with bright-violet tips when alive.

Occurrence.—Bikini Atoll: Bikini island (10f); Ourukaen island (4a); Bokororyuru island (5); lagoon, 6–8 fms (47, 49). Eniwetok Atoll: Bogen island (17); Bogon island (15). Rongerik Atoll: Latoback island (20a). Samoa Islands; Fiji Islands.

Acropora tizardi (Brook), 1892

Plate 125, figures 5, 6

Madrepora tizardi Brook, 1892, Annals and Mag. Nat. History, v. 10, p. 464.
Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 89, pl. 11, figs. C, D. [Synonymy.]

Two small colonies from about 10 fms in Bikini Lagoon correspond well with Brook's type (BM 89.9.24.115) from Tizard Bank at 5 fms. They are from the same site as one of the specimens of *A. hystrix* discussed below. Another specimen, from a reef on Bokororyuru island, Bikini Atoll, is also typical. This species is marked by the considerable thickening or tumidity of the outer radial wall below the calyx, the aperture of which usually opens inwards. The occurrence of *A. tizardi* both in the lagoon and at nearly the same sites on leeward reefs as *A. hystrix* suggests that these two species are very closely related, if not identical

Occurrence.—Bikini Atoll: Bokororyuru island (5a); lagoon, 10 fms (44). Tizard and Macclesfield Banks, South China Sea, 5–13 fms.

Acropora hystrix (Dana)

Plate 125, figures 1–4

Madrepora hystrix Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 176. [Synonymy.]

This species is very close to *A. tizardi*, but the radials are much more spreading, often at right angles; the walls are thinner, the coenenchyme less dense, and the axials have only one cycle of septa. Dana's type, USNM 298, Fiji Islands, is refigured here (pl. 125, fig. 1). It is identical with the figured Bikini Atoll specimen (pl. 125, figs. 2, 3). Ortmann's specimen of the species from the Palau Islands, cited by Brook, is probably another species, because its axial and radial corallites are much larger.

One specimen (pl. 125, fig. 4), from the reef of the lee side of Bikini Atoll, is stunted; but its structures correspond closely to those of the two specimens from the lagoon.

Occurrence.—Bikini Atoll: Bokororyuru island (6); lagoon, 3.5–10 fms (39, 44). Fiji Islands.

Acropora humilis (Dana), 1846

Plate 100, figure 1; plate 126, figures 1–6; plate 127, figures 3, 4; plate 128, figures 3–5

Madrepora humilis Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 483, pl. 31, fig. 4; pl. 41, fig. 4.
Madrepora globiceps Dana, 1846, idem, p. 454, pl. 34, fig. 3.
Madrepora acervata Dana, 1846, idem, p. 460, pl. 34, fig. 4.
Madrepora scherzeriana Brueggemann, 1878, Naturwiss. Ver. Bremen Abh., Band 5, p. 397, pl. 8, figs. a, b.
Madrepora canaliculata Klunzinger, 1879, Korallthiere des rothen Meeres, Heft 2, p. 12, pl. 1, fig. 3; pl. 4, fig. 10; pl. 9, fig. 8.
Madrepora pelewensis Rehberg, 1892, Naturwiss. Ver. Hamburg Abh., Band 12, p. 42, pl. 3, fig. 11.
Madrepora spectabilis Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 141, pl. 18, fig. B.
Madrepora gemmifera Brook, 1893, idem, p. 142, pl. 21.
Madrepora samoensis Brook, 1893, idem, p. 143, pl. 6, fig. C; pl. 31, fig. A.
Madrepora fruticosa Brook, 1893, idem, p. 138, pl. 18, fig. A.
Madrepora leptocyathus Brook, 1893, idem, p. 159, pl. 16, fig. C.
Madrepora guppyi Brook, 1893, idem, p. 158, pl. 23, fig. D.
Madrepora australis Brook, 1893, idem, p. 155, pl. 23, fig. C.
Madrepora bullata Brook, 1893, idem, p. 151, pl. 13, fig. D.
Madrepora cophodactyla Brook, 1893, idem, p. 148, pl. 23, fig. E.

Madrepora contecta Hinde, 1904, Royal Soc. London, Rept. Coral Reef Comm., Atoll of Funafuti, p. 326, figs. 21, 22.
Acropora sp. cf. *A. canaliculata* (Klunzinger), Vaughan, 1906, Harvard Coll. Mus. Comp. Zoology Bull., v. 50, p. 70, pl. 5, figs. 1–1b.
Acropora scherzeriana (Brueggemann). Von Marenzeller, 1906, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., Band 80, p. 15, pl. 12, figs. 27–31; pl. 13, figs. 27a, 29a, 31a, 32–35; pl. 18, fig. 28a. [Synonymy.]
Madrepora seriata Bedot, 1907 [not Ehrenberg?], Rév. Suisse Zoologie, v. 15, p. 245, pl. 38, figs. 199–207.
Madrepora scherzeriana Brueggemann. Gravier, 1911, Inst. Océanographique Annales, v. 2, fasc. 3, p. 71.
Acropora scherzeriana (Brueggemann). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 176, pl. 75, figs. 1–4.
Acropora gemmifera (Brook). Vaughan, 1918, idem, p. 177, pl. 77, figs. 1–3.
Acropora samoensis (Brook). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 60, pl. 11, figs. 3a, 3b.
Acropora humilis (Dana). Hoffmeister, 1925, idem, p. 60, pl. 11, fig. 4.
Acropora leptocyathus (Brook). Hoffmeister, 1925, idem, p. 67, pl. 17, figs. 1a–1d.
Acropora canaliculata (Klunzinger). Hoffmeister, 1925, idem, p. 61, pl. 12, fig. 2.
Acropora gemmifera (Brook). Stephenson and Stephenson, 1933, Great Barrier Reef Exped., Sci. Repts., v. 3, pl. 3, figs. 3, 4; pl. 9, figs. 1, 3, 4; pl. 10, figs. 3, 5.
Acropora digitifera (Dana). Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 207, pl. 35, fig. 2.
Acropora fruticosa (Brook). Crossland, 1952, idem, p. 220.
Acropora spectabilis (Brook). Crossland, 1952, idem, p. 220.
Acropora gemmifera (Brook). Crossland, 1952, idem, p. 220.
Acropora humilis (Dana). Crossland, 1952, idem, p. 221.

After much study of large suites of specimens, including types and typical specimens of the forms listed above, I have concluded that at least 17 "species" are actually only a single somewhat variable species. In addition, von Marenzeller previously included Klunzinger's *Madrepora pyramidalis, M. pallida, M. depressa,* and *M. vagabonda* in *M. scherzeriana,* and the synonymy is not yet complete.

I had great difficulty in separating a series from Bikini and suspected that the apparent differences between such forms as *Acropora samoensis* and *A. gemmifera* were ecological. This was confirmed by study of a large suite of specimens which I collected in 1950 at Arno Atoll, Marshall Islands. Von Marenzeller (1906, pl. 12, figs. 27–31,) has already shown the three principal facies of the species in his figures of *A. scherzeriana* from the Red Sea. These facies or formae may be termed α (*A. samoensis*), β (*A. humilis*), and γ (*A. gemmifera*). The growth form is basically corymbose or caespitose. The length and proliferation of the branches are functions of the environment, especially low tide level. The *A. samoensis* facies, forma α, with tall, upright main branches often bearing proliferous secondary branchlets, is developed in colonies growing in quiet water well below low tide level. The closely corymbose *A. humilis* facies, forma β, with short cylindrical obtuse branches, is conditioned by water a few inches deep in protected sites. The *A. gemmifera* facies, forma γ, with broad, almost encrusting colonies bearing short, conical, or closely packed polygonal branches, occurs on exposed rough-water sites a few inches deep at low tide.

Other species criteria in this group, such as size, shape, and attitude of axial corallites, thickness of walls, development of the septa in the radials, and structure of the surface of the coenenchyme, are quite useless in characterizing species in Brook's subgenus *Tylopora.* This can be quickly seen if one examines closely these details from one part to another in a single large colony. Broadly, the species as now conceived may be characterized as follows: Corallum caespitose or corymbose; branches upright, obtuse cylindrical to short conical, 1.0 to 2.5 cm thick, rarely less than 1.5 cm. Axial corallites 2–6 mm in diameter, usually between 2.5 and 4.0 mm, hemispherical, sometimes slightly exsert. Radial corallites usually thick walled, spreading from 45° to 90°, 1.5–2.5 mm in diameter, inner wall weak or developed; aperture normal to axis of corallite, oblique, dimidiate, or even gutter-shaped. Septa usually well-developed. Coenenchyme spongy to evenly echinulate; walls of radials striato-echinulate to echinulate.

The list of "species" in the synonymy was based on *Acropora* specimens falling into the three formae broadly as follows:

Forma α: *samoensis, pelewensis*
Forma β: *humilis, pallida, fruticosa, globiceps, acervata, leptocyathus, canaliculata, seriata* (Bedot), *bullata, cophodactyla.*
Forma γ: *gemmifera, pyramidalis, spectabilis, guppyi, australis, contecta.*

This species, in its several facies, is one of the commonest on the surface reefs of the Marshall Islands, and is very widespread throughout the Indo-Pacific. The living colonies are pale brown, pale brown with whitish tips, yellow green, asparagus green, or eosin green. The *A. gemmifera* facies or forma γ, is more often green than brown.

The *A. samoensis* facies (pl. 126, figs. 1–6) occurs in the lagoons on coral knolls and lagoon reefs, sparingly on seaward flats in sheltered spots on large microatolls of *A. palifera,* and rarely in the *A. digitifera* zone. On the coral knoll north of Eninman island, Bikini Atoll, in 6 fms, several large clumps, a meter in extent, were seen. Colonies nearly as large were seen on the lagoon reef at Latoback island, Rongerik Atoll, in 1–1½ fms. The radial corallites tend to be more spreading and tubular on colonies with longer branches and less so on the shorter branched colonies living in shallower,

quiet water. In short-branched colonies the proliferant radials with rosettes of small corallites are numerous; in those with long, slender branches, they are proportionally fewer but more prominent.

Two forma α specimens from the *A. palifera* zone on the windward reef at Bikini island illustrate rather extreme individual variation in the same colony (pl. 126, figs. 1–4). On the side facing the outer edge of the reef, the branches are normal—long and fingerlike; but on the shoreward side the branches are short, subconical, and blunt with only slightly protruding corallites, the whole having a much smoother aspect.

A large specimen from Jaluit Atoll represents forma β (pl. 128, figs. 3, 4). It is much larger than Dana's type of *A. humilis*, which has been refigured by Hoffmeister, but shows precisely the same type and arrangement of radial corallites. In the type, which is an immature colony, the branches are 8–14 mm in diameter and up to 35 mm high. In the Jaluit Atoll specimen the major branches are 20 mm thick basally, but the smaller ones with a length of 25-30 mm are about 10 mm thick.

Forma γ (pl. 100, fig. 1; pl. 127, figs. 3, 4; pl. 128, fig. 5) is represented by the largest number of specimens, 25 from the Marshall Islands, and is the characteristic form of this species in the *A. digitifera* zone immediately behind the algal ridge and at other sites in very shallow water. The growth form varies from massive stalked clumps with thick subconical branches (pl. 127, fig. 3; cf. Brook, 1893, pl. 21) to low, encrusting colonies with short, thick, obtuse, subpolygonal branches.

Occurrence.—Forma α: Bikini Atoll: Bikini island (10b); Ourukaen island (4b); lagoon, 6 fms (49). Eniwetok Atoll: Rigili island (13), Lidilbut island (16). Rongerik Atoll: Latoback island (20a). Forma β: Bikini Atoll: lagoon, 4 fms (45). Jaluit Atoll (Imp. Coll. 3). Forma γ: Bikini Atoll: Bikini island (10b), Enyu island (12a), Ourukaen island (4, 4a, 4b), Namu island (7b), Aomoen island (9). Eniwetok Atoll: Bogon island (15), Lidilbut island (16, 16a). Rongelap Atoll: Tufa island (21). Generally throughout Indo-Pacific from Red Sea eastward to Tuamotu Archipelago, and northward to Kyūshū.

Acropora digitifera (Dana), 1846

Plate 127, figures 1, 2

Acropora digitifera (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 175, pl. 13, fig. 7; pl. 76, figs. 1, 1a, 2. [Synonymy.]

This species is abundant on the windward reef flats behind the algal ridge, characterizing a shallow-water zone between the ridge (*A. cuneata* zone) and the slightly deeper water towards shore.

Sixteen specimens were examined, among them a fine large colony 30 cm broad, 12 cm high, with a very broad, expanded encrusting base from which arise patches of proliferous branches. None present noteworthy departures from the descriptions and figures by Vaughan and Verrill (1902). Colonies growing in shallow water and awash at low tide have short, stubby branches; those in deeper spots have relatively longer branches, but the corallites are constant in character. Living colonies are usually of a bright eosin green, easily distinguished on the reefs. Some, however, were observed which were a light brown. These last show no distinguishable skeletal differences.

Occurrence.—Bikini Atoll: Aomoen island (9); Bikini island (10b); Namu island (7b); Enyu island (12ε); lagoon, 3.5 fms (39). Great Barrier Reef; Torres Strait; Madagascar.

Acropora squarrosa (Ehrenberg), 1834

Plate 129, figures 1, 2

Acropora squarrosa (Ehrenberg). Von Marenzeller, 1906, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., Band 80, p. 46, pl. 14, figs. 36–39.
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 184, pl. 83, figs. 2, 2a, 2b.

Twelve specimens represent this well-marked species. Several of them correspond very closely to the specimen from Murray Islands described and figured by Vaughan. They are lax, caespitose, small clumps with relatively slender branches.

The two specimens from Bikini Lagoon, 5 fms (fixed to *Tridacna*) have denser, more finely echinulate coenenchyme and somewhat smaller apertures in the thick-walled radials than specimens from the reefs. They also have the second cycle of septa well developed in the radials, as is not uncommon in the lagoon facies of many reef species. In these characters they resemble *A. glauca* (Brook), which has already been pointed out by Vaughan as a possible synonym of *A. squarrosa*.

Other specimens have thicker, rapidly tapering branches with many lateral branchlets; the form of the corallum is a pedicellate clump of ascending main branches.

Three interesting specimens from the seaward reef at Enirik island show the growth form just described. Two of these specimens, one from the reef margin and the other from the *Heliopora* zone, are identical in the character of the corallites. These were also the same color when alive: brown with white tips. The third specimen, which was growing within a few feet of the specimen from the *Heliopora* zone, has larger, thick-walled, more prominent corallites and was yellow brown with yellow tips. This specimen approaches *A. murrayensis* Vaughan, a very closely related species

with considerably larger axial corallites and which Vaughan suggested may be merely a variant of *A. squarrosa*. Careful scrutiny of the outer ends of the branches of the two specimens from the *Heliopora* zone, however, shows that they are identical. The specimen figured, from Enyu island, seems to be intermediate between these two.

Occurrence.—Bikini Atoll: Enyu island (12a); Enirik island (1, 1a); lagoon, 4–5 fms (40). Rongelap Atoll: Tufa island (21). Rongerik Atoll: Bock island (18). Red Sea; Murray Islands, Australia.

Acropora syringodes (Brook), 1892

Plate 129, figures 3, 4; plate 130, figures 5, 6

Madrepora syringodes Brook, 1892, Annals and Mag. Nat. History, v. 10, p. 463.
Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 177, pl. 33, fig. E.
Acropora syringodes (Brook). Vaughan 1918, Carnegie Inst. Wash. Pub. 213, p. 185, pl. 83, figs. 1, 1a–1d.
not *Acropora syringodes* (Brook). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 340, pl. 15, fig. 51.
Hoffmeister, 1925, idem, Pub. 343, p. 65, pl. 15, figs. 2a, 2b.
?*Acropora syringodes* (Brook). Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 129, pl. 10, fig. 3.

A specimen from Jaluit Atoll, identified from photographs, is very close to Brook's figured type (BM 92.6.8.209), except that the coenenchyme is denser and less striato-echinulate. In this respect it is like another specimen identified by Brook from an unknown locality (BM 93.4.7.163). Vaughan's specimen from the Murray Islands is a variant with a more open, straggly growth form and more appressed corallites. Hoffmeister believed that his specimens from the Samoa Islands were more typical than Vaughan's, but actually they do not appear to be this species. The corallites are all much smaller and very appressed, and the growth form is corymbose rather than caespitose. Brook's, Vaughan's, and the Marshall Islands' specimens are the only ones which can be referred with certainty to *A. syringodes*.

Two specimens, which were dredged from the seaward slope off Bikini Atoll, probably represent deepwater forms of this species. One is a complete subhorizontal frond; the other (pl. 130, figs. 5, 6) consists of two fragments from a caespitose corallum. Both have branchlets identical with the smaller branchlets of Vaughan's specimen except that the radials are proportionally fewer in number, which gives a sparser appearance. Distally they are rather spreading, strongly appressed lower down, and often subimmersed.

Another specimen, from Rongelap Atoll, is a stunted subcaespitose colony of this species.

Occurrence.—Bikini Atoll: seaward slope, 33–96 fms (106, 107). Rongelap Atoll: Yugui island (27). Jaluit Atoll (Imp. Coll. 29). Great Barrier Reef; Murray Islands; Torres Strait, *in* Vaughan, 1918.

Acropora variabilis (Klunzinger), 1879

Plate 128, figures 1, 2; plate 130, figures 1, 2

Acropora variabilis (Klunzinger). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 181, pl. 80, figs. 2, 3, 3a, 3b. [Synonym.]
Acropora variabilis pachyclados Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 222, pl. 38, figs. 1, 6.

This species is uncommon at Bikini Atoll; only four specimens were collected and a few more seen. The largest were found in shallow pools just behind the algal ridge at Bikini island, where collapsed roofs of surge-channel caves formed a suitable site. Groups of colonies up to 18 inches in height covered an area of some 25 square feet. These, when alive, were either pale brown with whitish tips or reddish brown below and tan above and are like the thicker stemmed facies described by Vaughan. An occasional colony was found in surge channels.

The species was also found on the leeward side of the atoll on the reef flat and infrequently on the algal ridge. These are like Vaughan's slender-stemmed facies and were brown with white tips. The specimen from the reef flat at Ourukaen island (pl. 128, figs. 1, 2) is intermediate between these facies. Hoffmeister has pointed out the difference between this species and *A. valida*.

Occurrence.—Bikini Atoll: Bikini island (10b), Ourukaen island (4b), Enirik island (1, 1a). Red Sea; Ceylon; Cocos-Keeling Islands; Great Barrier Reef; Samoa Islands; Tongatabu, Tonga; Mergui Islands; Fiji Islands.

Acropora rosaria (Dana), 1846

Plate 130, figures 3, 4

Madrepora rosaria Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 465, pl. 36, fig. 3.
Madrepora rosaria var. *diffusa* Brook 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 180.
Acropora rosaria (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 184, pl. 82, figs. 2a, 2b.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 224, pl. 40, figs. 1, 3, 4.

One specimen from Bikini island is placed here. It was the only one seen and was growing with *A. variabilis* in a pool in a surge-channel cave. The living corallum was pale brown with whitish tips. There is very little difference between these two species except the growth form, which is caespitose in *A. variabilis* and is characterized by a central stem from which branches radiate outwards in all directions and subdivide once or twice in *A. rosaria*.

Brook identified a number of specimens with *A. rosaria* and subdivided them into several formae and varieties:

A. forma *rosaria*
  α. var. *caespitosa*
  β. var. *diffusa*
B. forma *pygmaea*
C. forma *dumosa*

Vaughan refigured Dana's type (USNM 281) of *A. rosaria* and suggested that Brook's *A. rosaria* was misidentified and was possibly the same as Vaughan's *A. murrayensis*. I have examined Brook's material in the British Museum and found that the only specimen which corresponds closely to *A. rosaria* Dana is var. *diffusa*. Forma *pygmaea* is *A. microphthalma* Verrill (see below). Forma *rosaria* and var. *caespitosa* are both marked by very dense and finely echinulated coenenchyme and thick-walled radials with small apertures quite different from *A. rosaria* Dana and also distinct from *A. variabilis* and *A. squarrosa;* a distinct species is probably involved. Forma *dumosa* has the small corallites of *pygmaea* but coarser coenenchyme and longer radials which are not so closely packed on the branchlets; it may also represent a distinct species.

Occurrence.—Bikini Atoll: Bikini island (10b). Fiji Islands; Samoa Islands (var. *diffusa* Brook, 1893: BM 62.1.27.2).

Acropora valida (Dana), 1846

Plate 130, figures 7–9

Acropora valida (Dana). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 60, pl. 12, figs. 1, 1a–1c. [Synonymy.]

Three specimens correspond very closely to Dana's type (USNM 272) which has been refigured and redescribed by Hoffmeister. It is an uncommon form and was found only at two sites on the leeward side of Bikini Atoll. Living colonies are brown or violet brown below with violet tips.

Occurrence.—Bikini Atoll: Ourukaen island (4a), Enirik island (1). Fiji Islands; Samoa Islands; Tongatabu, Tonga; Torres Strait; Singapore; Mergui Islands.

Acropora microphthalma Verrill, 1869

Plate 126, figures 7–9

Madrepora microphthalma Verrill, 1869, Essex Inst., Commun., v. 6, p. 83, 102.
Madrepora rosaria Dana. Quelch, 1886, Rept. Sci. Results Voyage H. M. S. *Challenger*, Zool., v. 16, p. 162.
Acropora microphthalma Verrill, 1902, Conn. Acad. Arts and Sci. Trans., v. 11, p. 232, pl. 36C, fig. 1; pl. 36F, fig. 15.
Madrepora rosaria pygmaea Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 180.
not *Madrepora microphthalma* Verrill. Brook, 1893, idem, p. 168.

This species is not uncommon in the *A. palifera* zone on the windward reef flat of Bikini island, where finely branched clumps grow on the sides of the microatolls and are very pale brown to pale brown with white tips. The only difference between this species and Verrill's type is the radial corallites, which are more often nariform than tubular.

The specimens from the Fiji Islands identified with *M. rosaria* Dana by Quelch (BM 86.12.9.234, 407; 91.3.5.1), and distinguished by Brook as *M. rosaria* forma *pygmaea*, also belong to this species.

A. exilis (Brook) (1893, p. 172, pl. 10, figs. C, D) is very close to this species, the principal difference being that the radials are more appressed or ascending than in *A. microphthalma*.

A large corymbose colony, 12 cm high, 38 cm broad, collected by the *Albatross* at Jaluit Atoll in 1900, also seems to be *A. microphthalma* in spite of its different growth form.

Occurrence.—Bikini Atoll: Bikini island (10b). Jaluit Atoll (USNM). Ryukyu Islands; Fiji Islands; Louisiade Islands; Great Barrier Reef.

Acropora cuneata (Dana), 1846

Plate 100, figure 3; plate 131, figures 1–3; plate 133, figure 4

Madrepora cuneata Dana. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 134. [Synonymy.]
Madrepora securis Dana. Brook, 1893, idem, p. 133. [Synonymy.]
Madrepora plicata Brook, 1891, Annals and Mag. Nat. History, v. 8, p. 465. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 134, pl. 9, fig. D.
Acropora cuneata (Dana). Vaughan, 1898, Carnegie Inst. Wash. Pub. 213, p. 179, pl. 80, figs. 1, 1a, 1b.

Study of the types and other specimens of *A. cuneata*, *A. securis*, and *A. plicata*, together with a large suite of specimens from the Marshall Islands, leads me to combine all three as a single species. The only difference between the types of *A. cuneata* and *A. securis* is a slight variation in the form of the corallum (Vaughan, 1918, p. 179). *A. plicata* is supposed to differ by its more appressed corallites with thinner walls. In Brook's type of *M. plicata* (BM 91.3.6.7), the corallites are no more markedly appressed than in the other two species, projecting at angles of 30° to 80°. In the type of *M. plicata* the coralites are smaller than those of *M. securis* or *M. cuneata*, but specimens showing complete intergradation are common.

Because Dana's types of *A. cuneata* (USNM 334) and *A. securis* (USNM 304) have never before been figured, they have been illustrated on plate 131, figure 3, and plate 133, figure 4.

Twenty specimens from the Marshall Islands are included under *A. cuneata*, which is very abundant on the inner side of the algal ridge and for a short distance inwards on the flat, especially at Bikini island. The colonies are low with broad, spreading, roughly circular encrusting bases, in the midst of which rise ridges 5 to 15 cm in height. In some colonies the ridges radiate irregularly from the center, but in many they are oriented parallel to the direction of water movement. The living corallum is a yellow or grayish brown, pale on crests.

Occurrence.—Bikini Atoll: Ourukaen island (4); Bokororyuru island (6); Aomoen island (9); Bikini island (10b); Enyu island (12a); lagoon, 4 fms (45). Rongerik Atoll: Latoback island (20a), Bock island (18). Fiji Islands (type of *A. cuneata*); Tongatabu, Tonga (type of *A. plicata*); "East Indies" (type of *A. securis*); Great Barrier Reef; Murray Islands, Australia; Amirante Isles; Solomon Islands.

Acropora palifera (Lamarck), 1816

Madrepora palifera Lamarck. Brook 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 131. [Synonymy.]

Acropora palifera (Lamarck). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 178, pl. 13, fig. 8; pl. 78, figs. 1, 1a–1d; pl. 79, fig. 1.

Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 69.

Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 125, pl. 14, figs. 1, 2.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 218.

Nine specimens from the Marshall Islands with radial corallites 2 mm or more in diameter are identified with the typical form of this species. This form does not appear to be as abundant as forma α. Living colonies are small, platelike rather than branching, pale to very pale brown when alive. The most characteristic specimens came from Enirik island, Bikini Atoll, where they are quite abundant on the *Heliopora* colonies near the inner edge of the reef flat in very shallow water.

Occurrence.—Bikini Atoll: Ourukaen island (4a), Bokororyuru island (6), Enyu island (12a), Enirik island (1a). Eniwetok Atoll: Bogen island (14). Rongerik Atoll: Latoback island (20a). New Guinea; Solomon Islands; Tizard Bank, 5 fms; Diego Garcia; Amboina; Philippines; Cocos-Keeling Islands; Torres Strait; Great Barrier Reef; Samoa Islands; New Caledonia; Misoöl.

Acropora palifera forma α (Brook)

Plate 132, figures 1–4; plate 133, figures 1, 2

Madrepora palifera var. α Brook 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 132.

Acropora palifera var. α (Brook). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 178, pl. 79, figs. 2, 3, 4, 4a, 4b; pl. 13, fig. 8.

Madrepora hispida Brook, 1893, op. cit., p. 133, pl. 9, fig. C. [Synonymy.]

Brook's types of his variety (BM 92.6.8.52, 53, 54, 67) show gradation into the typical form but may be distinguished by the less compressed branches and slightly smaller, more elongate, often conical, appressed radial corallites. There is much individual variation in his specimens, and he seems to have included some specimens, such as BM 87.1.29.4, from New Guinea, in which the branches are not flattened and possess smaller (1.5–2.0 mm) corallites, under typical *A. palifera*.

I am including under forma α specimens which are thickly branching rather than platelike and which have smaller (1.25–1.75 mm), often conical, radial corallites. In this grouping belongs *M. hispida* Brook, distinguished only by the hispid coenenchyme, which, however, occurs in forma β and some specimens of typical *A. palifera*.

The coenenchyme in both *A. palifera* forma *typica* and *A. palifera* forma α varies widely in its surface development in different parts of the same corallum. In general it is compact below, but the surface ornamentation ranges from simple spines through platelike, echinulations to thickly set, even-topped, hispid spines.

A. palifera forma α is very abundant on the reef flats, especially on the windward reef at Bikini island, where it characterizes the zone between the inner, or *Heliopora*, zone and the outer zones near the algal ridge. Colonies may be very large, often 2 m across, truncated at low tide level and dead on top. Alive they are a pale brown or light fawn with nearly colorless tips.

It is less common on the lagoon reefs, such as the one at Latoback island, Rongerik Atoll. Here the colonies are more open and less thickly branching.

Occurrence.—Bikini Atoll: Ourukaen island (4), Bokororyuru island (5a), Namu island (7b), Bikini island (10b). Eniwetok Atoll: Bogon island (15), Lidilbut island (16). Rongerik Atoll: Latoback island (20a). Rongelap Atoll: Busch island (22). Jaluit Atoll (Imp. Coll. 43, 44). Great Barrier Reef, *in* Brook, 1893; Murray Islands, Australia, *in* Vaughan, 1918; Pulau-pulau Banda; Philippines; Flinders Bank, 9 fms; Ponape.

Acropora palifera forma β Wells, n. form

Plate 133, fig. 3; plate 134, figs. 1–5

This is a deeper water facies of *A. palifera*, characterized by large, openly branching growth form similar to forma α and the huge dimensions it attains—as much as 2 m in height. Forma β has much smaller corallites, rarely over 1.5 mm, which have very contracted apertures not over 0.5 mm and usually less than 0.4 mm. The coenenchyme is very dense with very close-set hispid echinulations.

The holotype is a basal limb (pl. 134, fig. 1) of a large colony, obtained by dredging, and measures 65 mm in diameter and 300 mm in length. It has consistently small calicular apertures, except for an excrescence on one side where the corallites are of the normal *A. palifera* type, 2.5 mm in diameter with 1 mm apertures, a feature that indicates that this is not a distinct species, as might be supposed.

A large colony, observed alive at a depth of 6 fms on a coral knoll in Bikini Lagoon, had pale-pinkish polyps against a very pale tan or nearly colorless ground.

Holotype, USNM 44648.

Occurrence.—Bikini Atoll: lagoon, 5–30 fms (38a, 38b, 43, 47, 49).

Acropora rayneri (Brook), 1892

Plate 134, figure 6; plate 137, figures 1, 2; plate 139, figures 1, 2

Madrepora rayneri Brook, 1892, Annals and Mag. Nat. History, v. 10, p. 461.

Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 181, pl. 8, fig. A.

Hoffmeister (1925, p. 66) suggested that this species is the same as *A. prolixa* Verrill, but they are quite distinct. *A. prolixa* has an erect, branching, arborescent, growth form. *A. rayneri* is horizontal and flabellate. The radial corallites (2 mm) of *A. rayneri* are larger than in *A. prolixa* (1.25 mm), with second cycle often present.

This is a deepwater species and seems to be common at Bikini Atoll both in the lagoon and on the seaward slope. A fragrant 30 cm across, from a large frond, was a pale lavender when alive.

A specimen from the seaward slope off Bikini island is more loosely branching with fewer corallites on the under surface than those from the lagoon.

Occurrence.—Bikini Atoll: lagoon, 17–23 fms (31, 37); seaward slope, 12–44 fms (103, 110, 114). Eniwetok Atoll: lagoon, 15–28 fms (89, 90, 91). Fiji Islands (Types: BM 62.2.4.30, 43, 44).

Acropora rambleri (Bassett-Smith), 1890

Plate 137, figures 3, 4; plate 138, figures 1–6

Madrepora rambleri Bassett-Smith. Brook, 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 189, pl. 29, fig. F.

This species, which is much like *A. rayneri* in form but with corallites less than half as large, is also a deepwater type. Several specimens, pale lavender when alive, were obtained by dredging in Bikini Lagoon and correspond very closely to the types (BM 89.9.24.152). Another specimen (pl. 138, figs. 4–6), dredged from the seaward slope in deeper water, seems also to be this species but shows some differences, possibly the effect of depth and situation. The frond is less closely anastomosed and more open, somewhat as in *A. reticulata*; on the branches of the reticulum immersed corallites are more numerous, also as in *A. reticulata*; and on the upright twigs the radials are shorter, less tubular, and mostly hooked-nariform. Striking as these differences at first appear, similar conditions are found here and there on both the Bikini and type specimens of *A. rambleri*.

Occurrence.—Bikini Atoll: lagoon, 22–30 fms (31, 43, 64); seaward slope, 25–44 fms (110). Tizard Bank, 26 fms; Macclesfield Bank, 27–31 fms.

Acropora tenella (Brook), 1892

Plate 139, figures 3–5

Madrepora tenella Brook 1892, Annals and Mag. Nat. History, v. 10, p. 464.

Brook. 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 193, pl. 29, fig. E.

Two specimens from Bikini Lagoon accord most nearly with Brook's *A. tenella* (BM 92.10.17.33, 34). They have flattened branches 3-7 mm wide, 3–4 mm thick, bearing axial corallites 1.5 mm in diameter with two cycles of septa, and radial corallites appressed or short and tubular about the same size as the axials and with the same septal arrangement. A few radials are immersed. On the small branchlets the radials tend to alternate and lie in the same plane. The vermiculo-echinulate coenenchyme is moderately dense but not so dense as in Brook's specimens, which came from considerably greater depth.

Occurrence.—Bikini Atoll: lagoon, 16 fms (59). Macclesfield Bank, South China Sea, 31–37 fms, *in* Brook, 1893; Balikias Bay, Lubany, Philippines (USNM).

Acropora inermis (Brook), 1891

Madrepora inermis Brook, 1891, Annals and Mag. Nat. History, v. 8, p. 462.

Brook. 1893, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, p. 194, pl. 29, figs. A, B.

One specimen, a fragment showing a short main branch with several secondary branches and branchlets and flattened on the under side, agrees with Brook's types (BM 41.12.11.6, 7) except that the coenenchyme is clearly vermiculate-echinulate but very dense and shows only linear pits on the under surface.

Occurrence.—Rongelap Atoll: lagoon (99). "South Seas."

Genus ASTREOPORA de Blainville, 1830

Astreopora myriophthalma (Lamarck), 1816

Plate 141, figures 3–6

Astreopora myriophthalma (Lamarck). Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 87, pls. 25, 26; pl. 33, fig. 9. [Synonymy.]

Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 146, pl. 60, figs. 5, 5a.

Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 83, pl. 89, figs. 2–2c.
Wells, 1950, Raffles Mus. Bull. 22, p. 40.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 180.

Astreopora elliptica Yabe and Sugiyama 1941, op. cit., p. 84, pl. 91, figs. 1–1c.

Astreopora tayamai Yabe and Sugiyama 1941, op. cit., p. 84, pl. 91, figs. 2–2c.

This is a common species in the Marshall Islands; 35 specimens were examined. Among these, there is much individual variation in size of calices, distances of calices from each other, and protuberance of calices above interspaces. This may be classed into forms as follows:

A. Calices normal (2 mm), slightly protuberant, close-set (1.5 mm) (pl. 141, figs. 3, 4).
B. Calices normal (2–4 mm), very protuberant, well-separated (2–4 mm).
C. Calices small (1.5 mm), deep, protuberant, well-separated (pl. 141, figs. 5, 6).
D. Calices normal (2–3 mm), protuberant, well-separated.

There is little apparent correlation between these variations and their occurrence, although form *C* was taken only in the Bikini Lagoon or in sheltered parts of lagoon reefs. The others occur in nearly all situations.

Occurrence.—Bikini Atoll: Bokororyuru island (*A, D,*) (5, 5a, 5c); Bokororyuru island (*A*) (6); Namu island (*A*) (7b); Bikini island (*A, B*) (10b); Enyu island (*A*) (1); lagoon, 4–22 fms (*A, B, C*) (31, 34, 44, 45). Eniwetok Atoll: Rigili island (*A*) (13), Bogen island (*B*) (15), Lidilbut island (*A*) (16a). Rongerik Atoll: Bock island (*A, D*) (18), Latoback island (*C*) (20a). Jaluit Atoll (Imp. Coll. 2), Pokak [Taongi] Atoll, *A. elliptica in* Yabe and Sugiyama, p. 84, Nugol Atoll, *A. myriophthalma* Yabe and Sugiyama, Wotje Atoll, *A. tayamai* Yabe and Sugiyama. Red Sea, generally eastward to Fanning Island.

Astreopora listeri Bernard, 1896

Plate 141, figures 1, 2

Astreopora listeri Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 91, pls. 28, 29, 33, fig. 12.

Of two specimens from Bikini Atoll, belonging to this species, one is a fine spherical head 13 cm in greatest diameter. The primary septa are highly developed, very prominent, and meet in the axial space to form a weak columella. The columella suggests *A. profunda* (Hoffmeister, 1925, p. 48), but the calices in that species are much deeper, 3–4 mm against not more than 2 mm in *A. listeri.*

The other specimen, a small encrusting patch from the *A. palifera* zone, agrees well with Bernard's description and was a pale lavender when alive.

Occurrence.—Bikini Atoll: Bikini island (10b); lagoon, 3.5 fms (39). Tongatabu, Tonga.

Astreopora sp. cf. A. gracilis Bernard, 1896

Plate 141, figures 7, 8

Astreopora gracilis Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 93, pl. 29, pl. 33, fig. 14.

Astreopora sp. cf. *A. gracilis* Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 83, pl. 88, figs. 3–4c; pl. 92, figs. 3–3a.

A single small nodular colony from Bikini Lagoon compares well with Bernard's description and figures, although the slightly larger calices average 1.75 mm against 1.25 mm and the septa are better developed and in two cycles, the first occasionally forming a weak columella. The coenenchyme is quite different from that of *A. myriophthalma* and *A. listeri* (pl. 141, cf. figs. 2, 4, 8).

There is much resemblance to *A. profunda*, the type of which has been redescribed by Hoffmeister (1925, p. 48).

Occurrence.—Bikini Atoll: lagoon, 10 fms (44); Namorik Atoll. Solomon Islands; Ryukyu Islands.

Astreopora ocellata Bernard, 1896

Plate 140, figures 5, 6

Astreopora ocellata Bernard. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 147, pl. 17, figs. 36, 37. [Synonymy.]
Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 83, pl 88, figs. 1–2b.

This is a fairly common species on the windward reef flat at Bikini island in the *A. digitifera* and *A. palifera* zones, where it forms lumpy, platelike expansions or sizeable, flattened pulvinate masses, which are bright yellow green when alive. The calices are much larger than *A. myriophthalma*, which occurs in the same zones; a third cycle of septal ridges is present, and the spinules around the calices are lower and less roughly dentate.

Occurrence.—Bikini Atoll: Bikini island (24). Kwajalein Atoll, Ailuk Atoll. Great Barrier Reef; Baudin Islands, northwest Australia; Caroline Islands; Palau Islands.

Astreopora tabulata Wells, n. sp.

Plate 140, figures 3, 4

Corallum thin and encrusting in early stages, becoming regularly convex; pulvinate or subhemispherical in large colonies, the largest of which measures 27 by 30 cm, 12.5 cm high. Calices 1.25–2.0 mm in

diameter, averaging 1.5 mm or slightly less, elevated on subconical bosses and facing in all directions or slightly protuberant and subcylindrical. Septa, which can usually be easily seen by the naked eye, in two cycles, the first usually well developed but not meeting axially even at depth, the second forming ridges within the calices. In some calices both cycles nearly equally developed and prominent with vertical inner margins about one-third the distance from wall to axis. Six well-developed primaries and from 1 to 4 nearly equal (at the calicular margin) secondaries in other calices. In vertical section the coenenchyme consists of evenly spaced, thick, continuous horizontal laminae with very few perforations, supported by stout, evenly spaced rods which form surface echinulations. The echinulae relatively widely spaced when compared with *A. myriophthalma*, short and tufted-spinulose on tips.

Six living specimens of this deepwater *Astreopora* were dredged. Except for the species next to be described, *A. tabulata* is readily distinguished from other described forms, practically all of which are shallow-water in habit, by the continuous horizontal floors of the coenenchyme. One paratype is identical with the holotype; the others from the same haul have smaller, less protuberant calices. The species may be close to *A. expansa* Brueggemann (Bernard, 1896, p. 86, pl. 25; pl. 33, fig. 7), locality unknown, which also has continuous horizontal floors and similar-sized but nonprotuberant calices. The septa of this species have not been described.

A specimen in the British Museum (93.9.1.128) labeled "*Astreopora pulvinaria*? var." from 30–40 fms, Macclesfield Bank, is not mentioned by Bernard but probably represents this species. It is an encrusting colony agreeing in all respects, except that the horizontal laminae of the coenenchyme are discontinuous in patches and the septa are not always so well developed.

Holotype, USNM 44698

Occurrence.—Bikini Atoll: lagoon, 4–20 fms (58, 73); seaward slope, 29–75 fms (107—types, 114, 116). Macclesfield Bank, South China Sea, 30–40 fms.

Astreopora suggesta Wells, n. sp.

Plate 140, figures 7, 8

Corallum forming expanded horizontal plates or laminae with free margins, beneath which is a thin wrinkled epitheca. A young corallum 35 mm in diameter, 2 mm thick; a dead lamina over which a new one was growing, 15 mm thick. Surface topography similar to *A. tabulata*—protuberant, often slightly inclined calices separated from one to three diameters. Diameters of calices 0.75–1.25 mm, averaging very close to 1 mm. Septa irregularly developed, usually consisting of two cycles of ridges at the calyx margin, continuous with costal echinulations, with dentate vertical margins descending into the deep fossa. The first-cycle septa may expand deep in the fossa but do not appear to reach the axis. Coenenchyme as in *A. tabulata*, but horizontal floors slightly thinner and more closely spaced, and the surface echinulations closer and raggedly spinulose.

This species may only be a variant of *A. tabulata*, and the types came from the same haul as one specimen of that species, but they seem to be quite distinct. In *A. suggesta* the calices are consistently smaller with deeper fossae, in which the more widely developed septa can scarcely be seen by the naked eye; the growth form is laminar rather than pulvinate, and the coenenchymatal surface is more delicately echinulate.

A small, thin, laminar piece of a corallum of this species was dredged living from 58–90 fms. The calices are only slightly protuberant; the echinulations around the calicular margins form a raised ring. The echinulations over the interspaces are short, closely or thinly set, with flattened spinulae often grouped in irregular rows. The coenenchymatal floors are solid and continuous. They develop by spreading over or just below the tips of the echinulations outward from the margins of the calices.

A larger *Astreopora* colony, which was dredged from 33–125 fms off Enirik and Airukiiji islands, Bikini Atoll, may also belong to this species. This long-dead, worn, and overgrown colony is 38 cm broad, composed of successive laminae 35 mm thick in places, with free margins.

Holotype, USNM 44703

Occurrence.—Bikini Atoll: seaward slope, 29–90 fms (109, 114).

Genus MONTIPORA de Blainville, 1830
Glabrous species

Montipora subtilis Bernard, 1897

Plate 142, figures 3, 4

Montipora subtilis Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 21, pl. 31, fig. 2.

One specimen, an encrusting patch on an old head of *Astreopora myriophthalma*, associated with *Stylocoeniella armata*, agrees very closely with Bernard's type specimen in the British Museum.

Occurrence.—Bikini Atoll: lagoon, 22 fms (31). Providence Reef; Mascarene Islands.

Montipora granulosa Bernard, 1897

Plate 142, figures 1, 2

Montipora granulosa Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 21, pl. 1, fig. 2; pl. 31, fig. 3.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 181, pl. 25, figs. 1, 4; pl. 27, fig. 4.

A dozen small colonies about 4 cm in diameter and pieces of a large one at least 25 cm across were obtained in a haul off Bikini Atoll. All are expanding plates which are covered below by a thin epitheca which is only slightly attached to the substratum. The corallum is 1–2 mm thick in small colonies, 5–6 mm in one, 8 cm across, and in the large one it is about 20 mm thick. The coenenchyme is remarkably light and fragile, a large piece having about the weight of a comparable volume of pumice. Above the thin streaming layer the vertical elements predominate, and the velvety upper surface is composed of spinose expansions of these elements. The calices, which average 0.75 mm, are mostly flush with the surface and not sharply differentiated; in places they open on slight mounds of coenenchyme. All details correspond with Bernard's unique type (BM 89.9.24.125), except that the calices are less salient.

Occurrence.—Bikini Atoll: seaward slope, 50–97 fms (106). Macclesfield Bank, 44 fms; Great Barrier Reef.

Montipora sp. cf. M. complanata (Lamarck), 1816

Plate 145, figure 2

Montipora complanata Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 29. [Synonymy.]
Stiasny, 1930, Rijksmus. natuurlijke Historie Leiden Zool. meded., deel 13, p. 36, pl. 4, fig. 2.

A specimen from Bikini Lagoon, associated with *M. hoffmeisieri* on an old block of *Astreopora myriophthalma*, probably corresponds to Bernard's type specimen of this previously unfigured species from an unknown locality. It is an explanate, encrusting patch 3–6 mm thick and about 4 by 7 cm in extent. The details of the calices and coenenchyme are well shown by the figure (pl. 145, fig. 2).

Occurrence.—Bikini Atoll: lagoon, 10 fms (44). Java, *in* Stiasny, 1930.

Montipora sp. cf. M. pallida Bernard, 1897

Montipora pallida Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 27, pl. 2, fig. 2; pl. 31, fig. 10.

One specimen is probably Bernard's species and is characterized by the small calices with well-defined circular rims; but the basal layer is not solid, and the vertical elements in the upper thickening layer are clearly defined. The specimen is a small encrusting flexed patch about 2 cm in diameter, up to 4 mm in thickness.

Occurrence.—Bikini Atoll: Bikini island (10f). Holothuria Banks and Bassett-Smith Shoal, Timor Sea.

Foveolate species

Montipora foveolata (Dana), 1846

Plate 146, figures 5–7

Montipora foveolata (Dana). Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 54, pl. 6, fig. 1; pl. 32, fig. 12. [Synonymy.]
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 188.

Three specimens of this well-marked species were examined. Living specimens are a bright red violet.

An interesting specimen from Bikini Lagoon is a small, irregularly nodular mass 4 cm across and 3.5 cm high, one side of which shows "triangular plate" effusions of the coenenchyme. These are close to calices and form a sort of lip or hood and are the diagnostic feature of Milne Edwards and Haime's *M. quoyi* and Dana's *M. incrassata*. The other side of the same corallum is normal *M. foveolata*. This variation was described by Bernard.

Occurrence.—Bikini Atoll: Ourukaen island (4a); lagoon, 3.5 fms (39). Rongelap Atoll: Busch island (22). Niaufoo, and Tongatabu, Tonga; Kandavu, Fiji Islands; Sumatra; Amboina; Great Barrier Reef.

Montipora caliculata (Dana), 1846

Plate 144, figures 5–8

Montipora caliculata (Dana). Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 57, pl. 9; pl. 32, fig. 14. [Synonymy.]
Vaughan, 1917, New Zealand Inst. Trans., v. 49, p. 279, pl. 20, figs. 2, 2a.

Five specimens are referred to this species, which is possibly only a variant of *M. foveolata*. One specimen, a bright red-violet when alive, was collected from a cavity on the windward reef flat, Bikini island. On the upper surface it is typical *M. caliculata*, when compared with Dana's type (USNM 335) of the species; on one side the usually discrete calicular effusions merge into the *M. foveolata* condition; on the other side they become lower and finally disappear on a smooth surface. Another specimen, from the lagoon reef on Namu island, is similarly transitional.

Occurrence.—Bikini Atoll: Bokororyuru island (6); Namu island (7b); Eniairo and Rochikarai islands (11); lagoon, 4 fms (45). Rongelap Atoll: Tufa island (21). Fiji Islands; Torres Strait, Great Barrier Reef, New Guinea; Macclesfield Bank (?); Tuamotu Archipelago (USNM); Kermadec Islands, *in* Vaughan, 1917.

Montipora socialis Bernard, 1897

Plate 143, figures 1–3

Montipora socialis Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 56, pl. 5, fig. 4.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 188.
Montipora vaughani Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 49, pl. 6, figs. 1a, 1b.

Five irregularly nodular, explanate coralla from Eniwetok and Rongelap Atolls correspond closely with Bernard's accurate description and figures. The dried specimens are yellow brown, yellow, or pinkish brown; the specimen from Tufa island, Rongelap Atoll, was purple when alive, according to J. I. Tracey (specimen label).

One of the specimens from Rigili island, Eniwetok Atoll (pl. 143, figs. 1, 2) is interesting in that it shows the identity of *M. vaughani* and *M. socialis*. Plate 143, figure 2, is an enlargement of the upper, more or less even surface of the specimen shown in figure 1, and by itself it would be identified as *M. vaughani*; but laterally the meandrine, nearly continuous, vertical, close interstitial ridges or ramparts give way to the more open, sloping ridges of *M. socialis*.

This species, as Bernard indicated, is very close to *M. foveolata*, and portions of some specimens, such as one from Lidilbut island, Eniwetok Atoll, show a close approach to *M. foveolata* structures in the depressions between the nodular expansions.

A specimen from the top of a coral knoll, depth 6 fms, in Bikini Lagoon (loc. 49), a piece of an irregularly nodular colony, violet when alive, is almost certainly this species. Marginally it is foveolate and identical in every detail with the typical specimens from shallow water; but over most of the surface, the continuous ridges of the foveae are apt to be discontinuous and often stand as papillae or short papillar ridges, which resemble those of *M. tuberculosa*, except that the papillae are shorter, broader based, and farther apart, and the calices are much larger. This gradation of the interstitial swellings or ridges into definite papillae, which can be found here and there in the small crevices in more typical *M. socialis*, suggests very strongly that this species should more properly be placed in the papillate group of this genus.

Bernard's types of *M. socialis* (BM 92.12.1.3, 7) from the Capricorn Group are identical with the Marshall Islands specimens. They range from wholly foveolate to isolated papillae, but usually the effusions are continuous and enclose several calices, with a noticeable shelf around the calicular openings. Bernard's specimens of *M. socialis* from Îles Glorieuses, however, seem to be *M. caliculata* rather than *M. socialis*.

Occurrence.—Bikini Atoll: lagoon, coral knoll, 6 fms (49). Eniwetok Atoll: Rigili island (13), Lidilbut island (16, 16a). Rongelap Atoll: Tufa island (21). Capricorn Group and Great Barrier Reef; Tuamotu Archipelago (USNM); Îles Glorieuses.

Montipora turgescens Bernard, 1897

Plate 142, figures 5, 6

Montipora turgescens Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 53, pl. 6, fig. 2, pl. 32, fig. 11.
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 151, pl. 62, figs. 4, 4a.
?Montipora libera Bernard, 1897, op. cit., p. 52, pl. 6, fig. 3; pl. 32, fig. 6
?Montipora profunda Bernard, 1897, op. cit., p. 178.

Two specimens from reef patches in Bikini Lagoon belong to this species, which has been sufficiently described by Vaughan and Bernard. The larger, figured, specimen is a thick convex mass about 20 cm long and up to 3 cm thick with uniform surface and is more massive than the much smaller specimens previously recorded.

M. turgescens groups with *M. foveolata*, *M. caliculata*, and *M. socialis* and is closest to *M. foveolata*, from which it differs mainly by its smaller calices.

Occurrence.—Bikini Atoll: Bikini island (10f). Great Barrier Reef; northwest Australia; Murray Islands, Australia; Funafuti Atoll (*M. profunda*).

Papillate species

Montipora elschneri Vaughan, 1918

Plate 144, figures 1, 2

Montipora elschneri Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 154, pl. 64, figs. 1, 1a.
Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 51.

Five specimens from the windward reef flat at Bikini island and two from the *Heliopora* zone at Enirik island agree in every detail with Vaughan's type. The specimens from Enirik island were brown with green peristomes or wholly brown when alive. One of those from Bikini island, found in a dark cavity in a mass of *Acropora palifera* α, is a small, expanding, thin lobulate marginal expansion rather than an encrustation and was a pale violet brown when alive. A bright apple-green specimen from the reef margin at Bikini island, one of many encrusting patches, is evidently this species; but the calices are slightly smaller, rarely as much as 0.5 mm in diameter.

One of the specimens from the *Heliopora* zone at Enirik island shows small spumose proliferations and might be taken for *M. spumosa* except that the coenenchymatal reticulum is finer and the calices are smaller than in that species.

Occurrence.—Bikini Atoll: Bikini island (10b, 10c), Ourukaen island (4, 4a), Bokororyuru island (6), Enirik island (1a). Fanning Island, Line Islands; Samoa Islands.

Montipora hoffmeisteri Wells, n. sp.

Plate 145, figures 1–4

Corallum evenly encrusting, up to 15 mm in thickness, rarely with nodular protuberances, with basal epitheca. Calicular surface marked by many calices borne on mammiform protuberances about 2 mm in diameter, 1–2 mm in height, either clustered together in groups or isolated up to 3 mm apart. Many immersed calices between these protuberant ones. Diameter of aperture of both protuberant and immersed corallites, 0.5–0.75 mm. Septa in two cycles, primaries larger, with one large directive. Coenenchyme, including the proliferations bearing calices, finely and densely strewn with hirsute spines.

This species is based upon five specimens, all of which are from the same station in Bikini Lagoon and show consistency of characters as outlined above. Species of *Montipora* are uncommon with the foveae so developed as to isolate and elevate some calices, giving the effect of protuberant corallites. Only two need be compared with *M. hoffmeisteri: M. caliculata* (Dana) and *M. lobulata* Bernard. The growth form of the latter is quite different, and the protuberances bearing calices are less well defined and segregated. The corallites of *M. caliculata* are slightly larger; new corallites are developed on the tops of the much less well defined protuberances, and the coenenchyme is like that of *M. foveolata.*

Holotype, USNM 44730; paratype, 45176.

Occurrence.—Bikini Atoll: lagoon, 10 fms (44).

Montipora tuberculosa (Lamarck), 1816

Plate 144, figures 3, 4; plate 146, figure 8

Montipora tuberculosa Bernard 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 112. [Synonymy.]
Hoffmeister 1925, Carnegie Inst. Wash. Pub. 343, p. 51, pl. 6, figs. 3a, 3b, 3c.

The identification of specimens from reefs at Bikini Atoll is based upon Hoffmeister's interpretation of this species. The calices are about 0.4 mm in diameter, nearer Lamarck's type, described by Bernard, than Hoffmeister's specimens from the Samoa Islands. Two of the specimens, one from Ourukaen island and the other from a coral knoll in the lagoon at 6 fms, were bright violet when alive. The species is fairly common on reef flats on the windward side of the atoll but was not found on the windward flats.

In a specimen (pl. 144, figs. 3, 4) from behind the algal ridge at Ourukaen Island, pale apple green when alive, there is a complete gradation from the glabrous surface through isolated papillae, plates of fused papillae, to a foveolate condition. The specimen in places resembles *M. sinensis* Bernard (1897, p. 109, pl. 9, fig. 3; pl. 33, fig. 11), especially on the tuberculated areas; but *M. sinensis* apparently does not have foveolate calices.

Occurrence.—Bikini Atoll: Ourukaen island (4, 4a); lagoon, coral knoll, 6 fms (49). Samoa Islands; Amami-Ō-shima, Ryukyu Islands (Imp. Coll.).

Montipora venosa (Ehrenberg), 1834

Montipora venosa (Ehrenberg). Bernard, 1897, British Mus. (Nat. History (Cat. Madreporarian Corals, v. 3, p. 69, pl. 32, fig. 15. [Synonymy.]
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 153, pl. 63, fig. 3; pl. 19, fig. 46.
Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 50, pl. 6, figs. 2a, 2b.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 188, pl. 26, fig. 5; pl. 27, fig. 5; pl. 29, fig. 7.

Six specimens of this well-marked species were examined. They accord well with previous descriptions and figures. The dried coralla are from pale red violet into very pale yellow brown and drab.

Occurrence.—Bikini Atoll: Bokororyuru island (5a); lagoon, 5–10 fms (44, 67). Eniwetok Atoll: Lidilbut island (16a). Red Sea; Amboina; Murray Islands, Australia; Fiji Islands; Samoa Islands; Great Barrier Reef.

Montipora sp. cf. M. studeri Vaughan, 1907

Plate 143, figures 4, 5

Montipora studeri Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 166, pl. 62, figs. 1, 2; pl. 63, fig. 1.

Two small pieces from Bikini Atoll are referred to this species. The calices, which are 0.75–1.0 mm in diameter, are marked by the well-developed septa which are closely crowded in the axial space. The papillae are rarely isolated but, as in *M. elschneri*, rise as nearly complete walls or ramparts around the calices or in places (pl. 143, fig. 5) fuse laterally in clumps or irregular, submeandrine hillocks. The coenenchyme is finer, the spinules simple and not hirsute, compared with *M. hoffmeisteri*, which also has smaller corralites.

Occurrence.—Bikini Atoll: lagoon, 3–10 fms (39, 44). Hawaiian Islands, 23–43 fms.

Montipora conicula Wells, n. sp.

Plate 146, figures 3, 4

Corallum thick and encrusting with closely adherent edge about 3 mm thick, thickening to 15 mm. Calices small, inconspicuous, 0.6–0.75 mm in diameter, flush, filled by six prominent laminar-spinose primary septa

which extend nearly to the axis, and with minute weakly developed secondary septa in some systems. Coenenchyme dense; surface minutely, evenly, and thickly spinulose; the low spinulae flaky or granulose, not simple or smooth. Papillae irregularly scattered especially near the margins; close to calices, rounded cylindroconical or slightly compressed, standing singly or in more or less fused pairs, 1 mm thick, up to 1.5 mm high. Close to the margin the papillae die down; the coenenchyme appears smooth with very small calices filled with septa and almost invisible to the eye.

The holotype, a specimen from deeper water, is clearly distinct from forms of similar facies: *M. tuberculosa* and *M. sinensis*. It might be regarded as a deeper water facies of *M. tuberculosa*, but the surface ornamentation of the coenenchyme is different, and the specimen bears only a superficial resemblance to the specimen of *M. tuberculosa* from 6 fms from another coral knoll in Bikini Lagoon. The papillae are shaped and arranged like those of *M. sinensis* but are more scattered; the coenenchymatal surface is much denser; the calices are more widely scattered and less sharply defined with more crowded, larger septa. The coenenchyme also distinguishes this from the specimen of *M. socialis* with some separated papillae.

On the side of the holotype, which has spread over the rounded top of a block about 14 by 16 cm, is a separate patch, 5 by 7.5 cm, of very thin, closely encrusting glabrous corallum. The coenenchymatal surface is very finely granulose or spinulose, like the edges of the main colony, with extremely minute scattered calices and only the faintest hints of papillose emergences. This probably also belongs to *M. conicula* and bears the lower surface character as a result of its less favorable situation. A small specimen from 12–15 fms on the seaward slope of Bikini Atoll shows similar structures and may represent *M. conicula*.

Holotype, USNM 44742.

Occurrence.—Bikini Atoll: lagoon, coral knoll, 8–23 fms (38a).

Montipora colei Wells, n. sp.

Plate 146, figures 1, 2

Corallum forms thick, dense, heavy plates, 20 mm in thickness centrally, 4 mm marginally, lightly attached or loose, with epitheca extending to within 2 or 3 cm of the margin. Upper surface undulating and uneven. Calices small, inconspicuous, appearing nearly filled by the septa. Septa of first cycle complete, well developed, nonlaminar, and composed of vertical series of stout spines, the two directives larger. Six secondaries present but weakly developed. Surface of coenenchyme covered with fine, simple echinulae, the upper ends of the thick vertical threads. Papillae highly echinulate, small, rounded or flattened cones, sometimes overhanging calices as hoods, standing free or uniting here and there in short series, rarely more than 1 mm high and about 1 mm apart. Near the margins the papillae unite or the coenenchyme foams up into ridges which meet irregularly or rise into crests, often showing a roughly radiating arrangement, and enclosing 1 to 3 calices. One or two low subfoveolate knobs or proliferations may rise centrally. The under surface bears numerous minute slightly raised calices and appears pimply.

The holotype is part of a broad plate, partly rejuvenated on one side, 36 cm in diameter. It resembles few other species of the genus in its characters. *M. undata* Bernard (1897, p. 98, pl. 21, fig. 2; pl. 33, fig. 9) from the Moluccas has somewhat similar coenenchymatal ornamentation and irregularly uniting ridges, which are continuous over the whole upper surface. The calices in *M. undata* are also larger, lack hoods, and are frequently elevated on the upper surface. The ornamentation is like that of *M. mammifera* Bernard (1897, p. 108, pl. 33, fig. 13) from the Seychelles (7 fms), which, however, lacks any ridges or foveolation and has very minute (0.25 mm) calices. At first glance there is a resemblance to *M. floweri* Wells, n. sp., but the texture of the coenenchymatal surface is quite different, and the calices in *M. colei* are somewhat larger and closer. There is also a superficial resemblance to *M. aenigmatica* Bernard (1897, p. 73, pl. 8, fig. 2, pl. 32, fig. 18) from Tizard Bank, but the coenenchymatal surface is different, and the margins show no foveolation.

Holotype, USNM 44744.

Occurrence.—Bikini Atoll: seaward slope, 58–90 fms (109).

Montipora floweri Wells, n. sp.

Plate 147, figures 4–8

Corallum forms a crust over old stocks and builds thick, irregularly convex masses several centimeters thick and as much as 18 cm broad. Margins closely adherent, bent downwards. Calices small, between 0.5 and 0.7 mm in diameter, but readily visible to the eye, flush, with poorly differentiated margins. Septa laminar, formed by fused rows of spines free along the inner margin. Those of the first cycle stout, well developed, very slightly exsert, nearly reaching to the axis; the second cycle represented by small spines in less than half of the systems. Near the margins the surface of the coenenchyme is smooth and nearly even, with only occasionally very low papillar swellings, and the calices mere pinpricks 1.0–1.5 mm apart. Over much of the corallum the calices either similarly isolated or associated with hoodlike papillae, which tend to be behind the calices "facing" the margins. One papilla may

stand as a single low conical protuberance behind a calyx, slightly leaning over it, or several may encircle a calyx and raise it above the interstitial area. The surface of the coenenchyme and the papillae ornamented with close-set spinulose or cristate spines and appear nearly smooth to the unaided eye.

This species is very near *M. bilaminata* Bernard (1897, p. 80, pl. 16, fig. 2; pl. 33, fig. 4) from Macclesfield Bank (32 fms), which has calices of the same size, similar septa and coenenchymatal ornamentation. However, the growth form is quite different, and the hoodlike arrangement of the papillae is not so marked in *M. floweri*. The papillae are often scattered in the present species, and many calices are elevated by polypapillary proliferation.

One small specimen, a chip from a large convex encrusting colony growing at 6 fms on a coral knoll, blue violet when alive, seems also to represent this species. The calices are more sharply differentiated, and the coenenchymatal spines are slightly coarser and not so densely packed as in the holotype.

Holotype, USNM 44746.

Occurrence.—Bikini Atoll: seaward slope, 25–44 fms (holotype) (110); lagoon, coral knoll, 6 fms (49).

Montipora verrucosa (Lamarck), 1816

Plate 143, figures 6, 7; plate 147, figure 3

Montipora verrucosa (Lamarck). Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 103, pl. 19, fig. 2. [Synonymy.]
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 156. [Synonymy.]
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 193.

This species is fairly common on the lagoon reef at Latoback island, Rongerik Atoll, where it thickly encrusts *Heliopora* and other corals, forming uneven masses as much as a meter across. Alive it is a rich brown to pale yellow brown.

The only specimens found at Bikini Atoll came from deeper water in the lagoon and down the seaward slope.

Occurrence.—Bikini Atoll: seaward slope, 25–44 fms (110); lagoon, 22 fms (30). Rongerik Atoll: Latoback island (20a). Great Barrier Reef; Murray Islands, Australia; Fiji Islands; Fanning Island; Hawaii.

Montipora danae Milne-Edwards and Haime, 1851

Plate 147, figures 1, 2

Montipora danae Milne-Edwards and Haime, 1851, Annales Sci. Nat., 3d ser., v. 16, p. 65.
Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 101, pl. 20. [Synonymy.]

Two specimens, one a large corallum 40 by 60 cm, of this well-marked but seemingly rare species were obtained by dredging. Both correspond very well with Bernard's description, except that the papillae are not so closely packed, and the interspaces are thereby broader. The surface of the coenenchyme is thickly frosted with echinulations. These details agree closely with Dana's type of *Montipora tuberculosa* (USNM 307), except that the cushionlike papillae are not so neatly and sharply defined.

Occurrence.—Bikini Atoll: lagoon, coral knoll, 6.5–23.0 fms (37, 37a). Great Barrier Reef: Macclesfield Bank, 13–32 fms. Milne-Edwards and Haime indicated Fiji Islands as locality of Dana's specimen, but Dana cited no locality, and his specimen has no locality indicated.

Tuberculate species

Montipora verrilli Vaughan, 1907

Plate 145, figures 3, 5; plate 148, figures 1, 2; plate 179, figure 4

Montipora verrilli Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 168, pl. 63, figs. 2, 2a, 2b; pl. 64, figs. 1, 1a.
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 158.
Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 53, pl. 7, figs. 3a, 3b (var. *auaensis*).

This species is fairly common in nearly all reef environments, but the colonies are usually inconspicuous, forming small encrusting violet patches in crevices or on other corals. A bright yellow-green variant was found forming crusts several feet square on the windward reef on Enirik island, Bikini Atoll (loc. 1).

A specimen from the lagoon (pl. 145, figs. 3, 5), on the same block as the holotype of *M. hoffmeisteri*, is typical. Several from the seaward slope differ slightly in that the elevation of many calices by close clusters of tubercles is more pronounced than in the types.

The large specimen from the floor of Bikini Lagoon (pl. 148, figs. 1, 2), apparently columnar-ramose in form but actually encrusting a branching *Acropora*, resembles *M. cactus* Bernard (1897, p. 118, pl. 21, fig. 5; pl. 33, fig. 16); but the calices are smaller with less well-developed septa, and the interstitial coenenchyme is not so thickly tuberculate and more coarsely porous and reticulate.

Occurrence.—Bikini Atoll: Enirik island (1); Bokoroyuru island (5); Bikini island (10b); lagoor, 10–30 fms (43, 44); seaward slope, 13.5–17 fms (103). Hawaii Fanning Island; Samoa Islands.

Montipora ehrenbergii Verrill, 1875

Montipora ehrenbergii Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 52, pl. 7, fig. 1. [Synonymy.]
Faustino, 1927, Philippine Dept. Agriculture and Nat. Resources, Bur. Sci. Mon. 22, p. 253, pl. 82, figs. 1, 2.
?Montipora annularis Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 113, pl. 23, fig. 4; pl. 33, fig. 15.

This species, which superficially resembles *M. verrilli,* is distinguished by the slender hispid tubercles and coarse, very porous interstitial coenenchyme. The holotype of *M. annularis* (BM, no number) from New Guinea is a very small fragment much like *M. ehrenbergii* and may well be the same species. *M. hispida* (Dana) is probably the same.

Two specimens, one from the lagoon reef at Latoback island, Rongerik Atoll, the other from the *Heliopora* zone off Enirik island, Bikini Atoll, are placed here. The former is a nearly free, undulant lamina, the latter encrusts *Heliopora* with stubby columnar or digitiform proliferations. On both, the tubercles are slender hispid projections from an open, meshlike coenenchyme, the whole having a coarse woolly appearance. When alive these were yellow green to gray green with bright magenta or violet peristomes.

Occurrence.—Bikini Atoll: Enirik island (1a). Rongerik Atoll: Latoback island, lagoon reef (20a). Red Sea; Philippines; Samoa Islands.

Montipora granulata Bernard, 1897

Plate 148, figure 3

Montipora granulata Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 129, pl. 34, fig. 1.

One specimen, a piece of an explanate frond, agrees with the types (BM 97.3.9.202, 203, 204, 205) and Bernard's description. It shows well the "tubercles over the whole surface * * * singularly uniform in size and shape * * *, looking like packed grains." The epitheca on the under surface is well developed.

Occurrence.—Bikini Atoll: lagoon, 30 fms (43). Torres Strait.

Montipora sp. cf. M. myriophthalma Bernard, 1897

Plate 147, figures 5, 6

Montipora myriophthalma Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 181. [No figs.]

A small piece of encrusting montipore from Bikini Atoll is referred to this species. It fits Bernard's description and holotype specimen (BM 97.11.19.8) in all respects; but as Bernard pointed out, the type is itself a fragment which may be merely a variant portion of another equituberculate species, possibly *M. informis.* The Bikini Atoll specimen has close-set tubercle-ringed calices with few tubercles in the interspaces, although near the margin interstitial tubercles are present.

Occurrence.—Bikini Atoll: Ourukaen island (4). Île Lifu, Loyalty Islands.

Montipora minuta Bernard, 1897

Plate 149, figures 1–6

Montipora minuta Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 124, pl. 23, fig. 3; pl. 33, fig. 19.

This is an extremely variable species. Seven specimens from Bikini Lagoon correspond to Bernard's types (BM 92.10.17.137). All represent larger colonies than the original and are thin, circular horizontal plates or suberect curled folia with well-developed marginal ridges. Over most of the surface the details are as given by Bernard; but toward the base and on the basal parts of several specimens, the tubercles die down and on some specimens are absent completely, with the calices slightly protuberant on low mounds. On two specimens this basal region is papillate, and the papillae rise as hoods over the calices (pl. 149, fig. 4) or are arranged in irregular groups which carry the calices upwards, somewhat as in *M. floweri.* Separate fragments of this region and the main part of the fronds would ordinarily be placed not only in different species but in different species groups of *Montipora.* In some specimens the tubercles near the margins are wholly fused together in radiating (pl. 149, fig. 6) or irregular intersecting ridges. In one specimen the tubercles in places are tightly clustered in domelike effusions 2 mm broad and up to 2 mm high, each bearing a minute calyx; between these mounds the tubercles are either absent or else low and evenly packed.

Occurrence.—Bikini Atoll: lagoon, 6.5–30 fms (37, 37a, 44, 46). Macclesfield Bank, 13 fms.

Montipora composita Crossland, 1952

Plate 148, figures 4, 5; plate 150, figures 1–3

Montipora composita Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 195, pl. 28, figs. 1, 5; pl. 29, figs. 1, 3, 4.

One of the specimens from the Bikini Lagoon of this handsome species is a massive frond, part of which is shown on plate 148, measuring 45 cm from point of origin to margin, 40 cm in width, and averaging 10 mm in thickness (from 2 mm at margin to 30 mm near the base), with a finely wrinkled epitheca to within about 15 mm of the margin. Calices on undersurface scattered, very minute, slightly protuberant, less than 0.25 mm in diameter. Upper surface with conspicuous calices, 0.5–0.75 mm in diameter about 1 mm apart. Septa of both cycles developed, primaries largest, one of them a prominent directive, secondaries variable, usually not all present. Tubercles small, discrete, and elongate, regularly hispid and round-topped. About a

third of the calices surrounded by a packed cluster of basally fused, diverging tubercles which lift these calices 1 or 2 mm above the general surface. The other calices definitely circumscribed by synapticular rings and lie flush. Tubercles on interspaces somewhat smaller than those which encircle calices and either closely packed or somewhat scattered.

The general topography of the upper surface indicates a relationship with *M. verrilli*, but the growth form is quite distinct, and the calices and tubercles are larger. There is also a resemblance to *M. scutata* Bernard, but in that species most of the calices are ringed by tubercles and much less protuberant.

Occurrence.—Bikini Atoll: lagoon, 10–30 fms (43, 44) Great Barrier Reef, *in* Crossland, 1952.

Montipora marshallensis Wells, n. sp.

Plate 151, figures 1–4

Corallum composed of explanate, undulant, horizontal to suberect plates. Thickness of fronds 2 mm at edge, up to 10 mm towards base; margins either crumpled or even. Under surface usually epithecate to within 1 or 2 mm of margin but only to within 10–15 mm in one specimen, with very minute calices which protrude slightly. On the upper surface calices much less conspicuous than in *M. composita*, owing to the rich development of the tubercles, 0.5–1.0 mm in diameter. Calices usually smaller on interspaces, larger on tubercle clusters, with six well-developed primary septa and usually a few weakly developed, inconspicuous secondaries reduced to spinous projections. Tubercle and calicular topography similar to *M. composita*, but the tubercles taller and stouter, tending to fuse in vertical rows or series around calices so that the calices are carried up 4 or 5 mm above the general level on 5- or 6-ridged prominences. Marginally the tubercles tend to fuse in short series normal to the edge.

Five specimens from the same haul in Bikini Lagoon are the types of this species. The holotype (pl. 151, figs. 3, 4) nearly a complete frond 15 by 15 cm. One paratype is identical topographically with the holotype, but the other three show some individual variation:

Specimen *A* (pl. 151, figs. 1, 2). Calices rarely over 0.5 mm, and very inconspicuous. Tubercles closely packed everywhere but fusing only close to the margins. The specimen was regenerating backwards from the margin over an old frond.

Specimen *B*. A thin, curled frond with minute calices (0.5 mm) roughly arranged in rows concentric with the margins on low eminences.

Specimen *C*. Part of a thin frond, one side curled closely under; surface crammed with seedlike tubercles forming scattered mounds, less effusive than in the holotype; calices minute.

Three specimens from the seaward slope of Bikini Atoll (loc. 110) are also placed in this species. One is part of an old horizontal plate, 14 by 20 cm; the others are small pancakelike young colonies. All have facies of specimen *A* above.

Several fragments of large suberect curved fronds from the side of a coral knoll in Bikini Lagoon also represent both the typical form and variant B described previously.

Very few described species approach this form in which the ridged calicular eminences are characteristic. It may be related to *M. composita* but differs by the larger, coarser, more closely packed tubercles with ridge-forming tendency and especially by much less conspicuous calices. Fusion of the tubercles in ridges normal to the margin is confined to the marginal region rather than extending deeply inward as in *M. foliosa*, which has a characteristic cucullate growth form and finer structures. *M. effusa* (Dana) is probably also related, having similar ridged calicular protrusions but an entirely different growth form.

Holotype, USNM 44771; paratype A, USNM 44772; paratype B, 44442; paratype C, USNM 44454; paratype D, 44810.

Occurrence.—Bikini Atoll: lagoon, 30 fms (43); seaward slope, 25–44 fms (110).

Genus ANACROPORA Ridley, 1884

Anacropora gracilis Quelch, 1886

Plate 139, figures 6–8

Anacropora gracilis Quelch, 1886, Rept. Sci. Results Voyage of H. M. S. *Challenger*, Zool., v. 16, p. 170, pl. 10, figs. 6, 6a. Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 171.

Four specimens, fragments from bushy colonies, fit most closely Quelch's *A. gracilis*, as redescribed by Bernard (holotype, BM 85.2.1.10). Like the British Museum specimens from Evans Bank, the specimen from 28 fms in Bikini Lagoon has less protuberant calices than the type. The specimen from 10.5 fms in Bikini Lagoon has protuberant calices like the type.

Occurrence.—Bikini Atoll: lagoon, 10.5–28.0 fms (32, 33, 50). Pulau-pulau Banda; Evans Shoal, Arafura Sea, 12–15 fms.

Anacropora reptans Bernard, 1897

Plate 140, figures 1, 2

Anacropora reptans Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 174, pl. 34, fig. 11.

This species, which is very close to *A. gracilis*, seems to be represented by two fragments of stems 5 mm in thickness; one stem is 80 mm in length. The corallites are very protuberant with very small calices filled with

septa. The coenenchyme is densely echinulate but less so than in the types (BM 93.9.1.197) from the South China Sea.

Occurrence.—Bikini Atoll: lagoon, 11 fms (83). Macclesfield Bank, 32 fms.

Anacropora forbesi Ridley, 1884

Anacropora forbesi Ridley, 1884, Annals and Mag. Nat. History, v. 13, p. 287, pl. 11, fig. 1.
Bernard, 1897, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, p. 170, pl. 34, fig. 17.

A branch from Bikini Lagoon, which is referred to this species, is 80 mm long, 5–7 mm in diameter, with two short branches at about 75°, and thickly set with sharp rimmed, slightly protuberant calices about 0.75 mm in diameter. The calices are more closely set with more prominent septa than in *A. gracilis*, and the coenenchymatal surface is denser, with a frosting of tiny granules.

Two small fragments from Rongelap Lagoon, slender branch tips 2 mm in diameter with almost immersed calices 0.5 mm in diameter with feebly developed septa, probably also represent this species.

Occurrence.—Bikini Atoll: lagoon, 10 fms (56). Rongelap Atoll: lagoon (98). Cocos-Keeling Islands, Indian Ocean (types: BM 84.2.16.40–47).

Suborder FUNGIIDA Duncan, 1884
Superfamily AGARICIOIDAE Vaughan and Wells, 1943
Family AGARICIIDAE Gray, 1847
Genus PAVONA Lamarck, 1801

Pavona frondifera Lamarck, 1816

Pavona frondifera Lamarck. Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 40, pl. 3, figs. 1a–e. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 57, pl. 40, figs. 1–3. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 47.
Umbgrove, 1940, idem, deel 22, p. 297, pl. 30, figs. 2, 3, 4.

One specimen from Jaluit Atoll, represented by a photograph, shows no departures from typical specimens of this well-known species. No specimens were found at Bikini Atoll.

Occurrence.—Jaluit Atoll (Imp. Coll. 32). Indian Ocean eastward to Samoa Islands.

Pavona minor Brueggemann, 1879

Pavona minor Brueggemann, 1879, Mus. Godeffroy, Hamburg, Jour., Heft 14, p. 207.
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 135.

Several large, subspherical depressed heads, 15 cm high and up to 30 cm across, from Jaluit Atoll, were identified by T. Wayland Vaughan.

Occurrence.—Jaluit Atoll (USNM); Arno Atoll (USNM). Ponape, Caroline Islands.

Pavona danai (Milne-Edwards and Haime), 1860

Pavona danai (Milne-Edwards and Haime). Vaughan 1918, Carnegie Inst. Wash. Pub. 213, p. 136, pl. 55, fig. 2; pl. 56, figs. 2, 2a. [Synonymy.]

Two fine colonies of this species from Jaluit Atoll were identified by T. Wayland Vaughan. They compare closely with specimens from the southern Philippine Islands, except that carinae are very weakly developed or wholly absent.

Occurrence.—Jaluit Atoll (USNM). Red Sea eastward to Marshall Islands.

Pavona praetorta (Dana), 1846

Pavona praetorta (Dana). Van der Horst, 1921, *Siboga*-Expeditie, Mon. 16b, p. 24. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 58, pl. 41, fig. 8; pl. 42, figs. 8, 9; pl. 44, fig. 2. [Synonymy.]

This species has been reported from the Marshall Islands by Yabe, Sugiyama, and Eguchi; a characteristic colony is shown in photographs of the Jaluit Atoll corals.

Two fine colonies collected by the *Albatross* Expedition at Jaluit and Likiep Atolls are in the U. S. National Museum. In the specimen from Likiep Atoll the structures are very fine indeed, and the surface of the fronds appears smooth to the naked eye. Normally in this species the septa number from 25 to 30 per 5 mm, but in this specimen there are 35 septa per 5 mm.

Occurrence.—Jaluit Atoll (Imp. Coll. 34; Yabe, Sugiyama, and Eguchi, 1936; and USNM); Likiep Atoll (USNM); Nugol Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936; Arno Atoll (USNM). Indian Ocean and eastward to Tahiti.

Pavona clavus (Dana), 1846

Plate 152, figures 1, 2

Pavona clavus (Dana). Van der Horst, 1922, Linnean Soc. London Trans., 2d ser., Zool., v. 18, p. 420, pl. 41, fig. 7. [Synonymy.]
Pavona clavus Umbgrove, 1939, Rijksmus, natuurlijke Historie Leiden Zool. Meded., deel 22, p. 47.
?Siderastrea maldivensis Gardiner, 1905, Fauna and Geography of the Maldive and Laccadive Archipelagoes, v. 2, p. 935, pl. 89, figs. 1–3.
Pavona maldivensis (Gardiner). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 57, pl. 58, figs. 4, 5.
Pavona liliacea (Klunzinger). Yabe, Sugiyama, and Eguchi, 1936, idem, p. 58, pl. 46, figs. 3–6.
Pavona duerdeni Vaughan. Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 163.

Typical colonies of this species, angularly nodular to columnarclavate in shape, are uncommon but occur in nearly all zones down to about 10 fms. They are most abundant in the surge channels on windward reefs,

where they grow on the sides just below low water level. The living colonies are usually a pale or very pale brown, but one colony collected was of a radiant though pale apple-green. This same color variation was noted in this species at Johnston Island.

A pale brown, irregularly columniform colony a meter in height was found while diving at 6 fms on one of the coral knolls in Bikini Lagoon. The corallites of this specimen were in no way different from those of specimens from the surge channels. The same is true of large colonies observed on the lagoon reef in 1.5 fms of water at Latoback island, Rogerik Atoll.

A specimen from a depth of 10 fms in Bikini Lagoon has slightly thicker septa and corallite centers about 2 mm apart rather than the usual 1–1.5 mm.

Siderastrea maldivensis Gardiner, considered a synonym of *P. clavus* by Vaughan and van der Horst, does not appear to be the same. The writer has seen typical specimens identified by Gardiner in the British Museum: the calices are larger, more discrete, and usually with more septa than *P. clavus;* and in parts of the colony they approach the *Pseudocolumnastraea* condition.

Occurrence.—Bikini Atoll: Bikini island (10b); lagoon, 6–10 fms (44, 49). Rongerik Atoll: Latoback island (20a). Indian Ocean and eastward to Marshall Islands; Hawaii (*P. duerdeni* Vaughan); type from Fiji Islands (USNM 221).

Pavona minuta Wells, n. sp.

Plate 152, figures 5, 6

Corallum a thin, encrusting lamina, 1–2 mm thick. Upper surface plain, without hydnophoroid protuberances or collines. Calicular centers very small, 0.5–0.75 mm, rarely 1 mm in diameter, superficial or very slightly raised but nowhere protuberant, with small shallow fossette, at the bottom of which is a very small columellar tubercle. Columella absent in young centers. Distance between centers averages slightly less than 1 mm, but in places may be as distant as 3 mm. Septa normally 12 in number, but in a few centers 14 or even 16, and only 10 in others. Septa equal in thickness but alternate in length and height; major septa longer, reaching to the columella, and decidedly higher or more exsert than the secondaries. Septocostae corresponding to all septa and alternating like them in height, confluent between centers, occasionally circumscribed and discontinuous. On thin, growing margins the septa and septocostae nearly equal.

Although represented only by a single specimen, a corallum which has thoroughly encrusted the irregularities on the upper half of an old, dead algal nodule 13 by 15 by 7.5 cm, this species is clearly distinct from other known encrusting species of *Pavona*. Except for its encrusting growth form, it looks like a *P. clavus* with minute corallites. It is apparently related to that species and perhaps to encrusting species such as *P. explanatula* and *P. diffluens*, but the corallites are very much smaller.

P. microstoma Umbgrove, 1925, from the Pliocene and Pleistocene of Nias, Sumatra, and Java is a closely related species, but the corallum is nodular or branched, and the centers are somewhat more distant from each other.

Holotype, USNM 44786.

Occurrence.—Bikini Atoll: lagoon, coral knoll, 5–12.5 fms (38b).

Pavona varians Verrill, 1864

Plate 152, figures 3, 4

Pavona varians Verrill. Van der Horst, 1921, *Siboga*-Expeditie, Mon. 16b, p. 25. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 57, pl. 58, fig. 6.
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 47.
Umbgrove, 1940, idem, deel 22, p. 298.
Matthai, 1948, Royal Soc. London Philos. Trans., v. 233B, p. 181, p. 197, pl. 5; pl. 15, fig. 1; pl. 16, figs. 3, 4, 5, 9, 10.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3 p. 162, pl. 14, fig. 4. [Not pl. 13, figs. 1, 2, which is *P. (Polyastra) obtusata.*]
not *Pavona varians* Verrill. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, pl. 57, figs. 1, 1a,=*P. (Polyastra) planulata.*

This common and very widely distributed species, which has previously been reported from the Marshall Islands by Yabe, Sugiyama, and Eguchi, is not uncommon at Bikini Atoll on windward and lagoon reefs and in the lagoon. Specimens from the reef flats are most typical; those from deeper water are less irregular in form with much shallower calices, fewer collines, which often enclose several series, better developed columellae, and proportionally more septa (30–35 per 5 mm). Intergradation is clear, and the variation is certainly ecological.

Living colonies are usually light or pale brown with white tentacles; some are yellow or green brown or dark brown with green peristomes. The green-brown colonies are from 6 fms on a coral knoll.

Occurrence.—Bikini Atoll: Namu island (7a); Bikini island (10b); lagoon, coral knoll, 6 fms (49); seaward slope, 12.5–17 fms (103). Rongelap Atoll: Tufa island (21). Namotik [Namarik], Ailuk, and Jaluit Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward generally through the Indian Ocean, northwards over the Pacific to the Bonin Islands, and Hawaii.

Subgenus PSEUDOCOLUMNASTRAEA Yabe and Sugiyama, 1933

Pavona (Pseudocolumnastraea) pollicata Wells, n. sp.

Plate 153, figures 1–3

Pavona maldivensis Matthai, 1948 [not Gardiner, 1905], Royal Soc. London Philos. Trans., v. 233B, p. 182, pl. 6, fig. 20; pl. 12, fig. 47.

Corallum primarily encrusting, with thin, free laminar margins; but centrally, upward growth of corallites produces thick clusters of fingerlike branches 10 to 25 mm in thickness and up to 130 mm high, the whole resembling in form a head of *Pocillopora*. New corallites apparently added mainly by extratentacular budding. Corallites well-differentiated, bosslike, protuberant up to 2 mm especially on the sides of the branches, with thick, solid walls. Marginally and on the tops of the branches, however, the synapticular structure of the walls is visible. Diameter of corallites averages 2 mm at calices; distance between corallite centers, 3 to 4 mm, usually nearer 3 mm. Calices shallow, with circular fossette about 0.5 mm across. The bottom of the fossette is filled by a solid stylitorm columella. Septa of the typical pavonid type, alternating and very thick at the walls, tapering rapidly towards the columella, with sharp, minutely crenulated margins, 16 to 22 in number, separated by very narrow interspaces. Eight to eleven, usually ten, septa extend to the columella and laterally are thickly and minutely spinulose. Septa continuous over the wall with the septocostae, which are confluent but frequently twisted and bifurcated between calices and only slightly less alternating than the septa.

Of this remarkable coral only one specimen, a much rejuvenated colony 15 cm in height and 18 cm broad, was obtained. It is clearly congeneric with the subgenotype, *P. vamanarii* Yabe and Sugiyama (1933, p. 15, pl. 3, figs. 2, 3; pl. 4, figs. 3, 4), based upon a unique specimen from the Daitō-jima, but is specifically quite distinct. The corallites are much more protuberant and prominent, slightly larger but with fewer and thicker septa and no paliform lobes. Further, the calices are relatively deeper, more open, and lack a definite fossette in *P. yamanarii*.

In the U. S. National Museum there are two specimens labeled "*Pavona latisiella*? Dana" which were collected in 1899 by the *Albatross* Expedition from a depth of 15 fms in the lagoon at Makermo, Tuamotu Archipelago. These are conspecific with the Bikini Atoll specimen, essentially encrusting, with free margins, thickening centrally, and sending up fingerlike columns.

Another species of this subgenus may be *Siderastrea maldivensis* Gardiner (see *Pavona clavus*), in which the calices are mostly larger with more septa, and less protuberant, except basally where they resemble the basal corallites of *P. pollicata* very closely.

Holotype, USNM 44792.

Occurrence.—Bikini Atoll: seaward slope, 12.5–17 fms (103); Arno Atoll (USNM): Tuamotu Archipelago 15 fms; Tahiti (submerged flat).

Genus LEPTOSERIS Milne-Edwards and Haime, 1849

Leptoseris gardineri van der Horst, 1921

Leptoseris gardineri van der Horst. Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 59, pl. 30, fig. 6. [Synonymy.]
Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 73, pl. 63, figs. 1–1c.

A small but typical fragment of this species was dredged in Bikini Lagoon.

Occurrence.—Bikini Atoll: lagoon, 30 fms (46). Bostoninseln [Ebon] Atoll (Rehberg, 1892). Fiji Islands; Java; Samoa Islands; Amboina; Palau Islands.

Leptoseris papyracea (Dana), 1846

Plate 154, figures 1, 2

Pavonia papyracea Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 323, pl. 22, fig. 3.
Pavonia ramosa Bassett-Smith, 1890, Annals and Mag. Nat. History, 6th ser., v. 6, p. 444.
Pavonia pretiosa Bassett-Smith, 1890, idem, p. 444.
?Pavonia papyracea Dana. Bassett-Smith, 1890, idem, p. 44.
Leptoseris papyracea Dana. Van der Horst, 1921, *Siboga*-Expeditie, Mon. 16b, p. 30, pl. 5, fig. 7.
Leptoseris digitata Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 140, pl. 42, figs. 1, 2.
Matthai, 1924, Indian Mus. Mem., v. 8, p. 52, pl. 11, figs. 5, 7.
not *Folioseris papyracea* (Dana). Rehberg, 1892, Naturwiss. Ver. Hamburg Abh., Band 12, p. 26, pl. 2, fig. 8; pl. 4, fig. 2.

Several small, twisted, branched fronds, 2–3 mm wide, semicircular in section, were obtained by dredging, seem to be identical with one of van der Horst's specimens (*Siboga* Expedition sta. 315). The fronds are much narrower than is typical, but according to van der Horst, these narrow branches grade into the broader, flatter ones. Specimens from *Albatross* Expedition station 5142, in the Philippines, differ from Dana's type (USNM 137) only in these narrower fronds. Close comparison of the types of *L. digitata* and *L. papyracea* shows no significant differences: the number and arrangement of the septa are the same; the costae are similar, although the columella is usually better developed, and the septa are somewhat thicker in *L. digitata*. Bassett-Smith's *Pavonia ramosa* from Macclesfield Bank (holotype: BM 89.9.24.73) is a narrow-branched form, identical with the Bikini Atoll specimens. *P. pretiosa* from Tizard Bank (holotype: BM 89.9.24.61) is also very similar but has wider (3.5–4.0

mm) branches and a slightly better developed columella. Bassett-Smith's specimens of *P. papyracea* (BM 93.9.109) from Macclesfield Bank may not be Dana's species; the fronds or branches are multiserial with 12 to 18 equal septa reaching the centers; the septa are laterally ridged parallel to the smooth margins.

Occurrence.—Bikini Atoll: seaward slope, 59–96 fms (106), Ebon [Boston] Atoll, *in* Rehberg, 1892. Hawaii, 23–43 fms (*L. digitata* Vaughan); Philippines, 21–29 fms (*Albatross* Expedition sta. 5142, USNM); Macclesfield Bank, 26–40 fms; Tizard Bank, 27 fms, *in* Bassett-Smith; Great Paternoster Islands, 18 fms; Pulau-pulau Banda, 4.5–23 fms; Sulu Sea, 7 fms; Andaman Islands, 15 fms; Amirante Isles, 20–60 fms.

Leptoseris incrustans (Quelch), 1886

Plate 154, figures 5–7

Cylloseris incrustans Quelch, 1886, Rept. Sci. Results Voyage H. M. S. *Challenger*, Zool., v. 16, p. 124, pl. 6, figs. 4–4b.
Leptoseris incrustans (Quelch). Gardiner, 1905, Fauna and Geography of the Maldive and Laccadive Archipelagoes, v. 2, supp. 1, p. 948, pl. 92, fig. 25.
Van der Horst, 1921, *Siboga*-Expeditie, Mon. 16b, p. 31.
Van der Horst, 1922, Linnean Soc. London Trans., 2d ser., Zool. v. 18, p. 422, pl. 31, figs. 3, 4.
Leptoseris gravieri van der Horst, 1922, idem, p. 422.

Ten specimens, ranging from young coralla 3 cm in diameter with 3 centers to mature ones 11 cm across, were obtained by dredging. They correspond very closely to Quelch's cotypes from Tahiti (BM 86.12.9.171–172). Most specimens are closely adherent, but some are foliaceous and centrally adherent with margins flexed upwards. The characteristic upswelling of the septocostae between calicular centers is marked even in young colonies.

There does not seem to be any significant difference between *L. incrustans* Gardiner (*L. gravieri* van der Horst) and Quelch's species, so far as can be made out from Gardiner's description and single figure. Van der Horst evidently considered them distinct but gave no details or figures of *L. gravieri*.

Occurrence.—Bikini Atoll: lagoon, coral knoll, 8–23 fms (38a); seaward slope, 12.5–48 fms (103, 107, 114); Arno Atoll, 20 fms (USNM); Tahiti; Great Paternoster Islands, 36 fms; western Indian Ocean, 15–43 fms.

Leptoseris solida (Quelch), 1886

Plate 154, figures 8, 9

Domoseris solida Quelch, 1886, Rept. Sci. Results Voyage of H. M. S. *Challenger*, Zool., v. 16, p. 126, pl. 5, figs. 5–5a.
Domoseris porosa Quelch, 1886, idem, p. 126, pl. 5, figs. 4–4c.
Domoseris regularis Quelch, 1886, idem, p. 128, pl. 5, figs. 6–6b.
Leptoseris solida (Quelch). Van der Horst, 1922, Linnean Soc. London Trans., 2d ser., Zool., v. 18, p. 423.
Leptoseris columna Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 75, pl. 63, figs. 2–2d.
?Leptoseris explanata Yabe and Sugiyama, 1941, idem, p. 75, pl. 63, figs. 3–3c.

A specimen dredged off the northwest side of Bikini Atoll is like Quelch's type of *D. solida* (BM 86.12.9.177), except that it is encrusting with margins bent under or upwards. The septocostae are very unequal: large, swollen, minutely granulated ones alternating with thin, minutely denticulated ones. Between and around the centers, these are swollen upwards into excrescences. The facies is somewhat like *L. incrustans*, but the septocostae are quite different.

D. porosa and *D. regularis* Quelch (BM 86.12.9.295, 296), also from Tahiti, appear to represent merely variants of *L. solida*, all of which are marked by the thickening or swelling of the margins of the septocostae.

Occurrence.—Bikini Atoll: seaward slope, 58–90 fms (109). Tahiti; Seychelles, 50–78 fms; Palau Islands (as *L. columna* Yabe and Sugiyama, 1941).

Leptoseris hawaiiensis Vaughan, 1907

Plate 154, figures 3, 4

Leptoseris hawaiiensis Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 137, pls. 39, 40.
Van der Horst, 1921, *Siboga*-Expeditie, Mon. 16b, p. 31.
Leptoseris sp. cf. *L. hawaiiensis* Vaughan. Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 73, pl. 62, figs. 3–3d.

One specimen, a young corallum 33 by 43 mm, with slightly concave upper surface, a central calyx, and four irregularly arranged secondary centers, is probably this species. The details of septa and septocostae agree closely with Vaughan's types in the U. S. National Museum.

Occurrence.—Bikini Atoll: seaward slope, 50–96 fms (106). Hawaiian Islands, 29–257 fms; Great Paternoster Islands, 18 fms; Palau Islands, 60 fms, *in* Yabe and Sugiyama, 1941.

Leptoseris scabra Vaughan, 1907

Plate 155, figures 1, 2

Leptoseris scabra Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 139, pl. 41, figs. 1, 1a, 2.
Van der Horst, 1922, Linnean Soc. London Trans., 2d ser., Zool., v. 18, p. 421.
Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 43.

One specimen, broad, lobate-margined, and saucer-shaped, with a maximum diameter of 13 mm and a height of 4.5 cm, is this species. It resembles Vaughan's types very closely and shows swollen septocostae, which form convex proximal cushions on one side of the centers. These cushions are prominent excrescences

in places and very low in others. The septocostae alternate in thickness, the larger ones being marked by minute, thin, acute, transverse, regularly and closely spaced ridges or denticulations. This feature persists even at the margins of the corallum. On the excrescences these are irregular and have a labyrinthine or spongy structure.

Occurrence.—Bikini Atoll: seaward slope, 50–96 fms (106) Hawaiian Islands, 26–222 (?) fms; Samoa Islands, 12–16 fms; Indian Ocean: Amirante Isles; Providence Island; Cargadas, Carajos Shoals. 30–78 fms.

Leptoseris? mycetoseroides Wells, n. sp.

Plate 153, figures 4–6

Agaricia? minikoiensis Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 55, pl. 42, figs. 5, 6, 7.

not *Agaricia ponderosa* var. *minikoiensis* Gardiner, 1905, Fauna and Geography of the Maldive and Laccadive Archipelagoes, v. 2, p. 937, pl. 90, fig. 7.

Corallum thin, explanate, either slightly convex or concave, with uneven upper surface and fairly even margins. Undersurface very finely and evenly costate, the costae visible only under a lens. Colony formation probably circumoral in early stages, but mostly by marginal budding, with secondary centers developing on either side of parent centers in short rows approximately parallel to margin. Marginally the development that of normal *Leptoseris:* superficial centers or calices which develop low ridges or collines on their inner sides, giving the centers an outward-looking aspect. But with continued growth and thickening of the lamina, the collines develop upwards and laterally forming roughly concentric rows. Inwards from the margins the collines here and there bend and extend radially and intersect each other, enclosing short valleys in which are 1 to 12 centers in single or double rows or scattered. Series of centers from 3 to 6 mm apart radially; laterally 1.5 to 2.5 mm apart. Septa and septocostae equal for the most part but in places subalternating in height and thickness, fine, minutely spinulose laterally or with feeble lateral ridges. Upper margins subacute, finely spinulose or granulose, appearing entire in places. In the centers, 12–16 septa extend to the columella, with regularly intercalated, shorter septa; the total septa from 25 to 35. Between centers and over collines, where practically parallel, septocostae number 20–30 in 5 mm. Columella present in most centers as a small, single papilla; in some centers elongate and somewhat trabecular. Corallite wall not developed, but the closeness of the septa, their thickly spinulose sides, and abundant synapticulae render the colline internally nearly solid.

The figured holotype is part of a large frond 23 cm broad, which was dead and corroded centrally, with a living zone extending 8 cm inwards from the edge. Another specimen from the same haul is a nearly complete oval expansion 8 cm broad growing on a dead frond. Two specimens from shallower water on the seaward slope are thin encrustations on dead branches of *Heliopora* and *Acropora.* A single specimen from Bikini Lagoon may represent a variant of this species. It is a thick, encrusting lamina with stouter septa numbering only 15 per 5 mm.

The generic position of this coral is puzzling. The general aspect is similar to *Pachyseris*, but the centers are discrete and well defined, never continuous and undifferentiated with regularly developed collines as in that genus. There are no species of *Leptoseris* with such fine septa or so highly developed collines, but the growing margin of the specimens is wholly *Leptoseris.* The rich development of irregular collines enclosing series is not that of *Pavona* but more like *Agaricia,* a living West Indian form with well-developed mural structures. There is much resemblance to *Mycetoseris,* a Tethyan Oligocene genus which seems to represent the stock from which, *Pavona, Agaricia, Pachyseris,* and *Leptoseris* developed, and which in different parts of the same corallum frequently shows agaricid, pavonid, leptoserid, and pachyserid conditions. Aside from the consistent leptoserid marginal condition and presence of a well-developed columella, there is little to distinguish *L.? mycetoseroides* from *Mycetoseris.*

Holotype, USNM 44805; paratype, USNM 44806.

Occurrence.—Bikini Atoll: lagoon, 8–23 fms; seaward slope (holotype and paratypes), 12.5–44 fms (103, 105, 110). Kyūshū; Honshū.

Genus PACHYSERIS Milne-Edwards and Haime, 1849

Pachyseris rugosa (Lamarck), 1801

Plate 155, figures 3, 4

Pachyseris rugosa (Lamarck). Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 93, pl. 15, figs. 1, 2; pl. 21, figs. 3, 4. [Synonymy.]

Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 63, pl. 39, figs. 1, 2; pl. 43, figs. 1–3, 5.

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 47.

Pachyseris torresiana Vaughan. Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 164.

A fine colony of this species is represented by a photograph.

Occurrence.—Jaluit Atoll (Imp. Coll. 5). Indian Ocean eastward to the Marshall Islands and northward to the Ryukyu Islands.

293438—54——5

Pachyseris speciosa (Dana), 1846

Pachyseris speciosa (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 63, pl. 43, fig. 4. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurl. historie Leiden Zool. Meded., deel 22, p. 45.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 164.

Three specimens of this deepwater *Pachyseris* were dredged at Bikini Atoll. One is a large, dead and corroded, bowl-shaped, regenerated corallum 21 cm across; another is a small piece of a living corallum which is identical with Dana's type in the U. S. National Museum. A third specimen, from 50–96 fms, with collines almost obsolete and approaching *P. levicollis*, is a small, recently dead, but much regenerated corallum.

Occurrence.—Bikini Atoll: seaward slope, 30–96 fms (106, 110). Malay Archipelago to Samoa Islands and Marshall Islands, 7.5–27 fms.

Family SIDERASTREIDAE Vaughan and Wells, 1943

Genus COSCINARAEA Milne-Edwards and Haime, 1848

The species of *Coscinaraea* and *Psammocora* are much in need of study, but no attempt is made here to clarify the status of all of them. Some species now placed in *Psammocora* probably pertain to *Coscinaraea*.

Coscinaraea columna (Dana), 1846

Plate 156, figures 1–3

Coscinaraea columna (Dana). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 43, pl. 4, figs. 3a–3c.
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 61, pl. 42, fig. 10.
?*Coscinaraea kusimotoensis* Yabe, Sugiyama, and Eguchi, 1936, idem, p. 62, pl. 46, figs. 1, 2.

This species is fairly common in the surge channels and cavities in the algal ridge. Occasional colonies are met with on the reef flat just behind the ridge where the growth form is nodular or subcolumniform. In the sheltered cavities from low water down to about 2 fms, it forms bracket-shaped expansions up to 5 decimeters broad. The living corallum is usually a red violet, often grading to brown in the same corallum. Colonies in more exposed situations are pale ash, and the corallites are smaller.

Nine specimens, in which there is considerable individual variation, are identified with this species. The identification followed Hoffmeister's analysis and study of Dana's type (USNM 118). All are explanate with free edges, thickening centrally. Several are irregularly convex or subcolumniform, 5 cm thick. Calices range from 2 to 4 mm, single or in series of 2 to 5 within the thick sloping walls, which have rounded or subacute upper edges and are often very porous in structure. From 10 to 16 septa reach the small, neatly defined papillary columella; septal margins slope uniformly from calicular margin to columella.

Hoffmeister and Umbgrove are inclined to place *C. fossata* and *C. columna* in the synonymy of *C. monile*, but it seems to me that these three are distinct. In typical *C. monile* of the Red Sea, the calices are much larger (6–9 mm) than in the others, often nearly superficial, with more septa. *C. fossata* (Dana) (pl. 156, figs. 4, 5) is marked by smaller calices (3–5 mm), fewer septa (about 40 with about 15 reaching columella), and high rounded walls, close to which the relatively broad septa descend abruptly to the calyx floor, which thus appears flattened. In *C. columna*, as previously pointed out, the calices are still smaller, deeper, and with a comparatively small number of septa. *C. monile* does not seem to be a Pacific species but represents the genus in the Red Sea and western Indian Ocean.

Of the two new species of *Coscinaraea* described by Yabe, Sugiyama, and Eguchi, *C. kusimotoensis* from Honshū is not markedly different from *C. columna*, as pointed out by Umbgrove (1940, p. 300). *C. hahazimaensis* Yabe, Sugiyama, and Eguchi (1936, p. 61, pl. 39, fig. 3; pl. 59, figs. 1–3) from the Ogasawara-guntō, shows the high walls and flat floors of *C. fossata*, but the calicular series are longer and more meandrine. It may represent a geographical variant of *C. columna*. *C. acuticarinata* Umbgrove (1940, p. 301, pl. 33, fig. 1) from northern Celebes, does not appear to be a siderastreid but a pavonid.

Occurrence.—Bikini Atoll: Ourukaen island (4a); Namu island (7); Bikini island (10b, 10f); Enyu island (12a). Fiji Islands; Funafuti Atoll; Samoa Islands; Kyūshū: Honshū.

Coscinaraea ostreaeformis van der Horst, 1922

Plate 155, figures 5, 6

Coscinaraea ostreaeformis van der Horst, 1922, Linnean Soc. London Trans., 2d ser., Zool., v. 18, p. 424, pl. 32, figs. 5, 6; figs. 1, 2.

Four specimens referable to this species were obtained in dredgings. They correspond very closely to van der Horst's holotype (BM 1937.11.17.164). The calices are 4–5 mm apart between centers and usually slightly protuberant, forming very low bosses, or superficial. The septa are like those of *C. monile*, 12–14, exceptionally up to 22, reaching the columella and equal in thickness. The papillose columella is in a sharply defined fossette about 0.75 mm in diameter and circular or oval.

This species is very close to *C. donnani* Gardiner (1905, p. 950, pl. 90, fig. 12), which has, however, a

more massive growth form, larger total number of septa, larger fossettes, and larger, more definitely circumscribed calices.

Occurrence.—Bikini Atoll: seaward slope, 29–50 fms (106, 114; dead specimen from 125 fms, 108). Providence Island, Indian Ocean, 29–78 fms.

Superfamily FUNGIOIDAE Vaughan and Wells, 1943
Family FUNGIIDAE Dana, 1846
Genus CYCLOSERIS Milne-Edwards and Haime, 1849

Cycloseris hexagonalis Milne-Edwards and Haime, 1849

Fungia hexagonalis (Milne-Edwards and Haime). Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddel., Bind 79, p. 188, pl. 5, figs. 1–11; pl. 11, figs. 136–137. [Synonymy.]

Fungia patella (Ellis and Solander). Faustino, 1927, Philippine Dept. Agricultural and Nat. Resources, Bur. Sci. Mon. 22, p. 168. [But not pl. 46, figs. 1, 2.]

Two specimens, from Bikini and Eniwetok Lagoons, are typical of this species as diagnosed and restricted by Boschma (1925).

Occurrence.—Bikini Atoll: lagoon, 30 fms (43). Eniwetok Atoll: lagoon 15–20 fms (89). Pulau-pulau Banda; Philippine Islands; Great Paternoster Islands; Tonga.

Cycloseris vaughani (Boschma), 1923

Plate 157, figures 4, 6

Fungia patella Vaughan, 1907 [not *Madrepora patella* Ellis and Solander], U. S. Nat. Mus. Bull. 59, p. 128, pl. 27, figs. 2, 3; pl. 28, fig. 2.

Fungia vaughani Boschma, 1923, *Siboga*-Expeditie, Mon. 16d, p. 17, pl. 10, figs. 27–27b.

Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddel, Bind 79, p. 205, pl. 5, fig. 20

Ten specimens of this species were obtained from depths 33–133 fms. All correspond closely with the Hawaiian specimens but show some variation in form. The 6 specimens from hauls at 58–90 and 96–133 fms are either flat on concave underneath, convex above, and centrally much elevated. Three from 33–48 and 50–96 fms are almost bowl shaped with gently convex bases and concave marginally above and slightly elevated centrally. Mature specimens are 50–55 mm in diameter.

The difference between this species and *C. patelliformis* is very slight: in *C. vaughani* the costae are unequal; in *C. patelliformis* they are practically equal.

Occurrence.—Bikini Atoll: seaward slope, 33–133 fms (106, 107, 109, 112). Hawaiian Islands, 44–253 fms, 9–36 fms; Red Sea (?).

Cycloseris patelliformis (Boschma), 1923

Plate 157, figures 1–3

Fungia patelliformis Boschma, 1923, *Siboga*-Expeditie, Mon. 16d, p. 8, pl. 9, figs. 9, 11, 13–16a. [Synonymy.]

Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddel., Bind 79, p. 192, pl. 5, figs. 12–14, 21.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 154.

Several specimens of this species were dredged in Bikini Lagoon. Three of them, from 6.5–14 fms, are strongly arched centrally; the largest measures 45 by 48 by 21 mm.

Occurrence.—Bikini Atoll: lagoon, 6.5–30 fms (37a, 57, 86). Indian Ocean eastward to Samoa Islands, 3–54 fms.

Cycloseris distorta (Michelin), 1843

Fungia distorta Michelin. Doederlein, 1902, Senckenberg. naturf. Gesell. Abh., Band 27, p. 74, pl. 3, pl. 5, figs. ? 3a. [Synonymy.]

Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddel., Bind 79, p. 203, pl. 6, figs. 55–64.

Four specimens, small fragments of *Diaseris* forms, were dredged, three in Bikini Lagoon, the other in Rongelap Lagoon.

Occurrence.—Bikini Atoll: lagoon, 24–30 fms (53a, 60a, 77). Rongelap Atoll: lagoon (97). Red Sea eastward to Tahiti, 5–50 fms.

Cycloseris fragilis (Alcock), 1893

Fungia fragilis Alcock. Boschma, 1923, *Siboga*-Expeditie, Mon. 16d, p. 10, pl. 10, figs. 17–23. [Synonymy.]

Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddel., Bind 79, p. 196, pl. 5, figs. 18, 19.

One specimen, a small fragment of the *Diaseris* form, was dredged in Bikini Lagoon.

Occurrence.—Bikini Atoll: lagoon, 28 fms (60). Indian Ocean; Malay Archipelago; Hawaii; 8–66 fms.

Genus FUNGIA Lamarck, 1801

Fungia scutaria Lamarck, 1801

Plate 95, figure 1

Fungia scutaria Lamarck. Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 131, pl. 28, figs. 3, 3a, 3b; pls. 29–32 [Synonymy.]

Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 128.

Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddl., Bind, 79, p. 215.

Faustino, 1927, Philippine Dept. Agriculture and Nat. Resources, Bur. Sci. Mon. 22, p. 175, pl. 50, figs. 1, 2.

Boschma, 1929, Zool. Soc. London Proc., 1929, p. 44.

Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 63, pl. 8, fig. 3. [Synonymy.]

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 43.

Umbgrove, 1940, idem, deel 22, p. 291, pl. 29, figs. 1, 2.

Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 78, pl. 61, figs. 6, 6a; pl. 67, figs. 3–5; pls. 68, 69.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 152.

About 30 specimens of this well-known species were examined. Three suites of 7, 8, and 9 individuals from the same sites include specimens graded in size from 34 by 26 mm to 83 by 125 mm. None of them shows any notable departure from the usual form. The tentacular lobes are well developed on all except the smallest and youngest. On one specimen, a thick convex corallum from Naen island, Rongelap Atoll, the lobes are extraordinarily prominent, 3 or 4 times as thick as the septa and exsert up to 2 mm. One specimen from Latoback island, Rongerik Atoll, also shows similar thickening.

Fungia scutaria occurs sporadically in nearly all the shallow reef zones and is commonest on the lagoon reefs, where clusters of individuals of all sizes from still-attached anthocauli to old, highly convex individuals are found, especially in the sandy-bottomed pockets between coral heads. The living polyps vary from a very pale brown in those in the strongest light to deep, rich brown in the shade. This is also true of other species of *Fungia*. The color of the peristome shows some variation, from undifferentiated brown, to white, yellow green, brown red, and red violet. Generally all the individuals in a cluster or "family" (pl. 95, fig. 1) have similarly colored peristomes, but one group was noted on the lagoon reef at Bikini island in which the young anthocauli had pale-green peristomes, and older coralla had pinkish-brown ones. No variation in skeletal structures corresponding to this color variation can be detected.

Occurrence.—Bikini Atoll; Ourukaen island (4c); Bokororyuru island (5a); Namu island (7b); Bikini island (10b, 10f). Eniwetok Atoll: Lidilbut island (16). Rongelap Atoll: Tufa island (21); Naen island (24); Yugui island (27); Burok island (28); Enybarbar island (29a). Rongerik Atoll: Latoback island (20a); Pokak [Taongi], Ailuk, and Jaluit Atolls, *in* Yabe and Sugiyama, 1941. Red Sea and generally eastward into tropical Pacific to Bonin Islands, Tuamotu Archipelago, and Hawaii.

Fungia echinata (Pallas), 1766

Fungia echinata (Pallas). Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 67, pl. 10, fig. 1. [Synonymy.]
Umbgrove, 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 290. [Synonymy.]
Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 78, pls. 70–72.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 152.

A typical specimen from Jaluit Atoll (photograph) is 18.2 cm long and 8.8 cm wide.

Occurrence.—Jaluit Atoll (Imp. Coll. 19). Red Sea generally eastward to Tahiti; Hawaii; Ryukyu Islands.

Fungia fungites (Linnaeus), 1758

Plates 158, 159, 160

Fungia fungites (Linnaeus). Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 69. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Histoire Leiden Zool. Meded., deel 22, p. 44.
Umbgrove, 1940, idem, deel 22, pl. 294.
Yabe and Sugiyama, 1941, Tohoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 80, pl. 77, figs. 2–3b; pl. 78.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 153.

Specimens referable to 4 of the 13 varieties of this widespread species were examined.

Fungia fungites haimei Verrill, 1864

Plate 158, figures 1, 2

Fungia haimei Verrill, 1864, Harvard Coll. Mus. Comp. Zoology Bull., v. 1, no. 3, p. 51.

This is the commonest form of *F. fungites* in the Marshall Islands. All specimens correspond closely to Doederlein's analysis and show the regularly dentate margins. There is some variation, however, in the costae. Three specimens from Rongelap Atoll (one is figured on plate 158) show relatively thick, high, subequal costae with high conical spines and much more porous wall. The others show a marked difference in the relative thickness of the costae: the spines are shorter and less conical, more saw toothed in shape, and the wall is less porous. The smallest specimen, an attached anthocaulus 32 mm in diameter with about 175 septa, has an imperforate wall.

Occurrence.—Bikini Atoll: lagoon, 30 fms (43); Rongelap Atoll: Rongelap island, 3 fms (29); Busch island, 2 fms (22a); Jaluit Atoll (Imp. Coll. 20, 38), and *in* Doederlein, 1902. Zanzibar, Celebes; Amami-guntō.

Fungia fungites incisa Doederlein, 1902

Plate 158, figures 3–6

Fungia fungites var. *incisa* Doederlein, 1902, Senckenberg. naturf. Gesell. Abh., Band 27, p. 150, pl. 20, figs. 7, 8.

Five specimens, from 21 to 112 mm in longer diameter, show the incised, irregularly lacerate, fine dentations of this variety. The costae are like those of *Fungia fungites haimei* Verrill but not so coarse.

Occurrence.—Rongelap Atoll: Naen island, 1–1.5 fms (24); Lomuilal island, 1–3.5 fms (28). Amboina; Pulau Ternate; Ralum, New Britain.

Fungia fungites stylifera Doederlein, 1902

Plate 159

Fungia fungites var. *stylifera* Doederlein, 1902, Senckenberg. naturf. Gesell. Abh., Band 27, p. 55, pl. 24, figs. 1, 3–5.
Fungia fungites (Linnaeus). Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 80, pl. 78, figs. 2–2d.

Three fine specimens of this large form of this species were obtained in Bikini Lagoon. On their larger diameters they measure 190, 210, and 212 mm. Near one margin the figured specimen shows an excrescence which resulted from the development of several adventitious stomodaea.

Occurrence.—Bikini Atoll: lagoon, 5 fms (40); Jaluit Atoll; Singapore; Palau Islands.

Fungia fungites dentata Dana, 1846

Plate 160

Fungia dentata Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 293, pl. 18, fig. 7.

One large specimen of this stout *Fungia* is from Rongelap Atoll. It measures 245 mm on the larger diameter, is 100 mm high, weighs 2.92 kg, and has about 700 septa (7 complete cycles and part of 8th).

Another specimen, 170 mm in diameter, nearly flat, and pale brown when alive, was found at a depth of about 2 fms on the sandy floor between *Heliopora* microatolls at the west end of Namu island, Bikini Atoll.

Occurrence.—Bikini Atoll: Namu island (7a); Rongelap Atoll: lagoon, 3 fms (29); Jaluit Atoll (Imp. Coll. 17 and USNM). Singapore; Samoa Islands.

Fungia concinna serrulata Verrill, 1864

Plate 161, figures 1–3

Fungia concinna Verrill, var. *serrulata* Verrill. Doederlein, 1902, Senckenberg. naturf. Gesell. Abh., Band 27, p. 114, pl. 12, figs. 3, 3a.

Fungia concinna Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 75, pl. 8, figs. 1, 2. [Synonymy.]

Umbgrove, 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 43.

Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 79, pl. 73, figs. 1–1c; pl. 74, fig. 3; pl. 75, figs. 1–2d.

Eight specimens belonging to *F. concinna serrulata* range in size from 78 to 150 mm, with 425 to 700 septa. The specimen figured, from Rongelap Atoll, is distomodaeal. The two specimens from about 10 fms in Bikini Lagoon are concave rather than plane or planoconvex, with the margins reflected upwards, and many of the septa are greatly thickened along their upper margin. Mural perforations are almost completely lacking in all the specimens. This is the principal distinction from *F. repanda*. The specimens from Namu island, when alive, were a pale brown.

Occurrence.—Bikini Atoll: Namu island (7a); lagoon, 10 fms. Rongelap Atoll: Naen island, 1–1.5 fms (24); Lomuilal island, 1–3.5 fms (25). *F. concinna*: widely distributed from Red Sea eastward to Tahiti and Canton Island (USNM), and north to Ryukyu Islands; Type locality of *F. concinna serrulata*: Gilbert Islands.

Genus HERPOLITHA Eschscholtz, 1826

Herpolitha limax (Esper), 1797

Plate 162, figures 3, 4

Herpolitha limax (Esper). Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 87. [Synonymy.]

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 45.

Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 80, pls. 79, 80.

Three specimens of this handsome fungiid were collected. They measure in height, width, and axial length: 48 by 77 by 235 mm, 25 by 65 by 340 mm, and 50 by 80 by 385 mm. The last specimen, shown on plate 162, is a very large individual or colony, which has 32 centers. A small specimen from Jaluit Atoll is 50 mm wide, 192 mm long, with 14 centers.

Occurrence.—Bikini Atoll: Ourukaen island (4c); lagoon, 6 fms (48). Rongelap Atoll: Naen island, 1–2.5 fms (24). Jaluit Atoll (Imp. Coll. 37 and USNM). Generally distributed from the Red Sea eastward to Tahiti and Canton Island and northward to Amamiguntō.

Genus HALOMITRA Dana, 1846

Halomitra philippinensis Studer, 1901

Halomitra pileus (Linnaeus). Van der Horst, 1921, *Siboga*-Expeditie, Mon. 16b, p. 20. [Synonymy.]

Halomitra philippinensis Studer. Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddel., Bind 79, p. 237, pl. 8, figs. 93–98; pl. 9, figs. 105, 106, 111, 118, 119, 121; pl. 10, figs. 127, 129.

Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 82, pl. 81, figs. 1–1c.

Two fine large irregularly convex specimens, one 310 mm in diameter, the other 230 mm, were collected at Jaluit Atoll by the *Albatross* Expedition in 1900.

This species may well be the same as *Madrepora pileus* Linnaeus, 1758; but until we have a more accurate idea of the form represented by Rumphius' figures, Studer's later name may be used.

A smaller specimen 175 mm in diameter, from Canton Island, collected by Dr. L. P. Schultz in 1939, is in the U. S. National Museum.

Occurrence.—Jaluit Atoll (USNM; also Yabe and Sugiyama, 1941). Moluccas; Indian Ocean; Fiji Islands; Samoa Islands; Canton Island; Palau Islands.

Genus PARAHALOMITRA Wells, 1937

Parahalomitra robusta (Quelch), 1886

Plate 161, figures 4, 5; plate 162, figures 1, 2

Halomitra robusta Quelch. Boschma, 1925, Dansk Naturh. Fören. Vidensk. Meddel., Bind 79, p. 242, pl. 8, figs. 99–104; pl. 9, figs. 107, 108, 112–116, 120, 122; pl. 10, figs. 130–133. [Synonymy.]

Umbgrove, 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 295, pl. 27, fig. 2.

Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 82, pl. 81, figs. 1–1c.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 155.

Two specimens from Jaluit Atoll, represented by photographs, belong to this species. The specimen figured is irregular in shape with a lateral offset; the other has the familiar cap-shape of *Halomitra pileus* and is 240 mm in diameter and about 120 mm high.

A young anthocaulus of this species (pl. 161, figs. 4, 5), 25 by 37 mm, very broadly attached, with narrow free undersurface still imperforate and finely costate, was dredged off Bikini Atoll. It is identical with the one figured by Boschma (1925, pl. 8, figs. 102–103) from Pulau-pulau Banda, except that it has four secondary centers.

Neither Boschma nor Umbgrove agrees that this species represents a genus distinct from *Halomitra*, although Gardiner clearly demonstrated its necessity when he set up *Doederleinia* (not *Doederleinia* Steindachner, 1883) for *Halomitra irregularis* (=*H. robusta* Quelch) in 1909. *Halomitra* is derived from the *F. fungites* group and shows the same type of septal dentations and single conical costal spines; *Parahalomitra* is a *Halomitra* homeomorph with the characteristic septal dentations and costal spines of the *F. repanda* type.

Occurrence.—Bikini Atoll: seaward slope, 12.5–17 fms (103); Jaluit Atoll (Imp. Coll. 18, 47). Indonesia eastward to Society Islands and northward to Amamiguntō.

Parahalomitra dentata (Quelch), 1884

Sandalolitha dentata Quelch, 1884, Annals and Mag. Nat. History, v. 13, p. 295.
Quelch, 1886, Rept. Sci. Results Voyage of H. M. S. *Challenger*, Zool., v. 16, p. 144, pl. 7, figs. 1–1d.
Podabacia dentata (Quelch). Studer, 1901, Zool. Jahrbücher Abt. Systematik, Band 14, p. 413.

One specimen, recently dead and with one end broken off, was dredged off Bikini Atoll. The undersurface has been worn and crusted over so that the nature of the costal spines cannot be determined, but the septa on the oral surface are intact. The growth form is similar to Quelch's specimen (holotype, BM 86.12.9.216): roughly oval, with irregular margins 7 mm thick, rising centrally to the primary center where the thickness is 17 mm. The longer radius from the center to one end is 57 mm. Centrally the primary center has divided into two equal centers, one slightly to one side of the long axis. Smaller secondary centers occur in line with the long axis, and several are found on the side of the central primaries. The septa are alternately thick and thin: the thinner ones with minutely lacerate, spinulose margins, the larger ones with irregularly spaced subtransverse spinose, tuftlike teeth, as in Quelch's type.

Studer's reference of *Sandalolitha* to *Podabacia* seemed sound on the basis of similarities of septal structure, but the habit of these two genera is quite different. The structures are also those of *Doederleinia* Gardiner (=*Parahalomitra*), which has a free habit. And if the present reference of *S. dentata* to *Parahalomitra* proves correct, then *Sandalolitha* will have precedence over my *Parahalomitra*.

The validity of *P. dentata* as a distinct species is not certain and cannot be determined until more material is collected. It seems distinct on the basis of the relatively smaller number of centers in proportion to the size of the corallum.

Occurrence.—Bikini Atoll: seaward slope, 33–125 fms (105). Tahiti.

Superfamily PORITOIDAE Vaughan and Wells, 1943
Family PORITIDAE Gray, 1842

Genus GONIOPORA de Blainville, 1830

The taxonomy of the Indo-Pacific species of *Goniopora* is still in a primitive state, because, as in the related genus *Porites*, species discrimination is difficult. Very little work has been done since Bernard's monograph of 1903, in which he described and figured a host of specimens. Bernard, completely baffled in an attempt to apply Linnaean names, gave up and used his own geographical taxonomy. Some of his specimens have been given Linnaean names, but many other species still remain buried in his work.

Goniopora somaliensis Vaughan, 1907

Plate 163, figures 1–3

Goniopora somaliensis Vaughan, 1907, U. S. Natl. Mus. Proc., v. 32, p. 262, pl. 25, pl. 27, fig. 1.

Three specimens of this well-defined but rare species were obtained from about 10 fms in Bikini Lagoon. Close comparison with part of Vaughan's holotype (USNM 121990) shows no significant differences. Four specimens of thin, explanate species of *Goniopora* were described by Bernard:

G. Barrier Reef 1, 1903, p. 48, pl. 11, fig. 9, pl. 2, fig. 1 (from Australia).
G. NW. Australia 3, 1903, p. 61, pl. 12, fig. 3; pl. 4, fig. 2 (from Holothuria Bank, 15 fms).
G. China Sea 2, 1903, p. 71, pl. 12, fig. 8, pl. 5, fig. 4 (from Macclesfield Bank, 15 fms).
G. China Sea 3, 1903, p. 72, pl. 12, figs. 9a, 9b, pl. 5, fig. 5 (also Macclesfield Bank, 28 fms).

None of these, however, seems close to *G. somaliensis* except in growth form, and the calices and septa are quite different.

Occurrence.—Bikini Atoll: lagoon, 10 fms (43). French Somaliland (Recif du Météore, 7.5 fms).

Goniopora traceyi Wells, n. sp.

Plate 163, figures 6–8

Corallum pulvinate, holotype measuring 70 by 85 mm, 70 mm high, with thin margins, epithecate, folded under at edges. Calices subpolygonal, averaging 2 mm in diameter, ranging from 1.5 to 3.0 mm within the walls; shallow, almost superficial on upper surface but deeper (up to 1.5 mm) laterally where sheltered. Walls thick and flattened on upper surface of corallum, thinner and subacute laterally, formed by about three rows of synapticulae and trabeculae. Septa 24, but only 12 extend to columella; others very short and often lost in mural structures, with rarely more than one vertical element between wall and columella, tending to be sublaminar. Columella large, nearly compact, 2 mm broad in 3-mm summit calices, smaller and less compact in laterals. Pali indistinguishable in most calices, feebly developed as a crown of six in those near margins of colony; no columellar tubercle.

Of the named and comparable species of *Goniopora*, none seems to be the same as this Bikini Atoll specimen. Species differing by having much larger (3 mm or more) and usually deeper calices are: *G. tenella* (Quelch), *G. stokesii* Milne-Edwards and Haime, *G. viridis* Quoy and Gaimard, *G. lagrenei* Milne-Edwards and Haime, *G. columna* Dana, and *G. duofaciata* Thiel. Species with about the same size calices but with the palar crown very prominent are: *G. tenuidens* Quelch, *G. bernardi* Faustino, and *G. gracilis* Bassett-Smith (not Milne-Edwards and Haime). The nearest species appears to be *G. pedunculata*, from New Guinea, which has about the same size calices with irregular septal apparatus. The type specimen of this species has not certainly been identified (Bernard, 1903, p. 36–37); but of three alleged type specimens which I saw in 1934 at the Paris Museum, one may have been Quoy and Gaimard's holotype. It has calices 2.5–3.0 mm with 6 large septa or sets of septal spines and 6 smaller and 12 rudimentary septa, with columella formed by a loose tangle of septal ends as in *Alveopora;* pali not developed. The only form described by Bernard which approaches *G. traceyi*, except for the species noted above, is *G. fruticosa* Saville-Kent (1891), p. 123, pl. 15, figs. 1–4; pl. 16, fig. 1; and Bernard, 1903, p. 58, pl. 3, figs. 7, 8) from the Great Barrier Reef, but this is a ramose type arising from an explanate base, with smaller calices.

Holotype, USNM 44868.

Occurrence.—Bikini Atoll: Enirik island (1).

Goniopora sp. cf. G. gracilis (Bassett-Smith), 1890

Plate 163, figures 4, 5

Rhodaraea gracilis Basset-Smith, 1890, Annals and Mag. Nat. History, v. 6, p. 457.

not *Rhodaraea gracilis* Milne-Edwards and Haime, 1860, Histoire naturelle des coralliaires, tome 3, p. 184.

Goniopora China Sea 4 Bernard, 1903, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 4, p. 72, pl. 5, fig. 6; pl. 12, fig. 10.

A convex cushion-shaped corallum about 180 mm across from Jaluit Atoll is probably the same as Bernard's *G.* China Sea 4 and very likely represents a new species.

Occurrence.—Jaluit Atoll (Imp. Coll. 15). Tizard Bank, 2 fms.

Goniopora pulvinula Wells, n. sp.

Plate 164, figure 3, 4

Corallum primarily encrusting, about 7 mm thick, forming small convex pulvinate limbs in early stages, later expanding laterally with curled-under margins and extremely wrinkled, folded epitheca. Upper surface gently convex with flush circular calices 2.0–2.5 mm in diameter, separated by flat-topped walls 1.0–1.5 mm wide. In the walls and interspaces the synapticular elements flattened horizontally and more prominent than the vertical elements. Within the calices 24 septa form 3 complete cycles, arranged after the gonioporid plan, but as usual in this genus, somewhat irregularly. One or two other vertical elements between the wall and the innermost vertical septal element. Pali rarely distinguishable as a definite crown. Columella a large tangle of synapticulae, and union of inner septal trabeculae about the axis makes it about half the diameter of the calyx. The free ends of the vertical elements minutely spined or granulated. Holotype laterally lobate, with maximum dimensions of 8.5 by 13 cm.

This is quite distinct from *G. muscosa* in its complete septal complement and increased prominence of the horizontal elements. It does not closely resemble other described species, practically all of which have come from shallower water. As Bernard noted in 1903 (p. 31), "* * * there is certainly a wealth of (unknown) forms * * * from deeper water * * *."

Holotype, USNM 44871.

Occurrence.—Bikini Atoll: seaward slope, 29–96 fms (106, 107, 114).

Goniopora muscosa Wells, n. sp.

Plate 164, figures 1, 2

Corallum primarily encrusting, growing in layers over old stocks, forming crusts up to 10 mm in thick-

ness. Undersurface, where free, much wrinkled and covered with epitheca. Upper surface flat or convex, even, with margins bent downwards. Calices shallow, nearly flush, circular, 2–3 mm in diameter within the walls. Corallite wall formed by 24 vertical elements, each tipped by a knob and forming a neat ring. Between the mural elements of adjoining corallites there may be one or two costal elements which reach to the same height as the mural ring and give the appearance of a flat-topped, broad wall between calices. All elements united laterally by equally stout synapticular bars so that in section the skeleton is a regular meshwork. Within the calyx there are 12 main septa, arranged in the poritid plan; each septum usually formed by three vertical elements, the innermost slightly larger, but rarely forming a distinct palar crown. Axial space open above, but lower down has a weak columellar tangle formed by a few trabeculae. Third cycle of septa undeveloped in most systems, although there are mural elements corresponding to all. In most calices there are from 2 to 6 third-cycle septa in the systems on either side of the main septum of the triplet, but all of the third-cycle septa are present only in very few calices.

This deepwater species is decidedly different from other Recent species of *Goniopora* in its septal plan, and it resembles an overgrown *Porites* in many respects. The reduced septal plan is similar to that found in many Tertiary species. In the same haul with *G. muscosa* were two small specimens of typical *G. pulvinula;* but there is no hint here that *G. muscosa* is an aberrant form.

Holotype, USNM 44872.

Occurrence.—Bikini Atoll: seaward slope, 50–97 fms (106).

Genus PORITES Link, 1807

Porites lobata Dana, 1846

Plate 166, figures 1, 2

Porites lobata Dana. Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 196, pl. 81, figs. 1–1b; pls. 82, 83; pl. 84, figs. 1, 2; pl. 85, fig. 1. [Synonymy.]
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 192, pl. 85, figs. 2, 3.
Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 73, pl. 21, figs. 1a, 1b.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 242.

Ten specimens, from Bikini and Rongerik Atolls, belong to this species, all of them representing *P. lobata* forma *centralis* of Vaughan, and most of them close to Vaughan's *P. lobata* subforma *epsilon:* with weak pali; deep, flat floored calices; and thin, high walls. Small nodular colonies are fairly common near the seaward margins of reefs in the *A. cuneata, A. digitifera,* and *A. palifera* zones. The living colonies are pale yellow brown, ochre, or pale red violet gray. Colonies on the edge of the seaward reef at Latoback island, Rongerik Atoll, were dull olive green, the polyps with red columns.

Occurrence.—Bikini Atoll: Ourukaen island (4a), Bikini island (10b), Enyu island (12a). Rongerik Atoll: Bock island (18), Latoback island (20). Fiji Islands; Samoa Islands; Fanning Island; Hawaii.

Porites australiensis Vaughan, 1918

Plate 166, figures 3, 4

Porites australiensis Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 194, pl. 85, figs. 4–6a; pl. 13, fig. 13; pl. 14, fig. 15.
Faustino, 1927, Philippine Dept. Agr. and Nat. Resources, Bur. Sci. Mon. 22, p. 289.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 243.

Six specimens are placed in this species. They agree well with Vaughan's description and specimens. A large nodular head growing on a coral knoll in Bikini Lagoon in 6 fms was pale olive green when alive.

Occurrence.—Bikini Atoll: Enirik island (1); Bokororyuru island (5a); lagoon, 6 fms (49). Eniwetok Atoll: Bogen island (17). Rongelap Atoll: Tufa island (21). Great Barrier Reef; Murray Islands, Australia; Philippines; Kyūshū; Ryuku Islands; Palau Islands; New Caledonia.

Porites lutea Milne-Edwards and Haime, 1851

Plate 165, figures 1, 2; plate 166, figures 5, 6; plate 167, figures 1–7

Porites lutea Milne-Edwards and Haime. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 198, pl. 88, figs. 1–1b. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 58. [Synonymy.]
Porites haddoni Vaughan, 1918, op cit., p. 197, pl. 87, figs. 1–1b.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 241.

About 30 specimens from the Marshall Islands were examined. They show individual variation in depth of calyx, prominence and development of pali and columella, and thickness of walls, but the calicular diameter and septal plan are constant. As pointed out by Hoffmeister (1925), the difference between *P. lutea* and *P. haddoni* is slight and seems to lie in the character of the walls and prominence of the pali. On the basis of this lack of clear-cut difference, he made *P. haddoni* a variety of *P. lutea.* It is doubtful whether even this variant can be recognized. The height of the pali varies too much on different parts of the same corallum; the walls similarly show variation from coarse to delicate,

and their upper edges may be either straight or zigzag. Further, as Hoffmeister pointed out, the basal parts of *P. haddoni* are typical *P. lutea*. (See pl. 167, figs. 2, 4.)

Crossland (1952, p. 242) seems to have been under the impression that *P. lutea* was based upon a *Porites* from the Red Sea and for this reason referred his Great Barrier Reef specimens to *P. haddoni*. However, as pointed out by both Bernard and Vaughan, *P. lutea* of Milne Edwards and Haime was based primarily on Dana's *P. conglomerata* from Fiji, redescribed in 1918 by Vaughan. The species does not appear to occur in the Red Sea or Indian Ocean.

The growth form of this species is subspherical, subcolumnar, nodular, and reniform to globose with meridional rows of lumpy, low proliferations. A very large specimen from Bikini island, in form like the specimen from Jaluit Atoll (pl. 146, fig. 5), is 35 cm in diameter and 30 cm high, but much larger colonies can be found.

This species is common on all the shallow reef environments and especially so in the very shallow water between the *Heliopora* zone and the beach on reef flats, where it forms microatolls (the *P. lutea* zone, pl. 165, figs. 1, 2). The living corallum varies from a pale yellow to brown red and purple.

Occurrence.—Bikini Atoll: Rukoji island (2), Chieerete island (3), Bokororyuru island (5a, 6), Namu island (7, 7a), Bikini island (10b, 10f), Enyu island (12a). Eniwetok Atoll: Rigili island (13). Rongelap Atoll: Tufa island (21). Jaluit Atoll (Imp. Coll. 40). Teluk Djakarta; Amboina; Palau Islands; Ryukyu Islands; Shikoku; Murray Islands, Australia; Great Barrier Reef; Funifuti Atoll; Samoa Islands; Fiji Islands.

Porites lichen Dana, 1846

Plate 165, figure 3; plate 168, figures 1–6

Porites lichen Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 566, pl. 56, fig. 4.
Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 214, pl. 90, figs. 2–2b.
Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 203, pl. 90, fig. 3.
Porites reticulosa Dana, 1846, op. cit., p. 567, pl. 56, fig. 3.
Vaughan, 1907, op. cit., p. 215, pl. 90, fig. 3; pl. 91, figs. 1, 1a.
Porites viridis Gardiner, 1898, Zool. Soc. London Proc., p. 268. pl. 24, figs. 1b, 2.
Umbgrove, 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 304.
Porites purpurea Gardiner, 1898, op. cit., p. 269, pl. 24, figs. 1, 3, d.
Porites Fiji Islands 19 Bernard, 1905, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 5, p. 57, pl. 4, figs. 2, 3, 4; pl. 13, fig. 11.
Porites Fiji Islands 16 Bernard, 1905, idem, p. 55.
Porites Fiji Islands 17 Bernard, 1905, idem, p. 55.
Porites Great Barrier Reef 32 Bernard, 1905, idem, p. 136, pl. 17, fig. 8; pl. 21, fig. 23.
Porites Ellice Islands 3 Bernard, 1905, idem, p. 65, pl. 5, figs. 4, 5; pl. 11, fig. 2.
Porites mayeri Vaughan, 1918, op. cit., p. 196, pl. 86, figs. 1–1b.

Study of a large suite of specimens from the Marshall Islands and the types of *P. lichen*, *P. reticulosa*, and *P. mayeri* leads me to the conclusion that they, together with *P. viridis* and *P. purpurea*, are all one species. In 1907 Vaughan pointed out the great similarity between the type specimens of *P. lichen* and *P. reticulosa*. Umbgrove has recently (1940) united *P. mayeri* with *P. viridis*. A general description of the species follows:

Corallum encrusting, explanate, rising centrally into small hillocks and gibbosities. Calices averaging 1.25 mm (range: 1–2 mm), shallow, sides sloping; some intratentacular budding. Lateral septa with pali about size of dentations; ventral directive palus smaller; dorsal with small palus flanked by small pali on laterals of triplet. Trident structure usually not developed, and the entire septal plan tends to be irregular. Wall irregular, thickened by outer synapticular ring, often very thick near margins of corallum, with horizontal thickening of elements in upper part of synapticular ring forming a "shelf." Columella variable, a single small pillar or absent with the axial space marked by an inner synapticular ring or a solid platform.

All the variations in septal and mural structures, on which the various "species" have been based, details of which are found in the cited references, are likely to be found in a single colony. The pali vary decidedly in development from almost nonexistent to a crown of tall, stout pillars. They are often more prominent in specimens from quieter water such as the *Heliopora* zone. The thickening of the horizontal elements tends to be more pronounced in specimens from this zone. However, consistent variation with respect to ecological situation was not found.

The color of the living coralla shows a wide range. Most colonies are yellow, grading to brown. Several were found of a violet or purple shade, and some were seen in which the ground color was brown with red peristomes, or pale pink-brown with bright-pink peristomes. Fresh coralla dry a deep brown.

The species is very common on the windward reefs at Bikini in the *A. cuneata*, *A. digitifera*, *A. palifera*, and occasionally in the *Heliopora* zones. It was not noticed on lagoon reefs at the windward end of the atoll.

Occurrence.—Bikini Atoll: Enirik island (1a), Ourukaen island (4a, 4b), Bokororyuru island (5, 5c, 6), Namu island (7a), Bikini island (10b), Eniairo and Rochikarai islands (11), Enyu Island (12a). Rongerik Atoll: Bock island (18). Fiji Islands; Cocos-keeling Islands; Bonin Island; Murray Islands; Funafuti Atoll; Pulau-Pulau Penju; Palau Islands; Rotuma Island.

293438—54——6

Porites superfusa Gardiner, 1898

Plate 169, figures 1–4

Porites superfusa Gardiner, 1898, Zool. Soc. London Proc., p. 274 pl. 24, figs. 1m, 7.

Porites Ellice Islands 2 Bernard, 1905, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 5, p. 64, pl. 5, fig. 3; pl. 13, fig. 15.

Fourteen specimens of this curious species of *Porites* were collected. The structures closely parallel the descriptions of Gardiner and Bernard that were based upon a single specimen, of which no figures have been published showing the general aspect of the corallum. Specimens (pl. 169, fig. 1) from the lagoon reefs are convex-encrusting, surface rising in crowded gibbosities 10–20 mm across, rarely becoming columniform, with narrow, sharply defined grooves between them in which the corallites are closely packed, often reduced to a coarse reticulum. Laminate-encrusting coralla from the outer reef flats have smaller, lower gibbosities similar to those of the type. One specimen (pl. 169, fig. 3), partly overgrown by *Heliopora*, shows the proliferations of round worm tubes, which were particularly noted by Gardiner and Bernard in the type. As if punched in, the calices, averaging 0.75 mm, are sharply differentiated from the thick walls. Septa are short and thick, with only one trabecula between wall and palus. In most calices trident structure of the triplet is well developed; of the 6 pali 4 are laterals and 2 directives, but the palus of the ventral directive is very feeble. Columella is a mere pin, and all are structures decidedly frosted.

Besides the peculiar appearance of the corallum given by the crowded gibbosities, the species is well characterized by the circular calices sharply indented below the thick walls.

Colonies from the seaward reefs are smaller, with more compact structures than those from lagoon reefs. On the seaward reefs the small, patchy, pale-green colonies are very common just behind the algal ridge in the *A. cuneata* zone and on the sides of surge channel pools. A few lavender colonies were noted in crevices in the *A. palifera* zone.

Occurrence.—Bikini Atoll: Ourukaen island (4, 4a, 4b), Bokororyuru island (5c), Bikini island (10b, 10f), Enyu island (12). Rongelap Atoll: Tufa island (21). Funafuti Atoll, 7 fms.

Porites studeri Vaughan, 1907

Plate 171, figure 3

Porites studeri Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 210, pl. 88, figs. 2, 2a.

One specimen of this deepwater species, the living top of a thick, glomerate corallum 70 mm in diameter, was obtained by dredging. It corresponds in every detail with Vaughan's original description and specimens and need not be redescribed.

Occurrence.—Bikini Atoll: seaward slope, 12.5–17 fms (103). Hawaii, 28–43 fms.

Porites fragosa Dana, 1846

Plate 171, figure 1

Porites fragosa Dana. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 194, pl. 86, figs. 2, 2a. [Synonymy.]

?Porites Great Barrier Reef 7 Bernard, 1905, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 5, p. 114, pl. 14, fig. 7; pl. 21, fig. 3.

Two, small nodular colonies, dredged from the seaward slope at Bikini Atoll, are referable to this species, which is characterized by the stout wall, wedge-shaped septa, and prominent but deep-seated palar ring, within which is a deep fossette.

Occurrence.—Bikini Atoll: seaward slope, 12.5–17 fms (103). Fiji Islands; Palm Islands, Great Barrier Reef (?).

Porites murrayensis Vaughan, 1918

Plate 171, figure 2

Porites murrayensis Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 192, pl. 84, figs. 4, 5; pl. 13, figs. 12, 14.

Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 76, pl. 22, figs. 1a, 1b.

?Porites brighami Vaughan, 1907, U. S. Natl. Mus. Bull. 59, p. 208, pl. 84, figs. 3, 3a.

Eguchi, 1938, Palao Tropical Biol. Sta. Studies, no. 3, p. 384.

One specimen, a fragment, was taken from a huge subspherical yellow-green head from 6 fms on a coral knoll in Bikini Lagoon.

The distinction between *P. murrayensis* and *P. brighami* is very slight, and the Bikini Atoll specimen could be placed in either one.

Occurrence.—Bikini Atoll: coral knoll, lagoon, 6 fms (49). Murray Islands, Australia; Samoa Islands; Fiji Islands (?); Hawaii and Palau Islands.

Porites andrewsi Vaughan, 1918

Plate 165, figure 4; plate 169, figures 5, 6

Porites andrewsi Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 203, pl. 91, figs. 1–2a; pl. 14, fig. 16.

Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 77, pl. 22, figs. 2a–2c.

Thiel, 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 135, pl. 13, fig. 3. [Synonymy.]

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 58.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 244.

This species occurs only on the lagoon reefs where it may form huge, flat-topped masses as much as 20 feet across and solid inside (pl. 165, fig. 4). There is much

variation in the shape of the branches, which taper rapidly and crookedly and may be slender, elongate, evenly divergent (pl. 169, fig. 5), or stout. Some are compressed distally, even uniting laterally, becoming subpalmate; others are clavate. The calicular characters, however, are relatively constant, except that in some parts of colonies the mural summits are formed by definite polygonal ridges of united vertical elements.

The living colonies are generally olive green or ashy gray-green, but the colonies at Namu island (pl. 165, fig. 4) were a buff yellow. The fresh corallum turns black on drying.

Occurrence.—Bikini Atoll: Namu island (7a), Bikini island (10f). Rongerik Atoll: Latoback island (20a). Jaluit Atoll: lagoon reef (*Albatross* Coll., USNM). Great Barrier Reef; Samoa Islands; Tonga; Teluk Djakarta; Murray Islands, Australia; Palau Islands; Pulau-pulau Banda; Fiji Islands; Samoa Islands.

Porites matthaii Wells, n. sp.

Plate 170, figures 1, 2

Porites conferta Bassett-Smith, 1890, Annals and Mag. Nat. History, v. 6, p. 456.

not *Porites conferta* Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 157.

Porites China Sea 18 Bernard, 1905, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 5, p. 180, pl. 27, fig. 8; pl. 29, fig. 3.

A specimen from Jaluit Atoll, represented by photographs, fits Bernard's description and figures exactly. A new species of ramose *Porites* is involved here and is herewith named. Its characteristics are the ramose growth form; calices with Bernard's septal plan C, with well-defined pali (eight, as in *P. nigrescens*) that form a well-marked ring within which is a small columella; horizontal elements well-developed; and wall formed by one median ring of vertical elements, with occasionally another vertical trabecula between the outer one and the palar ring.

P. andrewsi has a similar growth form and a black color when dry, but the septal structure is quite different (see pl. 169, fig. 6); *P. eridani* Umbgrove (1940, p. 306, pl. 33, fig. 4, pl. 35, fig. 2) lacks a columella tubercle; *P. capricornis* Rehberg (see Umbgrove, 1940, p. 306) has 3 or 4 vertical elements in each septum and is closer to *P. andrewsi*. *P. nigrescens* Dana is perhaps most closely related but has denser, thicker walls and larger calices. *P. suppressa* Crossland (1952, p. 245, p. 51, figs. 2, 3) from the Great Barrier Reef, with larger calices than *P. matthaii*, and rarely more than five stout pali, may well be the same as *P. nigrescens*.

Holotype, specimen 46, Imp. Coll.

Occurrence.—Jaluit Atoll (Imp. Coll. 46). Tizard Bank, 2.5 fms (*P. conferta* Bassett-Smith).

Subgenus SYNARAEA Verrill, 1864

Porites (Synaraea) hawaiiensis Vaughan, 1907

Plate 170, figures 6, 7

Porites (Synaraea) hawaiiensis Vaughn, 1907, U. S. Natl. Mus. Bull. 59, p. 216, pl. 91, figs. 2, 2a.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 247.

Specimens from Bikini Atoll extend the known range of this species beyond the Hawaiian area. The only observable differences are that the calices are slightly larger (about 1 mm), and the surface of the corallum is raised into low gibbosities. Most of the specimens came from the deeper water in the lagoon or on the seaward slope, but a few specimens were found in crevices in the microatolls in the *A. palifera* zone on windward flats. One of these last was a dark green brown when alive.

Occurrence.—Bikini Atoll: Bikini island (10b); Bokororyuru island (6); lagoon, 6.5–30 fms (43, 73, 75, 84); seaward slope, 12.5–17 fms (103, 115). Rongerik Atoll: lagoon, 2.5 fms (94). Hawaii (Kaliki Harbor, Oahu); Great Barrier Reef; Macclesfield Bank, 30–34 fms.

Porites (Synaraea) horizontalata Hoffmeister, 1925

Plate 171, figure 4

Porites (Synaraea) horizontalata Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 80, pl. 22, figs. 3a, 3b.

One specimen, a small fragment broken from a horizontal plate, showing the basal epitheca, was dredged in Rongelap Lagoon.

Occurrence.—Rongelap Atoll: lagoon (96a). Samoa Islands, 8–18 fms.

Porites (Synaraea) monticulosa (Dana), 1846

Porites monticulosa Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, 566, pl. 55, figs. 7, 7a–7c.

Synaraea monticulosa (Dana). Verrill, 1864, Bull. Mus. Comp. Zool., Harvard, v. 1, p. 42.

Porites Fiji Islands 15, Bernard, 1905, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 5, p. 54.

Several large specimens, collected at Jaluit by the *Albatross* expedition in 1900, and identified by T. Wayland Vaughan, are in the U. S. National Museum.

Occurrence.—Jaluit Atoll (USNM). Fiji Islands, *in* Dana, 1846.

Porites (Synaraea) iwayamaensis Eguchi, 1938

Plate 170, figures 3–5

Porites Caroline Islands 3 Bernard, 1905, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 5, p. 94, pl. 9, fig. 5; pl. 12, figs. 1, 2, 3.

Porites iwayamaensis Eguchi, 1938, Palao Tropical Biol. Sta. Studies, no. 3, p. 385.

?*Synaraea irregularis* Verrill, 1864, Bull. Mus. Comp. Zool., Harvard, v. 1, p. 43.

One specimen, from Jaluit Atoll, closely corresponding to Bernard's description and figures, is represented by photographs.

Occurrence.—Jaluit Atoll (Imp. Coll. 31). Ponape, Caroline Islands; Palau Islands, *in* Eguchi 1938.

Genus ALVEOPORA de Blainville, 1830

Alveopora allingi Hoffmeister, 1925

Plate 163, figures 9, 10

Alveopora allingi Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 81, pl. 23. figs. 2–2c.
Stiasny, 1930, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 13, p. 35, pl. 3, fig. 3; pl. 5, fig. 1.

One specimen from Rongelap Lagoon is identical with Hoffmeister's specimens in the U. S. National Museum.

Occurrence.—Rongelap Atoll: lagoon 17–20 fms (95). Tutuila Island, Samoa Islands, 12–17 fms; Padang, Sumatra.

Alveopora ocellata Wells, n. sp.

Plate 164, figures 5–7

Corallum, forming a flattened expansion 1–2 cm thick, basally covered by very thin epitheca. Corallites cylindrical, 1.25–1.5 mm in diameter, with well-defined circular walls formed by 12 regular, vertical, rodlike elements, horizontally linked by stout, regularly spaced synapticulae. Corallites very close-set, linked by synapticulae and spines from mural elements. Septal spines well-developed, regular, in 2 unequal cycles of 6 each. The first-cycle spines are stout and extend horizontally inward from the mural rods almost to the axis, their inner ends swollen and almost making contact with each other. The secondary spines are short, extending less than halfway to the axis and tapering to points. Thin, subtabular endotheca.

About 13 species of *Alveopora* are known from the Indo-Pacific. None of them is common, and the genus as a whole is not well known. Species criteria lie principally in size of corallites and number of septal spines. Only 4 species approach *A. ocellata* in size of corallites: *A. daedalea* (Forskaal), *A. tizardi* Bassett-Smith, *A. verrilliana* Dana, and *A. viridis* (Quoy and Gaimard). Of these, *A. daedalea* and *A. viridis* have only one cycle of six septal spines; *A. verrilliana* has a lobate growth form with irregular structures and calices ranging from 1.0 to 1.25 mm, and *A. tizardi* has slightly smaller and polygonal corallites and shorter septa. Outstanding in *A. oceallata* are the cylindrical, separated corallites, and well-developed, thick, first-cycle septa.

Holotype, USNM 44941.

Occurrence.—Bikini Atoll: seaward slope, 25–125? fms (105–110).

Suborder FAVIIDA Vaughan and Wells, 1943
Family FAVIIDAE Gregory, 1900
Subfamily FAVIINAE Vaughan and Wells, 1943
Genus BIKINIASTREA Wells, n. gen.

Type species: Bikiniastrea laddi Wells, n. sp.

Dendroid faviid, colony formation by frequent, equal, probably distomodaeal intratentacular budding; new corallites often anastamosed with adjacent ones with small patches of common peritheca. Corallites strongly costate, with parathecal wall; septa with strong, spaced dentations. Columella trabecular.

At first glance, this form resembles *Echinopora*, especially *E. gemmacea* forma *fruticosa;* but intratentacular budding is the rule, and the septal structures are much coarser. It is probably closest to *Caulastrea*, especially *C. furcata;* but this genus is phaceloid in form; tristomodaeal budding is the usual mode of colony formation; exotheca is practically absent; secondary coalescence of corallites rarely occurs; and the septal teeth and costal spines much smaller and finer.

The type of the genus *Barabattoia* Yabe and Sugiyama (1941, p. 72), *B. mirabilis* from Yap, is certainly allied to *Caulastrea, Bikiniastrea,* and *Plesiastrea,* but is subplocoid, with protuberant corallites increasing by both extratentacular and intratentacular (triple stomodaeal?) budding, neither seeming to predominate in the only specimen known. These four genera represent a structural series: *Caulastrea* (phaceloid), *Bikiniastrea* (subdendroid), *Barabattoia* (subplocoid), and *Plesiastrea* (plocoid).

Bikiniastra laddi Wells, n. sp.

Plate 172

Intratentacular budding frequent; corallites bifurcating after having attained a length of about 10 mm, producing a rapidly expanded, dendroid clump. Adjacent corrallites frequently anastomosed, their edgezones fusing and losing individuality. Endothecal dissepiments cellular; some blisterlike exotheca. Corallites cylindrical, but may have oval calices, indicative of impending budding, averaging 10 mm in diameter. Mature calices 10 mm; budding calices often 10 by 15 mm. Costae stout, nearly equal, bearing thick, short, acutely pointed spines. Septa exsert, thick at walls, 24–30 in number, of which about half extend to the axis where their loose inner trabeculae tangle to form a columella. Cyclical arrangement scarcely evident. Septa of the second cycle slightly thinner than the primaries and here and there united to them; tertiaries very thin and short; all represented by costae. Septal

margins strongly dentate with about five well-spaced teeth which become longer over the walls and toward the columella, the innermost tooth often prominent and simulating a palus. Sides of septa scarcely granulate, nearly smooth. Corallite wall parathecal, formed by an inner series of simple endothecal vesicles and an outer series of smaller simple exothecal vesicles, with a total thickness of nearly 2 mm. Epitheca thin, forming collarettes.

Holotype, USNM 44942.

Occurrence.—Bikini Atoll: lagoon, 2 fms (30).

Genus FAVIA Oken, 1815

Favia stelligera (Dana), 1846

Plate 173, figures 5, 6

Favia stelligera (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 101, pl. 34, figs. 2, 3; pl. 35, figs. 1–4. [Synonymy.]
Crossland, 1931, Zool. Soc. London Proc., p. 380, pls. 13, 14, figs. 11–13.
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 29, pl. 26, fig. 5.
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 28.
Umbgrove, 1940, idem, deel 22, p. 278.
Crossland, 1952, Great Barrier Reef Exped., Sci. Rpts., v. 6, No. 3, p. 128.

Typical specimens, showing the nodular to subclavate growth form which resembles *Pavona clavus*, were found on the reef flat at Ourukaen island, Bikini Atoll. Small, undulant-laminar colonies, with the calicular characters of the species, occur on the mixed microatolls of the windward reef at Bikini island, and on the barren seaward reef flat at Latoback island, Rongerik Atoll. Three specimens similar to these last in form but thicker and with calices averaging near the maximum for this species (2.5 mm) were obtained by dredging off the seaward slope of Bikini.

Most of the specimens seen alive were of a pale yellow brown or tan, but the specimen from Latoback was violet brown.

Occurrence.—Bikini Atoll: Ourukaen island (4a); Bikini island (10b, 10c); seaward slope, 12.5–17 fms (103). Rongerik Atoll: Latoback island (20). Jaluit Atoll (Imp. Coll. 14). Jaluit, Pokak [Taongi], and Ailuk Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward to Tuamotu Archipelago and northward to Daitō-jima.

Favia speciosa (Dana), 1846

Plate 174, figure 2

Favia speciosa (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 103, pl. 36, figs. 1–4a; pl. 37, figs. 1–4a. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 28, pl. 20, fig. 7; pl. 23, fig. 1. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 27.
Umbgrove, 1940, idem, deel 22, p. 277.
Crossland, 1952, Great Barrier Reef Exped., Sci. Rpts., v. 6, no. 3, p. 127.

Only one specimen of this very common and widespread Indo-Pacific *Favia* was collected on the reef flats: a small colony resembling closely Vaughan's figures (1918, pl. 36, fig. 4) of Dana's type of *F. pandanus*.

Six specimens, four living and two recently dead, were obtained by dredging off the seaward slope of Bikini Atoll: broad, explanate, basally epithecate colonies, one of them 19 cm in diameter and 7 cm high, with calices of the *F. pandanus* type. The major septa are thick and bear flattened transverse denticulations.

Occurrence.—Bikini Atoll: seaward slope, 25–48 fms (107, 110, 114). Eniwetok Atoll: Bogen island (15). Eniwetok, Jaluit, Ailuk, Wotje, Pokak [Taongi], and Namotik [Namorik] Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea generally eastward to Fanning Island northward to Honshū.

Favia pallida (Dana), 1846

Plate 173, figures 1–4; plate 174, figure 1

Favia pallida (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 105, pl. 38, figs. 1–7; pl. 16, figs. 26, 27, 29, 30. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 29, pl. 19, figs. 1, 2. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 27.
Umbgrove, 1940, idem, deel 22, p. 278.
Favia doreyensis (Milne-Edwards and Haime). Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 127.

This is the most abundant species of *Favia* in the Marshall Islands. Colonies, which are pale brown, buff, or light yellow brown, occur in nearly all reef environments. They show considerable individual variation in size of calyx, separation of corallites, and relative thickness of septa; and four facies can be recognized on the basis of these differences: (1) Small close-set subpolygonal calices (pl. 173, fig. 3); (2) small oval calices (fig. 2); (3) calices separated at least 2–3 mm, with 6 major septa thicker and more prominent (fig. 4); and (4) calices larger than 10 mm, separated by more than 3 mm. Confirmation of any correlative significance to these variations, however, is lacking. No ecological or geographical concentration of any one of them seems to obtain, and statistical analysis of dimensions, septal number, septal thickness, and other measurable factors fails to establish any consistent relationships.

One specimen (pl. 174, fig. 1), with dark-brown polyps, collected from the dark underside of an overhanging ledge in a pool on the windward reef flat at Bikini island, departs rather widely from the usual aspect of this species. Over most of the corallum, which is encrusting with curled-under margins, the corallites resemble Vaughan's facies 4 (1918, p. 107, pl. 16, fig. 29) except that the septal dentations are smaller and less spinulose and pali are more weakly developed. Toward one margin the calices increase greatly in diameter, become more protuberant with thick, broad walls. Over the margin they are closely packed and distorted, some measuring 8 by 18 mm. The number of major septa remains about the same, but the minor ones increase from one between each pair of majors to three, usually noticeable at the wall but with corresponding costae. The costae vary in size cyclically, but all are relatively thick, closely packed, with granulated edges that give way to single dentations towards the walls.

Occurrence.—Bikini Atoll: Bokororyuru island (5, facies 1; 5a, facies 3), Namu island (7, 7b, facies 2; 7b, facies 3), Aomoen island (9, facies 2), Bikini island (10a, facies 2, 4; 10b, facies 1, 2), Eniaro and Rochikarai islands (11), Enyu island (12a, facies 1). Eniwetok Atoll: Rigili island (13, facies 1), Bogen island (15, facies 1), Lidilbut island (16*a*, facies 1). Rongerik Atoll: Bock island (18, facies 3), Latoback island (20a, facies 2). Jaluit Atoll (Imp. Coll. 23, facies 3). Nugol Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Western Indian Ocean eastward to Samoa Islands, northward to Shikoku.

Favia rotumana (Gardiner), 1899

Astraea rotumana Gardiner, 1899, Zool. Soc. London Proc., p. 750, pl. 47, fig. 3.

Favia rotumana (Gardiner). Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 24, pl. 1, figs. 3a–3c.

?Favia rotumana (Gardiner). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 29, pl. 19, fig. 7.

Three specimens from Enyu island and one from Bikini island are referred to this well-marked species, because they agree closely with Gardiner's and Hoffmeister's analyses. The specimen from the Palau islands figured by Yabe, Sugiyama, and Eguchi looks much like Vaughan facies 6 of *F. pallida*, and their other records of *F. rotumana* are therefore uncertain.

The specimen from Bikini island, when living, was pale buff with light-green tints. The species is occasionally in the mixed microatoll area on the reef flat (*A. palifera* zone), where it grows isolated in the shallow spots and forms small microatolls.

Occurrence.—Bikini Atoll: Bikini island (10c); Enyu island (12a). Rotuma island; Funafuti Atoll; Vakaya; Héréhérétué, Tuamotu Archipelago; Samoa Islands.

Favia favus (Forskaal), 1775

Favia favus (Forskaal). Matthai, 1914, Linnean Soc. London Trans., 2d ser., Zool., v. 17, p. 79, pl. 9, fig. 2; pl. 20, figs. 1–6; pl. 21, figs. 1–8, pl. 22, figs. 1–5; pl. 32, fig. 1. [Synonymy.]

Hoffmeister, 1925, Carnegie Inst. Wash. Pub. 343, p. 22.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 125.

Favia danae Verrill. Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 108, pl. 39, figs. 1, 1a.

Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 30, pl. 19, figs. 3, 4.

Two specimens of *Favia* from the windward reef flat at Bikini island accord well with Matthai's description of this species and figures and with specimens in the U. S. National Museum identified by Hoffmeister. One specimen is identical with a Red Sea specimen figured by Matthai (1914, pl. 20, fig. 1).

Occurrence.—Bikini Atoll: Bikini island (10c). Red Sea and Indian Ocean eastward to the Fiji Islands, and Fanning Island.

Favia valenciennesii (Milne-Edwards and Haime), 1850

Favia bertholleti (Milne-Edwards and Haime). Matthai, 1914, Linnean Soc. London Trans., 2d ser., Zool., v. 17, p. 94, pl. 7, fig. 2; pl. 22, fig. 7, pl. 23, figs. 4, 6; pl. 24, fig. 1.

Phymastrea valenciennesii Milne-Edwards and Haime. Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 31, pl. 23, figs. 3–5; pl. 24, fig. 5. [Synonymy.]

Favia (*Phymastraea*) *valenciennesii* (Milne-Edwards and Haime). Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 28, pl. 2, fig. 6.

Favia valenciennesii (Milne-Edwards and Haime). Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, p. 125.

Eleven specimens of this species, which forms small, subplane colonies on the reef flats, were examined. None of them shows as deep intercorallite grooves as those figured by Yabe, Sugiyama, and Eguchi or Umbgrove, and in most specimens the corallites are closely united to their summits. All these specimens, however, agree in their dimensions and septal characters.

Specimens observed alive on the windward reef at Bikini Atoll were a light greenish brown with green peristomes.

Occurrence.—Bikini Atoll: Namu island (7); Aomoen island (9); Bikini island (10c); lagoon, 4 fms (45). Rongerik Atoll: Bock island (18). Red Sea eastward to the Philippines and Great Barrier Reef, northward to Honshū.

Favia helianthoides Welles, n. sp.

Plate 174, figures 3–6

Corallum forms small, irregular or nodular masses. The holotype a broad-based nodule 50 by 65 mm, 55 mm

high. Colony formation by intratentacular distomodaeal or tristomodaeal budding. Corallites circular or often slightly distorted, subpolygonal, projecting 1–2 mm, 1.5–2.0 mm apart, separated by polygonal furrows. Calices 3.0–3.5 mm in diameter, about 1.5 mm deep. Septa 20–24 in number, equal, relatively thin; margins convex over the wall, then nearly level to a point about halfway to the axis, where they descend vertically to the columella and terminate in paliform lobes forming a prominent crown. Their margins set with fine, slightly irregular, often spinose, denticulations. Very rarely, one or two septa fail to reach the columella and end in a paliform lobe. A second set of 20–24 narrow septa alternate with the principals and are well developed at the wall but extend only about a fourth of the distance to the palar crown, their inner margins free and vertical. Costae correspond to all septa and are equal in size, rarely continuous but represented by rows of spinulose granulations between corallites, confluent or not. Endotheca thin and subtabular; exotheca coarse, with more widely spaced subtabular to subcellular elements. Living polyps pale yellow brown with violet tints.

Four specimens from deeper water on the seaward slope differ but little from the holotype and another specimen from the exposed reef flat. These nodular specimens are less rounded, more convex-laminar, rising here and there in prominences; and the corallites are rarely less than 2 mm apart and less protuberant.

At first glance this species resembles *Plesiastrea versipora*, for which I originally collected the specimens on the reef flat. But closer scrutiny shows the intratentacular budding of *Favia* rather than the characteristic extratentacular condition of *Plesiastrea*. The feature which distinguishes this form from other species of both *Favia* and *Plesiastrea* is the uniformity of the principal septa and their paliform lobes: in most species the principal septa form two groups, stouter ones bearing lobes and smaller ones without them and roughly alternating with the larger ones. Further, the average number of principal septa is proportionally higher for the size of the corallites than is usual in *Favia*.

Holotype, USNM 44980.

Occurrence.—Bikini Atoll: Bikini island (holotype, 10c); Enyu island (12a); lagoon, 4 fms (45); seaward slope, 12.5–17 fms (103).

Genus FAVITES Link, 1807

Favites virens (Dana), 1846

Favia vasta (Klunzinger). Matthai, 1914, Linnean Soc. London Trans., 2d ser., Zool., v. 17, p. 108, pl. 27, figs. 3, 5, 6.

Favites virens (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 111, pl. 41, figs. 4, 5; pl. 16, fig. 28.

Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 33, pl. 19, figs. 8, 9. [Synonymy.]

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 29.

Umbgrove, 1940, idem, deel 22, p. 279.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 130, pl. 6, figs. 1, 2.

Specimens of this species are fairly common on reef flats. Very large colonies, 3–4 feet in diameter, were seen on the lagoon reef at Latoback island, Rongerik Atoll. Living colonies on the windward flat at Bikini island were yellow brown with gray-green peristomes.

Occurrence.—Bikini Atoll: Bikini island (10c). Rongerik Atoll: Latoback island (20a). Red Sea eastward to the Fiji Islands and northward to Shikoku.

Favites flexuosa (Dana), 1846

Plate 175, figures 1, 2

Favites flexuosa (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 32, pl. 20, fig. 1. [Synonymy.]

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 29.

One specimen of this species, which is allied to *F. virens* but with slightly larger, rounded, often slightly separated calices, and packed septa, was collected from a pool on the windward reef on the north side of Bikini Atoll.

Another specimen, which I believe belongs here, was dredged off the seaward slope of Bikini Atoll (pl. 175, fig. 2). The calices are large, averaging 14 mm in diameter, shallow, rounded, and separated from 2 to 5 mm. In places they are quite superficial; the upper margins of the septa are flat or level from the columella to the almost obliterated wall.

Occurrence.—Bikini Atoll: Yurochi island (8); seaward slope, 12.5–17 fms (103). Teluk Djakarta; Palau Islands; Fiji Islands.

Favites abdita (Ellis and Solander), 1786

Favites abdita (Ellis and Solander). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 31, pl. 22, figs. 3, 4. [Synonymy.]

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 28.

Umbgrove, 1940, idem, deel 22, p. 279.

Crossland, 1948, Natal Mus. Annals, v. 11, p. 189.

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, p. 129.

Only one specimen of this common Indo-Pacific species was seen. The living colony was dark to pale brown with green tints, owing to *Ostreobium* in the skeletal tissues. The corallites illustrate the rounded walls and interspaces of the *F. fusco-viridis* facies rather than the fused acute walls of the typical form. Even for the *F. fusco-viridis* facies, the corallites are unusually widely separated and *Favia*-like.

Occurrence.—Bikini Atoll: Bikini island (10c). Namotik [Namorik] Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea and Indian Ocean eastward to Fiji Islands, northward to Honshū.

Genus PLESIASTREA Milne-Edwards and Haime, 1848

Plesiastrea versipora (Lamarck), 1816

Astrea versipora Lamarck, 1816, Histoire naturelle des animaux sans vertèbres, tome 2, p. 264.

Astrea (Orbicella) curta Dana, 1846, U. S. Exploring Exped., v. 7, Zoophytes, p. 209, pl. 10, fig. 3.

Plesiastrea versipora (Lamarck). Crossland, 1931, Zool. Soc. London Proc., p. 384, pls. 15–18; pl. 19, fig. 32.

Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 23, pl. 57, figs. 5, 6. [Synonymy.]

Plesiastrea curta (Dana). Yabe, Sugiyama, and Eguchi, 1936, idem, p. 22, pl. 50, fig. 5. [Synonymy.]

Umbgrove, 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 275, pl. 22, fig. 3.

Orbicella curta (Dana). Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 124.

Crossland (1931) included *P. curta* as a synonym of *P. versipora*, after a field study of Tahitian specimens. Before consulting Crossland's work, I reached the same conclusion on the basis of the Marshall Islands material. A study of the literature and many specimens of both "species" shows that there is no real difference but rather that a single somewhat variable species is involved. Nearly every specimen shows, on different parts of the corallum, corallites characteristic of both *P. versipora* and *P. curta*, as well as *P. coronata* and *P. solida*; and this variation does not seem to be an ecologic function.

Twenty specimens were obtained in the Marshall Islands. Those observed living on the windward reef at Bikini island were pale yellow brown.

Occurrence.—Bikini Atoll: Enirik island (1); Ourukaen island (4, 4a); Bokororyuru island (5); Bikini island (10b); Enyu island (12a); seaward slope, 12.5–17 fms (103); lagoon, 4 fms (45). Eniwetok Atoll: Rigili island (13). Rongerik Atoll: Bock island (18). Rongelap Atoll: Tufa island (21), Busch island (22). Pokak [Taongi], Jaluit, Ailuk, Namotik [Namorik], and Eniwetok Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Indian Ocean eastward to Tuamotu Archipelago, northward to Honshū.

Plesiastrea lilli Wells, n. sp.

Plate 171, figures 5–7

Forming horizontal, flat or slightly undulant plates, similar to *Turbinaria*, fixed laterally, 5 mm in thickness and 80 mm or more broad. Colony formation by extratentacular marginal, generally concentric budding; occasional buds scattered over the surface. Lower surface with thin concentric lines of noncontinuous epitheca; the living surface extending about 10 mm back from the edge. This surface noncostate but porous, owing to irregular canalicular extensions of coenosarc, suggestive of the dendrophylliids, but eventually becoming solid. Corallites usually slightly protuberant, separated by 1.0–1.5 mm of costate interspaces, walls septothecal. Calices varying little, from 2.0 by 2.25 mm, about 0.5 mm deep. Septa 18–20, subequal over the wall; 12–14 extend to the columella where they may or may not terminate in an irregular crown of ragged paliform lobes; the remainder extend about halfway. In one or two systems, very small, thin, weakly developed secondary septa may appear. Septal margins minutely and irregularly dentate, flat over the wall, laterally spinose, inner margins descending abruptly to the calyx floor at a point about halfway to the columella. Columella about one-half the diameter of the calyx, spongy, with surface of minutely spinulose plates, in some instances merging with the paliform lobes. Costae corresponding to all principal septa, thick at the calicular margin, minutely spinulose, thinning rapidly toward and rarely extending to center of interspaces, nonconfluent. Polyps of holotype a rich reddish brown when alive.

This species, encountered only once in the sheltered recess of a surge channel at Bikini island, resembles *Favia stelligera*, laminar colonies of which are occasionally found in the same niche. The corallites of these two are very much alike in size and structure, but the growth form and mode of colony formation are quite different. From other species of *Plesiastrea*, *P. lilli* is distinguished by the tree-fungus growth form and small corallites.

One specimen which may belong here was collected from the exposed part of a surge channel. The growth form is laminar encrusting, probably owing to its more rugged environment; and the soft parts were a pale yellow brown, possibly the effect of stronger illumination.

Holotype, USNM. 45002.

Occurrence.—Bikini Atoll: Bikini island (10b).

Plesiastrea russelli Wells, n. sp.

Plate 174, figures 7, 8

Corallum explanate, thin (5–15 mm); upper surface irregularly convex following configuration of surface of substratum; lower surface epithecate. Colony formation by extratentacular budding. Corallites well separated, very slightly protuberant above general surface. Interspaces 1.0–2.5 mm wide, crossed by low costae. Calices circular, occasionally ovoid, 4–6 mm in diameter, very shallow. Septa somewhat irregularly arranged in two groups, the principal septa, 8–11 in number, which are extremely thick and highly exsert at the walls, thinning rapidly toward the center. Just

within the wall, the margin of each falls abruptly and deeply into the calyx, terminating internally in a prominent, minutely granulated, paliform lobe, from which it is separated by a deep notch. The thickened exsert portions of the major septa thickly and irregularly set with sharp spines or granulations. The septa of the secondary group rarely thickened, scarcely exsert, mostly regularly dentate with spinulose teeth. Usually three secondary septa between each pair of major septa, the middle one extending nearly to the columella and often terminating in a paliform lobe nearly as large as that of a primary. To this middle septum, a pair of similar but smaller septa joined. Often each of these latter has yet another attached to it; this makes a total of five between major pairs. In many instances, however, these last two, one lying close on each side of a major septum, are obliterated by the thickening of the major septum and evidenced only by corresponding costae. Costae usually developed corresponding to still another pair of undeveloped septa: those that would be expected to develop on either side of the main secondary septum between a major pair. The total number of septa is about 24 in a normal corallite, not counting the undeveloped ones represented only by costae. The columella is small, compact, and spongy, and its surface lies well below the prominent palar crown. The costae low and broad, flattened or rounded on top, with very narrow grooves between them, and covered with minute granulations. Costae practically equal between corallites, confluent or not, often winding and dividing, becoming unequal cyclically towards the calices.

The very thick exsert septal margins, delimiting calicular margins, which otherwise are almost superficial; the densely costate interspaces, apparently below the calices but on nearly the same plane; and the sharply discrete palar crown, rising above the small columella are very striking aspects of this coral. Aside from these features, the species differs from other *Plesiastreae* in the larger size of the corallites.

It might be thought that the remarkable thickening of the major septa is an abnormal or ecological development, possibly owing to the considerable depth at which the holotype was living. On the same block was a small colony of *Favia speciosa*, which has major septa only slightly thicker than usual; other faviids from hauls at similar depths do not show any thickening.

Holotype, USNM 45004.

Occurrence.—Bikini Atoll: seaward slope, 29–42 fms (114).

Genus GONIASTREA Milne-Edwards and Haime, 1848

Goniastrea retiformis (Lamarck), 1816

Goniastrea retiformis (Lamarck). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 34, pl. 18, figs. 5, 6. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 32.
Umbgrove, 1940, idem, deel 22, p. 282.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 133.

This species is not abundant at any site but occurs from the seaward reefs through to the *Heliopora* zone on the lagoon reefs and was obtained by diving down to a coral knoll at 6 fms. There is no appreciable difference between a specimen from near the reef edge and one from the quieter depths of a lagoon coral knoll.

Occurrence.—Bikini Atoll: Bikini island (10c); lagoon, coral knoll, 6 fms (49). Eniwetok Atoll: Bogen island (15), Lidilbut island (16). Rongerik Atoll: Bock island (18). Jaluit, Ailuk, and Eniwetok Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward to Samoa Islands and northward to Shikoku.

Goniastrea pectinata (Ehrenberg), 1834

Goniastrea pectinata (Ehrenberg). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 34, pl. 23, fig. 2; pl. 24, fig. 4. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 32.
Umbgrove, 1940, idem, deel 22, p. 282, pl. 23, figs. 4, 6.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 135.

Three specimens were obtained at Bikini, where the species seems to be rare: one with normal, deep calices with narrow walls from the mixed microatoll zone on the reef flat; two with shallow calices and broad walls from deep water outside the atoll. In the specimen from 25 fms, the calices are nearly superficial.

Color of living corallum from reef flat: pale violet to violet brown; from 25 fms: pale yellow brown.

Occurrence.—Bikini Atoll: Bikini island (10c); seaward slope, 25–44 fms (103, 110). Jaluit Atoll (Imp. Coll. 16). Pokak [Taongi] Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward to Samoa Islands, northward to Honshū.

Genus OULOPHYLLIA Milne-Edwards and Haime, 1848

Oulophyllia crispa (Lamarck), 1816

Oulophyllia crispa (Lamarck). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 42, pl. 25, fig. 6; pl. 34, fig. 4. [Synonymy.]
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 147.

This is an uncommon species. One convex colony, shaped like an obese croissant, was collected from the lagoon reef at Latoback island, Rongerik Atoll. Another was seen on the rich lagoon reef (*Heliopora* zone) at the west end of Namu island, Bikini Atoll. The polyps of both were pale brown. The dimensions and structure were similar to those referred to below, but the coralla were much more convex.

Two specimens were dredged from Bikini Lagoon. Both are small with thickened structures and valleys about 10 mm wide and about 7 mm in depth.

Occurrence.—Bikini Atoll: Namu island (7a); lagoon, 10 fms (44). Rongerik Atoll: Latoback island (20a). Namotik [Namorik] Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Gulf of Aden; Maldives; Torres Strait; Great Barrier Reef; Singapore; Palau and Caroline Islands.

Genus PLATYGYRA Ehrenberg, 1834

Platygyra rustica (Dana), 1846

Coeloria rustica (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 36, pl. 21, figs. 4–8. [Synonymy, in part.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 33.
Umbgrove, 1940, idem, deel 22, p. 282, pl. 24, figs. 4, 5.

This well-known and widespread species is fairly common in the Marshall Islands. Specimens show no radical departures from the usual form. The polyps range from uniform yellow brown to pale buff, occasionally with eosin-green peristomes. It is most abundant in the mixed microatoll area on windward reefs and on the lagoon reefs, where it may form rounded masses up to 2 m across.

Huge colonies of *P. rustica* 3–5 m in diameter and as much as 2 m high, with broad, flat, mostly dead tops, occur on the lagoon reef at Latoback island, Rongerik.

Occurrence.—Bikini Atoll: Enirik island (1), Ourukaen island (4a), Aomoen island (9a), Bikini island (10c), Enyu island (12a). Eniwetok Atoll: Bogen island (15), Lidilbut island (16a). Rongelap Atoll: Tufa island (21). Rongerik Atoll: Latoback island (20a). Nugol, Jaluit, and Ailuk Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward to Samoa Islands, northward to Honshū.

Platygyra sinensis (Milne-Edwards and Haime), 1849

Plate 175, figure 3

Astroria sinensis Milne-Edwards and Haime, 1849, Annales Sci. Nat., 3d ser., v. 11, p. 298.
Coeloria sinensis Milne-Edwards and Haime, 1857, Histoire naturelle des coralliaires, tome 2, p. 416.
Ortmann, 1892, Zool. Jahrbücher Abt. Systematik, Band 6, p. 660.
Gardiner, 1899, Zool. Soc. London Proc., p. 742, pl. 46, fig. 3.
Matthai, 1924, Indian Mus. Mem., v. 8, p. 23.
Coeloria edwardsi Gardiner, 1899, op. cit., p. 744, pl. 46, fig. 6.
Gardiner, 1904, Fauna and Geography of the Maldive and Laccadive Archipelagoes, p. 762.
Macandra sinensis (Milne-Edwards and Haime). Faustino, 1927, Philippine Dept. Agriculture and Nat. Resources, Bur. Sci. Mon. 22, p. 144, pl. 34, figs. 2, 3.
Coeloria daedalea (Forskaal). Matthai, 1928 [in part]. British Mus. (Nat. History) Cat. Madreporarian Corals, v. 7, p. 24, pl. 5, figs. 2, 3.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 148, pl. 11, fig. 1; pl. 12, fig. 2.
Coeloria rustica (Dana). Yabe, Sugiyama, and Eguchi, 1936 [in part]. Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 36, pl. 21, figs. 9, 10.
Umbgrove, 1939 [in part]. Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 33.
Umbgrove, 1940 [in part]. idem, deel 22, p. 282.

Although this species is indeed close to *P. rustica*, it has regularly been discriminated by some workers on the basis of the very short valleys with rarely more than four centers, proportionally coarser septa, and very weak columella. I believe it should be recognized as a distinct form. Matthai, in his extensive study of meandroid corals cited above, did not demonstrate gradation between *P. sinensis* and *P. rustica*.

A typical specimen was collected at Rongerik Atoll: valleys rarely as much as 15 mm long; average width, 4 mm; depth, 2.5 mm; about 10 septa in 10 mm, of which only half extend to the columella.

Occurrence.—Rongerik Atoll: Bock island (18). South China Sea; Rotuma Island; Funafuti Atoll; Philippines; Teluk Djakarta; Celebes; Mariana Islands; Mergui Islands; Great Barrier Reef.

Genus HYDNOPHORA Fischer de Waldheim, 1807

Hydnophora microconos (Lamarck), 1816

Hydnophora microconos (Lamarck). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 40, pl. 32, fig. 5. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 34.
Umbgrove, 1940, idem, deel 22, p. 284
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 151.

One typical specimen was obtained at Pongelap Atoll. The species has also been reported from the Marshall Islands by Yabe, Sugiyama, and Eguchi.

It was not observed alive at Bikini, but one very large boulder about a meter across was found among other coral boulders along the shore of the windward reef at Bikini island. It evidently occurs and thrives in that least explored zone on the shallower part of the seaward slope off the algal ridge.

Occurrence.—Bikini Atoll: Bikini island (loose boulder on beach). Rongelap Atoll: Tufa island (21). Wotje,

Eniwetok, and Pokak [Taongi] Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Arno Atoll (USNM). Maldive Islands eastward to the Samoa Islands, northward to Daitō-jima.

Hydnophora rigida (Dana), 1846

Hydnophora rigida (Dana). Matthai, 1928, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 7, p. 157, pl. 18, fig. 4; pl. 49, fig. 8. [Synonymy.]
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 40, pl. 30, fig. 5; pl. 34, fig. 2.
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 34.
Umbgrove, 1940, idem, deel 22, p. 284, pl. 25, fig. 1.

One small piece, the tip of a slender branch 3 cm in length, was obtained in a bottom sample. Specimens from Jaluit Atoll were identified from photographs.

Occurrence.—Bikini Atoll: lagoon, 25 fms (72). Jaluit Atoll (Imp. Coll. 9). Arno Atoll (USNM). Malay Archipelago eastward to Fiji Islands, northward to South China Sea.

Subfamily MONTASTREINAE Vaughan and Wells, 1943

Note on the use of Montastrea.—Recently, Alloiteau (1949, p. 15–16) has tried to revive *Heliastrea* Milne-Edwards and Haime, 1857, on the grounds that my selection (1936, p. 97) of *Astrea guettardi* Defrance as the type species of *Montastrea* de Blainville, 1830, which made this generic name displace *Heliastrea* Milne-Edwards and Haime and *Orbicella* Dana, violated the law of priority. He contends that of the two genera in which de Blainville placed the bulk of the species included now in *Heliastrea, Orbicella,* or *Montastrea,* the name *Tubastrea* should have been chosen because it was the first listed by de Blainville and because it contained more species. But, instead of proposing that *Tubastrea* be used, as his argument based on "la loi de priorité et la logique" would thus require, Alloiteau drops both of them in favor of *Heliastrea.* His reasoning is faulty in other respects: (*a*) if neither *Tubastrea* nor *Montastrea* were to be used, the next available name would be *Orbicella* Dana, not *Heliastrea,* Stumm (1948) having shown that Dana's "Zoophytes" was published in 1846 rather than 1848; (*b*) *Tubastrea* was not used by de Blainville in its Latin form either in 1830 or 1834, but as "Tubastrées," the first use of *Tubastrea* in proper form being in 1834 by Lesson for a dendrophylliid coral, (*c*) my selection of *A. guettardi* as type species of *Montastrea* is valid under the rules of zoological nomenclature and cannot be changed, and (*d*) strict interpretation of the rules show that the type species of *Astrea* Lamarck, 1801, is *Madrepora rotulosa* Ellis and Solander, 1786, which by the rule of substitution became the type species of *Heliastrea,* thereby making *Heliastrea* a subjective synonym of *Plesiastrea* Milne-Edwards and Haime, 1848.

Genus LEPTASTREA Milne-Edwards and Haime, 1848

Leptastrea purpurea (Dana), 1846

Leptastrea purpurea (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 26, pl. 48, figs. 5–7. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 26.
Umbgrove, 1940, idem, deel 22, p. 277.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 115, pl. 1, fig. 5; pl. 3, fig. 3.
Wells, 1950, Raffles Mus., Bull. 22, p. 48.

Small colonies, from deeper water to seaward and from the lagoon, at first glance resemble *Oulastrea:* the calices are superficial, and the septa thick and exsert. Others from the reefs are typical. Living colonies on reefs are mainly pale brown, sometimes with deep-brown tentacles; those growing in shade show violet tints.

Occurrence.—Bikini Atoll: Bikini island (10c); Aomoen island (9a); lagoon, 10 fms (44); seaward slope, 29 to 42 fms (114). Red Sea eastward to Fanning Island and Hawaii, northward to Honshū.

Genus CYPHASTREA Milne-Edwards and Haime, 1848

Cyphastrea serailia (Forskaal), 1775

Cyphastrea serailia (Forskaal). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 24, pl. 18, fig. 2. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 26.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, No. 3, p. 118.
?Cyphastrea gardineri Matthai, 1914, Linnean Soc. London Trans., 2d ser., Zool., v. 17, p. 48, pl. 13, figs. 4, 5; pl. 34, fig. 5.

Many specimens of this species were examined. They show considerable individual variation in growth form and structure. Most specimens are "normal," with salient corallites, vesicular peritheca, and nodular growth form. The size of the calices is usually about 2 mm, but in some colonies it is only rarely as much as 1.5 mm. Corallites range in protuberance from nearly flush to 1.5 mm exsert. Two specimens are encrusting in habit, with solid peritheca that suggests *C. chalcidicum;* but the septa of the first cycles strongly alternate in size, and third-cycle costae are present. One laminar specimen from the reef margin north of Bikini island measures 30 by 37 cm in extent, rarely as much as 1 cm in thickness, and has a nearly even calicular surface with here and there a low proliferant clump of corallites. The free margins are strongly reflected under as a very thin growing surface.

A specimen from down the seaward slope off Bikini island has widely spaced (2–3 mm) calices with rather distant simple spines scattered over the blistery perithecal surface, very suggestive of *C. gardineri* Matthai; but the septal plan is that of *C. serailia*. A specimen very close to *C. gardineri* came from the windward reef at Bikini island. This has the septal plan of *C. gardineri*, with only the six primaries reaching the columella; but in all other respects, except for solid peritheca, it is *C. serailia*. *C. gardineri* is scarcely separable from *C. serailia*.

Living colonies are usually pale brown or yellow brown. One from cavities in the *A. digitifera* zone, however, was pale gray violet.

Occurrence.—Bikini Atoll: Bokororyuru island (6); Aomoen island (9, 9a); Bikini island (10a, 10b, 10c); Enyu island (12a); seaward slope, 34–45 fms (107). Eniwetok Atoll: Lidilbut island (16). Namotik [Namorik] and Ailuk Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward to Marshall Islands, northward to Honshū.

Cyphastrea chalcidicum (Forskaal), 1775

Cyphastrea chalcidicum (Forskaal). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 24, pl. 18, fig. 1; pl. 49, fig. 5. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 26.
Umbgrove, 1940, idem, deel 22, p. 277.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 117.

Two specimens, one a large, typical, very nodular colony, were collected on the reef flats at Bikini island. Another example, from Jaluit Atoll, was identified from photographs. Two more were obtained by dredging on the seaward slope off Bikini Atoll. These last have undersized corallites (1.25–1.50 mm), salient and widely spaced (1–2 mm) with thickly set spinulose granulations on a blistery peritheca. Third-cycle costae or costal spines are not developed. Corallum green owing to *Ostreobium*.

Occurrence.—Bikini Atoll: Bikini island (10c); Enyu island (12a); seaward slope, 25–45 fms (107, 110). Jaluit Atoll (Imp. Coll. 22); Nugol Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward to Marshall Islands, northward to Honshū.

Genus ECHINOPORA Lamarck, 1816

Echinopora lamellosa (Esper), 1787

Echinopora lamellosa (Esper). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 48, pl. 58, fig. 1. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 38.
Umbgrove, 1940, idem, deel 22, p. 289.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 119.

This is a very uncommon species at Bikini, where only one living colony was seen—a large one almost completely encircling the base of a mixed microatoll on the windward reef flat. Its facies is that of typical *E. lamellosa* as figured by Matthai (1914, pl. 14, fig. 2; pl. 16, fig. 6). The living colony had pale yellow-brown polyps with greenish coenosarc between them.

Occurrence.—Bikini Atoll: Bikini island (10c); seaward slope, 260 fms (dead, worn specimen, 102). Jaluit Atoll (Imp. Coll. 12). Nugol, Namotik, [Namorik] and Pokak [Taongi] Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Western Indian Ocean eastward to Fiji Islands, northward to Ryukyu Islands.

Genus DIPLOASTREA Matthai, 1914

Diploastrea heliopora (Lamarck), 1816

Diploastrea heliopora (Lamarck). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 54, pl. 11, figs. 5, 6. [Synonymy.]
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 166.

One small, corroded fragment of this species was dredged in Bikini Lagoon.

Occurrence.—Bikini Atoll: lagoon, 7 fms (33). Generally distributed from the western Indian Ocean eastward to Fiji Islands and Samoa Islands and northward to Honshū.

Family RHIZANGIIDAE d'Orbigny, 1851

Genus CULICIA Dana, 1846

Culicia rubeola (Quoy and Gaimard), 1833

Plate 185, figures 3–6

Dendrophyllia rubeola Quoy and Gaimard, 1833, Voyage de découverte de l'Astrolabe, Zoologie, v. 4, Zoophytes, p. 97, pl. 15, figs. 12–15.
Angia rubeola (Quoy and Gaimard). Milne-Edwards and Haime, 1848, Annales Sci. Nat., 3d ser., v. 10, pl. 7, fig. 6.
Milne-Edwards and Haime, 1849, idem, v. 12, p. 176.
Culicia rubeola (Quoy and Gaimard). Milne-Edwards and Haime, 1851, Monographie polypiers fossiles des terrains paléozoiques, p. 119.
Milne-Edwards and Haime, 1857, Histoire naturelle des coralliaires, tome 2, p. 607.
Tenison-Woods, 1878, Linnean Soc. New South Wales Proc., v. 2, p. 324.
Dennant, 1904, Royal Soc. South Australia Trans. Proc., v. 28, p. 9.
Matthai, 1927, Madras Govt. Mus. Bull., new ser. (Nat. History), v. 1, p. 46.
Culicia sp. cf. *C. rubeola* (Quoy and Gaimard). Wells, 1950, Raffles Mus., Bull. 22, p. 50.

The species of *Culicia* are difficult to differentiate. Ten or more have been described from the Indo-Pacific region, but few have been adequately figured. The species are based primarily on the number of septa.

the nature of the septal margins, depth of the calyx, and size of the calyx. Until a revision of the genus is undertaken, the assignment of the Bikini specimens is tentative.

Three specimens of *Distichopora* from Bikini Atoll bear small colonies of *Culicia* on their basal expansions. The mature calices are 3.5–4.0 mm in diameter and up to 6 mm in height. The septa may be either exsert or lower than the epithecal wall. The central fossette is fairly deep. There are three cycles of septa and a partly developed fourth in two systems. The total number of septa is consistently 28. The first cycle is prominent, mostly exsert, with the upper margins prolonged upward as a lacerate lobe. The second-cycle septa are slightly thinner with dentate margins sloping gently to the columella. The third cycle is very short and thin, feebly dentate. The columella is papillary, the papillae merging with inner septal dentations.

The distinctive characters of these specimens seem to be lobation of the primary septa, the number of septa, and the deep fossette. Species which show similar features are *C. rubeola* (Quoy and Gaimard), *C. verreauxi* and *C. smithi* Milne-Edwards and Haime, and *C. stellata* and *C. truncata* Dana. I have seen type or topotype specimens of all of these and suspect that they may all pertain to the same species, *C. rubeola*. In all these "species" the corallites have a diameter of 3.0 to 4.0 mm, with the first one or two cycles of septa prominently notched next to the wall and below the upper marginal lobe. In *C. rubeola* and *C. stellata* only the first-cycle septa are lobulate or subentire; in *C. truncata* 6 or 12 septa are larger and lobulate; in *C. verreauxi* and *C. smithi* the first 12 septa are equal and lobulate. Dana's third species, *C. tenella* (type: USNM 184), seems distinct, having all the septa dentate. The specimens described as *C. tenella* by Hoffmeister (1933, p. 11, pl. 3, figs. 1, 2) from off Kingston, South Australia, in 30 fms, are probably not this species. Strong palar lobes are developed, nearly four complete septal cycles are present, and the septa are much more smooth lobed and less dentate than in the types of *C. tenella* from Port Jackson. The Bikini specimens, with only the first cycle of 6 septa lobulate, group with *C. stellata* and *C. rubeola*, and differ only in the number of septa: *C. stellata* with at least 4 complete cycles, *C. rubeola* with 3 cycles, the last of which is incomplete. The value of these slight differences cannot yet be assessed, and reference to *C. rubeola*, the oldest name, will serve for the present.

Occurrence.—Bikini Atoll: Bikini island (10a). New Zealand; Australia; Gulf of Mannar.

Family OCULINIDAE Gray, 1847
Subfamily OCULININAE Vaughan and Wells, 1943
Genus SCLERHELIA Milne-Edwards and Haime, 1850

Sclerhelia alcocki Wells, n. sp.

Plate 177, figures 1, 2

Corallum dendroid; the main branches up to 6 mm thick but mostly about 3.5 mm; colony formation by regular, alternate, extratentacular budding at intervals of about 3 mm; the budded corallites growing around laterally with calices eventually parallel to the branches and arranged in the same plane about 2 mm from the axis of main growth. Surface of peritheca with minute but distinct elongate granulations arranged in irregular linear series. Near the calices these series merge into low costae. Internally corallites almost filled with stereome. Mature calices 2.5 mm in diameter between walls; the upper part of the columella about 1 mm below the plane of the septal margins. Septa in three complete cycles; those of the first cycle very exsert and prominent; those of the second cycle less so but with a crown of six prominent pali standing just athwart the ring of the inner margins of the primary septa. The third-cycle septa small and thin, lacking pali and fused by their inner margins to the secondary septa. Laterally septa strongly and roughly granulated. In some calices these granulations may fuse between adjacent septa above the septothecal wall and form thereby an occasional perforation above the wall proper. Columella conspicuous, elongate, composed of several straggly trabecular pillars, the upper surface well below the palar ring.

Living polyps rich orange. Tenacles simple, 24 in number, corresponding to the septa and cyclically arranged in a single ring, with massed nematocyst batteries distally. No sphincter or infolding of column wall upon contraction. Stomodaeum cylindrical or slightly elongated, apparently not ridged.

Two specimens, a living colony 12.5 cm high, and a dead terminal fragment, were obtained by dredging. The septal and palar arrangements indicate the rare genus *Sclerhelia*. The dimensions, however, are somewhat less than those of the two known species: *S. hirtella* (Pallas) and *S. formosa* Alcock. *S. hirtella*, as yet definitely known only from depths of about 90 fms off St. Helena, has less salient calices about 5 mm in diameter, with a columella of a number of twisted trabecular laths. *S. formosa*, first described as *Cyathohelia? formosa* by Alcock (1898, p. 26, pl. 3, figs. 2, 2a), from a depth of 210 fms in the Maldive Islands, has colorless polyps, with mature calices about 3 mm in

diameter, irregular pali, and different mode of growth. Alcock later (1902, p. 36) recorded the species from 61 fms in the Celebes and referred it to *Sclerhelia*. Eguchi (1939, p. 41) reported, but did not describe, specimens of the genus from Toyama Bay, Japan, 55 fms.

Holotype, USNM 45056.

Occurrence.—Bikini Atoll: seaward slope, 97–133 fms (112, 118).

Subfamily GALAXEINAE Vaughan and Wells, 1943
Genus ACRHELIA Milne-Edwards and Haime, 1849

Acrhelia horrescens (Dana), 1846

Acrhelia horrescens (Dana). Vaughan 1918, Carnegie Inst. Wash. Pub. 213, p. 81, pl. 18, fig. 41.
Theil 1932, Mus. royale histoire nat. Belgique Mém., (hors sér.), v. 2, p. 35. [Synonymy.]
Eguchi 1938, Palao Tropical Biol. Station Studies, no. 3, p. 337.
Umbgrove 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 274, pl. 21, fig. 7.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 123.

Only two specimens of this species from the Marshall Islands have been seen by the writer: a small corallum on the base of a colony of *Porites andrewsi* from a lagoon reef at Jaluit Atoll and a small colony from a lagoon reef at Arno Atoll. It has also been reported from the Marshall Islands by Eguchi.

Occurrence.—Jaluit Atoll; Ailuk Atoll (Eguchi, 1939); Arno Atol (USNM); Pulau-pulau Banda; Philippines; Palau Islands; Murray Islands; Fiji Islands.

Family MUSSIDAE Ortmann, 1890
Genus LOBOPHYLLIA de Blainville, 1830

Lobophyllia costata (Dana), 1846

Lobophyllia costata (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 43, pl. 31, fig. 3. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 37.
Umbgrove, 1940, idem, deel 22, p. 287.

This species was occasionally met with on reef flats, where it forms small hemispherical heads in sheltered sites. Alive the column is pale gray green with ash-brown-gray discs.

On the lagoon reef at Latoback island, Rongerik Atoll, large dome like coralla up to 2 m in diameter occur in about 2 fms of water.

Occurrence.—Bikini Atoll: Yurochi island (8), Bikini island (10c). Rongerik Atoll: Latoback island (20a). Pokak [Taongi] and Ailuk Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Red Sea eastward to Society Islands, northward to Kyūshū.

Lobophillia corymbosa (Forskaal), 1775

Lobophyllia corymbosa (Forskaal). Crossland, 1931, Zool. Soc. London Proc., p. 373, pl. 10, fig. 21; pl. 12, fig. 23.
Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 43, pl. 33, fig. 1. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 36.
Umbgrove, 1940, idem, deel 22, p. 287.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 142, pl. 9, fig. 3.

Like other mussids, this is a rare species in the Marshall Islands, only one colony having been seen. It was gray green and brown.

Occurrence.—Bikini Atoll: Namu island (7a). Red Sea eastward to Tahiti; northward to Bonin Islands.

Lobophyllia hemprichii (Ehrenberg), 1834

Lobophyllia hemprichii (Ehrenberg). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 43, pl. 32, fig. 1; pl. 33, fig. 2. [Synonymy.]
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 143, pl. 10, figs. 1, 2; pl. 30, figs. 1, 2.

Three specimens were collected at Bikini Atoll. One from a depth of nearly 30 fms in the lagoon is tall, with very shallow valleys. Another, from the seaward reef flat near Bokororyuru island, is short and expanded, with relatively deep valleys and thorny costal spines. A third specimen, from the lagoon reef at Latoback island, Rongerik Atoll, was greenish brown when alive.

Occurrence.—Bikini Atoll: Bokororyuru island (6); Yurochi island (8); lagoon, 30 fms (46). Rongerik Atoll: Latoback island (20a). Red Sea eastward to Fiji Islands, northward to Honshū.

Genus SYMPHYLLIA Milne-Edwards and Haime, 1848

Symphyllia nobilis (Dana), 1846

Symphyllia recta (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 46, pl. 31, fig. 4. [Synonymy.]
Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 37.
Umbgrove, 1940, idem, deel 22, p. 288.
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 144, pl. 11, figs. 2, 3.

I am following Vaughan's use (1918, p. 124) of Dana's name *S. nobilis* for Quoy and Gaimard's *Meandrina sinuosa* [not Le Sueur], instead of the later use by Matthai (1928, p. 227) of Dana's *S. recta* for the same species.

Four good specimens were examined. They show some individual variation of valley width that ranges from 15 to 25 mm.

Occurrence.—Bikini Atoll: Ourukaen island (4a), Namu island (7b). Eniwetok Atoll: Rigili island (13).

Rongelap Atoll: Busch island (22). Pokak [Taongi] and Wotje Atolls, *in* Yabe, Sugiyama, and Eguchi, 1936. Western Indian Ocean eastward to Rotuma Island, northwards to Shikoku.

Genus ACANTHASTREA Milne-Edwards and Haime, 1848

Acanthastrea echinata (Dana), 1846

Plate 175, figures 4, 5

Favia hirsuta (Milne-Edwards and Haime). Matthai, 1914, Linnean Soc. London Trans., 2d ser., Zool., v. 17, p. 100, pl. 24, figs. 7, 8. [Synonymy.]

Acanthastrea echinata (Dana). Vaughan, 1918, Carnegie Inst. Wash. Pub. 213, p. 125, pl. 50, figs. 2, 2a; pl. 51, fig. 1 [not fig. 2].

Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 141, pl. 8, figs. 1, 3; pl. 9, figs. 1, 2.

Favia hemprichii (Ehrenberg). Crossland, 1931, Zool. Soc. London Proc., p. 317, pl. 21.

Favia dipsacea (Lamarck). Crossland, 1948, Natal Mus. Annals, v. 11, p. 186, pl. 5.

?Acanthastrea sp. cf. *A. echinata* (Dana). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 47, pl. 34, fig. 1.

not *Acanthastrea hemprichii* (Ehrenberg). Faustino, 1927, Philippine Dept. Agriculture and Nat. Resources, Bur. Sci. Mon. 22, p. 163, pl. 44, fig. 1.

not *Acanthastrea hemprichii* Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 48, pl. 57, fig. 4.

not *Favites halicora—Acanthastrea hemprichii* Umbgrove, 1940, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 280, pl. 24, figs. 6–8.

A colony from Namu island (loc. 7a), a broad, expanded, flat-topped head with calices 10–12 mm in diameter, belongs to this species. The living corallum was a transparent dark brown with green tints owing to bright-green *Ostreobium* in the skeletal tissues. Crossland's description and figure of a Tahitian specimen apply here very closely, including the "thorny" appearance caused by the unbroken septal spines and white appearance of the spines in the living colony.

Although Matthai (1914, p. 102) indicates that Lamarck's specimen of *Astrea dipsacea* is similar to *Acanthastrea hirsuta* var. *megalostoma* Klunzinger, it is not certain that he saw Lamarck's specimen (according to Milne-Edwards and Haime the specimen is lost). Until it is known just what *A. dipsacea* Lamarck is, Dana's *A. echinata* may be used for this species.

Many specimens have been referred to this rare but rather widespread species, most of them incorrectly, seemingly because of failure to appreciate the difference between *Favia* (and *Favites*) and *Acanthastrea:* the former has faviid-type septa, the latter mussid septa. The specimen figured by Yabe, Sugiyama, and Eguchi (1936, pl. 57, fig. 4) as *A. hemprichii* does not appear to have mussid septa, nor do the specimens figured by Umbgrove in 1940, although all these may be correctly attributed to Ehrenberg's *F. hemprichii*. Matthai's figure (1914, pl. 36, fig. 3) of Ehrenberg's type shows clearly that *hemprichii* is a *Favites*, although the other specimens referred to *hemprichii* by Matthai in the same paper are *A. echinata*.

Occurrence.—Bikini Atoll: Namu island (7a), Arno Atoll (USNM). Red Sea scatteringly eastward to Tahiti.

Family PECTINIIDAE Vaughan and Wells, 1943
Genus ECHINOPHYLLIA Klunzinger, 1879

Echinophyllia aspera Ellis and Solander, 1786

Plate 176

Tridacophyllia echinata Saville-Kent, 1871, Zool. Soc. London, Proc., p. 283, pl. 23, fig. 3.

Echinopora magna Gardiner, 1904, Fauna and Geography of the Maldive and Laccadive Archipelagoes, v. 2, p. 782, pl. 60, fig. 10.

not *Mycedium aspera* Matthai, 1924, Indian Mus. Mem., v. 8, p. 58, pl. 3, fig. 6; pl. 7, fig. 2.

Echinophyllia sp. Crossland, 1935, Zool. Soc. London, Proc., p. 503, pl. 2.

Oxyphyllia aspera Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 50, pl. 36, figs. 1–4. [Synonymy.]

Umbgrove, 1939, Rijksmus. natuurlijke Historie Leiden Zool. Meded., deel 22, p. 40, pl. 10, figs. 1, 2.

Echinophyllia aspera Matthai, 1948, Royal Soc. London, Philos. Trans., v. 233B, p. 180, pl. 11, figs. 44, 45.

Lithophyllia vitiensis Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3. p. 138, pl. 9, fig. 4.

Oxypora aspera Crossland, 1952, idem, p. 159.

Seven interesting specimens were obtained by dredging at Bikini. Their facies is decidedly different from typical *E. aspera*, as illustrated by Ellis and Solander's original figure and later figures by Yabe, Sugiyama, and Eguchi. They are bowl-shaped in earlier stages, becoming even-surfaced, horizontally expanded plates (pl. 176, figs. 1, 2). The centers are more widely spaced, more superficial, and rarely with definite calicular boundaries; the septa and septocostae are lower and less strikingly dentate.

Within these specimens there is much variation, mostly corresponding to the relative age of the coralla. In the earliest stages the costae on the lower surface tend to be nearly equal, thin, and widely spaced, with a few simple dentations. Later they become thicker, rounded, and irregularly lacerate, and are usually in two groups: major and minor, between each of which are fascicles of small, almost smooth tertiaries. The centers are quite superficial at first but become pseudoprotuberant from the great thickening of the septa and the swelling of the septal dentations at the "calicular" margin. In some cases this is accompanied by a low, ringlike upwelling of the perithecal vesicles in the same region. However, the development of a definite sep-

tothecal wall on the inner side of the centers, which is characteristic of *Mycedium* and gives an "outward-looking" aspect, can scarcely be found. At the centers there are about 20 septa, more or less alternating in size. Each of 7 to 10 larger and thicker septa has a tall tooth near the junction with the columella.

The most complete of the larger corallum (pl. 176, fig. 1), which has part of the margin broken away, measures 240 mm in diameter. This larger corallum has a large central parent center with the first circumoral ring of centers about 35 mm from it. Fragments of other coralla indicate circular coralla at least 500 mm across. A small disklike corallum 60 mm in diameter, with part of the first ring of centers developed, shows the identity of such forms as *Tridacophyllia echinata* Saville-Kent (Solomon Islands) and *Lithophyllia vitiensis* Crossland (Great Barrier Reef) with this form. A larger, very concave or bowl-shaped young specimen (pl. 176, fig. 2) is 90 mm across, 45 mm deep, and monocentric, except for a large secondary center. The thin, acute septa of this specimen have coarse tufted transverse teeth and thin, high, distant costae, which are lightly dentate on one side of the corallum and coarsely lacerate on the other.

The young coralla and growing margins of large ones are thin and solid, later thickening by addition of vesicular endothecal and exothecal dissepiments. This cellular thickening begins when a width of about 50 mm is reached.

An additional specimen of the same facies was collected from a cavity in the reef at Rongelap Atoll—fragments of a large horizontal frond, dead and overgrown by a number of young colonies developed from planulae, representing all stages from monocentric (7 mm) to bowl shaped with several circumoral secondary centers (115 mm). The monocentric corallite is wholly cemented to the substratum until a diameter of about 20 mm is reached, where the margins start to bend up and out, occasionally being reflexed to the substratum and developing a second main center (pl. 176, fig. 5). In the early stages represented by these coralla, the centers are superficial, lacking walls and appearing merely as septal centers. The septal and septocostal margins are lacerately dentate with tall, concave spines, spaced 1–2 mm, the tips of which are multispinose transversely.

Although these specimens clearly represent a quiet-water or deep-water facies of *E. aspera*, their similarity to *Mycedium* is apparent. The only real difference between *Echinophyllia* and *Mycedium* is in the attitude of the calicular centers: parallel in the former and inclined peripherally in the latter. This is probably the tropic effect of the variation in the plane of the lamina—parallel centers in horizontal fronds and inclined in vertical folia. The resemblance between the present facies and *M. tenuicostatum* is obvious. Further study is needed to clarify the status of these closely allied if not identical genera.

Occurrence.—Bikini Atoll: seaward slope, 25–90 fms (107, 109, 110). Rongelap Atoll: Naen island (24). Arno Atoll (both facies) (USNM). Red Sea eastward to Tahiti, northward to Honshū.

Genus OXYPORA Saville Kent, 1871

Oxypora lacera (Verrill), 1864

Plate 177, figures 7, 8

Oxypora lacera (Verrill). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 53, pl. 29, figs. 6, 7; pl. 37, figs. 1, 2. [Synonymy.]
Crossland, 1952, Great Barrier Reef Exped., Sci. Repts., v. 6, no. 3, p. 158.

Four small fragments of young fronds and large pieces of an old colony were dredged off Bikini island. The young fronds are typical and show no noticeable differences from previously described specimens, but the old corallum provides additional data. The old colony appears to have been 500 mm or more across and consists of horizontal, relatively flat lamina that average 10 mm in thickness. Most of it had died, but a thin sheet of rejuvenated living corallum a couple of millimeters thick extends, with curled-up margins, over much of the old calicular surface. The old corallum is dense and heavy, partly from stereome and partly from thicker, more closely spaced dissepiments than in *Echinophyllia* from the same station. The characteristic perforations of the lamina are found only on the thin, free margins of the rejuvenated portion. The nature of the centers varies considerably. On the thin, free margins they are typical, similar to the fragments of the young fronds referred to above. Elsewhere, however, the centers are more prominent and more nearly circumscribed, rather than quite superficial. The prominence and sharper delimitation are due to the thickening of the septa at the margin of the center or calyx and greater development of the septal dentations. The septocostae, which are parallel on the thin, upturned margins, are labyrinthine between centers as a result of the development of many additional centers.

Another specimen, a segment of a frond with a radius of 140 mm, is typical *O. lacera* in every respect except for complete absence of perforations or slits at point of

insertion of new septocostae. For this reason it might be considered to be *Echinophyllia*, but the corallum, though thin, is wholly dense, without the vesicular dissepiments of that genus.

Occurrence.—Bikini Atoll: seaward slope, 25–45 fms (110). Red Sea eastward to Samoa Islands, northward to Honshū.

Suborder CARYOPHYLLIIDA Vaughan and Wells, 1943
Superfamily CARYOPHYLLIOIDAE Vaughan and Wells, 1943
Family CARYOPHYLLIIDAE Gray, 1847
Subfamily CARYOPHYLLIINAE Milne-Edwards and Haime, 1857
Genus CARYOPHYLLIA Lamarck, 1801

Caryophyllia rugosa Moseley, 1881

Plate 177, figures 5, 6

Caryophyllia rugosa Moseley, 1881, Rept. Sci. Results Voyage of H. M. S. *Challenger*, Zool., v. 2, p. 141, pl. 1, fig. 8.
Caryophyllia paraoctopali Yabe and Eguchi, 1942, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 22, p. 150, pl. 10, figs. 12a, 12b.

Two specimens of this little species were obtained in dredgings. The calyx of one measures 3.5 by 4.5 mm; in the other it is circular, 3 mm in diameter. These specimens correspond very closely with Moseley's and Yabe and Eguchi's descriptions and figures. Both have very strongly ridged epitheca, a feature especially noted by Moseley, and 32 septa octamerally arranged with 8 pali before the second series of septa. The columella consists of three curled trabecular processes. One specimen shows thin flat pali before three septa of the first series.

This species possesses the same symmetry as *C. octopali* Vaughan (1907, p. 74, pl. 5, fig. 2) from the Hawaiian Islands (281–371 fms). Yabe and Eguchi separated their *C. paraoctopali* from *C. octopali* on the basis of the subturbinate rather than cornute growth form and presence of a strongly developed epitheca. The Bikini specimen with compressed calyx, however, is cornutiform; the other, with circular calyx, is turbinate. A more valid distinction, however, is in the prominently curled inner edges of the first and second series of septa in *C. paraoctopali*, whereas in *C. octopali* they are nearly straight. This is also the principal character of *C. rugosa* Moseley, and a comparison of his description and figures with those of Yabe and Eguchi shows the identity of *C. rugosa* and *C. paraoctopali*.

Occurrence.—Bikini Atoll: seaward slope, 50–121 fms (101, 118). Kii Islands (*C. rugosa* Moseley, five unnumbered cotypes in BM), 126 fms; Basilan Strait, 102 fms; Japan: off southern Honshū, 36 fms; off southern Kyūshū, Ōsumi-kaikyō, 51 fms, about 100 fms (*C. paraoctopali*).

Genus DELTOCYATHUS Milne-Edwards and Haime, 1848

Deltocyathus italicus (Michelotti), 1838

Deltocyathus italicus (Michelotti). Alcock, 1902, *Siboga*-Expeditie, Mon. 16a, p. 19. [Synonymy of Recent forms.]
Von Marenzeller, 1904, Deutsche Tiefsee-Exped. 1899–1900 [*Valdivia*] Wiss. Ergebnisse, Band 7, p. 281
Gravier, 1920, Campagnes Scientifiques Albert 1er de Monaco Résultats, fasc. 55, p. 34, pl. 3, figs. 44–46; pl. 13, figs. 198, 199.
Faustino, 1927, Philippine Dept. Agr. and Nat. Resources, Bur. Sci. Mon. 22, p. 74.
Deltocyathus ornatus Gardiner, 1899. Willey, A., Zoological results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected 1895–1897, pt. 2, p. 163, pl. 20, fig. 25.

One subdiscoidal juvenile specimen, 3 mm in diameter and 1 mm thick, with four complete cycles of septa and well-developed pali, was found in a bottom sample. This new record of this cosmopolitan species extends its range much farther into the Pacific. Heretofore it has not been reported east of the Philippines. Moseley's record of a specimen from 2,375 fms in the South Pacific (1881, p. 147, pl. 2, fig. 2) is uncertain. The figure does not look like *D. italicus;* and according to Gardiner and Waugh (1938, p. 195), the specimen is not in the British Museum and may be lost.

Occurrence.—Bikini Atoll: lagoon, 26 fms (80). North and South Atlantic Oceans; eastern Indian Ocean; Malay Archipelago; in depths from 102 to 1,500 fms.

Genus PARACYATHUS Milne-Edwards and Haime, 1848

Paracyathus parvulus Gardiner, 1899

Plate 177, figure 3, 4

Paracyathus parvulus Gardiner, 1899, Willey, A., Zoological results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected 1895–1897, pt. 2, p. 165, pl. 19, fig. 4.

One specimen was obtained in a dredging. It is short-turbinated, slightly compressed, the calyx measuring 5.0 by 5.5 mm, 5 mm in height, partially epithecate, with rounded, granulated costae. Septa in four complete cycles, regularly arranged, with pali in two crowns: an inner crown of 12 before the first two cycles, an outer crown of 12 before the third cycle. Columellar papillae about 10, less compressed than the pali. First cycle of septa exsert and prominent.

The calyx of this specimen is slightly larger than that of Gardiner's specimens, and the corallum is turbinate rather than cylindrical. Otherwise, the two correspond very closely.

One very small, immature specimen, 2 mm in diameter, from another dredging, may also belong here.

Occurrence.—Bikini Atoll: seaward slope, 50–121 fms (106, 118). Baie du Sandal, Île Lifu, 40 fms.

Subfamily DESMOPHYLLINAE Vaughan and Wells, 1943
Genus DESMOPHYLLUM Ehrenberg, 1834

Desmophyllum sp. cf. D. crista-galli Milne-Edwards and Haime, 1948

Desmophyllum crista-galli Milne-Edwards and Haime. Vaughan, 1907, U. S. Natl. Mus. Bull., 59, p. 67, pl. 7, figs. 3, 3a, 3b. [Synonymy.]

One specimen, preserved with soft parts, seems referable to this species. It is not, however, mature, measuring 20 mm in height, with calicular diameters of 15 by 17 mm. Septa of the first two cycles unequal but very exsert; third cycle septa not exsert; fourth cycle incomplete, more exsert but narrower than those of third, probably derived by substitution. Costae only faintly developed. Wall thin. Polyp pink when alive, lacking sphincter; no infolding of column wall on retraction. Tentacles equal in number to septa, in a single, cyclically arranged, subperipheral ring. Stomodaeum faintly ridged.

D. crista-galli is a cosmopolitan species, living in depths from 30 to 1,000 fms.

Occurrence.—Bikini Atoll: seaward slope, 50–97 fms (106). Mediterranean; North and South Atlantic; Indo-Pacific.

Desmophyllum delicatum Yabe and Eguchi, 1942

Desmophyllum delicatum Yabe and Eguchi, 1942, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 22, p. 144, pl. 9, figs. 7a, 7b.

Three small specimens pertain to this species which is characterized by its oval calyx and thin, lightly costate, nonepithecate walls. The calices, measuring 3.5–5.0 by 7 mm, are considerably smaller than that of the single specimen described by Yabe and Eguchi; the fourth-cycle septa are developed only in a few systems. These may well represent still younger stages than the type, which is an immature individual according to Yabe and Eguchi. The thin walls, thin septa, and light costae are regular features of the younger stages of more robust species, such as *D. crista-galli* and *D. ingens* (Moseley, 1881, pl. 4, figs. 1–6).

D. gracile Studer (1878, p. 629, pl. 1, fig. 2), from 90 fms off New Zealand, appears to be very close to, if not the same as, this species.

Occurrence.—Bikini Atoll: lagoon, 8–24 fms (38a). Off east central Honshū, 270 fms.

Genus DACTYLOTROCHUS Wells, n. gen.

Genotype: *Tridacophyllia cervicornis* Moseley, 1881. Recent. Locality unknown. (Types: BM 80.11.25.105.)

Solitary, cyathiform, flaring broadly near calyx, fixed by an expanded base from which new corallites may be budded. Wall septothecate. Calyx very deep, marked by two or more fingerlike prolongations or ramifying, often recurved branches. Costae obsolescent, marked by rows of low granules; external surface thickened by stereome. Septa nonuniting, thin except near wall, but appearing thick owing to well-developed, thin trabecular ridges roughly parallel to the wall, nonuniting. Columella absent.

Tridacophyllia cervicornis Moseley and *T. primordialis* Gardiner slightly resemble *Tridacophyllia* (=*Pectinia*), but none of the specimens show traces of secondary calicular centers or colonial habit. Very young individuals are turbinate and like *Desmophyllum*. With the attainment of a height of a few millimeters, however, the peculiar fingerlike expansions of the wall and septa begin to develop in the manner described by Gardiner (1899, p. 168). The constancy of development of these extracalicular prolongations and the lack of the prominent septal dentations of the pectiniids lead me to the conclusion that a new genus should be recognized, probably related to *Desmophyllum*.

Dactylotrochus cervicornis (Moseley), 1881

Plate 178, figures 1–3

Tridacophyllia cervicornis Moseley, 1881, Rept. Sci. Results Voyage of H. M. S. *Challenger*, Zool., v. 2, p. 183, pl. 10, figs. 2, 3.

Bassett-Smith, 1890, Annals and Mag. Nat. History, 6th ser., v. 6, p. 368.

Tridacophyllia primordialis Gardiner, 1899. Willey, A., Zoological results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected 1895–1897, pt. 2, p. 168, pl. 19, fig. 7.

Gardiner distinguished his species from *T. cervicornis* on the basis of thicker, more regular extracalicular extensions, the presence of some endotheca, and laterally granulated septa with smooth margins. The eight specimens from Bikini show still further differences from both *T. cervicornis* and *T. primordialis:* the exterior is more coarsely granulated; the septa are thin but show thin, acute latera; ridges but no granulations; their margins are smooth; endotheca is absent. Instead of representing a third species, however, it is more probable that only one is represented by all the material. The Bikini specimens show very regularly arranged extracalicular prolongations in early stages of growth, as in *T. primordialis;* but later, new ones appear irregularly placed and frequently recurved, as in *T. cervicornis*. The development of endotheca in Gardiner's specimens may be correlated with the thickening of the processes by stereome. In both Moseley's and the Bikini specimens, stereome is developed but not enough to thicken the processes appreciably.

Occurrence.—Bikini Atoll: seaward slope, 67–75 fms (113). Baie du Sandal, Île Lifu, 40 fms *in* Gardiner,

1899; Tizard Bank, 52–70 fms *in* Bassett-Smith, 1890; Philippines, 46 fms, (*Albatross* Expedition, sta. 5336 USNM).

Subfamily EUSMILIINAE Milne-Edwards and Haime, 1857
Genus EUPHYLLIA Dana, 1846

Enphyllia glabrescens (Chamisso and Eysenhardt), 1821

Euphyllia glabrescens (Chamisso and Eysenhardt). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 17, pl. 8, fig. 5. [Synonymy.]

This species is rare in the Marshall Islands. One specimen was collected in the *Heliopora* zone of the western lagoon reef at Namu island. Two other colonies were seen, both on the windward reef at Bikini island, one of them in a recess on the side of a mixed microatoll, the other in the shelter of a shallow recess extending inward from a surge channel. Worn fragments were found on beaches at both Bikini and Rongerik Atolls.

In living colonies the polyps were ashy brown, the bulbed tips of the nonretractile tentacles creamy.

These specimens may be regarded as topotypes: Chamisso's specimen came from the Ratak Chain, the eastern chain of the Marshall Islands.

Occurrence.—Bikini Atoll: Namu island (7a), Bikini island (10c). Rongerik Atoll: Bock island (drift on beach). Namotik [Namorik] Atoll, *in* Yabe, Sugiyama, and Eguchi, 1936. Western Indian Ocean eastward to Fiji Islands and Rotuma Island, northward to Honshū.

Genus PHYSOGYRA Quelch, 1884

Physogyra lichtensteini Milne-Edwards and Haime, 1851

Plate 178, figure 4

Physogyra lichtensteini (Milne-Edwards and Haime). Yabe, Sugiyama, and Eguchi, 1936, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, p. 18, pl. 8, fig. 6. [Synonymy.]

A small but typical specimen of this uncommon species, from Jaluit Atoll, is represented by a photograph.

Occurrence.—Jaluit Atoll (Imp. Coll. 26). Gulf of Aden; Pulau-pulau Banda; Palau Islands.

Suborder DENDROPHYLLIIDA Vaughan and Wells, 1943
Family DENDROPHYLLIIDAE Gray, 1847

Genus TURBINARIA Oken, 1815

The species of this genus require a thorough revision; and as Vaughan (1918, p. 148) has remarked, many of Bernard's species are largely based upon growth form and are of doubtful validity. For the present, however, I have based my identifications of Marshall Islands species of *Turbinaria* on Bernard's classification, admittedly an unsatisfactory and provisional treatment.

Turbinaria crater (Pallas), 1766

Turbinaria crater (Pallas). Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 23, pl. 1; pl. 31, fig. 1. [Synonymy.]
Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 86, pl. 102, figs. 1–2.

One specimen from Bikini Atoll, in the from of a broad, open, undulant-margined cup with calices averaging 2 mm and 20–24 septa, is placed in this species.

Occurrence.—Bikini Atoll: Ourukaen island (4a). Teluk Djakarta, Amboina; Western Australia; Torres Strait; Great Barrier Reef; Kyōshō.

Turbinaria irregularis Bernard, 1896

Plate 178, figures 5, 6

Turbinaria irregularis Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 50, pl. 12; pl. 32, fig. 4.
Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 86, pl. 95, figs. 2, 2a, 2b.

Seven specimens appear to be this species, which is allied to *T. mesenterina* and *T. magna* but distinguished by the proportionally larger number of septa in the calices. In the present specimens the calices average 2.5 mm, often larger, with 24–32 septa, usually 30; the columella is large and prominent. The growth form ranges from explanate or convex-explanate in the smaller colonies (pl. 138, fig. 5) to a mass of gyrating fronds in the larger older ones.

One specimen, part of an irregularly frondose colony growing in a crowded situation on *Heliopora* at Namu island, was deep yellow when alive.

Occurrence.—Bikini Atoll: Enirik island (1); Namu island (7a); lagoon, 4–10 fms (44, 45). Eniwetok Atoll: Bogen island (15), Rigili island (13). Mauritius; Palau Islands.

Turbinaria sp. cf. T. sinensis Verrill, 1866

Turbinaria sinensis Verrill, 1866, Essex Inst. Proc., v. 5, p. 27. Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 53.

One specimen from Bikini Atoll is referred with some doubt to this species. It came from the same station as the specimen *T. crater* but is a foliate mass, calices 1.5–2.0 mm, with 24–28 slightly protuberant septa and a very deep, small columella.

Occurrence.—Bikini Atoll: Ourukaen island (4d). Formosa; Hongkong (?); Kyūshū; South China Sea; Great Barrier Reef.

Turbinaria mesenterina (Lamarck), 1816

Turbinaria mesenterina (Lamarck). Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 57, pl. 15; pl. 32, fig. 10. [Synonymy.]
Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 86, pl. 96, figs. 1, 1a, 1b.

Five pieces, probably all from the same large foliate colony, composed of curled and in places, cylindriform fronds, represent this species. The projecting corallites are hemispherical, with calices averaging 1.5 mm and 18–20 septa.

Another specimen, taken from a colony of similar facies at Ourukaen island, Bikini Atoll, was brownish yellow with strong-yellow polyps.

This species occurs sporadically on the flats behind the algal ridge on the leeward side of Bikini Atoll.

Occurrence.—Bikini Atoll: Ourukaen island (4d), Bokororyuru island (5a). Rodriguez; Great Barrier Reef; Red Sea; Caroline Islands.

Turbinaria sp. cf. T. stellulata (Lamarck), 1816

Turbinaria stellulata (Lamarck). Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 65, pl. 20. [Synonymy.]
Yabe and Sugiyama, 1941, Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 88, pl. 100, fig. 5; pl. 101, figs. 2, 2a.

A *Turbinaria* which seems close to *T. stellulata* occurs infrequently in the *A. digitifera* zone on mixed microatolls. It forms small, irregularly massive heads by repeated overgrowth of platelike expansions. The calices are 2.0–2.5 mm in diameter and slightly projecting, with about 24 equal and neatly radiating septa extending to a large, spongy columella. The surface of the coenenchyme is finely reticulate with close-set, minute echinulations. The polyps are bright yellow brown with bright yellow-green peristomes.

Occurrence.—Bikini Atoll: Bikini island (10c). Tonga; Fiji Islands; Tizard Bank, 5–10 fms; Saipan.

Turbinaria sp. cf. T. veluta Bernard, 1896

Plate 178, figures 7, 8; plate 179, figures 1, 2

Turbinaria veluta Bernard, 1896, British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, p. 64, pl. 20; pl. 32 fig. 19.

This form, which may represent a new species, is common in the surge channel caves at Bikini island, where it forms clusters of horizontal, leaflike, thin expansions about the size of a cabbage leaf (pl. 179, figs. 1, 2); whole clumps are a meter or so broad. When alive the corallum is brownish yellow, with bright yellow-green peristomes.

These seem to be linked to *T. veluta* by the peculiar coenenchyme, as described by Bernard (1896, p. 64). "exquisitely delicate arrangement of gyrating ridges and furrows, the former being very finely echinulate." The calices, however, are smaller, 1.5–2.0 mm rather than 2.0–2.5 mm; the septa are fewer, 12–18; regularly arranged; and sloping evenly down to the columella, which is composed of curly, interlaced processes.

Another *Turbinaria*, occurring in the same environment and having the same growth form, although the two do not live side by side in the same pools or caves, is included here. The color of the specimen when alive was a pale reddish brown with creamy peristomes. The calices are the same size but contain 20 to 32 septa, which are thinner and appear more crowded in the calices. On one specimen the surface of the coenenchyme is mostly evenly spongy, with vermiculate rows of flattened spinulae in places; on the other it is like that of the first specimen described, but the ornamentation is much finer.

Occurrence.—Bikini Atoll: Bikini island (10d). Tongatabu, Tonga (types).

Genus DENDROPHYLLIA de Blainville, 1830

Dendrophyllia fistula (Alcock), 1902

Plate 180, figures 1–3

Balanophyllia (Thecopsammia) fistula Alcock, 1902, *Siboga*-Expeditie, Mon. 16a, p. 42, pl. 5, fig. 36a.
Thecopsammia fistula Alcock. Von Marenzeller, 1906, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., Band 80, p. 16, pl. 1.
Balanophyllia fistula Alcock. Yabe and Eguchi, 1942, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 22, p. 141, pl. 12, figs. 14–16. [Synonymy.]
Dendrophyllia fistula (Alcock). Gardiner and Waugh, 1939, John Murray Exped. 1933–34, British Mus. (Nat. History), Sci. Repts., v. 6, p. 237.

Pieces of colonies of this species were obtained by dredging. The polyps of many corallites were alive and bright orange but dried to an olive brown. One piece was preserved in alcohol and remained olive brown, whereas a piece of *D. florentula*, which was a brilliant vermilion orange when alive, soon became quite colorless in the same preservative. The polyps have no sphincter, the disk and tentacles upon retraction being drawn deep into the calyx.

None of the specimens shows any epitheca, and in most of them the coenosarc extends down several centimeters, uniting a number of polyps. All specimens are freely branching, the buds usually at about right angles at first, then bending upwards or downwards. Several old stocks, much thickened by perithecа and excrusting organisms, have a thickness of 15 mm.

On one specimen is a fragment of the curious hexactinellid sponge, *Fieldingia lagettoides* Saville Kent,

reviously known only from the holotype dredged rom 500 fms off Portugal and another specimen obtained by the *Challenger* Expedition off Little Kei Island (now Nuhurowa), Banda Sea, in 140 fms.

Aside from the uniform absence of epitheca, the Bikini specimens correspond closely to the descriptions of von Marenzeller (1907), van der Horst (1922), and Yabe and Eguchi (1942). Gardiner and Waugh (1939) pointed out that the continuity of the costae between parent and bud corallites in most cases precludes the idea of all the buds being developed from secondarily attached polyps; and removing the species from *Balanophyllia* (*Thecopsammia*), they placed it properly in *Dendrophyllia*.

Occurrence.—Bikini Atoll: seaward slope, 117–121 fms (118). Philippine Islands, 135–136 fms; Borneo Bank, 17 fms; Pulau-pulau Ewab, 45 fms; Selat Sape, 37 fms; Red Sea, 245–450 fms, 183 fms; Japan, off southern Honshū, Shikoku, and Kyūshū, 24 stations, 51–265 fms.

Dendrophyllia florentula van der Horst, 1922

Plate 180, figures 4, 5

Dendrophyllia florentula van der Horst, 1922, *Siboga*-Expeditie, Mon. 16c, p. 54, pl. 7, fig. 5.

One dredged specimen was a large fragment broken from a bushy corallum. The base of the main branch is 14 mm thick; the longest secondary branch is 15 cm in length with 15 corallites. Except for the mature calices, which are as much as 7 by 9 mm (4.5 by 6.5 mm in van der Horst's types), the specimen agrees very closely with van der Horst's description and figure, including the uniplanar, alternate mode of budding.

The living polyps and continuous coenosarc were a brilliant orange vermilion with 12 yellow tentacles and ridged stomodaeum.

Occurrence.—Bikini Atoll: seaward slope, 133 fms (104). Malay Archipelago: Selat Molo, 35–46 fms; Selat Solor, 57 fms.

Dendrophyllia n. sp.?

Two small dead tips of branches of what is probably a new species of *Dendrophyllia* came from Bikini Lagoon. Budding is alternate and the corallites are short and appressed, with shallow calices 2 mm in diameter. Septa are arranged in the usual manner, 24 in 3 complete cycles. Columella small but definite. Exterior of corallites and branches are finely vermiculate, scarcely perforate, and covered with granulations.

This is similar to *D. pusilla* Alcock (1902, p. 44, pl. 5, figs. 38, 38a) from the Sulu Sea (262 fms), but in that species the columella is said to be wholly absent.

Occurrence.—Bikini Atoll: lagoon, 24 fms (80).

Genus RHIZOPSAMMIA Verrill, 1869

Rhizopsammia chamissoi Wells, n. sp.

Plate 180, figure 6, 7

Corallum consisting of scattered corallites adhered to old, decayed coral rock. Separate corallites usually spaced a centimeter or so apart, but occasionally they may be united basally or even adhered laterally on older ones. Stolonlike expansions about 2 mm broad, mostly concealed by encrusting organisms or badly decayed. Corallites cylindrical, tapering slightly basally, up to 24 mm in height, slightly compressed, with mature calices 7.0 by 7.5 mm. Lower part of corallites covered by very thin epitheca to within 5 or 10 mm of calicular margin; upper part costate with thin, porous, irregularly granulated, subequal costae. Walls very thin and porous. Calices open, 2–4 mm deep. Septa in five incomplete cycles; those of the first cycle very exsert, rounded and spongy peripherally, their inner edges minutely dentate, dropping vertically to the columella. Second-cycle septa much thinner, shorter, coarsely dentate, slightly exsert only at the wall, inner margins concave. Septa of higher cycles arranged in the usual Pourtalès plan, and porous; those of the fifth cycle very small, present only in a few systems. Columella well-developed, spongy, elongate, projecting but deep in the calyx, joined to the 12 septa of the first two cycles.

When I first examined the specimens some hours after they had been dredged alive, later, they were macerated, but still brick-red.

This species, based upon eight specimens from a single colony about a decimeter square, is closely related to *R. verrilli* van der Horst (1922, p. 65, pl. 8, figs. 1, 2), from Indonesia (14–17 and 130 fms), from which it differs by its consistently smaller and shorter corallites. The calices of *R. verrilli* are 10 mm or more when mature, and corallites may be as much as 34 mm in height. The other species of the genus (*R. pulchra* Verrill from Panama; *R. minuta* van der Horst from the Malay Archipelago and Japan, var. *mutsuensis;* and *R. nuda* van der Horst from Singapore) all have considerably smaller calices.

Holotype, USNM 45104; paratype, USNM 45105.

Occurrence.—Bikini Atoll: lagoon, 8–23 fms (38a).

Rhizopsammia minuta van der Horst var. bikiniensis Wells, n. var.

Plate 180, figures 8, 9

Rhizopsammia minuta van der Horst, 1922, *Siboga*-Expeditie, Mon. 16c, p. 65, pl. 7, figs. 9, 10.

One small specimen is close to van der Horst's species. It consists of a dozen or so corallites up to 4 mm in diameter and 6 mm high, adhered to a nodular bit of

coral rock and united to each other by broad, costate expansions. The costate walls are free from epitheca except basally. The calices were all more or less damaged by the dredge, but appear to have been shallow and slightly oval in outline. The septa are relatively thick and are arranged in four cycles. The columella is spongy and well developed but not projecting as in *R. chamissoi*.

There are several small differences between this form and typical *R. minuta:* the corallites are smaller with deeper calices, relatively taller, freer from epitheca, slightly compressed rather than cylindrical, and the stolons are costate rather than trabecular. Some of these features, such as the taller corallites and costate stolons, serve to distinguish the Japanese variety *R. minuta mutsuensis* Yabe and Eguchi (1932). These differences are slight and probably represent a geographical variant, here named *bikiniensis*.

Holotype, USNM 45106.

Occurrence.—Bikini Atoll: seaward slope, 50–96 fms (106). Malay Archipelago; Japan.

Subclass ALCYONARIA de Blainville, 1830
Order STOLONIFERA Hickson, 1883
Family TUBIPORIDAE Milne-Edwards and Haime, 1857
Genus TUBIPORA Linnaeus, 1758

Tubipora musica Linnaeus, 1758

Tubipora musica Linnaeus. Milne-Edwards and Haime, 1857, Histoire naturelle des coralliaires, tome 1, p. 132. [Synonymy.]

Hickson, 1924, Introduction to the study of recent corals, p. 112–116, fig. 51.

This well-known and widespread coral is represented by 10 specimens from the Marshall Islands, where it occurs most abundantly on windward reef flats on or just behind the algal ridge. It is less common on lagoon reefs.

Occurrence.—Bikini Atoll: Rukoji island (2); Ourukaen island (4); Bokororyuru island (5, 5d, 6); Enyu island (12c); lagoon, 4 fms (45). Eniwetok Atoll: Rigili island (13). Rongerik Atoll: Bock island (18). Widespread throughout the Indo-Pacific coral reef area.

Order COENOTHECALIA Bourne, 1900
Family HELIOPORIDAE Moseley, 1876
Genus HELIOPORA de Blainville, 1834

Heliopora coerulea (Pallas), 1766

Plate 167, figure 5; plate 169, figures 3, 4; plates 181, 182

Heliopora coerulea (Pallas). Milne-Edwards and Haime, 1860, Histoire naturelle des coralliaires, tome 3, p. 231, pl. F1, figs. 3a, b, c. [Synonymy.]

Saville-Kent, 1893, The Great Barrier Reef of Australia, p. 193, pl. 10, figs. 1–5.

Hickson, 1924, Introduction to the study of recent corals, p. 118–120, figs. 52, 53.

Faustino, 1927, Philippine Dept. Agr. and Nat. Resources, Bur. Sci. Mon. 22, p. 298, pl. 100, figs. 7, 8.

Eguchi, 1948, Jour. Paleontology, v. 22, p. 362, pl. 60, figs 3, 4, 6.

The number of specimens of this coral collected in the Marshall Islands is greater than that of any other form, and it is indeed very abundant on the seaward reef flats, where colonies were found many meters in extent. Because of the variation in growth form and the lack of adequate figures, five specimens have been illustrated. The following formae are recognized:

α—digitate.
β—clavate.
γ—flabellate (var. *meandrina* Dana).
δ—encrusting.

The commonest and most characteristic growth form is digitate (forma α, pl. 182, fig. 1), with blunt, flattened branches up to 10 mm broad and about half as thick, tending to have the planes of branching roughly oriented in the same direction. This form grades into one in which the branches are more coalescent-compressed (forma β, pl. 182, fig. 2), with a few small branchlets from the long clavate main branches. By further gradations in the lateral coalescence of the branches, the upright branches become highly compressed undulant or flabellate fronds (forma γ, pl. 182, fig. 4) 3–4 mm thick. These are the "erect meandering plates" of Dana's var. *meandrina* and Verrill's *H. compressa* from the Kingsmills Islands. In another variation, the corallum is predominantly encrusting (forma δ, pl. 182, fig. 3; pl. 76, fig. 3) as a closely adherent sheet a few millimeters thick, in places free at the edges, revealing a wrinkled basal epitheca. This is similar to Dana's var. *tuberosa* (1846, p. 450, pl. 52, fig. 2; Bourne, 1896, p. 456). Most specimens show the thin calcareous tubes of the polychaete *Leucodra*.

The growth stages of *Heliopora* have not yet been described, although Bourne (1896, pl. 2, fig. 11) shows the probable appearance of a young colony based upon the general mode of increase. His concept is borne out by the young corrallum shown on plate 167, figure 3.

Hickson (1924, p. 120) says:

> There is no record at present of the colour and appearance of the expanded polyps of *Heliopora*, and observations that have been made at low tide in the daytime suggest that they are never expanded in such conditions. It is probable that like many other polyps they expand only at night.

He overlooked that in 1893 Saville-Kent, in his famous work on the Great Barrier Reef, figured the expanded polyps (p. 193, chromolithographic pl. 10, fig. 2).

At Bikini large colonies of *Heliopora* with large areas of expanded polyps were often noticed at midday both in the *Heliopora* zone in intense light and in pools or

caves on the algal ridge in subdued light. The color of the expanded polyps is a gray blue green, less blue than the surface of the corallum, which is a gray blue when the polyps are retracted. Saville-Kent noticed that the polyps of his specimen retracted slowly when disturbed, and I noted this same slowness at Bikini in contrast to the rapid withdrawal of most scleractinian polyps.

Occurrence.—Bikini Atoll: Rukoji island (α) (2); Ourukaen island (α) (4, 4a, 4b); Bokororyuru island (α) (5, 5a, 6); Namu island (α, β) (7b); Bikini island (α) (10a, 10b, 10c, 10d), (β) (10f); lagoon, 4–10 fms (α) (44, 45); seaward slope, 12.5–44 fms (α) (103, 110). Eniwetok Atoll: Rigili island (β) (13), Bogon island (β) (15). Rongelap Atoll: Tufa island (α) (21), Naen island (δ) (24), Lomuilal island (γ) (25). Rongerik Atoll: Bock island (α) (18), Latoback island (α) (20a). Maldive Islands eastward to Funafuti Atoll and Marshall Islands; northward to Ryukyu and Bonin Islands.

Class HYDROZOA Huxley, 1856
Order MILLEPORINA Hickson, 1899
Family MILLEPORIDAE Blainville, 1834

Genus MILLEPORA Linnaeus, 1758

The species problem in this widespread genus has recently been reviewed in detail by Prof. H. Boschma, who recognizes 10 Recent species, of which 3 are confined to the Atlantic and 7 are found in the Indo-Pacific. Boschma's classification is followed here.

Millepora platyphylla Hemprich and Ehrenberg, 1834

Plate 183, figure 1

Millepora platyphylla Hemprich and Ehrenberg. Boschma 1948, Rijksmus. natuurlijke Historie Leiden Zool. Verh., no. 1, p. 35, pl. 2, figs. 1, 2; pl. 4, fig. 2; pl. 5, figs. 2, 3; pl. 15, figs. 4, 5; text figs. 4, 5, 11, 19. [Synonymy.]
Wells, 1950, Raffles Mus. Bull. 22, p. 51.

This is the commonest *Millepora* in the Marshall Islands where it occurs abundantly on the algal ridge and immediately behind the ridges on seaward reefs. It usually shows the characteristic growth form in vertical plates laterally united in honeycomblike masses.

Two loose, irregularly nodular, encrusting masses from the seaward slope may belong to this species.

Occurrence.—Bikini Atoll: Rukoji island (2); Ourukaen island (4); Bokororyuru island (5, 5d, 6); Bikini island (10b); lagoon, 4 fms (45); seaward slope, 33–48 fms (107) (doubtfully this species). Eniwetok Atoll: Rigili island (13). Rongerik Atoll: Bock island (18). Red Sea generally eastward to Tuaumotu Archipelago and northward to Ryukyu Islands.

Millepora tenera Boschma, 1949

Plate 183, figures 3, 4

Millepora tenella Ortmann, 1892, Zool. Jahrbücher Abt. Systematik, Band 6, p. 668.
not *Millepora tenella* Esper, 1795, Fortsetzungen der Pflanzerthiere, Band 1, p. 113.
Millepora tenella Ortmann. Boschma, 1948, Rijksmus. natuurlijke Historie Leiden Zool. Verh., no. 1, p. 41, pls. 12, 13; pl. 14, figs. 1, 2; text figs. 3, 4, 5, 12, 13. [Synonymy.]
Wells, 1950, Raffles Mus. Bull. 22, p. 51.
Millepora tenera Boschma, 1949, Zool. Soc. London Proc., p. 669.

One specimen of this species is identified from a photograph of a beautiful colony from Jaluit Atoll. Another Jaluit Atoll specimen, now in the U. S. National Museum, is a compact subspherical head with finely subdivided branches. Several specimens, all fragments, were obtained in dredgings on the seaward slope off Bikini Atoll.

Occurrence.—Bikini Atoll: seaward slope, 33–48 fms (107). Jaluit Atoll (Imp. Coll. 11; USNM). Western Indian Ocean eastward to Fiji Islands and Johnston Island, northward to Ryukyu and Daitō-jima.

Millepora exaesa Forskaal, 1775

Plate 183, figure 2

Millepora exaesa Forskaal. Boschma, 1948, Rijksmus. natuurlijke Historie Leiden Zool. Verh., no. 1, p. 29, pl. 5, fig. 1; text fig. 2c. [Synonymy.]

Two specimens were collected in the Marshall Islands.

Occurrence.—Bikini Atoll: Bokororyuru island (6). Rongelap Atoll: Tufa island (21). Red Sea eastward to Tuamotu Archipelago, northward to Philippines.

Order STYLASTERINA Hickson, 1899
Family STYLASTERIDAE Gray, 1847

Stylaster asper Saville Kent, 1871

Plate 184, figures 1, 2

Stylaster asper Saville Kent. Broch, 1936, Norske Vidensk.-Akad. i. Oslo Math. Nat. Kl. Skr., no. 8, p. 36, pl. 4, figs. 13–15, text fig. 9. [Synonymy.]

Three specimens, pale-pink fragments of delicate fronds, show the characteristic, minutely echinate surface of the coenosteum. The gastropores, however, are only about 0.3 mm, which is considerably less than the usual 1 mm.

Occurrence.—Bikini Atoll: lagoon, 13–23 fms (78, 79); seaward slope, 58–133 fms (108, 109, 113). Type locality unknown; Mauritius, 60–150 fms, *in* Broch, 1936.

Stylaster elegans Verrill, 1864

Plate 184, figures 3, 4

Stylaster sanguineus Milne-Edwards and Haime. Broch, 1936 [part], Norske Vidensk.-Akad. i. Oslo Math. Nat. Kl. Skr., no. 8, p. 33, pl. 3, pl. 4, fig. 12; text fig. 8. [Synonymy]

A number of specimens of this species were dredged. It is distinguished from other species of *Stylaster* by its rosier color and relatively smooth coenosteum. Broch places *S. elegans* with some doubt in the synonymy of *S. sanguineus* Milne-Edwards and Haime.

Occurrence.—Bikini Atoll: lagoon, 8–23 fms (38a); seaward slope, 12.5–90 fms (103, 109, 110, 115). Eniwetok Atoll: lagoon, 21 fms (92a). Jaluit Atoll (USNM, determined by W. K. Fisher). Ebon Atoll (Verrill, 1864). Gilbert Islands (USNM, determined by W. K. Fisher).

Genus ERRINA Gray, 1835

Errina sp.

One small cream-white specimen, a young corallum 1.5 mm in height, was dredged in Bikini Lagoon. It is too immature to be specifically determinable.

Occurrence.—Bikini Atoll: lagoon, 13 fms (78).

Genus DISTICHOPORA Lamarck, 1816

Distichopora violacea (Pallas), 1776

Plate 185, figure 3

Distichopora violacea (Pallas). Broch, 1942, Norske Vidensk.-Akad. i. Olso Math. Nat. Kl. Skr., no. 3, p. 9, pl. 1, fig. 1. [Synonymy.]

The species of this genus have recently been reviewed by Broch, and the identification of two species from the Marshall Islands is based upon his work. Eleven specimens are assigned to *D. violacea*. Four are from Bikini Atoll: rich-salmon, flabellate colonies; one faded fragment is from Rongelap Atoll; and six specimens with thick, stout branches like *D. fisheri* α, pale vermilion with crimson patches, were dredged on the leeward slope of Bikini Atoll. A magnificent purple colony from Jaluit Atoll, spiroflabellate in form, 22 cm in height and 30 cm in diameter, is represented by photographs.

Occurrence.—Bikini Atoll: Bikini island (10b, in a cranny under a shelf on algal ridge, depth 2 m); seaward slope, 12.5–15 fms (115). Rongelap Atoll: Kabelle island (fragment found on beach). Jaluit Atoll (Imp. Coll. 1). Likieb Atoll (USNM). Ebon Atoll (*D. nitida* Verrill). Marshall Islands, *in* Broch, 1942. Philippine Islands, 50–100 fms; Gilbert Islands; Great Barrier Reef; New Caledonia (*D. coccinea* Gray: BM 60.5.16.1–6); Johnston Island (USNM); Rarotonga (*D. coccinea* Gray, BM 85.5.4.4, labeled "*Distichopora granulosa*"); Tahiti; Dar es Salaam, East Africa.

Distichopora fisheri Broch, 1942

Plate 185, figures 1, 2

Distichopora fisheri Broch, 1942, Norske Vidensk.-Akad. i. Oslo Math. Nat. Kl. Skr., no. 3, p. 14, pl. 2, fig. 3; text fig. 2.

This species, recently proposed by Broch for a *Distichopora* differing from *D. violacea* in that the gastropores lie along the bottom of a relatively deep and persistent sulcus rather than practically flush with the surface, is represented by seven specimens from the Marshall Islands. These fall into two forms: α, in which the branches are narrow (2.5 mm or less) and slender (pl. 185, fig. 2); and β, in which the branches are relatively broad (3.5 mm) and stubby (pl. 185, fig. 1). All are a deep, cloudy violet, usually nearly white on growing tips. Although Broch does not give dimensions of the branches, comparison with his figures indicates that α is closest to his type. Type β may be a geographical variant.

Occurrence.—Form α: Rongelap Atoll: Kabell island (on beach, faded to pale creamy-violet), Piganiyaroyaro island (23), Mellu island (24a, 1 m deep under shelf in pool near reef edge). Form β: Eniwetok Atoll: Lidilbut island (16); Buganegan island, reef edge. Barrier reef, Namuka, Viti levu, Fiji island; Pulau Peunasoe, western Sumatra.

LITERATURE CITED

Alcock, A. W., 1898, Account of the deep-sea Madreporaria collected by the Royal Indian Survey Ship *Investigator:* Calcutta, 29 p., 3 pls.

——— 1902, Report on the deep-sea Madreporaria of the *Siboga* Expedition: Siboga-Expeditie, Mon. 16a, 55 p., 5 pls.

Alloiteau, J., 1949, Les coraux de l'Éocène de Bojnice-les-Bains près de Prievidza dans les Karpates Slovaques: Práce Státneho Geologického Ustavu, Sŏsit 24, 30 p., 6 figs., 7 pls.

Bassett-Smith, P. W., 1890, Report on the corals from Tizard and Macclesfield Banks: Annals and Mag. Nat. History, 6th ser., v. 6, p. 353–374; 443–458, pls. 12–14.

Bernard, H. M., 1896, The genus *Turbinaria.* The genus *Astraeopora:* British Mus. (Nat. History) Cat. Madreporarian Corals, v. 2, 106 p., 33 pls.

——— 1897, The genus *Montipora.* The genus *Anacropora:* British Mus. (Nat. History) Cat. Madreporarian Corals, v. 3, 192 p., 34 pls.

——— 1903, The genus *Goniopora:* British Mus. (Nat. History) Cat. Madreporarian Corals, v. 4, 206 p., 14 pls.

——— 1905, *Porites* of the Indo-Pacific region: British Mus. (Nat. History) Cat. Madreporarian Corals, v. 5, 303 p., 35 pls.

Boschma, H., 1925, Madreporaria I. Fungiidae. (Papers from Dr. Mortensen's Pacific Expedition, 1914–1916, and the Danish Expedition to the Kei Islands, 1922): Dansk. Naturh. Fören. Meddel., Band 79, p. 185–259, pls. 5–11.

Bourne, G. C., 1896, On the structure and affinities of *Heliopora coerulea* Pallas: Royal Soc. London Philos. Trans., v. 186B, p. 455–483, pls. 10–13.

Brook, G., 1893, The genus *Madrepora*: British Mus. (Nat. History) Cat. Madreporarian Corals, v. 1, 212 p., 35 pls.

Chamisso, A., and Eysenhardt, C. G., 1821, De animalibus quibusdam e classe Vermium linneana, in circumnavigatione terrae * * *: Nova Acta Leopoldina, Band 10, p. 243–373, pls. 24–33.

Crossland, C., 1952, (edited by A. K. Totton) Madreporaria, Hydrocorallineae, *Heliopora:* British Mus. (Nat. History) Great Barrier Reef Expedition, 1928–29, Sci. Repts., v. 6, 257 p., 56 pls.

Dana, J. D., 1846–49, Zoophytes: U. S. Exploring Exped., v. 7, 740 p. [1846], atlas, 61 pls. [1849].

Doederlein, L., 1902, Die Korallengattung *Fungia:* Senckenberg. naturf. Gesell., Abh., Band 27, 162 p. 25 pls.

Eguchi, M. 1939, On the coral fauna of the Toyama Bay, Japan, p. 41–47 [in Japanese].

Emery, K. O., Tracey, J. I., Jr., and Ladd, H S., 1954, Geology of Bikini and nearby atolls, Bikini and nearby atolls, part 1, Geology: U. S. Geol. Survey Prof. Paper 260–A.

Finckh, A. E., 1904, Biology of the reef-forming organisms at Funafuti Atoll: Royal Soc. London, Rept. Coral Reef Comm., The Atoll of Funifuti, sec. 6, p. 125–150.

Gardiner, J. S., 1898, On the perforate corals collected by the author in the South Pacific: Zool. Soc. London Proc., p. 257–276, 2 pls.

——— 1898, The Coral Reefs of Funafuti, Rotuma and Fiji together with some notes on the structure and formation of coral reefs: Cambridge Philos. Soc. Proc., v. 9, p. 417–503, 7 figs., 1 pl.

Gardiner, J. S., 1899, On the solitary corals collected by Dr. A. Willey, *in* Willey, A., Zoological results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected 1895–1897, Cambridge, pt. 2, p. 161–170, pls. 19, 20.

——— 1903–6, The Fauna and Geography of the Maldive and Laccadive Archipelagoes. v. 1, 1903: Rept. 1, Introduction, Narrative and Route of the Expedition, p. 1–11, figs. 1, 2; Rept. 2, chaps. 1–4, The Maldive and Laccadive Groups, with Notes on other Coral Formations in the Indian Ocean, p. 12–50, figs. 3–11, pls. 1, 2; Rept. 11, chaps. 5–7, The Maldive and Laccadive Groups, with Notes on other Coral Formations in the Indian Ocean (continued), p. 146–168, figs. 25–33, pls. 8–12; App A, Special Observations and Work relating to the Formation and Growth of Coral Reefs, p. 313–346, figs. 74–75, pls. 16, 17; Apps. B, Detailed Descriptions of the Atolls and Banks, and C, Concluding Remarks, p. 376–423, figs. 90–109, pls. 19–21. v. 2, 1906: Rept. 13, Madreporia—pt. 1, Introduction with Notes on Variations, p. 755–757; pt. 2, Astraeidae, p. 758–790, pls. 59–64; pt. 3, Fungida, p. 933–953; pt. 4, Turbinolidae, p. 953–957, fig. 143, pls. 89–93, Cambridge University Press.

——— 1909, The madreporarian corals, pt. 1, Family Fungidae, with a revision of its genera and species and an account of their geographical distribution: Linnean Soc. London Trans., 2d ser., Zool., v. 12, p. 257–290, pls. 33–39.

Gardiner, J. S. and Waugh, Peggy, 1938, The flabellid and turbinolid corals: John Murray Exped. 1933–34, British Mus. (Nat. History), Sci. Repts., v. 5, no. 7, 167–202, 6 figs., pls. 1–7.

——— 1939, Madreporaria excluding Flabellidae and Turbinolidae: idem, v. 6, no. 5, p. 225–242, pls. 1, 2, 3 figs.

Hedley, C., and Taylor, T. G., 1908, Coral reefs of the Great Barrier, Queensland—A study of their structure, life-distribution and relation to mainland physiography: Australasian Assoc. Adv. Sci. Rept., v. 11, p. 397–413, 6 figs., 3 pls.

Hickson, S. J., 1924, An introduction to the study of recent corals: Manchester Univ. Pub., Biol. Ser., no. 4, 257 p., 110 figs.

Hoffmeister, J. E., 1925, Some corals from American Samoa and the Fiji Islands: Carnegie Inst. Wash. Pub. 343, 89 p., 23 pls.

——— 1929, Some reef corals from Tahiti: Wash. Acad. Sci. Jour., v. 19, p. 357–365, pls. 1, 2.

——— 1933, Report on some deep sea corals, obtained by F. I. S. *Endeavour* on the coasts of New South Wales, Victoria, South Australia, and Tasmania: Australia Dept. Trade and Customs: Fisheries, Biol. Results of * * * F. I. S. *Endeavour* 1909–14, v. 6, pt. 1, p. 1–16, pls. 1–4.

Klunzinger, C. B., 1877–79, Die Korallthiere des rothen Meeres, Berlin, pt. 1, Die Alcyonarien und Malacodermen, 98 p., 8 pls. [1877]; pt. 2, Die Madreporaceen und Oculinaceen, 88 p., 10 pls. [1879]; pt. 3, Die Astraeaceen und Fungiaceen, 100 p., 10 pls. [1879].

Manton, S. M., 1935, Ecological surveys of coral reefs: Great Barrier Reef Exped. 1928–29, British Mus. (Nat. History), Sci. Repts., v. 3, no. 10, p. 273–312, 2 figs., 16 pls.

Marenzeller, E. von, 1907, Tiefsee-Korallen [*Pola* Exped.]: Akad. Wiss. Wien, Math.-naturwiss. Kl. Denkschr., Band 80, p. 12–26, 2 pls.

Matthai, G., 1914, A revision of the recent colonial Astraeidae possessing distinct corallites: Linnean Soc. London Trans., 2d ser., Zool., v. 17, p. 1–140, pls. 1–38.

——— 1928, A monograph of the recent meandroid Astraeidae: British Mus. (Nat. History) Cat. Madreporarian Corals, v. 7, 288 p., 72 pls.

Mayor, A. G. [see also Mayer, A. G.], 1918, Ecology of the Murray Island coral reef: Carnegie Inst. Wash. Pub. 213, p. 1–48, 9 figs., pls. 1–9.

——— 1924, Structure and ecology of Samoan reefs: Carnegie Inst. Wash. Pub. 340, p. 1–25, 4 figs., 8 pls.

Rehberg, H., 1892, Neue und wenig bekannte Korallen: Naturwiss. Ver. Hamburg Abh., Band 12, p. 1–50, pls. 1–4.

Robinson, M. K., 1952, Sea temperatures in the Marshall Islands area: Calif. Univ. Scripps Inst. Oceanography, Oceanographical Rept. 29, 16 p., 42 figs.

Saville-Kent, W., 1891, Notes on new or little-known Australian Madreporaceae: Australian Mus. Rec., v. 1, p. 123–124, 3 pls.

——— 1893, The Great Barrier Reef of Australia; its products and its potentialities, 387 p., 48 pls., 16 color pls., London.

Stephenson, T. A., Stephenson, A., Tandy, G., and Spender, M., 1931, The structure and ecology of Low Isles and other reefs: Great Barrier Reef Exped. 1928–29, British Mus. (Nat. History) Sci. Repts., v. 3, p. 17–112, 15 figs., 27 pls.

Studer, T., 1878, Uebersicht der Steinkorallen a. d. Familie der Madreporaria Aporosa, Eupsammia u. Turbinaria, welche a. d. Reise S. M. S. *Gazelle* um die Erde gesammelt wurden: K. preuss. Akad. Wiss. Monatsber. 1877, p. 625–655, pls. 1–4.

Stumm, E. C., 1948, The priority of Dana, 1846–48, versus Hall 1847, and of Rominger 1876, versus Hall, 1876 [1877?]: Mich. Univ. Mus. Paleontology Contr., v. 7, no. 1, 6 p.

Tracey, J. I., Ladd, H. S., and Hoffmeister, J. E., 1948, Reefs of Bikini, Marshall Islands: Geol. Soc. America Bull., v. 59, p. 868–878, 8 figs., 11 pls.

Umbgrove, J. H. F., 1928, de Koraalriffen in de Baai van Batavia: Dienst Mijnbouw Nederlandsche-Indie Wetensch. Meded., no. 7, p. 1–62, pls. 1–33.

——— 1939, Madreporaria from the Bay of Batavia: Rijksmuseum Natuurlijke Historie Leiden Zool. Meded., deel 22, p. 1–64, pls. 1–18, 1 map.

293438—54——7

——— 1940, Madreporaria from the Togian reefs (Gulf of Tomini, North Celebes): Rijksmuseum Natuurlijke Historie Leiden Zool. Meded., deel 22, p. 265–310, 3 figs., pls. 21–35.

Umbgrove, J. H. F.,1947, Coral reefs of the East Indies: Geol. Soc. America Bull., v. 58, p. 729–778, 24 figs., 1 map, 7 pls.

Van der Horst, C. J., 1922, Madreporaria of the *Siboga* Expedition, pt. 3, Eupsammidae: *Siboga*-Expeditie Repts., Mon. 16c, p. 99–127, pls. 7-8.

Vaughan, T. W., 1907, Recent Madreporaria of the Hawaiian Islands and Laysan: U. S. Natl. Mus. Bull., v. 59, 427 p., 1 fig., 96 pls.

——— 1918, Some shoal-water corals from Murray Island, Cocos-Keeling Islands, and Fanning Island: Carnegie Inst. Wash. Pub. 213, p. 51–234, pls. 20–93.

——— 1919, Corals and the formation of coral reefs: Smithsonian Inst. Ann. Rept. 1917, p. 189–238, 16 figs., 38 pls.

Vaughan, T. W., and Wells, J. W., 1943, Revision of the suborders, families, and genera of the Scleractinia: Geol. Soc. America Special Paper 44, 363 p., 39 figs., 3 tables, 51 pls.

Verrill, A. E., 1864, List of the polyps and corals sent by the Museum of Comparative Zoology to other institutions in exchange, with annotations: Harvard Coll. Mus. Comp. Zool. Bull. 3, p. 29–60.

——— 1866–67, Synopsis of the polyps and corals of the North Pacific Exploring Expedition * * * with descriptions of some additional species from the west coast of North America. Pt. 3, Madreporaria: Essex Inst. Commun., v. 5, p. 17–32, pls. 1, 2 (1866); p. 33–50 (1867).

Verrill, A. E. 1902, Notes on corals of the genus *Acropora* (*Madrepora* Lam.), with new descriptions and figures of types, and of several new species: Conn. Acad. Arts and Sci. Trans., v. 11, p. 207–266, pls. 36–36F.

Wells, J. W., 1936, The nomenclature and type species of some genera of recent and fossil corals: Am. Jour. Sci., 5th ser., v. 31, p. 97–134.

——— 1952, The coral reefs of Arno Atoll, Marshall Islands: Nat. Res. Council, Pacific Sci. Board, Atoll Research Bull., no. 9, 14 p., 16 figs.

Yabe, H., and Eguchi, M., 1932, *Rhizopsammia minuta* van der Horst var. *mutsuensis* nov., a eupsammid coral: Tōhoku Imp. Univ. Sci. Repts., 4th ser., v. 7, p. 206–209, pl. 9.

——— 1942, Fossil and Recent simple corals from Japan: Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 22, p. 105–170, pls. 9–12.

Yabe, H., and Sugiyama, T., 1933, Notes on three new corals from Japan: Japanese Jour. Geology and Geography, v. 11, p. 11–18, pls. 2–4.

——— 1941, Recent reef-building corals from Japan and the South Sea islands under the Japanese mandate, pt. 2: Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 2, p. 67–91, pls. 59–104.

Yabe, H., Sugiyama, T., and Eguchi, M., 1936, Recent reef-building corals from Japan and the South Sea islands under the Japanese mandate: Tōhoku Imp. Univ. Sci. Repts., 2d ser., special v. 1, 66 p., 59 pls.

INDEX

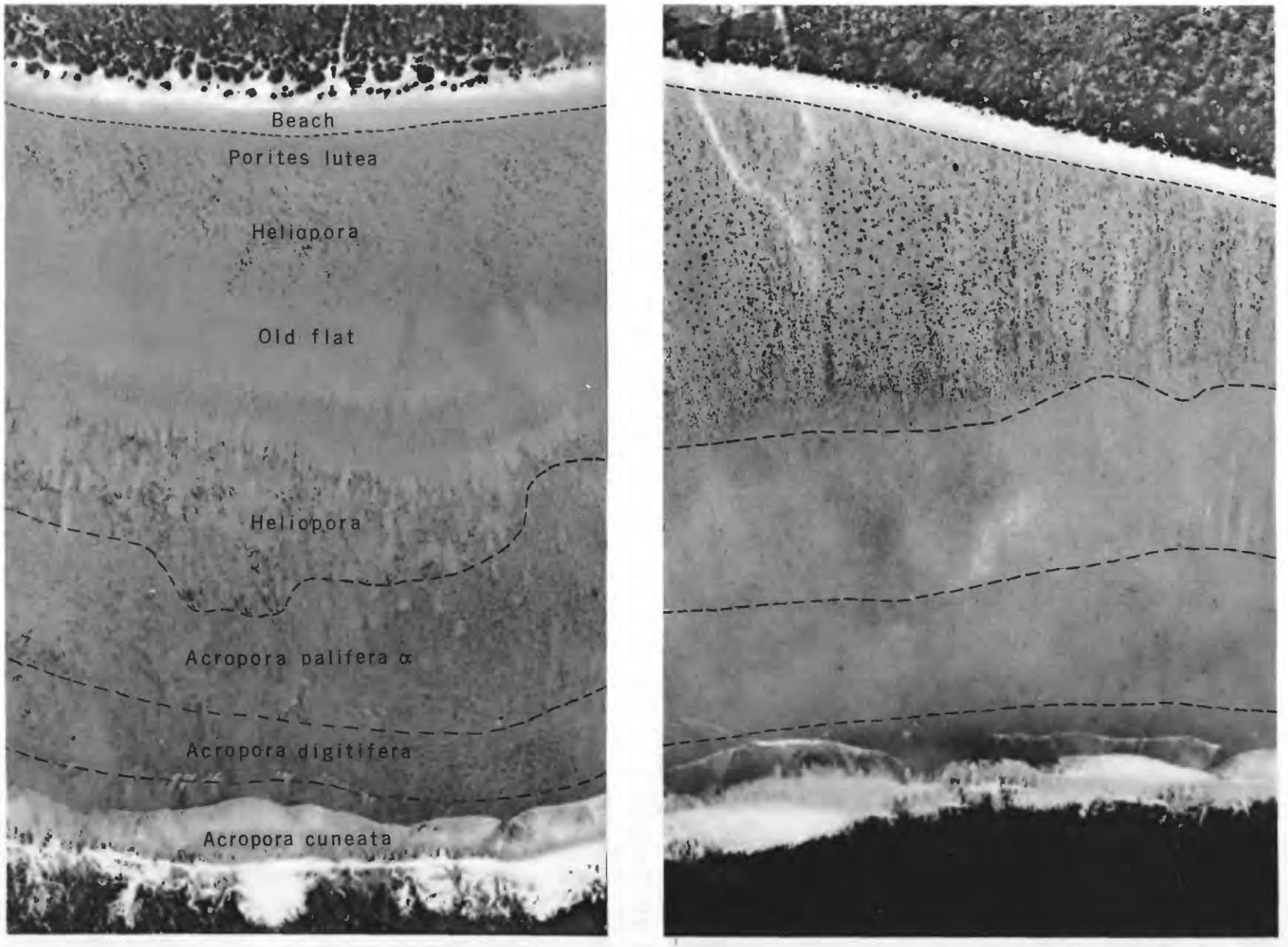
[Italic numbers indicate descriptions]

U. S GOVERNMENT PRINTING OFFICE: 1954

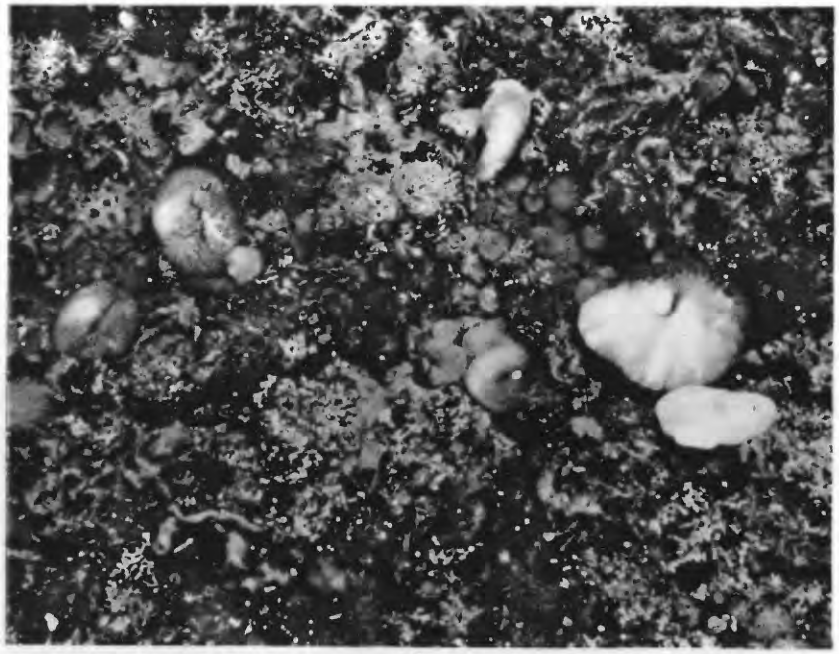
PLATES 94–185

PLATE 94

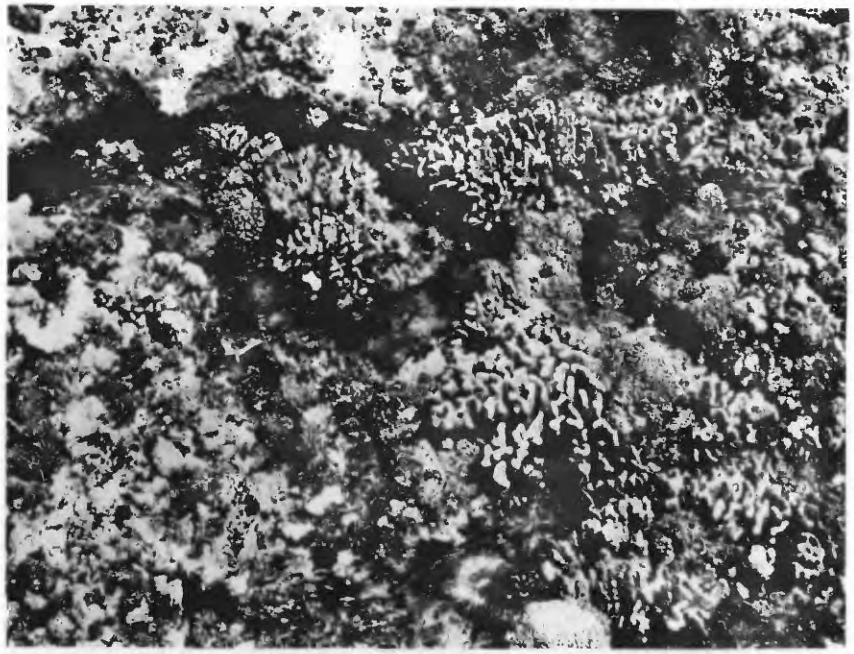
The two sections of the windward reef at Bikini Atoll shown by the photographs lie off the north and northeast sides of Bikini island and are about 3,000 feet apart. The width of the reef flat is about 2,500 feet in the lower section (1 cm=55 m). Coral zones are marked for comparison with plate 187.



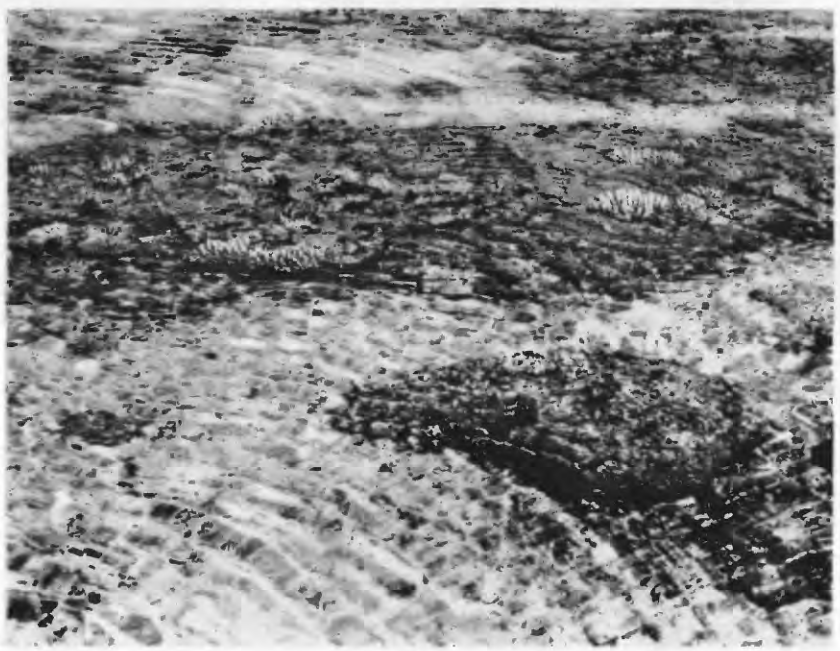
AIR VIEWS: WINDWARD REEF, BIKINI ISLAND



1



2



3

4

REEF CORAL HABITS: BIKINI ISLAND

PLATE 95

FIGURE 1. *Fungia scutaria* (p. 447).
A "family," ranging from attached anthocauli to large adult coralla, exposed at low tide on top of huge *Heliopora* microatoll, west end of Namu island, loc. 7a. All with yellow-green peristomes; diameter of largest *Fungia:* about 10 cm.

2. *Pocillopora elegans* (p. 413).
Low tide in surge channel, windward reef margin, Bikini island, loc. 10b; width covered by photograph: about 2.5 m.

3. *Acropora digitifera* zone (p. 427).
Reef flat, windward reef, Bikini island, showing mixed microatolls, loc. 10c; width covered by photograph: about 6 m.

4. *Acropora* (p. 414).
Rich development of *Acropora* on seaward margin of lagoon reef with algal ridge, lagoon side of Namu island, loc. 7b; colonies average 30–50 cm.

293438—54——A

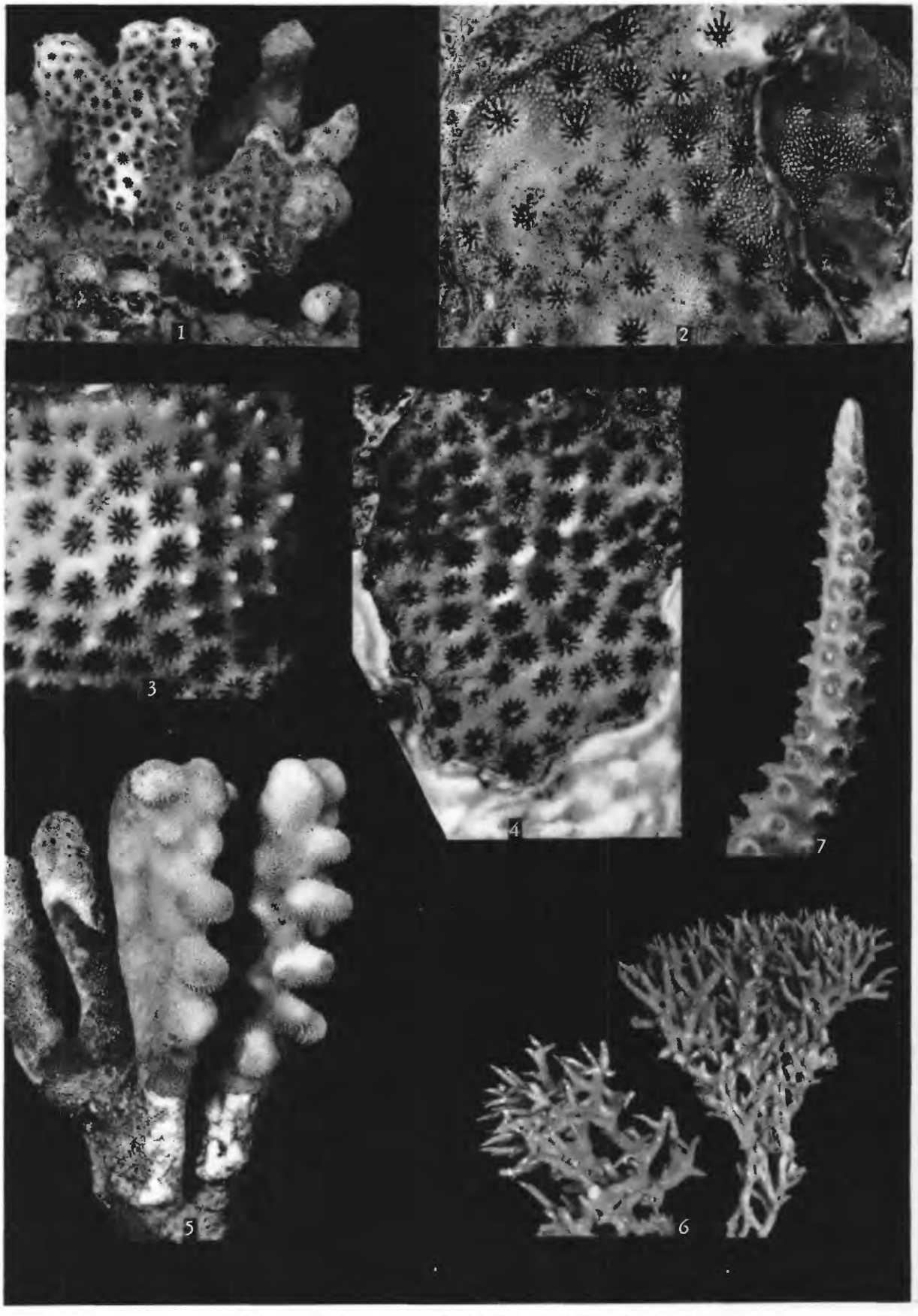
PLATE 96

FIGURES 1–4. *Stylocoeniella armata* (Ehrenberg) (p. 409).

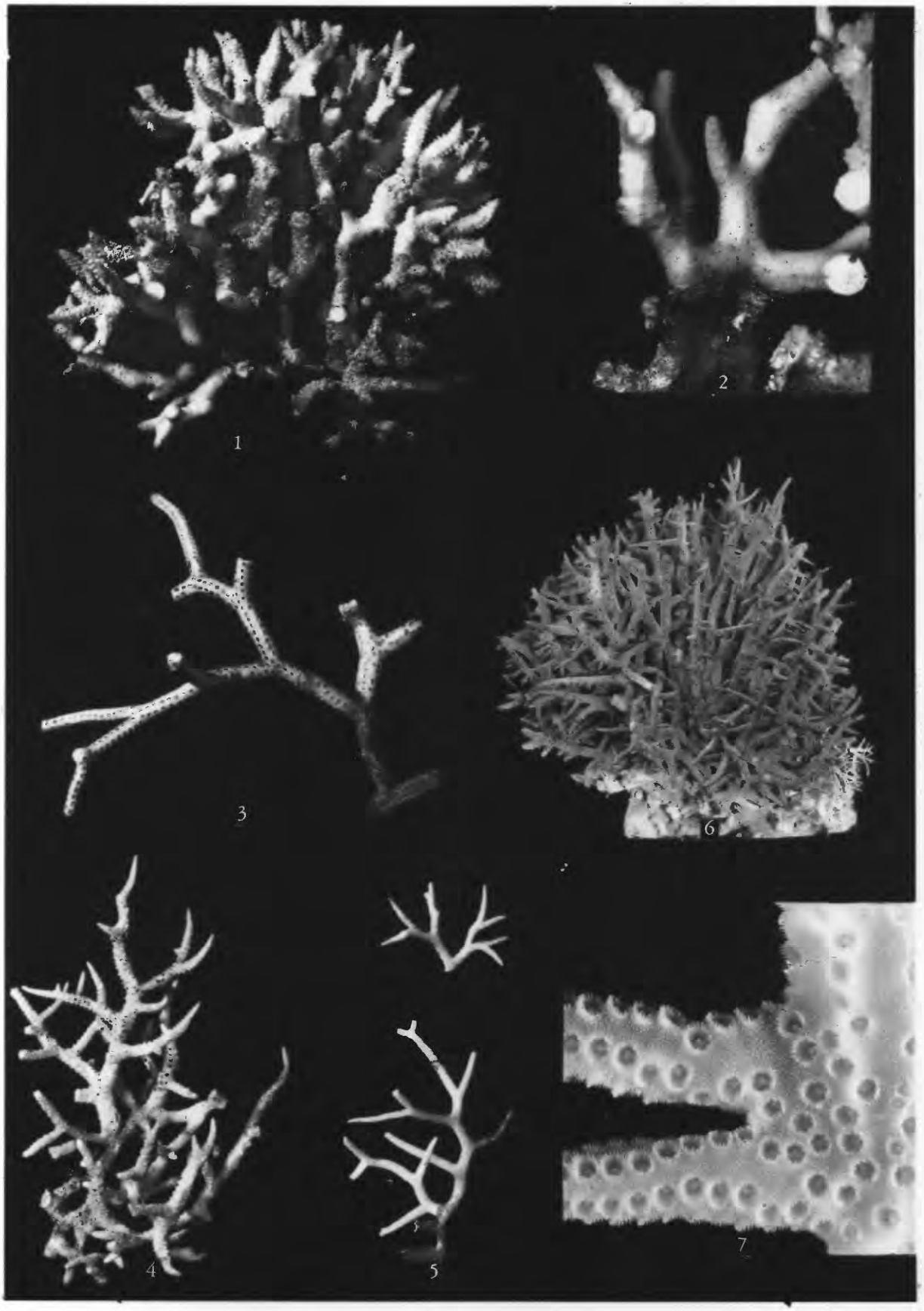
1. × 2. Lagoon, Bikini Atoll, 14 fms, loc. 36. USNM 44314.
2. × 5.4. Lagoon, Bikini Atoll, 22 fms, loc. 31. USNM 44705.
3. × 5.4. Reef channel, east side of Bokororyuru island, Bikini Atoll, loc. 5b. USNM 44309.
4. × 5.4. Lagoon reef, Bikini island, loc. 10f. USNM 44311.

5. *Stylophora mordax* (Dana) (p. 411).
× 0.6. Enyu Channel, Bikini Atoll, 8 fms, loc. 47. USNM 44337.

6, 7. *Seriatopora hystrix* Dana (p. 411).
× 0.54, × 5.4. Jaluit Atoll. Imp. Coll. 33.



STYLOCOENIELLA, STYLOPHORA, AND *SERIATOPORA*



SERIATOPORA

PLATE 97

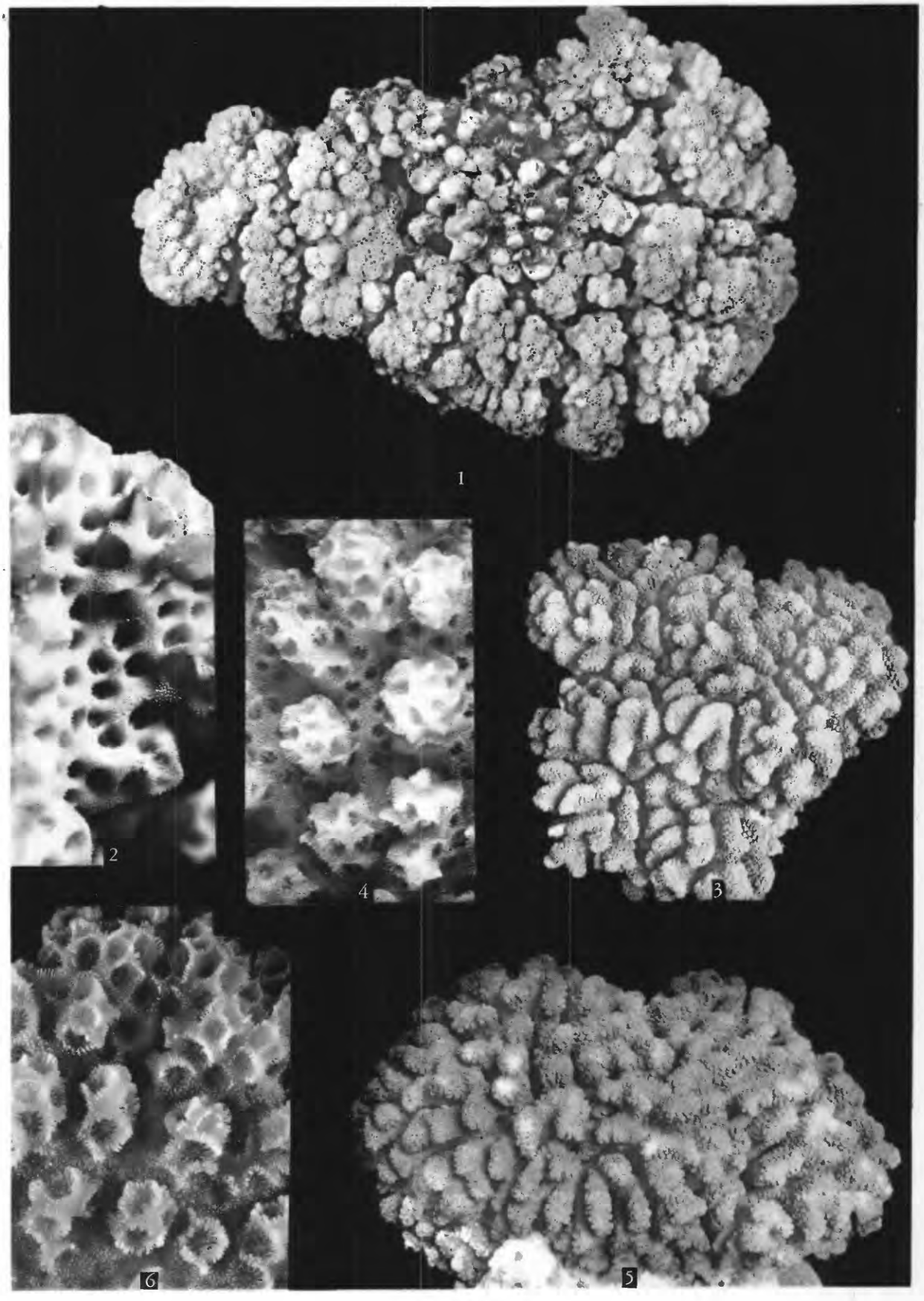
FIGURES 1, 2. *Seriatopora hystrix* Dana (p. 411).
× 0.9, × 2. Lagoon, Bikini Atoll, 10 fms, loc. 44. USNM 44341.

3–7. *Seriatopora angulata* Klunzinger (p. 412).
3. × 0.9. Lagoon, Bikini Atoll, 25 fms, loc. 66. USNM 44350.
4. × 0.9. Lagoon, Eniwetok Atoll, 25 fms, loc. 89. USNM 44351.
5. × 0.9. Lagoon, Bikini Atoll, 28 fms, loc. 32. USNM 44344.
6, 7. × 0.36, × 0.54. Jaluit Atoll. Imp. Coll. 13.

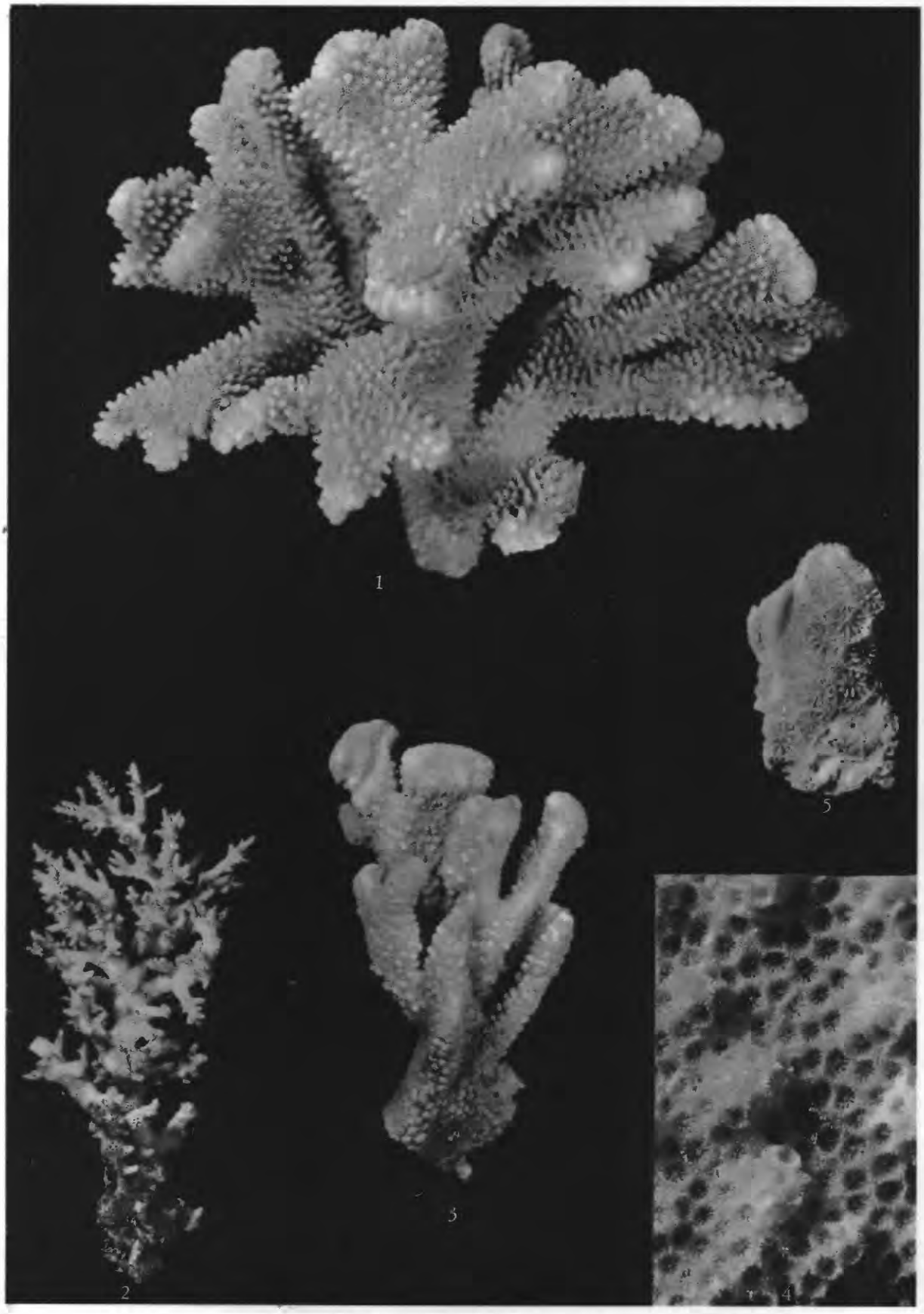
293438—54——B

PLATE 98

FIGURES 1, 2. *Pocillopora brevicornis* Lamarck (p. 413).
× 0.9, × 5.4. South side Ourukaen island, Bikini Atoll, loc. 4. USNM 44393.
3, 4. *Pocillopora eydouxi* Milne-Edwards and Haime (p. 414).
× 0.23, × 3.6. Jaluit Atoll. Imp. Coll. 1.
5, 6. *Pocillopora verrucosa* Eguchi and Sugiyama (p. 413).
× 0.32, × 5.4. Jaluit Atoll. Imp. Coll. 41.



POCILLOPORA



POCILLOPORA AND *MADRACIS*

PLATE 99

FIGURE 1. *Pocillopora eydouxi* Milne-Edwards and Haime (p. 414).
× 0.45. Coral knoll, Bikini Lagoon, 6 fms, loc. 49. USNM 44405.

2. *Pocillopora damicornis caespitosa* Dana (p. 412).
× 0.45. Seaward slope, Bikini Atoll, 33–48 fms, loc. 107. USNM 44361.

3, 4. *Pocillopora ligulata* Dana (p. 413).
× 0.5, × 9. Surge channel, windward reef, Bikini island, loc. 10d. USNM 44400.

5. *Madracis* sp. (p. 414).
× 3.6. Seaward slope, Bikini Atoll, 25–44 fms, loc. 110. USNM 44407.

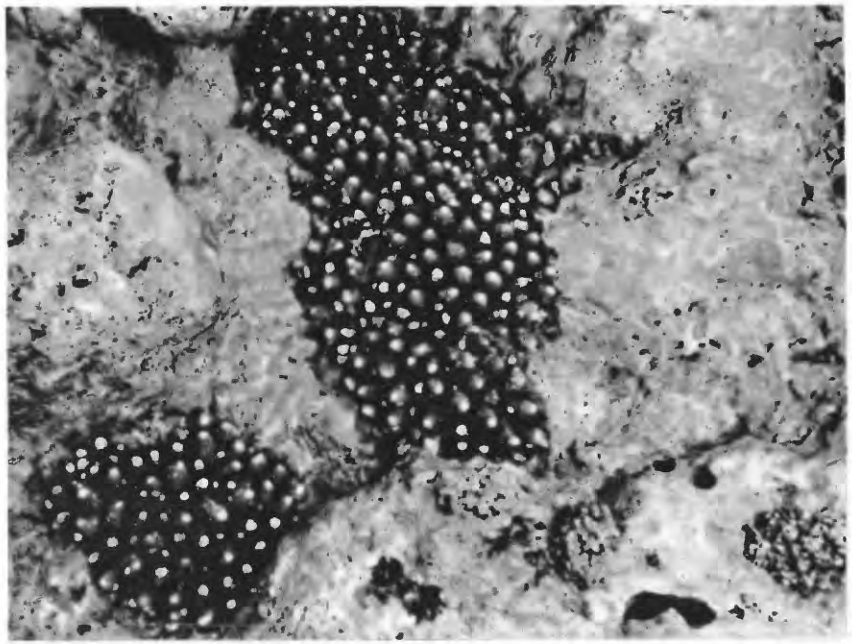
PLATE 100

FIGURE 1. *Acropora humilis* forma β (p. 425).
On algal ridge, windward reef north of Bikini island, loc. 10a. Color of colonies: a brilliant eosin green; width of larger colony about 20 cm.

2. *Acropora acuminata* (p. 415).
On top of huge *Heliopora* microatoll, inner reef, west end of Namu island, loc. 7a. Color of colonies: a pale creamy yellow-brown. *Hippopus* at right. Lateral scope of photograph about 2 m.

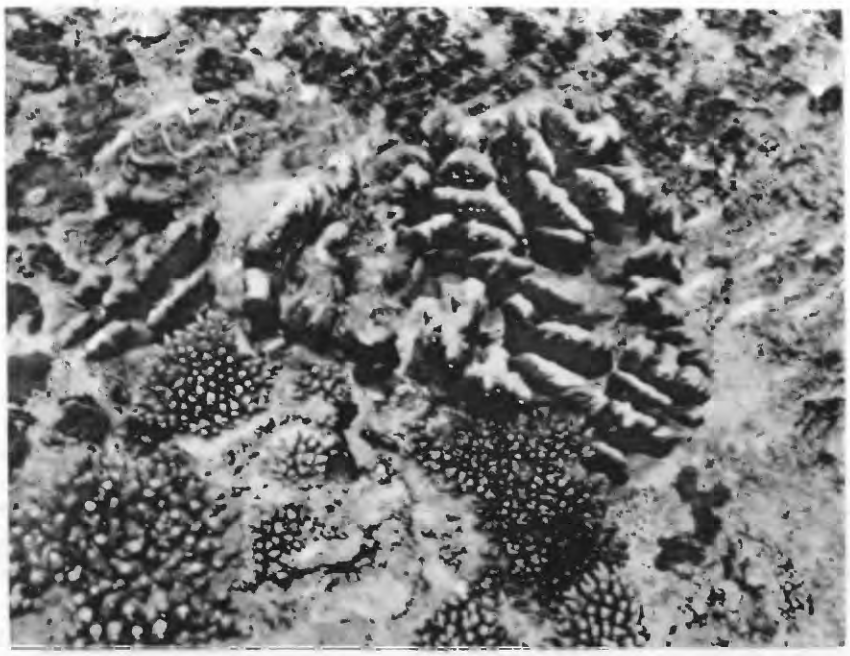
3. *Acropora cuneata* (p. 429).
On rocky flat just behind algal ridge, windward reef, Bikini island, loc. 10b. Color of colony: brown, white over tops of ridges; diameter about 30 cm. Note small colonies of *A. corymbosa* and *A. digitifera*.

4. *Acropora palmerae* (p. 419).
On algal ridge, windward reef north of Bikini island, loc. 10a. This yellow-brown colony with greenish tints covers about 80 square feet from the center to the left center margin.



1

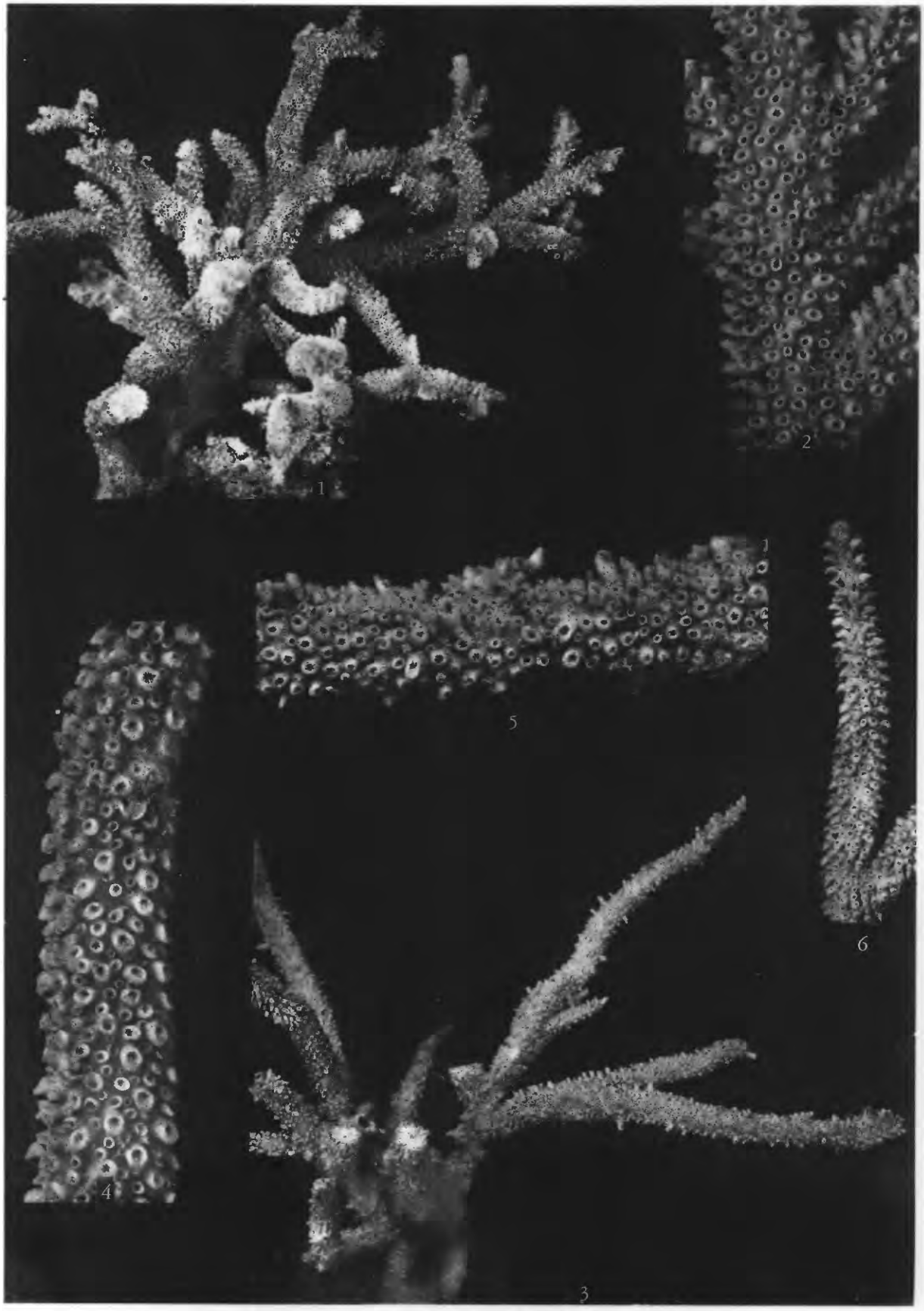
2



3

4

ACROPORA: HABITS ON BIKINI ATOLL REEFS



ACROPORA

PLATE 101

FIGURES 1–6. *Acropora acuminata* Verrill (p. 415).

1, 2. × 0.45, × 2. Lagoon reef, Namu island, Bikini Atoll, loc. 7b. USNM 44412.
3, 5. × 0.54, × 2. Enirik island, Bikini Atoll, loc. 1. USNM 44408.
4. × 2. Lagoon reef, Namu island, Bikini Atoll, loc. 7b. USNM 44413.
6. × 0.9. Lagoon reef, Namu island, Bikini Atoll, loc. 7b. USNM 44412.

293438—54——G

PLATE 102

FIGURES 1–9. *Acropora formosa* (Dana) (p. 415).

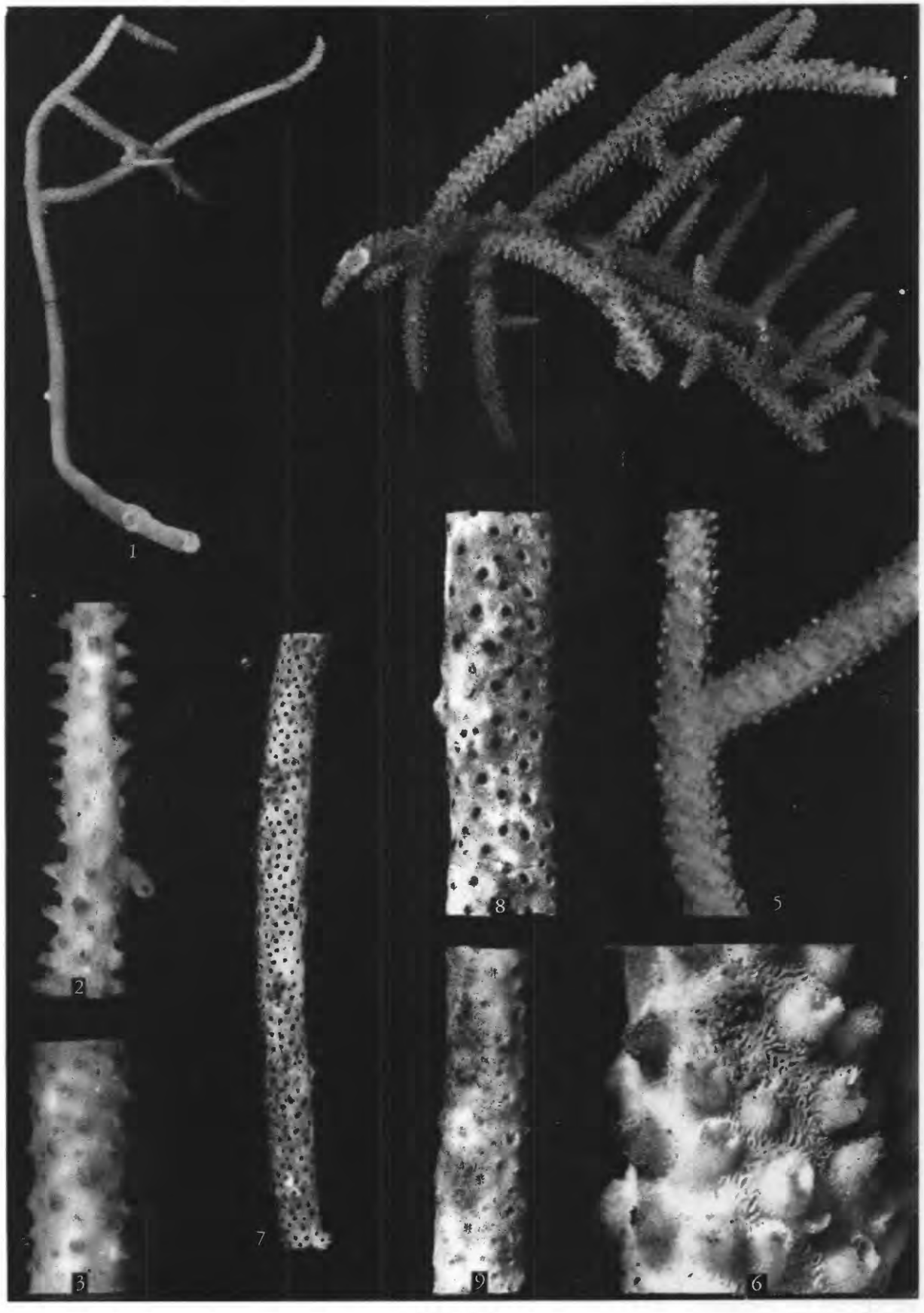
1–3. Forma $\alpha \rightarrow \beta$, $\times$ 0.3, $\times$ 2, $\times$ 2. Lagoon, Rongelap Atoll, 12 fms. USNM.

4. Forma α, $\times$ 0.6. Lagoon, Eniwetok Atoll, 7.5 fms, loc. 87. USNM 44441.

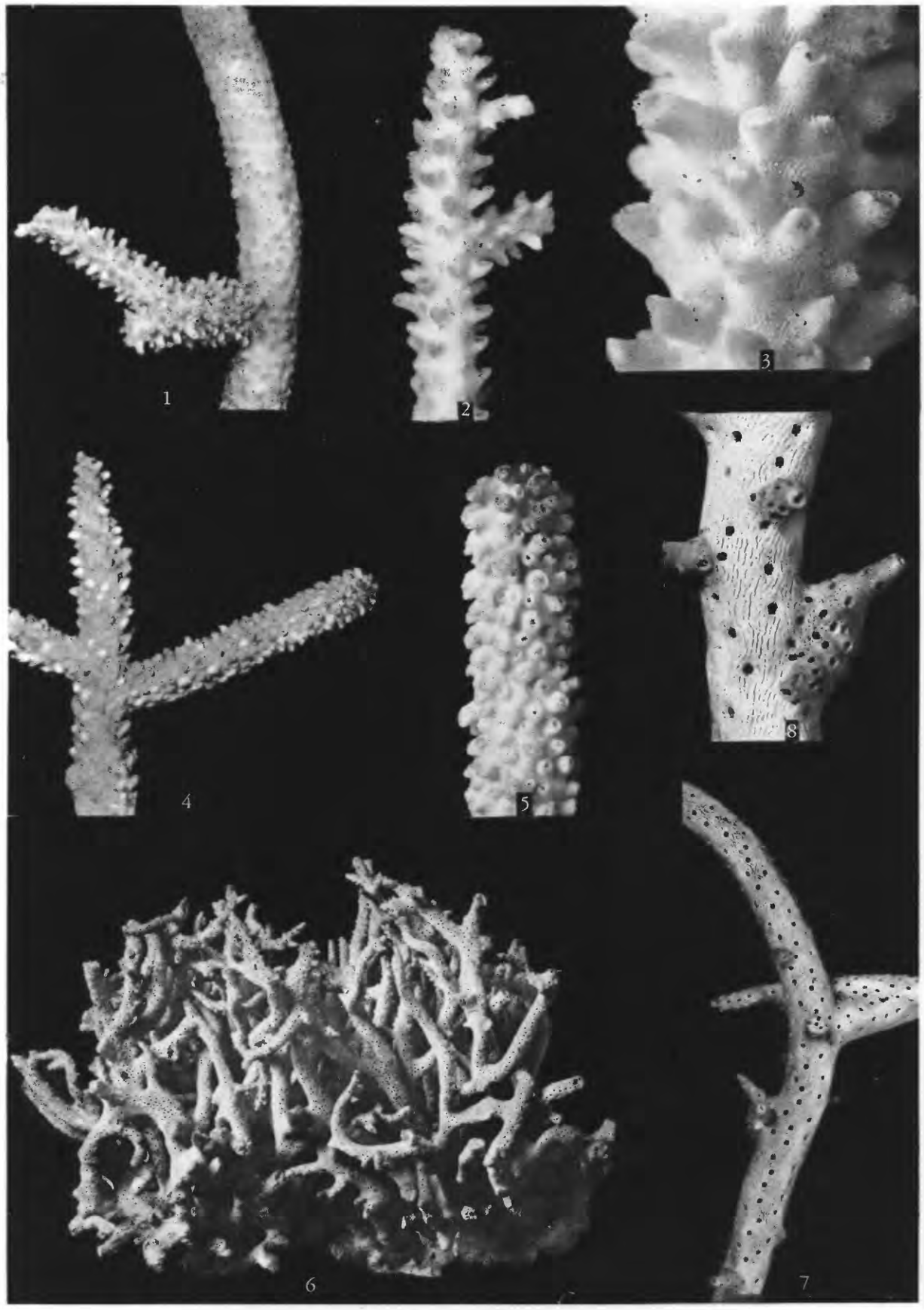
5, 6. Forma α, $\times$ 0.9, $\times$ 5.4. Lagoon, Bikini Atoll, 30 fms, loc. 43. USNM 44426.

7, 8. Forma β, $\times$ 0.9, $\times$ 2. Lagoon, Bikini Atoll, 18 fms, loc. 35. USNM 44420.

9. Forma β, $\times$ 2. Lagoon, Bikini Atoll, 18 fms, loc. 35. USNM 44419.



ACROPORA



ACROPORA

PLATE 103

FIGURES 1–5. *Acropora formosa* forma α (p. 415).

1–3. × 0.9, × 2, × 5.4. Lagoon, Bikini Atoll, 14 fms, loc. 36. USNM 44422.

4, 5. × 0.9, × 2. Lagoon, Bikini Atoll, 10 fms, loc. 44. USNM 44427.

6–8. *Acropora implicata* (Dana) (p. 416).

6. × 0.38. Fiji Islands. Holotype, USNM 283.

7, 8. × 0.9, × 2. Lagoon, Bikini Atoll, 4 fms, loc. 62. USNM 44444.

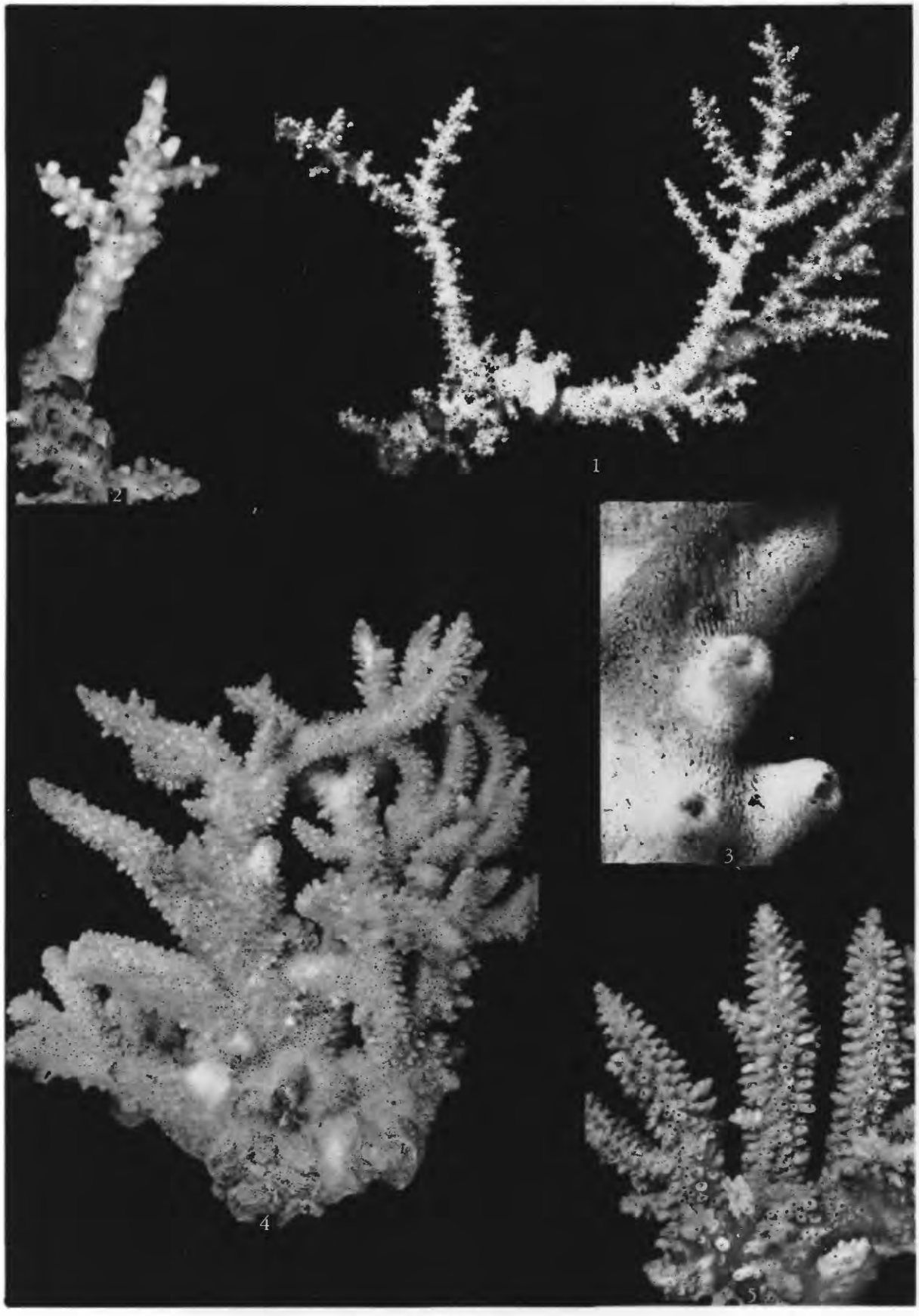
PLATE 104

FIGURES 1, 2. *Acropora nobilis* (Dana) (p. 416).
× 0.45, × 4.5. Lagoon, Bikini Atoll, 7–14 fms, loc. 37a. USNM 44445.

3. *Acropora hebes* (Dana) (p. 423).
× 0.9. Bogen island, Eniwetok Atoll, loc. 15. USNM 44541.

4. *Acropora formosa* forma *α* (p. 415).
× 0.36. Lagoon, Bikini Atoll, 7–14 fms, loc. 37a. USNM 44430.

ACROPORA



ACROPORA

PLATE 105

FIGURE 1. *Acropora vaughani* Wells, n. sp. (p. 416).
× 0.33. Seaward slope, Bikini Atoll, 21–25 fms, loc. 117. USNM 44457.
2–5. *Acropora polymorpha* (Brook)? (p. 416).
2, 3. × 0.9, ×5.4. Lagoon, Bikini Atoll, 22 fms, loc. 31. USNM 44449.
4. × 0.54. Lagoon reef, Namu island, Bikini Atoll, loc. 7b. USNM 44447.
5. × 0.9. Lagoon reef, Namu island, Bikini Atoll, loc. 7b. USNM 45173.

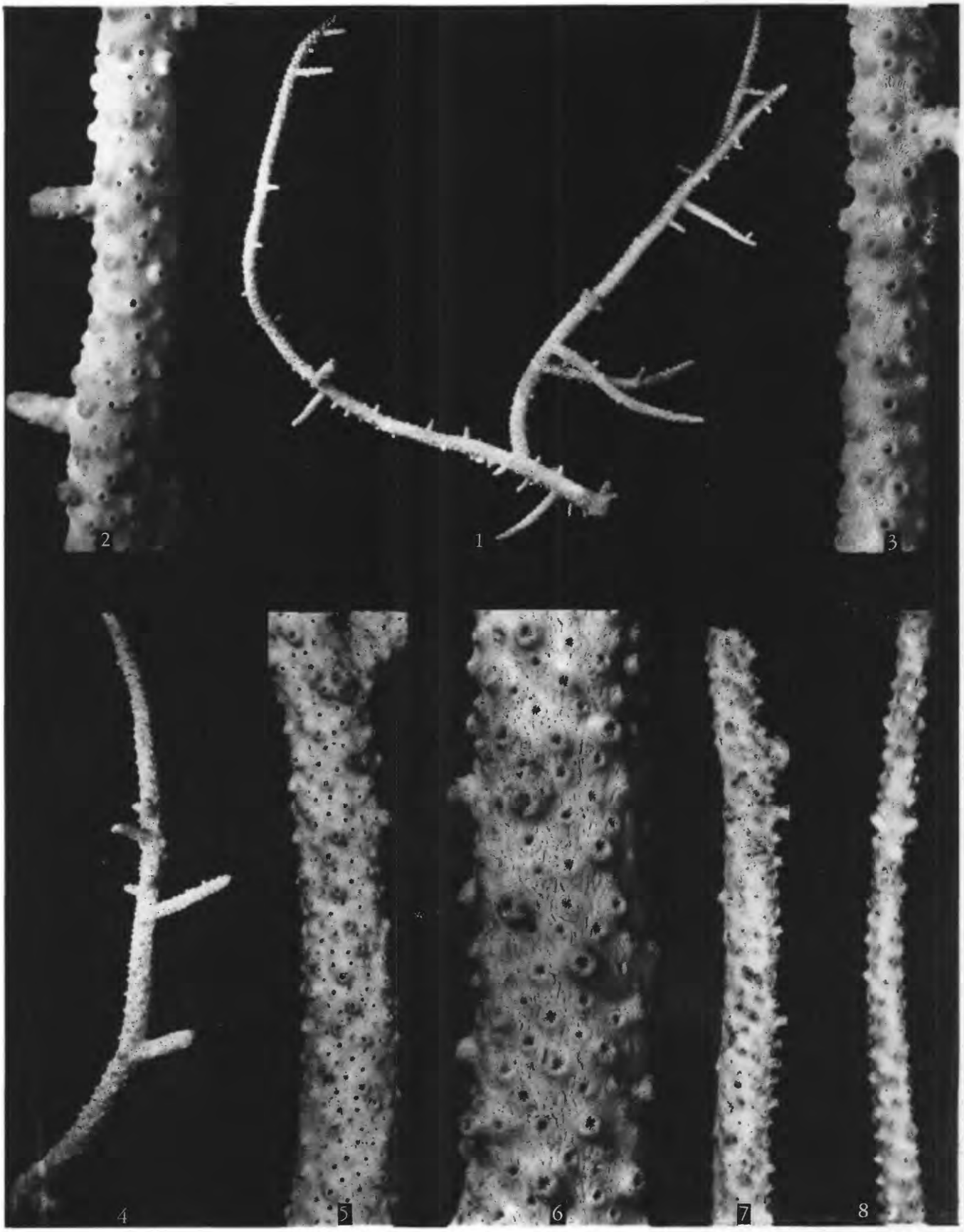
PLATE 106

FIGURES 1–8. *Acropora vaughani* Wells, n. sp. (p. 416).

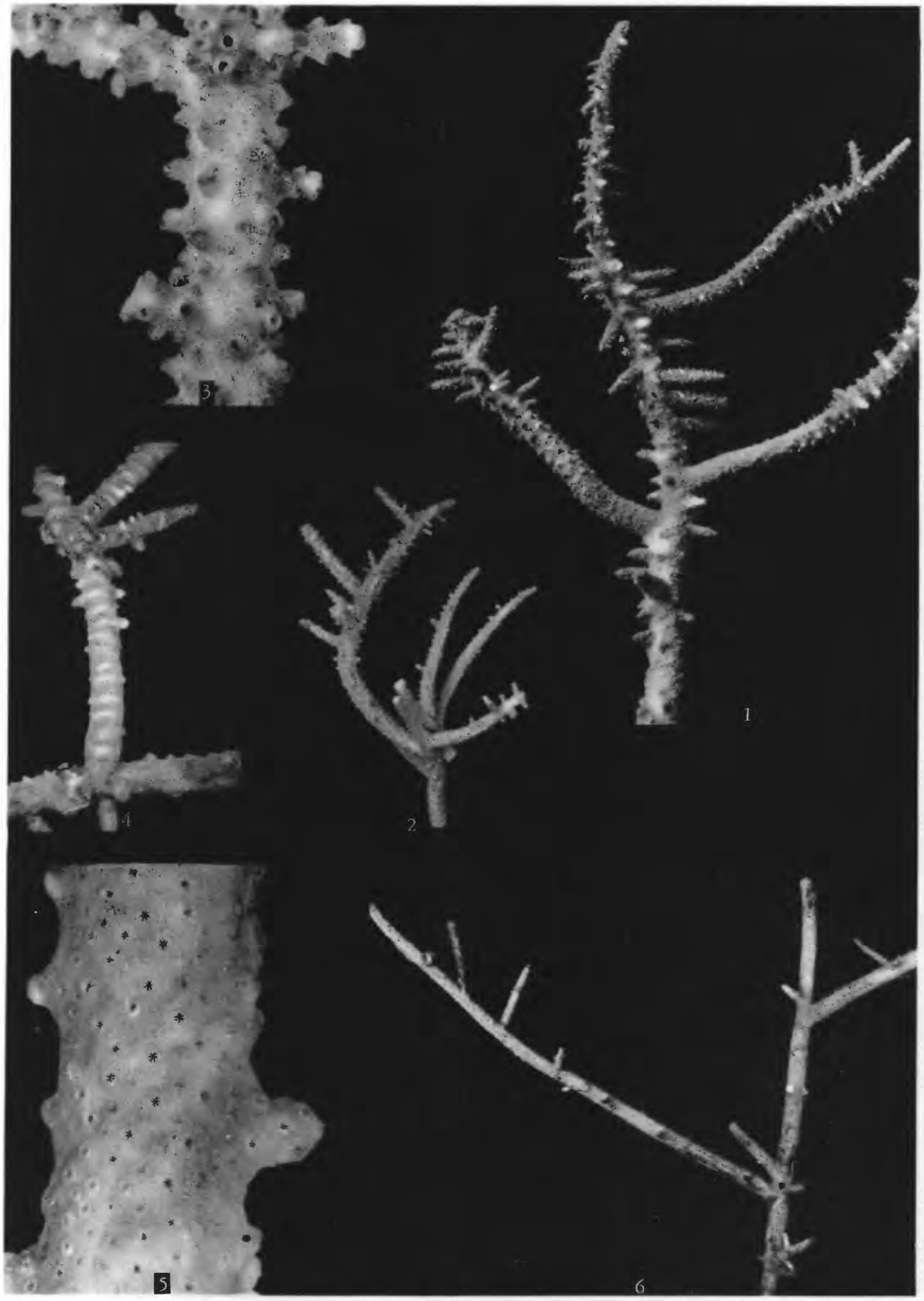
1, 2, 3. × 0.23, × 1.35, × 2. Rongelap Atoll, lagoon, 12 fms. USNM.

4, 5, 6. × 0.23, ×0.9, × 2. Bikini Lagoon, 18 fms, loc. 35. Holotype, USNM 44452.

7, 8. × 0.9, × 0.9. Bikini Lagoon, 18 fms, loc. 35. Paratypes, USNM 44453.



ACROPORA



ACROPORA

PLATE 107

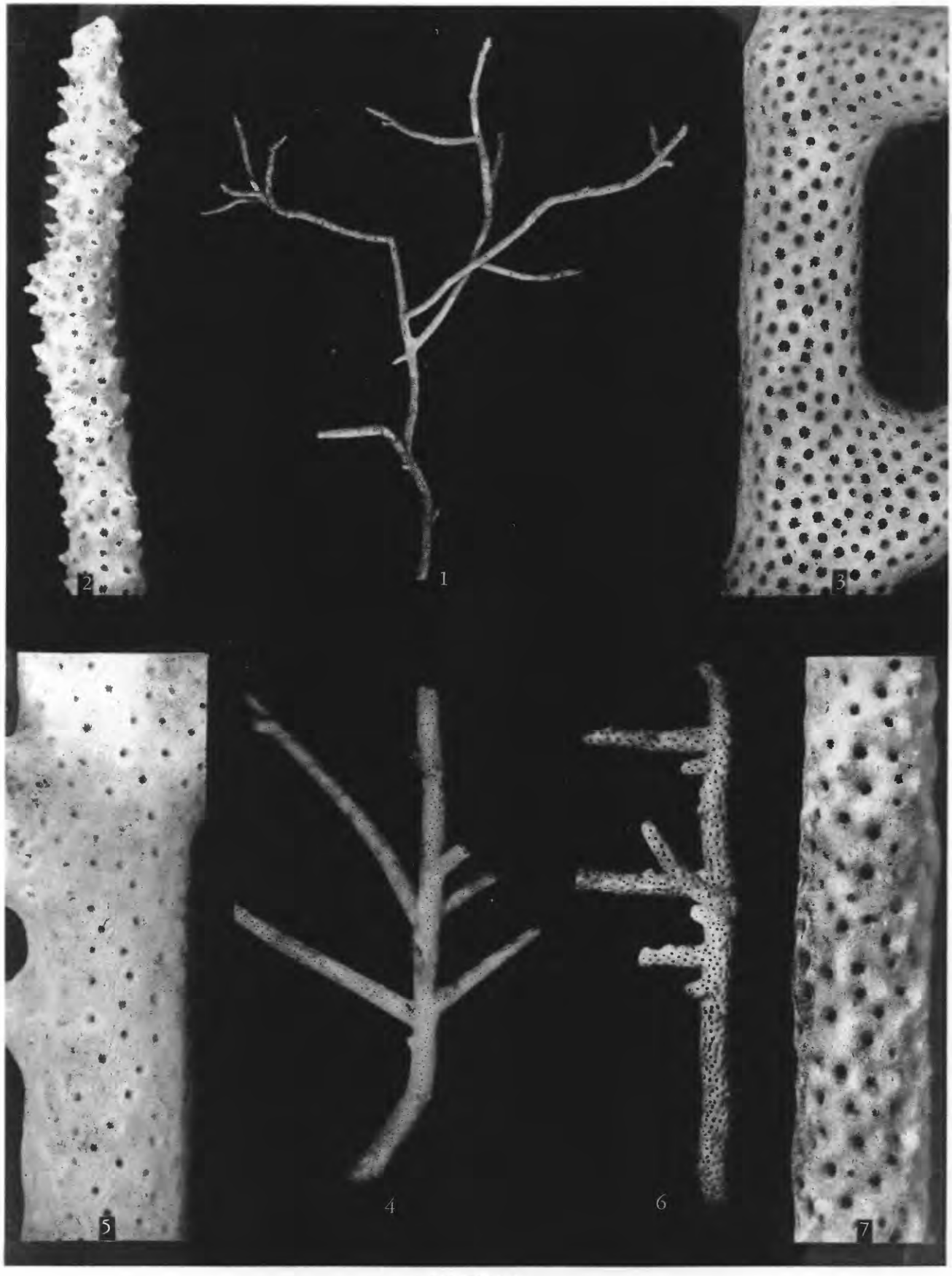
FIGURE 1. *Acropora horrida* (Dana) (p. 417).
× 0.23. Fiji Islands. Holotype, USNM 291.
2–6. *Acropora vaughani* n. sp. (p. 416).
2, 3. × 0.3, × 2. Bikini Lagoon, 4 fms, loc. 62. USNM 44456.
4, 5. × 0.27, × 2. Bikini Lagoon, 12 fms, loc. 34. USNM 44451.
6. × 0.23. Bikini Lagoon, 18 fms, loc. 35. Paratype, USNM 44453.

PLATE 108

FIGURES 1–7. *Acropora virgata* (Dana) (p. 417).

1, 2, 3. × 0.38, × 2, × 2. Bikini Lagoon, 18 fms, loc. 35. USNM 44458.
4. × 0.3. Fiji Islands. Holotype, USNM 290.
5. × 0.23. Bikini Lagoon, 18 fms, loc. 35. USNM 44458.
6, 7. × 0.9, × 2. Bikini Lagoon, 18 fms, loc. 35. USNM 44458.

ACROPORA



ACROPORA

PLATE 109

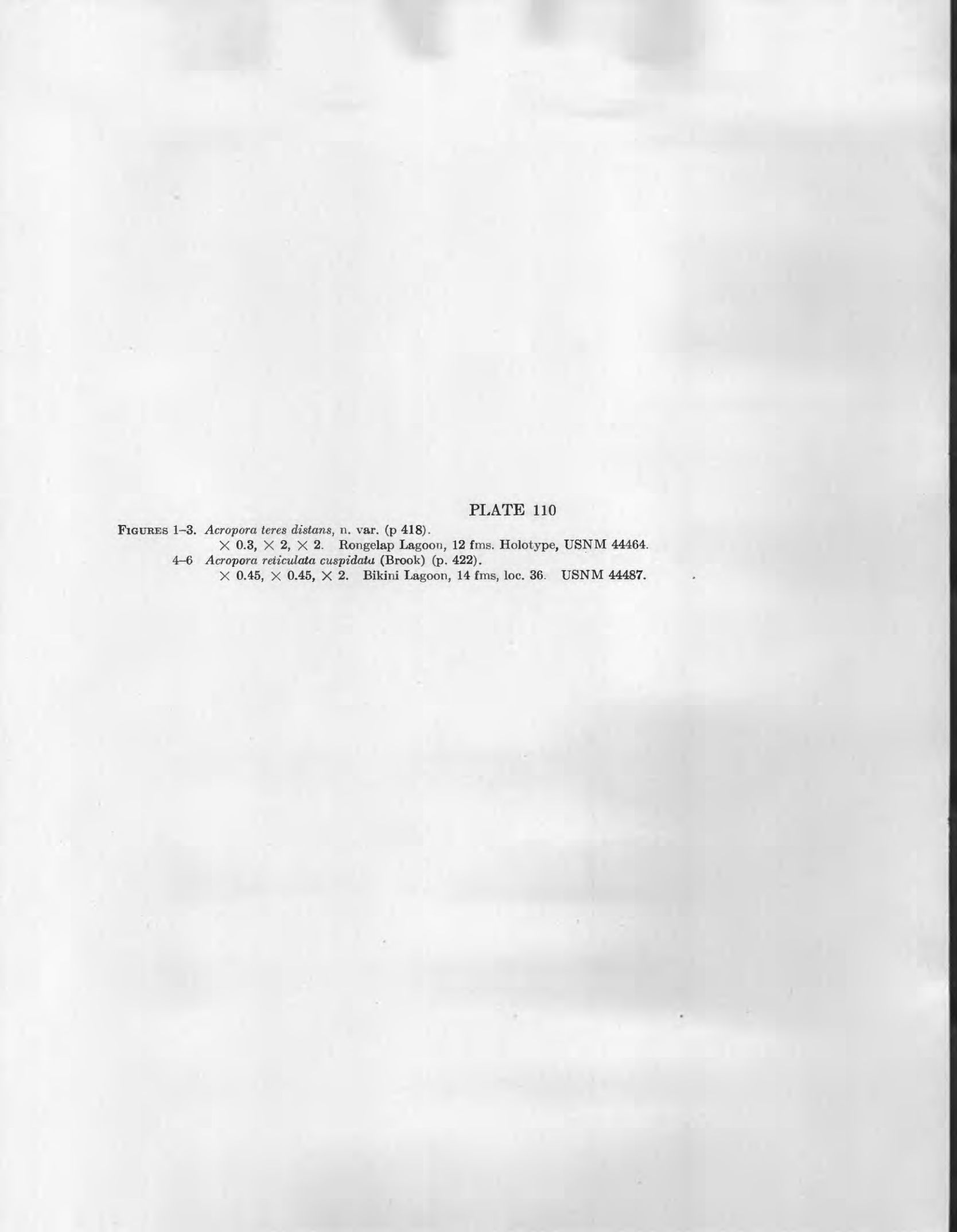
FIGURES 1–7. *Acropora teres* Verrill (p. 417).

1, 2, 3. × 0.14, ×2, ×2. Eniwetok Lagoon, 13 fms, loc. 88. USNM 44463.

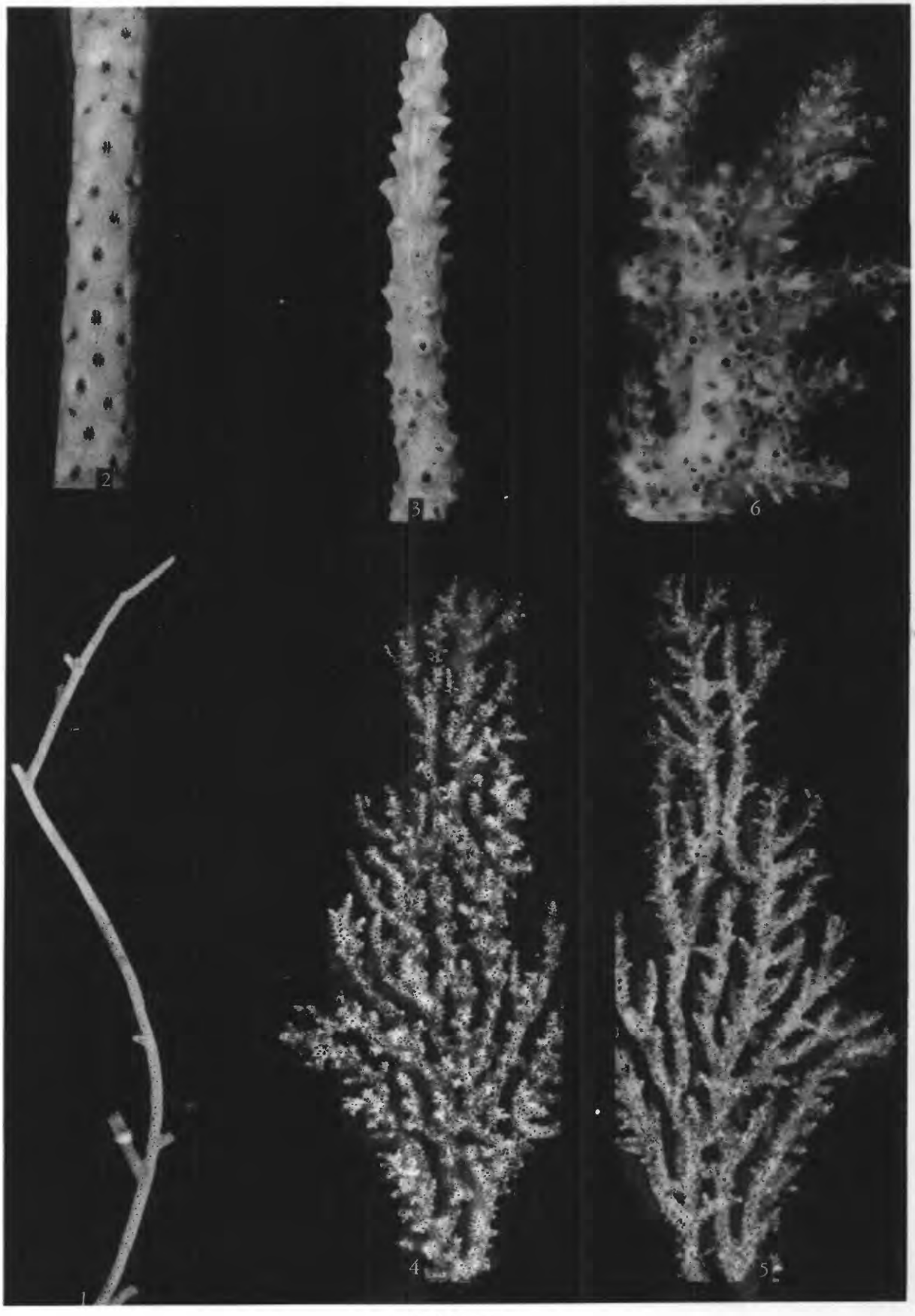
4, 5. × 0.3, × 2. Bikini Lagoon, 18 fms, loc. 35. USNM 44459.

6, 7. × 0.36, × 2. Bikini Lagoon, 16 fms, loc. 59. USNM 44460.

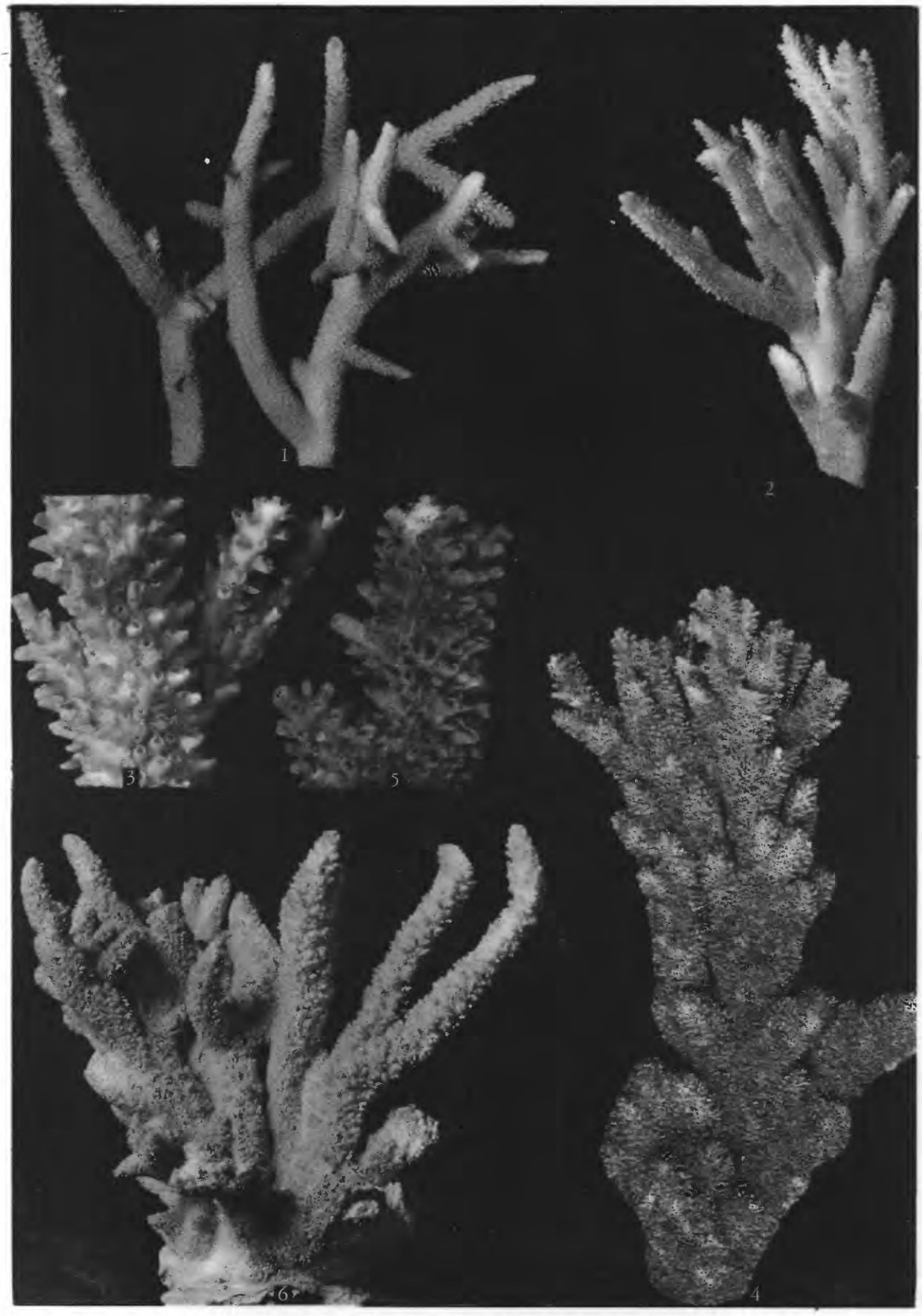
PLATE 110



FIGURES 1–3. *Acropora teres distans*, n. var. (p 418).
× 0.3, × 2, × 2. Rongelap Lagoon, 12 fms. Holotype, USNM 44464.
4–6 *Acropora reticulata cuspidata* (Brook) (p. 422).
× 0.45, × 0.45, × 2. Bikini Lagoon, 14 fms, loc. 36. USNM 44487.



ACROPORA



ACROPORA

PLATE 111

FIGURES 1–3. *Acropora arbuscula* (Dana) (p. 418).

1. × 0.3. Sulu Sea. Holotype, USNM 296.
2, 3. × 0.36, × 2. Bikini Lagoon, 8 fms, loc. 47. USNM 44466.

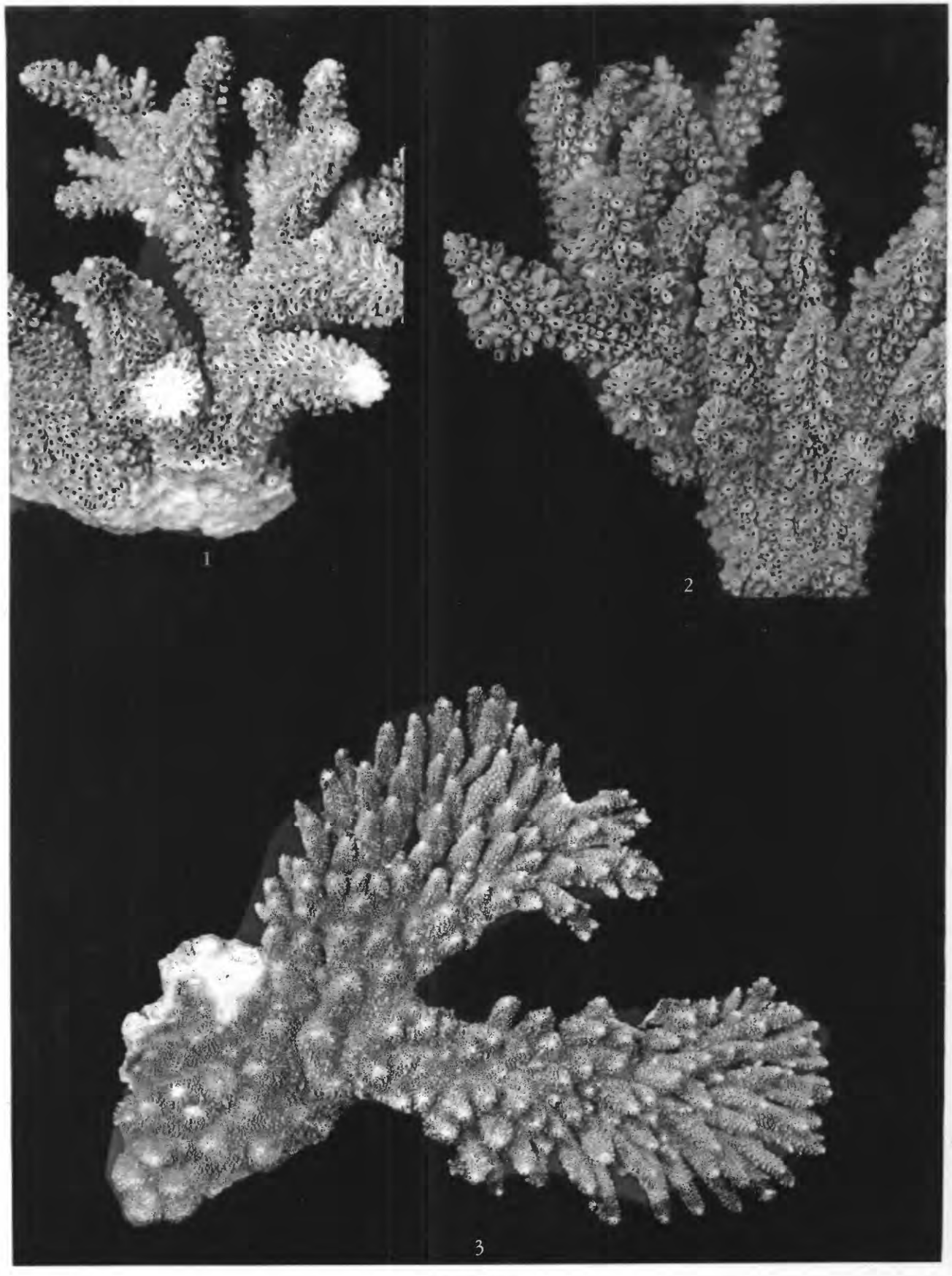
4–6. *Acropora danai* (Milne-Edwards and Haime) (p. 418).

4, 5. × 0.45, × 2. Tufa island, Rongelap Atoll, loc. 21. USNM 45175.
6. × 0.3. Tahiti. Holotype, USNM 303.

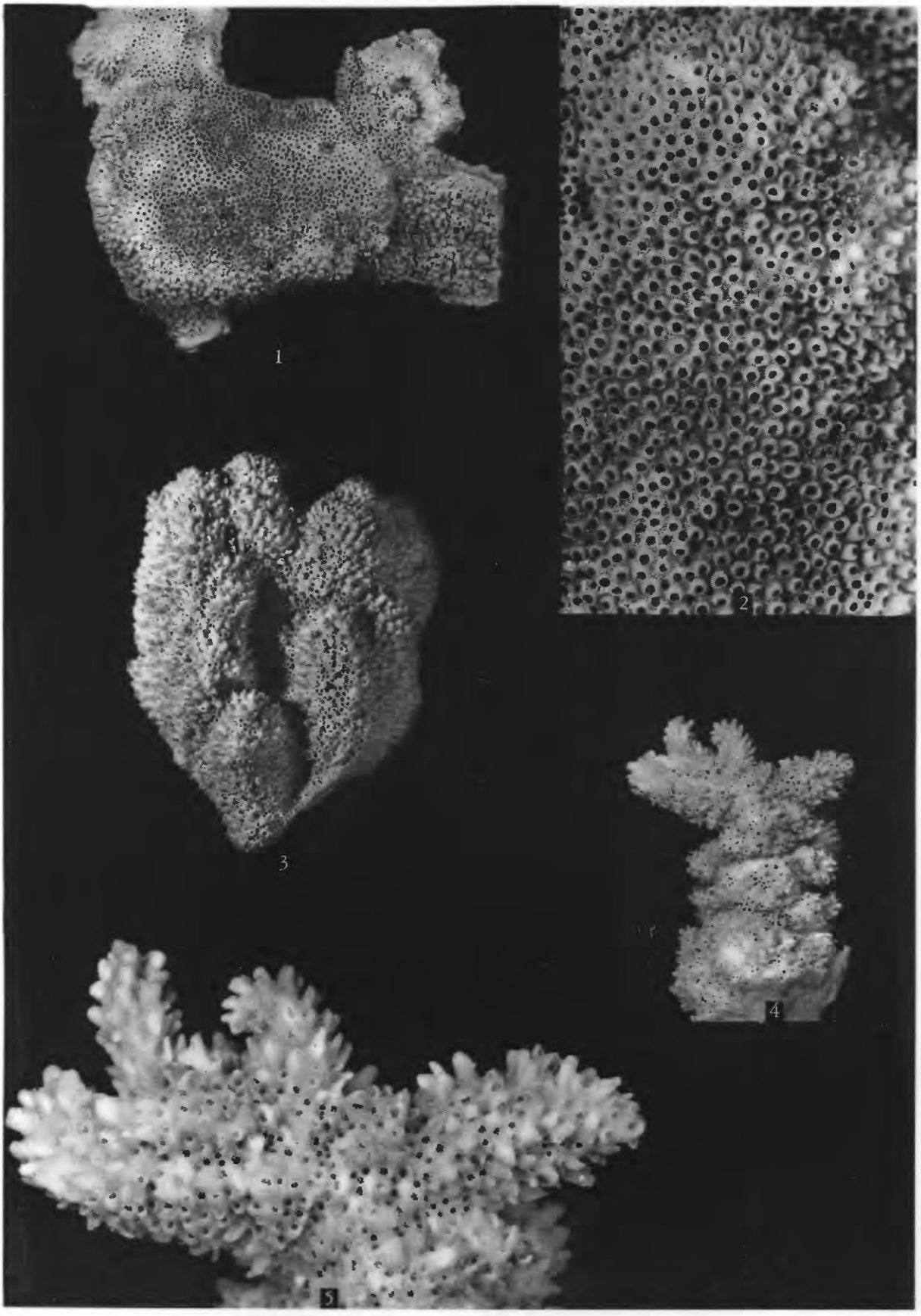
PLATE 112

FIGURES 1–3. *Acropora rotumana* (Gardiner) (p. 419).

1. × 0.9. Ourukaen island, Bikini Atoll, loc. 4. USNM 44470.
2. × 0.9. Lagoon reef, Latoback island, Rongerik Atoll, loc. 20a. USNM 44477.
3. × 0.3. Ourukaen island, Bikini Atoll, loc. 4. USNM 44472.



ACROPORA



ACROPORA

PLATE 113

FIGURES 1–3. *Acropora palmerae* Wells, n. sp. (p. 419).

1, 2. × 0.68, × 2. Bikini island, loc. 10b. Holotype, USNM 44482.

3. × 0.45. Bikini island, loc. 10a. Paratype, USNM 44480.

4, 5. *Acropora rotumana* (Gardiner) (p. 419).

Pathologic specimen (?). Rigili island, Eniwetok Atoll, loc. 13. USNM 44475.

293438—54——C

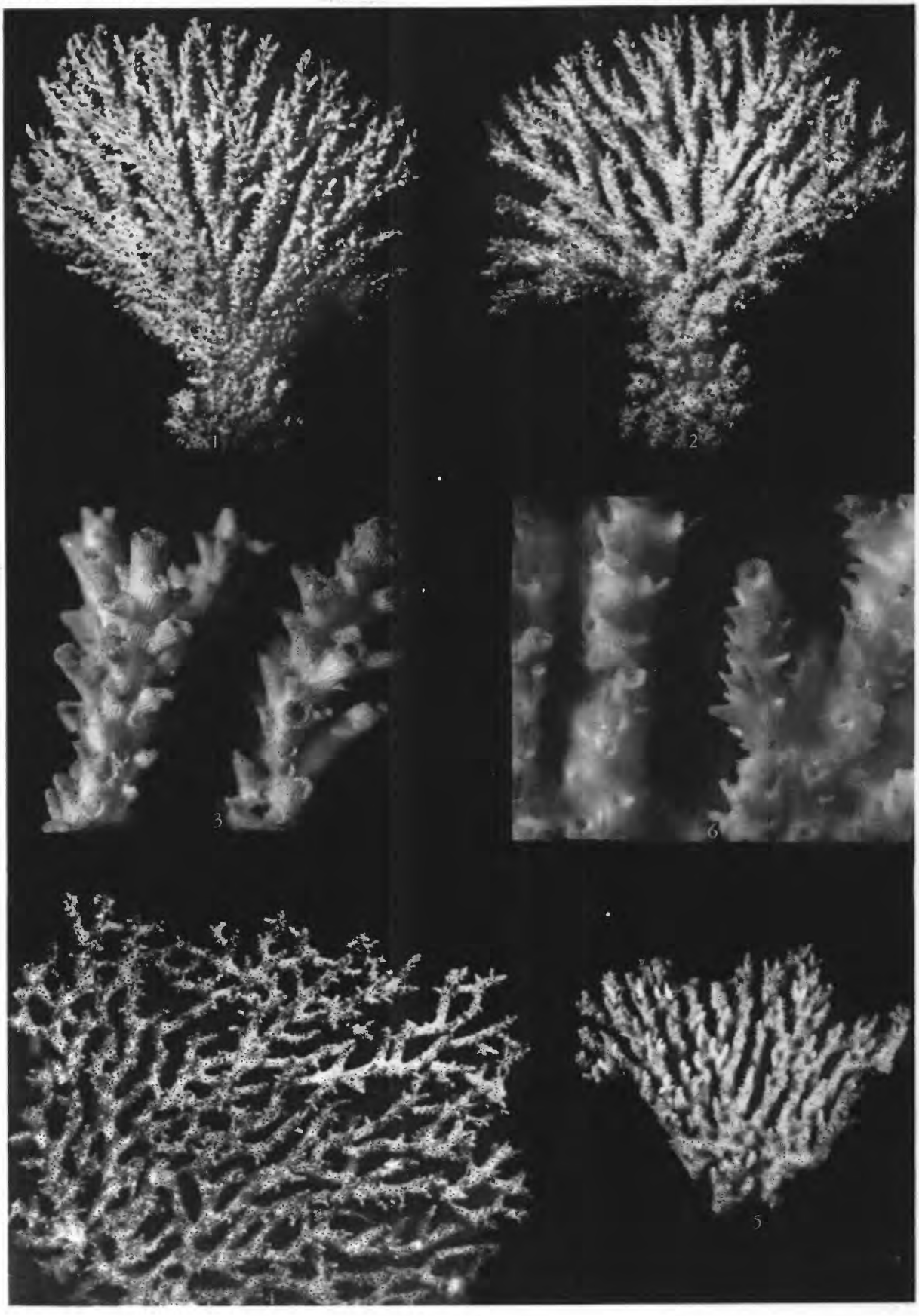
PLATE 114

FIGURES 1–6. *Acropora reticulata* (Brook) (p. 422).

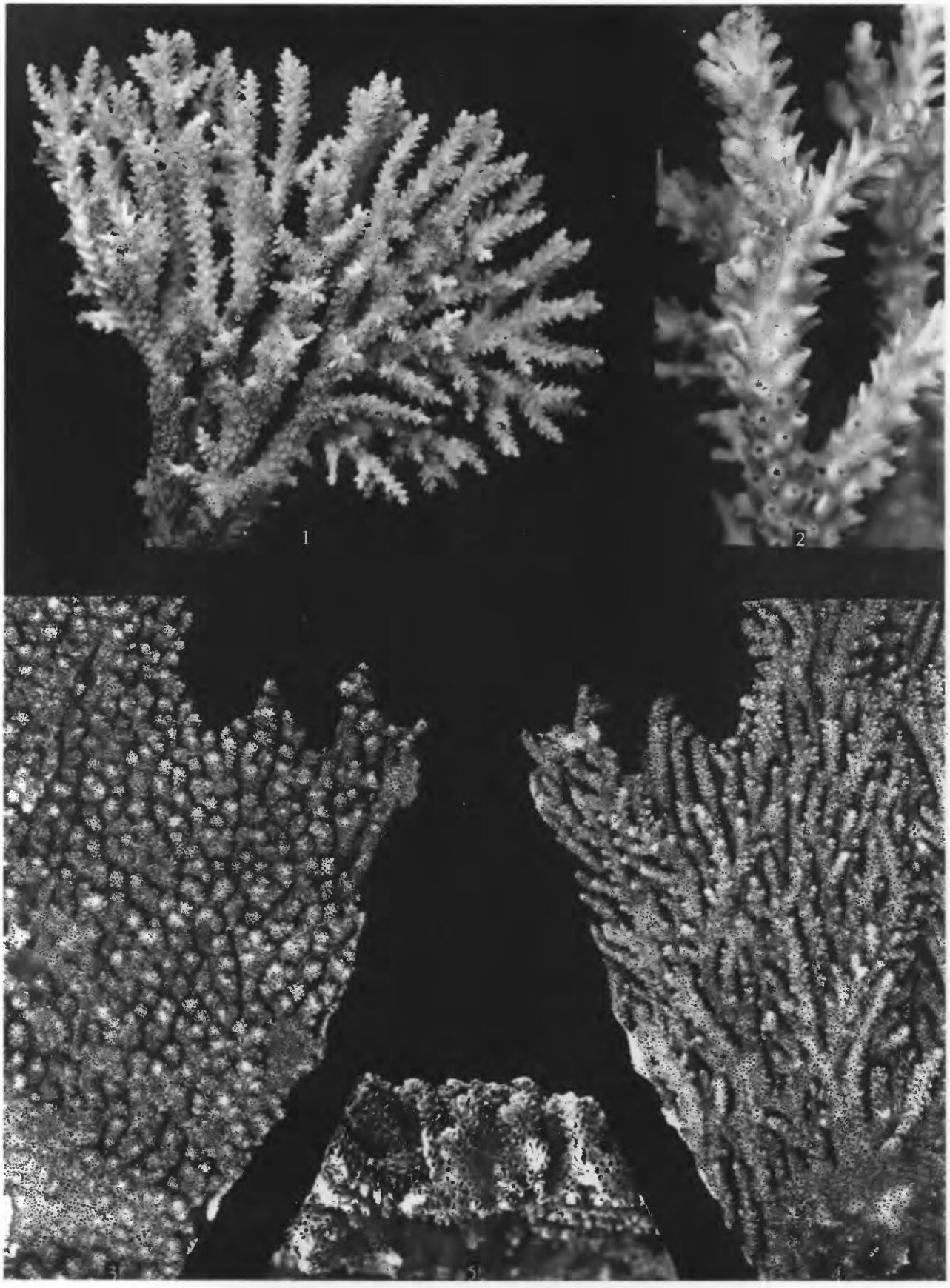
1, 2, 3. × **0.45,** × **0.45,** × 4.5. **Bikini Lagoon, coral knoll, 6 fms, loc. 49. USNM 44490.**

4. × **0.45. Seaward slope, Bikini Atoll, 21–25 fms. loc. 117. USNM 44491.**

5, 6. × 0.45, × 4.5. **Bikini Lagoon, coral knoll, 6 fms. loc. 49. USNM 44489.**



ACROPORA



ACROPORA

PLATE 115

FIGURES 1, 2. *Acropora delicatula* (Brook) (p. 420).
× 0.68, × 2. Bikini Lagoon, 22 fms, loc. 31. USNM 44494.

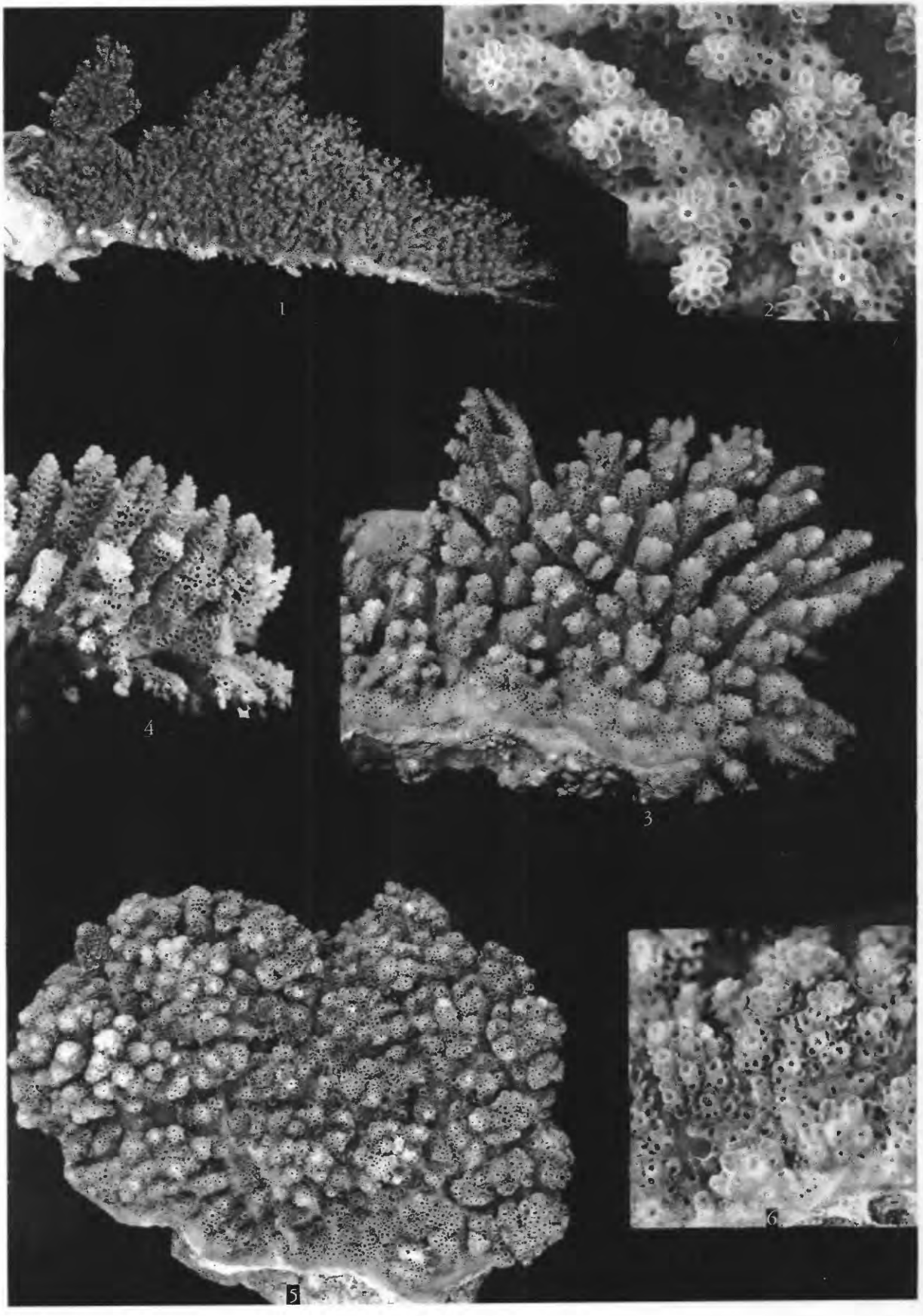
3–5. *Acropora conferta* (Quelch) (p. 420).
× 0.38, × 0.38, × 1. Bokororyuru island, Bikini Atoll, loc. 5a. USNM 44497

PLATE 116

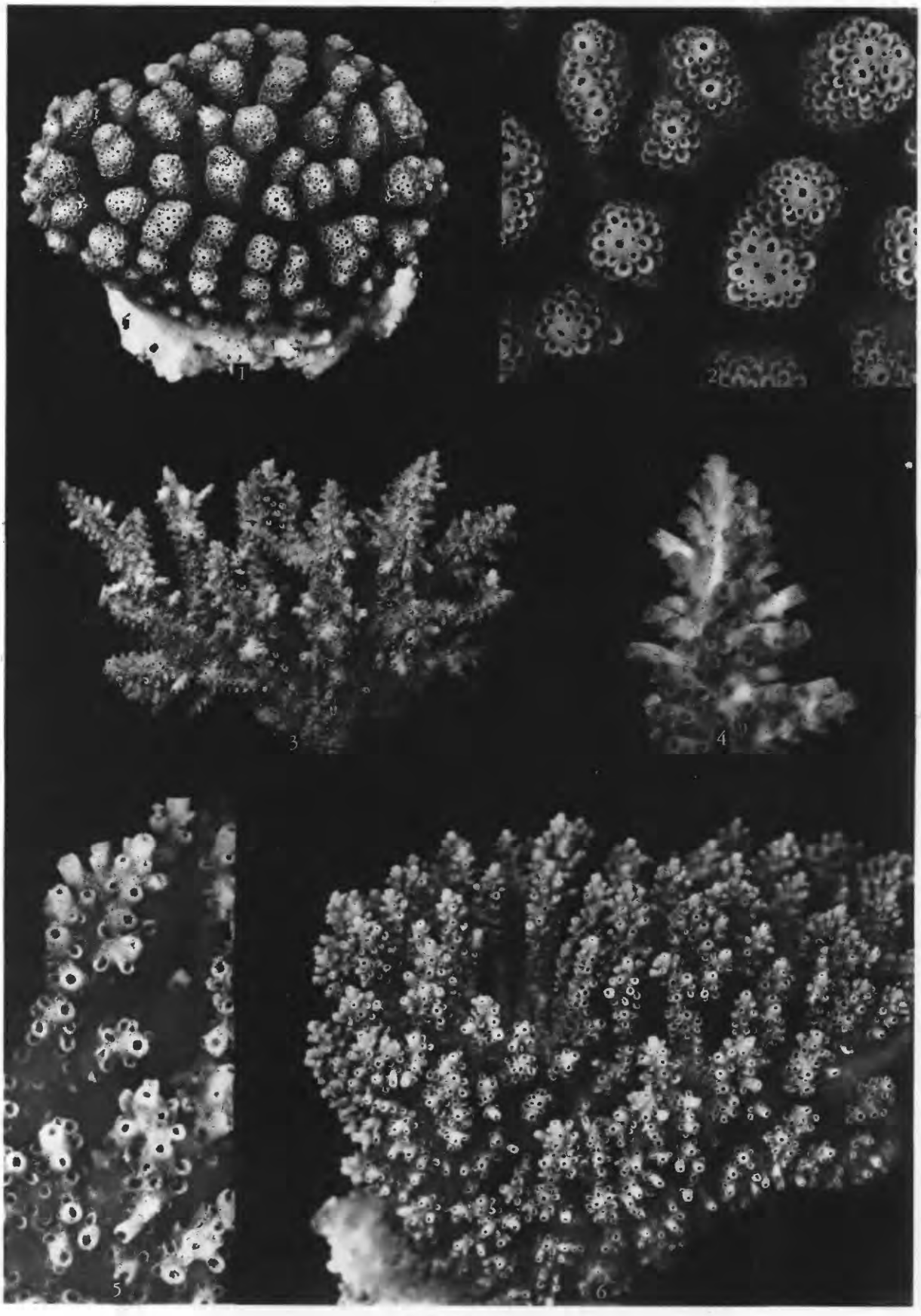
FIGURES 1, 2. *Acropora conferta* (Quelch) (p. 420).
× 0.23, × 1.8. Jaluit Atoll. Imp. Coll. 6.

3, 4. *Acropora corymbosa* (Lamarck) (p. 420).
× 0.58, × 0.72. Enyu island, Bikini Atoll, seaward reef, loc. 12a. USNM 45178.

5, 6. *Acropora corymbosa* (Lamarck) (p. 420).
× 0.72, × 2. Rigili island, Eniwetok, loc. 13. A stunted colony. USNM 44504.



ACROPORA



ACROPORA

PLATE 117

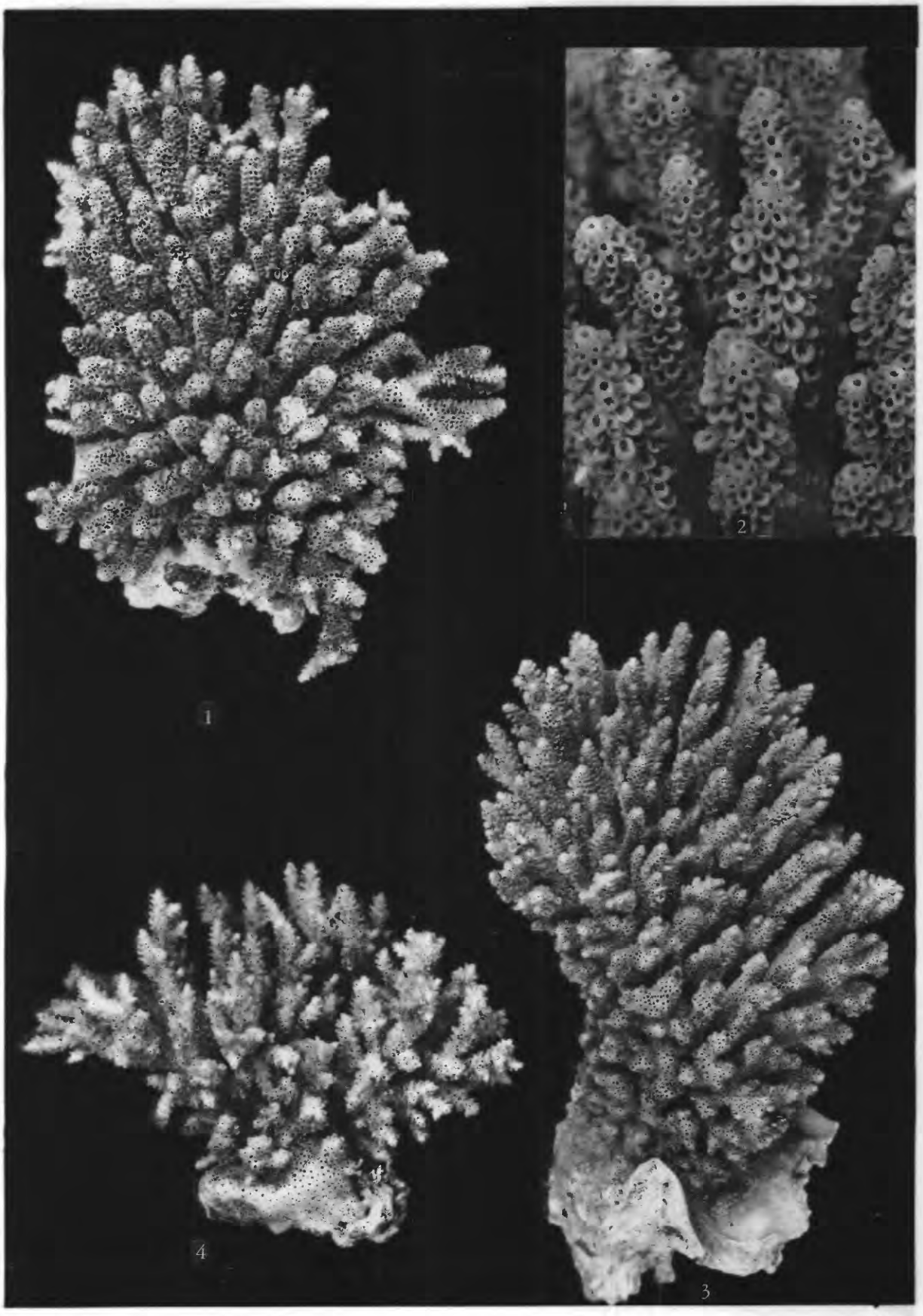
FIGURES 1, 2. *Acropora corymbosa* (Lamarck) (p. 420).
$\times$ 0.6, $\times$ 2. Ourukaen island, Bikini Atoll, loc. 4b. USNM 44501.

3–6. *Acropora diversa* (Brook) (p. 427).
3, 4. $\times$ 0.8. Namu island, Bikini Atoll, loc. 7b. USNM 44543.
4. $\times$ 2. Namu island, Bikini Atoll, loc. 7b. USNM 44544.
5, 6. $\times$ 0.67, $\times$ 2. Bokororyuru island, Bikini Atoll, loc. 5. USNM 44543.

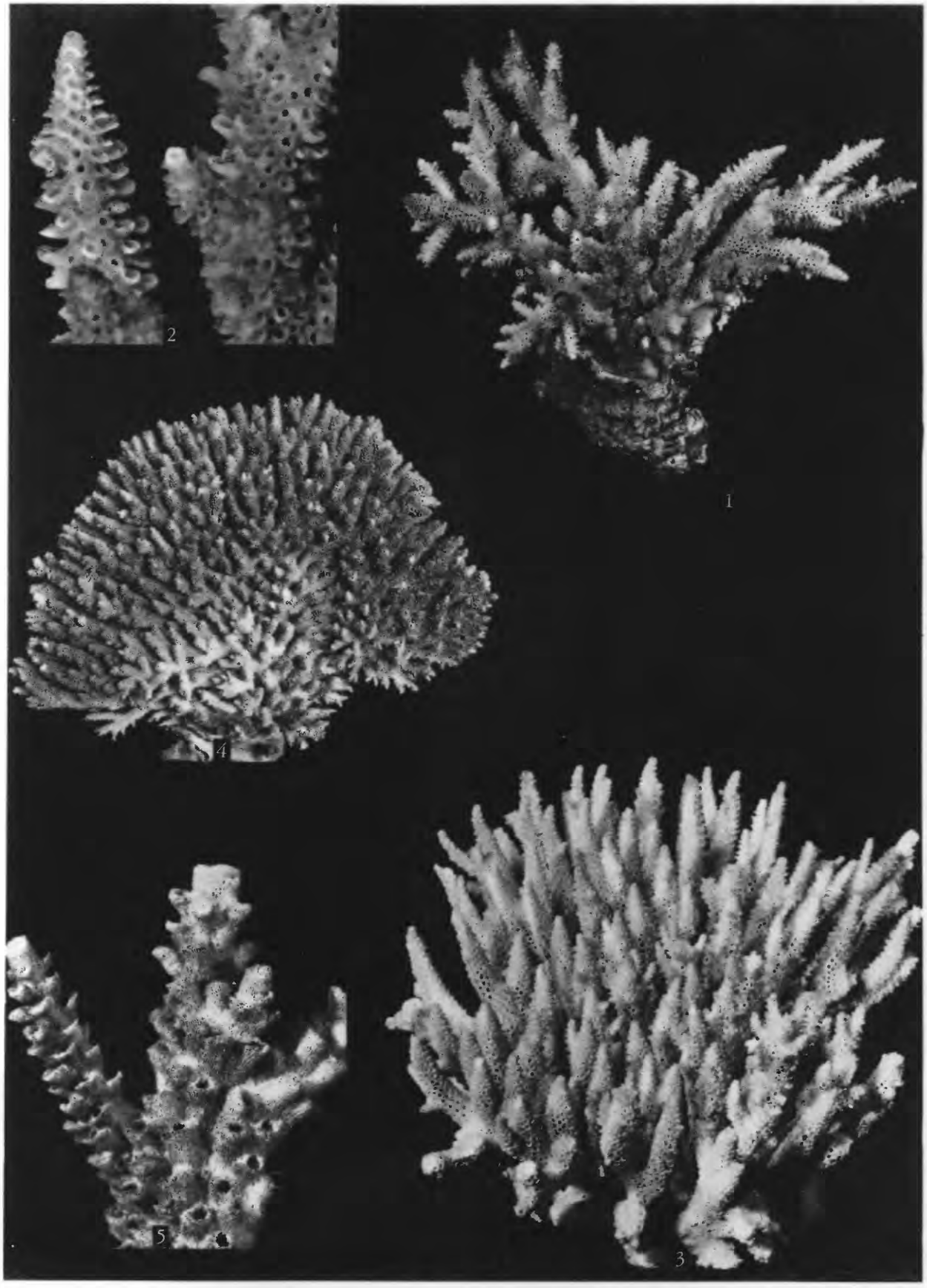
PLATE 118

FIGURES 1, 2. *Acropora surculosa* (Dana) (p. 421).
$\times$ 0.6, $\times$ 2. Tufa island, Rongelap Atoll, loc. 21. USNM 44521.

3, 4. *Acropora hyacinthus* (Dana) (p. 421).
3. $\times$ 0.6. Rigili island, Eniwetok Atoll, loc. 13. USNM 44529.
4. $\times$ 0.6. Namu island, Bikini Atoll, loc. 7b. USNM 44528.



ACROPORA



ACROPORA

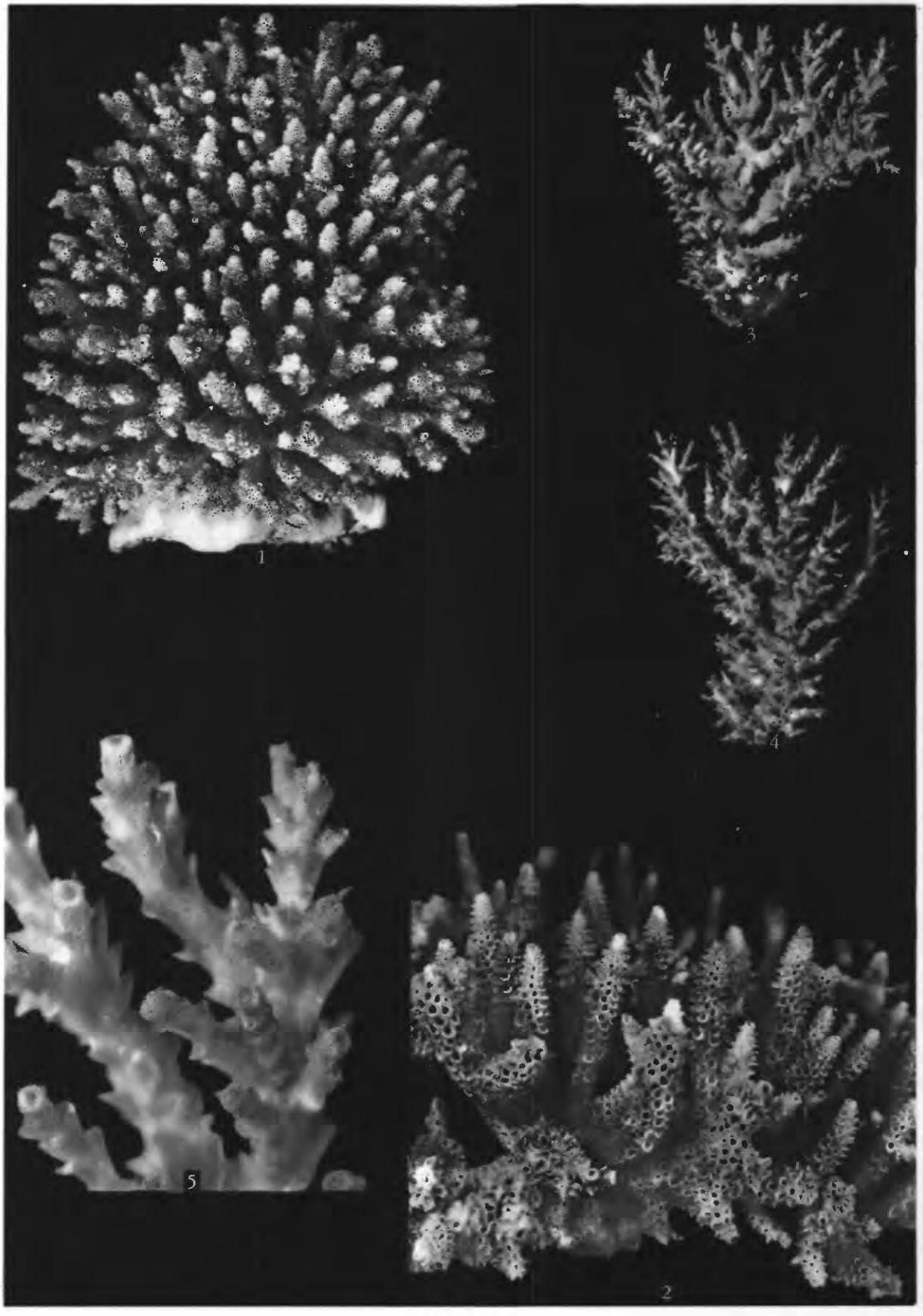
PLATE 119

FIGURES 1–3. *Acropora surculosa* (Dana) (p. 421).
1, 2. × 0.6, × 2. Namu island, Bikini Atoll, loc. 7b. USNM 44517.
3. × 0.68. Holotype. Fiji Islands. USNM 248.
4, 5. *Acropora kenti* (Brook) (p. 423).
× 0.27, × 4.5. Jaluit Atoll. Imp. Coll. 8.

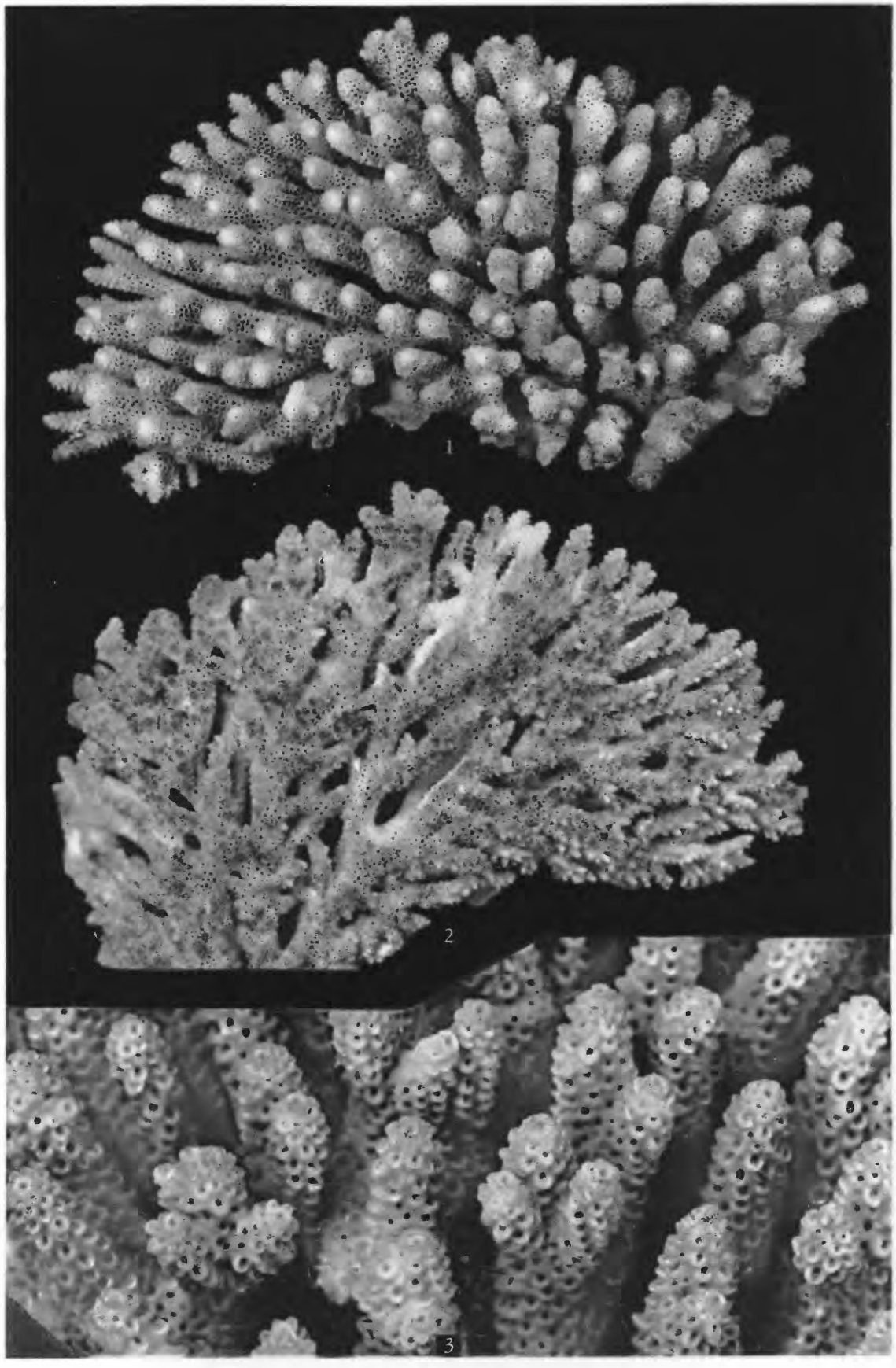
PLATE 120

FIGURES 1, 2. *Acropora prostrata* (Dana) (p. 421).
× 0.5, × 1. Bikini island, Bikini Atoll, loc. 10b. USNM 44523.

3–5. *Acropora hyacinthus* (Dana) (p. 421).
× 0.45, × 0.45, ×4.5. Bikini Lagoon, coral knoll, 6 fms, loc. 49. USNM 44531.



ACROPORA



ACROPORA

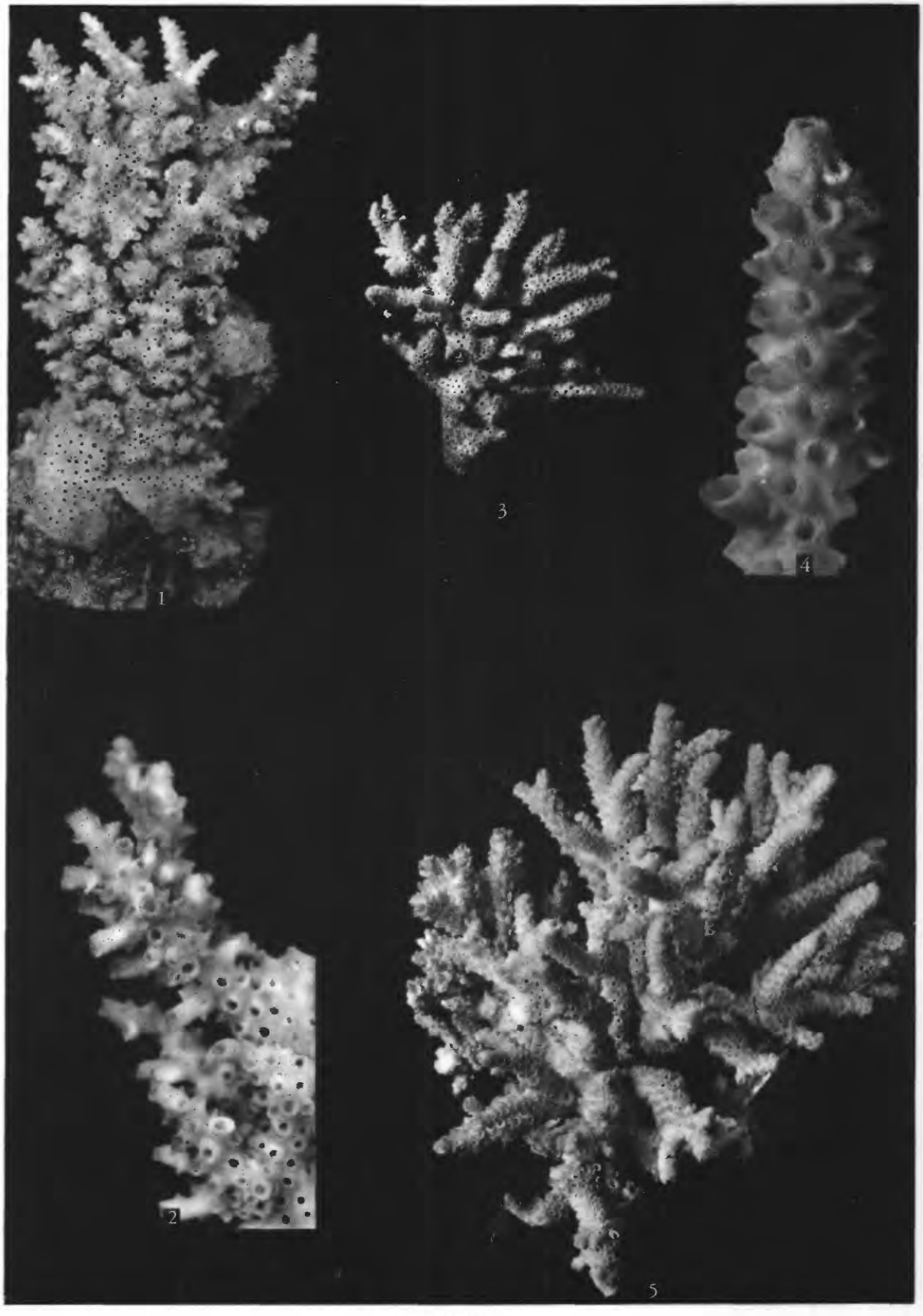
PLATE 121

FIGURES 1–3. *Acropora spicifera* (Dana) (p. 421).
× 0.68, × 0.68, × 2. Enyu island, Bikini Atoll, loc. 12a. USNM 44524.

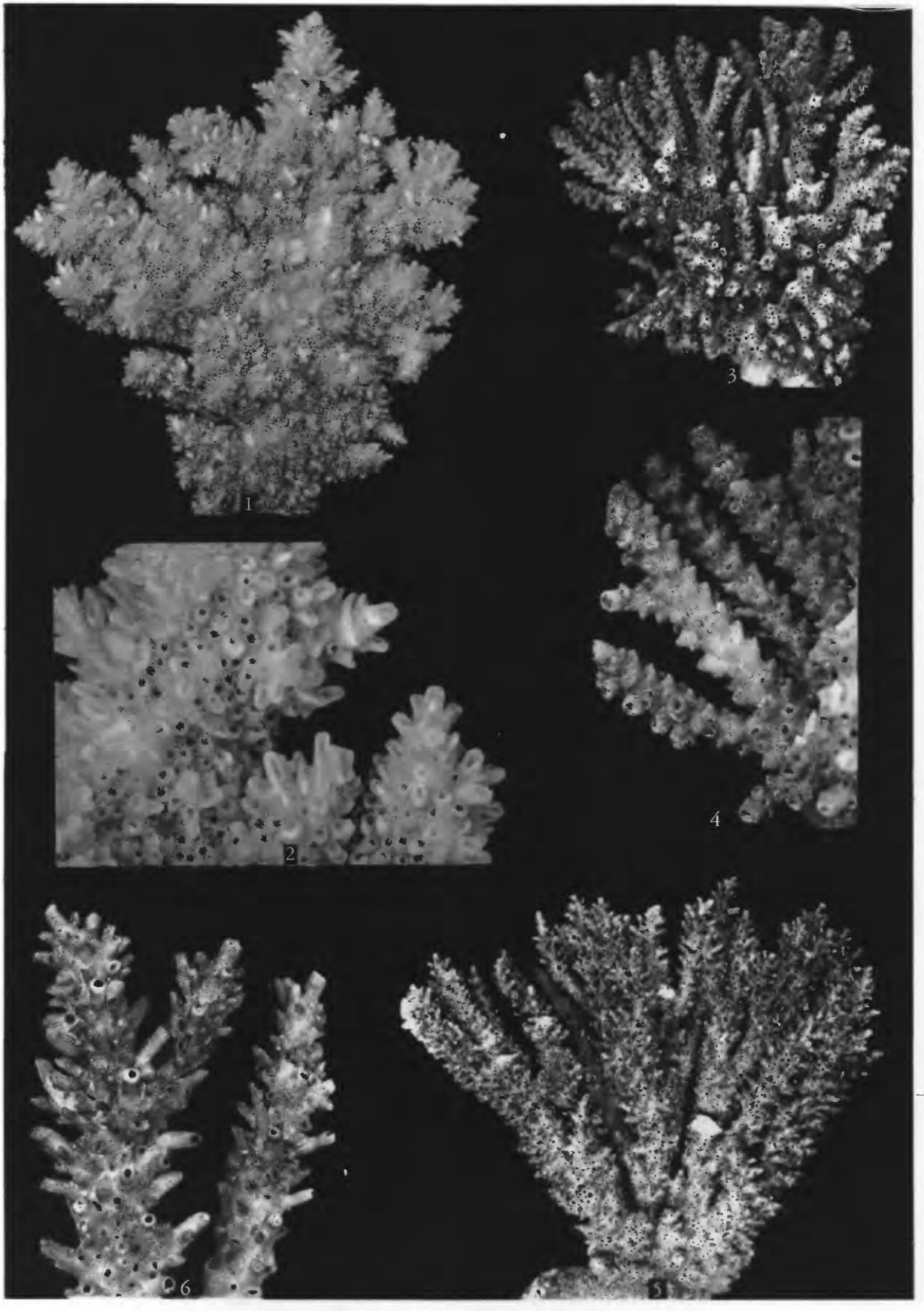
PLATE 122

FIGURES 1, 2. *Acropora striata* Verrill (p. 422).
$\times$ 0.68, $\times$ 2. Namu island, Bikini Atoll, loc. 7b. USNM 44533.

3–5. *Acropora tubicinaria* (Dana) (p. 423).
3, 4. $\times$ 0.45, $\times$ 4.5. Bikini island, Bikini Atoll, loc. 10c. USNM 44540.
5. $\times$ 0.68. Fiji Islands. Holotype, USNM 258.



ACROPORA



ACROPORA

PLATE 123

FIGURES 1, 2. *Acropora abrotanoides* (Lamarck) (p. 418).
× 0.45, × 2. Bikini Lagoon, 8 fms, loc. 47. USNM 44468.

3, 4. *Acropora ramiculosa* (Dana) (p. 424).
× 0.6, × 2. Bokororyuru island, Bikini Atoll, loc. 6. USNM 44549.

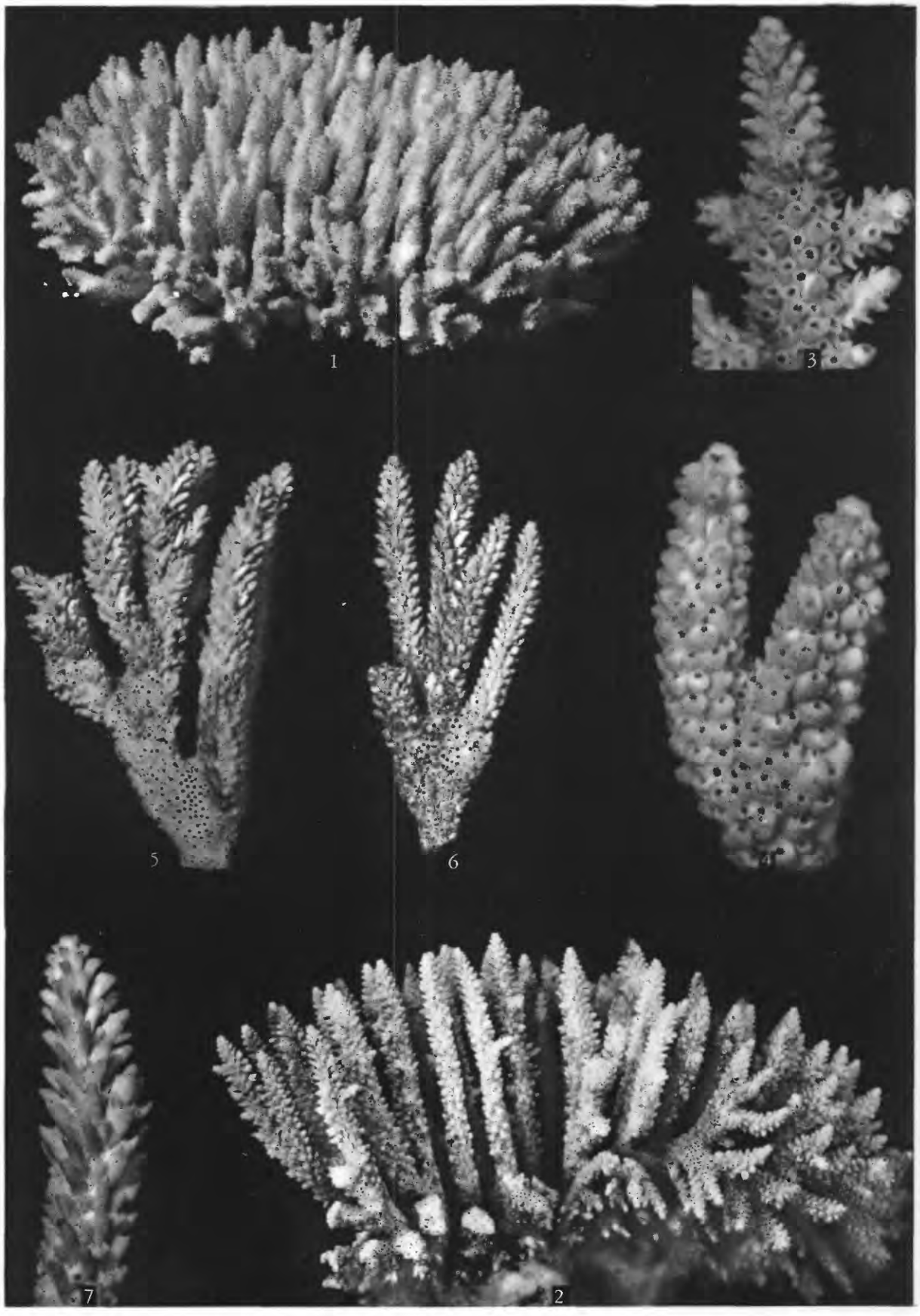
5, 6. *Acropora paniculata* Verrill (p. 424).
× 0.6, × 2. Bokororyuru island, Bikini Atoll, loc. 5a. USNM 44548.

PLATE 124

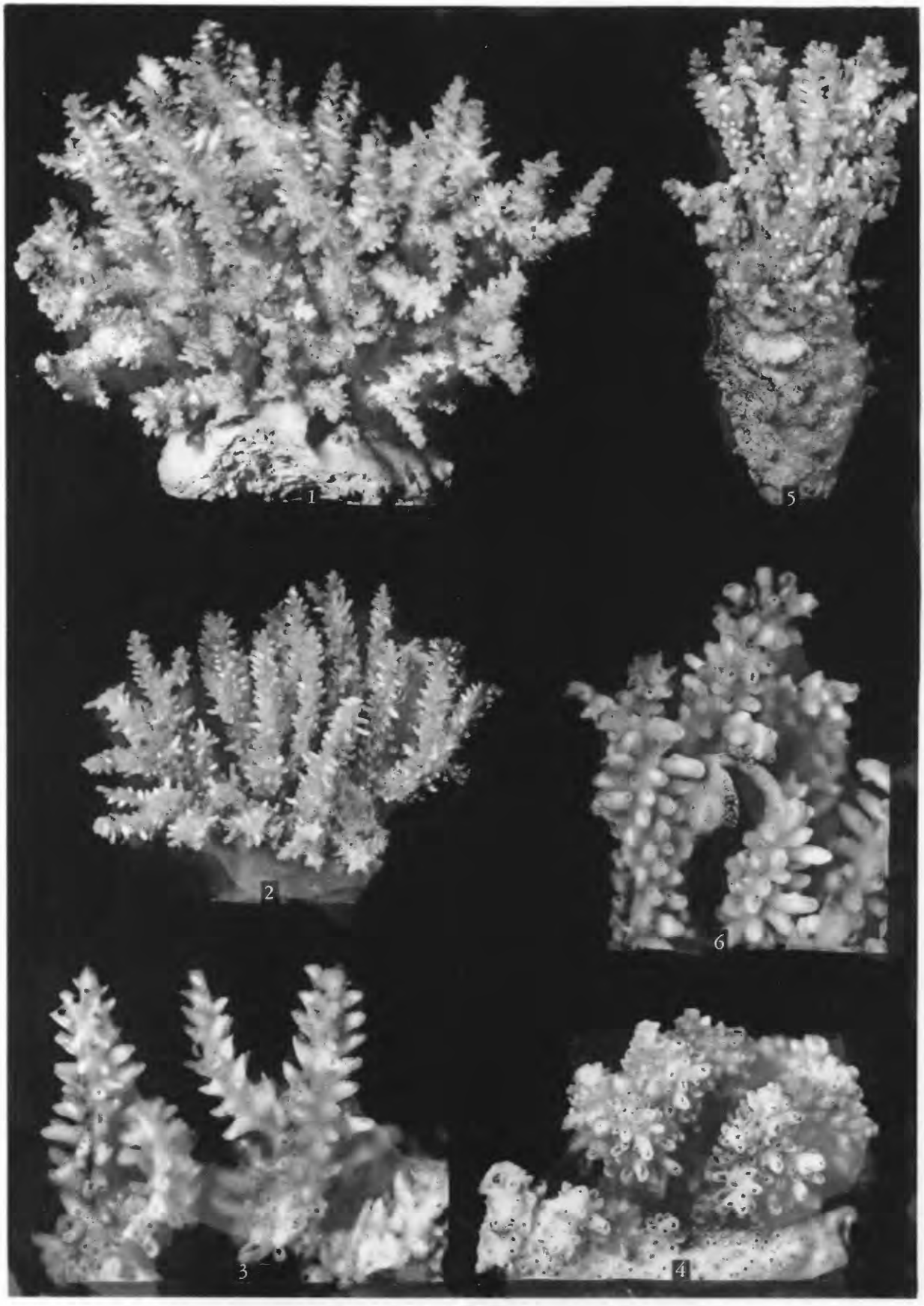
FIGURES 1–3. *Acropora nasuta* (Dana) (p. 424).
1. × 0.36. Tahiti, Holotype. USNM 260.
2, 3. × 0.45 × 2. Lagoon reef, Bikini Atoll, loc. 10f. USNM 44554.

4. *Acropora nasuta crassilabia* (Brook) (p. 425).
× 2. Enyu island, Bikini Atoll, loc. 12a. USNM 44562.

5-7. *Acropora cymbicyathus* (Brook) (p. 425).
5, 7. × 0.8, × 2. Bikini island, Bikini Atoll, loc. 10f. USNM 44567.
6. × 0.9. Ourukaen island, Bikini Atoll, loc. 4a. USNM 44563.



ACROPORA



ACROPORA

PLATE 125

FIGURES 1–4. *Acropora hystrix* (Dana) (p. 425).

1. × 0.8. Fiji Islands. Holotype, USNM 298.

2, 3. × 0.68, × 2. Bikini Lagoon, 10 fms, loc. 44. USNM 44577.

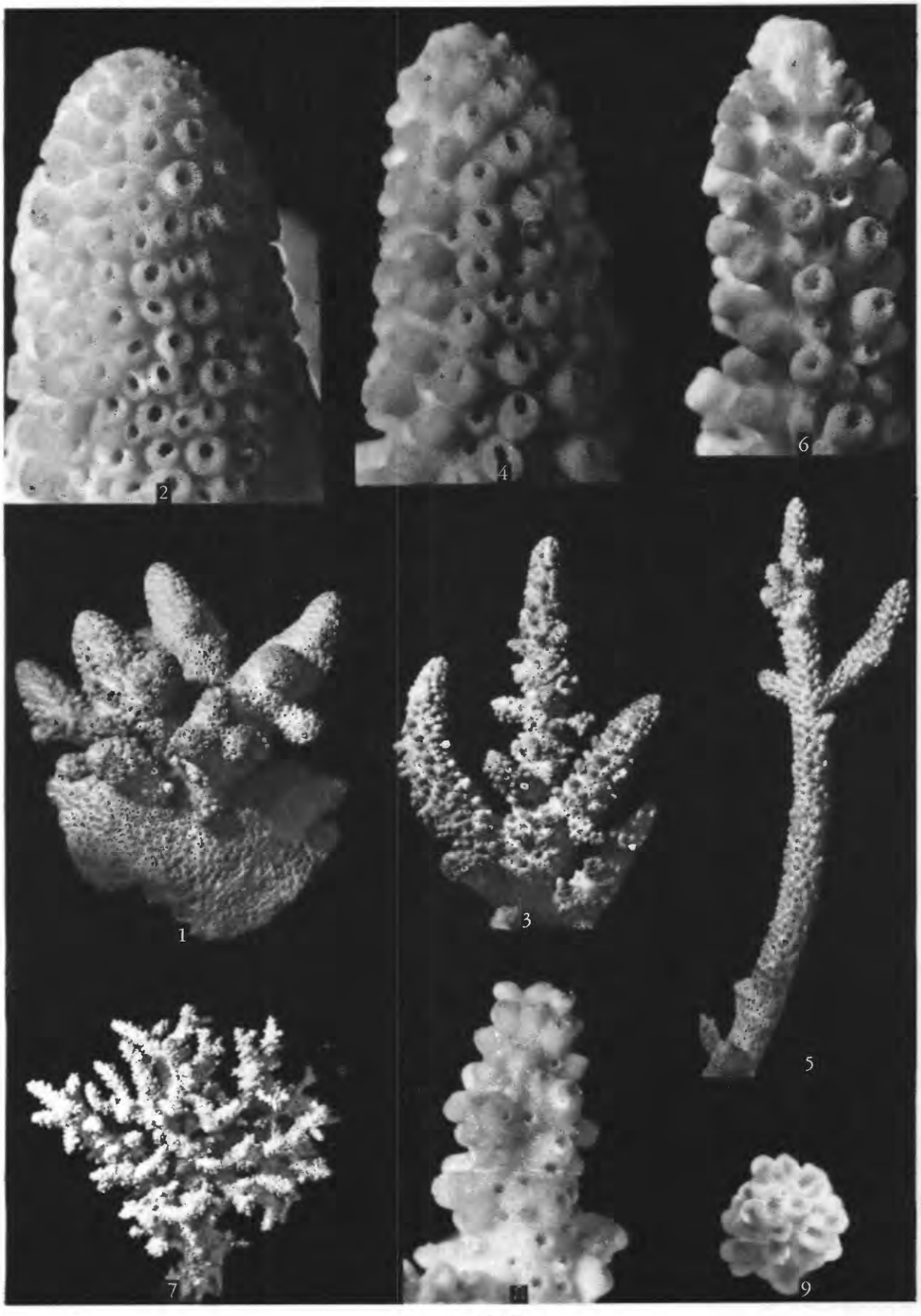
4. × 1.3 Stunted specimen from reef, Bokororyuru island, loc. 6. USNM 44578.

5, 6. *Acropora tizardi* (Brook) (p. 425).

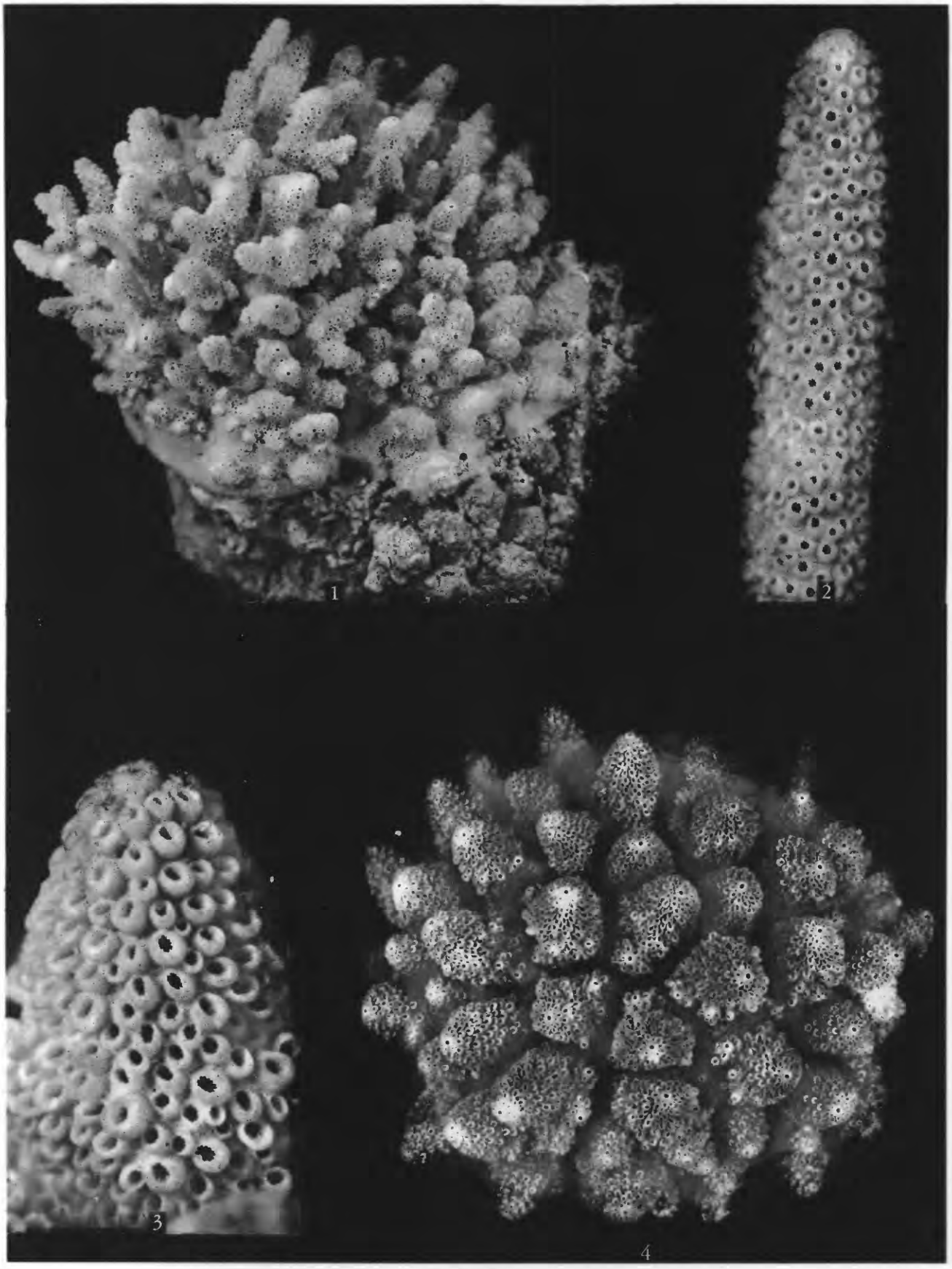
× 0.68, × 2. Bikini Lagoon, 10 fms, loc. 44. USNM 44575.

PLATE 126

FIGURES 1–6. *Acropora humilis* (Dana) forma α (p. 425).
1, 2. × 0.45 × 4.5. Bikini island, Bikini Atoll, loc. 10c. USNM 44581.
3, 4. × 0.45, × 4.5. Another part of same colony as that shown in figs. 1, 2.
5, 6. × 0.45, × 4.5. Latoback island, Rongerik Atoll, loc. 20a. USNM 44584.
7–9. *Acropora microphthalma* Verrill (p. 425).
× 0.45, × 4.5, × 4.5. Bikini island, Bikini Atoll, loc. 10c. USNM 44625.



ACROPORA



ACROPORA

PLATE 127

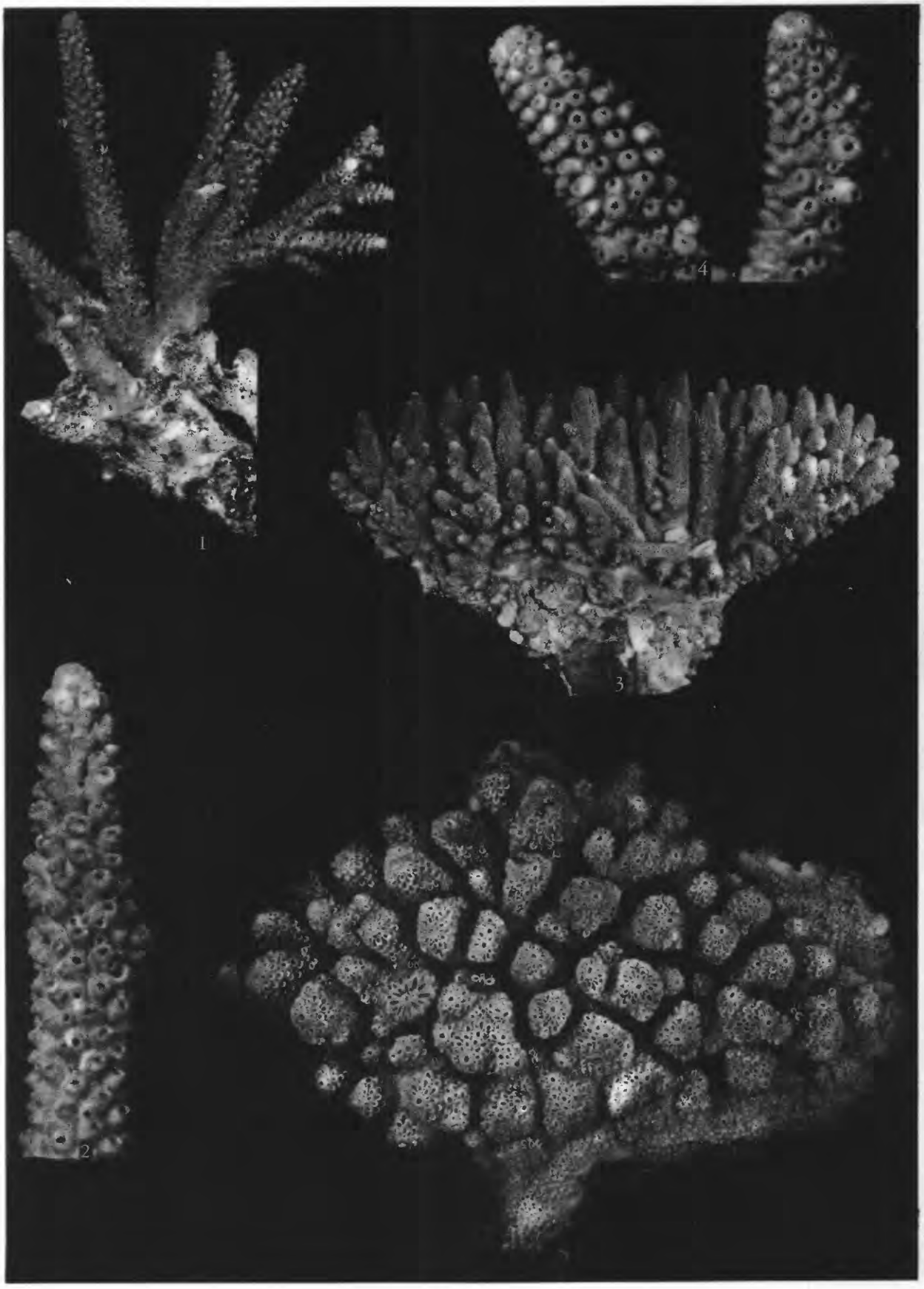
FIGURES 1, 2. *Acropora digitifera* (Dana) (p. 427).
× 0.54, × 2. Enyu island, Bikini Atoll, loc. 12a. USNM 44607.
3, 4. *Acropora humilis* (Dana) forma γ (p. 425).
× 0.58, × 2.7. Tufa island, Rongelap Atoll, loc. 21. USNM 44599.

PLATE 128

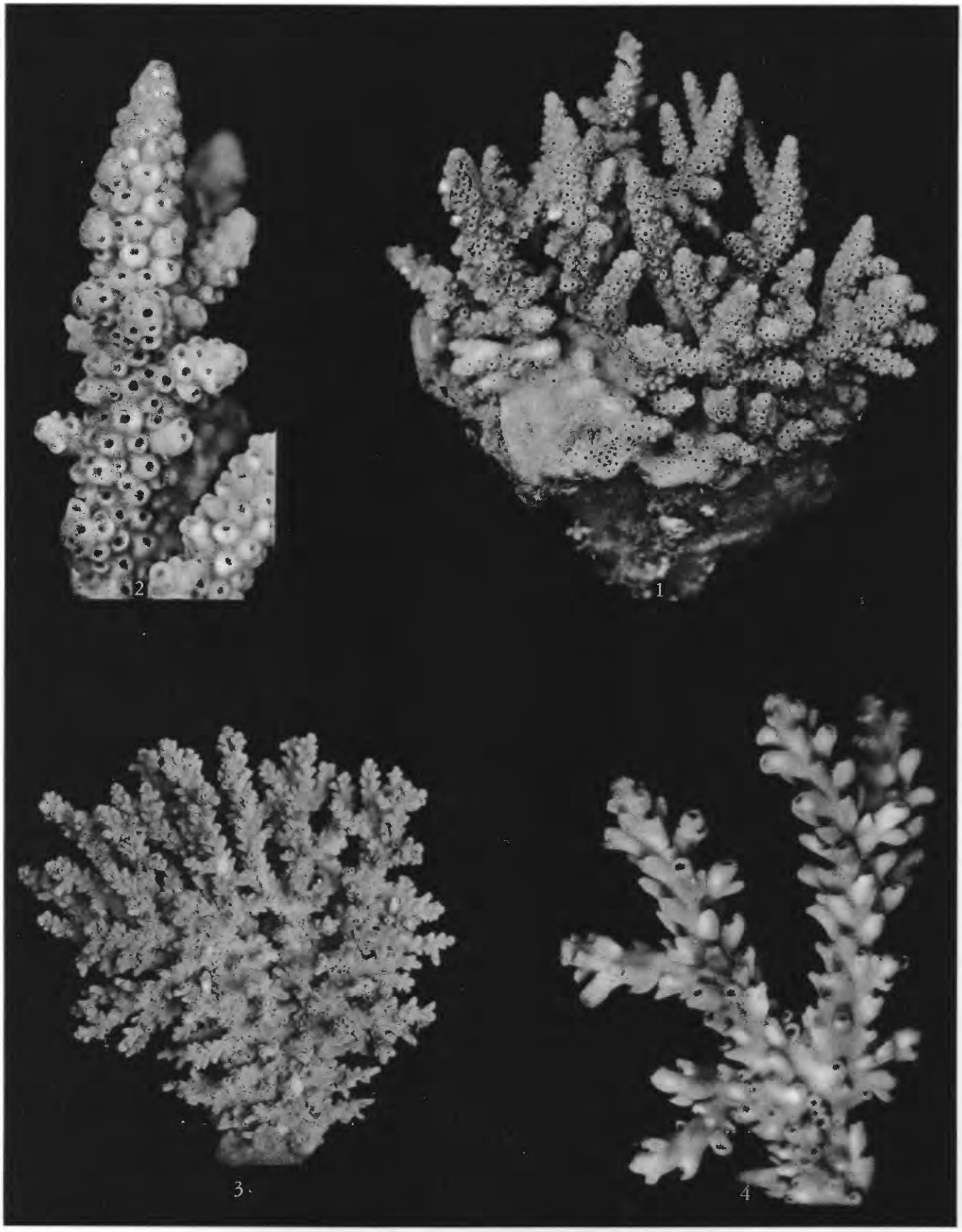
FIGURES 1, 2. *Acropora variabilis* (Klunzinger) (p. 428).
× 0.76, × 2. Ourukaen island, Bikini Atoll, loc. 4b. USNM 44626.

3, 4. *Acropora humilis* (Dana) forma β (p. 425).
× 0.23, × 2.3. Jaluit Atoll. Imp. Coll. 3.

5. *Acropora humilis* (Dana) forma γ (p. 425).
× 0.58. Bikini island, Bikini Atoll, loc. 10c. USNM 44592.



ACROPORA



ACROPORA

PLATE 129

FIGURES 1, 2. *Acropora squarrosa* (Ehrenberg) (p. 427).
× 0.68, × 2. Enyu Island, Bikini Atoll, loc. 12a. USNM 44611.

3, 4. *Acropora syringodes* (Brook) (p. 428).
× 0.68, × 1.8. Jaluit Atoll. Imp. Coll. 29.

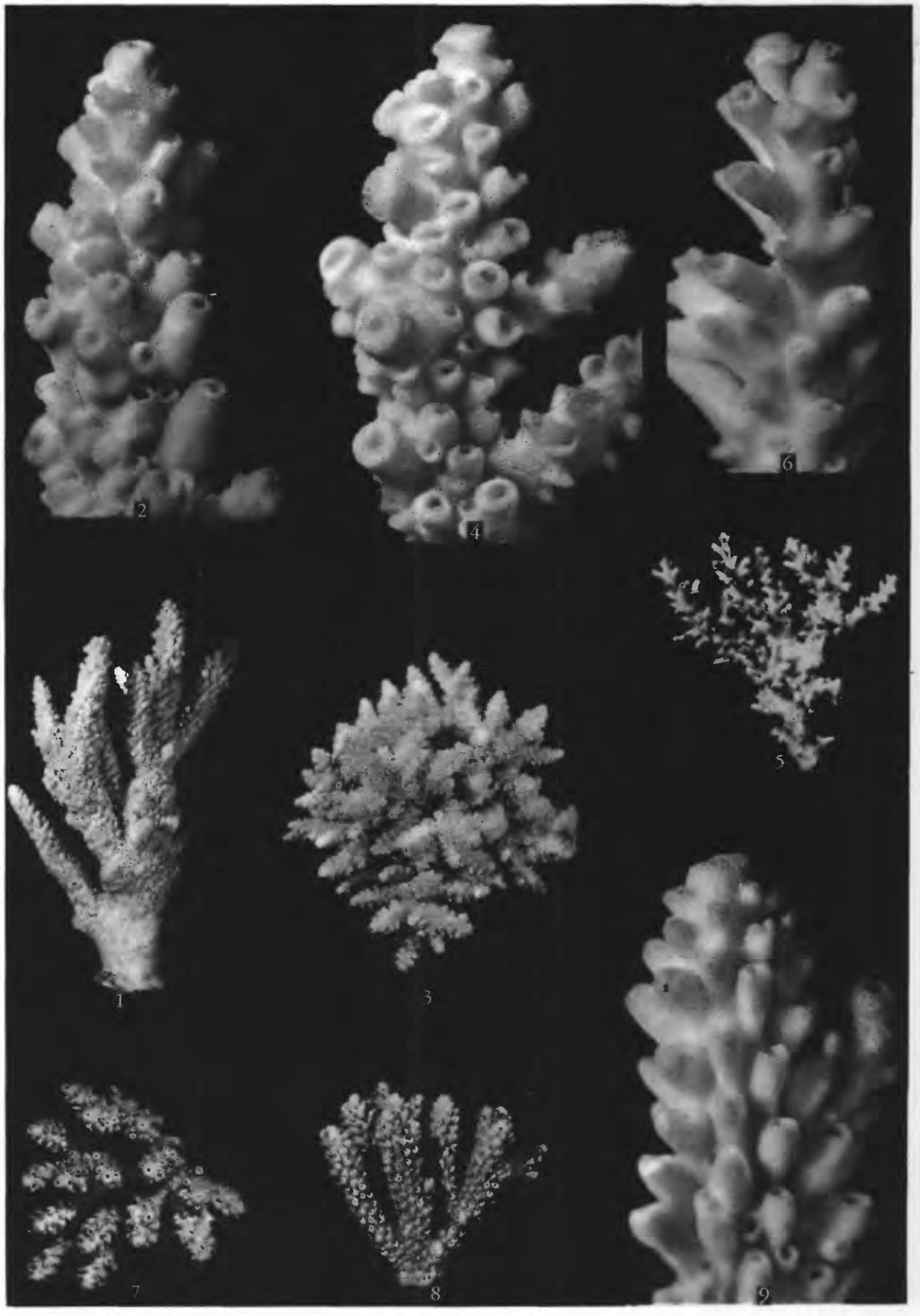
PLATE 130

FIGURES 1, 2. *Acropora variabilis* (Klunzinger) (p. 428).
× 0.45, × 4.5. Bikini island, Bikini Atoll, loc. 10d. USNM 44621.

3, 4. *Acropora rosaria* (Dana) (p. 428).
× 0.45, × 4.5. Bikini island, Bikini Atoll, loc. 10b. USNM 44622.

5, 6. *Acropora syringodes* (Brook) var. (p. 429).
× 0.45, × 4.5. Seaward slope, Bikini Atoll, 50–94 fms, loc. 106. USNM 44617.

7–9. *Acropora valida* (Dana) (p. 429).
× 0.45, × 0.45, × 4.5. Ourukaen island, Bikini Atoll, loc. 4a. USNM 44624.



ACROPORA

ACROPORA

PLATE 131

FIGURES 1–3. *Acropora cuneata* (Dana) (p. 429).

1, 2. × 0.45, × 2. Enyu island, Bikini Atoll, loc. 12a. USNM 44631.

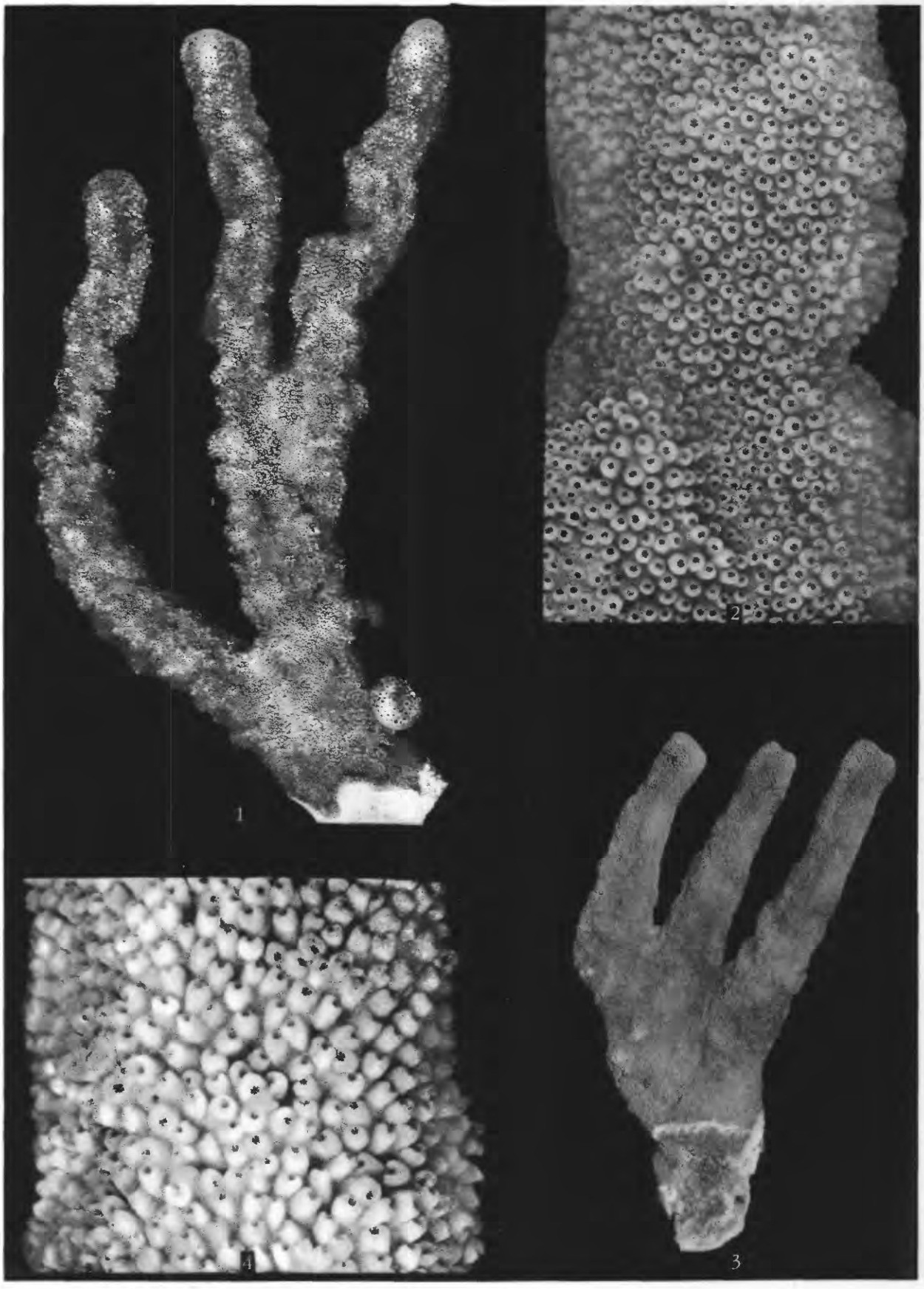
3. × 0.45. Fiji Islands. Holotype specimen of *Madrepora cuneata* Dana. USNM 334.

293438—54——D

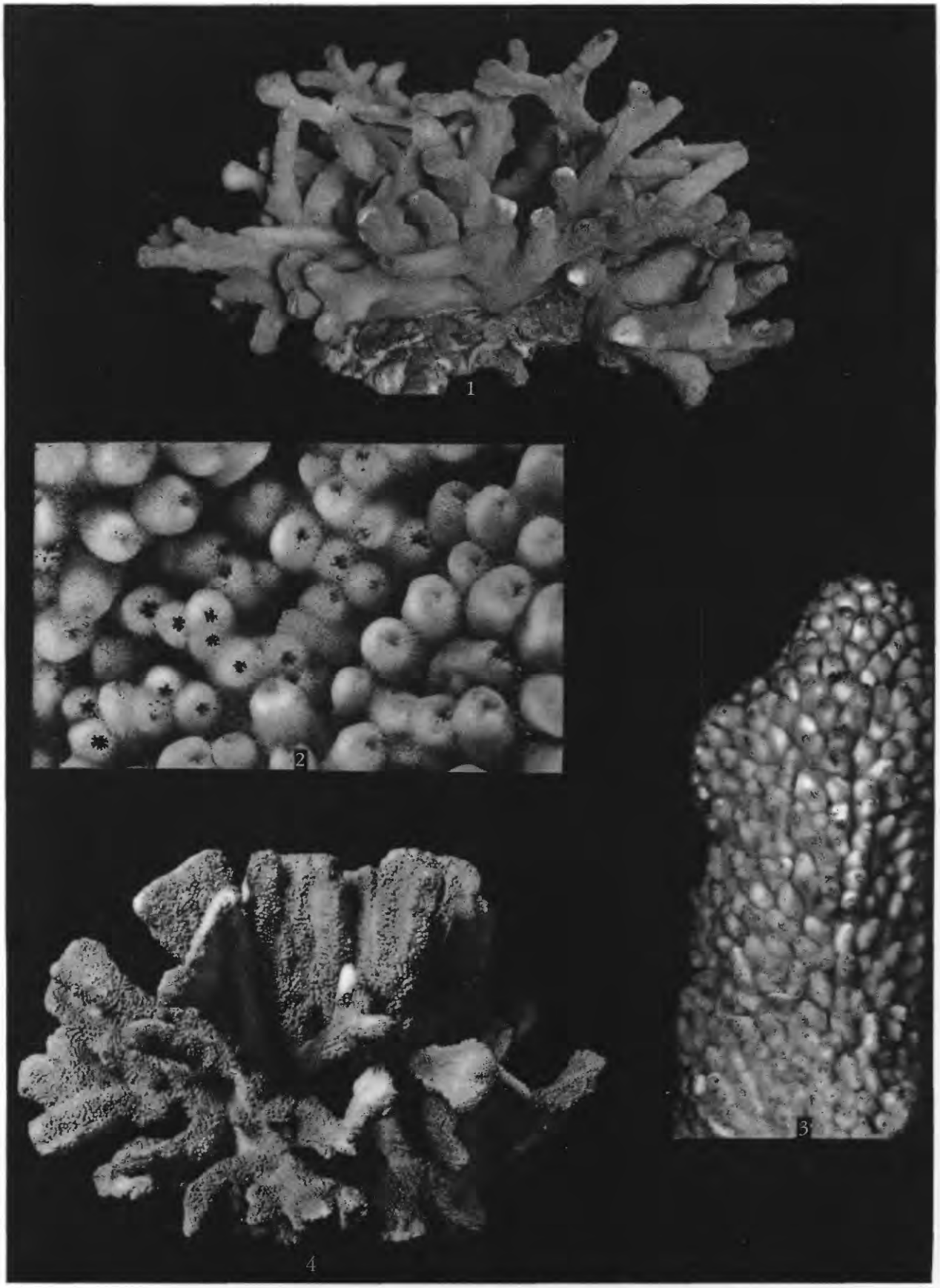
PLATE 132

FIGURES 1, 2. *Acropora palifera* forma α (Brook) (p. 430).
$\times$ 0.45, $\times$ 2. Bokororyuru Island, Bikini Atoll, loc. 5a. USNM 44643.

3, 4. *Acropora palifera* forma α (p. 430).
$\times$ 0.45, $\times$ 1.8. Jaluit Atoll. Imp. Coll. 44.



ACROPORA



ACROPORA

PLATE 133

FIGURES 1, 2. *Acropora palifera* forma α (Brook) (p. 430).
$\times$ 0.18, $\times$ 5.4. Jaluit Atoll. Imp. Coll. 43.

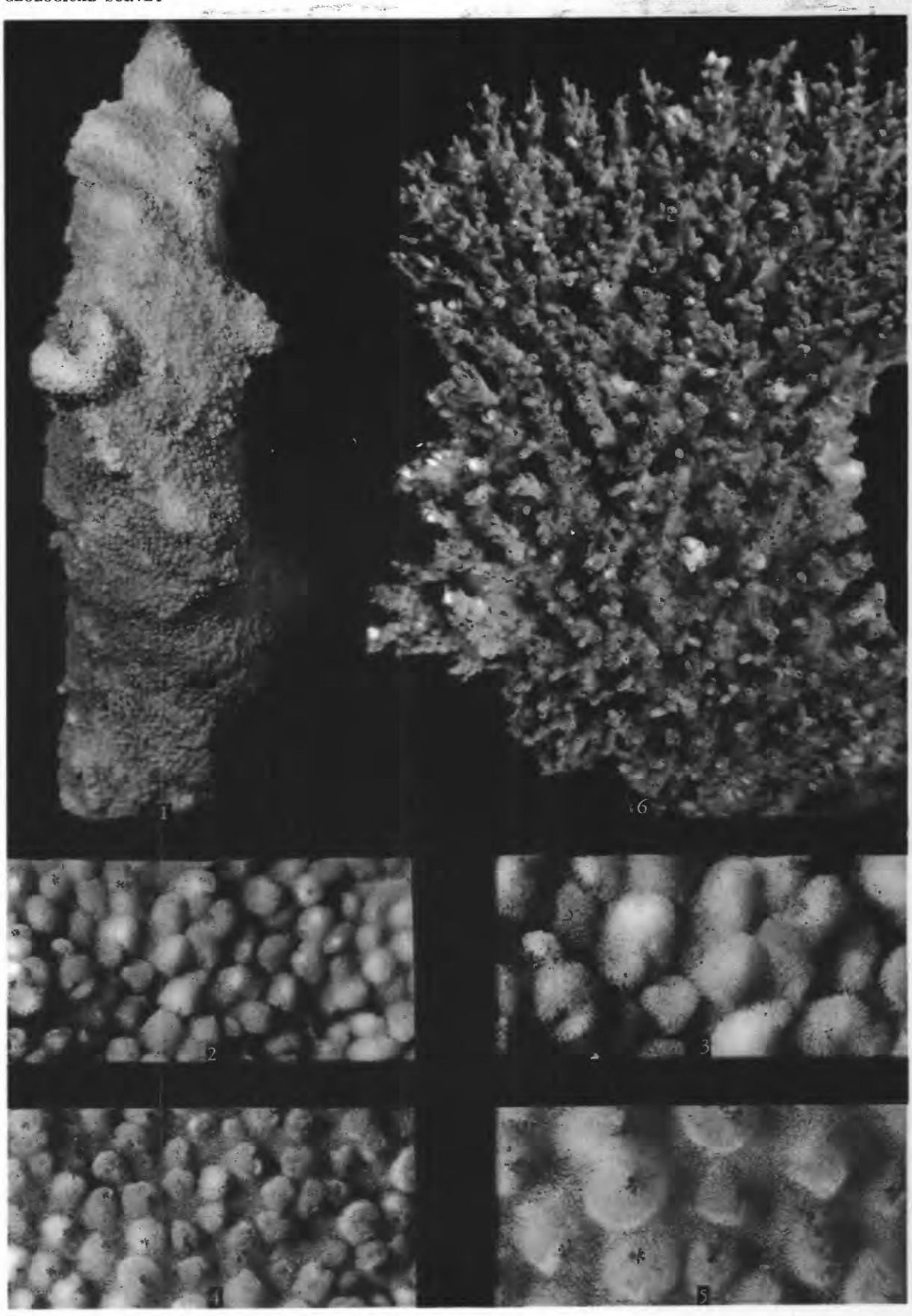
3. *Acropora palifera* forma β n. form (p. 430).
$\times$ 2. Bikini Lagoon, 30 fms, loc. 43. USNM 44649.

4. *Acropora securis* (Dana) (p. 429).
$\times$ 0.3. Holotype. "East Indies." USNM 304.

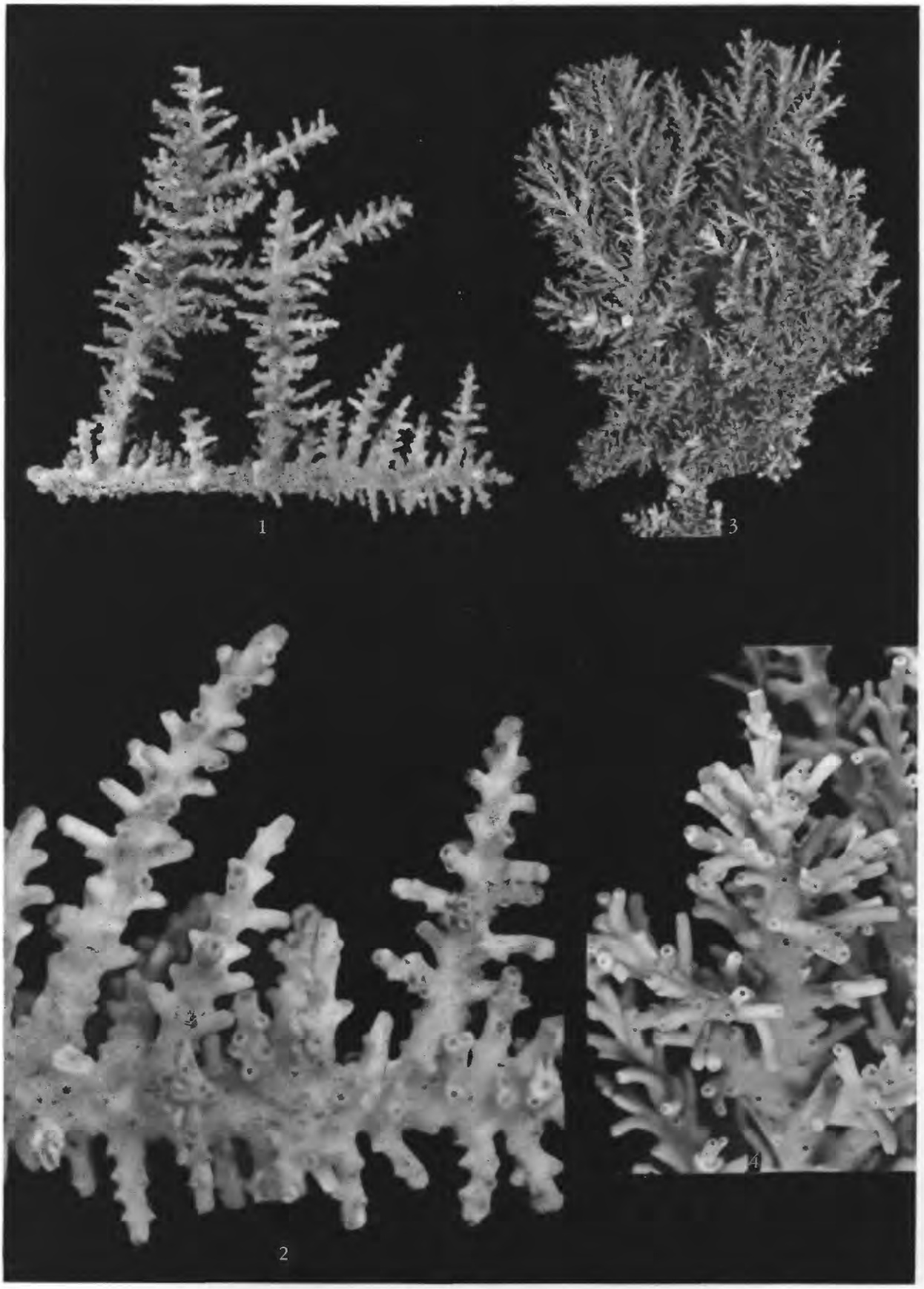
PLATE 134

FIGURES 1–5. *Acropora palifera* forma β, n. form (p. 430).
$\times$ 0.5, $\times$ 4.5, $\times$ 9, $\times$4.5, $\times$ 10. Coral knoll, Bikini Atoll, 5–12.5 fms, loc. 38b. Holotype, USNM 44648.

6. *Acropora rayneri* (Brook) (p. 431).
$\times$ 0.6. Seaward slope, Bikini Atoll, 27–42 fms, loc. 114. USNM 44665.



ACROPORA



ACROPORA

PLATE 135

FIGURES 1–4. *Acropora echinata* (Dana) (p. 423).

1, 2. × 0.54, × 2. Eniwetok Lagoon, 7.5 fms, loc. 87. USNM 44657.

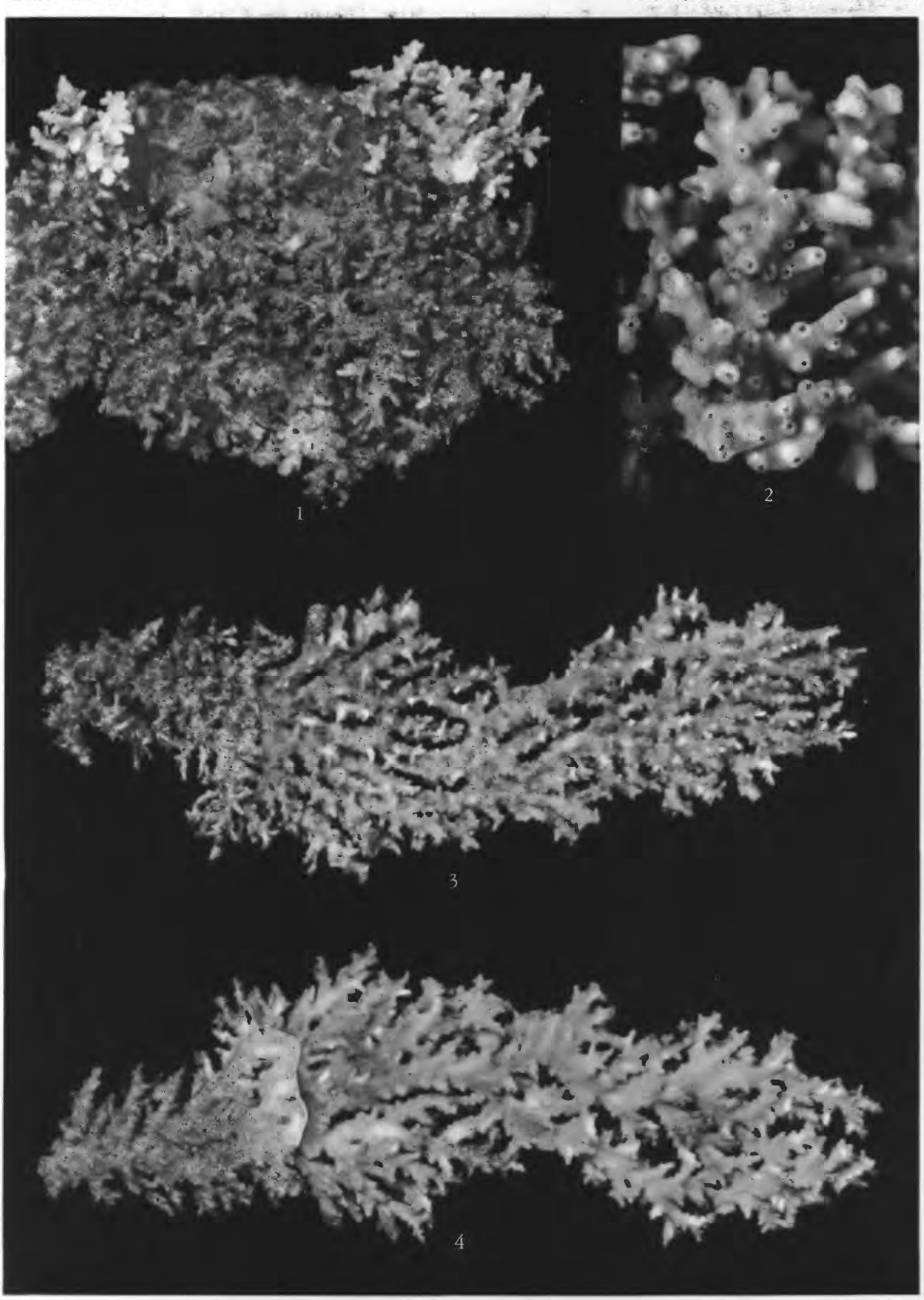
3, 4. × 0.27, × 1.8. Jaluit Atoll. Imp. Coll. 10.

PLATE 136

FIGURES 1–6. *Acropora echinata* (Dana) (p. 423).

1, 2. × 0.38, × 2. Bikini Lagoon, 4 fms, loc. 62. USNM 44655.
3, 4. × 0.54, × 2. Bikini Lagoon, 14 fms. loc. 36. USNM 44653.
5, 6. × 0.3, × 1.8. Jaluit Atoll. Imp. Coll. 7.

ACROPORA



ACROPORA

PLATE 137

FIGURES 1, 2. *Acropora rayneri* (Brook) (p. 431).
× 0.58, × 2. Bikini Lagoon, 22 fms, loc. 31. USNM 45172.

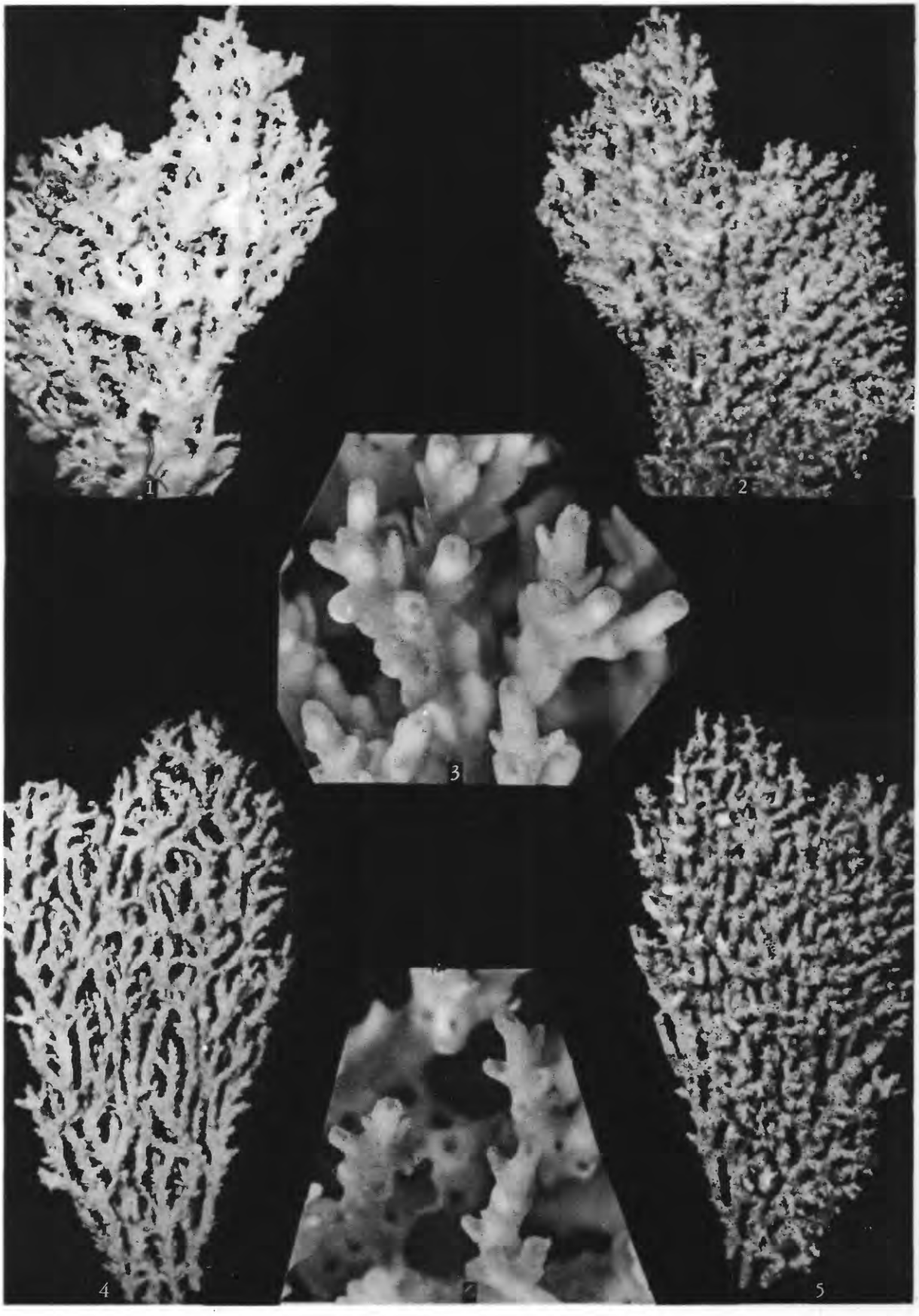
3, 4. *Acropora rambleri* (Bassett-Smith) (p. 431).
× 0.54, × 0.54. Bikini Lagoon, 26–30 fms, loc. 43. USNM 44670.

PLATE 138

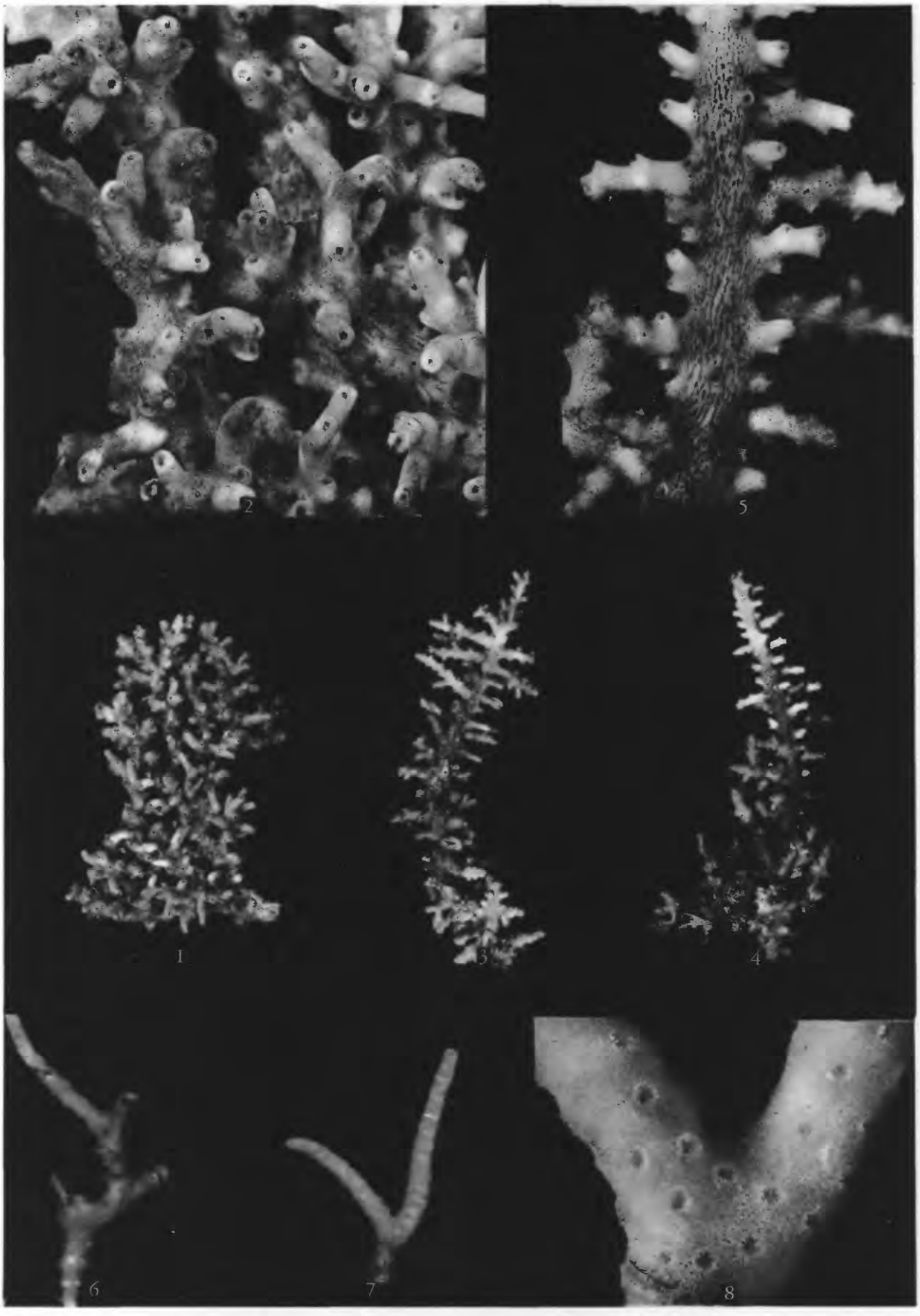
FIGURES 1–6. *Acropora rambleri* (Bassett-Smith) (p. 431).

1, 2, 3. × 0.45, × 0.45, × 4.5. Coral knoll, Bikini Lagoon, 17–23 fms, loc. 37. USNM 44669.

4, 5, 6. × 0.45, × 0.45, × 4.5. Seaward slope, Bikini Atoll, 25–44 fms, loc. 110. USNM 44672.



ACROPORA



ACROPORA AND *ANACROPORA*

PLATE 139

FIGURES 1, 2. *Acropora rayneri* (Brook) (p. 431).
× 0.54, × 2. Eniwetok Atoll, 15–20 fms, loc. 89. USNM 44662.

3–5. *Acropora tenella* (Brook) (p. 431).
× 0.54, × 0.54, × 2. Bikini Lagoon, 16 fms, loc. 59. USNM 44673.

6–8. *Anacropora gracilis* Quelch (p. 440).
× 0.9, × 0.9, × 5.4. Bikini Lagoon, 28 fms, loc. 32. USNM 44777.

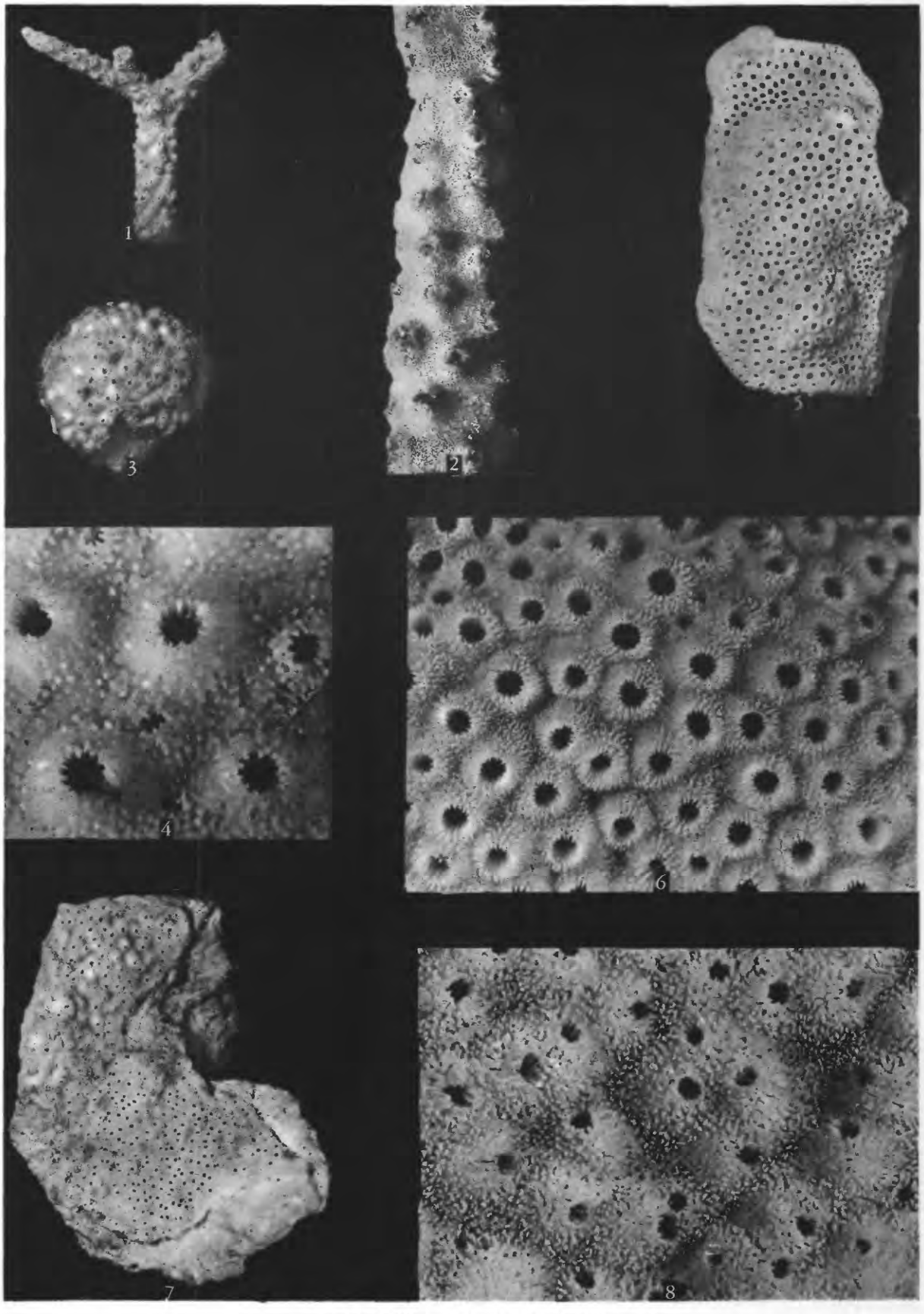
PLATE 140

FIGURES 1, 2. *Anacropora reptans* Bernard (p. 440).
× 0.9, × 4.5. Bikini Lagoon, 11 fms, loc. 83. USNM 44779.

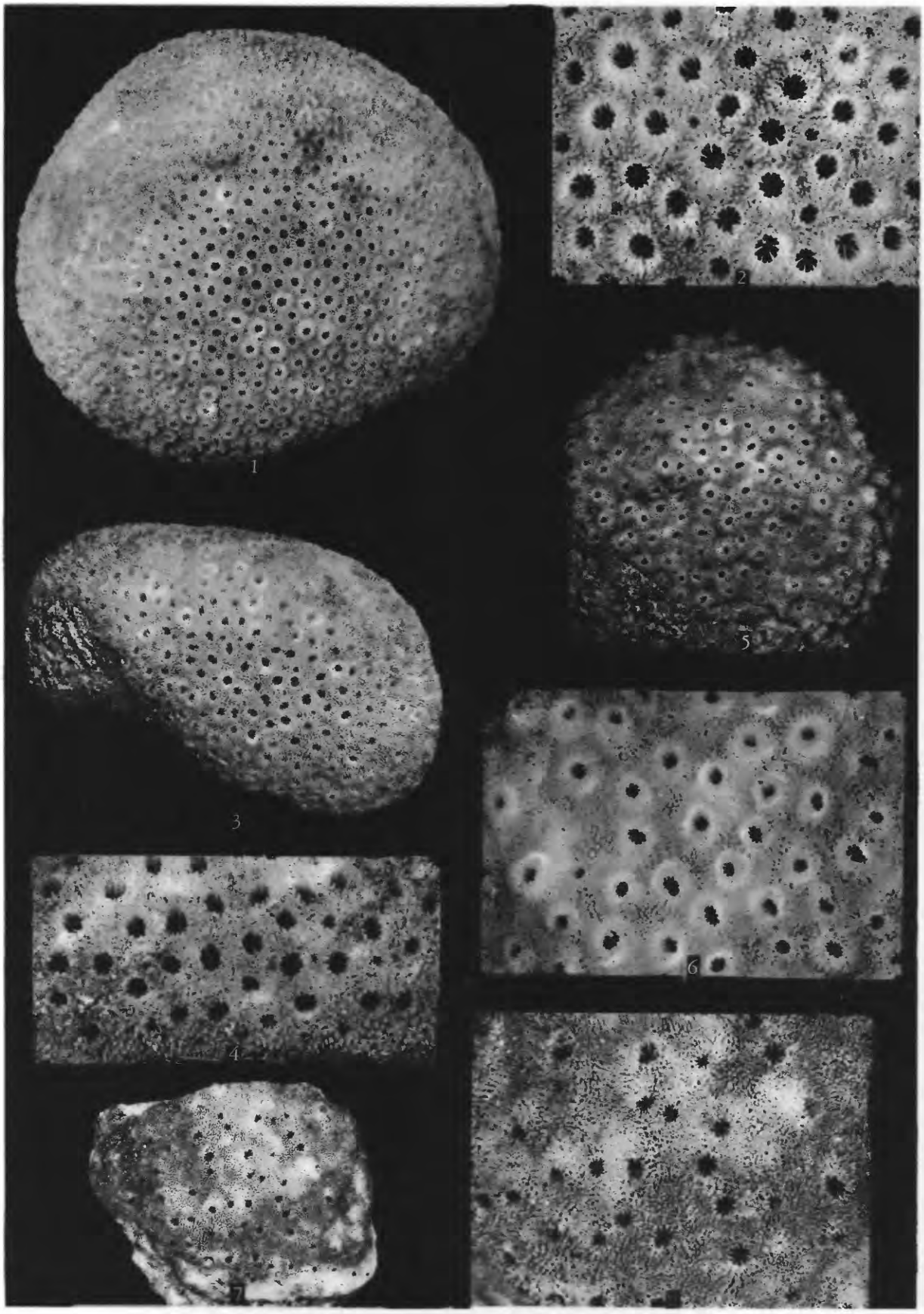
3, 4. *Astreopora tabulata* Wells, n. sp. (p. 432).
× 0.45, × 4.5. Seaward slope, Bikini Atoll, 33–48 fms, loc. 107. Holotype, USNM 44698.

5, 6. *Astreopora ocellata* Bernard (p. 432).
× 0.45, × 1.8. Bikini island, Bikini Atoll, loc. 10c. USNM 44695.

7, 8. *Astreopora suggesta* Wells, n. sp. (p. 433).
× 0.45, × 4.5. Seaward slope, Bikini Atoll, 27–42 fms, loc. 114. Holotype, USNM 44703.



ANACROPORA AND *ASTREOPORA*



ASTREOPORA

PLATE 141

FIGURES 1, 2. *Astreopora listeri* Bernard (p. 432).
× 0.6, × 2. Bikini Lagoon, 3.5 fms, loc. 39. USNM 44693.

3–6. *Astreopora myriophthalma* (Lamarck) (p. 431).
3, 4. Form *A*, × 0.76, × 2. Bikini Lagoon, 10 fms, loc. 44. USNM 44688.
5, 6, Form *C*, × 0.76, × 2. Bikini Lagoon, 22 fms, loc. 31. USNM 44705.

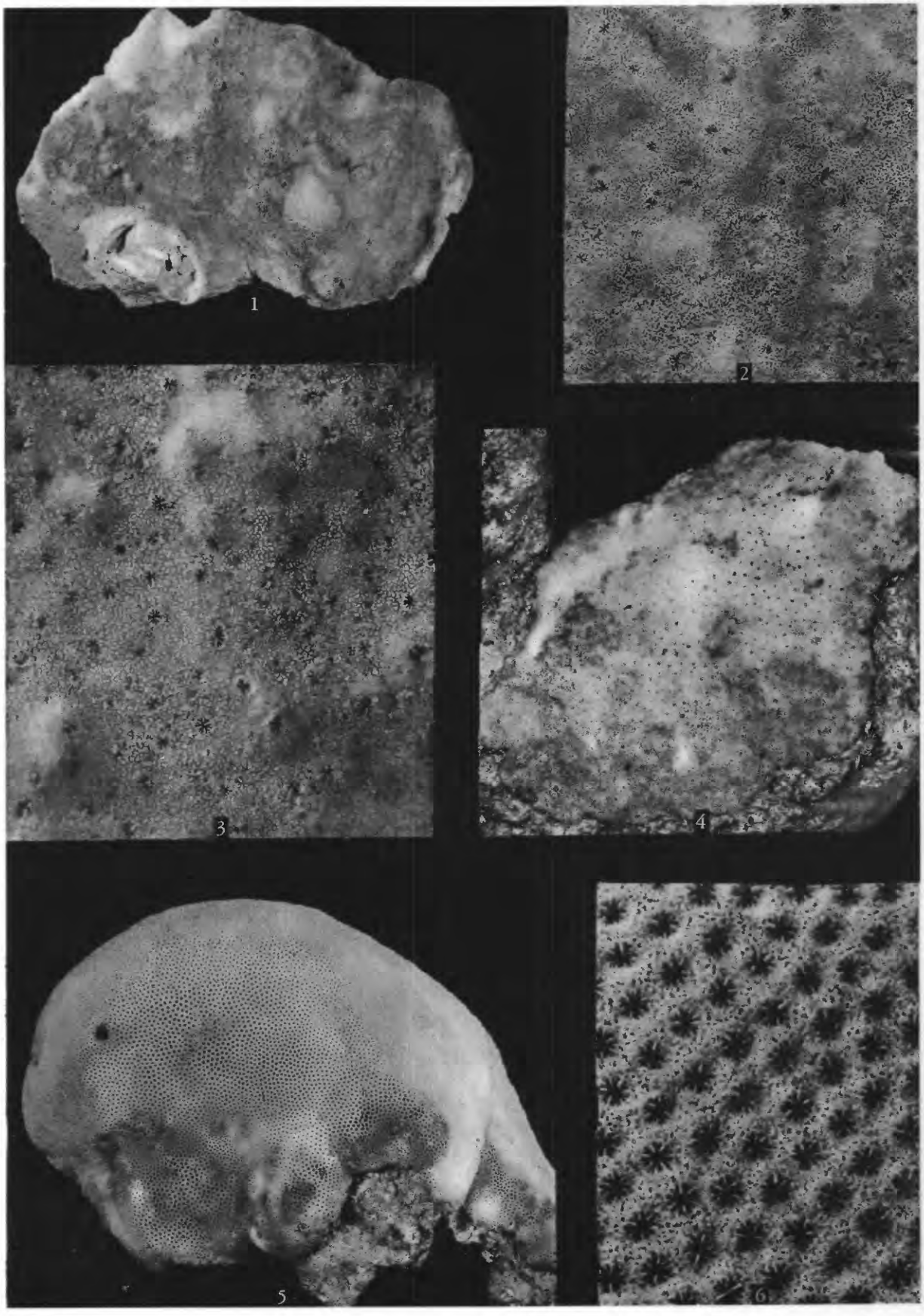
7, 8. *Astreopora* sp. cf. *A. gracilis* Bernard (p. 432).
× 0.76, × 2. Bikini Lagoon, 10 fms, loc. 44. USNM 44694.

PLATE 142

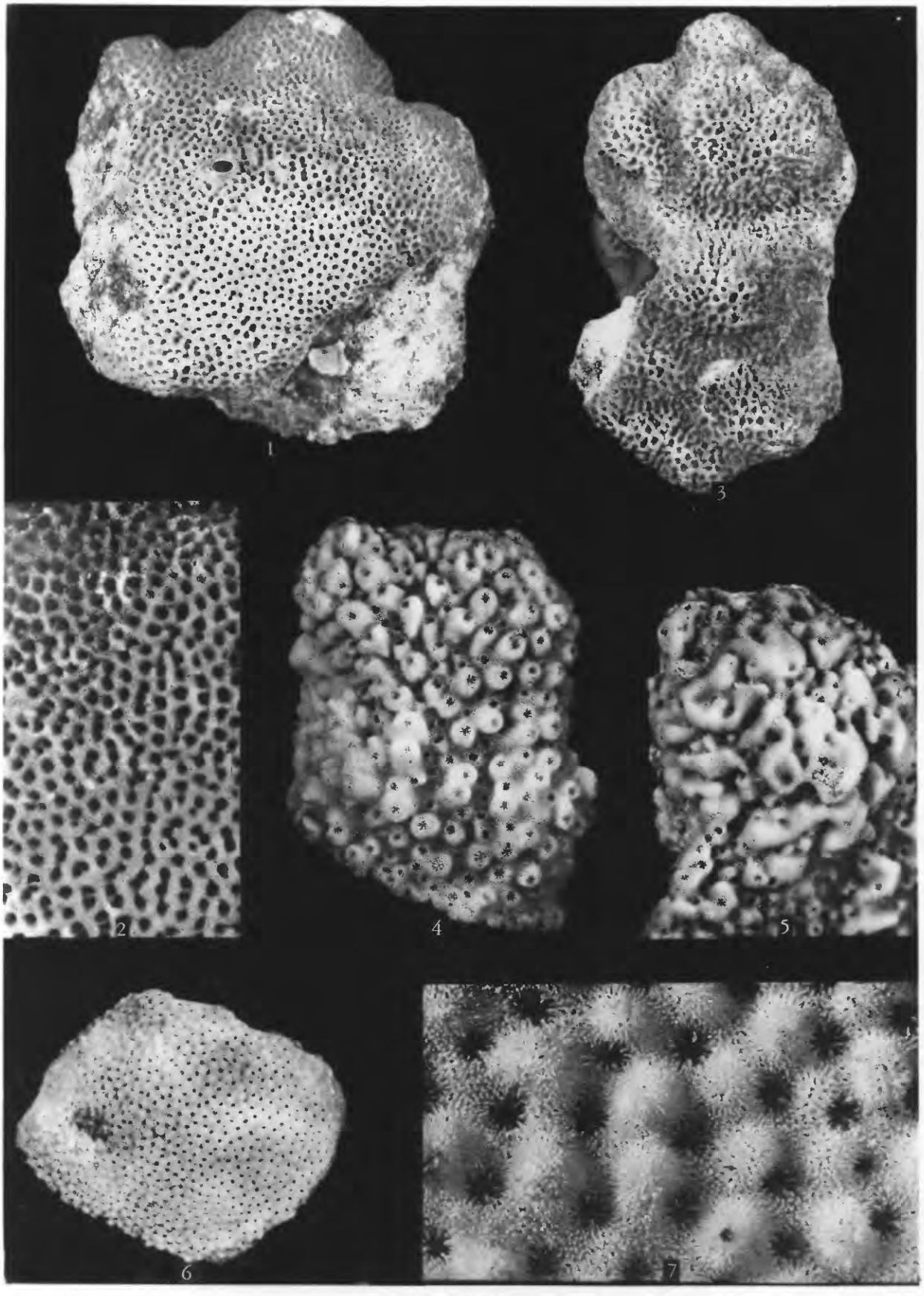
FIGURES 1, 2. *Montipora granulosa* Bernard (p. 434).
× 0.4, × 4.5. Seaward slope, Bikini Atoll, 50–97 fms, loc. 106. USNM 44706

3, 4. *Montipora subtilis* Bernard (p. 433).
× 1.35, × 5.4. Bikini Lagoon, 22 fms, loc. 31. USNM 44705.

5, 6. *Montipora turgescens* Bernard (p. 435).
× 0.54, × 5.4. Lagoon reef, Bikini island, loc. 10f. USNM 44721.



MONTIPORA



MONTIPORA

PLATE 143

FIGURES 1–3. *Montipora socialis* Bernard (p. 435).
× 0.9, × 2, × 0.9. Rigili island, Eniwetok Atoll. Figure 2 shows *M. vaughani* condition. Loc. 13. USNM 44716.

4, 5. *Montipora* sp. cf. *M. studeri* Vaughan (p. 436).
4. × 2. Bikini Lagoon, 3.5 fms. loc. 39. USNM 44740
5. × 2. Bikini Lagoon, 10 fms, loc. 39a. USNM 44741.

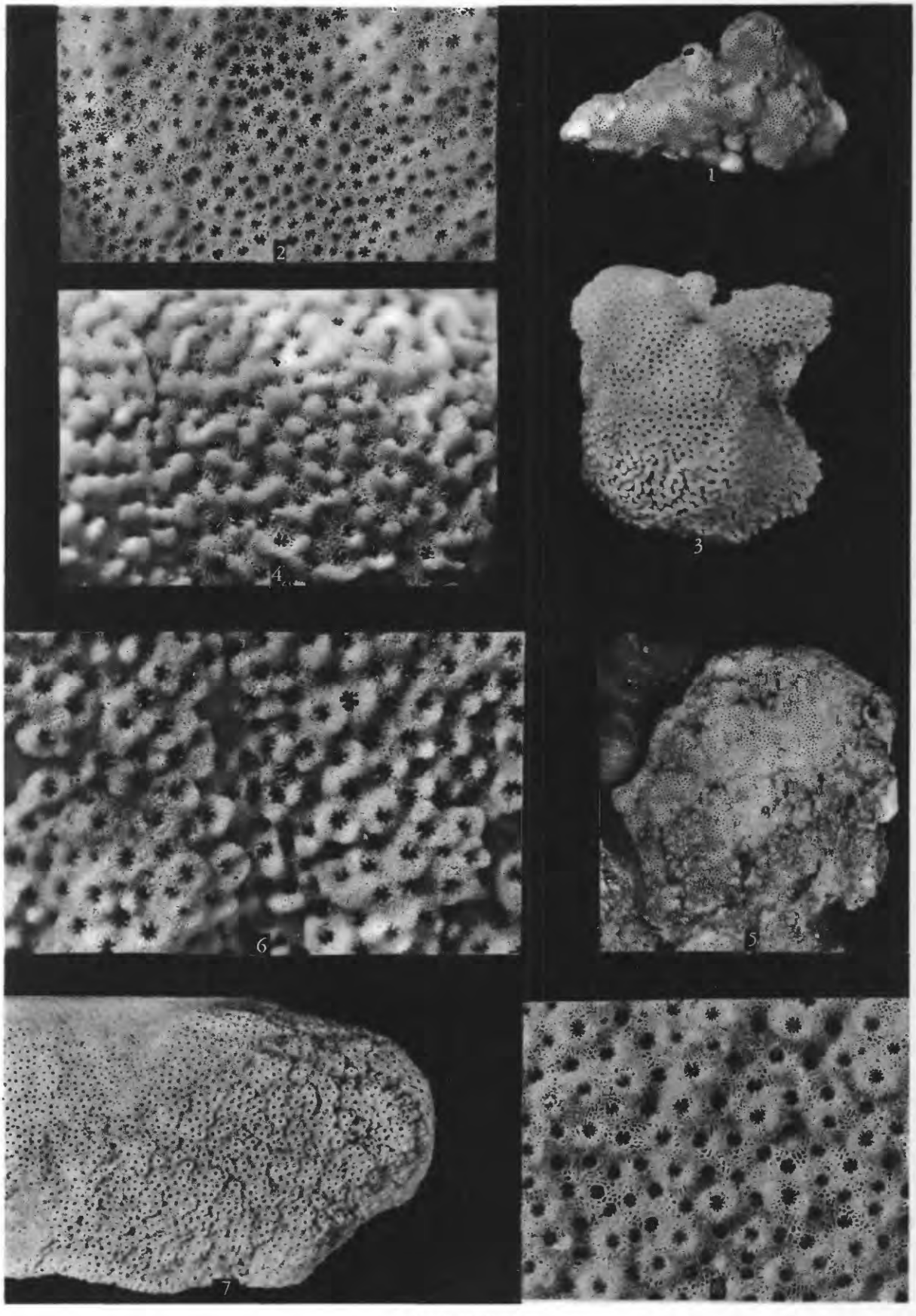
6, 7. *Montipora verrucosa* (Lamarck) (p. 438).
× 0.6, × 5.4. Bikini Lagoon, 22 fms, loc. 30. USNM 44749.

PLATE 144

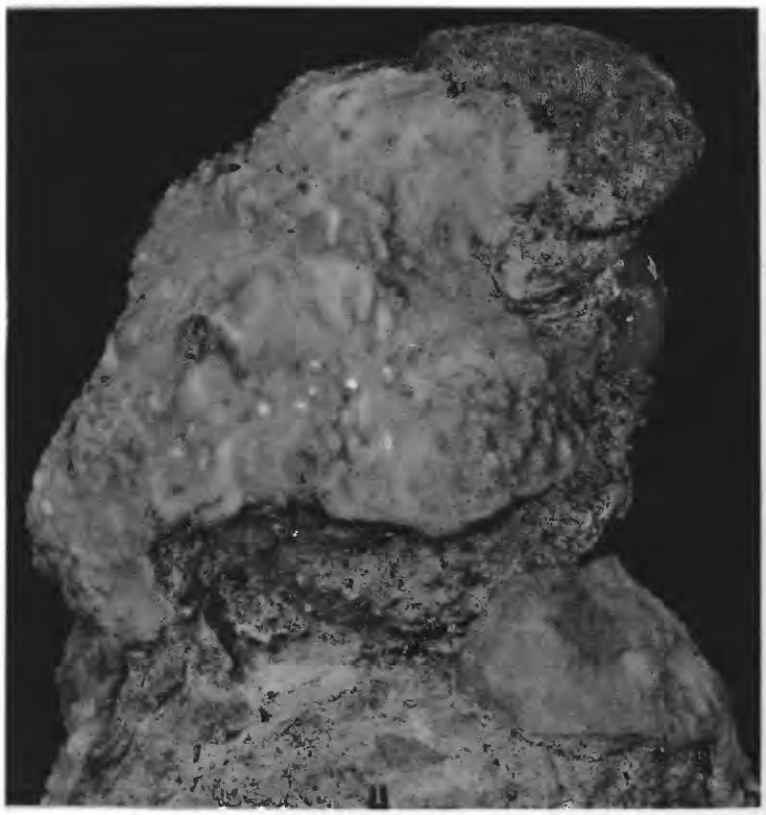
FIGURES 1, 2. *Montipora elschneri* Vaughan (p. 435).
× 0.45, × 4.5. Enirik island, Bikini Atoll, loc. 1a. USNM 44724.

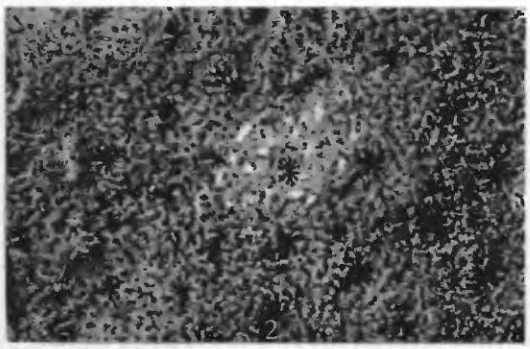
3, 4. *Montipora tuberculosa* (Lamarck) (p. 436).
× 0.9, × 4.5. Ourukaen island, Bikini Atoll, loc. 4a. USNM 44722.

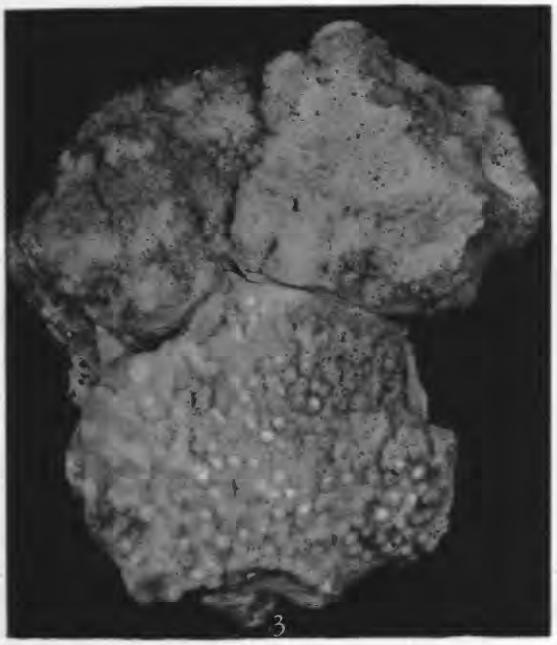
5–8. *Montipora caliculata* (Dana) (p. 434).
5, 6. × 0.63, × 5.4. Bikini Lagoon, 4 fms, loc. 45. USNM 44729.
7, 8. × 0.9, × 4.5. Eniairo-Rochikarai islands, Bikini Atoll, loc. 11. USNM 44712.

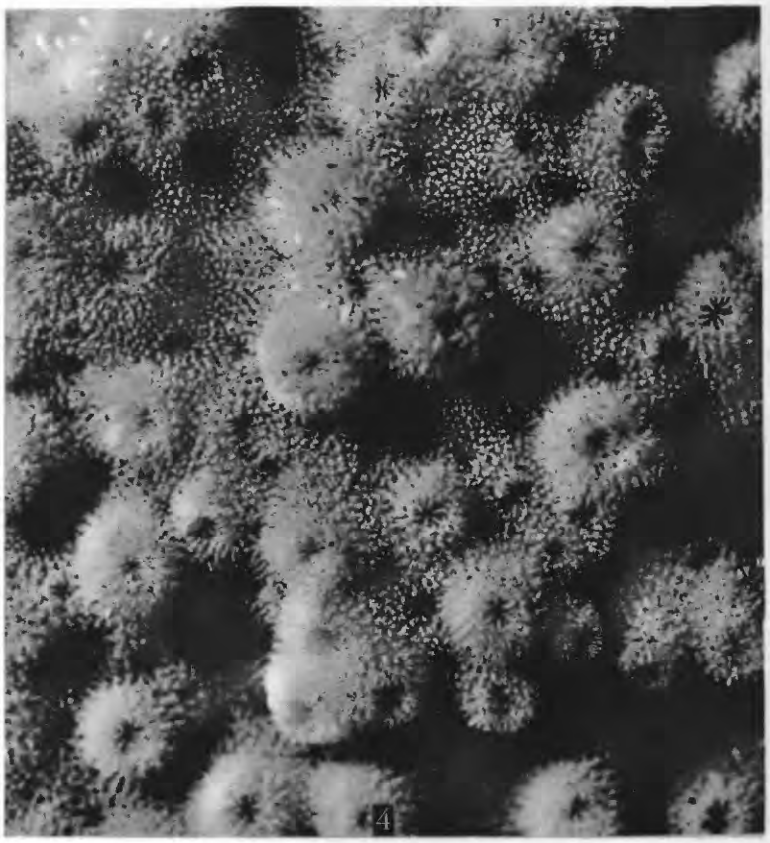


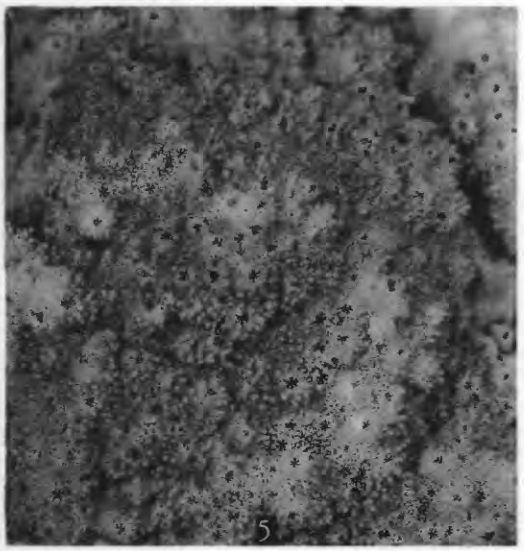
MONTIPORA











MONTIPORA

PLATE 145

FIGURE 1. *Montipora hoffmeisteri* Wells, n. sp (paratype) and *M.* sp. cf. *M. complanata* Bernard (p. 434).
× 0. 6. Bikini Lagoon, 10 fms, loc. 44. USNM 45176.

2. *Montipora* sp. cf. *M. complanata* Bernard (p. 434).
× 5.4. Portion of above specimen.

3. *Montipora hoffmeisteri* Wells, n. sp. (holotype) and *M. verrilli* Vaughan (p. 438).
× 0.6. Bikini Lagoon, 10 fms, loc. 44. USNM 44730.

4. *Montipora hoffmeisteri* Wells, n. sp. (holotype).
× 5.4. Portion of specimen in figure 3.

5. *Montipora verrilli* Vaughan.
× 2. Portion of specimen in figure 3.

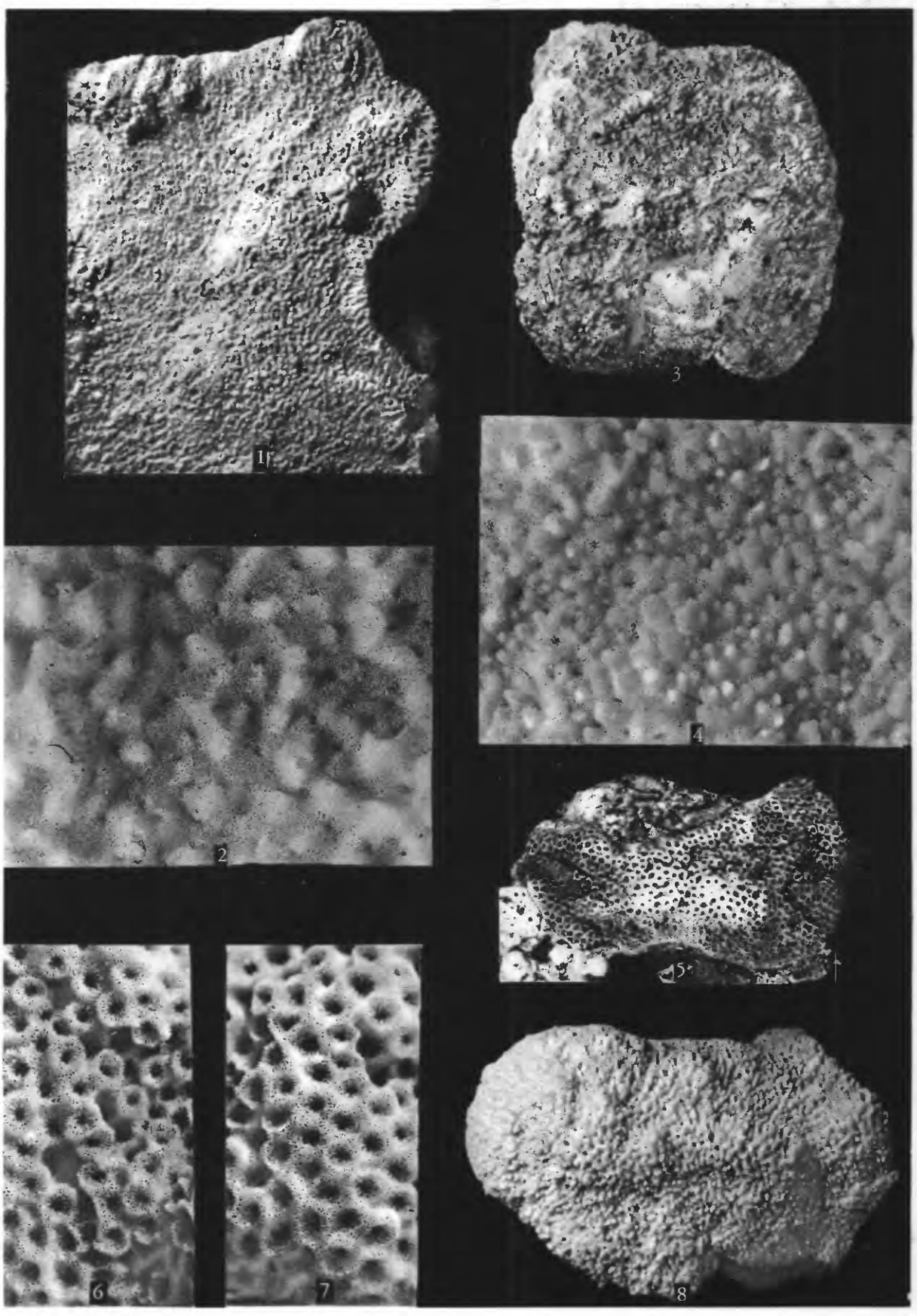
PLATE 146

FIGURES 1, 2. *Montipora colei* Wells, n. sp. (p. 437).
× 0.45, × 4.5. Seaward slope, Bikini Atoll, 59–90 fms, loc. 109. Holotype, USNM 44744.

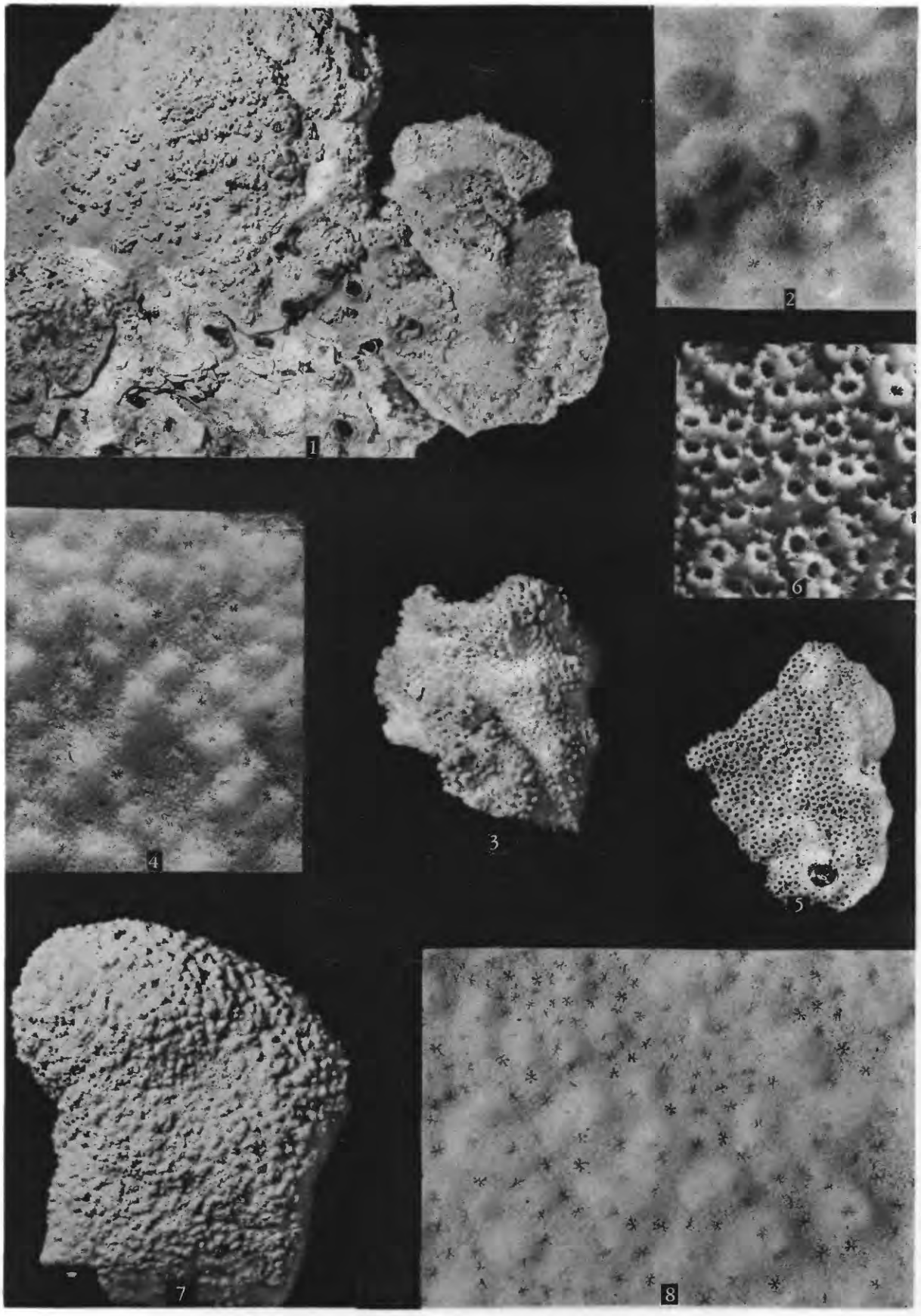
3, 4. *Montipora conicula* Wells, n. sp. (p. 436).
× 0.45, × 4.5 Coral knoll, Bikini Lagoon, 8.5–23.5 fms, loc. 38a. Holotype, USNM 44742.

5–7. *Montipora foveolata* (Dana) (p. 434).
× .09, × 4.5, × 4.5. Busch island, Rongelap Atoll, loc. 22. USNM 44709.

8. *Montipora tuberculosa* (Lamarck) (p. 436).
× 1. Coral knoll, Bikini Lagoon, 7–14 fms, loc. 49. USNM 44734.



MONTIPORA



MONTIPORA

PLATE 147

FIGURES 1, 2. *Montipora danae* Milne-Edwards and Haime (p. 438).
× 0.23, × 4.5. Coral knoll, Bikini Lagoon, 7–14 fms, loc. 37a. USNM 44752.

3. *Montipora verrucosa* (Lamarck) (p. 438).
× 0.45. Latoback island, Rongerik Atoll, loc. 20a. USNM 44748.

4. *Montipora floweri* Wells, n. sp. (p. 437)
× 4.5. Coral knoll, Bikini Lagoon, 6 fms, loc. 49. USNM 44745.

5, 6. *Montipora* sp. cf. *M. myriophthalma* (Bernard) (p. 439).
× 0.9, × 4.5. Ourukaen island, Bikini Atoll, loc. 4a. USNM 44762.

7, 8. *Montipora floweri* Wells, n. sp. (p. 437).
×0.45, × 4.5. Seaward slope, Bikini Atoll, 25–44 fms, loc. 110. Holotype, USNM 44746.

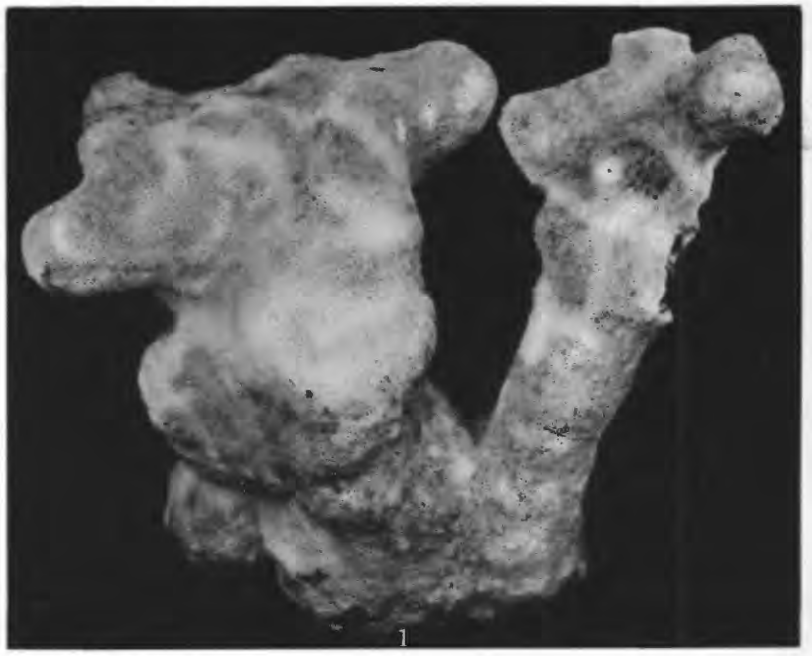
293438—54——E

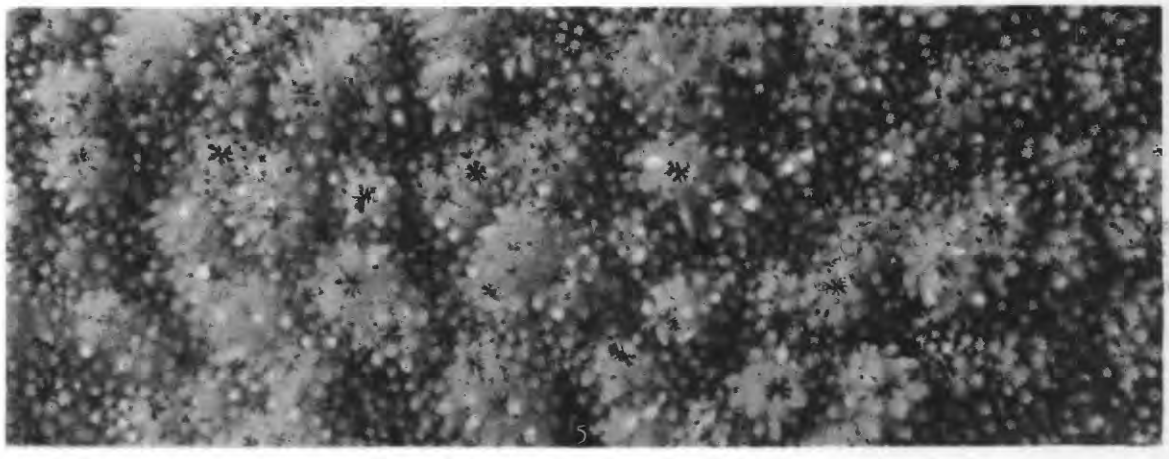
PLATE 148

FIGURES 1, 2. *Montipora verrilli* Vaughan (p. 438).
× 0.6, × 6. Enirik island, Bikini Atoll, loc. 1. USNM 44754.

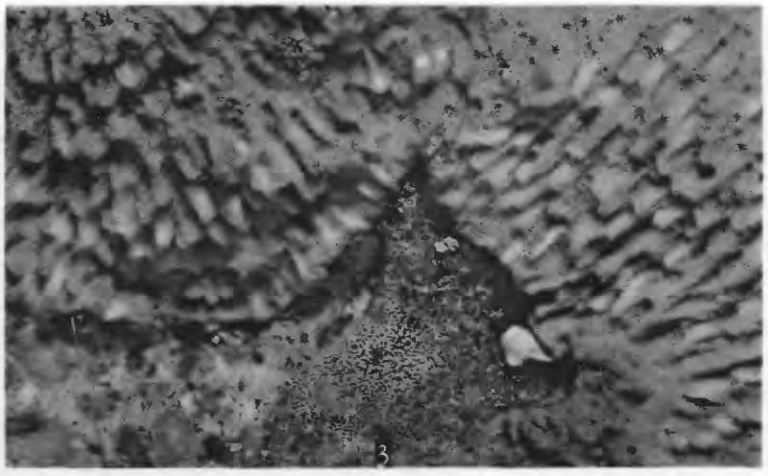
3. *Montipora granulata* Bernard (p. 439).
× 5.4. Bikini Lagoon, 30 fms, loc. 43. USNM 44761.

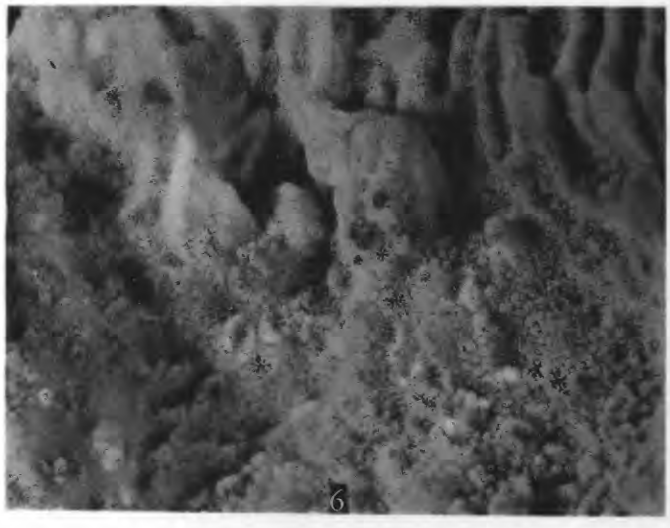
4, 5. *Montipora composita* Crossland (p. 439).
× 0.54, × 5.4. Bikini Lagoon, 10 fms, loc. 44. USNM 44769.





MONTIPORA





MONTIPORA

PLATE 149

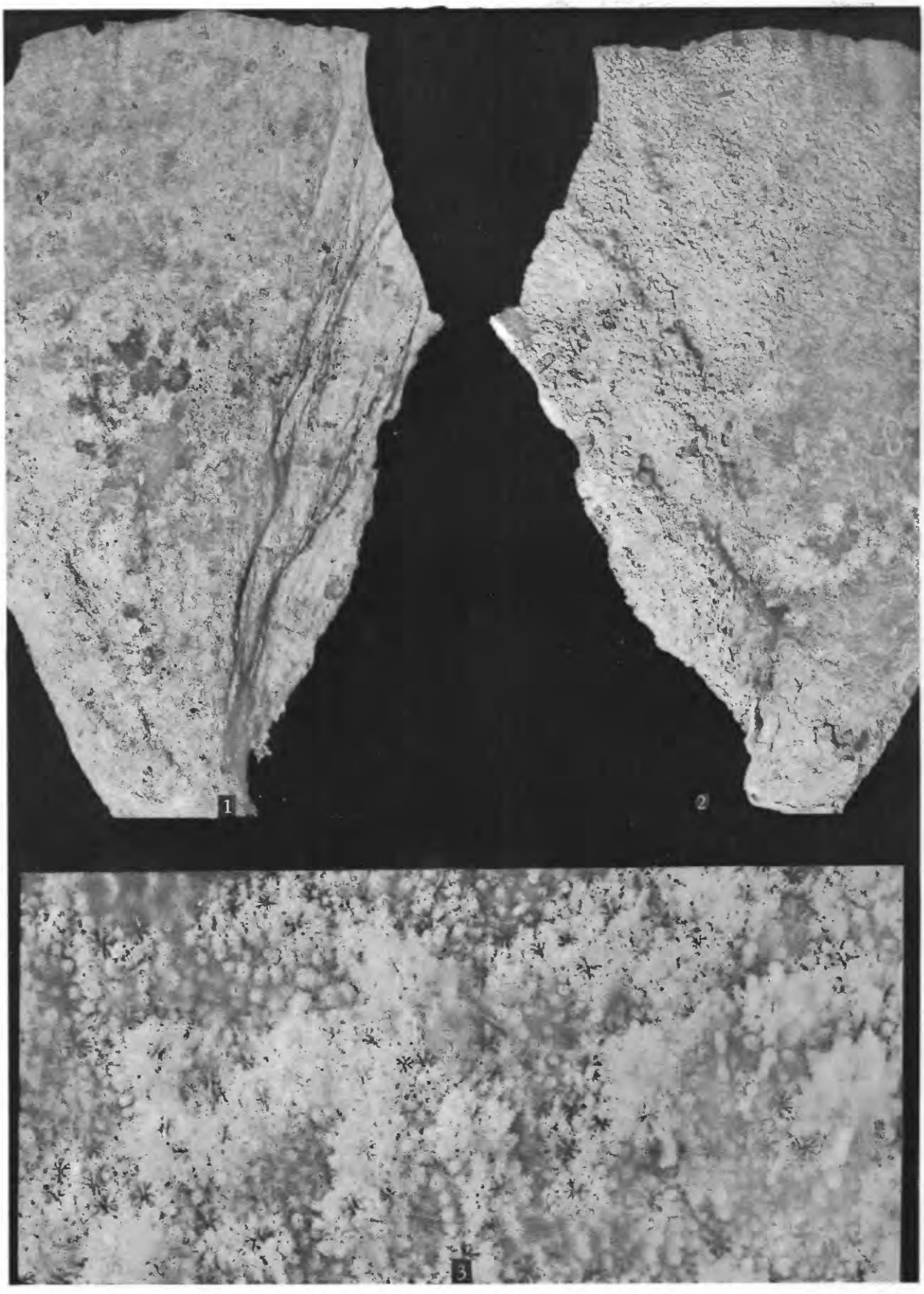
FIGURES 1–6. *Montipora minuta* Bernard (p. 439).

1, 2, 3, 4. × 0.63, × 0.63, × 2.3, × 5.4. Bikini Lagoon, 30 fms, loc. 43. USNM 44766.

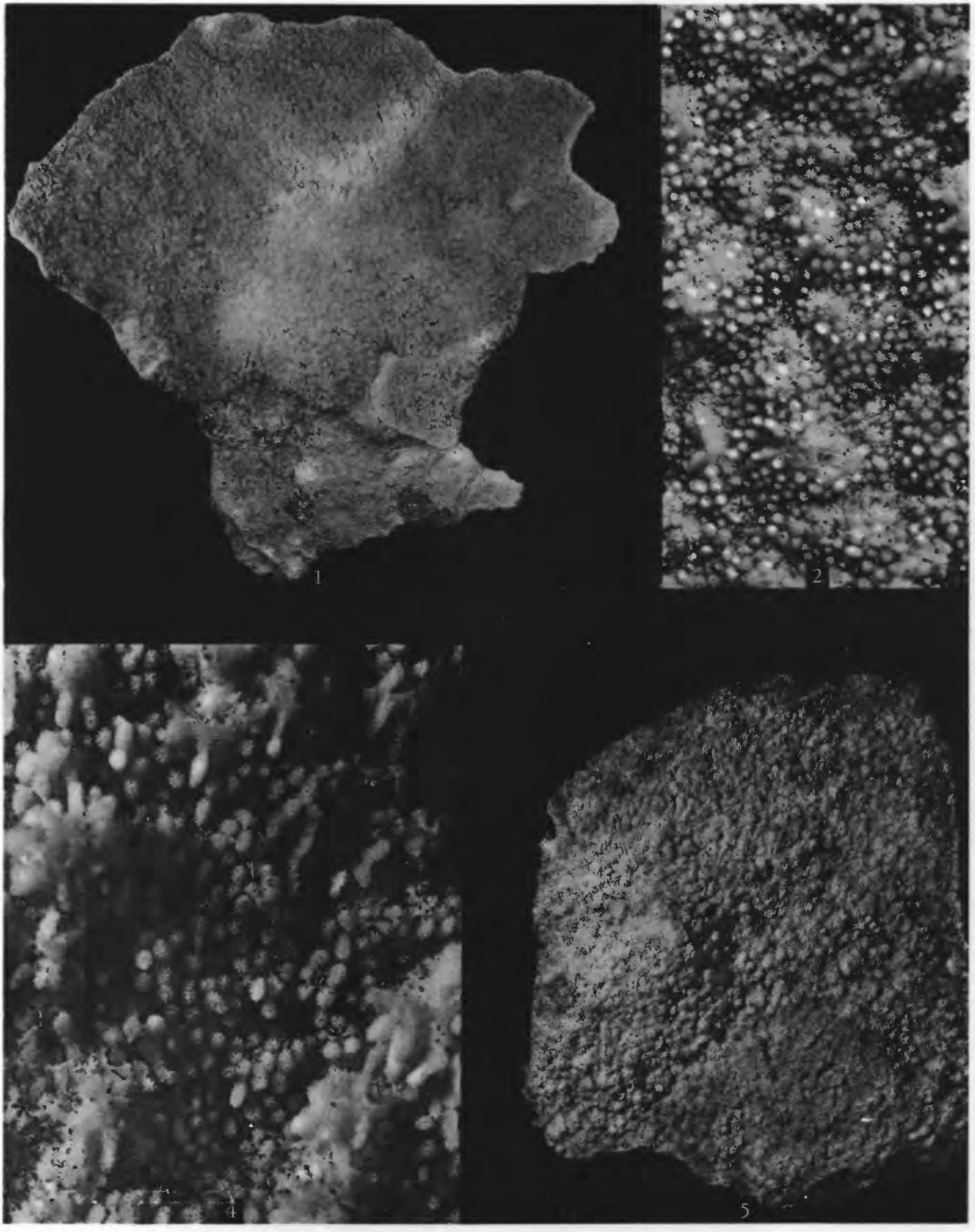
5, 6. × 0.45, × 4.5. Coral knoll, Bikini Lagoon, 6.5–14 fms, loc. 37a. USNM 44765.

PLATE 150

FIGURES 1–3. *Montipora composita* Crossland (p. 439).
× 0.3, × 0.3, × 5.4. Bikini Lagoon, 30 fms, loc. 43. USNM 44768.



MONTIPORA



MONTIPORA

PLATE 151

FIGURES 1–4. *Montipora marshallensis* Wells, n. sp. (p. 440).

1, 2. × 0.45, × 5.4. Bikini Lagoon, 30 fms. Specimen *A*, Paratype A, loc. 43, USNM 44772.

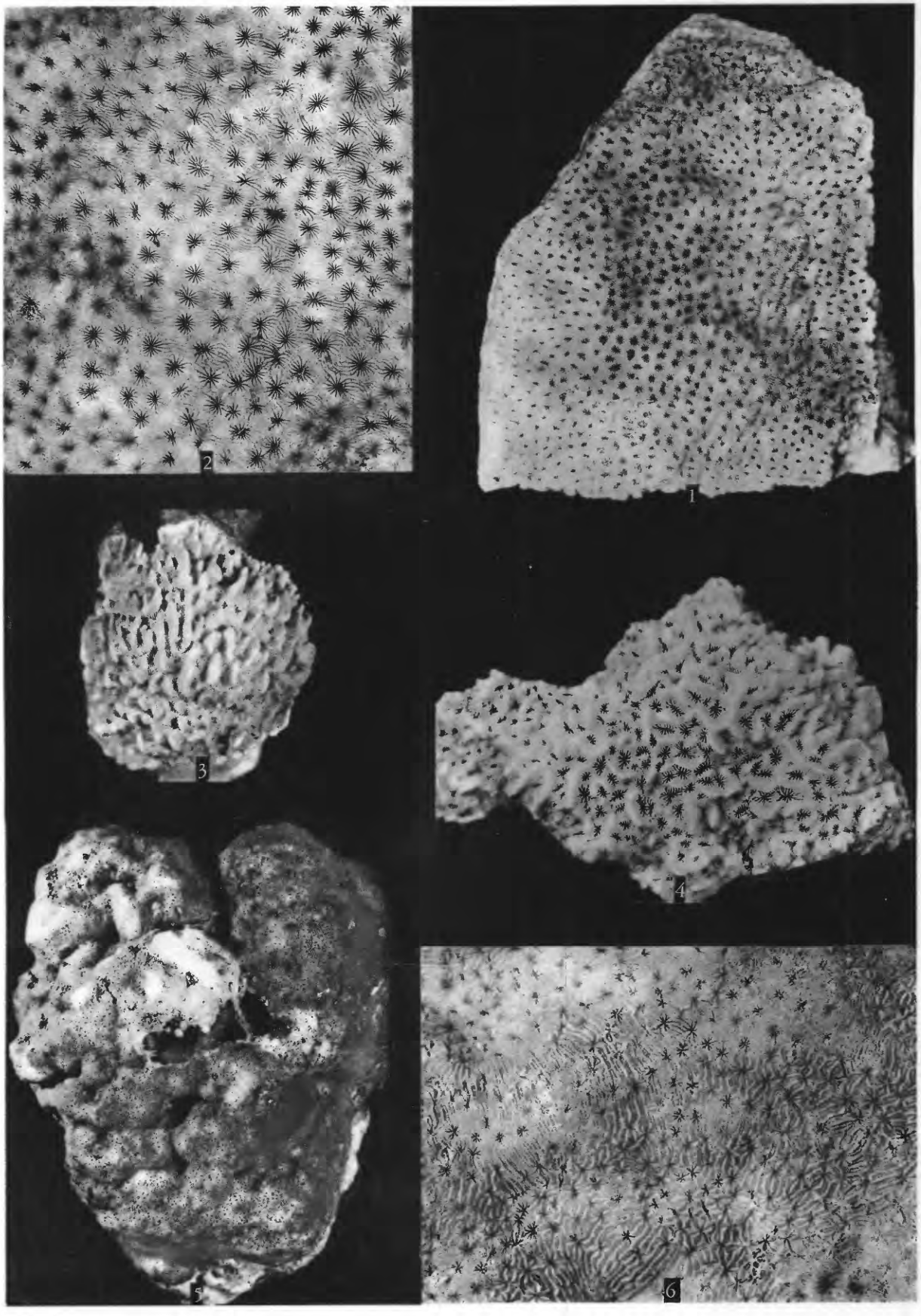
3, 4. × 0.6, × 5.4. Bikini Lagoon, 30 fms, loc. 43. Holotype, USNM 44771.

PLATE 152

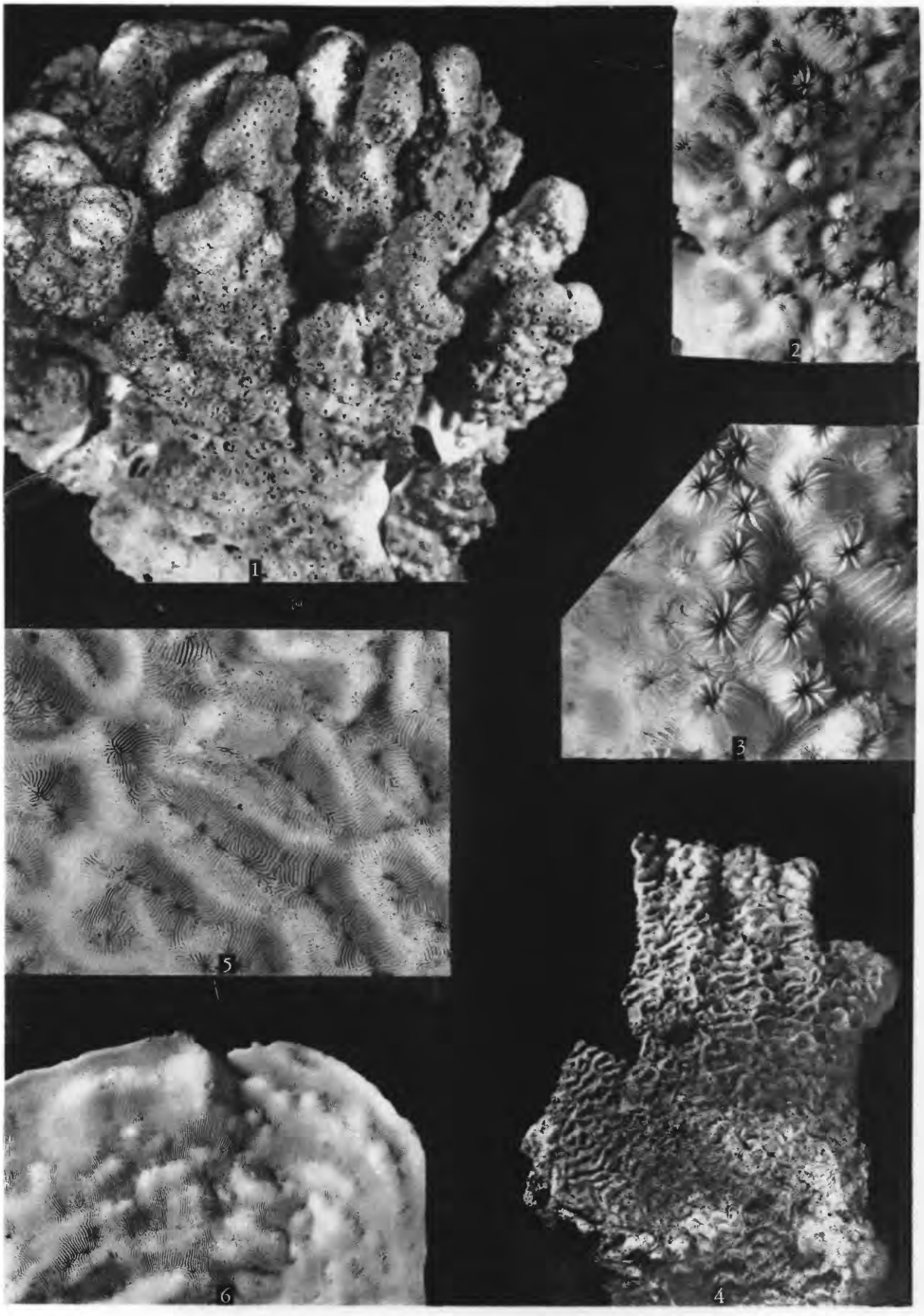
FIGURES 1, 2. *Pavona clavus* (Dana) (p. 441).
× 0.9, × 2. Bikini Lagoon, 10 fms, loc. 44. USNM 44784.

3, 4. *Pavona varians* Verrill (p. 442).
3. × 0.9. Namu island, Bikini Atoll, loc. 7a. USNM 44787.
4. × 0.9. Bikini island, Bikini Atoll, loc. 10c. USNM 44788.

5, 6. *Pavona minuta* Wells, n. sp. (p. 442).
× 0.45, × 4.5. Coral knoll, Bikini Lagoon, 6–2.5 fms, loc. 38b. Holotype, USNM 44786.



PAVONA



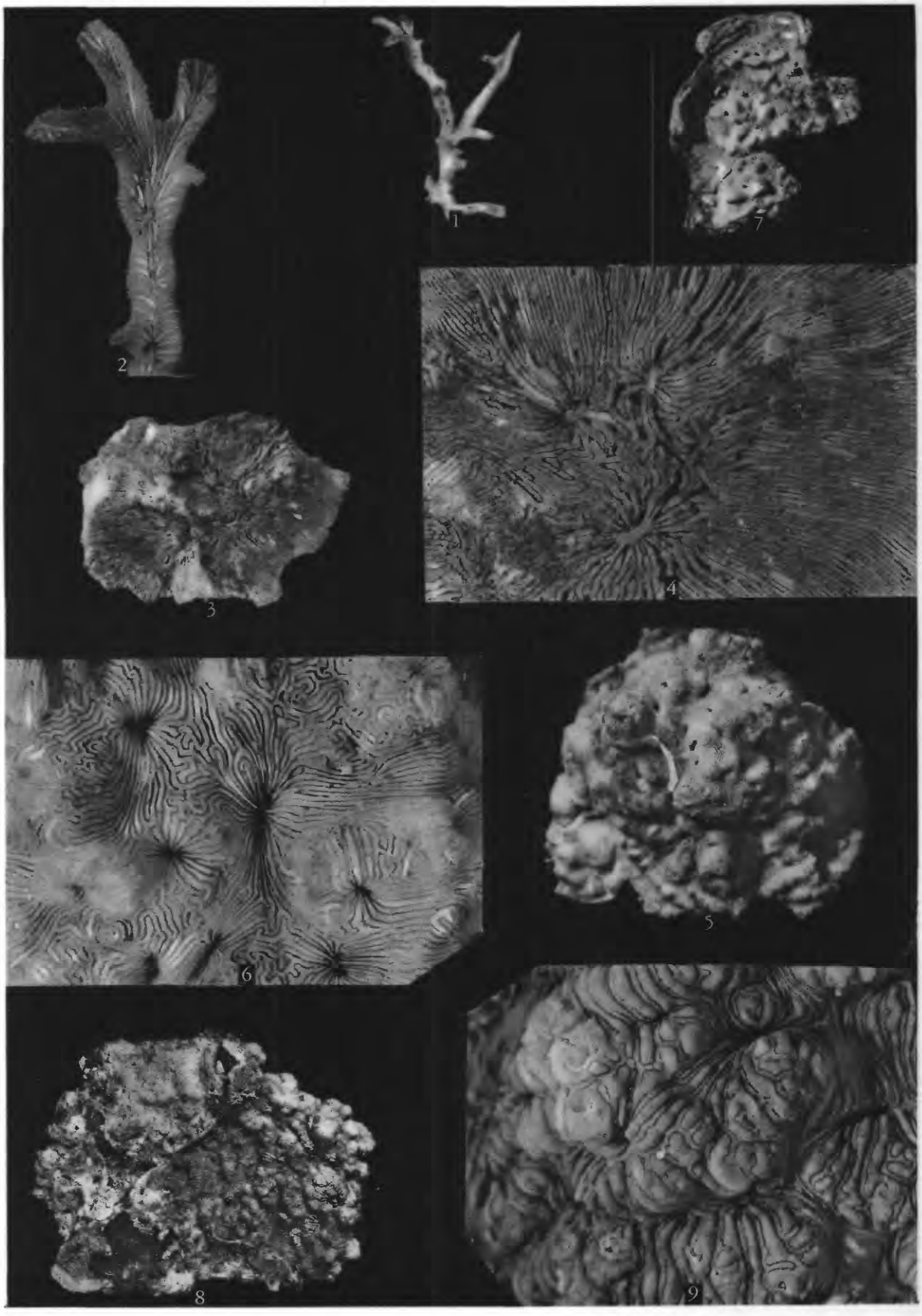
PAVONA (*PSEUDOCOLUMNASTRAEA*) AND *LEPTOSERIS*

PLATE 153

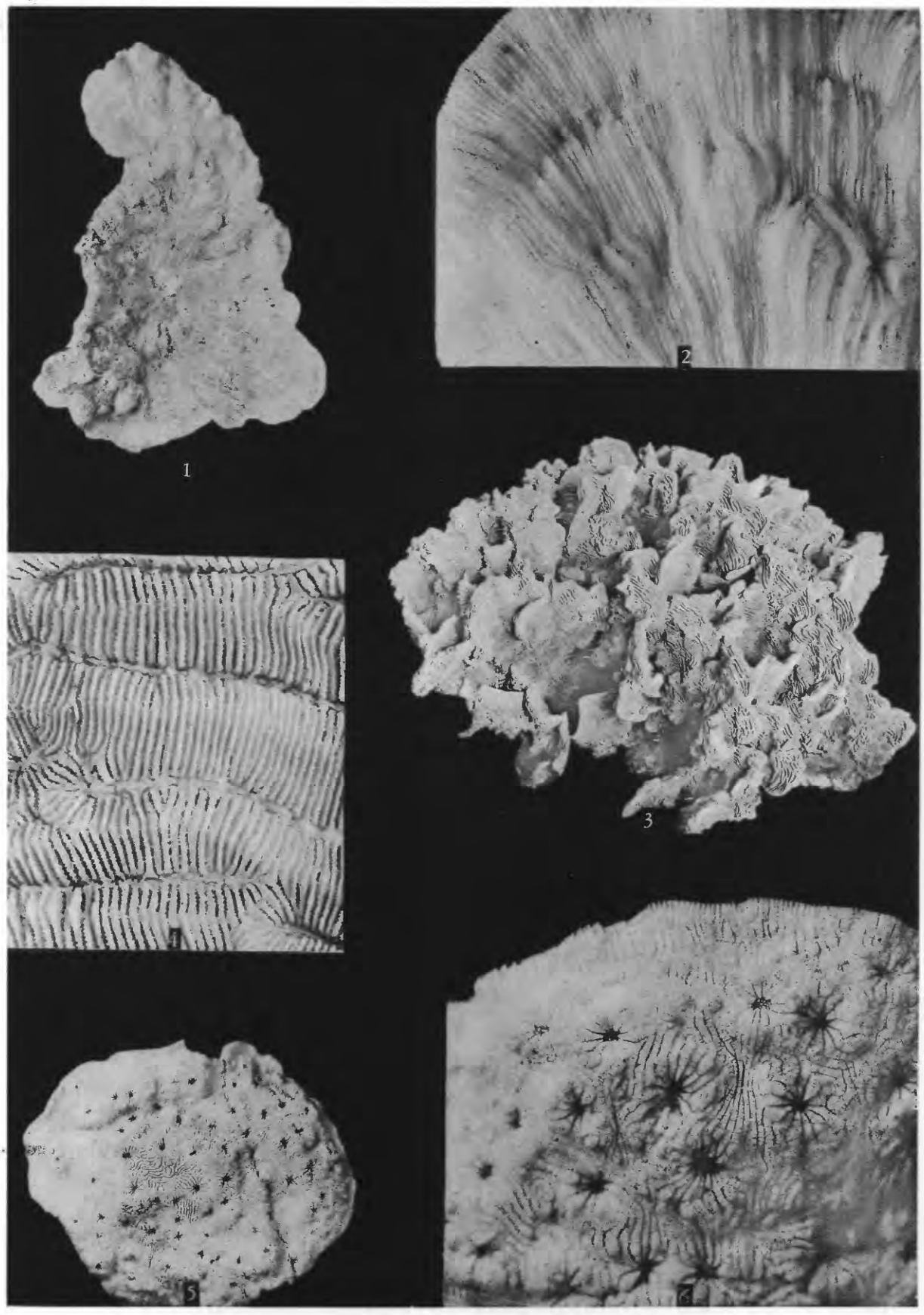
FIGURES 1–3. *Pavona* (*Pseudocolumnastrea*) *pollicata* Wells, n. sp. (p. 443).
× 0.45, × 1.8, × 4.5. Seaward slope, Bikini Atoll, 12.5–17 fms, loc. 103. Holotype, USNM 44792.
4–6. *Leptoseris? mycetoseroides* Wells, n. sp. (p. 445).
4, 5. × 0.45, × 4.5. Seaward slope, Bikini Atoll, 25–44 fms, loc. 110. Holotype, USNM 44805.
6. × 2. Loc. 110. Showing *Leptoseris* condition of margin. Paratype, USNM 44806.

PLATE 154

FIGURES 1, 2. *Leptoseris papyracea* (Dana) (p. 443).
× 0.9, × 4.5. Seaward slope, Bikini Atoll, 50–96 fms, loc. 106. USNM 44794.
3, 4. *Leptoseris hawaiiensis* Vaughan (p. 444).
× 0.9, × 4.5. Seaward slope, Bikini Atoll, 50–96 fms, loc. 106. USNM 44800.
5–7. *Leptoseris incrustans* (Quelch) (p. 444).
5, 6. × 0.9, × 4.5. Coral knoll, Bikini Atoll, 8–12.5 fms, loc. 38a. USNM 44798.
7. × 0.45. Seaward slope, Bikini Atoll, 33.5–48 fms, loc. 107. USNM 44796.
8, 9. *Leptoseris solida* (Quelch) (p. 444).
× 0.45, × 4.5. Seaward slope, Bikini Atoll, 58–90 fms, loc. 109. USNM 44799.



LEPTOSERIS



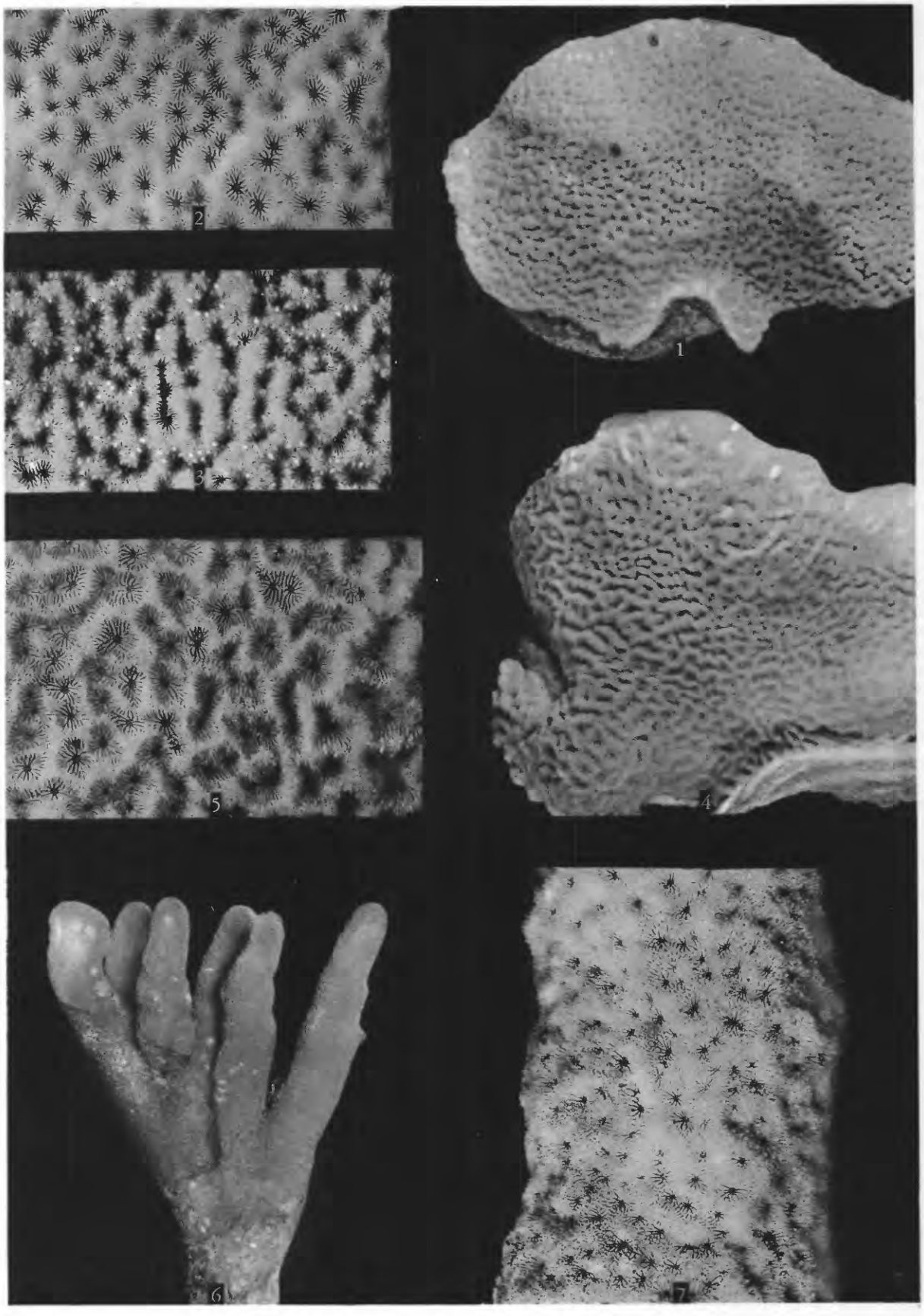
LEPTOSERIS, PACHYSERIS, AND *COSCINARAEA*

PLATE 155

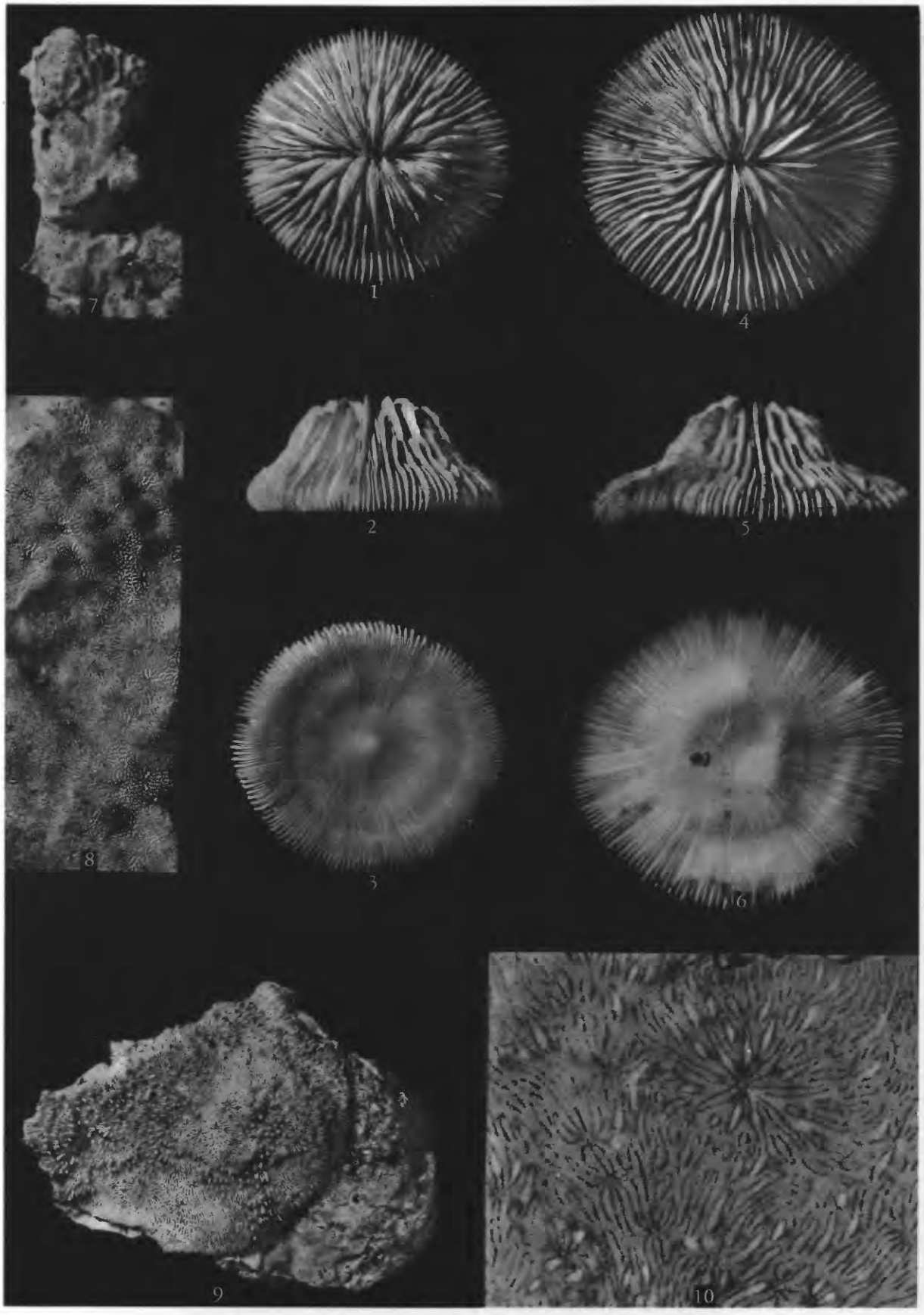
FIGURES 1, 2. *Leptoseris scabra* Vaughan (p. 444).
× 0.54, × 4.5. Seaward slope, Bikini Atoll, 50–97 fms, loc. 106. USNM 44801.
3, 4. *Pachyseris rugosa* (Lamarck) (p. 445).
× 0.23, × 5.4. Jaluit Atoll. Imp. Coll. 5.
5, 6. *Coscinaraea ostreaeformis* van der Horst (p. 446).
× 0.9, × 4.5. Seaward slope, Bikini Atoll, 29–42 fms, loc. 114. USNM 44818.

PLATE 156

FIGURES 1–3. *Coscinaraea columna* (Dana) (p. 446).
1, 2. × 0.63, × 2. Enyu island, Bikini Atoll, loc. 12a. USNM 44815.
3. × 2. Bikini island, Bikini Atoll, loc. 10d. USNM 44811.
4, 5. *Coscinaraea fossata* (Dana) (p. 446).
× 0.63, × 2. Reef, Funafuti Atoll, Ellice islands. USNM.
6, 7. *Psammocora togianensis* Umbgrove (p. 410).
× 0.23, × 1.8. Jaluit Atoll. Imp. Coll. 45.



COSCINARAEA AND *PSAMMOCORA*



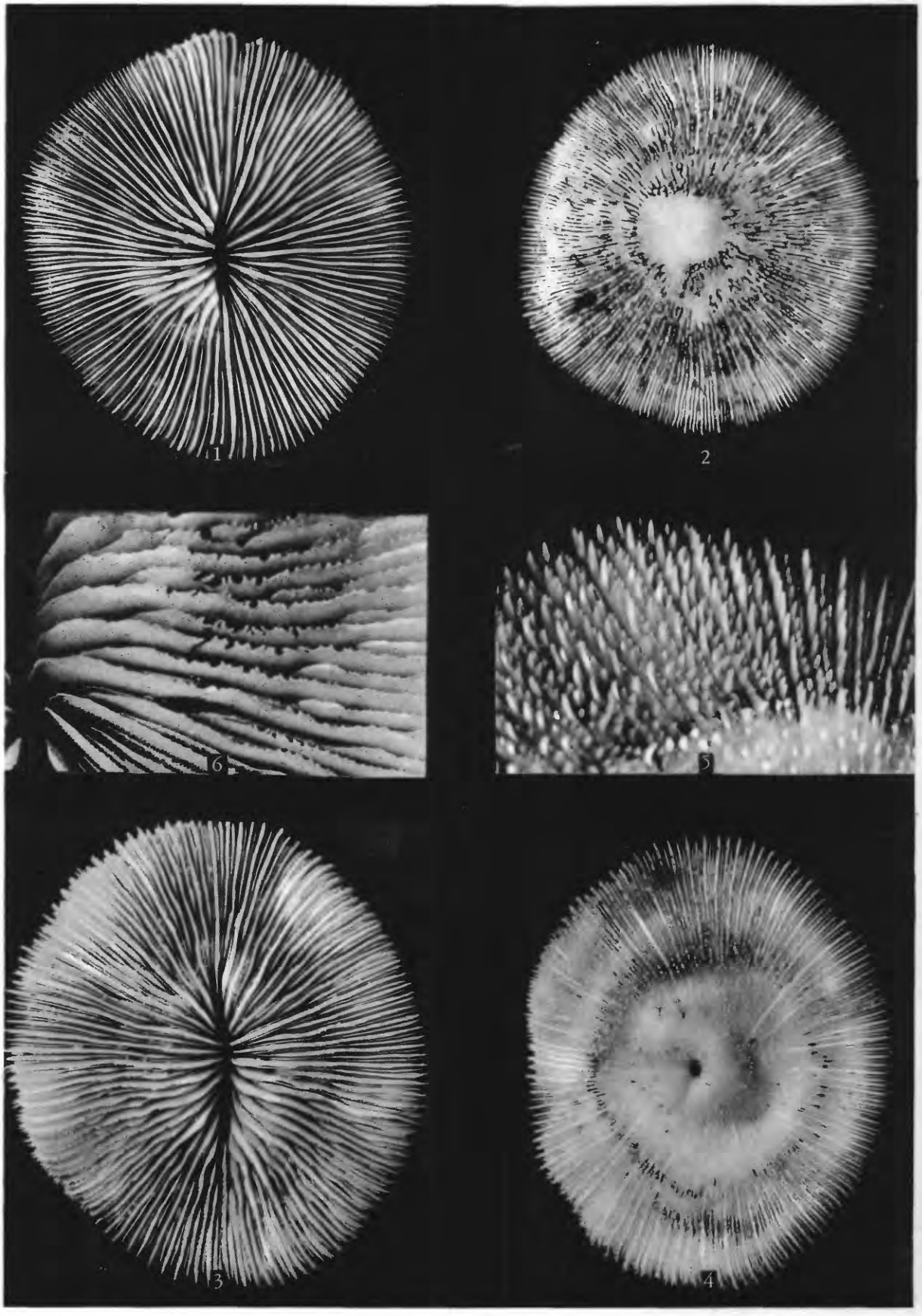
CYCLOSERIS AND *PSAMMOCORA*

PLATE 157

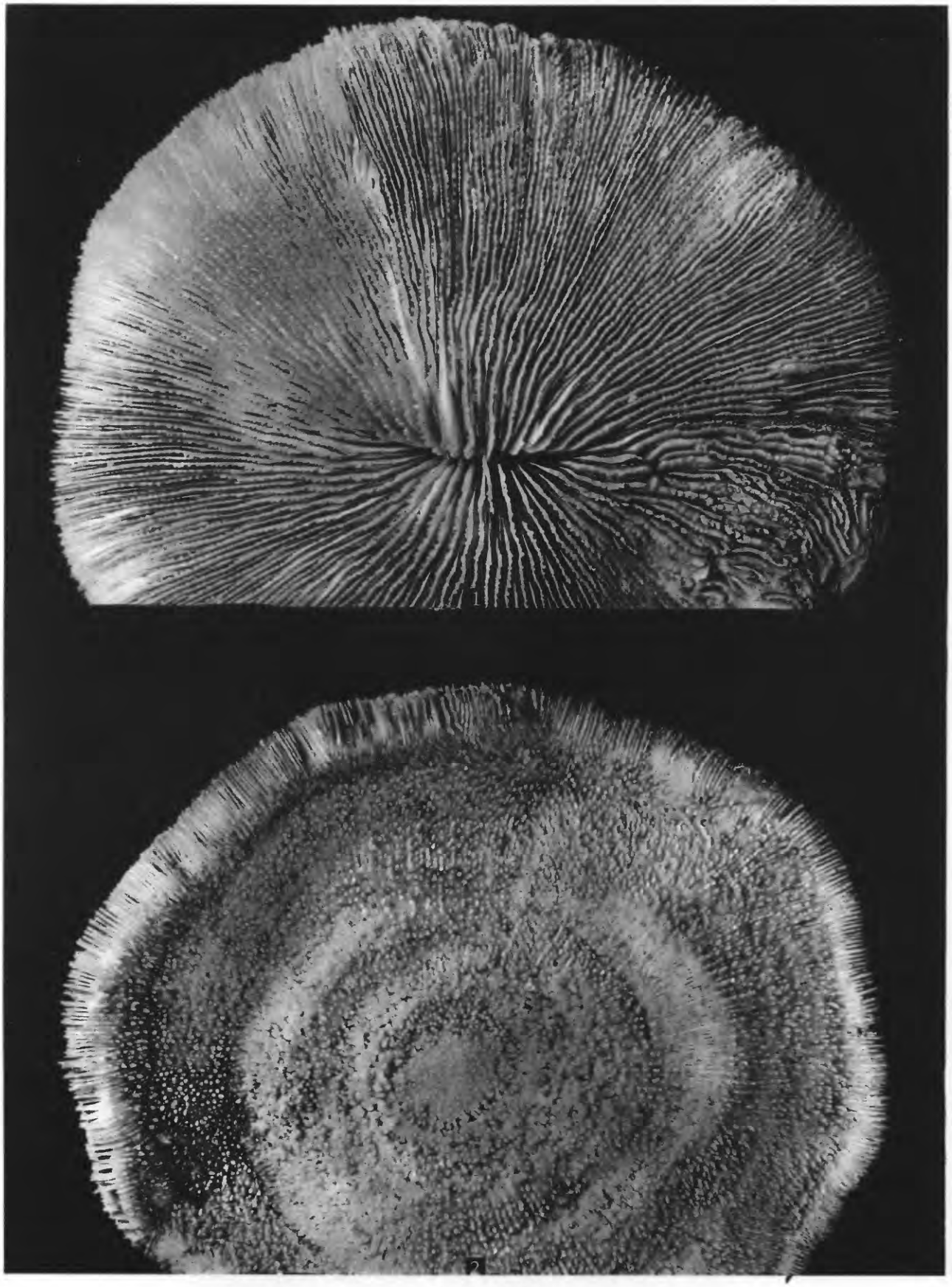
FIGURES 1–3. *Cycloseris patelliformis* (Boschma) (p. 447).
× 0.9, × 0.9, × 0.9. Coral knoll, Bikini Lagoon, 7–14 fms, loc. 37a. USNM 44831.
4–6. *Cycloseris vaughani* (Boschma) (p. 447).
× 0.9, × 0.9, × 0.9. Seaward slope, Bikini Atoll, 58–90 fms, loc. 109. USNM 44829.
7, 8. *Psammocora nierstraszi* van der Horst (p. 410).
× 0.9, × 4.5. Enirik island, Bikini Atoll, loc. 1a. USNM 44819.
9, 10. *Psammocora explanatula* van der Horst (p. 410).
× 0.9, × 4.5. Seaward slope, Bikini Atoll, 25–44 fms, loc. 110. USNM 44820.

PLATE 158

FIGURES 1, 2. *Fungia fungites haimei* Verrill (p. 448).
× 0.72, × 0.72. Rongelap island, Rongelap Atoll, loc. 29. USNM 44851.
3–6. *Fungia fungites incisa* Doederlein (p. 448).
× 0.72, × 0.72, × 2, × 2. Naen island, Rongelap Atoll, loc. 24. USNM 44853.



FUNGIA



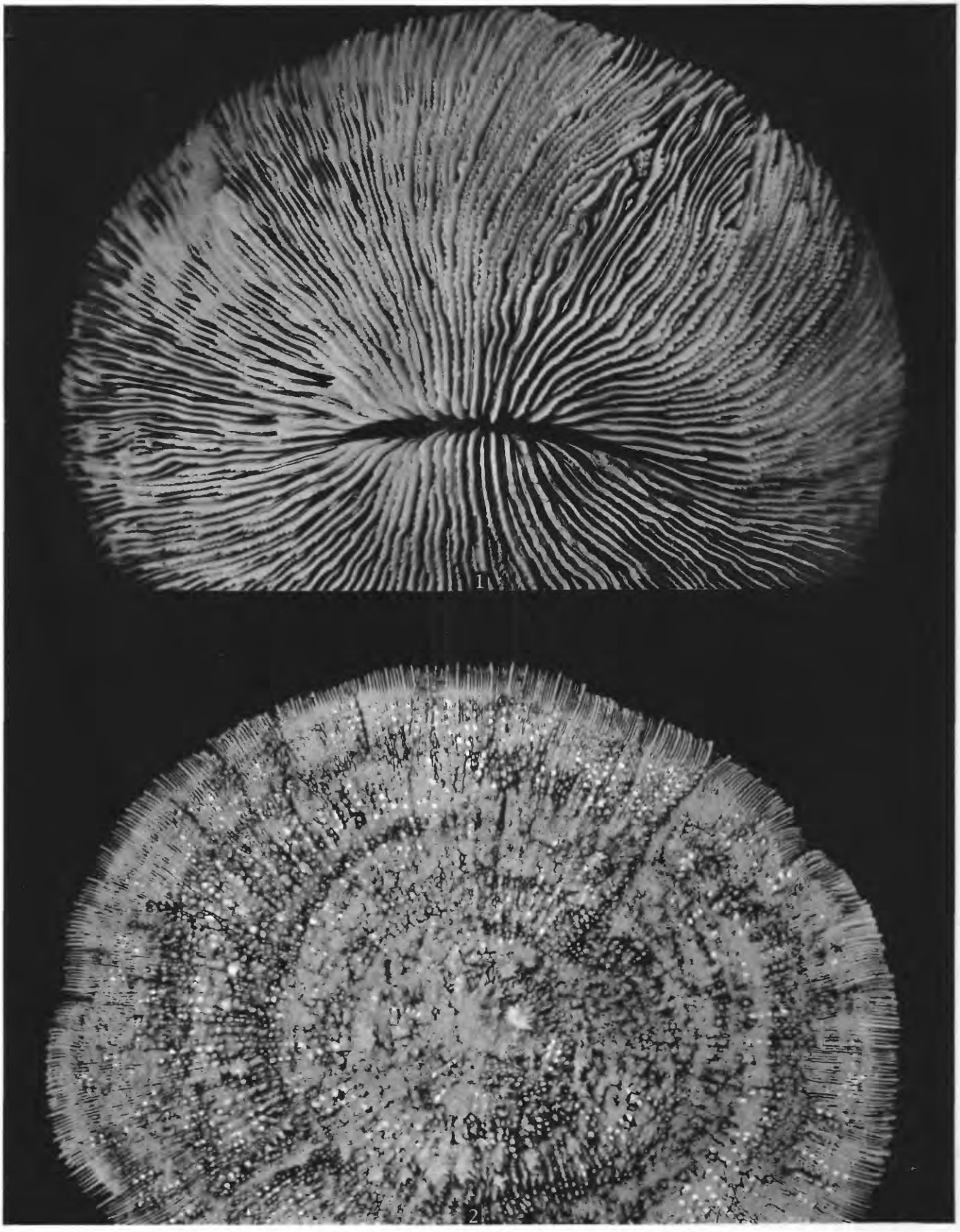
FUNGIA

PLATE 159

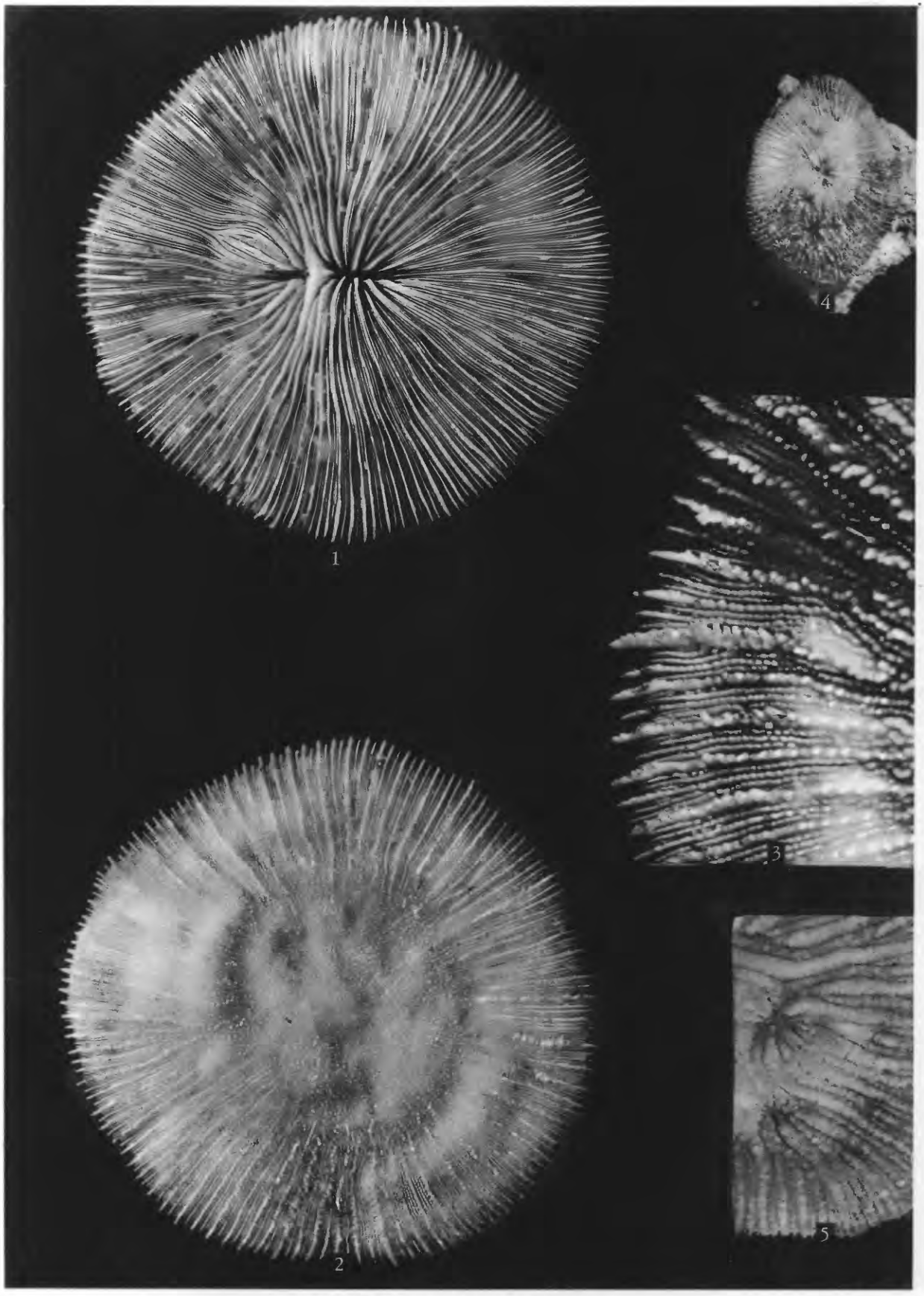
FIGURES 1, 2. *Fungia fungites stylifera* Doederlein (p. 448).
× 0.58, × 0.58. Bikini Lagoon, 5 fms, loc. 40. USNM 44855.

PLATE 160

FIGURES 1, 2. *Fungia fungites dentata* Dana (p. 449).
× 0.58, × 0.58. Rongelap island, Rongelap Atoll, 3 fms, loc. 29. USNM 44857.



FUNGIA



FUNGIA AND *PARAHALOMITRA*

PLATE 161

FIGURES 1–3. *Fungia concinna serrulata* Verrill (p. 449).
× 0.63, × 0.63, × 2. Lomuilal island, Rongelap Atoll, loc. 25. USNM 44860.

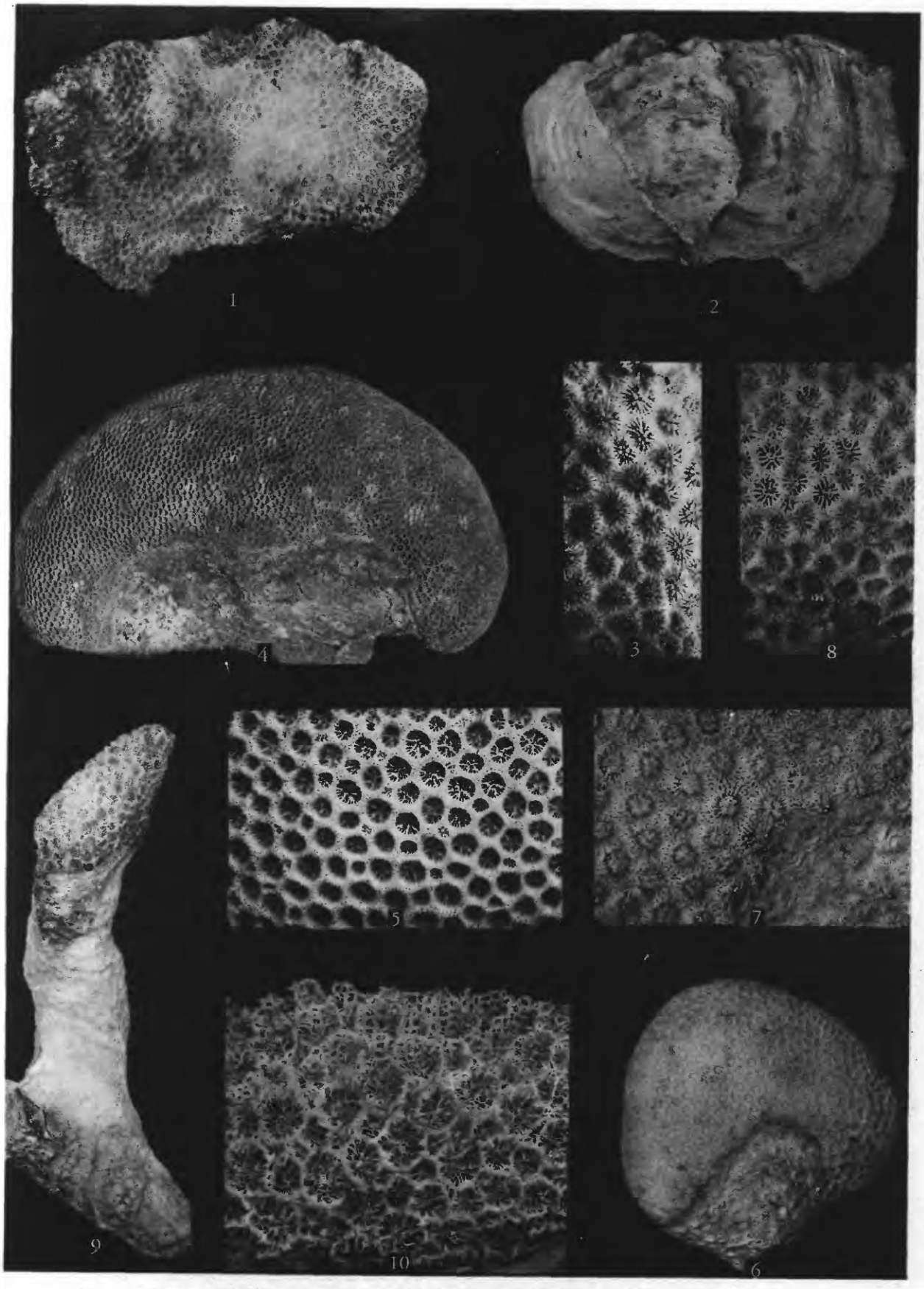
4, 5. *Parahalomitra robusta* (Quelch) (p. 449).
× 0.9, × 4.5. Young anthocaulus. Seaward slope, Bikini Atoll, 12.5–17 fms, loc. 103. USNM 44865.

PLATE 162

Figures 1, 2. *Parahalomitra robusta* (Quelch) (p. 449).
× 0.54, × 0.54. Jaluit Atoll. Imp. Coll. 18.

3, 4. *Herpolitha limax* (Esper) (p. 449).
× 0.36, × 0.4. Bikini Lagoon, 6 fms, loc. 48. USNM 44864.

PARAHALOMITRA AND *HERPOLITHA*



GONIOPORA AND *ALVEOPORA*

PLATE 163

FIGURES 1–3. *Goniopora somaliensis* Vaughan (p. 450).
× 0.6, × 0.6, × 2. Bikini Lagoon, 10 fms, loc. 44. USNM 44867.

4, 5. *Goniopora* sp. cf. *G. gracilis* (Bassett-Smith) (p. 451).
× 0.4, × 1.8. Jaluit Atoll. Imp. Coll. 15.

6–8. *Goniopora traceyi* Wells, n. sp. (p. 451).
× 0.6, × 2, × 2. Enirik island, Bikini Atoll, loc. 1. Holotype, USNM 44868.

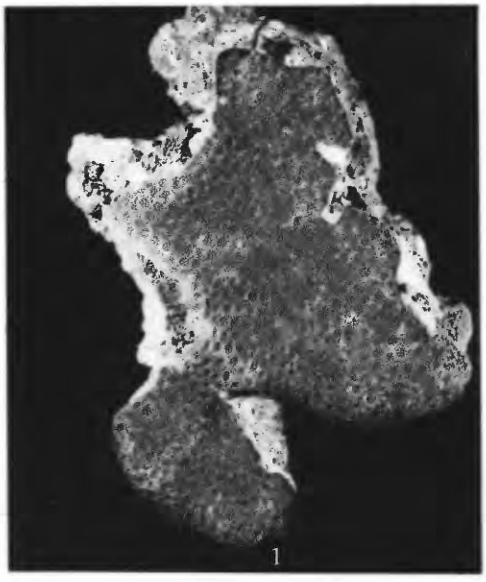
9, 10. *Alveopora allingi* Hoffmeister (p. 456).
× 0.54, × 2. Rongelap Lagoon, 17–20 fms, loc. 95. USNM 44939.

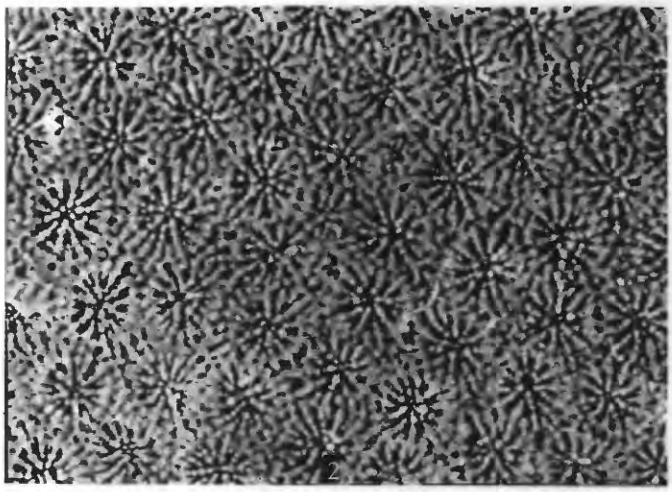
PLATE 164

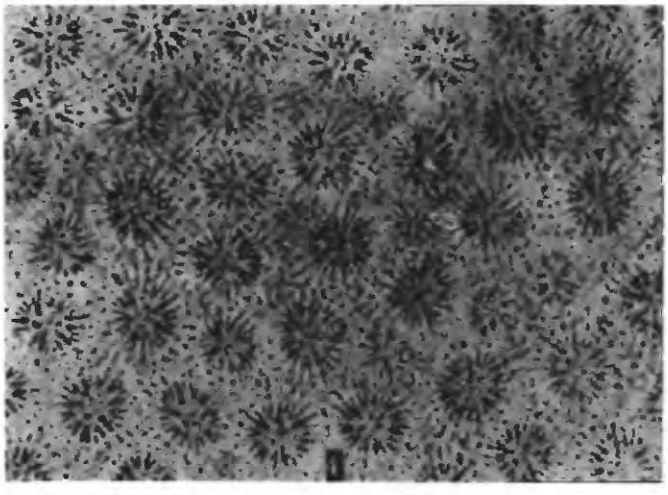
FIGURES 1, 2. *Goniopora muscosa* Wells, n. sp. (p. 451).
× 0.45, × 4.5. Seaward slope, Bikini Atoll, 50–96 fms, loc. 106. Holotype, USNM 44872.

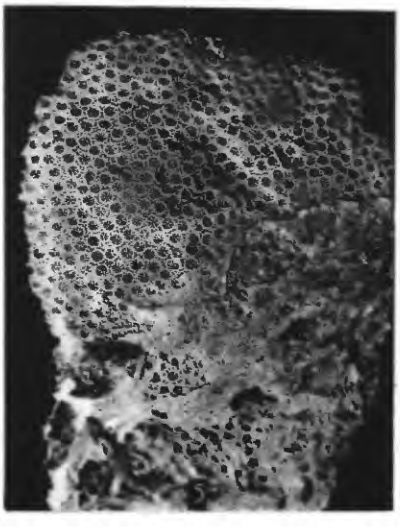
3, 4. *Goniopora pulvinula* Wells, n. sp. (p. 451).
× 0.45, × 4.5. Seaward slope, 29–42 fms, loc. 114. Holotype, USNM 44871.

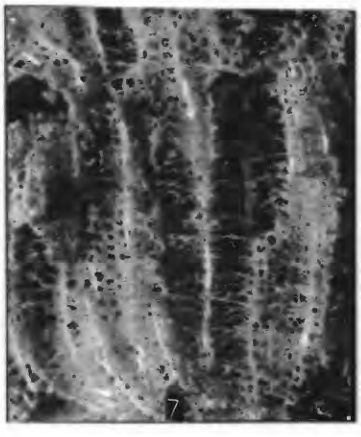
5–7. *Alveopora ocellata* Wells, n. sp. (p. 456).
× 0.9, × 4.5, × 4.5. Seaward slope, Bikini Atoll, 25–44 fms, loc. 110. Holotype, USNM 44941.

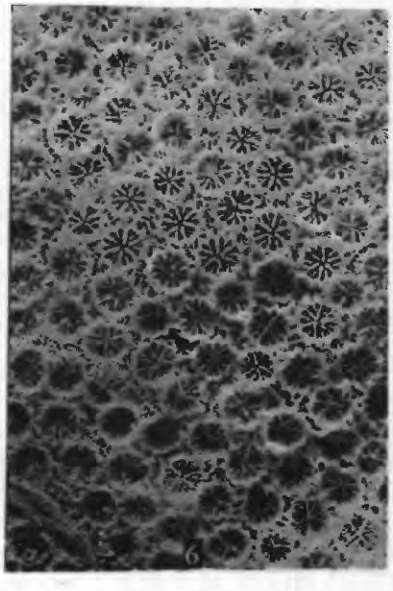






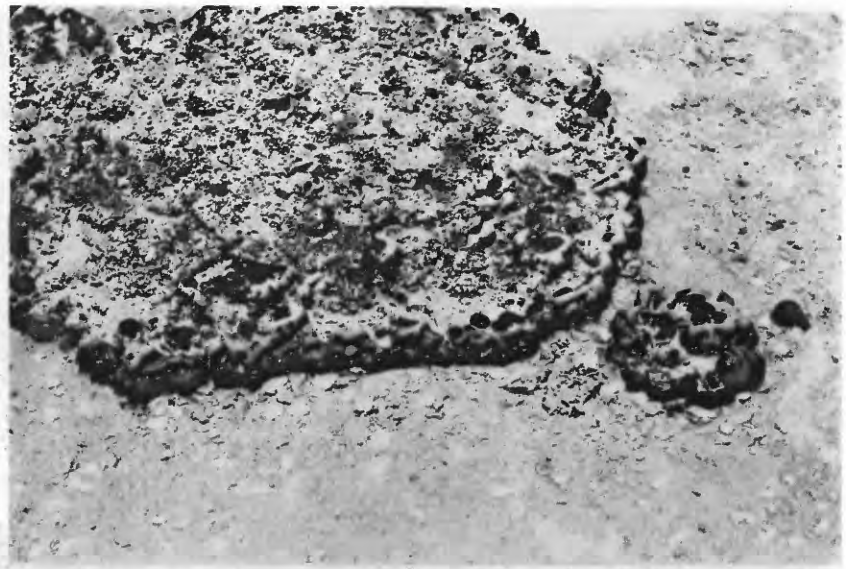




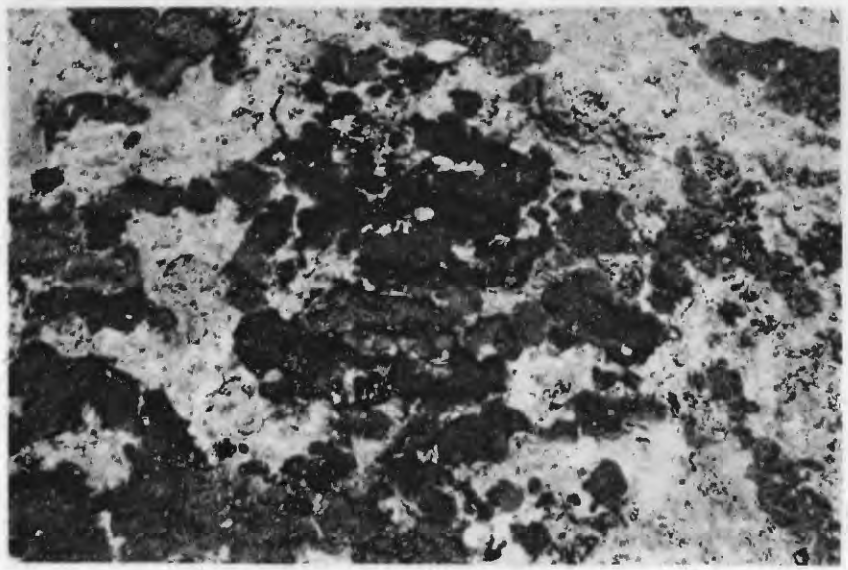


GONIOPORA AND *ALVEOPORA*

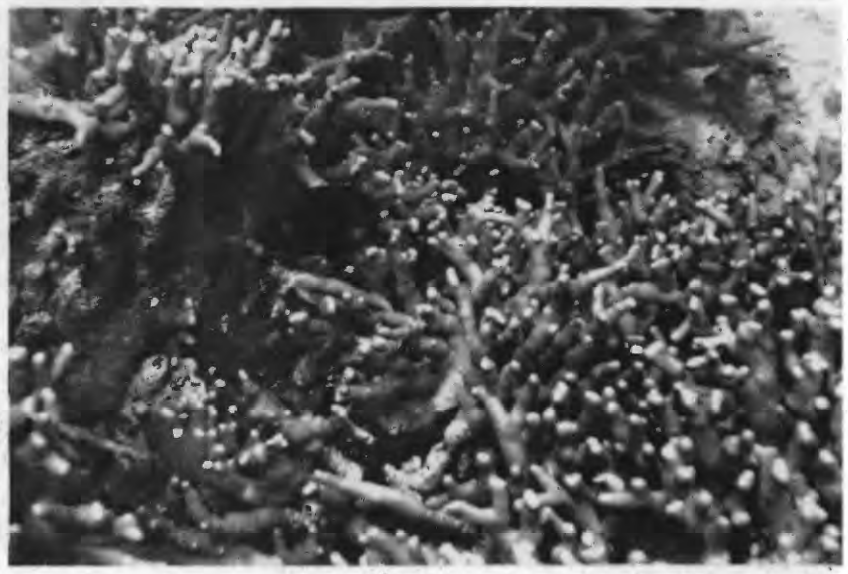
1



2



3



4

PORITES: HABITS ON BIKINI ATOLL REEFS

PLATE 165

FIGURES 1, 2. *Porites lutea* Milne-Edwards and Haime (p. 452).

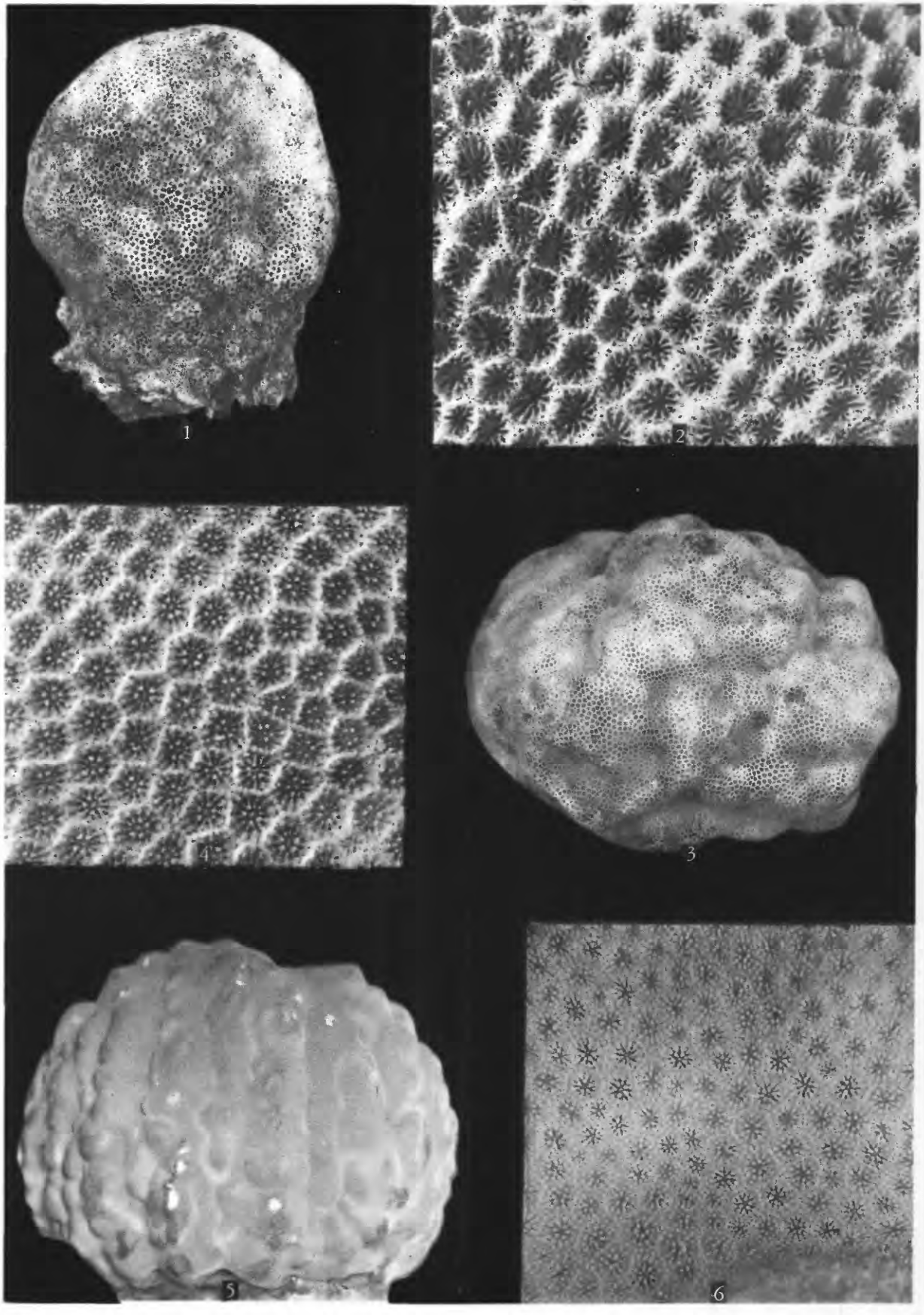
1. Pale-yellow facies, on large *Heliopora* microatoll, west reef, Namu island, Bikini Atoll, loc. 7a. Colony about 40 cm broad.
2. Pinkish-brown facies, innermost part of windward reef flat, Bikini island, loc. 10c. Nodular colonies 5–20 cm broad.

3. *Porites lichen* Dana (p. 453).
   Encrusting on rocky flat just behind algal ridge (*Acropora cuneata* zone), windward reef, Bikini island, loc. 10b. Rich red-brown; patches are 10–20 cm broad.
4. *Porites andrewsi* Vaughan (p. 454).
   Underwater view of side of large microatoll formed by this species, west reef, Namu island, Bikini Atoll, loc. 7a. Pale gray-green; larger branches 2–4 cm thick.

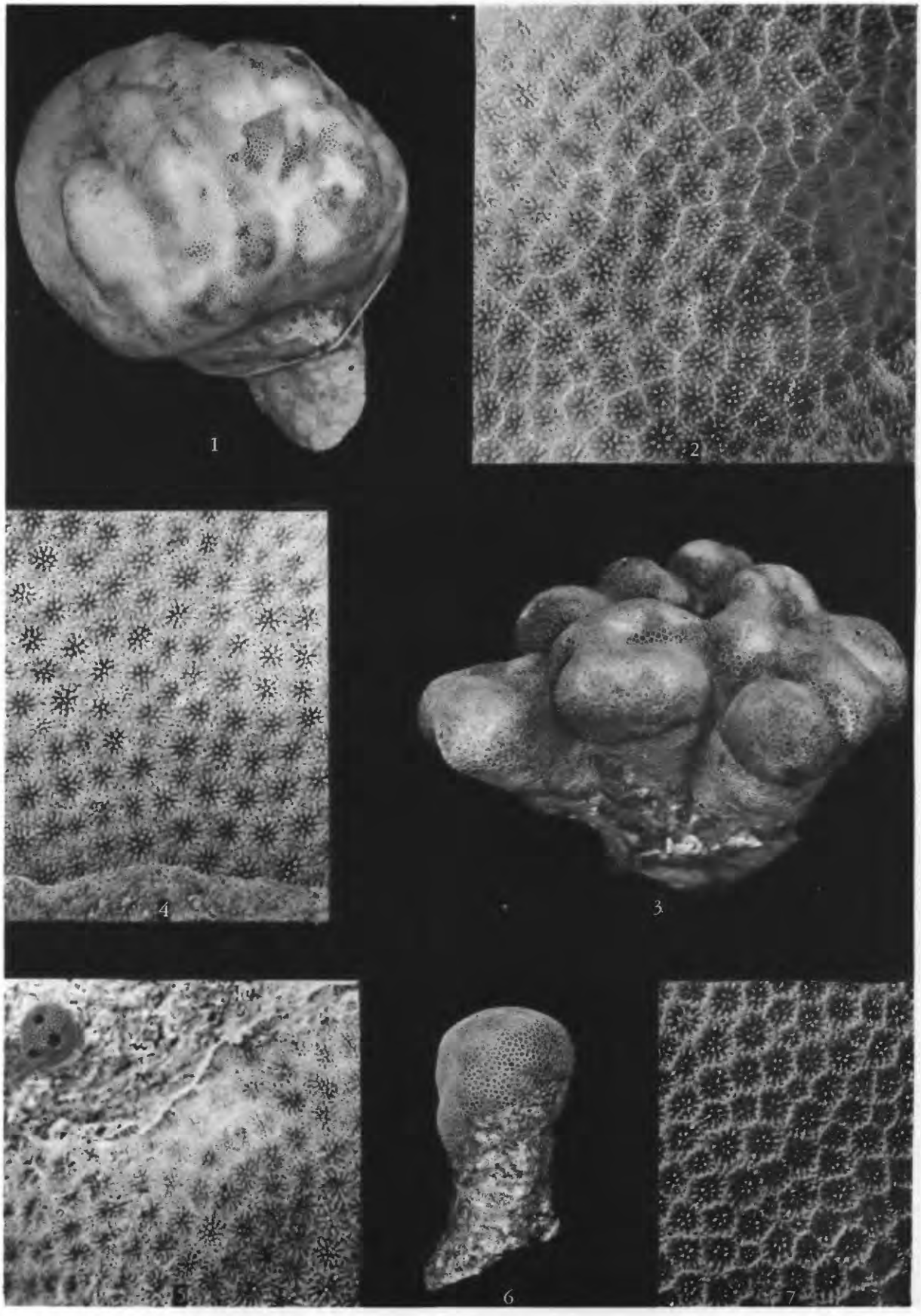
293438—54——F

PLATE 166

FIGURES 1, 2. *Porites lobata* Dana (p.452).
× 0.63, × 5.4. Enyu island, Bikini Atoll, loc. 12a. USNM 44877.
3, 4. *Porites australiensis* Vaughan (p. 452).
× 0.63, × 5.4. Enirik island, Bikini Atoll, loc. 1. USNM 44880.
5, 6. *Porites lutea* Milne-Edwards and Haime (p. 452).
× 0.54, × 5.4. Jaluit Atoll. Imp. Coll. 40.



PORITES



PORITES

PLATE 167

FIGURES 1–7. *Porites lutea* Milne-Edwards and Haime (p. 452).

1, 2, 4. × 0.63, × 5.4, × 5.4. Upper and lower surfaces. Namu island, Bikini Atoll, loc. 7b. USNM 44889.

3. × 0.36. Bikini island, Bikini Atoll, loc. 10a. USNM 44890.

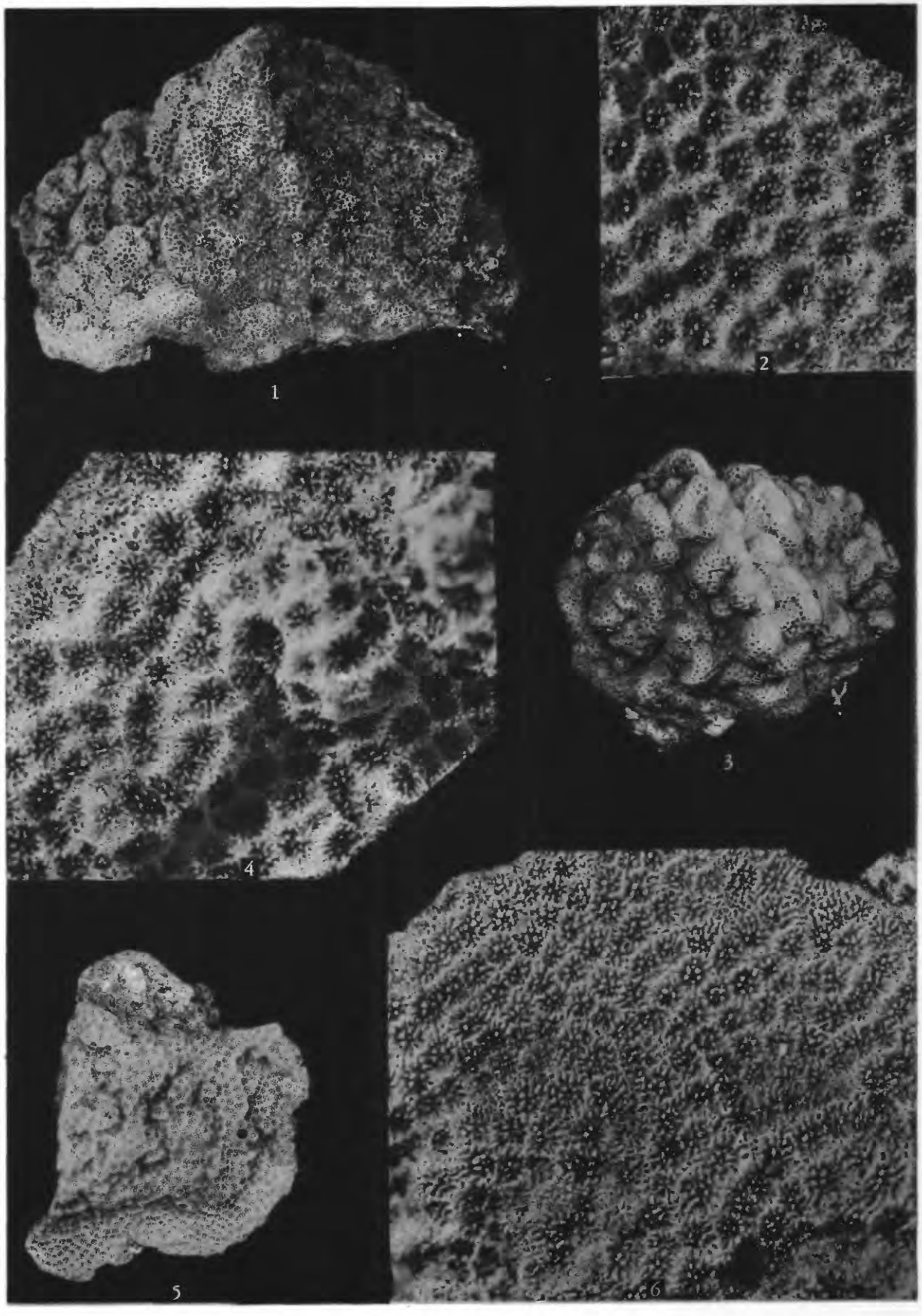
5. × 5.4. With young corallum of *Heliopora*. Bikini island, Bikini Atoll, loc. 10a. USNM 44890.

6, 7. × 0.8, × 4.5. Bikini island, Bikini Atoll, loc. 10c. USNM 44891.

PLATE 168

FIGURES 1–6. *Porites lichen* Dana (p. 453).

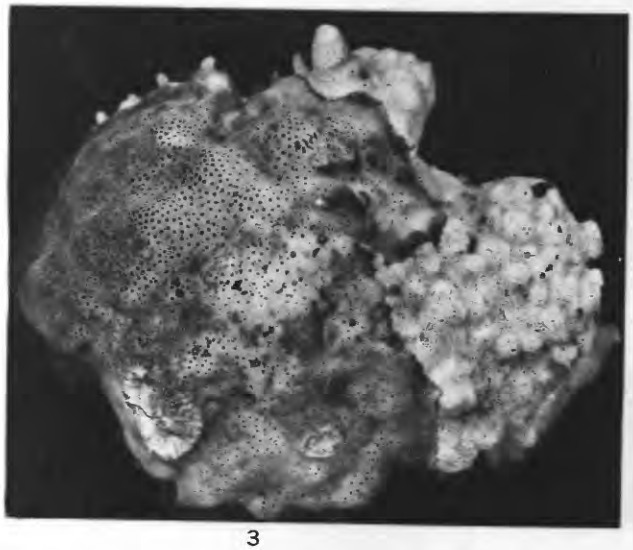
1, 2. × 0.63, × 5.4. Enyu island, Bikini Atoll, loc. 12a. USNM 44907.
3, 4. × 0.6, × 5.4. Bokororyuru island, Bikini Atoll, loc. 5c. USNM 44899.
5, 6. × 1.35, × 5.4. Bikini island, Bikini Atoll, loc. 10c. USNM 44903.



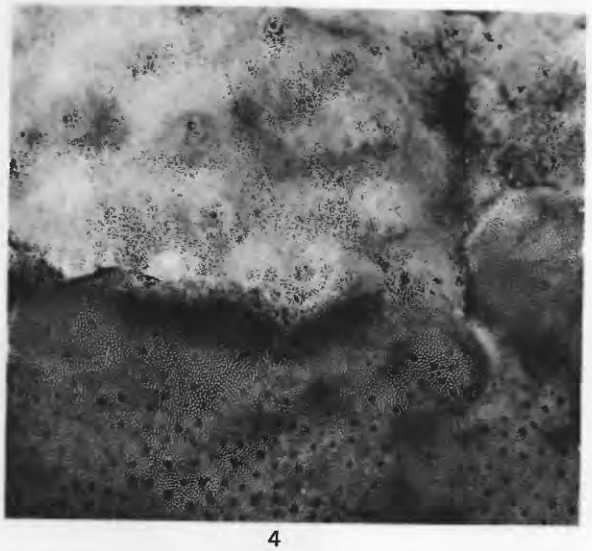
PORITES

2

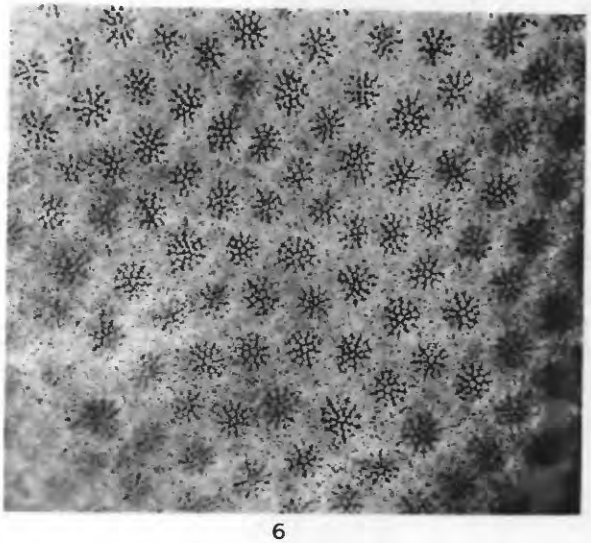
1



3



4



6

5

PORITES

PLATE 169

FIGURES 1–4. *Porites superfusa* Gardiner (p. 454).

1, 2. × 0.63, × 5.4. Bikini island, Bikini Atoll, loc. 10f. USNM 44917.

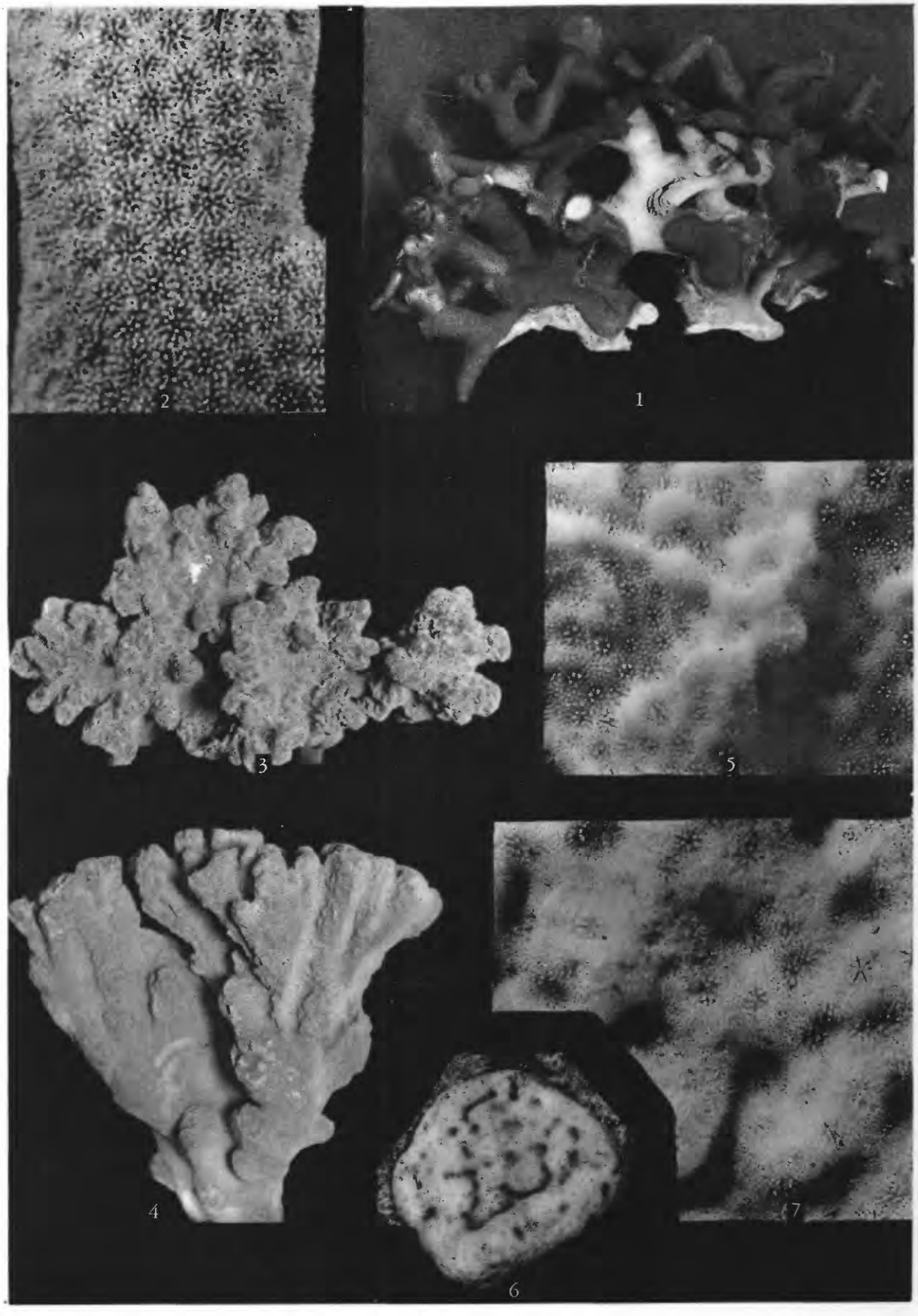
3, 4. × 0.63, × 2. With *Heliopora coerulea* at Bikini island, Bikini Atoll, loc. 10f. USNM 44916.

5, 6. *Porites andrewsi* Vaughan (p. 454).

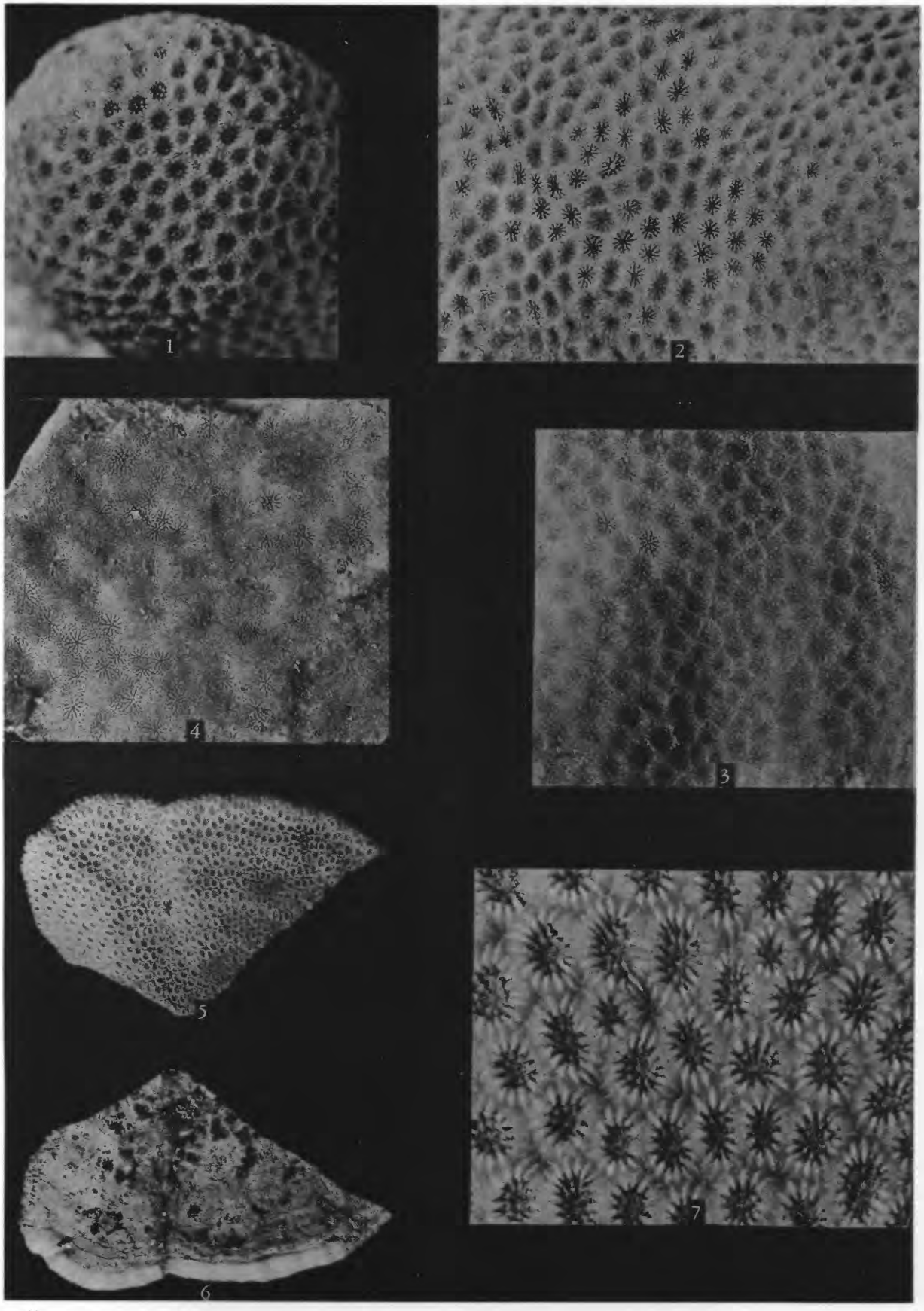
× 0.4, × 5.4. Latoback island, Rongelap Atoll, loc. 20a. USNM 44925.

PLATE 170

FIGURES 1, 2. *Porites matthaii* Wells, n. sp. (p. 455).
× 0.36, × 5.4. Jaluit Atoll, Holotype, Imp. Coll. 46.
3–5. *Porites* (*Synaraea*) *iwayamaensis* Eguchi (p. 455).
× 0.9, × 0.9, × 5.4. Jaluit Atoll. Imp. Coll. 31.
6, 7. *Porites* (*Synaraea*) *hawaiiensis* Vaughan (p. 455).
× 1.35, × 5.4. Bikini Lagoon, 30 fms, loc. 43. USNM 44929.



PORITES AND *SYNARAEA*



PORITES, SYNARAEA, AND *PLESIASTREA*

PLATE 171

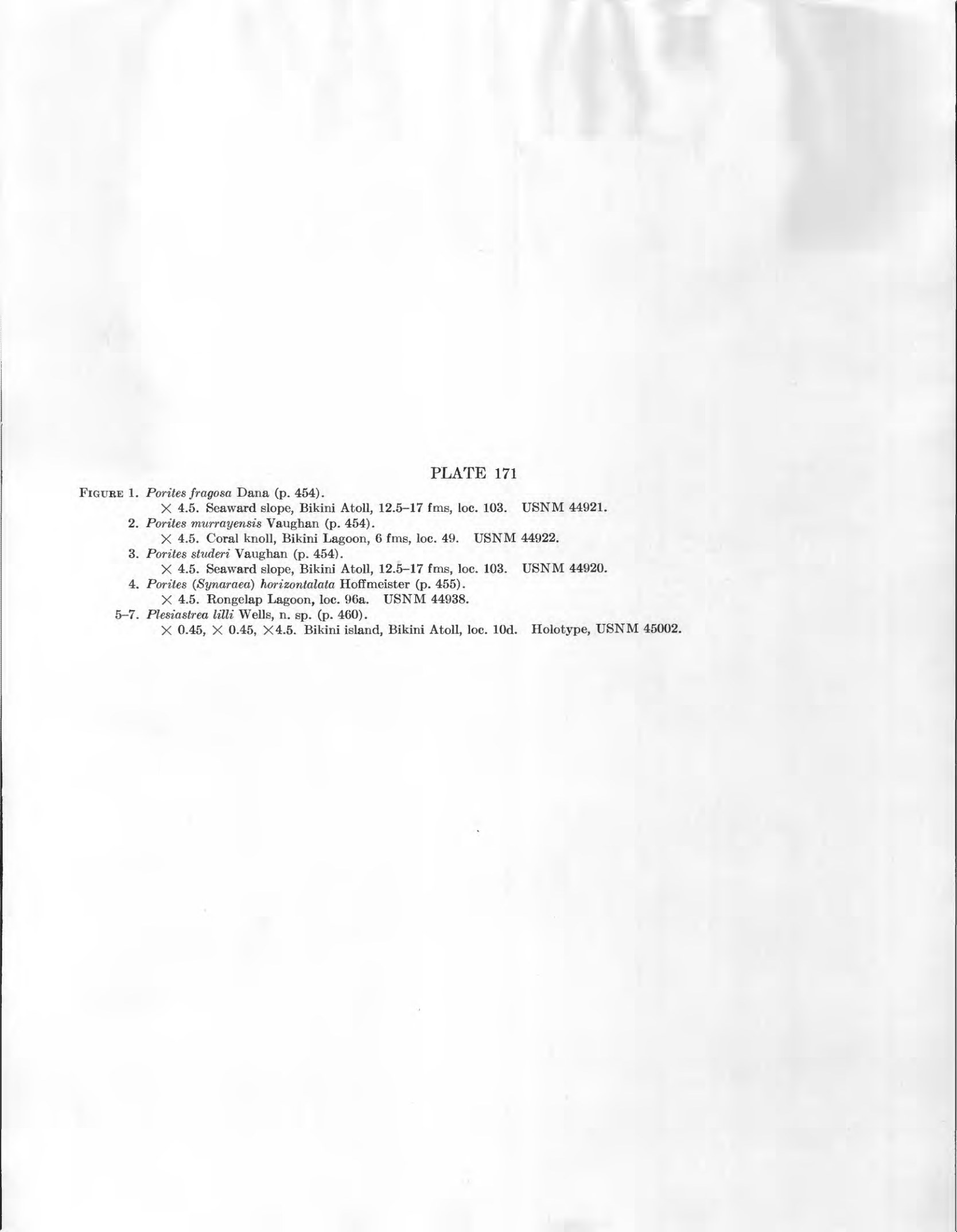


FIGURE 1. *Porites fragosa* Dana (p. 454).
× 4.5. Seaward slope, Bikini Atoll, 12.5–17 fms, loc. 103. USNM 44921.

2. *Porites murrayensis* Vaughan (p. 454).
× 4.5. Coral knoll, Bikini Lagoon, 6 fms, loc. 49. USNM 44922.

3. *Porites studeri* Vaughan (p. 454).
× 4.5. Seaward slope, Bikini Atoll, 12.5–17 fms, loc. 103. USNM 44920.

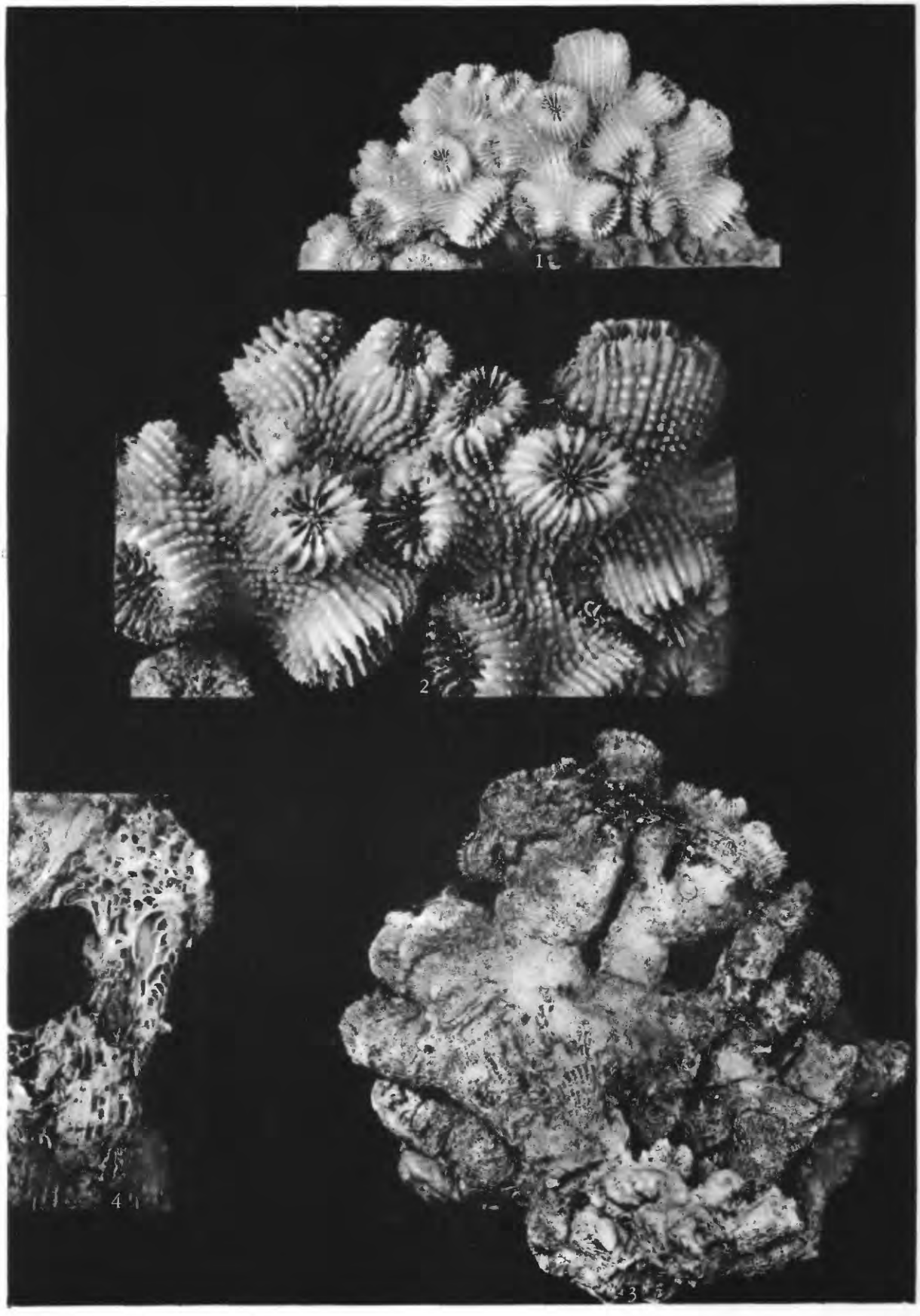
4. *Porites* (*Synaraea*) *horizontalata* Hoffmeister (p. 455).
× 4.5. Rongelap Lagoon, loc. 96a. USNM 44938.

5–7. *Plesiastrea lilli* Wells, n. sp. (p. 460).
× 0.45, × 0.45, ×4.5. Bikini island, Bikini Atoll, loc. 10d. Holotype, USNM 45002.

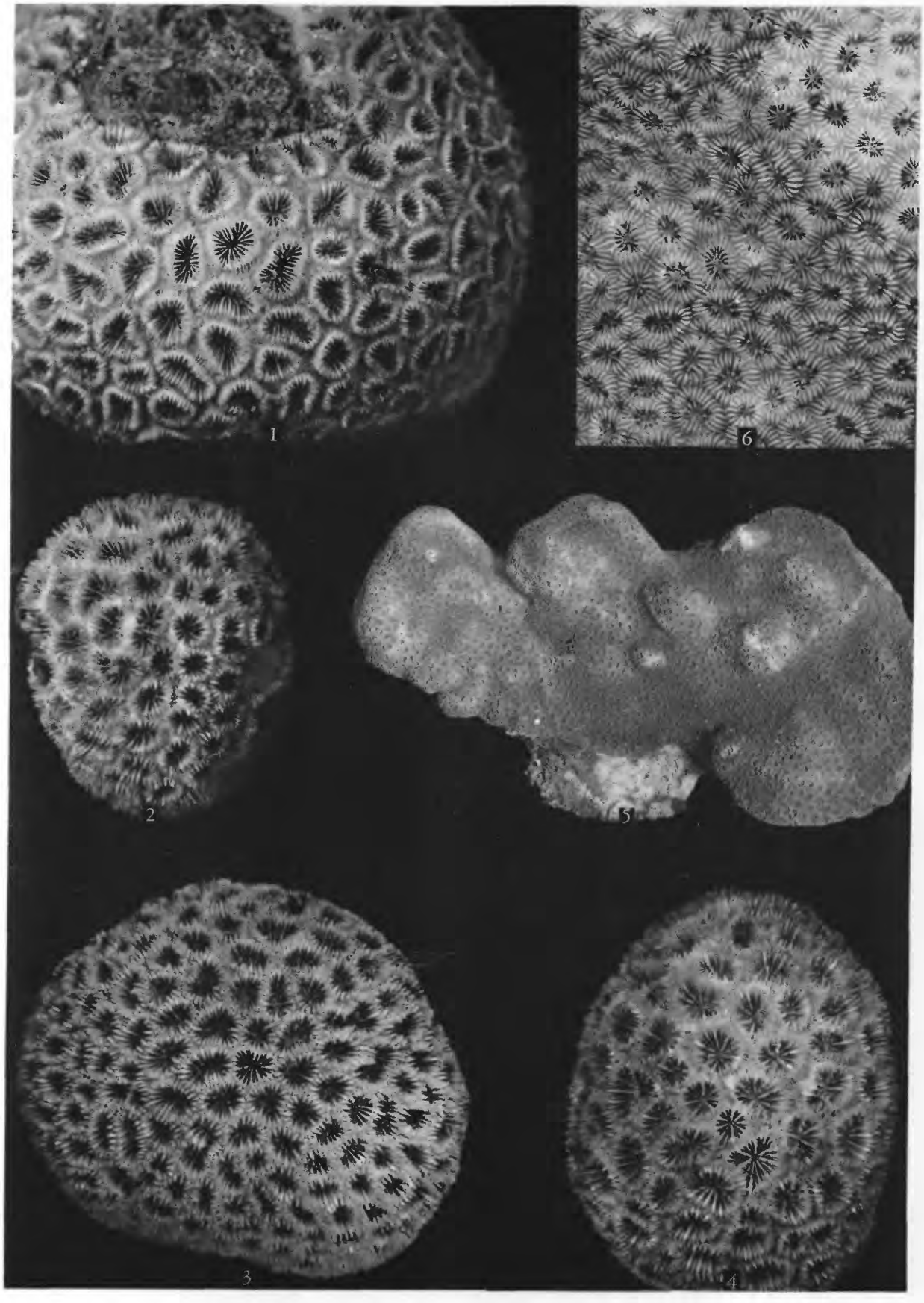
PLATE 172

FIGURES 1–4. *Bikiniastrea laddi* Wells, n. gen., n. sp. (p. 456).
Bikini Lagoon, 22 fms, loc. 30. Holotype, USNM 44942.

1. × 0.9. Calices, upper surface.
2. × 2. Calices, enlarged.
3. × 0.9. Basal view.
4. × 2. Longitudinal section, showing wall.



BIKINIASTREA



FAVIA

PLATE 173

FIGURES 1–4. *Favia pallida* (Dana) (p. 457).
All × 0.76. All from Bikini Atoll.
1. Forma 4. Bikini island, loc. 10a. USNM 44968.
2. Forma 2. Namu island, loc. 7b. USNM 44957.
3. Forma 1. Bikini island, loc. 10c. USNM 44952.
4. Forma 3. Namu island, loc. 7b. USNM 44965.

5, 6. *Favia stelligera* (Dana) (p. 457).
× 0.4, × 2. Jaluit Atoll. Imp. Coll. 14.

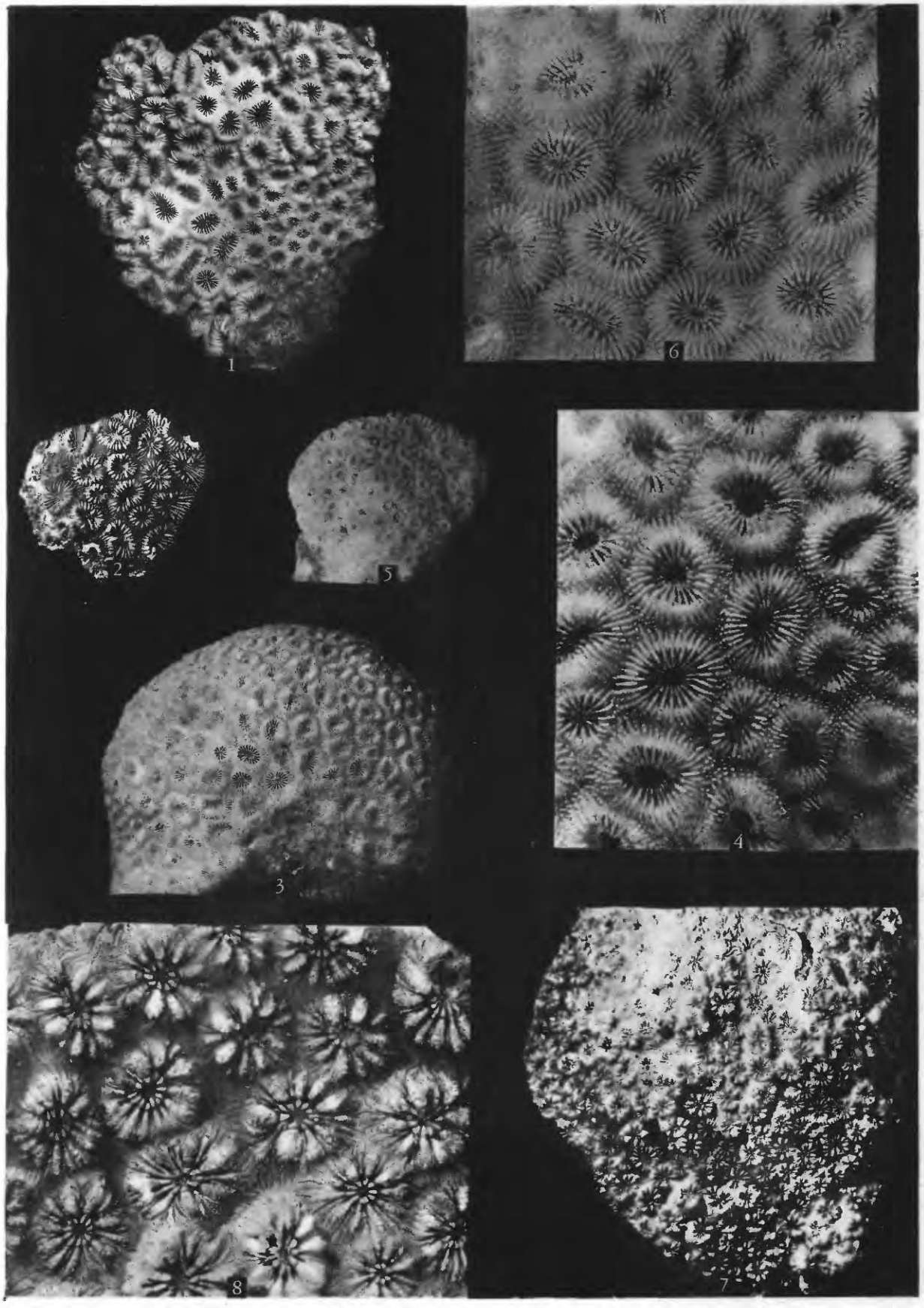
PLATE 174

FIGURE 1. *Favia pallida* (Dana) (p. 457).
× 0.45. Eniairo-Rochikarai islands, Bikini Atoll, loc. 11. USNM 44969.

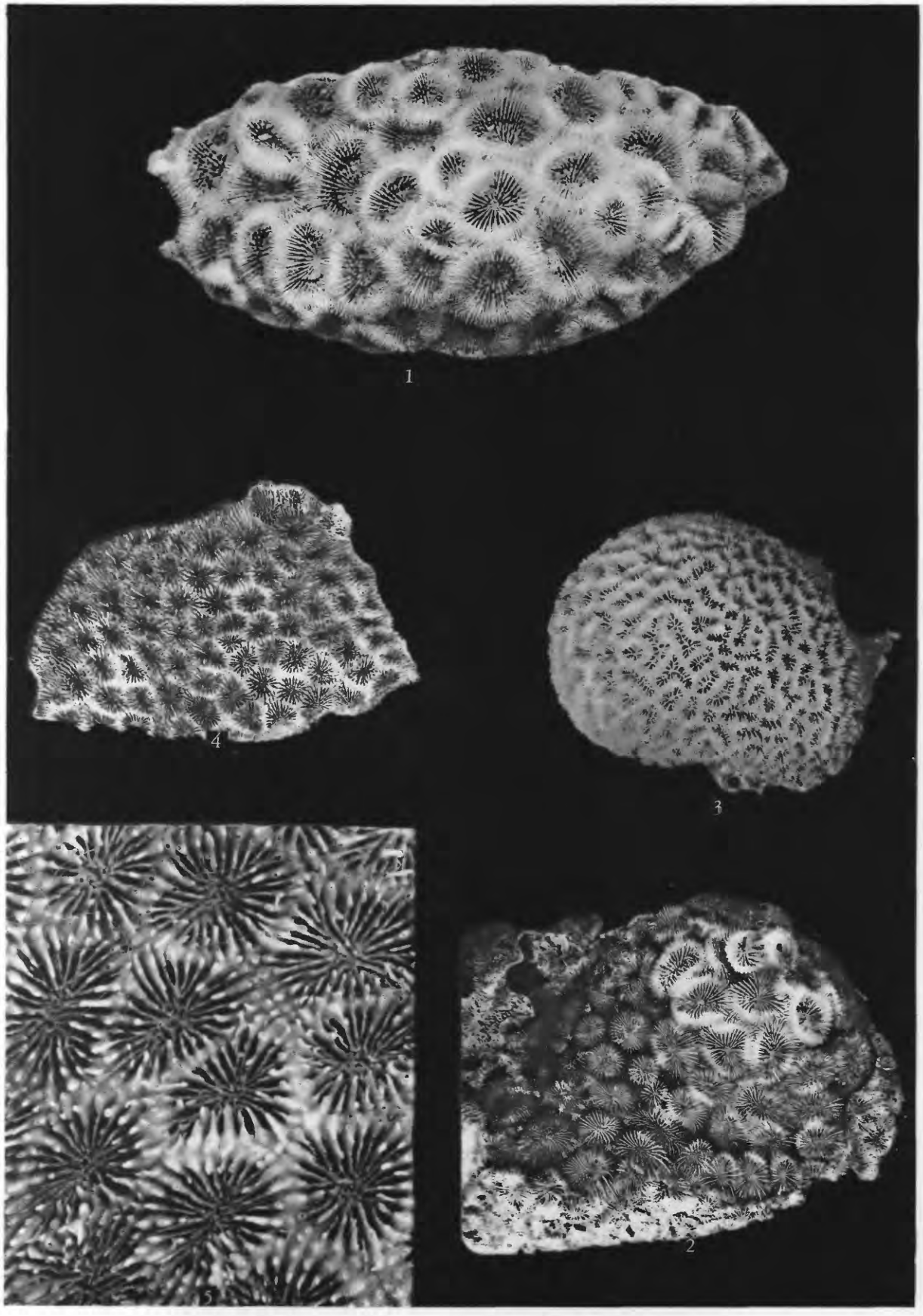
2. *Favia speciosa* (Dana) (p. 457).
× 0.45. Seaward slope, Bikini Atoll, 33–48 fms, loc. 107. USNM 44948.

3–6. *Favia helianthoides* Wells, n. sp. (p. 458).
3, 4. × 0.9, × 4.5. Bikini island, Bikini Atoll, loc. 10c. Holotype, USNM 44980.
5, 6. × 0.5, × 4.5. Seaward slope, Bikini Atoll, 12.5–17 fms, loc. 103. USNM 44981.

7, 8. *Plesiastrea russelli* Wells, n. sp. (p. 460).
× 0.45, × 2.3. Seaward slope, Bikini Atoll, 29–42 fms, loc. 114. Holotype, USNM 45004.



FAVIA AND *PLESIASTREA*



FAVITES, PLATYGYRA, AND *ACANTHASTREA*

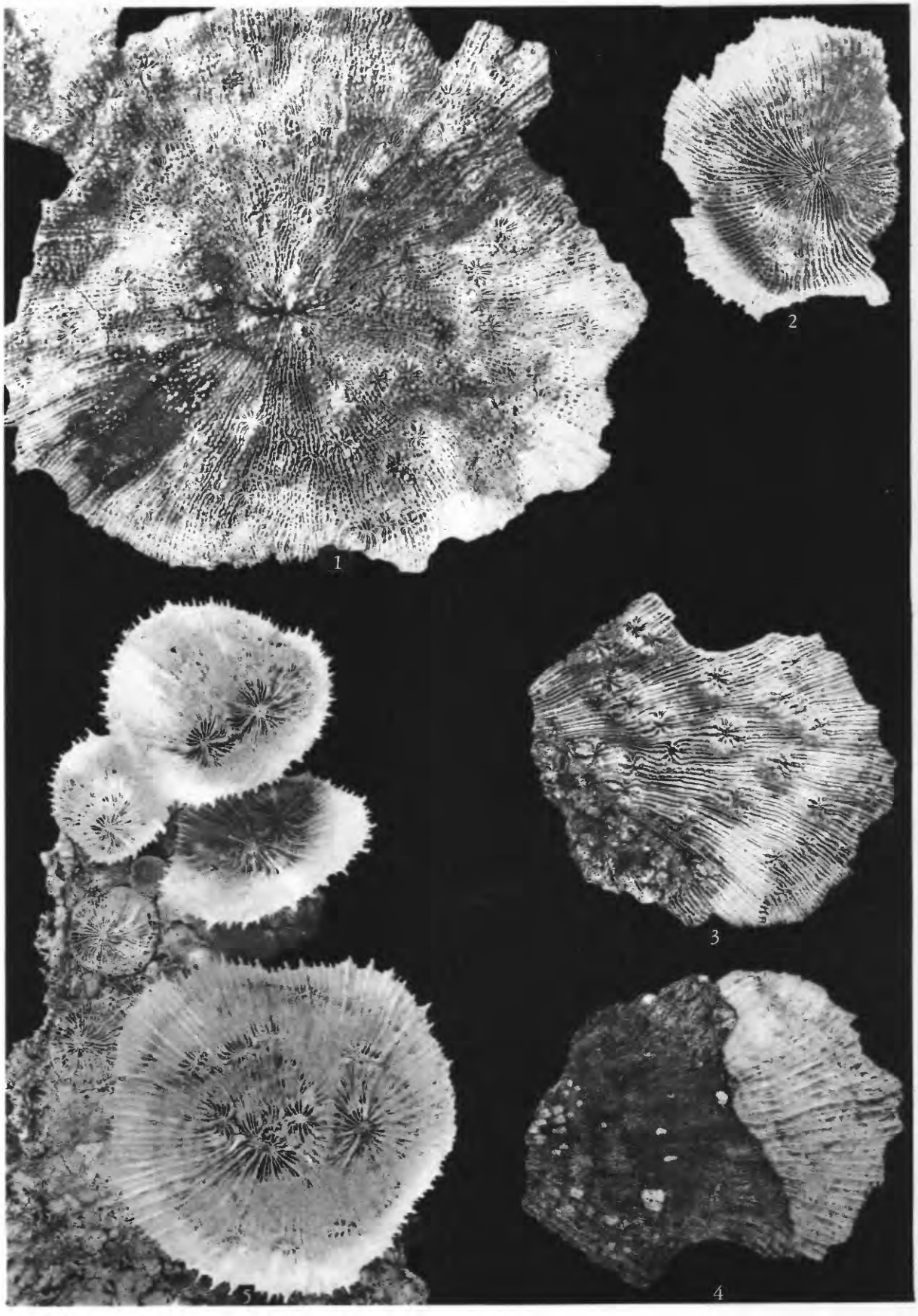
PLATE 175

FIGURES 1, 2. *Favites flexuosa* (Dana) (p. 459).
1. ×0.8. Yurochi island, Bikini Atoll, loc. 8. USNM 44987.
2. ×0.45. Seaward slope, Bikini Atoll, 12.5–17 fms, loc. 103. USNM 44988.
3. *Platygyra sinensis* Milne-Edwards and Haime (p. 462).
×0.8. Bock island, Rongerik Atoll, loc. 18. USNM 45028.
4, 5. *Acanthastrea hemprichii* (Ehrenberg) (p. 467).
×0.45, ×2.3. Namu island, Bikini Atoll, loc. 7a. USNM 45070.

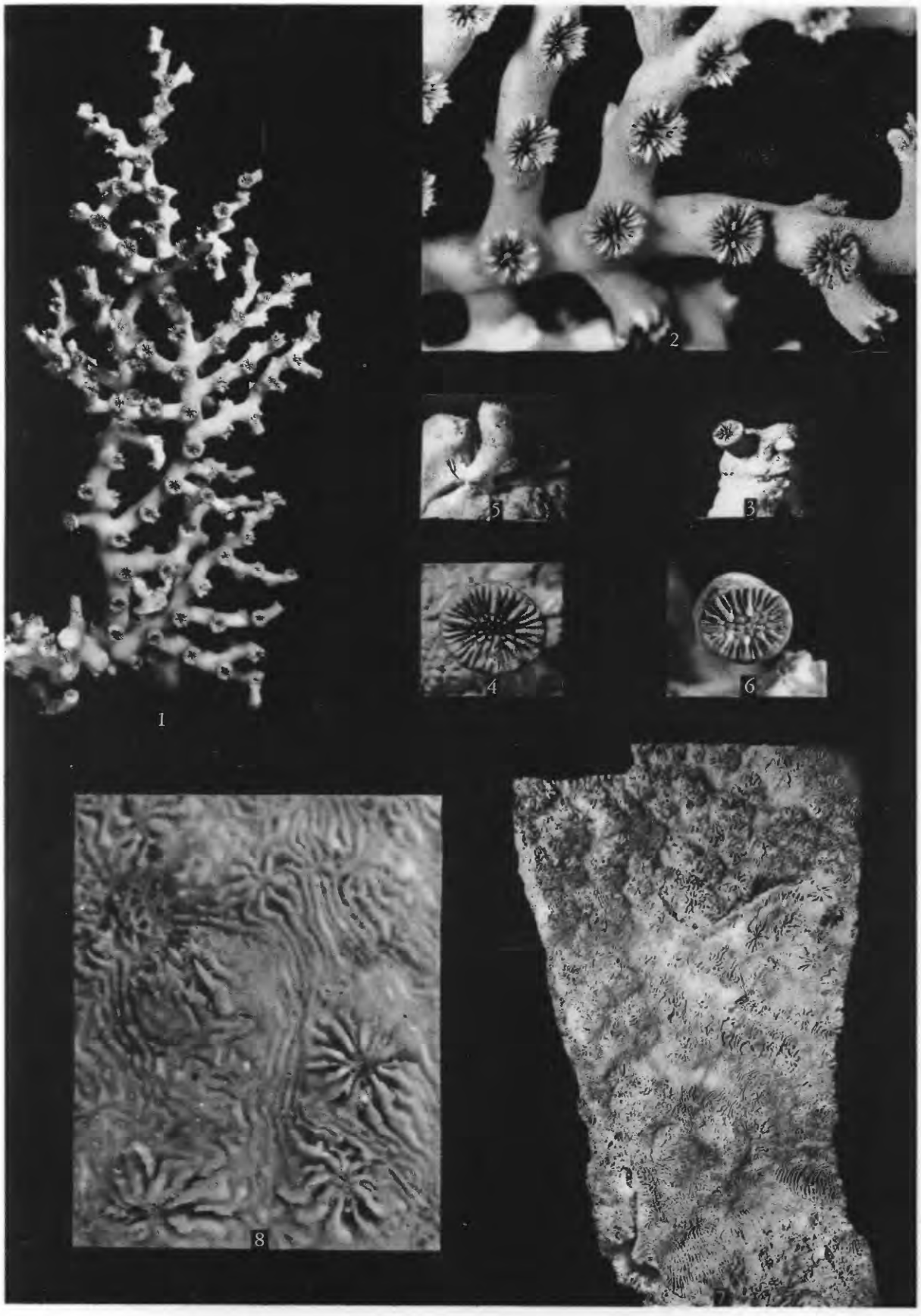
PLATE 176

FIGURES 1–5. *Echinophyllia aspera* (Ellis and Solander) (p. 467).

1. ×0.45. Seaward slope, Bikini Atoll, 58.5–90 fms, loc. 109. USNM 45074.
2. ×0.45. Seaward slope, 33.5–48 fms, Bikini Atoll, loc. 107. USNM 45072.
3, 4. ×0.45, ×0.45. Seaward slope, 25–44 fms, Bikini Atoll, loc. 110. USNM 45076.
5. ×0.8. Young colonies on old, dead frond. Naen island, Rongelap Atoll, loc. 24. USNM 45071.



ECHINOPHYLLIA



SCLERHELIA, PARACYATHUS, CARYOPHYLLIA, AND *OXYPORA*

PLATE 177

FIGURES 1, 2. *Sclerhelia alcocki* Wells, n. sp. (p. 465).
×0.9, ×4.5. Seaward slope, Bikini Atoll, 116–120 fms, loc. 118. Holotype, USNM 45056.
3, 4. *Paracyathus parvulus* Gardiner (p. 469).
×0.9, ×3.6. Seaward slope, Bikini Atoll, 50–96 fms, loc. 106. USNM 45081.
5, 6. *Caryophyllia rugosa* Moseley (p. 469).
×1.35, ×3.6. Seaward slope, Bikini Atoll, 50–96 fms, loc. 106. USNM 45080.
7, 8. *Oxypora lacera* (Verrill) (p. 468).
×0.45, ×2.3. Seaward slope, Bikini Atoll, 25–44 fms, loc. 110. USNM 45077.

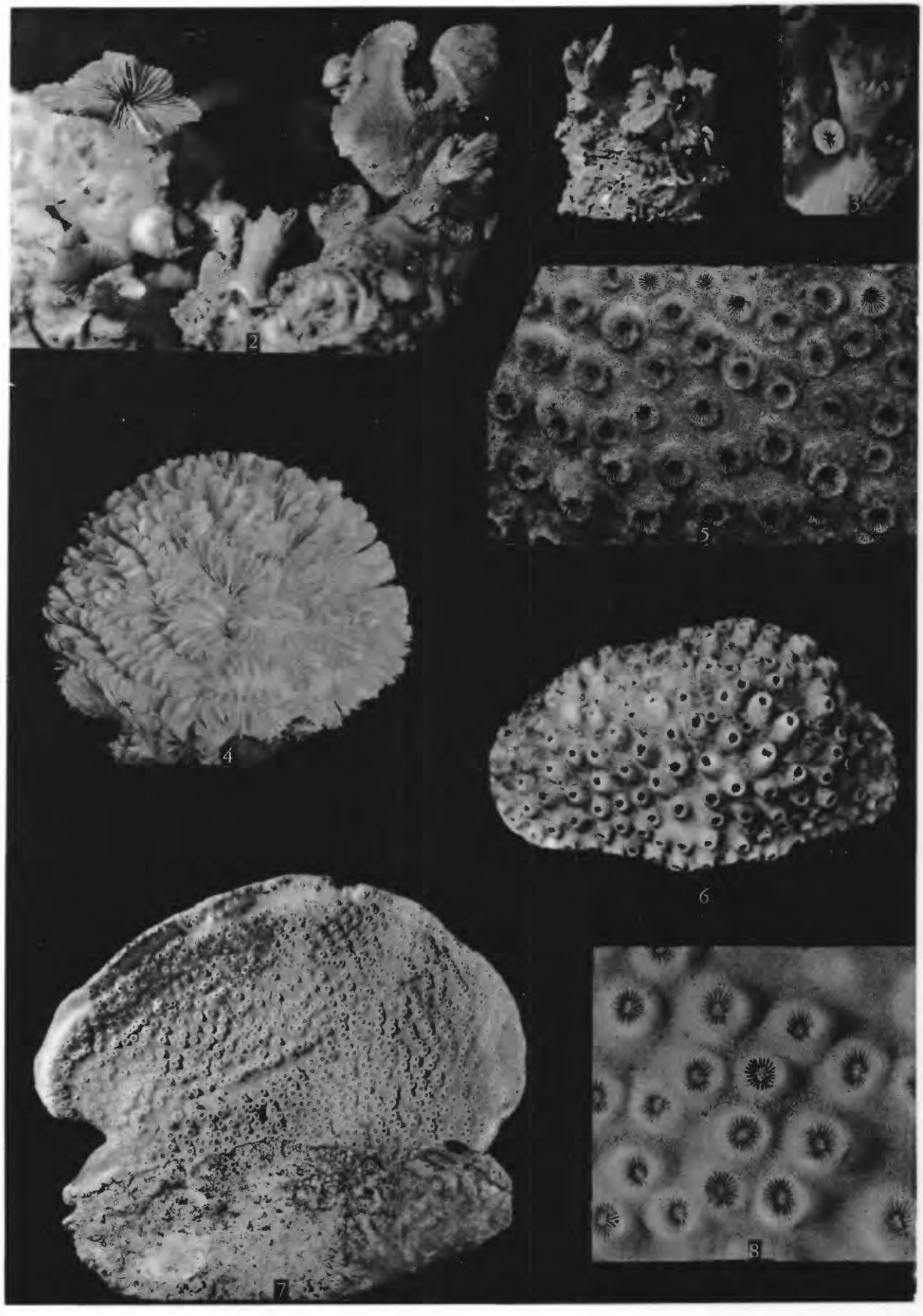
PLATE 178

FIGURES 1–3. *Dactylotrochus cervicornis* (Moseley) (p. 470).
×0.9, ×2.3, ×4.5. Seaward slope, Bikini Atoll, 67-75 fms, loc. 113. USNM 45085.

4. *Physogyra lichtensteini* Milne-Edwards and Haime (p. 471).
×0.72. Jaluit Atoll. Imp. Coll. 26.

5, 6. *Turbinaria irregularis* Bernard (p. 471).
×0.76. Bogen island, Eniwetok Atoll, loc. 15. USNM 45092.

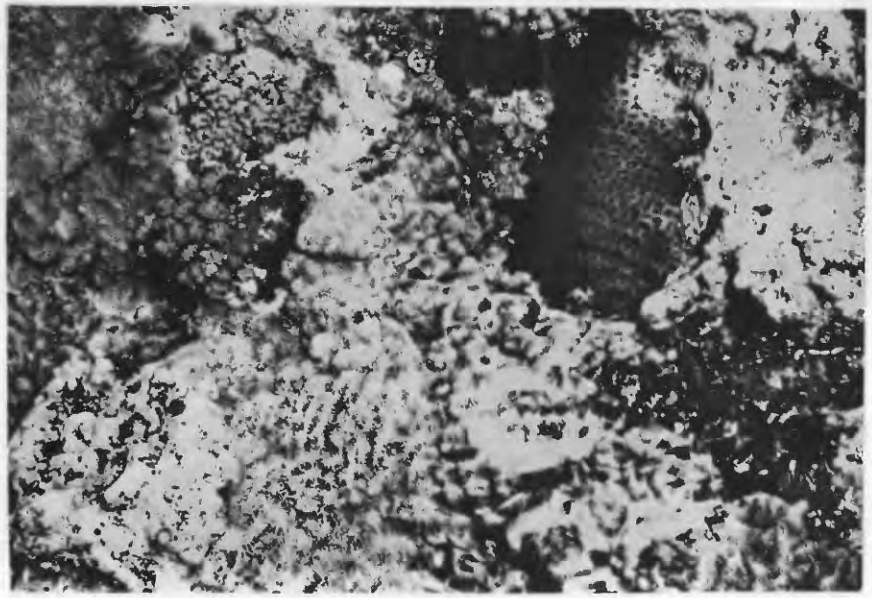
7, 8. *Turbinaria* sp. cf. *T. veluta* Bernard (p. 472).
×0.45, ×4.5. Bikini island, Bikini Atoll, loc. 10d. USNM 45100.



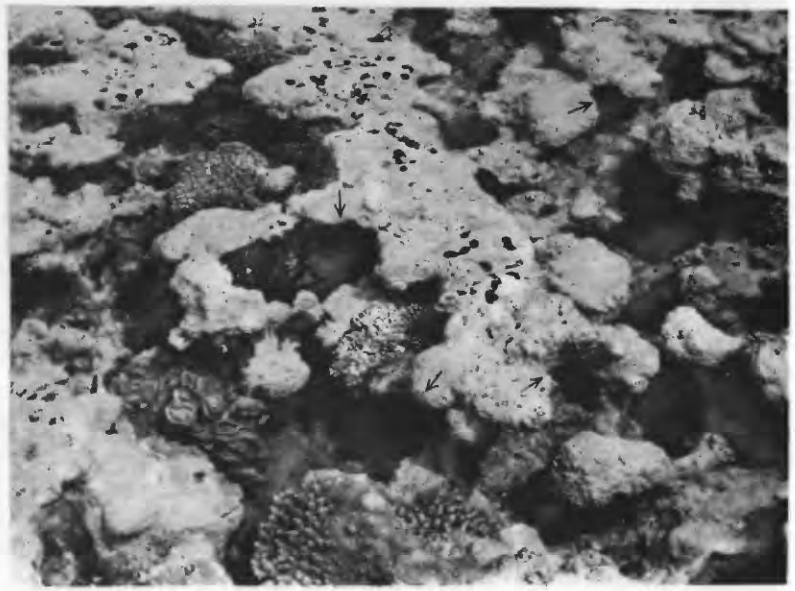
DACTYLOTROCHUS, PHYSOGYRA, AND *TURBINARIA*

1

2



3



4

REEF CORAL HABITS: BIKINI ATOLL REEFS

PLATE 179

FIGURE 1. *Turbinaria* sp. cf. *T. veluta* (p. 472).
Colonies in surge channel cave, depth 1 fathom, Bikini island, loc. 10d. Diameter of fronds, about 20 cm. (Black object at upper left is a reef fish, *Acanthurus achilles* Shaw.)

2. *Turbinaria* cf. *T. veluta*, *Coscinaraea columna* (p. 446).
Colonies 20–40 cm broad in surge channel cave, depth 1½ fms, Bikini island, loc. 10d. *Coscinaraea* in upper right corner.

3. *Favites virens* (upper right), *Acropora cuneata* (center), *Pocillopora danae*, and *Acropora palmerae* (upper left) (p. 419).
On inner part of algal ridge, windward reef, Bikini island, loc. 10b. Lateral scope of photograph about 1 m.

4. *Montipora verrilli* (p. 438).
A vivid magenta encrustation, indicated by arrows, especially the large cavity near center, partly occupied by slate-pencil urchin. *Acropora rotumana* at bottom center; *A. cuneata*, the wrinkled corallum to left of arrows. Sea-urchin-riddled landward side of algal ridge, windward reef north of Bikini island, loc. 10. Lateral scope of photograph, about 1 m.

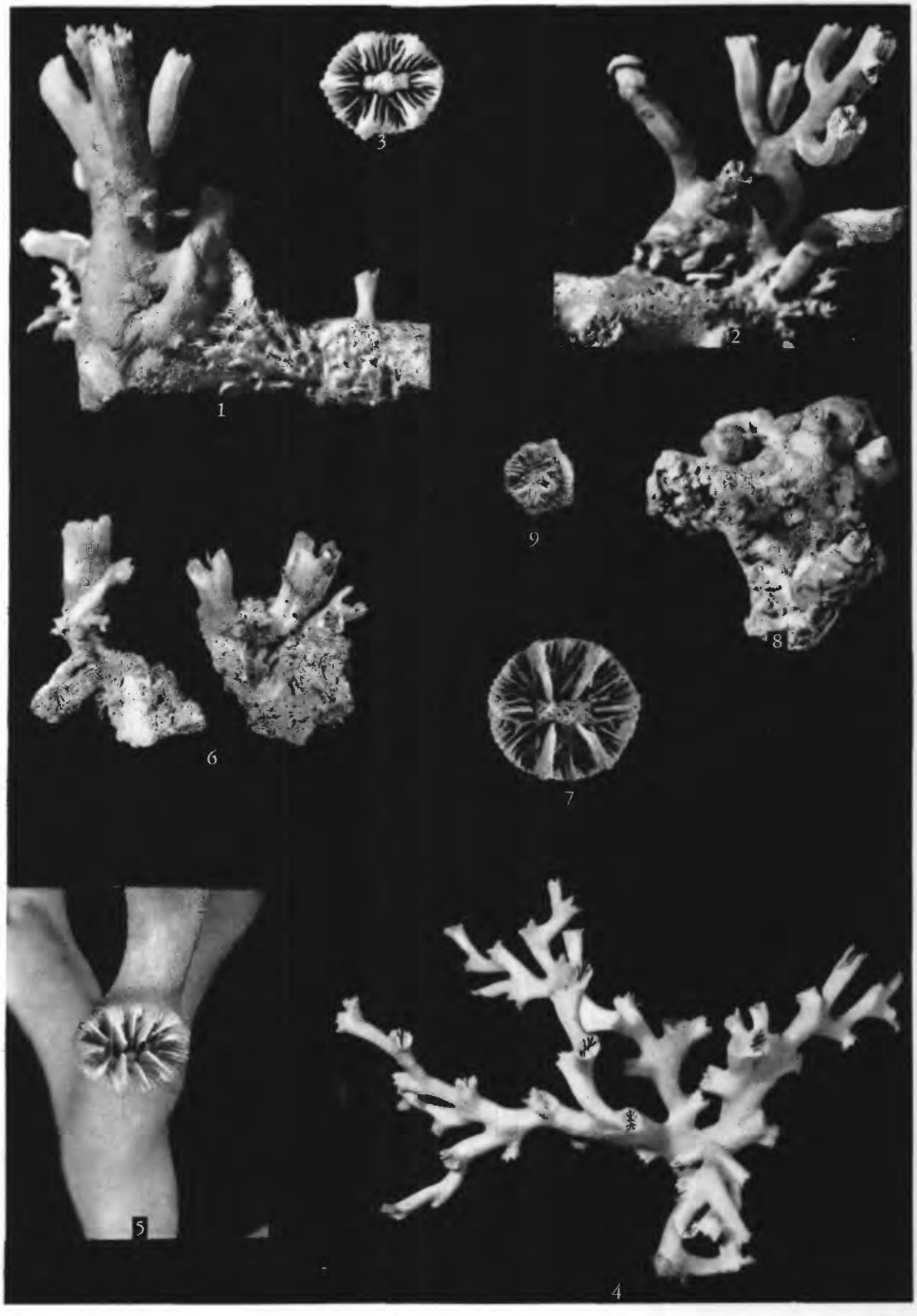
PLATE 180

FIGURES 1–3. *Dendrophyllia fistula* (Alcock) (p. 472).
× 0.9, × 0.9, × 3.6. Seaward slope, 117–121 fms, Bikini Atoll, loc. 118. (At base of fig. 1 is *Fieldingia* sp., a sponge.) USNM 45101.

4, 5. *Dendrophyllia florentula* van der Horst (p. 473).
× 0.45, × 2.3. Seaward slope, 134 fms, Bikini Atoll, loc. 104. USNM 45102.

6, 7. *Rhizopsammia chamissoi* Wells, n. sp. (p. 473).
× 1.35, × 1.35, × 4.5. Bikini Lagoon, 8–23 fms, loc. 38a. Holotype, USNM 45104; paratype, 45105.

8, 9. *Rhizopsammia minuta bikiniensis* Wells, n. var. (p. 473).
× 1.8, × 4.5. Seaward slope, 50–97 fms, Bikini Atoll, loc. 106. Holotype, USNM 45106.



DENDROPHYLLIA AND *RHIZOPSAMMIA*

1

2

3

4

HELIOPORA: HABITS ON BIKINI ATOLL REEFS

PLATE 181

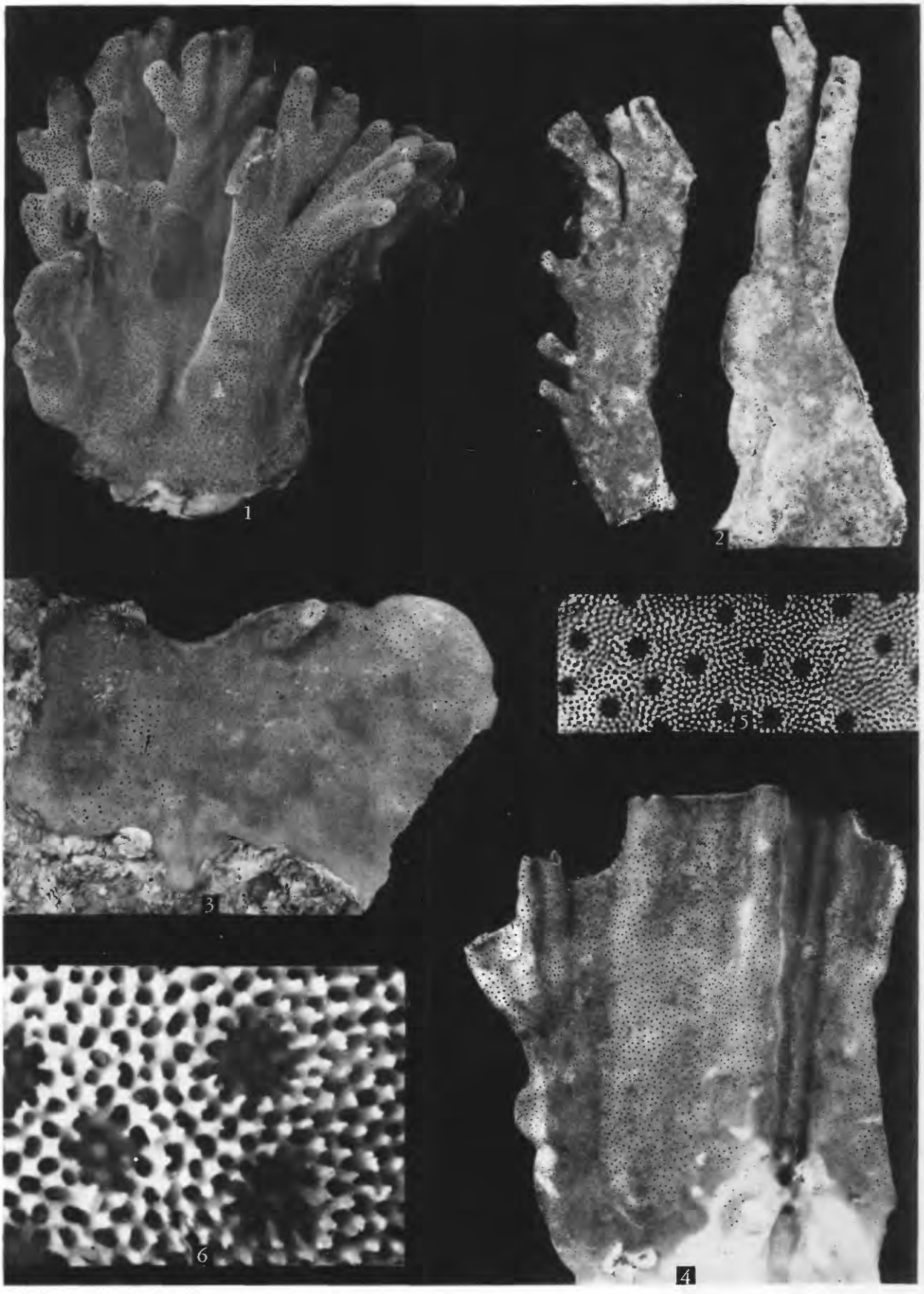
FIGURES 1–4. *Heliopora coerulea* forma α (p. 474).

1. Very large micratolls, 1–2 fms in depth, Namu island, Bikini Atoll, loc. 7a; exposed width of microatoll in foreground about 6 m.
2. Small microatolls, 1½–4 feet in depth, inner reef flat, Bikini island, loc. 10e; breadth of microatolls from 1 to 2 m.
3. Underwater view of side of one of the small microatolls shown in figure 2. Lateral scope of photograph, about 0.5 m. Note coarse sand bottom between microatolls.
4. A colony formed by stout, upright, tapering fingers 5–10 cm thick, 1–1½ fms in depth, in surge channel cave, algal ridge, Bikini island, loc. 10d. In center of picture polyps are expanded.

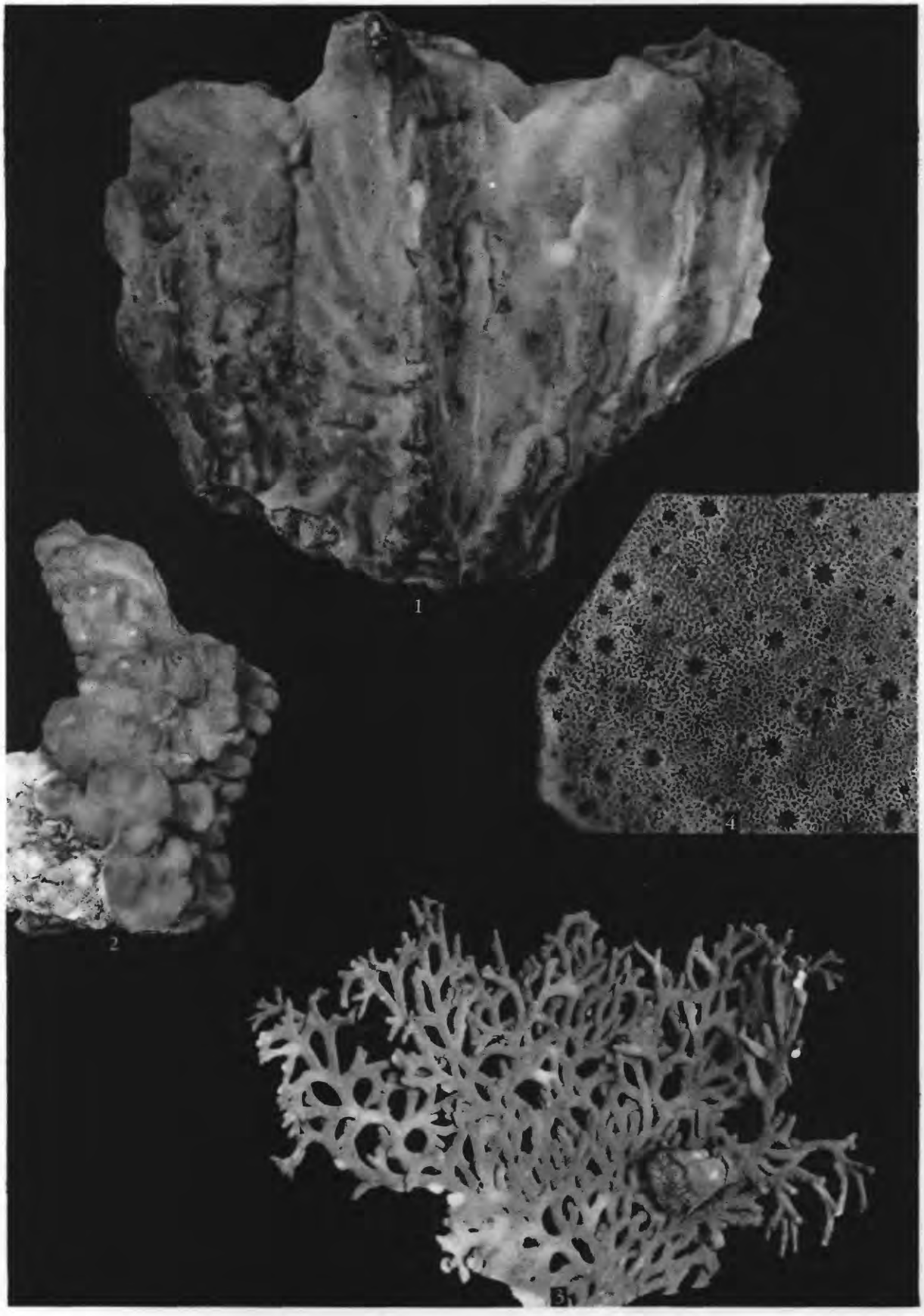
PLATE 182

FIGURES 1–6. *Heliopora coerulea* (Pallas) (p. 474).

1. Forma α. × 0.6. Digitate form. Enyu island, Bikini Atoll, loc. 12a. USNM 45123.
2. Forma β. × 0.45. Clavate form. Rigili island, Eniwetok Atoll, loc. 13. USNM 45134.
3. Forma δ. × 0.68. Encrusting *Echinophyllia*. Naen island, Rongelap Atoll, loc. 24. USNM 45138.
4. Forma γ. ×0.45. Flabellate form. Lomuilal island, Rongelap Atoll, loc. 25. USNM 45117.
5, 6. × 5.4, × 22.5. Surface of colony. Bikini island, Bikini Atoll, loc. 10f. USNM 44916.



HELIOPORA



MILLEPORA

PLATE 183

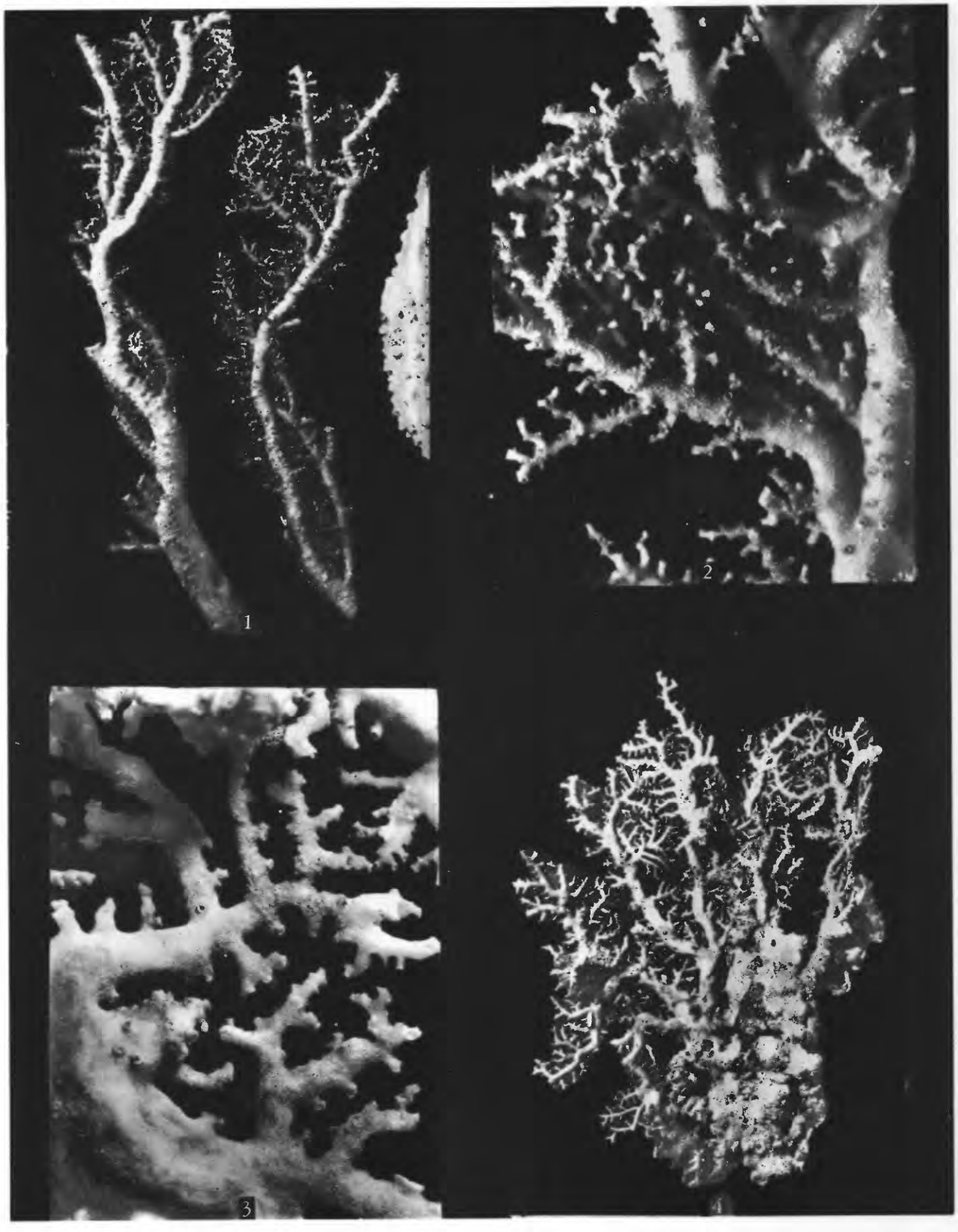
FIGURE 1. *Millepora platyphylla* Hemprich and Ehrenberg (p. 475).
× 0.5. Enyu island, Bikini Atoll, loc. 12a. USNM 45143.

2. *Millepora exaesa* Forskaal (p. 475).
× 0.6. Bokororyuru island, Bikini Atoll, loc. 6. USNM 45151.

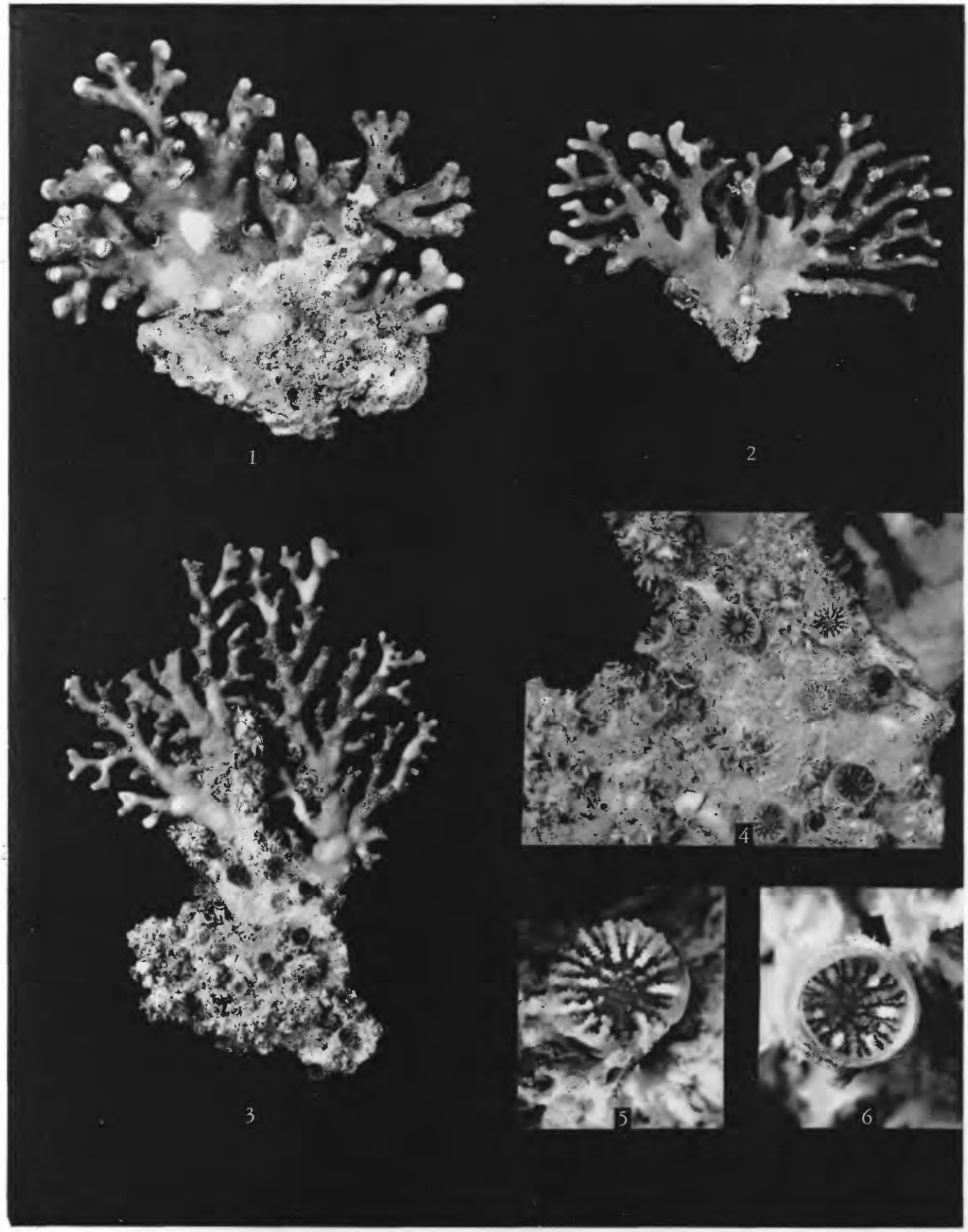
3, 4. *Millepora tenera* Boschma (p. 475).
× 0.18, × 10.8. Jaluit Atoll. Imp. Coll. 11.

PLATE 184

FIGURES 1, 2. *Stylaster asper* Kent (p. 475).
× 0.9, × 4.5. Seaward slope, Bikini Atoll, 58–90 fms, loc. 109. USNM 45160.
3, 4. *Stylaster elegans* Verrill (p. 476).
× 4.5, × 0.45. Seaward slope, Bikini Atoll, 12.5–17 fms, loc. 115. USNM 45155.



STYLASTER



DISTICHOPORA AND *CULICIA*

PLATE 185

FIGURE 1. *Distichopora fisheri* Broch, type β (p. 476).
× 0.9. Lidilbut island, Eniwetok Atoll, loc. 16. (Color: purple.) USNM 45168.

2. *Distichopora fisheri*, type α (p. 476).
× 0.9. Piganiyaroyaro island, Rongelap Atoll, loc. 23. (Color: purple.) USNM 45165.

3. *Distichopora violacea* (Pallas) (p. 476).
× 0.9. (With *Culicia rubeola*.) Under shelf on reef margin, 1 fm depth, Bikini island, Bikini Atoll, loc. 10b. (Color: salmon-pink.) USNM 45054.

4–6. *Culicia rubeola* (Quoy and Gaimard) (p. 464).
× 2, × 5.4, × 5.4. Same specimen as figure 3.

○