SMITHSONIAN INSTITUTION

UNITED STATES NATIONAL MUSEUM

Bulletin 59

RECENT MADREPORARIA

OF THE

HAWAIIAN ISLANDS AND LAYSAN

BY

T. WAYLAND VAUGHAN

Custodian of Madreporarian Corals, U. S. National Museum

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WASHINGTON

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Published July 12, 1907.

ADVERTISEMENT.

The scientific publications of the National Museum consist of two series—the *Bulletin* and the *Proceedings*.

The *Bulletin*, publication of which was begun in 1875, is a series of more or less extensive works intended to illustrate the collections of the United States National Museum and, with the exception noted below, is issued separately. These bulletins are monographic in scope and are devoted principally to the discussion of large zoological and botanical groups, faunas and floras, contributions to anthropology, reports of expeditions, etc. They are usually of octavo size, although a quarto form, known as the Special Bulletin, has been adopted in a few instances in which a larger page was deemed indispensable.

This work forms No. 59 of the Bulletin series.

Since 1902 the volumes of the series known as "*Contributions from the National Herbarium*," and containing papers relating to the botanical collections of the Museum, have been published as bulletins.

The *Proceedings*, the first volume of which was issued in 1878, are intended as a medium of publication of brief original papers based on the collections of the National Museum, and setting forth newly acquired facts in biology, anthropology, and geology derived therefrom, or containing descriptions of new forms and revisions of limited groups. A volume is issued annually, or oftener, for distribution to libraries and scientific establishments, and in view of the importance of the more prompt dissemination of new facts a limited edition of each paper is printed in pamphlet form in advance.

CHARLES D. WALCOTT,
Secretary of the Smithsonian Institution.

WASHINGTON, U. S. A., *June 15, 1907.*

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RECENT MADREPORARIA OF THE HAWAIIAN ISLANDS AND LAYSAN.

By T. WAYLAND VAUGHAN,

Custodian of Madreporarian Corals, U. S. National Museum, and Geologist, U. S. Geological Survey.

INTRODUCTION.

After the return of the U. S. Bureau of Fisheries steamer *Albatross* expedition of 1902 from the Hawaiian Islands, Prof. C. H. Gilbert requested me to prepare a report on the Madreporaria that had been collected. The material proved more interesting than was at first anticipated, and as a considerable number of the original specimens of the United States Exploring Expedition under Captain Wilkes were preserved in the United States National Museum, it was decided to attempt as full an account of the Madreporarian fauna of the islands as is at present possible. In the execution of this purpose assistance has been received from a number of persons, and to these I desire to express my heartiest thanks.

Prof. A. E. Verrill, of Yale University, allowed the study of his own types and those of Dana preserved in Yale University Museum. He loaned specimens for the purpose of having them photographed, and donated fragments of types not in the United States National Museum.

Dr. W. T. Brigham, Director of the Bernice Pauahi Bishop Museum, of Honolulu, had collections made on the reefs of Molokai and Oahu.

Prof. Theodore Studer, of Berne, sent photographs of the corals from the Hawaiian Islands and Laysan, figured in his Madreporarier von Samoa, den Sandwich-Inseln und Laysan.

Prof. Ludwig Döderlein, of the University of Strassburg, sent photographs of his *Fungia erosa* and *F. oahensis*, and identified for me the specimens of *F. patella* from the Hawaiian Islands.

Mr. Henry M. Bernard, of the British Museum (Natural History), furnished advance proofs of the plates of the Hawaiian *Porites* from his volume on the Porites of the Indo-Pacific Region, and gave his opinion, from photographs sent him, of *Porites evermanni*.

Dr. Richard Rathbun, Assistant Secretary of the Smithsonian Institution, in charge of the United States National Museum, has allowed unrestricted use of all the material in the museum under his charge. As has already been stated, this material comprises a number of Dana's types.

For purposes of comparison, access was given to the collections of the Yale University Museum and of the United States National Museum. The collection made by the *Albatross* under Dr. Alexander Agassiz in the South Pacific in 1900, and a collection sent by Dr. Charles Gravier, of the Muséum d'Histoire Naturelle, Paris, made by himself on the coast of French Somaliland, East Africa, were studied.

Mr. J. F. G. Stokes and Dr. C. Montague Cooke, of the Bernice Pauahi Bishop Museum, of Honolulu, have furnished valuable data on the physical surroundings of the corals which they collected on the Hawaiian reefs, a portion of which were later sent to the United States National Museum by Dr. W. T. Brigham.

Prof. J. E. Duerden, during the summer of 1904, made an extensive collection of Hawaiian shallow-water corals under the auspices of the Carnegie Institution and the American Museum of Natural History (New York). An opportunity to study this material was granted by the two organizations concerned, and a set of duplicates was presented to the United States National Museum by the trustees of the Carnegie Institution.

In the preparation of this work several tasks have been set. They are as follows:

1. To describe and figure all forms known from the Hawaiian waters or supposed to occur in them, in so thorough a manner that reference to previous publications on the Madreporaria of the islands will not be necessary. It has not, however, been possible to figure the *Porites* contained in Bernard's recent volume on the Porites of the Indo-Pacific region.

2. To throw as much light as possible on the morphology of the hard parts, and on problems of classification dealt with from that standpoint.

3. To describe the variations of the different forms represented as thoroughly as the material and the conditions under which the work was done would permit.

4. To record the physical conditions under which the different forms live in as much detail as possible, and to determine the influences of depth and temperature on distribution. In this connection the great need of experimental physiological work on members of the group is repeatedly pointed out.

5. The affinities of the Hawaiian Madreporaria to the Madreporaria of other areas in the Indo-Pacific region are considered, and an hypothesis as to the origin of the fauna is suggested.

No other person can be so conscious of the shortcomings and imperfections of this paper as myself, since there is on every side an insufficiency of data. All that it is hoped to have accomplished is to have presented a body of facts grouped around certain definite problems, and, may be, to have rendered some assistance in understanding a group of organisms whose complexity and perplexing nature are realized by only a small body of specialists.

CLASSIFICATION OF THE MADREPORARIA.

It is only to repeat what has been said by every recent student of the group to say that there is no satisfactory classification of the Madreporaria. A zoological classification is supposed to represent descent; in order to construct a logical one, a phylogenetic valuation must be placed on each character; but we are not yet sure of the correctness of our valuation of the characters. The following classification is used in this paper:

MADREPORARIA IMPERFORATA.

Family FLABELLIDÆ.

Genus *Flabellum*.
Gardineria.
Placotrochus.

Family CARYOPHYLLIIDÆ.

Genus *Desmophyllum*.
Paracyathus.
Deltocyathus.
Trochocyathus.
Caryophyllia.
Cyathoceras.
Ceratotrochus.

Family ANTHEMIPHYLLIIDÆ, new.

Genus *Anthemiphyllia*.

Family OCULINIDÆ.

Genus *Madrepora*.

Family STYLOPHORIDÆ.

Genus *Madracis*.

Family POCILLOPORIDÆ.

Genus *Pocillopora*.

Family ORBICELLIDÆ.

Genus *Leptastrea*.
Cyphastrea.

Family FAVIIDÆ.

Genus *Cœlastrea*.
Favia.

Family MUSSIDÆ.

Genus *Mussa*.

MADREPORARIA FUNGIDA.

Family FUNGIIDÆ.

Genus *Fungia*.

Family AGARICIIDÆ.

Genus *Pavona*.
Leptoseris.
Stephanaria.
Psammocora.
Bathyactis.

MADREPORARIA PERFORATA.

Family EUPSAMMIDÆ.

Genus *Stephanophyllia*.
Endopachys.
Balanophyllia.
Dendrophyllia.
Anisopsammia.

Family ACROPORIDÆ.

Genus *Acropora*.
Montipora.

Family PORITIDÆ.

Genus *Porites*.

Family FAVOSITIDÆ.

Genus *Alveopora*.

One family is described as new, the Anthemiphylliidæ. The other families have now become more or less traditional. I should like to say that I seriously doubt the affinity of *Alveopora* with the Paleozoic *Favosites*, in spite of the excellent arguments which have been brought forward to maintain that conclusion. I do not, however, know any modern perforate coral to which *Alveopora* shows in its skeletal characters any close relationship.

The use of *Leptastrea* as a genus name is continued, although Mr. Stanley Gardiner[a] thinks that it should be referred to the synonymy of *Orbicella*. A certain number or a group of orbicellan corals are characterized by a compact, costal exotheca, to which the name *Leptastrea* was applied. I find the name convenient, but think that it probably should be reduced to subgeneric rank.

THE SPECIES PROBLEM IN CORALS.

The species problem, as a problem of general biology, is still a subject of vigorous debate and wide divergence of opinions among biologists. Some contend that species originate by the gradual accumulation of small differences, the divergence of the daughter from the parent species being by infinitesimals;[b] others, de Vries and his followers, maintain that new species do not owe their origin to such infinitesimal divergence, but suddenly spring into existence, differing at the beginning by distinct lacunæ from the parent species. Some admit that new species may come into existence by either process. I have put myself on record as believing that the data accumulated to the present time are not sufficient to warrant our forming a positive conclusion.[c]

Since the problem as to how new species originate has not been satisfactorily solved, a logically grounded definition of biological species is at present impossible. The following definition is assumed: *A species is a group of individuals connected among themselves by intergrading characters and separated by distinct lacunæ from all other individuals or groups of individuals.* The lucunæ, or discontinuity of characters, would be accounted for by the infinitesimal theory on the assumption that the intergrades, assumed once to have existed, have become extinct; the mutation theory assumes that they never existed. Whichever theory may be correct, the recognition and definition of species is based on the study of variation.

Variation in corals is, we know, great and complex. If we knew its limits, we should know the limits of the different species. Bernard, in cataloguing the Perforate Corals in the British Museum (Natural History), experienced so much difficulty in defining them from the collections at his disposal that he decided to abandon the Linnæan system of nomenclature, and to use in his catalogues a geographical number system.

This system has been expounded in four different publications.[d] The scheme suggested can be briefly outlined as follows: The specimens belonging to a given genus from a specific locality or an area are divided into as many forms as possible, as, for example, he recognizes 9 different kinds of *Porites* from the Hawaiian Islands.

[a] Madreporaria, Fauna and Geography of the Maldive and Laccadive Archipelagoes, II, p. 774.

[b] C. H. Merriam, Is Mutation a Factor in the Evolution of the Higher Vertebrates? Science, n. s., XXIII, 1906, pp. 241–247.

[c] The Work of Hugo de Vries and its Importance in the Study of Problems of Evolution. Science, n. s., XXIII, 1906, pp. 681–691.

[d] A paper read before the Linnæan Society of London, February 7, 1901, pp. 10, 11.

Nomenclatur und Entwickelungslehre, International Zool. Congr., Berlin, 1901, pp. 891–896.

The Unit of Classification for Systematic Biology, Proceedings, Cambridge Philosophical Society, XI, 1901, pp. 268–280.

The Genus Goniopora, Cat. Madrep., Brit. Mus. (Natural History), IV, pp. 34, 35.

These 9 forms are not named, and no attempt is made to identify them with forms from another area. Each one is given a number, and they are designated *Porites* Sandwich Islands $\frac{1}{9}$, $\frac{2}{9}$, $\frac{3}{9}$, $\frac{4}{9}$, etc., the denominator indicating that he has recognized 9 forms from the Sandwich Islands, the numerator indicating which one of the 9 is meant. Should additional forms be discovered later, the numerator and the denominator could be increased. In this way Mr. Bernard hoped to record all the forms known from any particular area, and avoid expressing an opinion as to their grouping into species.

This proposition is so iconoclastic, in a way, that it was only to be expected that it would arouse considerable opposition. The criticism published by Mr. J. Stanley Gardiner is the one most deserving of attention.[a] Bernard's proposition is not absurd, for without large series of specimens for comparison it is impossible to work out the limits of variation; as he did not have such series, he recognized that if he were to describe as a species every specimen or group of specimens not connected with others by intermediates, he might be, or even probably would be, describing, as species, specimens that formed parts of a continuous series. Gardiner later realized more fully the difficulty with which Bernard was contending, and was not only more lenient in his criticism, but acknowledged[b] that Bernard had probably handled his material in the best possible manner. Gardiner, in his own work, however, thought that he could recognize specific limits with sufficient clearness to continue the use of the binomial system.

Whatever opinion may be held as to Bernard's method of designating the forms that he records, it is undeniable that he has made valuable contributions to our knowledge of the Madreporaria.

My own position regarding nomenclatorial problems is somewhat different from that of Mr. Bernard. There are comparatively few of the inductions of science that can properly be regarded as more than tentative. In the matter of species, we are not yet decided as to what a species is. The conclusions of de Vries, should they be correct, would furnish a working basis, but the mutation theory is at present only a valuable working hypothesis. All of our descriptive systematic work, therefore, must be regarded as only tentative. However, as it has the double object of recording the manifold forms assumed by organic nature and attempting the grouping of those forms according to the degree of their kinship, we are justified in naming forms as species; for, although we may not know with positiveness their actual systematic value, the determination of the relationship is attempted. The definition of species is only an attempt to divide organisms into groups in accordance with the definition of the term "species" previously given. I am in favor of attaching names to these tentative groups, as names are more serviceable in discussion than symbols, especially when the symbols are complicated.

Great perplexity has been experienced in preparing the succeeding paper, as to how the results obtained by the study of the material in hand should be presented. The term "species" is used in accordance with the definition given. The word

[a] On the Unit of Classification for Systematic Biology. A reply to Mr. Bernard. Proceedings, Cambridge Philosophical Society, XI, 1902, pp. 423–427.

[b] Madreporaria, Fauna and Geography of the Maldive and Laccadive Archipelagoes, II, pp. 756–757.

"variety" is used in the significance usually attributed to it in America. A "variety" would be a secondary mode on a species curve. The de Vries "variety" should be a retrograde "species." Mr. Gardiner, in speaking of *Fungia dentigera* as probably being a "true variety,"[a] misapplies the de Vries term "variety." *Fungia dentigera* differs from *F. scutaria* by the possession of strongly developed tentacular lobes. These tentacular lobes are an added, not a retrogressive character; therefore in the de Vries sense *F. dentigera* can not be a "variety." If *F. scutaria* has lost its tentacular lobes it might be a "variety" of *F. dentigera*. Later, it is shown that *F. dentigera* and *F. scutaria* are connected by continuous variations.

Porites compressa and *Porites lobata* are divided into numerous "*formæ*" and "*subformæ*." The variations recorded have been observed, and it is believed that they should be described and figured, but their origin is not known. It is not known whether they are of gametic or vegetative origin. Some of them may be of specific value, but the conformity to a type is so closely followed throughout all of them and there is so much observable intergradation that I fancy they all intergrade.

Throughout this paper, however, I have striven earnestly to make clear what forms, even down to minor variations, have been studied, so that the nomenclature may be considered of minor importance. The descriptions are usually elaborate, many statistical tables are given, and the illustrations are profuse.

NEED OF EXPERIMENTAL INVESTIGATION AND MORE ELABORATE STUDIES OF VARIATION IN CORALS.

Studies of variations, such as those contained in this paper, may appear elaborate to persons who have not gone deeply into the subject, but in reality they are of only a preliminary nature, for as stated in the introductory remarks "there is on every side an insufficiency of data," and consequently it is not possible to solve many of the fundamental problems pertaining to the group. The study of variation is inseparable from experimental physiological investigations, for these are a necessary foundation for the understanding of variation.

Mr. J. Stanley Gardiner divides variation in the Madreporaria into three classes: (a) *Continuous*, (b) *vegetative*, and (c) *discontinuous* or *specific*.[b] I think two kinds should be recognized: (a) *Gametic*, (b) *vegetative*. *Gametic* variation is due to differences in the parental gametes, and, should the de Vries mutation hypothesis be correct, it should be divided into *continuous* and *discontinuous*. *Vegetative* variation is due to the effect produced upon the organism by the environment under which it lives.

Variation in the Madreporaria should be studied in three ways: (1) In nature without experiment; (2) in nature by experiment; (3) under artificial conditions in aquaria.

1. *In nature without experiment.*—Coral fields, according to this method, should be ecologically surveyed. The study of specimens of the same species obtained under the same physical conditions would give information on gametic variation, while the comparative study of specimens belonging to the same species, obtained

[a] Madreporaria, Fauna and Geography of the Maldive and Laccadive Archipelagoes, II, p. 939.
[b] Idem, p. 755.

under different physical conditions, would throw light on the influence exerted by the environment. Numerous fragmentary studies of this kind have been made, but none has been thoroughly done. As much information obtained in this way, as is possible, is given in the present memoir.

2. *In nature by experiment.*—By planting attached young under the same physical conditions gametic variation could be observed. By transplanting specimens from one area to another, or by planting the young of a given colony under different physical conditions, the effect of environment could be studied.

3. *Under artificial conditions.*—As corals can be grown in aquaria, numerous experiments on both gametic and vegetative variation are possible. The behavior with reference to at least seven factors can be studied: Food supply, heat, light, character of bottom, strength of current, degree of salinity of the water, various kinds of impurities in the water. Even the influence of pressure might be studied.

The study of variation in nature should go more or less hand in hand with the experimental work. It is to be hoped that studies of the kind here outlined will be undertaken by some of our marine biological stations, and that other stations that can undertake such work will be established, for until these studies are made it will not be possible to understand variation in the Madreporaria. Until variation is understood the systematic work must be more or less unreliable; and until more is known concerning the physiology of corals we can not understand the factors that determine their distribution.

HISTORY OF SYSTEMATIC WORK ON THE HAWAIIAN MADREPORARIA.

Comparatively few men have described Madreporarian corals from the Hawaiian Islands, but work on them was begun at a rather early date.

Lesson, in his Illustrations de Zoologie, 1831, described and figured *Flabellum pavoninum*.

Dana, in his Zoophytes of the United States Exploring Expedition, 1846, reported the following species:

Euphyllia pavonina (Lesson).
Astræa (Orbicella) ocellina Dana.
Fungia dentigera Leuckart.
Manopora capitata Dana.
Pocillopora cespitosa Dana.
Pocillopora brevicornis Lamarck.
Pocillopora favosa Ehrenberg.
Pocillopora verrucosa Lamarck.
Pocillopora ligulata Dana.
Pocillopora meandrina Dana.
Pocillopora plicata Dana.
Pocillopora informis Dana.
Porites mordax Dana.
Porites mordax var. *elongata* Dana.
Porites compressa Dana.
Porites lobata Dana.
Alveopora dedalea (Forskål).

The specimen of *Alveopora*, supposed to have come from the Hawaiian Islands, was subsequently named *A. verrilliana.*[a]

Verrill, in his List of Polyps and Corals, sent by the Museum of Comparative Zoology to other Institutions in Exchange, 1864, added—

Synaræa irregularis.
Lobactis danæ (new name for the *Fungia dentigera* of Dana from the Sandwich Islands).
Pavona varians.
Pocillopora nobilis (new name for the *Pocillopora verrucosa* of Dana, from the Sandwich Islands).

In his Polyps and Corals of the North Pacific Exploring Expedition, 1865–1869, he added—

Montipora patula.
Cœnopsammia manni.
Pocillopora aspera (new name proposed for the specimens from the Sandwich Islands, identified by Dana as *Pocillopora favosa* and *Pocillopora plicata*).
Pocillopora aspera var. *lata.*
Pocillopora frondosa.
Pocillopora nobilis.
Pocillopora nobilis var. *tuberosa.*
Cælastrea tenuis. }
Astræa hombroni (Rousseau) ?. } Doubtfully from the Hawaiian Islands.
Astræa rudis. }
Leptastrea stellulata.

Dana's *Pocillopora brevicornis* from the Sandwich Islands is referred to Dana's *P. cæspitosa.*

Quelch, in his report on the Reef Coral, Challenger Expedition, 1886, reported, in addition to those already mentioned:

Pocillopora verrucosa Lamarck.
Fungia paumotensis Stutchbury.
Stephanaria stellata Verrill.
Montipora verrucosa (Lamarck).
Porites bulbosa, new species.
Porites lichen Dana.
Porites tenuis Verrill.

The last two determinations are undoubtedly erroneous. The name *Fungia verrilliana* is substituted for *Lobactis danæ* Verrill.

Quelch gives a list of 30 species reported from the Islands.

Fowler, 1888, published a few notes on the anatomy of *Pocillopora nobilis.*

Brook, in his Catalogue of the Genus Madrepora, 1893, reported *Madrepora echinata* Dana.

Bernard, in his Catalogue of the Genus Montipora, 1897, describes *Montipora verrucosa* (Lamarck) from the Hawaiian Islands and places the *Manopora capitata* Dana in its synonymy.

[a] Corals and Coral Islands, 1st ed., 1872, p. 77.

Studer in 1901 published his Madreporarier von den Sandwich Inseln und Laysan. He adds:

Fungia echinata (Pallas), remarking "an der Richtigkeit des Fundortes nicht zu zweifeln ist."

Madrepora echinata Dana, reported a second time.
Montipora flabellata Laysan.
Montipora dilatata Laysan.
Porites quelchi.
Porites lanuginosa Laysan.
Porites schauinslandi Laysan.
Porites discoidea Laysan.

Five of the six new species came from Laysan.

Bernard, in his Porites of the Indo-Pacific Region, 1905, divides the Hawaiian *Porites* into nine kinds and those from Laysan into three, designating them by his number symbols.

Vaughan, in a review of J. Stanley Gardiner's Fungida and Turbinolidæ of the Maldive and Laccadive Archipelagoes, 1905, gave a preliminary list of the Hawaiian Fungida (see p. 107 of the present memoir).

Duerden has made extended studies on the postembryonic development and the anatomy of the soft parts of the Hawaiian Madreporaria, under the auspices of the Carnegie Institution; but his results have not yet been published.

Previous to the study here presented, about 38 species, including synonyms, had been recorded from the area. If the forms whose occurrence in the area is doubtful be included, the Hawaiian Madreporarian fauna is now known to contain 129 recognizable forms, a number of which, however, are not considered of specific value.

SYSTEMATIC LIST OF THE FAUNA, WITH THE STATION NUMBERS OR LOCALITIES, DEPTH, TEMPERATURE, CHARACTER OF THE BOTTOM, DISTRIBUTION OUTSIDE THE HAWAIIAN ISLANDS, OR CLOSELY RELATED FORMS IN OTHER AREAS.

As it is probable that some of the species described in the descriptive portion of this report do not occur in the Hawaiian Islands, they are omitted from the list. They are as follows:

Fungia paumotensis Stutchbury.
Fungia echinata (Pallas).
Acropora echinata (Dana).
Porites lichen Dana.
Porites tenuis Verrill.

Flabellum lamellulosum Alcock and *Porites reticulosa*, although they have not been reported from the area, are described in the text to complete discussions.

The following abbreviations are used in describing the bottom:

Abbreviation.	Meaning.	Abbreviation.	Meaning.	Abbreviation.	Meaning.
alg.	algæ.	for.	foraminifera.	s.	sand.
br.	brown.	g.	gravel.	sh.	shells.
brk.	broken.	gy.	gray.	sml.	small.
co.	coral.	lt.	light.	st.	stones.
corln.	coralline.	m.	mud.	vol.	volcanic.
crs.	coarse.	nod.	nodules.	wh.	white.
dk.	dark.	p.	pebbles.	yl.	yellow.
fne.	fine.	r.	rock.		

The data relating to the stations are taken from the "Records of the dredging and other collecting stations of the U. S. Fish Commission steamer *Albatross* in 1901 and 1902."[a]

It is deeply regretted that it has not been practicable to present a map showing the submarine topography, the submarine isotherms, the distribution of the various kinds of sea bottom, and the location of the various stations.

[a] U. S. Fish Commission Report for 1902, 1903, pp. 397–432.

Systematic List of the Fauna.

Name.	Station number or locality.	Island.	Depth in fathoms (except when given in feet).	Temperature (degrees F.).	Bottom.	Distribution outside the Hawaiian Islands, or affinity.
Flabellum paroninum Lesson, typical	3856	Between Molokai and Maui.	127	66.5°	fne. s. yl. m	Indian Ocean to Cape Good Hope.
	4079	Maui	143–178	60.8°	gy. s. for.	
	4080	Maui	178–202	56.4°	gy. s. for.	
	4081	Maui	202–220	51.7°	gy. s. for.	
	4132	Kauai	257–312	46.8°	fne. gy. s. m.	
F. paroninum var. *latum* Studer	3865	Between Molokai and Maui.	256–283	45°	fne. vol. s. r.	Near New Zealand; Philippines.
F. paroninum var. *distinctum* Milne Edwards and Haime.	3999	Kauai	7–148		co. s. sh.	Western Pacific; Indian Ocean; eastern Atlantic.
	4101	Between Maui and Molokai.	122–143	59.7°	co. s. sh. for.	
F. paroninum var. *pariparoninum* Alcock.	3835	Molokai	169–182	55°	fne. br. s. m.	Indian Ocean.
	3856	Between Molokai and Maui.	127	66.5°	fne. s. yl. m.	
	3857	Between Molokai and Maui.	127–128	62.5°	fne. s. yl. m.	
	4079	Maui	143–178	60.8°	gy. s. for.	
	4080	Maui	178–202	56.4°	gy. s. for.	
	4081	Maui	202–220	51.7°	gy. s. for.	
	4115	Oahu	195–241	55.1°	co. s. for.	
Flabellum deludens v. Marenzeller	3977	Modu Manu	876	38°	fne. cor. s. for. r.	Indian Ocean.
	4036	Hawaii	687–692	38.2°	fne. dk. gy. s. for.	
	4038	Hawaii	670–689	38.5°	gy. m. for.	
	4039	Hawaii	670–697	38.7°	gy. m. for.	
Placotrochus fuscus Vaughan	3886	Between Molokai and Maui.	148	65°	p. r.	
	3999	Kauai	7–148		co. s. sh.	
Gardineria hawaiiensis Vaughan	3991	Kauai	272–296	43.7	fne. s. r.	

Systematic List of the Fauna—Continued.

Name.	Station number or locality.	Island.	Depth in fathoms (except when given in feet).	Temperature (degrees F.).	Bottom.	Distribution outside the Hawaiian Islands, or affinity.
Desmophyllum cristagalli Milne Edwards and Haime.	3893	Between Molckai and Oahu.	220–346	47	fne. wh. s. r	Universal.
Paracyathus gardineri Vaughan	Lost					
Paracyathus tenuicalyx Vaughan	3895	Molokai	252–429	47	co. r	
Paracyathus mauiensis Vaughan	4098	Maui	95–152	64. 8	co. s. for. r	
Paracyathus molokensis Vaughan	3833	Molokai	88–142	63	s. p. brk. sh. r	
Deltocyathus andamanicus Alcock	4045	Hawaii	147–198	49	co. s. for	Andaman Sea.
Trochocyathus oahensis Vaughan	4041	Hawaii	252–283	41. 6	gy. m. for	
	4133	Hawaii	41–312	43. 8	fne. gy. s. r	
Caryophyllia alcocki Vaughan	3977	Modu Manu	876	38	fne. co. s. for	
Caryophyllia octopali Vaughan	3827	Molokai	319–371	42. 1	lt. gy. br. m	Affinity, *C. cornuformis* Pourtalès, Antilles.
	3828	Molokai	281–319	43. 8	brk. s. g	
C. octopali var. *incerta* Vaughan	3827	Molokai	319–371	42. 1	lt. gy. br. m	
Caryophyllia hawaiiensis Vaughan	3838	Molokai	92–212	67	fne. gy. br. s	Affinity, *C. quadragenaria* Alcock.
	3885	Between Molokai and Maui.	136–148	64. 8	s. p	
Cyathoceras diomedeæ Vaughan	3835	Between Molokai and Maui.	169–182	55	fne. br. s. m	Affinity, *C. rubescens* Moseley.
	3863	Between Molokai and Maui.	127–154	60–61	brk. co. crs. g. r	
	?3952	Laysan	347–351	45	wh. s. g	
	3999	Kauai	7–148		co. s. sh	
	3810	Oahu	53–211	47. 7	fne. co. s	
	4115	Oahu	195–241	55. 1	co. s. for	
Ceratotrochus laxus Vaughan	3827	Molokai	319–371	42. 1	lt. gy. br. m	
Anthemiphyllia pacifica Vaughan	3838	Molokai	92–212	67	fne. gy. br. s	
	3856	Between Molokai and Maui.	127	66. 5	fne. s. yl. m	

	3857	Between Molokai and Maui.	127–128	62.5	fne. s. yl. m	
	3858	Between Molokai and Maui.	128	61.5–61.8	fne. s. gy. m	
Madrepora kauaiensis Vaughan	4136	Kauai	294–352	44.2	fne. co. s	
	3833	Molokai	88–142	63	s. p. brk. sh. r	Affinity, *M. mirabilis* Duchassaing and Michelotti, Antilles.
	3838	Molokai	92–212	67	fne. gy. br. s	
	3982	Kauai	40–233	48.5	crs. br. co. s. sh.	
	4061	Hawaii	24–83		co. s. corln. nod. for.	
	4135	Kauai	225–294	51.4	fne. co. s	
M. kauaiensis var. *macrocalyx* Vaughan	3833	Molokai	88–142	63	s. p. brk. sh. r	
Pocillopora cespitosa Dana, typical	Honolulu	Oahu	Reef			Southern Pacific.
	Waikiki	Oahu	Reef			
	Kaunakakai	Molokai	Reef			
	Pukoo	Molokai	Reef			
		Laysan				
P. cespitosa var. *tumida* Vaughan	Kahana	Oahu	3 to 6 feet			
	Pukoo	Molokai	3 to 6 feet			
P. cespitosa var. *laysanensis* Vaughan	3955	Laysan	20–30	74 (surface).	co. r. alg.	
	3968	French Frigate Shoal.	14.5–16.5	75 (surface).	crs. s. cor.	
P. cespitosa var. *stylophoroides* Vaughan	3959	Laysan	10	78 (surface).	wh. s. cor.	
	Kahana	Oahu	3 to 6 feet			
	Pukoo	Molokai	3 to 6 feet			
Pocillopora molokensis Vaughan	3847	Molokai	23–24	76 (surface).	s. st	Affinity, *P. solida* Quelch, Tahiti.
Pocillopora modumanensis Vaughan	4167	Modu Manu	21–22	78 (surface).	co. s	Affinity, *P. eydouxi* Milne Edwards, Southern Pacific.

Systematic List of the Fauna—Continued.

Name.	Station number or locality.	Island.	Depth in fathoms (except when given in feet).	Temperature (degrees F.).	Bottom	Distribution outside the Hawaiian Islands, or affinity.
Pocillopora ligulata Dana	3968	French Frigate Shoal.	14½	75 (surface).	crs. s. co	Affinity, *P. plicata*, Southern Pacific.
	Waikiki	Oahu	Reef			
	Honolulu	Oahu	Reef			
	Pukoo	Molokai	Reef			
Pocillopora frondosa Verrill						
Pocillopora meandrina Dana, typical	Pukoo	Molokai	3 to 6 feet			Southern Pacific.
P. meandrina var. *nobilis* Verrill	Kaunakakai	Molokai	Reef			Southern Pacific.
	4031	Oahu	27–28	76 (surface).	fne. cor. s. for. co.	
	Kahana	Oahu	3 to 6 feet			
	Pukoo	Molokai	3 to 6 feet			
	Honolulu	Oahu	Reef, 1–40			
	Waikiki	Oahu				
		Laysan				
P. meandrina var. *tuberosa* Verrill						
Pocillopora informis Dana						
Leptastrea stellulata Verrill						
Leptastrea agassizi Vaughan	Kaneohe	Oahu	3 to 6 feet			
	Waikiki	Oahu	3 to 6 feet			
Leptastrea hawaiiensis Vaughan	Pukoo	Molokai	3 to 6 feet			
	Waikiki	Oahu	Reef			
Cyphastrea ocellina (Dana)	Kaunakakai	Molokai	Reef			
	Pukoo	Molokai	3 to 6 feet			
	Kaneohe	Oahu	3 to 6 feet			
	Kahana	Oahu	3 to 6 feet			
	Waikiki	Oahu	Reef			
		Laysan				

Cœlastrea tenuis Verrill						
Favia hawaiiensis Vaughan	Pukoo	Molokai	3 to 6 feet			
	Waikiki	Oahu	3 to 6 feet			
Favia rudis Verrill						
Favia hombroni (Rousseau)?						
Mussa? sp. young?	4136	Kauai	294–352	44.2	fne. co. s.	
Fungia patella (Ellis and Solander)	3848	Molokai	44–73	71.1	s. g	Southern Pacific; Indian Ocean.
	3850	Molokai	43–66	71.7	crs. s. brk. sh. co.	
	4128	Kauai	68–253		crs. br. co. s. for.	
Fungia fragilis Alcock	3850	Molokai	43–66	71.7	crs. s. brk. sh. co.	Indian Ocean.
Fungia scutaria Lamarck		Laysan				Southern Pacific; Indian Ocean, etc.
	Pukoo	Molokai	3 to 6 feet			
	Kaneohe	Oahu	3 to 6 feet			
	Waikiki	Oahu	Reef			
Fungia oahensis Döderlein		Oahu				Jaluit?
Pavona varians Verrill	4053	Hawaii	26–29		fne. gy. s.	Affinity, *P. repens* Brueggemann, Red Sea; Indian Ocean.
	Kaunakakai	Molokai	Reef			
	Pukoo	Molokai	3 to 6 feet			
	Kahana	Oahu	3 to 6 feet			
	Kaneohe	Oahu	3 to 6 feet			
	Waikiki	Oahu	3 to 6 feet			
Pavona duerdeni Vaughan	Pukoo	Molokai	3 to 6 feet			
Leptoseris hawaiiensis Vaughan	3823	Molokai	78–222	69	fne. s. p	Affinity, *L. fragilis* Milne Edwards and Haime, Indian Ocean, etc.
	3845	Molokai	60–64	71–71.5	crs. s. p. sh	
	3848	Molokai	44–73	71.1	s. g	
	3849	Molokai	43–73	67.6	crs. s. brk. sh. co.	
	4024	Kauai	24–43	73.7	crs. co. s. for	
	4128	Kauai	68–253	47.8	crs. br. co. s. for.	
	4132	Kauai	257–312	46.8	fne. gy. s. m	

Systematic List of the Fauna—Continued.

Name.	Station number or locality.	Island.	Depth in fathoms (except when given in feet).	Temperature (degrees F.).	Bottom.	Distribution outside the Hawaiian Islands, or affinity.
Leptoseris hawaiiensis Vaughan	4053	Hawaii	26–29		fne. gy. s	
	4054	Hawaii	26–50		crs. co. s. corln	
	4055	Hawaii	50–62		fne. gy. s. for	
	4100	Between Molokai and Maui.	130–151	61	co. s. sh. for	
Leptoseris scabra Vaughan	3823	Molokai	78–222	69	fne. s. p	
	3848	Molokai	48–73	71.1	s. g	
	3876	Between Maui and Lanai.	28–43	74	s. g	
	4053	Hawaii	26–29		fne. gy. s	
	4054	Hawaii	26–50		crs. co. s. corln	
Leptoseris digitata Vaughan	3847	Molokai	23–24		s. st	Affinity *L. papyracea* (Dana), Indian Ocean, etc.
	3871	Between Maui and Lanai.	13–43		fne. wh. s	
	3872	Between Maui and Lanai.	32–43	74.6	yl. s. p. co	
	3876	Between Maui and Lanai.	28–43	74	s. g	
Leptoseris tubulifera Vaughan	3876	Between Maui and Lanai.	28–43	74	s. g	
Stephanaria stellata Verrill	Pukoo	Molokai	3 to 6 feet			Panama; Southern Pacific?
	Honolulu	Oahu	Reef			
	Waikiki	Oahu	Reef			
Stephanaria brighami Vaughan	Kahana	Oahu	3 to 6 feet			
Psammocora verrilli Vaughan	Kalaeloa	Molokai	3 to 6 feet			
Bathyactis hawaiiensis Vaughan	4125	Between Oahu and Kauai.	963–1124	36.4	br. m. for. r	

Stephanophyllia formosissima Moseley	3838	Molokai	92–212	67	fne. gy. br. s	Philippines.
	3855	Molokai	127–130	65.5	fne. br. s. g	
	3906	Molokai	66–96	72	gy. s. sh. p	
	3856	Between Molokai and Maui.	127	66.5	fne. s. yl. m	
	4101	Between Molokai and Maui.	122–143	59.7	co. s. sh. for	
	4080	Maui	178–202	56.4	gy. s. for	
	4045	Hawaii	147–198	49	co. s. for	
Endopachys oahense Vaughan	3810	Oahu	53–211	47.7	fne. co. s	
Balanophyllia hawaiiensis Vaughan	4059	Hawaii	190–291	44	vol. s	Affinity, *B. cornu* Moseley.
Balanophyllia desmophyllioides Vaughan	3823	Molokai	78–222	69	fne. s. p	Affinity, *B. desmophyllum* Milne Edwards and Haime, Eocene, Europe, North America.
	4061	Hawaii	2–83	77	co. s. corln. nod. for.	
Balanophyllia laysanensis Vaughan	3937	Laysan	130–148	63	wh. s. sml. sh	
Balanophyllia diomedeæ Vaughan	4098	Maui	95–152	64.8	co. s. for. r	Affinity, *B. rediviva* Moseley.
	3999	Kauai	7–148		co. s. sh	
B. diomedeæ var. *mauiensis* Vaughan	4101	Between Molokai and Maui.	122–143	59.7	co. s. sh. for	
Dendrophyllia oahensis Vaughan	4114	Oahu	154–195	60.7	co. s. for	
Dendrophyllia serpentina Vaughan	4045	Hawaii	147–198	49	co. s. for	
Dendrophyllia manni Verrill	Kaneohe	Oahu	3 to 6 feet			
Anisopsammia amphelioides (Alcock)	3893	Between Molokai and Oahu.	220–346	47	fne. wh. s. r	Indian Ocean.
A. amphelioides var. *cucullata* Vaughan	3827	Molokai	319–371	42.1	lt. gy. br. m	
	3922	Oahu	281–369	44.5	lt. gy. s. brk. sh. co. r.	
	3982	Kauai	233–240	48.5	crs. br. co. s. sh	
Montipora dilatata Studer		Laysan				

Systematic List of the Fauna—Continued.

Name.	Station number or locality.	Island.	Depth in fathoms (except when given in feet).	Temperature (degrees F.).	Bottom.	Distribution outside the Hawaiian Islands, or affinity.
Montipora verrucosa (Lamarck)	3999	Kauai	7–148		co. s. sh	Southern Pacific.
	4054	Hawaii	26–50		crs. co. s. corln	
	4147	Modu Manu	26	77.9	co. corln	
	4158	Modu Manu	20–30	78.6	co. corln	
	4163	Modu Manu	24–40	78.1	co.	
	Kaunakakai	Molokai	Reef			
	Pukoo	Molokai	3 to 6 feet			
	Kahana	Oahu	3 to 6 feet			
	Waikiki	Oahu	Reef			
	Kaneohe	Oahu	3 to 6 feet			
	Honolulu	Oahu	1–40			
Montipora tenuicaulis Vaughan	3847	Molokai	23–24			
	3872	Between Maui and Lanai.	32–43	74.6	yl. s. p. co	
Montipora bernardi Vaughan	3847	Molokai	23–34		s. st	
M. bernardi var. *subglabra* Vaughan	4054	Hawaii	26–60		crs. co. s. corln	
Montipora flabellata Studer		Laysan				
	Kahana	Oahu	3 to 6 feet			
	Pukoo	Molokai	3 to 6 feet			
Montipora studeri Vaughan	4024	Kauai	24–43	73.7	crs. co. s. for	
Montipora patula Verrill						
Montipora verrilli Vaughan	Kaunakakai	Molokai	Reef			Close to Southern Pacific forms.
	Kahana	Oahu	3 to 6 feet			
	Kaneohe	Oahu	3 to 6 feet			
Porites mordax Dana						
Porites compressa Dana	Honolulu	Oahu				
P. compressa forma *angustisepta* Vaughan	Kahana	Oahu	3 to 6 feet			
	Pukoo	Molokai	3 to 6 feet			

P. compressa forma *angustisepta* subforma *delicatula* Vaughan.	Pukoo	Molokai	3 to 6 feet		
P. compressa forma *angustisepta* subforma *paucispina* Vaughan.	Pukoo	Molokai	3 to 6 feet		
P. compressa forma *fragilis* Vaughan	Pearl Harbor	Oahu	3 to 6 feet		
P. compressa forma *conjungens* Vaughan.	Kaunakakai	Molokai	Reef		
P. compressa forma *profundicalyx* Vaughan.	Kaunakakai	Molokai	Reef		
P. compressa forma *pilosa* Vaughan	Kahana	Oahu	3 to 6 feet		
P. compressa forma *densimurata* Vaughan.	Pukoo	Molokai	3 to 6 feet		
P. compressa forma *granimurata* Vaughan	Kaneohe	Oahu	3 to 6 feet		
P. compressa forma *clavus* Vaughan	Pukoo	Molokai	3 to 6 feet		
P. compressa forma *compacta* Vaughan	Kahana	Oahu	3 to 6 feet		
P. compressa forma *divaricans* Vaughan.	Kahana	Oahu	3 to 6 feet		
P. compressa forma *elongata* Dana	Kaneohe	Oahu	3 to 6 feet		
P. compressa forma *profundorum* Vaughan.	3970	French Frigate Shoal.	17–17½		crs. s. sh. co
	4168	Modu Manu	20–21		co. s. for
P. compressa forma *breviramosa* Vaughan	4169	Modu Manu	21–22		co
P. compressa forma *abacus* Vaughan	Kaneohe	Oahu	3 to 6 feet		
	Pukoo	Molokai	3 to 6 feet		
P. compressa forma *tumida* Vaughan	Kaneohe	Oahu	3 to 6 feet		
P. compressa forma *bulbosa* Quelch	Honolulu	Oahu	Reef		
Porites duerdeni Vaughan	Kaneohe	Oahu	3 to 6 feet		
Porites evermanni Vaughan	Kaneohe	Oahu	3 to 6 feet		
	Waikiki	Oahu	Reef		
Porites pukoensis Vaughan	Pukoo	Molokai	Reef		
Porites lobata Dana, type			Reef		
P. lobata forma *lacera* Vaughan	Kahana	Oahu	3 to 6 feet		
	Waikiki	Oahu	Reef		
P. lobata forma *infundibulum* Vaughan.	Kahana	Oahu	3 to 6 feet		
	Waikiki	Oahu	Reef		

Systematic List of the Fauna—Continued.

Name.	Station number or locality.	Island.	Depth in fathoms, (except when given in feet).	Temperature. (degrees F.).	Bottom.	Distribution outside the Hawaiian Islands, or affinity.
P. lobata forma *parvicalyx* Vaughan	Pukoo	Molokai	3 to 6 feet			
	Waikiki	Oahu	Reef			
P. lobata forma *centralis* subforma *alpha* Vaughan.	Kahana	Oahu	3 to 6 feet			
	Pukoo	Molokai	3 to 6 feet			
P. lobata forma *centralis* subforma *beta* Vaughan.	Kaneohe	Oahu	3 to 6 feet			
	Pukoo	Molokai	3 to 6 feet			
P. lobata forma *centralis* subforma *gamma* Vaughan.	Pukoo	Molokai	3 to 6 feet			
	Waikiki	Oahu	Reef			
	Kaneohe	Oahu	Reef			
P. lobata forma *centralis* subforma *delta* Vaughan.	Kaunakakai	Molokai	Reef			
	Pukoo	Molokai	Reef			
	Waikiki	Oahu	Reef			
	Kaneohe	Oahu	Reef			
P. lobata forma *centralis* subforma *epsilon* Vaughan.	Pukoo	Molokai	3 to 6 feet			
	Waikiki	Oahu	Reef			
	Kaneohe	Oahu	Reef			
P. lobata forma *aperta* Vaughan	Pukoo	Molokai	3 to 6 feet			
	Waikiki	Oahu	Reef			
Porites quelchi Studer		Molokai				
		Hawaii				
Porites brighami Vaughan	Pukoo	Molokai	3 to 6 feet			
	Waikiki	Oahu	Reef			
Porites lanuginosa Studer		Laysan				
Porites studeri Vaughan	3876	Between Maui and Lanai.	28–43	74	s. g	
Porites bernardi Vaughan	3876	Between Maui and Lanai.	28–43	74	s. g	

Porites discoidea Studer		Laysan			
Porites schauinslandi Studer		Laysan			
Porites (*Synaræa*) *irregularis* Verrill					
Porites (*Synaræa*) *hawaiiensis* Vaughan	Kalihi Harbor	Oahu	3 to 6 feet		
Alveopora verrilliana Dana					

LISTS SHOWING THE GEOGRAPHIC DISTRIBUTION OF THE MADREPORARIA AROUND THE HAWAIIAN ISLANDS.

These lists begin with Hawaii, the most southeasterly island, and proceed toward the northwest, ending with Laysan. They, of course, can not be considered to be complete lists of the stony corals of the different islands, but they give all that is at present known.

Several species contained in the systematic list are omitted from these lists because specific data are not given as to where they were obtained. They are as follows:

Paracyathus gardineri Vaughan.
Pocillopora frondosa Verrill.
Pocillopora meandrina var. *tuberosa* Verrill.
Pocillopora informis Dana.
Leptastrea stellulata Verrill.
Cœlastrea tenuis Verrill.
Favia rudis Verrill.
Favia hombroni (Rousseau)?.
Fungia oahensis Döderlein.[a]
Montipora patula Verrill.
Porites mordax Dana.
Porites (*Synaræa*) *irregularis* Verrill.
Alveopora verrilliana Dana.

These lists are of particular interest as they show the association of the different species, as well as giving the forms found around each of the islands.

HAWAII ISLAND.

Northeast Coast.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
4053	26–29		fne. gy. s.	*Leptoseris hawaiiensis* Vaughan.
				Leptoseris scabra Vaughan.
4054	26–50		crs. co. s. corln.	*Leptoseris hawaiiensis* Vaughan.
				Leptoseris scabra Vaughan.
				Montipora verrucosa (Lamarck).
				Montipora bernardi var. *subglabra* Vaughan.
4055	50–62		fne. gy. s. for	*Leptoseris hawaiiensis* Vaughan.
4059	190–291	44	vol. s	*Balanophyllia hawaiiensis* Vaughan.
4061	24–83		co. s. corln nod. for.	*Madracis kauaiensis* Vaughan.
				Balanophyllia desmophyllioides Vaughan.

[a] This species came from Oahu, but from what part is not mentioned.

HAWAII ISLAND—Continued.

West Coast.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
4036	687–692	38.2	fne. dk. gy. s. for.	*Flabellum deludens* v. Marenzeller.
4038	689–670	38.5	gy. m. for	*Flabellum deludens* v. Marenzeller.
4039	670–697	38.7	gy. m. for	*Flabellum deludens* v. Marenzeller.
4041	253–382	41.6	gy. m. for	*Trochocyathus oahensis* Vaughan.
4045	147–198	49	co. s. for	*Deltocyathus andamanicus* Alcock.
				Stephanophyllia formosissima Moseley.
				Dendrophyllia serpentina Vaughan.

MAUI ISLAND.

Northeast and North Coast.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
4079	143–178	60.8	gy. s. for	*Flabellum paroninum* Lesson, typical.
				F. paroninum var. *pariparoninum* Alcock.
4080	178–202	56.4	gy. s. for	*Flabellum paroninum* Lesson, typical.
				F. paroninum var. *pariparoninum* Alcock.
				Stephanophyllia formosissima Moseley.
4081	202–220	51.7	gy. s. for	*Flabellum paroninum* Lesson, typical.
				F. paroninum var. *pariparoninum* Alcock.
4098	95–152	64.8	co. s. for. r	*Paracyathus mauiensis* Vaughan.
				Balanophyllia diomedeæ Vaughan.

Auau Channel: Between Maui and Lanai.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
3871	13–43		fne. wh. s	*Leptoseris digitata* Vaughan.
3872	32–43	74.6	yl. s. p. co	*Leptoseris digitata* Vaughan.
				Montipora tenuicaulis Vaughan.
3876	28–43	74	s. g	*Leptoseris scabra* Vaughan.
				Leptoseris digitata Vaughan.
				Leptoseris tubulifera Vaughan.
				Porites studeri Vaughan.
				Porites bernardi Vaughan.

MAUI ISLAND—Continued.

PAILOLO CHANNEL: BETWEEN MAUI AND MOLOKAI.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
3856	127	66.5	fne. s. yl. m	*Flabellum pavoninum* Lesson, typical.
				F. pavoninum var. *paripavoninum* Alcock.
				Anthemiphyllia pacifica Vaughan.
				Stephanophyllia formosissima Moseley.
3857	127–128	62.5	fne. s. yl. m	*Flabellum pavoninum* var. *paripavoninum* Alcock.
				Anthemiphyllia pacifica Vaughan.
3865	256–283	45	fne. vol. s. r	*Flabellum pavoninum* var. *latum* Studer.
3885	136–148	64.8	s. p	*Caryophyllia hawaiiensis* Vaughan.
3886	148	65	p. r	*Placotrochus fuscus* Vaughan.
4100	130–151	61	co. s. sh. for	*Leptoseris hawaiiensis* Vaughan.
4101	122–143	59.7	co. s. sh. for	*Flabellum pavoninum* var. *distinctum* Milne Edwards and Haime.
				Stephanophyllia formosissima Moseley.
				Balanophyllia diomedeæ var. *mauiensis* Vaughan.

MOLOKAI ISLAND.

SOUTH COAST.

Pukoo	3–6 feet			*Pocillopora cespitosa* Dana.
				P. cespitosa var. *tumida* Vaughan.
				P. cespitosa var. *stylophoroides* Vaughan.
				Pocillopora ligulata Dana.
				Pocillopora meandrina Dana, typical.
				P. meandrina var. *nobilis* Verrill.
				Leptastrea hawaiiensis Vaughan.
				Cyphastrea ocellina (Dana).
				Favia hawaiiensis Vaughan.
Pukoo	5–15 feet			*Fungia scutaria* Lamarck.
	3–6 feet			*Pavona varians* Verrill.
				Pavona duerdeni Vaughan.
				Montipora flabellata Studer.
				Porites compressa forma *angustisepta* Vaughan.
				P. compressa forma *angustisepta* subforma *delicatula* Vaughan.
				P. compressa forma *angustisepta* subforma *paucispina* Vaughan.
				Porites pukoensis Vaughan.
				Porites lobata forma *parvicalyx* Vaughan.
				P. lobata forma *centralis* subforma *alpha* Vaughan.

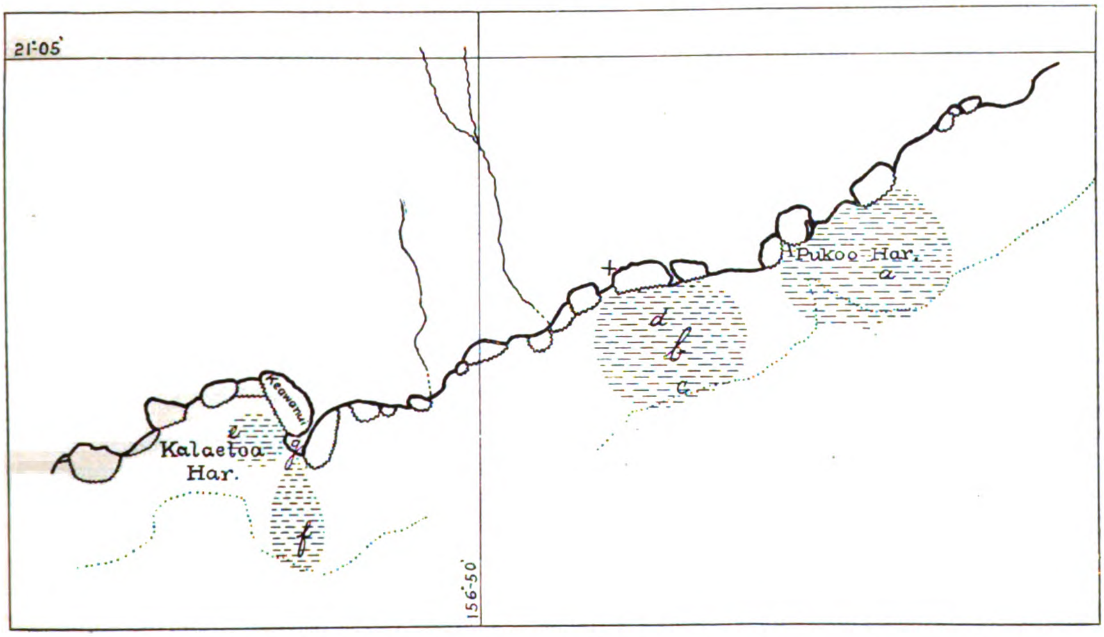
MOLOKAI ISLAND—Continued.

SOUTH COAST—Continued.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
Pukoo....	3–6 feet..	....	....	*P. lobata* forma *centralis* subforma *beta* Vaughan.
				P. lobata forma *centralis* subforma *gamma* Vaughan.
				P. lobata forma *centralis* subforma *delta* Vaughan.
				Porites brighami Vaughan.
Kalaeloa .	....	....	....	*Psammocora verrilli* Vaughan.

Mr. John F. G. Stokes, of Bernice Pauahi Bishop Museum, Honolulu, who aided in making the collection from Pukoo and Kalaeloa, has kindly furnished the following notes on the conditions under which the specimens from those localities were obtained.

The part of Molokai Doctor Duerden and I visited is steeply mountainous inland, fringed with a narrow strip of level land along the shore. I could not tell you if the plain were raised coral reef, as we did not investigate, but the surface is mountain wash. There are no streams to speak of, the water in this island generally reaching the sea by means of springs at the sea line. However, no springs



Coast line of the south side of Molokai Island. The letters *a* to *f* indicate places where collections were made and are referred to in the text; + and *g* indicate stations from which operations were conducted.

were noticed. There had been heavy rains just before our visit and for the first few days the sea was very dirty—probably from the surface wash.

The inclosed rough tracing is from the Hawaiian government map of 1897, the coast line being denoted by heavy and the fringing fish ponds by light lines. Merely approximately and only for the purpose of illustration, the line of the reef is marked by a dotted line and the areas explored by horizontal broken lines.

At Pukoo, a hut at + was our base, and from here we waded toward the outer edge of the reef, followed by the boat. Along the shore the water was a few inches deeper than a few yards out, with no coral, and then the depth gradually grew from 2 feet, increasing approximately at the rate of 6 inches in 100 yards, until the edge was reached. Unlike the reefs at Kahana and Waikiki, Oahu, there was no rise at the outer edge. Proceeding seaward from the first appearance of coral, for a long distance the surface of the bed was composed of living and dead coral, the proportion of the latter in sight being more than four to one of the former. The dead material was held together by thin growths of various colored corallines incrusted on the surface, and was so fragile and loosely piled up that our feet would often break through, sometimes to a depth of twelve inches, and stir up a cloud of fine white particles. There was little or no real beach sand, and in the area *b* less than at *a*. It was always a relief to meet something solid in the shape of a piece of the bare reef rock or a little mound of massive *Porites*. In this belt of *a* and *b*, nearly all the corals were found at depths of 2 to 5 feet—in fact I might say, specimens of all the Molokai corals intermingled except *Fungia* and *Psammocora*. Still going seaward, the bottom became smoother and the broken coral disappeared, leaving the reef rock bare and broken into holes and caverns (some of them immense) at the outer edge. It was in some of these holes (at *c*) that the specimens of *Fungia* were secured at depths of from 5 to 15 feet. Outside the broken coral, on the reef rock, the species occurring most numerously was *Pocillopora cespitosa*, while nearly all the specimens of *Porites brighami* were collected there, and no other forms of *Porites*. I believe that one or two specimens of *Pavona duerdeni* and *Pocillopora ligulata* were also met with, but I do not remember *P. meandrina* there. When I called this part of the reef bare I wished to convey the idea that there was no more coral than one small colony to a square rod of reef. At *d*, near the inside of the broken coral belt, was a large patch, 100 yards square or more, of *Montipora verrucosa* growing almost to the surface of the water and excluding all other species from the locality. Throughout *a* and *b* there was little or no vegetable growth apparent.

It might be worth mentioning that there was a general lack of firmness, and an appearance of debility, among the *Porites* gathered at Pukoo, which effect was also noticed at Waikiki. *Porites lobata* was always collected corroded at the base; while at Kahana, Oahu, on the windward side, the same species was very solid and looked much healthier.

From the point at *g* with its sandy beach, the area *e* at Kalaeloa was explored and *Pocillopora cespitosa* and *Cyphastrea ocellina* found in small colonies amid a thick growth of marine vegetation on a bar 18 inches deep. On either side of the bar was 6 feet of water over a sandy bottom. Then a canoe was rowed seaward and passed over acres of *Porites compressa* forma *abacus* 18 inches to 2 feet below the surface, as well as my memory serves me. Except at *f*, and a few specimens of *Cyphastrea*, the entire bed contained only the one species, but that one was in a very flourishing condition. The bed was composed of hummocks of *Porites*, with narrow strips of sand 6 feet deep between, and the sun shining on the extended animals made it appear that the bottom of the sea was paved with gold. At *f* the only specimens of *Psammocora verrilli* were found, all in one large colony about half a yard square.

Of course all collecting was done at low tide, but this would under ordinary circumstances only mean an advantage of about 2 feet over high tide. I might mention that we always prefer securing specimens ourselves to leaving that work to the native divers. The current at Pukoo, I understand, sets in from the northeast.

MOLOKAI, SOUTH COAST (continued).

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
Kaunakakai	Reef			*Pocillopora cespitosa* Dana, typical.
				Pocillopora meandrina var. *nobilis* Verrill.
				Cyphastrea ocellina (Dana).
				Pavona varians Verrill.
				Montipora verrucosa (Lamarck).
				Montipora verrilli Vaughan.
				Porites compressa forma *conjungens* Vaughan.
				P. compressa forma *profundicalyx* Vaughan.
				Porites lobata Dana.
3823	78–222	69	fne. s. p	*Leptoseris hawaiienses* Vaughan.
				Leptoseris scabra Vaughan.
				Balanophyllia desmophyllioides Vaughan.
3827	319–371	42.1	lt. gy. br. m	*Caryophyllia octopali* Vaughan.
				C. octopali var. *incerta* Vaughan.
				Ceratotrochus laxus Vaughan.
				Anisopsammia amphelioides var. *cucullata* Vaughan.
3828	281–319	43.8	brk. sh. g	*Caryophyllia octopali* Vaughan.
3833	88–142	63	s. p. brk. sh. r	*Paracyathus molokensis* Vaughan.
				Madracis kauaiensis Vaughan.
				M. kauaiensis var. *macrocalyx* Vaughan.
3835	169–182	55	fne. br. s. m	*Flabellum pavoninum* var. *paripavoninum* Alcock.
				Cyathoceras diomedeæ Vaughan.
3838	92–212	67	fne. gy. br. s	*Caryophyllia hawaiiensis* Vaughan.
				Anthemiphyllia pacifica Vaughan.
				Madracis kauaiensis Vaughan.
				Stephanophyllia formosissima Moseley.
3845	60–64	71	crs. s. p. sh	*Leptoseris hawaiiensis* Vaughan.
3847	23–24		s. st	*Pocillopora molokensis* Vaughan.
				Leptoseris digitata Vaughan.
				Montipora tenuicaulis Vaughan.
				Montipora bernardi Vaughan.
3848	44–73	71.1	s. g	*Fungia patella* (Ellis and Solander).
				Leptoseris hawaiiensis Vaughan.
				Leptoseris scabra Vaughan.
3850	43–66	71.7	crs. s. brk. sh. co.	*Fungia patella* (Ellis and Solander).
				Fungia fragilis (Alcock).
3855	127–130	65.5	fne. br. s. g	*Stephanophyllia formosissima* Moseley.

SOUTH OF MOLOKAI, WEST OF LANAI.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
3895	252–429	47	co. r	*Paracyathus tenuicalyx* Vaughan.

NORTH COAST OF MOLOKAI.

3906	66	72	gy. s. sh. p	*Stephanophyllia formosissima* Moseley.

KAIWI CHANNEL, BETWEEN MOLOKAI AND OAHU.

3893	220–346	47	fne. wh. s. r	*Desmophyllum cristagalli* Milne Edwards and Haime.
				Anisopsammia amphelioides (Alcock).

OAHU ISLAND.

SOUTH SIDE.

Honolulu	Reef			*Pocillopora cespitosa* Dana, typical.
				Pocillopora ligulata Dana.
				Pocillopora meandrina var. *nobilis* Verrill.
				Stephanaria stellata Verrill.
	1–40			*Montipora verrucosa* (Lamarck).
	Reef			*Porites compressa* Dana.
				P. compressa forma *bulbosa* Quelch.
				Porites lobata Dana.
				P. lobata forma *centralis* subforma *gamma* Vaughan.
Kalihi Harbor	3–6 feet			*Porites (Synaraea) hawaiiensis* Vaughan.
Waikiki	Reef			*Pocillopora cespitosa* Dana.
				Pocillopora ligulata Dana.
				Pocillopora meandrina var. *nobilis* Verrill.
				Leptastrea hawaiiensis Vaughan.
				Cyphastrea ocellina (Dana.)
				Favia hawaiiensis Vaughan.
				Fungia scutaria Lamarck.
				Stephanaria stellata Verrill.
				Pavona varians Verrill.
				Porites compressa forma *angustisepta* Vaughan.
				Porites evermanni Vaughan.
				Porites lobata Dana, typical.
				P. lobata forma *lacera* Vaughan.
				P. lobata forma *infundibulum* Vaughan.

OAHU ISLAND—Continued.

SOUTH SIDE—Continued.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
Waikiki	Reef			*P. lobata* forma *parvicalyx* Vaughan.
				P. lobata forma *centralis* subforma *alpha* Vaughan.
				P. lobata forma *centralis* subforma *beta* Vaughan.
				P. lobata forma *centralis* subforma *delta* Vaughan.
				P. lobata forma *centralis* subforma *epsilon* Vaughan.
				Porites brighami Vaughan.
Pearl Harbor				*Porites compressa* forma *fragilis* Vaughan.
3810	53–211	47.7	fne. co. s	*Endopachys oahense* Vaughan.
3922	281–369	44.5	lt. gy. s. brk. sh. co. r.	*Anisopsammia amphelioides* var. *cucullata* Vaughan.
4031	27–28		fne. co. s. for co.	*Pocillopora meandrina* var. *nobilis* Verrill.

NORTH SIDE.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
Kaneohe	3–6 feet			*Leptastrea agassizi* Vaughan.
				Cyphastrea ocellina (Dana).
				Fungia scutaria Lamarck.
				Pavona varians Verrill.
				Dendrophyllia manni Verrill.
				Montipora verrucosa (Lamarck).
				Montipora verrilli Vaughan.
				Porites compressa forma *granimurata* Vaughan.
				Porites compressa forma *elongata* Dana.
				Porites compressa forma *abacus* Vaughan.
				Porites compressa forma *tumida* Vaughan.
				Porites duerdeni Vaughan.
				Porites evermanni Vaughan.
				Porites lobata Dana.
Kahana	3–6 feet			*Pocillopora cespitosa* var. *tumida* Vaughan.
				P. cespitosa var. *stylophoroides* Vaughan.
				Pocillopora meandrina var. *nobilis* Verrill.
				Cyphastrea ocellina (Dana).
				Pavona varians Verrill.
				Stephanaria brighami Vaughan.
				Montipora verrucosa (Lamarck).
				Montipora flabellata Studer.
				Montipora verrilli Vaughan.

OAHU ISLAND—Continued.

North Side—Continued.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
Kahana	3–6 feet			*Porites compressa* forma *angustisepta* Vaughan.
				Porites compressa forma *pilosa* Vaughan.
				Porites compressa forma *compacta* Vaughan.
				Porites compressa forma *divaricans* Vaughan.
				Porites lobata forma *lacera* Vaughan.
				P. lobata forma *infundibulum* Vaughan.
				P. lobata forma *centralis* subforma *alpha* Vaughan.
Northwest Coast.				
4114	154–195	60.7	co. s. for	*Dendrophyllia oahensis* Vaughan.
4115	195	55.1	co. s. for	*Flabellum pavoninum* var. *paripavoninum* Alcock.
				Cyathoceras diomedeæ Vaughan.
Kaiele-Waho Channel, between Oahu and Kauai.				
4125	963–1124	36.4	br. m. for. r	*Bathyactis hawaiiensis* Vaughan.

VICINITY OF KAUAI ISLAND.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
3982	40–233	48.5	crs. br. co. s. sh	*Madracis kauaiensis* Vaughan.
				Anisopsammia amphelioides var. *cucullata* Vaughan.
3991	272–296	43.7	fne. s. r	*Gardineria hawaiiensis* Vaughan.
3999	7–148		co. s. sh	*Flabellum pavoninum* var. *distinctum* Milne Edwards and Haime.
				Placotrochus fuscus Vaughan.
				Cyathoceras diomedeæ Vaughan.
				Balanophyllia diomedeæ Vaughan.
				Montipora verrucosa (Lamarck).
4024	24–43	73.7	crs. co. s. for	*Leptoseris hawaiiensis* Vaughan.
				Montipora studeri Vaughan.
4128	68–253	47.8	crs. brk. co. s. for.	*Fungia patella* (Ellis and Solander).
				Leptoseris hawaiiensis Vaughan.
4132	257–312	46.8	fne. gy. s. m	*Flabellum pavoninum* Lesson, typical.
				Leptoseris hawaiiensis Vaughan.
4133	41–312	43.8	fne. gy. s. r	*Trochocyathus oahensis* Vaughan.
4135	225–294	51.4	fne. co. s	*Madracis kauaiensis* Vaughan.
4136	294–352	44.2	fne. co. s	*Madrepora kauaiensis* Vaughan.
				Mussa ? sp., young. ?

VICINITY OF MODU MANU, OR BIRD ISLAND.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
3977	876	38	fne. co. s. for. r.	*Flabellum deludens* v. Marenzeller.
				Caryophyllia alcocki Vaughan.
4147	26	77.9	co. corln	*Montipora verrucosa* (Lamarck).
4158	20–30	78.6	co. corln	*Montipora verrucosa* (Lamarck).
4163	24–40	78.1	co	*Montipora verrucosa* (Lamarck).
4167	18–20		co. s	*Pocillopora modumanensis* Vaughan.
4168	20–21	78.3	co. s. for	*Porites compressa* forma *profundorum* Vaughan.
4169	21–22	78.6	co	*Porites compressa* forma *breviramosa* Vaughan.

FRENCH FRIGATE SHOAL.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
3968	14½–16½		crs. s. co	*Pocillopora cespitosa* var. *laysanensis* Vaughan.
				Pocillopora ligulata Dana.
3970	17–17½		crs. s. sh. co	*Porites compressa* forma *profundorum* Vaughan.

LAYSAN.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
				Pocillopora cespitosa Dana.
				Pocillopora meandrina Dana.
				P. meandrina var. *nobilis* Verrill.
				P. meandrina var. *tuberosa* Verrill.
				Pocillopora ligulata Dana.
				Favia rudis Verrill.
				Leptastrea stellulata Verrill?
				Cyphastrea ocellina (Dana).
				Fungia scutaria Lamarck.
				Montipora verrucosa (Lamarck).
				Montipora flabellata Studer.
				Montipora dilatata Studer.
				Montipora patula Verrill?
				Porites lobata Dana.
				Porites quelchi Studer.
				Porites lanuginosa Studer.
				Porites schauinslandi Studer.
				Porites discoidea Studer.[a]

[a] The preceding list of species from Laysan is taken from Studer's Madreporarier von Samoa, den Sandwich Inseln und Laysan, Zool. Jahrb., Syst., V, 1901, p. 426, except *Fungia scutaria*, which is well represented in the collections made by the "Albatross" in 1902. I have somewhat modified Professor Studer's nomenclature to bring it into accord with the results of recent study, and have queried the determinations of *Leptastrea stellulata* Verrill and *Montipora patula* Verrill, as I doubt the correctness of each of them. Further than that the corals occur in reefs, no data regarding the physical conditions under which they live is given.

LAYSAN—Continued.

Station.	Depth.	Temperature of bottom.	Bottom.	Name.
3937	130–148	63	wh. s. sml. sh.	*Balanophyllia laysanensis* Vaughan.
3949	59–152	69.5	wh. s. brk. sh.	*Leptoseris hawaiiensis* Vaughan
3952	347–351	45	wh. s. g	? *Cyathoceras diomedeæ* Vaughan.[a]
3955	20–30	74	co. r. alg	*Pocillopora cespitosa* var. *laysanensis* Vaughan.
3959	10		wh. s. co	*Pocillopora cespitosa* var. *stylophoroides* Vaughan.

[a] I am not sure that this species came from Station 3952.

BATHYMETRIC DISTRIBUTION.

The bathymetric data relating to the collections of the Hawaiian corals are not so definite as is desirable, largely because of the rugged character of the sea bottom. During the same haul the dredge may be on the bottom at very different depths. For instance, at Station 3999, off Kauai Island, the depth between the beginning and end of the haul varied from 7 to 148 fathoms. At that station five species of corals were obtained, namely, *Flabellum pavoninum* var. *distinctum* Milne Edwards and Haime, *Placotrochus fuscus* Vaughan, *Cyathoceras diomedeæ* Vaughan, and *Montipora verrucosa* (Lamarck). It is impossible to ascertain from this record the depth at which any one of the species was obtained. By comparison with other records, it seems probable *Flabellum pavoninum* var. *distinctum* came from a depth of slightly more than 100 fathoms; *Placotrochus fuscus* from about 148; *Cyathoceras diomedeæ* from the same depth; while the *Montipora verrucosa* came from less than 40 fathoms.

SPECIES LIVING BETWEEN 1 AND 25 FATHOMS.

Pocillopora cespitosa Dana, typical.
Pocillopora cespitosa var. *tumida* Vaughan.
Pocillopora cespitosa var. *laysanensis* Vaughan.
Pocillopora cespitosa var. *stylophoroides* Vaughan.
Pocillopora molokensis Vaughan.
Pocillopora modumanensis Vaughan.
Pocillopora ligulata Dana.
Pocillopora frondosa Verrill.[a]
Pocillopora meandrina Dana.
Pocillopora meandrina var. *nobilis* Verrill.
Pocillopora meandrina var. *tuberosa* Verrill.
Pocillopora informis Dana.[a]
Leptastrea stellulata Verrill.
Leptastrea agassizi Vaughan.
Leptastrea hawaiiensis Vaughan.
Cyphastrea ocellina (Dana).
Cœlastrea tenuis Verrill.[a]

Favia hawaiiensis Vaughan.
Favia rudis Verrill.[a]
Favia hombroni (Rousseau)?.[a]
Fungia scutaria Lamarck.
Fungia oahensis Döderlein.[a]
Pavona varians Verrill.
Pavona duerdeni Vaughan.
Leptoseris digitata Vaughan.
Stephanaria stellata Verrill.
Stephanaria brighami Vaughan.
Psammocora verrilli Vaughan.
Dendrophyllia manni Verrill.
Montipora dilatata Studer.
Montipora verrucosa (Lamarck).
Montipora tenuicaulis Vaughan.
Montipora bernardi Vaughan?.
Montipora flabellata Studer.
Montipora patula Verrill.[a]
Montipora verrilli Vaughan.
Porites mordax Dana.
Porites compressa Dana.
P. compressa forma *angustisepta* Vaughan.
P. compressa forma *angustisepta* subforma *delicatula* Vaughan.
P. compressa forma *angustisepta* subforma *paucispina* Vaughan.
P. compressa forma *fragilis* Vaughan.
P. compressa forma *conjungens* Vaughan.
P. compressa forma *profundicalyx* Vaughan.
P. compressa forma *pilosa* Vaughan.
P. compressa forma *densimurata* Vaughan.
P. compressa forma *granimurata* Vaughan.
P. compressa forma *clavus* Vaughan.
P. compressa forma *compacta* Vaughan.
P. compressa forma *divaricans* Vaughan.
P. compressa forma *elongata* Dana.
P. compressa forma *profundorum* Vaughan.
P. compressa forma *breviramosa* Vaughan.
P. compressa forma *abacus* Vaughan.
P. compressa forma *tumida* Vaughan.
P. compressa forma *bulbosa* Quelch.
Porites duerdeni Vaughan.
Porites evermanni Vaughan.
Porites pukoensis Vaughan.
Porites lobata Dana.
P. lobata forma *lacera* Vaughan.

[a] Depth not given, but the assumption seems safe.

P. lobata forma *infundibulum* Vaughan.
P. lobata forma *parvicalyx* Vaughan.
P. lobata forma *centralis* subforma *alpha* Vaughan.
P. lobata forma *centralis* subforma *beta* Vaughan.
P. lobata forma *centralis* subforma *gamma* Vaughan.
P. lobata forma *centralis* subforma *delta* Vaughan.
P. lobata forma *centralis* subforma *epsilon* Vaughan.
P. lobata forma *aperta* Vaughan.
Porites quelchi Studer.[a]
Porites brighami Vaughan.
Porites lanuginosa Studer.[a]
Porites discoidea Studer.[a]
Porites schauinslandi Studer.[a]
Porites irregularis Verrill.[a]
Porites hawaiiensis Vaughan.
Alveopora verrilliana Dana?.

Of the 77 species or subdivisions of species here listed 2 are queried. The first, *Montipora bernardi*, occurs at a depth between 23 and 34 fathoms. It may have been obtained at a depth either greater or less than 25 fathoms. The locality of the second queried species, *Alveopora verrilliana*, is not positively known; it may not have come from the Hawaiian Islands. Data, as indicated by reference to a footnote, are deficient for 12 of the forms. As we know, however, something of the conditions under which they were collected, we feel assured that they came from very shallow water.

SPECIES LIVING BETWEEN 25 AND 40 FATHOMS.

Pocillopora cespitosa var. *laysanensis* Vaughan.
Pocillopora meandrina var. *nobilis* Verrill.
Pavona varians Verrill.
Leptoseris hawaiiensis Vaughan.
Leptoseris scabra Vaughan.
Leptoseris digitata Vaughan.
Leptoseris tubulifera Vaughan.
Montipora verrucosa (Lamarck).
Montipora tenuicaulis Vaughan.
Montipora bernardi Vaughan?.
M. bernardi var. *subglabra* Vaughan.
Montipora studeri Vaughan.
Porites studeri Vaughan.
Porites bernardi Vaughan.

This list, containing the names of 14 forms, is interesting, as it shows that several of the more strictly reef species may live at a depth as great as 30 or 40 fathoms. Four of the five genera present are reef builders, but one of them, *Porites*, is represented by forms sufficiently different to be considered distinct species.

The differences observed between individuals of the same species and different species of the same genera (as, for instance, *Montipora* and *Porites*), living at depths

[a] Depth not given, but the assumption seems safe.

both less and greater than 25 fathoms, in fact the greater limit in depth might be placed at 16 or 17 fathoms, should be especially noted. The specimens from the lower bathymetric limits are smaller, more slender and fragile in ramose forms, appearing to be stunted. The cause of the differences is not known at present. It probably is not due to differences in temperature, as will be shown later; nor can it be attributed to differences in the character of the bottom. Three possible causes suggest themselves, but no data are available to aid in reaching a conclusion. They are, differences in the strength of the light, in the pressure due to greater depth, or in the food supply. These physiologic factors need investigation.

Within this bathymetric zone the reef-building species cross boundaries with the deeper water forms; that is, the species of *Leptoseris*.

SPECIES LIVING BETWEEN 40 AND 100 FATHOMS.

Madracis kauaiensis Vaughan.
Fungia patella (Ellis and Solander).
Fungia fragilis (Alcock).
Leptoseris hawaiiensis Vaughan.
Leptoseris scabra Vaughan.
Stephanophyllia formosissima Moseley.
Balanophyllia desmophyllioides Vaughan.

The fauna of this bathymetric zone is poor. The two *Fungiæ* are confined to it, while the two species of *Leptoseris* are best represented here. The other forms really belong to a deeper water fauna.

SPECIES LIVING BETWEEN 100 AND 200 FATHOMS.

Flabellum pavoninum Lesson, typical.
F. pavoninum var. *distinctum* Milne Edwards and Haime.
F. pavoninum var. *paripavoninum* Alcock.
Placotrochus fuscus Vaughan.
Paracyathus mauiensis Vaughan.
Paracyathus molokensis Vaughan.
Deltocyathus andamanicus Alcock.
Caryophyllia hawaiiensis Vaughan.
Cyathoceras diomedeæ Vaughan.
Anthemiphyllia pacifica Vaughan.
Madracis kauaiensis Vaughan.
M. kauaiensis var. *macrocalyx* Vaughan.
Leptoseris hawaiiensis Vaughan.
Stephanophyllia formosissima Moseley.
Endopachys oahense Vaughan.
Balanophyllia desmophyllioides Vaughan.
Balanophyllia laysanensis Vaughan.
B. diomedeæ Vaughan.
Balanophyllia diomedeæ var. *mauiensis* Vaughan.
Dendrophyllia oahensis Vaughan.
Dendrophyllia serpentina Vaughan.

This zone is the richest in forms next to the reef zone.

SPECIES LIVING BETWEEN 200 AND 300 FATHOMS.

Flabellum pavoninum Lesson, typical.
F. pavoninum var *latum* Studer.
F. pavoninum var. *paripavoninum* Alcock.
Gardineria hawaiiensis Vaughan.
Desmophyllum cristagalli Milne Edwards and Haime.
Paracyathus tenuicalyx Vaughan?.
Trochocyathus oahensis Vaughan.
Caryophyllia octopali Vaughan.
Cyathoceras diomedeæ Vaughan.
Madracis kauaiensis Vaughan.
Leptoseris hawaiiensis Vaughan.
Anisopsammia amphelioides (Alcock).
A. amphelioides var. *cucullata* Vaughan.

SPECIES LIVING BETWEEN 300 AND 400 FATHOMS.

Desmophyllum cristagalli Milne Edwards and Haime.
Caryophyllia octopali Vaughan.
C. octopali var. *incerta* Vaughan.
Cyathoceras diomedeæ Vaughan?.
Ceratotrochus laxus Vaughan.
Madrepora kauaiensis Vaughan.
Mussa ? sp. young?.
Anisopsammia amphelioides var. *cucullata* Vaughan.

SPECIES LIVING BETWEEN 400 AND 500 FATHOMS.

None.

SPECIES LIVING BETWEEN 500 AND 600 FATHOMS.

None.

SPECIES LIVING BETWEEN 600 AND 700 FATHOMS.

Flabellum deludens von Marenzeller.

SPECIES LIVING BETWEEN 700 AND 800 FATHOMS.

None.

SPECIES LIVING BETWEEN 800 AND 900 FATHOMS.

Flabellum deludens von Marenzeller.
Caryophyllia alcocki Vaughan.

SPECIES LIVING BETWEEN 900 AND 1,150 FATHOMS.

Bathyactis hawaiiensis Vaughan.

No species was found at a depth greater than 1,150 fathoms.

Table showing the numerical distribution of forms according to depth.

Depth in fathoms	0–25	25–40	40–100	100–200	200–300	300–400	400–500	500–600	600–700	700–800	800–900	900–1,150
Number of forms found at that depth	77	14	7	21	13	8	0	0	1[a]	0	2	1
Number of forms confined to that depth	70	5	2	14	6	5	......	......	0	0	1	1
Number of forms ranging into the next deeper	7	2	4	5	3	0	......	......	0	0	0	......
Number of forms occurring in next shallower	......	7	2	4	5	3	......	......	0	......	0	......
Number of forms occurring in both shallower and deeper water	......	0	1	2	1	0	......	......	......	......	......	......

[a] This species was also collected between 800 and 900 fathoms.

The preceding table is not absolutely correct, because of the insufficiency of the data regarding the depth at which some of the forms were collected. As some of the species are divided into "varieties" or "formæ" the problem of comparison is additionally complicated. The following general conclusions are clearly indicated:

The greatest number of forms are developed in shallow water, between 0 and 25 fathoms. There are over five times as many forms between 0 and 25 fathoms as between 25 and 40. Forty fathoms represent the maximum depth to which any reef species extends. There is rapid further decrease between 40 and 100 fathoms, the ratio to the number occurring between 0 and 25 fathoms being 1:11; between 25 and 40 fathoms, 1:2. Only 2 forms are peculiar to this depth, the others ranging into shallower or deeper water, while one ranges into both shallower and deeper.

The number of forms increases between 100 and 200 fathoms; the ratio to the number between 40 and 100 being 3:1. Between 200 and 300 there is a marked decrease; between 300 and 400 a still further decrease. From 100 to 400 fathoms, however, seems to be a second faunal zone.

As this is considered a very important zone, the forms occurring in it are relisted.

FORMS OCCURRING BETWEEN 100 AND 400 FATHOMS.

Flabellum pavoninum Lesson, typical.
F. pavoninum var. *distinctum* Milne Edwards and Haime.
F. pavoninum var. *paripavoninum* Alcock.
F. pavoninum var. *latum* Studer.
Placotrochus fuscus Vaughan.
Gardineria hawaiiensis Vaughan.
Desmophyllum cristagalli Milne Edwards and Haime.

Paracyathus tenuicalyx Vaughan.
Paracyathus mauiensis Vaughan.
Paracyathus molokensis Vaughan.
Deltocyathus andamanicus Alcock.
Trochocyathus oahensis Vaughan.
Caryophyllia octopali Vaughan.
Caryophyllia octopali var. *incerta* Vaughan.
Caryophyllia hawaiiensis Vaughan.
Cyathoceras diomedeæ Vaughan.
Ceratotrochus laxus Vaughan.
Anthemiphyllia pacifica Vaughan.
Madrepora kauaiensis Vaughan.
Madracis kauaiensis Vaughan.
M. kauaiensis var. *macrocalyx* Vaughan.
Mussa? sp. young?.
Leptoseris hawaiiensis Vaughan.
Stephanophyllia formosissima Moseley.
Endopachys oahense Vaughan?.
Balanophyllia hawaiiensis Vaughan.
Balanophyllia desmophyllioides Vaughan.
Balanophyllia laysanensis Vaughan.
Balanophyllia diomedeæ Vaughan.
B. diomedeæ var. *mauiensis* Vaughan.
Dendrophyllia oahensis Vaughan.
Dendrophyllia serpentina Vaughan.
Anisopsammia amphelioides (Alcock).
A. amphelioides var. *cucullata* Vaughan.

Thirty-four of the 124 forms recognized occur between 100 and 400 fathoms. Not one of them ranges into deeper water; while only 4 (*Madracis kauaiensis* Vaughan, *Leptoseris hawaiiensis* Vaughan, *Stephanophyllia formossima* Moseley, *Balanophyllia desmophyllioides* Vaughan) certainly occur in shallower water. *Endopachys oahense* Vaughan, may have been procured in water less than 100 fathoms in depth. The species are most numerous between 100 and 200 fathoms.

Bathymetric distribution of the genera.

(Depths in fathoms.)

0–25.	25–40.	40–100.	100–200.	200–300.	300–400	400–500	500–600	600–700	700–800	800–900	900–1150
Pocillopora. Leptastrea. Cyphastrea. Cœlastrea. Favia. Fungia. Pavona. Leptoseris. Stephanaria. Psammocora. Dendrophyllia. Montipora. Porites. Alveopora.	Pocillopora. Pavona. Leptoseris. Montipora. Porites.	Madracis. Fungia. Leptoseris. Stephano-phyllia. Balano-phyllia.	Flabellum. Placotrochus. Paracyathus. Deltocyathus. Caryophyllia. Cyathoceras. Anthemi-phyllia. Madracis. Leptoseris. Stephano-phyllia. Endopachys. Balanophyl-lia. Dendrophyl-lia.	Flabellum. Gardineria. Desmophyl-lum. Paracyathus. Trochocya-thus. Caryophyllia. Cyathoceras. Madracis. Leptoseris. Anisopsam-mia.	Desmo-phyllum. Caryophyl-lia. Cyathoce-ras. Ceratotro-chus. Madrepora. Mussa? Anisop-sammia.	None.	None.	Flabel-lum.	None.	Flabel-lum. Caryo-phyllia.	Bathy-actis.

Total number of genera.

0–25.	25–40.	40–100.	100–200.	200–300.	300–400	400–500	500–600	600–700	700–800	800–900	900–1150
14	5	5	13	10	7	0	0	1	0	2	1

The table showing the bathymetric distribution of the genera shows even more clearly than the discussion of the species the existence of two bathymetric faunal zones: one between 0 and 25 fathoms; the other, between 100 and 400. Between 25 and 100 fathoms is an intermediate zone; 4 of the 5 genera between 25 and 40 fathoms represent a downward extension of the shallow water, or reef fauna; 4 of the 5 genera between 40 and 100 fathoms represent the upper limit of the deeper water fauna. The *Fungiæ* listed under "40–100" fathoms are a "*Cycloseris*" and "*Diaseris;*" they are not found between other depths around the Hawaiian Islands.

As the region between 100 and 400 fathoms represents, in my opinion, one faunal zone, the genera occurring in it are listed collectively, to bring out its richness in genera, and so that it may be contrasted with those found between 1 and 25 fathoms.

Flabellum.	*Caryophyllia.*	*Leptoseris.*
Placotrochus.	*Cyathoceras.*	*Stephanophyllia.*
Gardineria.	*Ceratotrochus.*	*Endopachys?.*
Desmophyllum.	*Anthemiphyllia.*	*Balanophyllia.*
Paracyathus.	*Madrepora.*	*Dendrophyllia.*
Deltocyathus.	*Madracis.*	*Anisopsammia.*
Trochocyathus.	*Mussa?.*	

Of the 20 genera occurring in this zone, only 2 were found in the 0–25 fathoms zone.

This bathymetric zone, limited by the 100 and 400 fathom lines, in the vicinity of the Hawaiian Islands is especially characterized by an abundance of species and genera of Turbinolid and Eupsammid corals and some species of slender, branching Oculinids and Stylophorids. There are also some fragile Fungids.

The zone between 0 and 25 is characterized by an abundance of larger, more luxuriant corals belonging to the Pocilloporidæ, Orbicellidæ, Faviidæ, the simple and compound Fungids, the Montiporinæ, and the Poritidæ.

Bathymetric studies of this kind are of decided importance in the interpretation of paleontologic data. The following generalizations can be made for the Hawaiian Islands:

1. An abundance of individuals belonging to the Pocilloporidæ, Orbicellidæ, Faviidæ, massive Fungids, Montiporinæ and the Poritidæ indicate a depth of less than 25 fathoms. Occasional individuals may grow at a depth of 40 fathoms. With increasing depth individuals of the same species become smaller and more fragile.

2. An abundance of Turbinolid and Eupsammid species, and slender, ramose Oculinids and Stylophorids (as, for instance, *Madracis*) indicate a depth of 100 to 400 fathoms. The best conditions for the growth of these corals are realized between 100 and 200 fathoms.

3. Around the Hawaiian Islands two faunal zones can be distinguished, with an intermediate zone from 25 to 100 fathoms. Within this zone there is some commingling of faunas.

4. Beyond the 400-fathom limit the fauna is poor, and the species outside it are extremely fragile.

As has been said, the data at hand warrant these conclusions for the Hawaiian Islands. Many studies of this kind are needed to know more thoroughly the relations between corals and depth of water.

DISTRIBUTION ACCORDING TO TEMPERATURE.

The first consideration here is to ascertain the temperature of the surface of the water. The records of the dredgings of the *Albatross* in 1902 have been used to furnish the data. The records for the various islands and channels will be given, beginning with the most easterly.

HAWAII ISLAND.

Northeast Coast.

For this coast there are twenty-four records: Two give a temperature of 74° F.; two, 75°; eight, 76°; twelve, 77°. The range is from 74 to 77°.

West Coast.

Records: Four, 76°; ten, 77°; nine, 78°; three, 79°; three, 80°. There are 29 records, which show a range from 76° to 80°.

MAUI ISLAND.

Northeast and North Coast.

Records: Forty, 76°; two, 77°: 42 records; range 76° to 77°.

AUAU CHANNEL, BETWEEN MAUI AND LANAI ISLANDS.

Records: Two, 75°; ten, 76°; four, 77°: 16 records; range 75° to 77°.

Pailolo Channel, between Molokai and Maui Islands, and Northeast Approach.

Records: Fifteen, 74°; ten, 75°; seven, 76°; six, 78°; two, 79°: 40 records; range, 74° to 79°.

MOLOKAI ISLAND.

South Coast.

Records: Two, 73°; eight, 74°; twenty-nine, 75°; thirty-six, 76°: 75 records; range, 73° to 76°.

North Coast.

Records: Four, 74°; five, 75°: 9 records; range, 74° to 75°.

Kaiwi Channel, between Molokai and Oahu Islands.

Records: Sixteen, 76°; two, 77°: 18 records; range, 76° to 77°.

OAHU ISLAND.

South Coast.

Records: Ten, 74°; nine, 75°; two, 76°: 21 records; range ,74° to 76°.

NORTHWEST COAST.

Records: Twelve, 77°; four, 78°: 16 records; range, 77° to 78°.

SOUTHWEST COAST.

Records: Six, 79°. Temperature the same for each record.

KAIEIE-WAHO CHANNEL, BETWEEN OAHU AND KAUAI ISLANDS.

Records: Two, 77°; four, 78°: 6 records; range, 77° to 78°.

VICINITY OF KAUAI ISLAND.

Records: Three, 75°; six, 76°; forty, 77°; thirty-six, 78°; two, 79°: 87 records; range, 75° to 79°.

VICINITY OF MODU MANU, OR BIRD ISLAND.

Records: Two, 74°; three, 75°; eighteen, 77°; thirty-one, 78°; eight, 79°: 62 records; range, 74° to 79°.

FRENCH FRIGATE SHOAL.

Records: Four, 74°; two, 75°; seven, 76°: 13 records; range, 74° to 76°.

LAYSAN.

Records: One, 73°; eight, 74°; twenty-three, 75°; thirty, 76°; four, 77°; one, 78°: 67 records; range, 73° to 78°.

These records, when considered together, show a total range in the surface temperature of the water from 73 to 80°. The observations were made between March 27 and August 29; they therefore are the summer temperatures. Unfortunately data regarding the winter temperatures are not at hand.

Reef corals, growing practically at the surface of the water, were obtained on the south coast of Molokai, the south coast of Oahu, the north coast of Oahu, and from Laysan. The surface temperature of the south coast of Molokai ranges from 73° to 76°; that of the south coast of Oahu from 76° to 77°; that of the north coast of Oahu from 74° to 75°; that of Laysan from 73° to 78°. There is in the summer time on the coral-reef areas of the Hawaiian Islands a range only of 5° in the surface temperature of the water.

These data offer nothing new regarding the temperature conditions favorable for the growth of reef corals, Dana, in his Corals and Coral Islands, third edition, having given a satisfactory discussion of the subject. The data here presented regarding the Hawaiian Islands, however, furnish a starting point for the present study. According to Dana, reef corals can endure a range in temperature from 68° F. to 85° F., but the annual mean must not be below 70°; the summer would be higher. The lowest summer surface temperature recorded by the *Albatross* was 73°. The following schedule will be adopted: Species found between 78° and 73°; 73° and 60°; 60° and 50°; 50° and 40°; 40° and 30°.

SPECIES FOUND AT A TEMPERATURE BETWEEN 78° AND 73° F.

This list would include all species occurring between 0 and 40 fathoms. The list of species found between those depths can be consulted, and its repetition is thus avoided (see p. 32).

SPECIES FOUND AT A TEMPERATURE BETWEEN 73° AND 60° F.

	Precise maximum temperature at which collected.
Flabellum pavoninum Lesson, typical.	66.5°
F. pavoninum var. *paripavoninum* Alcock.	66.5
Placotrochus fuscus Vaughan.	65
Paracyathus mauiensis Vaughan.	64.8
Paracyathus molokensis Vaughan.	63
Caryophyllia hawaiiensis Vaughan.	67
Cyathoceras diomedeæ Vaughan.	60.61
Anthemiphyllia pacifica Vaughan.	67
Madracis kauaiensis Vaughan.	67
M. kauaiensis var. *macrocalyx* Vaughan.	63
Fungia patella (Ellis and Solander).	71.7
Fungia fragilis (Alcock).	71.7
Leptoseris hawaiiensis Vaughan.	73.7
Leptoseris scabra Vaughan.	74
Stephanophyllia formosissima Moseley.	67
Balanophyllia desmophyllioides Vaughan.	69 (77?)
Balanophyllia laysanensis Vaughan.	63
Balanophyllia diomedeæ Vaughan.	64.8
Dendrophyllia oahensis Vaughan.	60.7

SPECIES FOUND AT A TEMPERATURE BETWEEN 60° AND 50° F.

Flabellum pavoninum Lesson, typical.
F. pavoninum var. *distinctum* M. Edwards and Haime.
F. pavoninum var. *paripavoninum* Alcock.
Cyathoceras diomedeæ Vaughan.
Madracis kauaiensis Vaughan.
Stephanophyllia formosissima Moseley.
Balanophyllia diomedeæ var. *mauiensis* Vaughan.

SPECIES FOUND AT A TEMPERATURE BETWEEN 50° AND 40° F.

	Precise minimum temperature at which collected.
Flabellum pavoninum Lesson, typical.	46.8°
F. pavoninum var. *latum* Studer.	45
Gardineria hawaiiensis Vaughan.	43.7
Desmophyllum cristagalli Milne Edwards and Haime.	47
Paracyathus tenuicalyx Vaughan.	47
Deltocyathus andamanicus Alcock.	49
Trochocyathus oahensis Vaughan.	41.6
Caryophyllia octopali Vaughan.	42.1
C. octopali var. *incerta* Vaughan.	42.1
Cyathoceras diomedeæ Vaughan.	45
Ceratotrochus laxus Vaughan.	42.1
Madrepora kauaiensis Vaughan.	44.2
Madracis kauaiensis Vaughan.	48.5
Mussa ? sp. young ?.	44.2
Leptoseris hawaiiensis Vaughan.	46.8
Stephanophyllia formosissima Moseley.	49
Endopachys oahense Vaughan.	47.7
Balanophyllia hawaiiensis Vaughan.	44
Dendrophyllia serpentina Vaughan.	49
Anisopsammia amphelioides (Alcock).	47
A. amphelioides var. *cucullata* Vaughan.	42.1

SPECIES FOUND AT A TEMPERATURE BETWEEN 40° AND 30° F.

Flabellum deludens von Marenzeller.
Caryophyllia alcocki Vaughan.
Bathyactis hawaiiensis Vaughan

General conclusions regarding the correlation between temperature and the distribution of the species of *Madreporaria* around the Hawaiian Islands:

Temperature 78°–73° F.—Seventy-seven of the 124 forms recognized live within these temperature limits and at a depth of less than 40 fathoms.

Temperature 73°–60° F.—Nineteen forms live between these limits. These forms should be divided into two temperature zones: *First*, between 73° and 70°, in which 4 species occur, namely: *Fungia patella* (Ellis and Solander), *Fungia fragilis* (Alcock), *Leptoseris hawaiiensis* Vaughan, and *Leptoseris scabra* Vaughan. The first two were found only within these temperature limits and only at a depth between 40 and 75 fathoms. *Leptoseris hawaiiensis* ranges in depth from about 25 fathoms to over 250 fathoms, in temperature from 46.8° to 73.7°; *L. scabra* in depth from about 25 to nearly 80 fathoms, in temperature from 61° to 74°. *Second*, between 60° and 70°, none of the remaining forms, possibly excepting *Balanophyllia desmophyllioides* Vaughan, which may have been found at a temperature as high as 77° F., was collected at higher temperature than 69° F.

Temperature 60°–50° F.—Only 7 forms were obtained within this range.

Temperature 50°–40° F.—Within these limits 21 forms were obtained, a comparatively rich fauna.

Temperature 40°–30° F.—Only 3 species were procured at a temperature below 40° F.

The greatest abundance of forms is between temperatures 73° and 78°, depth 0–40 fathoms; a second abundant fauna is between temperatures 70°, or somewhat less, and 40°, or somewhat more, depth 100–400 fathoms. There is a discordance between depth and temperature, for the greatest number of forms at a depth greater than 40 fathoms occurs between 100 and 200, while the greatest number of forms at a temperature below 70°F. is between 40° and 50°. However, the number between 40° and 50° is nearly the same as between 60° and 73°. It seems from these facts that temperature between 40° and 70° is not so important a factor in determining the number of the forms or species of corals developed as is the depth.

Distribution of genera according to temperature.

78°–73° F.	73°–60° F.	60°–50° F.	50°–40° F.	40°–30° F.
Pocillopora.	Flabellum.[a]	Flabellum.	Flabellum.	Flabellum.
Leptastrea.	Placotrochus.[a]	Cyathoceras.	Gardineria.	Caryophyllia.
Cyphastrea.	Paracyathus.[a]	Madracis.	Desmophyllum.	Bathyactis.
Cœlastrea.	Caryophyllia.[a]	Stephanophyllia.	Paracyathus.	
Favia.	Cyathoceras.[a]	Balanophyllia.	Deltocyathus.	
Fungia.	Anthemiphyllia.[a]		Trochocyathus.	
Pavona.	Madracis.[a]		Caryophyllia.	
Leptoseris.	Fungia.[b]		Cyathoceras.	
Stephanaria.	Leptoseris.		Ceratotrochus.	
Psammocora.	Stephanophyllia.[a]		Madrepora.	
Dendrophyllia.	Balanophyllia.[c]		Madracis.	
Montipora.	Dendrophyllia.[a]		Mussa? sp. young?.	
Porites.			Leptoseris.	
Alveopora.			Stephanophyllia.	
			Endopachys.	
			Balanophyllia.	
			Dendrophyllia.	
			Anisopsammia.	

Total number of genera.

14	12	5	18	3

[a] Not obtained at a temperature so high as 70°.
[b] Not obtained at a temperature so low as 70°
[c] Temperature range doubtful.

The preceding table shows that all the strictly reef-building genera live at a temperature of 73°–78° F.

The list under 73°–60° F. contains the names of 9 genera which were not found at a temperature so high as 70° F. Seven of these 9 were also found at a temperature between 40° and 50°. The 5 genera found between 60° and 50° were also found between 50° and 40°.

The genera occurring between 70° and 40° are precisely the same as those occurring between the 100 and 400 fathoms lines. They are Turbinolids, Eupsammids, some slender branching Oculinids and Stylophorids, and also some fragile Fungids. The greatest number of genera was found between 40° and 50° F. in temperature and between 100 and 200 fathoms in depth. Eleven of the 17 genera found between 40° and 50° F. occur between the 100 and 200 fathoms lines, while 11 of the 13 genera collected between 100 and 200 fathoms live at a temperature between 40° and 50°.

Temperature and depth, then, can be coupled. The best conditions for a profuse development of Turbinolid genera are, (1) a depth of 100–200 fathoms, and (2) a temperature of 40°–50° F.

It should be emphasized that these conclusions apply to the Hawaiian Islands, and that more extensive studies are necessary before the fundamental principles of control of distribution by depth and temperature can be firmly established.

INFLUENCE OF THE CHARACTER OF THE BOTTOM ON DISTRIBUTION.

At first I thought that the character of the bottom might influence the species of corals growing on it, but a glance down the general table, containing the names of the species, the station numbers, depth, etc., shows that the same species occurs on so great a variety of bottom that its importance as a factor in determining distribution is doubtful, except the water probably must be clear and the corals must have objects to which they can attach themselves.

ADDITIONAL FACTORS GOVERNING THE DISTRIBUTION OF MADREPORARIA.

Dana says: "The range of temperature 85° to 74° gives sufficient heat for the development of the greater part of coral-reef species; and yet the temperature at the 100-foot plane in the middle Pacific is mostly above 74°. The chief cause of limitation in depth is the diminished light, as pointed out by Prof. T. Fuchs." [a]

Pressure and diminished light are both correlative with depth. Both factors need further investigation. Another factor that needs study is the food supply; and probably the oxygen content of the water. Some of the factors to which considerable attention has been paid are not considered here, such as position with reference to the lines of the breakers, relations to the fall and rise of the tides, etc.

As yet comparatively few facts bearing upon the fundamental principles which determine the distribution of corals have been collected. Most authors have contented themselves with merely mentioning the station and depth at which a given form was procured; they usually have not utilized even these data in attempts to discover any underlying principles. We need much more information and more

[a] Corals and Coral Islands, 3d ed., p. 118.

tabulations of the physical surroundings under which the forms, from individuals to genera, have lived; and a wide range of phenomena should be made the subject of experimental physiological investigation.

The understanding of the relations of organisms to their physical environment is of the utmost importance to the paleontologist, for it is by the application of such knowledge that he is able to reconstruct the conditions under which organisms now extinct once lived.

FAUNAL AFFINITIES OF THE HAWAIIAN MADREPORARIA.

An examination of the last column, "Distribution outside Hawaiian Islands, or affinities," of the table on pages 11 to 21, will show that numerous species and varieties of the corals found in the Hawaiian Islands are found elsewhere or have close relations in other areas. This remark is true of the reef fauna (1–25 fathoms), the deep-water fauna (100–400 fathoms), and the one occupying the intermediate depth. Sufficient careful descriptive work has not as yet been done on the different areas of the Pacific to warrant detailed comparisons with other areas; besides, the problem of defining specific limits is in an unsatisfactory condition.

Comparison with the Panamic fauna.—Only two species from the Hawaiian Islands are actually identified with species from the west coast of America, namely: *Desmophyllum cristagalli* Milne-Edward and Haime, which is a deep-water form of universal occurrence, and *Stephanaria stellata* Verrill, which Quelch reports from the Fiji Islands. The specific resemblance between the faunas of the two areas is not close.

However, they have the following reef genera in common:

Pocillopora	*Stephanaria*	*Montipora*
Fungia	*Dendrophyllia*	*Porites.*
Pavona		

Several shallow-water species of *Paracyathus* have been described by Verrill from the Pacific coast. *Caryophyllia* and *Endopachys* are found in deeper water.

Some of the Hawaiian and the Panamic *Pocilloporæ* are rather close, the latter suggesting the *ligulata* group.

Fungia patella and *F. elegans* belong to the same section of *Fungia.*

The *Pavonæ* are close.

One species of *Stephanaria* is considered common to the two areas.

The *Dendrophylliæ* are very close.

The *Montiporæ* are different.

The *Porites* are different.

The Panamic fauna is very close to, or the same as, the Galapagos fauna, and is as closely related to the South Pacific fauna as to the Hawaiian. There is nothing to suggest faunal migration between the Hawaiian and Panamic regions.

Comparison with the South Pacific and Indian Ocean faunas.—The results of the comparison is immediately to show affinity. A number of the species are common throughout the area, and others have close relatives occupying the different areas. One of the most striking things about the Hawaiian fauna is the entire absence of distinctive genera. Excepting *Anthemiphyllia*, and very doubtfully

Madracis, there is not a genus that differentiates it from the faunas of the South Pacific-Indian Ocean region. In fact, as has been said, there has been only partial specific differentiation between the two areas. The Hawaiian fauna, therefore, should be classed with the Southern Pacific-Indian Ocean fauna, and it probably was derived from the latter at a comparatively recent date.

The Hawaiian reef fauna exhibits a peculiarity worthy of further notice, in the absence of some of the common reef-building genera of other areas. There are no species of the Oculinidæ, Eusmiliidæ, or the Astrangiidæ; there are very few Orbicellidæ, none of the large, massive, meandrinoid Faviidæ, nor of the Mussidæ. The genus *Acropora* is, possibly, but not probably, excepting *A. echinata*, entirely absent. Dana[a] noted the absence or scarcity of these corals about the Islands, and accounts for it by their lying outside the torrid zone of oceanic temperature, in the subtorrid, where the corals are consequently less luxuriant and much fewer in species. Dana's explanation may be correct, but it does not seem to be supported by sufficient evidence to warrant its acceptance. Therefore, I should like to suggest an alternative explanation. As is well known, the species inhabiting the waters of the Bermuda Islands are all identical with Antillean and Floridian species. No species of *Acropora*, however, is found in Bermuda. The Bermudan is an emigrant fauna, and I have suggested that the same is true of the Hawaiian. Is it not possible that the larvæ of some species and some genera can not be transported alive for great distances by currents, while others can be?

SYSTEMATIC DISCUSSION OF THE FAUNA.

MADREPORARIA IMPERFORATA.

Family FLABELLIDÆ Bourne.

1900. *Flabellinæ* GREGORY, Jurassic Cor. of the Cutch, p. 34.
1905. *Flabellidæ* BOURNE, Roy. Soc. Rept. on Pearl Oyster Fisheries, IV, p. 195.

Type-genus.—*Flabellum* Lesson.

Diagnosis.—Corallum with imperforate tissues, simple or reproducing by gemmation within the cup, cuneiform or conical, originally with a small base, which is attached in the early growth stages, but which subsequently may be broken off.

Wall composed of an epitheca that is closely applied to the outer ends of the septa and extends upward to the edge of the calice. Within this epithecal wall there may be a solid deposit of stereoplasm, which in some instances obliterates the interseptal loculi in the basal portion of the corallum.

Septal margins entire.

Remarks.—This family contains *Rhizotrochus*,[b] *Duncania* Pourtalès, *Haplophyllia* Pourtalès, and *Gardineria*, which is here described as a new genus. According to Bourne *Placotrochus* belongs here.

[a] Corals and Coral Island, 3d ed., p. 111.
[b] Considered a synonym of *Flabellum* by Gardiner, Marine Invest. in South Africa, II, p. 117.

Genus FLABELLUM Lesson.

FLABELLUM PAVONINUM Lesson.

Plate I, figs. 1, 1*a*, 1*b*, 2, 2*a*, 2*b*, 3, 3*a*; Plate II, figs. 1, 1*a*, 2, 2*a*, 2*b*, 3, 3*a*, 4, 4*a*, 5, 5*a*; Plate III, figs. 1, 2, 3, 4, 4*a*, 4*b*.

1831. *Flabellum pavoninum* LESSON, Illust. Zool., pl. XIV.
1846. *Euphyllia pavonina* DANA, Zooph. Wilkes Expl. Exped., p. 159, pl. VI, figs. 5, 6.
1848. *Flabellum pavoninum* MILNE EDWARDS and HAIME, Ann. Sci. Nat., 3ième sér., Zool., IX, p. 260.
1848. *Flabellum distinctum* MILNE EDWARDS and HAIME, Ann. Sci. Nat., 3ième sér., Zool., IX, p. 262.
1857. *Flabellum pavoninum* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 80.
1857. *Flabellum distinctum* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 80.
1873. *Flabellum distinctum* DUNCAN, Trans. Zool. Soc. London, VIII, p. 322, pl. XXXIX, figs. 1-13.
1878. *Flabellum latum* STUDER, Monatsber. Akad. Wissenschaft., Berlin for 1877, p. 630, pl. I, figs. 3*a*, 3*b*.
1881. *Flabellum patens* MOSELEY, Deep Sea Corals, Challenger Repts., p. 172, pl. VI, figs. 4, 4*a*, 5, 5*a*.
1881. *Flabellum australe* MOSELEY, Deep Sea Corals, Challenger Repts., p. 173, pl. VII, figs. 4, 4*a*, 5, 5*a*, 5*b*.
1894. *Flabellum paripavoninum* ALCOCK, Jour. As. Soc. Bengal, LXIII, p. 187.
1898. *Flabellum paripavoninum* ALCOCK, "Investigator" Deep Sea Madrepor., p. 21, pl. II, figs. 3, 3*a*, 3*b*.
1902. *Flabellum distinctum* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 30.
1902. *Flabellum lamellulosum* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 30, pl. IV, figs. 28, 28*a*, 28*b*.
1902. *Flabellum australe* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 30.
1902. *Flabellum latum* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 31.
1902. *Flabellum pavoninum* GARDINER, Marine Invest. in South Africa, II, pp. 123, 124, pl. IV, figs. 18-21 (with Synonymy).
1904. *Flabellum chunii* v. MARENZELLER, Steinkorallen, Valdivia Exped., p. 274, pl, XVIII, figs. 14, 14*a*, 14*b*.

The species described by von Marenzeller under the name of *F. magnificum*[a] is close to *F. pavoninum*, but is much larger. Height, 65 mm.; greater diameter, 93 mm.; lesser, 47. The proportions, however, are quite similar to those of typical *pavoninum*. The number of septa (212) is, for the size, proportionately less than in *F. pavoninum*.

Description.—Corallum cuneiform, base compressed, rising above a medially situated, rather slender, pedicel. Large individuals attain a height of 50 to 60 mm. Faces convex, plane or concave, their angle of divergence from 30° to 55°. Lateral edges acute and crested, acute but not crested, or obtusely rounded, the angle of divergence from 70° to 200° or more. Costæ variable in development, absent, subobsolete, or moderately developed. Margins of the calice rounded, never scalloped, incised, or lobed; they may arch beyond the curve of a half circle or may be depressed below such a curve. Septa between 5 and 7 cycles, with from 24 to a little more than 50 principals; the usual arrangement is for every fourth or every eighth septum to reach the columella, with intermediate lengths according to the cycle. The upper portions of the septal margins may reach the level of the upper edge of the wall, but they do

[a] Steinkorallen, Valdivia Exped., p. 276, pl. XVII, figs. 13, 13*a*.

not protrude beyond it and often are peripherally excavated. The interseptal loculi are usually open to the base of the corallum, and apparently are never greatly filled with stereoplasm. Columella trabecular, variable in development.

Distribution.—Almost world-wide; eastern Atlantic Ocean, South Africa, the Indian Ocean, East Indies, the western and central Pacific Ocean generally.

This species was first described from specimens brought to Lesson, presumably collected around the Hawaiian Islands. Since then it has been found in many seas and reported under its original name or some one of its numerous synonyms, but no expedition had again found it in the vicinity of the type locality. The *Albatross* expedition of 1902 obtained 114 specimens, divisible into four varieties. As these specimens are very interesting they have been carefully studied, and the results obtained are subsequently presented. My own data are supplemented by those published by Duncan[a] and by Gardiner.[b]

Gray[c] discussed the synonymy of this species and placed in it sixteen of the forms recognized as distinct by Milne Edwards and Haime.

Gardiner placed in the synonymy of *F. pavoninum*, *F. distinctum* Milne Edwards and Haime, *F. patens* and *australe* of Moseley, and *F. paripavoninum* Alcock. I have added *F. latum* Studer, and *F. lamellulosum*, described by Alcock in his last paper, and *F. chunii* von Marenzeller. This procedure refers seven specific names to the synonymy of *F. pavoninum*. Duncan[d] united *Flabellum extensum* (Michelin) with *F. distinctum*, but the evidence for this conclusion does not seem to me sufficient, although Duncan may be correct. It does not appear unlikely that several of the southern European Tertiary species of *Flabellum* may, upon closer study, prove to be connected with *F. pavoninum* through the varietal form *F. distinctum*. Another group of species closely related to *F. pavoninum* is those described by Philippi from the Tertiary formations of Chile, namely, *Lithomyces æqualis* and *costatus*.[e] The former especially seems near *F. pavoninum*. Philippi's genus *Lithomyces* is a precise synonym of *Flabellum*.

The characters by which the various corals here united under the specific name *F. pavoninum* were separated are presented in the following synopsis. The original descriptions of all these forms are subsequently given in discussing the varieties.

SYNOPSIS OF THE DIFFERENTIAL CHARACTERS OF THE CORALS UNITED WITH F. PAVONINUM.

	Called in the present paper—
Angle of lateral edges with each other more than 180°.	
7 cycles of septa, 48 principals, height 39 mm., length of calice 47 mm. *F. lamellulosum* Alcock	var. *lamellulosum* Alcock.
Angle of lateral edges with each other about 180°.	
6 cycles of septa, 48 principals. *F. pavoninum* Lesson	typical.

[a] Trans. Zool. Soc. London, VIII, 1873, p. 322.
[b] Marine Invest. in South Africa, II, 1902, p. 123.
[c] Proc. Zool. Soc. London, 1849, pp. 75, 76.
[d] Trans. Zool. Soc. London, VIII, 1873, p. 123.
[e] Tert. und Quart. Verstein. Chiles, 1887, p. 235, pl. LIV, figs. 1–4.

Called in the present paper—

Angle of lateral edges with each other less than 180°.
  Height of corallum less than the length of the calice.
    Lateral edges round, not crested, may be obscurely keeled near the pedicel.
      Angle 112°, 6 cycles of septa, 24 principals, height 39 mm., greater diameter of calice 56 mm. *F. latum* Studer .... var. *latum* Studer.
    Lateral edges acute, at least near the pedicel, often crested.
      Angle 100°-160°, 6 complete cycles of septa, some members of the seventh, 24 to 38 principals, height 43 mm., length of calice 55 mm. *F. patens* Moseley ...
      Angle about 90° ("not much larger than a right angle"), 6 cycles of septa, 24 principals. *F. distinctum* Milne Edwards and Haime ....
      Angle 70°-90°, 6 cycles of septa complete, or nearly so, 48 principals, height 57 mm., greater diameter 65 mm. Septal margins excavated at the wall. *F. australe* Moseley ....
      } Combined under var. *distinctum* Milne Edwards and Haime.
  Height of corallum equals or exceeds the length of the calice.
    Lateral edges sharp.
      Angle 108°,[a] 6 cycles of septa, 24 principals, height 39 mm., length of calice 37.5 mm. *F. paripavoninum* Alcock .... var. *paripavoninum* Alcock.

A study of the literature and the specimens submitted to me leads me to think that this protean species can best be handled by recognizing five varietal forms, vars. *lamellulosum* Alcock, *pavoninum* typical, var. *latum* Studer, var. *distinctum* Milne Edwards and Haime (+*F. patens* Moseley + *F. australe* Moseley), and var. *paripavoninum* Alcock. In the preceding synopsis the height of the corallum and the length of the calice are given merely to show the relative measurements. *F. latum* may have a wider basal angle and more numerous principal septa; the basal angle of *F. paripavoninum* is variable, and there may be as many as 50 principal septa.

FLABELLUM PAVONINUM var. LAMELLULOSUM Alcock.

Plate I, figs. 1, 1*a*, 1*b*.

1902. *Flabellum lamellulosum* Alcock, Deep Sea Madrepor., Siboga Exped., p. 30, pl. IV, figs. 28, 28*a*, 28*b*.

Original description.—Alcock's description is as follows:

Corallum snow-white, of excessively thin and translucent texture, shaped like a widely-stretched fan, its circumference being equal to about 285° of a circle. There is a slender short pedicle, and the lateral costæ, which arch outward and downward, are sharp and finely and irregularly jagged. The two faces of the corallum are slightly concave and moderately everted, are transversed by faint radiating costæ, and are very faintly marked with fine wavy transverse accretion lines. The septa, which are very thin, are in the unique specimen 336 in number. Forty-eight large ones of equal size divide the calicle into 48 compartments, each of which contains 7 smaller septa of diminishing size. Of these 7 septa, the largest one (fifth cycle) does not descend quite to the level of the columella, the two

[a] Measured in figures.

next largest (sixth cycle) do not descend quite half way down the calicular wall, and the four smallest (incomplete seventh cycle) are very short. The surfaces of the septa are finely, sharply, and somewhat sparsely granular, and their edges as they descend in the calicle become sinuous, especially in the case of the larger septa. The columella, which is deep-seated and narrow, is formed by small trabeculæ from the 48 large septa of the first four cycles.

Greatest height of corallum, 39 mm.; maximum diameter, 47 mm.

This species is, evidently, nearly related to *F. pavoninum*, but the corallum forms an arch of more than three-quarters of a circle and the septa are nearly twice as numerous.

Locality.—5° 28'.4 S., 132° 0'.2 E., 204 meters, 1 specimen.

A comparison of Alcock's description with the table for typical *F. pavoninum* will show that the characters by which *lamellulosum* can be separated from *pavoninum* typical are reduced to one, the basal angle exceeding 180°. Specimen No. 9 of that table has 326 septa, with 48 principals; specimen No. 8, which is of nearly the same size as Alcock's type, has 260 septa. Some specimens show a tendency for the basal angle to exceed 180°. Therefore I believe the *F. lamellosum* should be included in *F. pavoninum* and considered the extreme of its variation in one direction. No specimen of this variety was found by the *Albatross* on the Hawaiian expedition.

FLABELLUM PAVONINUM (typical).

Plate I, figs. 2, 2*a*, 2*b*, 3, 3*a*.

1831. *Flabellum pavoninum* LESSON, Illustr. Zool., pl. XIV.
1846. *Euphyllia pavonina* DANA, Zooph. Wilkes Expl. Exped., p. 159, pl. VI, figs. 5, 6.
1857. *Flabellum pavoninum* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 80.

Description.—In 1857 Milne Edwards and Haime described this species as follows:

Corallum flabelliform, compressed chiefly toward the base; faces subconcave; lateral crests little pronounced, almost horizontal, the obtuse angle that they form being almost 180°. Costæ slightly distinct. Calice strongly convex from one summit of the longer axis to the other, these summits angular; the curved line of its margin circumscribes a segment of a circle larger than a semicircle. The septa of the last cycle almost rudimentary; those of the first four cycles apparently equal, giving the appearance of 48 systems with three septa each. The principal septa have their inner vertical margins strongly undulated.

This characterization is good. The following tables will bring out other characters and also show variation. One character that needs special emphasis, besides the basal angle of the lateral edges, is that the greater diameter of the calice exceeds in length the height of the corrallum. The average difference for 18 specimens is 10.5 mm.

TABLE I.

Specimen number.	Station number.	Height, measured along face.	Angle of lateral edges.	Angle of faces.	Greater diameter of calice.	Lesser diameter of calice.	Shorter diameter above longer.	Number of septa.	Number of principal septa.	Faces: cv = concave; cx = convex; pl = plane.
		mm.	°	°	*mm.*	*mm.*	*mm.*			
1........	4081	22.5	174	35	29	13.5	19	191	45	pl.
2........	4081	22	180	39	27	14.5	18.5	197	48	pl.
3........	4081	30	166	41	42	22.5	25	191	48	pl. cv.
4........	4081	30.5	174	39	40	20.5	26	193	48	cv.
5........	4081	32	190	42	40	23.5	29	206	48	cv.
6........	4132	17	155	39	26	13.5	13	111	24	pl. cv.
7........	4132	20	188	40	25	14	13.5	150	24	pl. cv.
8 [a]	4132	37.5	180±	46±	48	32	34	260	48	cv.
9........	4132	46	170	47±	70	33	39	326	48	pl. cv.
10........	None.	41	168	30	64.5	20.5	30	240	48	cv. cx.
11 [a]	None.	40	167	44	69	24.5	31.5	239	50	cv. cx.
12........	4080	23.5	168	40	26	14	15	185	43	pl.
13........	4080	24.5	165	42	33.5	17.5	19	191	48	pl.
14........	4080	26.5	175	41	34.5	18	21	192	48	pl. cv.
15........	4080	30.5	180	41	39	20	25	192	48	cv.
16........	4080	29.5	184	43	36	22.5	27.5	196	48	cv.
17........	4080	31.5	180	53	39.5	26.5	27.5	207	48	cv.
18........	4079	24	180	34	28	14	16.5	182	33	pl.
19 [b]	None.	34	125	42	37	25	....	135	19	cv.
20 [a] [b].....	4079?	53	68	37	56	35	6.5	122	27	cv.
Average		29.3	174	40.3	39.8	20.2	23.8	203	44	

[a] Specimens Nos. 8, 11, and 20, figured.
[b] Specimens Nos. 19 and 20 have been broken and subsequently repaired; both are abnormal and are omitted in calculating the averages.

Several characters not brought out in the preceding table deserve notice. The faces in none of the specimens are strongly convex; they are only very gently so. The concavity of one, or even of both faces, may be pronounced. Specimens 9, 10, and 11 have one face decidedly concave; specimen No. 8 has both faces concave. The lateral edges are acute near the pedicel in all the perfect specimens, and in the smaller ones are usually acute throughout their length, but in large specimens—as, for instance, Nos. 8, 9, 10, and 11—the angles at the ends of the calices are rounded. The principal septa are arched above and fall inwardly steeply to the bottom of the calice. The outer portion of the septal arch may reach the upper edge of the wall, as in specimen No. 8, or the uppermost peripheral portion may be in large part cut away, forming a zone of narrow septal ends just below the upper edge of the wall. The excavation of the septal margins at the wall is one of the characters given by Moseley for his *F. australe*. Specimens Nos. 8 and 9 have both kinds of septa in the same calice. The inside of the wall and the septa are usually white, but in specimens Nos. 6 and 9 there is considerable purplish red on the wall and the peripheral portions of the septa.

There are two specimens from station No. 3856 not included in the preceding table. One of these is noteworthy in having an angle of divergence of the lateral edges of 134°; the sides are asymmetrical; on one side 76° is the angle with the vertical axis, on the other 58°, practically combining in the same specimen the angles of *pavoninum* typical with those of var. *paripavoninum*.

Three specimens that connect *pavoninum* typical with var. *distinctum* on one hand and with var. *paripavoninum* on the other are considered in the following table.

TABLE II.

Specimen number.	Station number.	Height, measured along side. p. b. = pedicel broken.	Angles of lateral edges.	Angle of faces.	Greater diameter of calice.	Lesser diameter of calice.	Shorter diameter above longer.	Number of septa.	Number of principal septa.	Faces: cv. = concave; cx. = convex; pl. = plane.
		mm.	°	°	*mm.*	*mm.*	*mm.*			
22[a]	4080	27	134	42	34	19	18	166	41	cv., cx.
23[a]	4080	30	135	34	37.5	15.5	21	186	47	pl.
24	4080	36 p. b.	124	46	43.5	28	25	200	48	subpl.

[a] Figured.

Specimens Nos. 22 and 23 differ so little from those of Table I that they could with propriety be placed with *pavoninum* typical. The lateral edges of No. 22 are slightly crested, and it is precisely intermediate between typical *pavoninum* and var. *distinctum*. Specimen No. 23 is decidedly compressed. The lateral edges, however, are not crested or sharp keeled, but obtusely rounded. It is intermediate between the typical form of the species and specimen No. 24, which connects with var. *paripavoninum*, represented by Table V, p. 60. The basal angle of the lateral edges is becoming smaller, and specimen No. 24 has the arch of the upper margin of the calice more produced than in typical *pavoninum*, presenting the essential characters of var. *paripavoninum*. Other variations and intergradation in the character of the septal margins are shown. In specimen No. 23 the septal arch is becoming less pronounced than in the specimens included in Table I, the upper and outer narrow portions of the margins of the principal septa forming a wider zone. In specimen No. 24 the septal arch is still more suppressed, the septa tending to slope in an almost straight line from the lower limit of the zone of narrow septal ends to the boundary of the axial fossa. The arch diminishes from the ends of the shorter toward the plane of the larger axis of the calice.

Localities.—Those from which previously reported: Sandwich Islands (Lesson, Dana); Singapore and China (Milne Edwards and Haime); Cape of Good Hope, 50 to 100 fathoms (Gardiner).

Albatross expedition, 1902:

Pailolo channel, between Molokai and Maui islands, Station 3856; depth, 127 fathoms; bottom, fine sand, yellow mud; temperature, 66.5° F.; 2 specimens, young.

Northeast and north coast of Maui Island, Station 4079; depth, 143–178 fathoms; bottom, gray sand, foraminifera; temperature, 60.8° F.; 1 specimen. Station 4080; depth, 178–202 fathoms; bottom, gray sand, foraminifera; temperature, 56.4° F.; 8 specimens. Station 4081; depth, 202–220 fathoms; bottom, gray sand, foraminifera; temperature, 51.7° F.; 5 specimens.

Vicinity of Kauai Island, Station 4132; depth, 257–312; bottom, fine gray sand, mud; temperature, 46.8° F.; 4 specimens.

No station number; 2 specimens.

Besides the above listed specimens there are two broken and subsequently mended; these are abnormal. Of the 18 specimens, concerning which the data on the surrounding physical conditions are explicit, 13 were obtained between 178 and 220 fathoms, on a gray sandy foraminiferal bottom, at a temperature between 50° and 60° F.; 4 came from deeper water, 257–312 fathoms, the temperature being lower, 46.8° F. The largest specimen obtained came from this greatest depth and lowest temperature.

FLABELLUM PAVONINUM var. LATUM Studer.

Plate II, figs. 2, 2*a*, 2*b*.

1878. *Flabellum latum* STUDER, Monatsber. Akad. Wissenschaft. Berlin, for 1877, p. 630, pl. I, figs. 3*a*, 3*b*.

1902. *Flabellum latum* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 31.

Original description.—Studer's description, published in 1878, is as follows:

Corallum strongly compressed, very wide and narrow, with a thin, cylindrical pedicel, which probably was attached, broken below. The wall is smooth, with only concentric lines of growth, the lateral angles rounded, only in the lower third obtusely keeled. The calicular margin strongly convex, the difference between the planes of the two axes 16 mm. Six cycles, three of which are equal, therefore apparently 24 systems. Septa smooth, sharp with perpendicular margins. Altitude of the corallum, 39 mm.; greater diameter, 56 mm.; smaller, 15 mm.; angle of divergence of sides, 112°.

The specimen on which the following table is based is associated with Studer's *latum*. It differs in having more widely diverging lateral edges; it is not so much compressed, and there are almost four cycles of principal septa. This specimen stands rather between *latum* and typical *pavoninum*. Specimen No. 23 of Table II shows some characters of *latum*. The variations are such that I do not believe it possible to retain *latum* as a distinct species.

TABLE III.

Specimen number.	Station number.	Height, measured along face.	Angle of lateral edges.	Angle of faces.	Greater diameter of calice.	Lesser diameter of calice.	Shorter diameter above longer.	Number of septa.	Number of principal septa.	Faces: cv = concave.
		mm.	°	°	*mm.*	*mm.*	*mm.*			
21[a]	3865	35	146	ca. 35	51.5	24	25	188	47	cv.

[a] This table and the preceding were transposed after they were prepared.

This specimen appears to be different from those in Table I in three particulars: (1) The basal angle is less; (2) there is no basal keel; (3) the septa and the inside of the wall are purplish red. On closer study all of these differences vanish. The basal angle is not 10° less than that in the specimens with the smallest angle in Table I, and is well within the limits of the variation of the species, as the next three tables will show. The lateral edges become more compressed toward the pedicel, the difference from the bases of specimens Nos. 9, 10, and 11 being only slight. The inside of the wall and the peripheral portions of the septa in specimens Nos. 6 and 9 are similarly colored, but not so dark as in the specimen here considered. The outside of this specimen is corroded, and that may have made the lower edges more obtuse than they originally were.

Localities.—34° 16.8′ S., 172° 59.6′ E., 45 fathoms (Studer's type); 6° 8′ N., 121° 19′ E., 275 meters (Alcock).

Albatross, 1902, Pailolo Channel, between Molokai and Maui islands, Station 3865; depth, 256–283 fathoms; bottom, fine volcanic sand, rock; temperature, 45° F.; 1 specimen.

FLABELLUM PAVONINUM var. DISTINCTUM Milne Edwards and Haime.

Plate II, fig. 5, 5*a*.

1848. *Flabellum distinctum* MILNE EDWARDS and HAIME, Ann. Sci. Nat., 3ième sér., Zool., IX, p. 262.
1857. *Flabellum distinctum* MILNE EDWARDS and HAIME, Hist. Nat. Corall, II, p. 80.
1873. *Flabellum distinctum* DUNCAN, Trans. Zool. Soc. London, VIII, p. 322, pl. XXXIX, figs. 1–13.
1881. *Flabellum patens* MOSELEY, Deep Sea Corals, Challenger Repts., p. 172, pl. VI, figs. 4, 4*a*, 5, 5*a*.
1881. *Flabellum australe* MOSELEY, Deep Sea Corals, Challenger Repts., p. 173, pl. VII, figs. 4, 4*a*, 5, 5*a*, 5*b*.
1902. *Flabellum distinctum* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 30.
1902. *Flabellum australe* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 30.
1904. *Flabellum chunii* VON MARENZELLER, Steinkorallen, Valdivia Exped., p. 274, pl. XVIII, figs. 14, 14*a*, 14*b*.

Flabellum distinctum Milne Edwards and Haime, 1848:

This coral has been confused with *F. pavoninum;* but its lateral costæ, instead of being almost horizontal, are ascending, and their angle is not much larger than a right angle. The calice is more compressed, and its margin forms an arc less than a semicircle. Only the first three cycles of septa are equal, and the appearance is of 24 systems, with 7 septa each.—Milne-Edwards and Haime, 1857.

Flabellum patens Moseley, 1881:

The adult corallum is wedge-shaped with smooth sides. The form varies very much, the lateral costæ, which are sharp and more or less indented, varying in the angle which they make with one another between 100° and 160°. The inclinations of the lateral faces to one another vary from 30° to 50°. The surface of the corallum is smooth, polished, and of a red-brown color. The principal costæ are only just visible. There is a distinct short pedicle. The summits of the short axis of the calicle are much higher than those of the long axis, and the lateral margins of the calicle describe even curves of nearly half a circle. In one perfect specimen there are 192 septa of three sizes, 24 being complete and in appearance equal and primary. In another more adult specimen there are 268 septa of four dimensions, but the septa are a little irregular, and at one end the corallum has evidently had a considerable piece broken away, and this has been restored with a remarkable maintenance of symmetry in the form of the corallum and septal arrangement. In another specimen there are 248 septa. The faces of the septa are covered with fine-pointed granules. There is a deep elongate, but narrow, fossa well filled up at its bottom by columellar outgrowth. From *Flabellum paronnium*, *Flabellum patens* differs in having its faces less smooth than the former and in having more septa.

Extreme height of the calicle of a large specimen, 43 mm. Extreme breadth of the calicle, 55 mm. Shorter diameter of the calicle, 28 mm.—Moseley, 1881.

Flabellum australe Moseley, 1881:

The adult corallum is very large, dense, and heavy. It is in the form of a compressed wedge, triangular in outline. The lateral costæ make with one another an angle of from 70° to 90°. The surfaces of the faces are smooth and glistening, of a brownish color, marked with evenly curved transverse accretion lines, sometimes with numerous very fine costal markings all over, sometimes with only a few obscure primary and secondary ridges near the base. There is a distinct short cylindrical pedicle. The lateral costæ are sharp and rough-edged, somewhat jagged. They usually cease toward the margin of the calicle, where the angles of the corallum are evenly rounded off. The form of the mouth of the calicle is extremely elongate and narrow, the ratio of the two axes being about as 100 to 40. The summits of the shorter axis of the calicle are somewhat higher than those of the longer axis, and the upper borders of the faces are evenly curved, with smooth edges. The septa are white, contrasting in color with the brown wall of the calicle. They are stout and straight, and covered with fine-pointed granules on their faces. All the septa are very low near the margin of the calicle, to which they do not quite extend, a narrow zone of bare calicular margin being present all round the mouth of the calicle. It appears therefore as if their free borders were, so to speak, cut away close to the calicular margin. The curved free edges of the principal septa bend over and descend nearly vertically to bound the fossa, which is extremely narrow, deep, and long. There are in one adult specimen, that figured, 48 complete septa sensibly equal to one another, and 144 incomplete septa of two different sizes—192 in all. In one specimen there are 96 septa on one side and 92 on the other. In another, 80 on one side, and 85 on the other. Another, 92 on one side, 94 on the other, and 28 of these complete on each side. A young one has 17 complete on each side, and 82 on each side in all. In all these specimens the septa are of three dimensions. The columella lies so deep in the fossa as to be almost invisible.

This species is well distinguished by its large size, its shape, and the peculiar cutting away, as it were, of the septal borders close to the margin of the calicle. The very young specimens are closely like those of *Flabellum patens* and *Flabellum stokesi*, though the adults are extremely different. *Flabellum distinctum* Milne-Edwards and Haime is also in its young stages very like the present species, but differs in having a wider mouth to its calicle. In *Flabellum australe* this is characteristically narrow.

Extreme height of the largest specimen, 57 mm. Extreme breadth, 65 mm. Shortest diameter of the calicle, 28 mm.—Moseley, 1881.

Von Marenzeller proposes *F. chunii* for the *F. distinctum* of Duncan (not Milne Edwards and Haime), collected by the *Porcupine* off the south and west coast of Portugal.

The great variability of Milne Edwards and Haime's *F. distinctum* was first pointed out by Duncan (1873). As there is no difference between the specimens described and figured by Duncan and Moseley's *F. patens*, Moseley's attaching a new name to his specimens may be attributed to an oversight. Both Gardiner (1902) and Alcock (1902) have identified *patens* with *distinctum*. Gardiner, as has already been noted, refers *F. australe* to the synonymy of *F. paroninum*, remarking that it "shows a cutting away of the septal borders close to the margin of the calicle, a character not found in the other specimens from the same dredging." Alcock says of *F. australe:* "This species, which is otherwise not different from *F. distinctum*, is distinguished by the density and weight of the corallum and by the more than usual cutting away of the septa near the calicular margin." The remarks made under typical *pavoninum* show that the excavation of the septal margins near the calicular edge is a common individual variation; consequently this criterion lapses. There is also variation in the density of the corallum. *F. patens* and *F. australe* of Moseley therefore are not only synonyms of *F. pavoninum*, but are synonymous with the variety *distinctum*.

Duncan's figures of *F. distinctum* (1873) showed that it could be separated specifically from *F. pavoninum* neither by the angle between the lateral edge nor by the septa having 24 instead of 48 principals, but he did not connect the two. Alcock evidently suspected that they probably should be united, judging from several remarks. Gardiner definitely united them. The specimens obtained by the *Albatross*, 1902, give additional confirmation to Gardiner's conclusion.

I think, however, that *distinctum* can be used advantageously as a varietal name under *pavoninum*, and would define it as follows: Angle of divergence of lateral edges less than 135°, the edges usually with crests; the greater diameter of the calice exceeds the height of the corallum.

Three specimens obtained by the *Albatross* are referred to this variety, and from them Table IV has been prepared.

TABLE IV.

Specimen number.	Station number.	Height, measured along side.	Angle of lateral edges.	Angle of faces.	Greater diameter of calice.	Lesser diameter of calice.	Shorter diameter above longer.	Number of septa.	Number of principal septa.	Faces: cv = concave; cx = convex; pl. = plane.
		mm.	°	°	*mm.*	*mm.*	*mm.*			
25........	4101	23	[a] 122	33	28	13.5	13	118	27	cv., cx.
26........	4101	23.5	132	38	31	15.5	11	126	27 or 28	cv.
27 [b]	3999	27.5	ca 117	30	37	15	11	118	44	cv.
Average......		24.7	127	33.7	35.3	14.7	11.7	121	33	

[a] Measured exclusive of the crests. [b] Figured.

Specimen No. 26 of this table is nearest to specimen No. 22 of Table II. No. 26 is actually smaller, and besides that it has undergone rejuvenescence. The new wall at one end of the calice is 2.5 mm. within the old; at the other end the newer wall is closer to the older; on the median portions of the faces the growth is continuous. This rejuvenescence succeeded a contraction of the calice, brought about by some unknown cause. The angles of divergence of the lateral edges and of the faces are not greatly different in the two specimens. The lateral edges in No. 26 bear well-developed crests, whereas in No. 22 they are weak. Specimen No. 25 stands between No. 26 and No. 27. The last is the most compressed specimen examined and compared with the other specimens is relatively heavy, the basal portion apparently having been filled, partially at least, with stereoplasm. In these specimens the excavated zone around the upper septal margins is absent or only faintly developed.

Localities.—Previously reported from Japan (Milne Edwards and Haime): *Porcupine* expedition (Duncan); 39° 85′ N., 9° 56′ W., depth 994 fathoms, temperature 40.3° F.; 36° 44′ N., 8° 8′ W., depth 364 fathoms, temperature 52.7° F.; 36° 29′

N., 7° 16′ W., depth 304 fathoms, temperature 53.3° F.: *Challenger* Expedition (Moseley); off Ki Islands, 129 fathoms (*F. patens* Moseley); off Twofold Bay, New South Wales, 120 fathoms (*F. australe* Moseley): *Siboga* Expedition (Alcock); 7° 15′ S., 115° 15.′6 E., 289 meters, 2 specimens; and 5° 28.′4 S., 132° 0′.2 E., 204 meters, 1 specimen (as *F. australe*).

Albatross, 1902:

Vicinity of Kauai Island, Station 3999; depth 7–148 fathoms; bottom, coral sand, shells; 1 specimen.

Pailolo channel, between Maui and Molokai islands, Station 4101; depth 122–143 fathoms; bottom, coral sand, shells, foraminifera; 2 specimens.

FLABELLUM PAVONINUM var. PARIPAVONINUM Alcock.

Plate III, figs. 1, 2, 3, 4, 4*a*, 4*b*.

1894. *Flabellum paripavoninum* ALCOCK, Jour. As. Soc. Bengal, LXIII, p. 187.

1898. *Flabellum paripavoninum* ALCOCK, Investigator Deep Sea Madrepor., p. 21, pl. II, figs. 3, 3*a*, 3*b*.

Description.—According to Alcock:

Corallum compressed, fan shaped, with a sessile scar of attachment, but no pedicle, and with the two faces somewhat concave. The lateral costæ are sharp, but not salient; they meet the basal scar at an angle of about 45°; the other costæ are merely sinuous striations. The margin of the calicle is almost entire, and forms a segment of a circle of about 230°, so that when the corallum is held straight in front of the eyes, with the major axis end on, and without any inclination, the columella, such as it is, is plainly visible above that plane of the calicular margin. The septa are in six cycles, the last cycle not quite complete; they are all extremely thin, and have the free edges sharp and straight (not sinuous) and the granular striæ of the surface inconspicuous Those of the first three cycles are almost equal and meet together at the bottom of the calicle to form a sort of columella by their slightly thickened ends. Those of the fourth cycle are not so very much smaller than their predecessors, but do not meet them. Those of the last two are small. * * *

Height of corallum, 39 mm.; major axis of calicular orifice, 37.5; minor axis, owing to the eversion of the rim of the calicle, 30.5 mm.—Alcock, 1898.

The angle of divergence of the lateral edges, measured in the figure, is about 110°; plane of shorter diameter of calice above that of the longer, 29 mm., this also measured on the figure.

The absence of the pedicel in Alcock's type, I am confident, is an accident; the figure looks as if the base of the specimen had been broken, therefore no importance attaches to this character. The angle between the lateral edges indicates var. *distinctum*, and the septa are the same as in the type of that form. The chief peculiarity of Alcock's form is the height exceeding the greater diameter of the calice, while the plane of the longer diameter of the calice is not much below the middle point in the altitude of the corallum—the arch of the calicular margin is decidedly high.

Eighty-five of the *Albatross*, 1902, specimens are referred to this variety. As their intergradation with typical *pavoninum* has been discussed at the end of the remarks on that form of the species (see p. 54), attention can be turned directly to their relations to Alcock's type specimen. In form there is no difference; the type was somewhat over 39 mm. in height, as the base is now broken. The number of the septa is the same, but there are more principal septa in the Hawaiian specimens than in the type. The principals over 24 are often, nearly always in part at least, smaller than the members of the first three cycles. The size of the fourth cycle has been shown to be variable, these specimens from Hawaii show variation, and can therefore be disregarded. Alcock states that the inner edges of the septa of *pariparoninum* are straight, not undulated. In the Hawaiian specimens the inner edges of the septa of this variety are not so strongly undulated as in the other varieties of *paroninum*, and in some cases the septa are so little undulated that they might be called straight. The upper portions of the principal septa in Alcock's figures of *pariparoninum* are wider than in the Hawaiian specimens, but this is a variable character. At first I thought of erecting a new variety for the *Albatross* specimens, separating them from *pariparoninum* because their principal septa are more numerous and narrower near the calicular margins, but both characters are too variable to furnish a valid basis for even varietal separation.

The following table is based upon 50 specimens, all of the best preserved and most perfect of those obtained. As remarks have already been made on the variation and some characters not expressed in the table, what is to be said along this line may appropriately be completed here. The bases of the specimens are often more compressed than the upper portions. Below the plane of the longer axis of the calice the faces of the corallum are normally gently convex; above that level they are almost flat until near the upper edge of the wall, where frequently there is a gentle bending outward, making the upper portions of the faces slightly concave. Those specimens that have their upper edges flaring outward in this way are marked "fl" in the following table. The lateral edges are subacute, except at the ends of the calice, where they are rounded; moderately developed crests are sometimes present. The angle of divergence is not always the same throughout the length of the lateral edges. When two angles are given in the table, the first one is taken nearer the center of the base.

TABLE V.

Specimen number.	Station number.	Height, measured along side; p. b. means pedicel broken.	Angle of lateral edges.	Angle of faces.	Greater diameter of calice.	Lesser diameter of calice.	Shorter diameter above longer.	Number of septa.	Number of principal septa.	Faces: cx. = convex; fl. = somewhat flaring superiorly.
		mm.	°	°	*mm.*	*mm.*	*mm.*			
28	4080	25	92	41	23.5	17	12	104	24	cx.
29	4080	26	90	46	26	18.5	12	114	24	cx.
30	4080	26.5	104	47	28.5	20	14	118	28	cx.
31	4080	33	ca. 120	46	31.5	21.5	16.5	148	28	cx.
32	4080	36	105	45	34	26	20	164	42	cx.
33	4080	36	ca. 100	47	35	28	20	190	48	fl.
34	4080	36	114	49	35.5	27.5	20.5	192	39	cx.
35	4080	38.5	106	38	34	26.5	21.5	178	38	fl.
36	4080	33 p. b.	109	51	37.5	28.5	22	164	40	fl.
37	4080	39	112	47	41	32	24.5	188	46	fl.
38	4080	37	120	45	40	30	23	176	39	fl.
39	4080	38.5	95	45	36	30	22	160	36	fl.
40	4080	36	100	45	37	27	21.5	178	44	cx.
41	4080	38.5	98	45	37.5	27	21	164	38	cx.

TABLE V—Continued.

Specimen number.	Station number.	Height, measured along side; p. b. means pedicel broken.	Angle of lateral edges.	Angle of faces.	Greater diameter of calice.	Lesser diameter of calice.	Shorter diameter above longer.	Number of septa.	Number of principal septa.	Faces: cx. = convex; fl. = somewhat flaring superiorly.
		mm.	°	°	mm.	mm.	mm.			
42 [a]	4080	40	85	43	34.5	28.5	23	162	39	cx.
43	4080	36	116	47	37	30	22.5	166	44	fl.
44	4080	35 p. b.	ca. 115	51	37.5	31	23	168	44	fl.
45	4080	40	101	48	36	32	21	146	37	cx.
46	4080	39	109	46	40	28.5	20	163	36	cx.
47	4080	39	104	41	38	27	22.5	174	39	fl.
48	4080	40.5	95	42	40	30	22	170	40	fl.
49	4080	35 p. b.	120	45	40.5	29.5	24	182	48	fl.
50	4080	39.5 p. b.	115	53	42.5	35	26.5	190	48	fl.
51	4080	37 p. b.	112	49	39.5	31	25.5	177	47	fl.
52	4080	40	102	39	39	29.5	22.5	180	44	cx.
53	4080	38.5 p. b.	114	45	42	30.5	25	184	47	fl.
54	4080	39	102	49	41	32.5	23	178	40	fl.
55	4080	40.5	106	44	38.5	29.5	24	178	36	cx.
56	4080	40.5	118	44	40	30	26	200	50	fl.
57	4080	40	102	46	39.5	32.5	24	180	42	fl.
58	4080	38	(136)115	44	39	28.5	27	194	48	fl.
59	4080	40 p. b.	100	46	40	31.5	25.5	178	45	cx.
60	4080	41.5 p. b.	92	44	40	32	25.5	170	43	fl.
61	4080	44	102	41	40.5	32	25.5	180	49	fl.
62	4080	44.5	88	38	42	29.5	24	172	40	cx.
63	4080	41	110	48	41	34	26	188	46	fl.
64 [a]	4080	39	128	52	39	33.5	27	198	48	fl.
65	4080	37.5 p. b.	120	47	41.5	30	25	186	46	fl.
66	4080	40	122	47	41.5	30	25	180	48	cx.
67	4080	43	114	46	43	30	27.5	178	36	cx.
68	4080	40	103	48	40	33	24	192	48	fl.
69	4080	43	118	42	40	30.5	27	192	48	fl.
70	4080	43	89	38	40	27.5	22	174	47	fl.
71 [a]	4080	41	107	47	41.5	32	24	190	48	fl.
72	4080	43.5	118	46	40	33	28.5	178	48	fl.
73	4080	43	110	50	41.5	35	27	186	47	fl.
74 [b]	4080	38	96	42	42	28.5	22	184	47–49	fl.
75 [b]	4080	39	ca. 99	48	40	29.5	19.5	152	43	fl.
76	4087	40	100	49	38.5	31.5	24	134	45	fl.
77 [a]	4115	51.5	125	(46) 36	55	41.5	36	262	49	fl.
Average		38.8 [c]	107	45.4	38.6	29.6	23	171	42	

[a] Figured specimens.
[b] Specimens broken and subsequently repaired. They are slightly asymmetrical, but otherwise normal.
[c] The specimens with broken pedicels are omitted in calculating this number.

Besides the specimens from which the above table is made, there are belonging to the same group from—

Station 4080	11 specimens.
Station 4079	11 specimens.
Station 3835	1 specimen.
Station 3856	6 specimens (young).
Station 3857	5 specimens (young).
	34

Adding the 1 specimen of Table II (No. 24), the 50 of Table V, and these 34, makes a total of 85 specimens of this variety.

Localities.—Alcock's type, off Pedro Bank (Laccadive Sea), 636 fathoms. *Albatross*, 1902:

South coast of Molokai Island:

Station 3835; depth, 169–182 fathoms; bottom, fine brown sand, mud; temperature, 55° F.; 1 specimen.

Pailolo Channel, between Molokai and Maui islands:

Station 3856; depth, 127 fathoms; bottom, fine sand, yellow mud; temperature, 66.5° F.; 6 specimens, small. Station 3857; depth, 127–128 fathoms; bottom, fine sand, yellow mud; temperature, 62.5° F.; 5 specimens, small.

Northeast and north coast of Maui Island:

Station 4079; depth, 143–178 fathoms; bottom, gray sand, foraminifera; temperature, 60.8° F.; 11 specimens. Station 4080; depth, 178–202 fathoms; bottom, gray sand, foraminifera; temperature, 56.4° F.; 60 specimens. Station 4081; depth, 202–220 fathoms; bottom, gray sand, foraminifera; temperature, 51.7° F.; 1 specimen.

Northwest coast of Oahu Island:

Station 4115; depth, 195–241 fathoms; bottom, coral sand, foraminifera; temperature, 55.1° F.; 1 specimen (the largest obtained).

The physical conditions under which this variety thrives best, judging by the Hawaiian specimens, are realized at stations 4079, 4080, 4081, and 4115; depth, 178 to 241 fathoms; bottom sandy, foraminiferal; temperature between 50° and 60° F. These conditions are practically the same as for typical *paroninum*, the two varieties occurring together, with intermediate examples. At station 4080, var. *pariparoninum*, however, is the more abundant. At station 4081, *paroninum* typical is the more abundant. A comparison of the data regarding the two varieties seems to point to the typical form's thriving best in somewhat deeper water and at a slightly lower temperature. This does not appear sufficient to account for the differences in form. It has occurred to me that the bases of the varieties with converging lateral edges might be sunk in the mud of the sea bottom, and that the differences in shape may thus be brought about mechanically; but it is difficult to prove or disprove such an hypothesis.

FLABELLUM DELUDENS von Marenzeller.

Plate III, figs. 5, 5*a*, 5*b*.

1848. *Flabellum laciniatum* MILNE EDWARDS and HAIME, Ann. Sci. Nat., 3ième sér., Zool., IX, p. 273 (? *Phyllodes laciniatum* Philippi, 1841).
1857. *Flabellum laciniatum* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 92.
1864. *Flabellum laciniatum* SEGUENZA, Corall. Foss. Terz. Messina, Pt. 2, p. 91, pl. x, figs. 7, 7*a*.
1898. *Flabellum laciniatum* ALCOCK, Investigator Deep Sea Madrepor., p. 21, pl. II, figs. 4, 4*a*.
1904. *Flabellum deludens* von MARENZELLER, Steinkorallen Valdivia Exped., p. 269, pl. XVII, fig. 10 (2 figs.).

Von Marenzeller proposes a new name for this coral, because Philippi's original material is too fragmentary for positive identification. He makes very appropriate remarks on the relations between *Flabellum macandrewsi* Gray, *Ulocyathus arcticus* M. Sars, and *Flabellum alabastrum* Moseley (=*Flabellum goodei* Verrill).

Description (based on the Hawaiian specimens).—Corallum very thin and fragile, with a compressed, elongate, horizontal or almost horizontal base, and a highly arched, deeply incised calicular margin.

A short, rather stout pedicel is persistently present, by which even the adult corallum seems to have been attached; angle of divergence of the lateral edges constantly about 180°, the variation slight. Below the edges are wide, thin, often transversely undulated, lamelliform crests which connect with the septa lying in the plane of the longer axis of the calice, and are frequently produced below the level of the lower end of the pedicel. The faces of the corallum diverge at an angle between 50° and 70°. About halfway up a face the outer portions diverge more rapidly than the medial, causing the upper part to be concave. Costæ usually correspond to the first and second cycles of septa, but are variable in development, frequently strong, wide at the base, acute or flattened along the summits; coarse, sinuous lines of growth often present.

The lower ends of the calice are approximately on a level with the top of the pedicel, the upper edge very much elevated. The deeply incised character of the calicular margin has been noted. The deepest incisions usually occur on the sides of the tertiaries in such a manner that the upper ends of the quaternaries are carried upward on the lobes bearing the ends of the principal septa, thus isolating the tertiaries, except those next the ends of the calices, where the incisions alongside the principal septa in the long axis are very deep. Deeper incisions occur in most of the larger specimens on each side of each inner tertiary of the terminal systems, i. e., the one nearest the medial system. This tertiary seems to project in the bottom of a deep sinus. Between these two sinuses on each face is a median lobe with a coarsely toothed upper margin. Below each of these sinuses is another lobe, its lower boundary formed by the deep incision near the principal septum at the end of the calice. The outer margin of this lobe is also coarsely dentate. To sum up these characters, the upper margin of each face is usually trilobed, and the margin of each lobe is coarsely dentate.

Septa distant, thin, in four cycles, in the larger specimens some members of the fifth. There are usually three sizes, the primaries and secondaries of equal size, fusing by their inner edges near the base of the corallum; the tertiaries are narrower, but they also reach the axis; the quaternaries are narrower and thinner, and do not extend all the way down the corallum wall; there may be a few still smaller or rudimentary quinaries. The arches of the principals extend as high as, or even a little beyond, the upper edge of the wall, their inner margins falling perpendicularly to the bottom of the calice. The septal faces show coarse transverse undulations. The interseptal loculi are very open, and the wall at the base of the corallum is translucent. Columella trabecular.

Greater diameter at base measured between outer edges of the septa, 37 mm.; measured between outer edges of wall, 28 mm.; lesser diameter of calice, 27.5 mm.; height of corallum, 33 mm. This is a well-preserved specimen, probably a few millimeters over the average size. The variation exhibited by the specimens is so small that it does not require compiling a table of measurements.

Localities.—Previously reported from Indian Seas, 400–600 fathoms (Alcock); west of Sumatra, 614 and 660 meters (von Marenzeller).

Albatross Expedition, 1902:

Vicinity of Modu Manu, or Bird Island: Station 3977; depth, 876 fathoms; bottom, fine coral sand, foraminifera, rock; temperature, 38° F.; 1 specimen.

West coast of Hawaii Island: Station 4036; depth, 687–692 fathoms; bottom, fine dark gray sand, foraminifera; temperature, 38.2° F.; 30 specimens. Station 4038; depth, 670–689 fathoms; bottom, gray mud, foraminifera; temperature, 38.5° F.; 4 specimens. Station 4039; depth, 670–697 fathoms; bottom, gray mud, foraminifera; temperature, 38.7° F.; 11 specimens.

This species lives around the Hawaiian Islands at a depth between 670 and 900 fathoms, on a foraminiferal bottom, either sand or mud, at a temperature of 38° to 39° F.

Remarks.—The Hawaiian specimens differ only slightly from those described by Alcock from the Indian Ocean. The principal difference consists in the pronounced tendency of the upper margins of the faces of the coralla to be trilobate, as has been described. This trilobation is brought about by some of the indentations of the septal margins becoming deeper and others shallower. There is variation in these characters. The Hawaiian specimens might be separated as a local variety from those from the Indian Ocean; but I believe that they should not be referred to a separate species.

This species, under the name of *F. laciniatum*, has been confused with *F. alabastrum* Moseley. There are large suites of the latter species in the United States National Museum, and I have compared about 170 of these specimens with the Hawaiian specimens of *F. deludens*. There is some resemblance between the young of *F. alabastrum* and the ordinary sized specimens of *F. deludens*. *F. alabastrum* is a larger species, with thicker walls and usually more thickened septa, and its lateral edges converge downward at a low angle. But the greatest difference between the two is that in *F. deludens* the septa occupying the long axis of the calice are continued downward into highly developed crests. The lateral edges in *F. alabastrum* are carinate, but there are no such crests as in *F. deludens*. Moseley's species seems to me very distinct from the latter, at least a comparison of 48 specimens of the former with 170 of the latter has shown no evidence of intergradation.

Genus GARDINERIA, new genus.

Diagnosis.—Calcareous tissues imperforate; new coralla arising from the old by internal gemmation, similar to that in *Schizocyathus fissilis* Pourtalès, except in *Gardineria* the parent corallite is not split. In the type species an older corallite produces only one younger. Wall epithecate, as in *Flabellum* or *Rhizotrochus*, extending upward beyond the outer ends of the septa. Septa with entire margins, arched above, showing no definite cyclical arrangement, alternately larger and smaller, all the larger and occasionally one of the smaller extending to the axis of the corallum.

Wide paliform lobes occur on the inner ends of most of the larger septa. *The loose fusion of the inner edges of these lobes and of the inner ends of a few long septa which do not have the lobes form a weak false columella. Interseptal loculi open to their bottoms.*

Type-species.—*Gardineria hawaiiensis*, new species.

Remarks.—This genus is most closely related to *Duncania*[a] Pourtalès, characterized by Pourtalès as follows: "Corallum attached, cylindrical, covered with a thick wrinkled epitheca rising over the border of the calicle. *Interseptal chambers filling up solidly from the bottom, a multiple pillared columella.* Sometimes paliform lobes."[b] The interseptal loculi in *Gardineria* are so little filled up that the wall is translucent even at the base of the corallum, and, as stated in the diagnosis of the genus, the columella is false. *Haplophyllia* Pourtalès is a closely related genus. It has a strongly developed columella and the interseptal loculi are solidly filled at the bottom.

Mr. J. Stanley Gardiner, in his Turbinolid Corals of South Africa,[c] describes a coral under the name of *Duncania capensis*, and remarks on the close affinity between *Duncania* and *Haplophyllia*. It is difficult to understand how it has escaped the attention of zoophytologists that de Koninck, in 1872[d], proposed the name *Duncania* for a Carboniferous coral, antedating Pourtalès in the use of the name by two years, and thus invalidating its later application to recent species.

GARDINERIA HAWAIIENSIS, new species.

Plate IV, figs. 1, 1*a*, 1*b*.

The type specimen seems to represent four individuals, there being only a fragment of the oldest; the second soon gave rise to the third, the base of the third almost filling the cavity of the second. The diameter of the third is 18.5 mm., height of second and third combined, 16 mm. In a half calice of the third are 16 septa alternately larger and smaller. The fourth individual is 22 mm. tall and 33 mm. in diameter. In form the corallites are inversely conical, attached by the base and some epithecal rootlets to the parent corallites.

The wall is epithecate, with transverse striæ and some encircling constrictions. There are no definite costæ, but there are some ill-defined discontinuous longitudinal

[a] Mem. Mus. Comp. Zool., IV, "Hassler Corals," 1874, p. 44.

[b] The contrasting portions of my description of *Gardineria* and of Pourtalès's description of *Duncania* are italicized in order to emphasize the differences.

[c] Marine Investigations in South Africa, III, 1904, pp. 120, 121, pl. I, figs. 6*a*–6*c*.

[d] Nouvelles Recherches sur les Animaux fossiles du Terrain carbonifère de la Belgique, p. 107.

ridges and fine longitudinal striations, while from place to place there are more or less continuous, sharply indented, longitudinal sulcations.

The septa do not show any definite cyclical arrangement. In one-half of the next to the last calice (diameter 18.5 mm.) there are 17 septa which are, with one exception, alternately larger and smaller. The largest calice has 36 septa, alternately larger and smaller. Nineteen of the septa extend to the columellar space, while ten have palifrom lobes on their inner ends. Between almost every pair of the 36 septa is a wide, low, rounded ridge, probably a rudimentary septum. Neglecting the ridges in the interseptal loculi, the septa are distant, their outer ends are thick, but they become thinner toward the columella. Upper margins strongly arched, the arch not extending to the wall, the septa set within the epitheca which extends upward beyond their outer ends. Inner margins of the larger septa steep, the smaller septa becoming narrow toward the base of the corallum. Septal faces irregularly and minutely granulated.

Columella false, poorly developed, formed of the loose fusion of the paliform lobes and of a few septa that do not bear lobes.

Calice moderately deep.

Locality.—Station 3991, vicinity of Kauai Island; depth, 272–296 fathoms; bottom, fine sand rock; temperature of bottom, 43.7° F.

Type.—Cat. No. 20731, U.S.N.M.

Remarks.—This coral presents so little resemblance to any other one known to me that scarcely any comparison can be made. From its general appearance it evidently should be placed near *Flabellum* and *Rhizotrochus*.

Genus PLACOTROCHUS Milne Edwards and Haime.

PLACOTROCHUS FUSCUS, new species.

Plate IV, figs. 2, 2*a*, 3, 3*a*.

This species is represented by three specimens, all of which were used in preparing the following description.

Corallum small, trumpet-shaped, attached by an expanded base.

MEASUREMENTS.

Specimen	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Greater diameter of calice	5.5	7	8.5
Lesser diameter of calice	4.5	5.5	7.5
Diameter of lower fractured end	2		3
Diameter of pedicel immediately above base		3.5 and 3	
Height corallum	10	12.5	13

Specimens Nos. 1 and 3 have been broken from their bases, and the measurements given in the table therefore do not represent the total height of the coralla.

The wall externally is rather glistening, resembling in appearance that of *Flabellum* or *Rhizotrochus*. Costæ lacking in young specimens, but well developed near the calice in mature specimens. For instance, there are none in specimen No. 1; faint costæ are appearing around the edge of the calice in No. 2; in No. 3, they are well developed for a distance of 1 to 2.5 mm. below the upper edge of the wall, corresponding to the first, second, and third cycles of septa, but not to the fourth.

Septa thin and distant, in four complete cycles, becoming progressively more exsert with increasing age. The first and second cycles about equal in prominence; the third cycle less prominent; the fourth corresponding to slight notches on the calicular margin. In young specimens the members of the first cycle are slightly longer than those of the second, but later these two cycles become equal in size; the members of the third are considerably shorter and thinner; those of the fourth cycle are rudimentary, very short and delicate, and must be looked for carefully to be seen, but the cycle is complete, even on the lower, broken end of specimen No. 3. The septal faces are beset with very minute granulations and there are faint striæ. The inner margins of the larger septa are slightly undulated and fall abruptly to the bottom of a deep narrow calicular fossa.

Columella a deep seated, very thin, delicate lamella, with a gently curved upper edge. It is best shown in specimen No. 1. It is distinct, but was difficult to discover, in No. 2. Apparently it has been broken and has fallen out of No. 3.

The corallum is usually reddish brown in color, with the inner third of the larger septa white. Specimen No. 1 is whitish with some brownish blotches.

Localities.—

Pailolo Channel, between Maui and Molokai islands: Station 3886; depth, 148 fathoms; bottom, pebbles and rock; temperature of bottom, 65° F.

Ukula Point, vicinity of Kauai Island: Station 3999; depth, not definitely given, 7–148 fathoms. (Specimens Nos. 1 and 3.)

Cotypes.—Nos. 20731, 20732, U.S.N.M.

Family CARYOPHYLLIIDÆ Verrill.

Genus DESMOPHYLLUM Ehrenberg.

DESMOPHYLLUM CRISTAGALLI Milne Edwards and Haime.

Plate VII, figs. 3, 3*a*, 3*b*.

1848. *Desmophyllum cristagalli* MILNE EDWARDS and HAIME, Ann. Sci. Nat., 3ième sér., Zool., IX, p. 253, pl. VII, fig. 10.
1857. *Desmophyllum cristagalli* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 76.
1873. *Desmophyllum cristagalli* DUNCAN, Trans. Zool. Soc. London, VIII, p. 321.
1878. *Desmophyllum cristagalli* POURTALÈS, Bull. Mus. Comp. Zool., V, No. 9, p. 203.
1880. *Desmophyllum cristagalli* POURTALÈS, Bull. Mus. Comp. Zool., VI, No. 4, p. 106.
1902. *Desmophyllum cristagalli* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 28.
1904. *Desmophyllum cristagalli* v. MARENZELLER, Stein-Korallen, Valdivia Exped., p. 267, pl. XV, figs. 2, 2*a*, 2*b*.

Remarks on the synonymy.—Duncan[a] refers *D. cumingi* and *D. costatum* Milne Edwards and Haime to the synonymy of *D. cristagalli*. Alcock[b] adds the names of

[a] Trans. Zool. Soc. London, VIII, 1873, p. 321. [b] Deep Sea Madrepor., Siboga Exped., 1902, p. 23.

D. reflexum and *D. rusei* Duchassaing and Michelotti. It seems to me that Duncan is correct in his conclusion; probably *D. reflexum* of Duchassaing and Michelotti and *D. incertum* of the same authors should be placed in the same synonymy. The *Desmophyllum riisei* of Pourtalès[a] is different from the *Desmophyllum rusei* of Duchassaing and Michelotti.[b] The specimens figured by Pourtalès are much more slender than the type of the species. While in Turin, during the winter of 1897, I found the type of *D. rusei*. It possesses an essential columella, composed of projecting laths, similar in character to that of *Caryophyllia*. Therefore, *D. rusei* is not a *Desmophyllum*, but is probably a *Cyathoceras*.

Description.—(Specimen from Hawaiian Islands):

The corallum is broken below, but evidently there was a basal attachment, above which rose a stalk. In its upper portion the corallum rapidly increases in diameter. Transverse outline of calice oval. Diameter of lower broken end of specimen, 7 mm.; greater diameter of calice (*a*) from outer edge to outer edge of wall, neglecting costæ, 22.5 mm.; (*b*) between outer edges of costæ, 26 mm.; lesser diameter (*a*) from outer edge to outer edge of wall, 17.5 mm., (*b*) between outer edges of costæ, 24.5 mm.; height of specimen, (*a*) to upper edge of wall, 26 mm., (*b*) to upper edges of septa, 31 mm.

Wall thick and dense. Costæ corresponding to the largest septa, large and prominent, extending rather far down the sides of the corallum, more prominent near the margin of the calice.

Septa in almost five complete cycles, the primaries and secondaries of similar size, thick, with very exsert margins; the tertiaries smaller but with decidedly exsert margins. The septa of the penultimate cycle are wider than those of the last cycle, but their upper margins are not so much elevated.

The axial fossa is narrow and very deep, as there is no columella.

Localities.—Previously reported from the Pliocene of Italy, the Mediterranean, eastern Atlantic, Antilles, Pacific coast of South America, and the Indo-Pacific.

Albatross, 1902: Kaiwi Channel, between Molokai and Oahu islands, Station 3893; depth, 220–346 fathoms; bottom, fine white sand, rock; temperature 47° F.; 1 specimen.

Genus PARACYATHUS Milne Edwards and Haime.

PARACYATHUS GARDINERI, new species.

Plate IV, figs. 4, 4*a*, 4*b*.

Corallum heavy for its size, shaped like the bowl of an ordinary water goblet, the base flattish or gently rounded, showing in the central portion a rather large scar of detachment. The sides of the corallum are almost perpendicular, that is, with increasing height there is very little increase in the measure of the diameters. Transverse outline of the calice broadly elliptical.

[a] Bull. Mus. Comp. Zool., VI, 1880, No. 4, p. 106, pl. I, fig. 14.

[b] Mém. Corall. Antilles, 1861, p. 61 (of reprint), pl. IX, fig. 4.

MEASUREMENTS.

Specimen	No. 1.	No. 2.
	mm.	*mm.*
Greater diameter of calice	14	16.5
Lesser diameter of calice	12.5	14.5
Height of corallum	13.5	13

Costæ corresponding to all septa, continuing to the edge of the basal scar; they are low, wide, equal, rounded or flattish, densely granulated. Intercostal spaces narrow and shallow.

Septa in four complete cycles, in some half systems there may be a few members of the fifth. The members of the first and second cycles are of nearly the same size, secondaries very slightly shorter; they are moderately thick, their upper margins rather prominent, projecting 1.5 mm. above the upper edge of the wall. The tertiaries and quaternaries are equal in prominence, length, etc., and are only slightly exsert. Septal faces delicately fluted and granulated. Pali in three definite crowns, before the septa of the first, second, and third cycles, narrowest before the first and widest before the third. Where septa of the fifth cycle are present pali may stand before septa of the fourth. Apparently some of the pali may have inner lobes.

Columella not very large, composed of a number of papillæ, upper surface elliptical and depressed below the pali.

Calicular fossa rather narrow, only moderately deep.

Locality.—Hawaiian Islands. If the station number was with these specimens when they were sent to me, it was lost.

Cotypes.—Three specimens, Cat. No. 20754, U.S.N.M.

PARACYATHUS TENUICALYX, new species.

Plate VI, figs. 1, 1*a*, 1*b*.

Corallum attached by an expanded base, above which rises a stout peduncle 5 mm. in diameter and 7 mm. tall, in its upper portion gradually increasing in diameter. The calice is almost circular, having a greater diameter of 8.5 mm. and a lesser of 8 mm. Height of corallum 18 mm.

The outer surface of the peduncle is without costæ, but possesses numerous transverse undulations. Above these are distinct equal costæ corresponding to all septa. The costal edges are subacute and very regularly beaded; intercostal furrows narrow.

Septa in four complete cycles. The members of the first and second cycles are of the same size, with somewhat exsert margins; those of the fourth cycle are usually slightly longer than those of the third, but their upper margins are equal in prominence. All of the septa are thicker in the thecal ring, where they are crowded, but become thinner toward the center. The inner ends of both the first and second cycles are thickened opposite the pali. The septal faces are very delicately fluted, and beset with numerous crowded conical granulations.

Pali tall, thin, wide, almost straight plates, with entire edges, and with delicately fluted, somewhat granulated faces; before all septa except the last cycle. Those before the third cycle are the widest, those before the first cycle are sometimes narrower than those before the second, but it is not always possible to distinguish the first from second cycle.

Columella terminated by irregularly shaped papillæ, 8 in the type.

Calicular fossa and the whole calice shallow.

Locality.—South of Molokai Islands and west of Lanai Island, Station 3895; depth, 252–429 fathoms; bottom, coral rock; temperature of bottom, 47° F.

Type.—Cat. No. 20755, U.S.N.M.

PARACYATHUS MAUIENSIS, new species.

Plate VI, figs. 2, 2*a*.

Corallum attached by an expanded base, diameter not increasing with the height, transverse outline broadly elliptical. Greater diameter of calice, 8 mm.; lesser, 7.25 mm. Base attached to an uneven surface. Height on one side, 6.5 mm.; on the other, 10 mm. Just above the attached area the corallum is almost circular in cross-section, diameter 8 mm. Between the base and the calice are several encircling constrictions.

The wall is thick, externally almost completely enveloped by a thick, more or less corrugated epitheca that extends to the very margin of the calice. In a few places can be seen low, obtuse costæ, which are subequal, or alternating in size. Near the base the epitheca possesses broad, low, flat, equal, granulated costæ, separated by shallow, narrow intercostal furrows.

The septa are in six systems; four complete cycles in four systems, in the outer halves of the two systems at one end of the calice the fourth cycle is wanting. The septa are straight, but the members of the last cycle seem to fuse by their inner ends to the sides of the large pali standing before the penultimate septa. Primaries and secondaries rather thick, the other septa somewhat thinner. The upper margins scarcely project above the upper edge of the wall, those of the first and second cycles slightly the more prominent. The septal faces densely and rather coarsely granulate.

Pali in three crowns, before all septa except the last cycle. Their inner margins lying in the same curve, but the narrowest are before the first cycle, and the widest before the third. In cross-section the pali are cuneiform, the thicker ends outward. Their margins are arched above and entire; faces with sharp elevated striæ broken in places into granulations.

Calicular fossa gradually excavated, moderately deep.

Columella well developed, terminated by rather tall papillæ, which resemble the pali before the primary septa, but stand at a somewhat lower level, therefore the columellar papillæ can be easily differentiated from the pali.

Locality.—North coast of Maui Island, Station 4098; depth, 95–152 fathoms; bottom, coral sand, foraminifera, rock; temperature, 64.8° F.; 1 specimen.

Type.—Cat. No. 20756, U.S.N.M.

PARACYATHUS MOLOKENSIS, new species.

Plate VI, figs. 3, 3*a*, 3*b*.

Corallum attached by a wide base, diameter not increasing with height, transverse outline subcircular. Greater diameter of calice, 6.5 mm.; lesser, 6 mm. The specimen is attached to an irregular surface, giving a height on one side of 5 mm.; on the other, 12 mm. The specimen has the appearance of having been broken and of subsequently having repaired itself.

Wall rather thin, naked. Costæ distinct from the calice to the base, alternating in width and prominence near the calice, the larger rather prominent, about halfway down the smaller disappear and the larger continue subequal to the base. In profile all are rounded and are densely granulated both along the summits and on the sides. Intercostal furrows narrow.

Septa distant, except in the thecal ring, where they stand close together. The arrangement is not very definite; probably the damage that the corallum suffered caused the apparent irregularity. There are fifty-two septa, which seems to occur in six systems, four complete cycles, and a quarter system in each of two systems has the fifth cycle represented. The primaries are slightly thicker and longer than the secondaries; the tertiaries are shorter and thinner than the latter; the last cycle is rudimentary. There are no definite septal groups, although there may be occasional fusion of a tertiary septum to a secondary through its palus. The primaries and secondaries slightly exsert, the others less so, according to the cycle. Margins entire. Faces with very faint ornamentation.

Pali irregular thin teeth, usually occur on the inner ends of the primaries, secondaries, and tertiaries, but they are not always present, especially on the primaries.

Calicular fossa rather deep and large compared to the size of the corallum. Greater diameter, 3 mm.; lesser, 2.5 mm.; depth, 2.5 mm.

Columella rather large, but of very loose texture, composed of anastomosing trabeculæ that send upward irregularly shaped projections, which are scarcely to be distinguished from the pali.

Locality.—South coast of Molokai Island, Station 3833; depth, 88–142 fathoms; bottom, sand, pebbles, broken shells, rock; temperature, 63° F.; 1 specimen.

Type.—Cat. No. 20757, U.S.N.M.

Remarks.—The irregular character and imperfect development of the pali caused me to hesitate to place this species in the genus *Paracyathus*, but its affinities are with that genus, unless it should be a *Parasmilia* with pseudo-pali.

Genus DELTOCYATHUS Milne Edwards and Haime.

DELTOCYATHUS ANDAMANICUS Alcock.

Plate VI, figs. 4, 4*a*.

1898. *Deltocyathus andamanicus* Alcock, Investigator Deep Sea Madrepor., p. 16, pl. I, figs. 5, 5*a*.

Original description.—Alcock describes this species as follows:

Corallum discoid, free, with a small central scar. Costæ, in their distal half, covered with spiniform granules. Those of the first three cycles are indistinct near the scar, but become sharply salient near the circumference; those of the last cycle, which have a ragged appearance owing to the size and abundance of their granules, can be distinguished only near the circumference and are smaller and less salient than those of the other cycles.

Septa and pali profusely ornamented with spiniform granules. The septa are in six systems and four complete cycles, but in some of the half-systems a fifth cycle is developed. The septa of the first cycle are large and exsert, and each, with its palus, remains perfectly independent of all the other septa and pali. The septa of the last cycle are small, independent, and without pali. The septa of the second and third cycles (and those of the fourth, also, in the half-systems in which a fifth cycle occurs) are as large as those of the first, but their pali (which are larger and farther from the center than the pali of the first cycle) soon unite to form "deltas." These "deltas," owing to the size and abundance of their granulation, have a lace-like appearance.

Columella sunken, concave, spongy-papillose.

Color of the living corallum, madder tinted.

Diameter of corallum about 18 mm.

A single specimen, from the Andaman Sea, 172–303 fathoms.

Notes on the Hawaiian specimens.—The measurements of the two specimens obtained by the *Albatross*, 1902, are: (1) diameter, 10 mm.; height, 3 mm.; (2) diameter, 12 mm.; height, 3.5 mm. These specimens are smaller and apparently younger than Alcock's type. The basal scar of detachment is not completely healed, and the costæ can be traced nearer to the center than in the type. The last cycle of septa rather constantly fuse to the sides of the next older cycle. In the smaller specimen some of the youngest septa appear to have free inner margins, but I suspect that this appearance may have been brought about, in some instances at least, by the breaking down of the connection with the older septa. There are four complete cycles, with some members of a fifth.

There are many hundreds of specimens of *Deltocyathus italicus* (Michelotti) in the United States National Museum, and a careful comparison has been made between them and the Hawaiian specimens. No evidence of intergradation was found. The former very constantly has four cycles of septa.

Locality.—West coast of Hawaii Island, Station 4045; depth, 147–198 fathoms; bottom, coral sand, foraminifera; temperature, 49° F.; 2 specimens.

Genus TROCHOCYATHUS Milne Edwards and Haime

The following species bears the same relation to the discoid *Trochocyathi* that *Diaseris* does to *Fungia*.

TROCHOCYATHUS OAHENSIS, new species.

Plate VI, figs. 5, 5*a*, 6, 6*a*.

Corallum small, flat, transversely slightly elliptical.

MEASUREMENTS.

Specimen	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Greater diameter	4	5.5	6	6	7	7
Lesser diameter	3.5	5	5	3.5	5.5	5.5
Height	2	2.5	3	2.5	2.5	3
				(*a*)	(*b*)	(*a*)

[a] New individual being formed at one corner. [b] Ready to divide.

Asexual reproduction seems to take place by one corner of the calice becoming elongated. The projecting portion may be of small diameter, then its diameter increases to almost the size of that of the mother calice. The two calices are subsequently separated by fission.

Wall rather thick. Costæ corresponding to all septa, equal, broad, rounded, and ornamented with minute, crowded granulations.

Septa in specimens Nos. 2 and 3 of the table (which appear to be as large as the specimens usually grow before division begins), 32 in number, i. e., there are three complete cycles and some members of the fourth. Specimen No. 5 has 35 septa in all. The different cycles are not well differentiated; it is practically impossible to distinguish between the first and second cycle. In general the members of the first cycle do not form parts of septal groups, while the members of the third bend toward those of the second. The members of the first and second cycles are of the same size, and when members of the fourth cycle are present the neighboring members of the third equal in size those of the preceding cycles. Around the edge of the calice the septa appear alternately larger and smaller, the last cycle always being smaller and having less prominent margins. Margins of the larger septa moderately exsert; the exsert and inner portions of all septa thin. Septal faces beset with crowded, tall, rather sharp-pointed, slender granulations (really delicate spines).

Pali before all septa, except the last cycle, in one or two crowns, sometimes showing a téndency to unite the septa into deltas, as in *Deltocyathus*. They are rather wide, very thin, and are granulated in the same fashion as the septa.

Columella terminated above by several stout papillæ, whose ends are minutely granulated.

Calice, superficial.

Localities.—West coast of Hawaii Island, Station 4041; depth, 252–283 fathoms; bottom, gray mud, foraminifera; temperature of bottom, 41.6° F.; 10 specimens, 6 of which were selected for the types. Vicinity of Kauai Island, Station 4133; depth, between 41 and 312 fathoms; bottom, fine gray sand, rock; temperature of bottom, 43.8° F.; 1 specimen.

Types.—Cat. No. 20760 U.S.N.M.

Genus CARYOPHYLLIA Lamarck.

CARYOPHYLLIA ALCOCKI, new species.

Plate V, figs. 1, 1*a*, 1*b*.

Corallum compressed, inversely conical, attached by a stout basal stalk.

MEASUREMENTS.

Specimen	No. 1.	No. 2.
	mm.	*mm.*
Greater diameter of calice	29	25
Lesser diameter of calice	23	23.5
Greater diameter of fractured base	8	5
Lesser diameter of fractured base	7	4.5
Height	23	24

These measurements are not made to the outer and the upper edges of the septa, but on the wall.

Wall polished, glistening. Costæ distinct, but not very prominent, those corresponding to the first and second cycles of septa more pronounced than the others and may be subacute; those corresponding to the third cycle often larger than those corresponding to the fourth.

Septa in four complete cycles. The margins of the first and second cycles very exsert, equal in prominence; the quaternaries fused in the thecal ring to the sides of the included member of the first or second cycle, the wall between them being continued upward considerably beyond its upper edge on each side of the members of the third. The margins of the septa of the fourth cycle therefore stand much higher than those of the third cycle. Between the quaternaries are incisions in the upper edge of the wall, and in these the tertiaries occur. The primaries and secondaries are equal in size, longer, wider, and thicker in the thecal ring, than the others; the fourth cycle is wider than the third, but these two cycles are of about equal length. The inner portion of all the septa and the upper portion of all except the third cycle are very thin and fragile.

Pali in a single crown, before the third cycle. They are tall, wide, very thin and fragile, and are undulated.

Columella well developed, prominent, consisting of four or more curled ribbons.

Calice shallow.

Locality.—Vicinity of Modu Manu, Station 3977; depth 876 fathoms; bottom, fine coral sand, foraminafera, rock; temperature of bottom, 38° F.

Type.—Cat. No. 20744, U.S.N.M.

I have named this very handsome species for Dr. A. Alcock, Superintendent of the Indian Museum and Professor of Zoology and Comparative Anatomy in the Medical College of Calcutta. Dr. Alcock's reports on the *Investigator* and *Siboga* deep sea corals are among the most valuable contributions that have been made to the subject. The present species bears a general, though apparently not close, resemblance to *Caryophyllia cultrifera* Alcock.[a]

CARYOPHYLLIA OCTOPALI, new species.

Plate V, figs. 2, 2*a*, 2*b*.

Corallum cornute, attached by a wide basal expansion. The specimen especially selected for the type is so crooked that a longitudinal measurement possesses no value. The calice is almost circular; greater diameter, 7 mm., lesser, 6.5 mm. Externally there are usually very low, broad, flattish, equal, granulated costæ. corresponding to all septa. Encircling wrinkles sometimes present, and occasionally there seems to be some epitheca. Wall stout.

The septa appear to be in eight systems of three cycles each.[b] Upper margins not exsert, those of the primaries slightly more prominent than those of the two

[a] Siboga Deep Sea Cor., p. 7, pl. I, figs. 1, 1*a*.

[b] In the description eight, for convenience, is considered the number of septa in the first cycle.

higher cycles. The outer ends of the septa are thick, becoming thinner toward the center, the first cycle of septa slightly longer than the third, and the third slightly longer than the second. The septal faces exhibit undulations coinciding with the courses of the septal trabeculæ and have granulations along their crests. The granulations are numerous, crowded, and prominent.

There are eight rather large, stout, undulated, and granulated pali, standing before the septa of the third cycle.

The columella consists of several, three to five, more or less twisted laths.

Calice shallow.

Localities.—South coast of Molokai Island: Station 3827, depth 319 to 371 fathoms; bottom, light gray-brown mud; temperature of bottom, 42.1° F. (two specimens, one attached to the other). Station 3828, depth 281 to 319 fathoms; bottom, broken-shell, gravel; temperature of bottom, 43.8° F. (one specimen, the type).

Type.—Cat. No. 20746, U.S.N.M.

Remarks.—This species is based on three specimens. The type has been broken from its attachment, but has the basal expansion preserved, one of the other specimens is attached to the third. The character of these specimens is very constant, but shows variation in the number and size of the columellar laths. They are very closely related to *Caryophyllia cornuformis* Pourtalès, from the West Indies, of which there is in the United States National Museum one specimen with seven well-developed and one rudimentary palus. In size and general appearance the two species are scarcely distinguishable. A difference, probably of no great value, is that *C. octopali* has a more expanded base than *C. cornuformis*. There seems to be good differences in the septal characters: In *C. octopali* the last cycle of septa are persistently as long as, or longer than those of the preceding cycle, and the inner ends of the second cycle are not thickened. In *C. cornuformis* the last cycle of septa are persistently shorter than those of the preceding cycle; the inner ends of the septa, before which the pali stand, are thickened, the septa are not so crowded, the margins of the first and second cycles are more exsert, and the septal faces are not so densely granulated.

CARYOPHYLLIA OCTOPALI var. INCERTA, new variety.

Plate V, figs. 3, 3*a*.

This variety is separated from the typical *octopali* by the exsert septa of the first cycle, which projects fully 1 mm. beyond the upper edge of the corallum wall. The pali are six or seven in number, not eight, as in typical *octopali*. The septal lengths are as in *octopali*.

This variety is represented by a cluster of individuals growing attached to one another by their bases.

Locality.—South coast of Molokai Island, Station 3827; depth, 319 to 371 fathoms; bottom, light gray-brown mud; temperature of bottom, 42.1° F.

Type.—Cat. No. 20748, U.S.N.M.

CARYOPHYLLIA HAWAIIENSIS, new species.

Plate V, figs. 4, *4a*, *4b*.

Corallum attached by an expanded base, gradually increasing in diameter toward the calice. Calice broadly elliptical.

MEASUREMENTS.

Specimen	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*
Greater diameter of calice	6	7	9	9
Lesser diameter of calice	5	6	7.5	8
Height	11.5	15	20	18
Number of pali	10	10	10	11

The wall externally is shiny and covered with numerous small granulations. Small individuals and the lower portion of large specimens are without costæ, but in older, adult, specimens, distinct but not prominent costæ correspond to the largest septa; between these, smaller costæ may be present.

The septa in fully grown individuals appear to be divided into ten or eleven systems of three cycles each. It is not possible to differentiate the primary six septa from the four or five large members of the second cycle. The ten or eleven principal septa have very prominent upper margins, which may project 1.5 mm. above the upper edge of the wall. The margins of the members of the last cycle are about half as high as those of the principal septa; the next to the last cycle are not so prominent as the last. The septal faces are delicately fluted, and inconspicuous granulations are numerous.

Pali ten or eleven in number, thin, delicate, erect, moderately wide, fluted, and granulated; in a single crown before the penultimate cycle of septa.

Columella rather small, composed of several curled ribbons.

Calicular fossa only moderately deep.

Localities.—South coast of Molokai Island, Station 3838; depth, not precisely given, 92–212 fathoms; bottom, fine gray brown sand; temperature of the bottom, 67° F.

Northeast coast of Hawaii Island, Station 4061; depth, 24–83 fathoms; bottom coral sand, corallines, nodules, foraminifera; temperature at surface, 77° F., 1 specimen.

Pailolo Channel, between Maui and Molokai islands, Station 3885; depth, 136–148 fathoms; bottom, sand, pebbles; temperature, 64.8° F.; 1 specimen.

Cotypes.—Four specimens, Cat. Nos. 20749, 20750, U.S.N.M.

Remarks.—This species is closely related to Alcock's *Caryophyllia quadragenaria.*[a] The principal difference seems to be in the much more developed costæ of the latter species. It is not improbable that the species here described may later be placed in the synonymy of *C. quadragenaria.*

[a] Deep Sea Corals, Siboga Expedition, p. 10, pl. I, figs. 4, 4a.

Genus CYATHOCERAS Moseley.

CYATHOCERAS DIOMEDEÆ, new species.

Plate VII, figs. 1, 1*a*, 2, 2*a*, 2*b*.

Corallum tall, lower portion a thick, elongate, curved or straight stalk, rising above an expanded base, upper portion enlarging rapidly. Transverse outline of calice elliptical or oval, usually more or less deformed.

MEASUREMENTS.

Specimen No.	Greater diameter of calice.[a]	Lesser diameter of calice.[a]	Diameter of stalk.	Height of corallum.[a]	Number of septa.	Number of principal septa.
	mm.	*mm.*	*mm.*	*mm.*		
1	16	13	4	24	82	12
2	20	15	5	33	86	12
3	26	20	6	36	90	12
4	31	22	7.5	44	96	12
5	35	30	8	45	94	12

[a] Diameters of calices measured to outer edges of the costæ; height measured to upper edges of septa.

Corallum wall rather thick. Costæ prominent around the calice, corresponding to all septa except those of the last cycle; in some specimens they may be prominent for some distance below the calice, in others they soon become very low. Low, flat, or rounded costæ extend to the base. The whole outer surface of the corallum is closely granulated, the granulation on the lower portion usually arranged transversely to the costæ.

Septa in adult specimens in five complete cycles, or only a few members of the fifth absent. The primaries and secondaries are of equal size, extend to the columella, and, except in young individuals, have very exsert margins; the tertiaries are smaller, are not quite so long, and not so exsert; the quaternaries still smaller, the quinaries the smallest, but even these are moderately exsert. The members of the last cycle are nearer to the outer septa of any quarter system than to the quaternary which they include, and are partially fused to the sides of the larger septa. Sometimes the margins of the quaternaries are higher than those of the quinaries, sometimes those of the quinaries are the taller. In young specimens the septa are crowded, in older individuals rather distant. Inner margins of the larger septa transversely undulate. The septal faces show faint striations, with the line of divergence at inner edge of wall. The granulations on the faces are not very numerous, usually low and rounded.

Calicular fossa moderately deep. Columella well developed, large, compressed, prominent, composed of numerous curled ribbons.

Localities.—South coast of Molokai Island, Station 3835; depth, 169–182 fathoms; bottom, fine brown sand, mud; temperature, 55° F.; 2 specimens, Nos. 3 and 4 of table.

Pailolo Channel, between Molokai and Maui islands, Station 3863; depth, 127–154 fathoms; bottom, broken coral, coarse gravel, rock; temperature, 60° to 61° F.; 1 specimen.

?Vicinity of Laysan Island, Station 3952; depth, 347–351 fathoms; bottom, white sand, gravel; temperature, 45° F.; 1 specimen, No. 5 of table, the finest obtained.

Vicinity of Kauai Island, Station 3999; depth, 7–148 fathoms; bottom, coral sand, shells; 2 specimens, Nos. 1 and 2 of table.

South coast of Oahu Island, Station 3810; depth, 53–211 fathoms; bottom, fine coral sand; temperature, 47.7° F.; 1 specimen.

Northwest coast of Oahu Island, Station 4115; depth 195–241 fathoms; bottom, coral sand, foraminifera; temperature, 55.1° F.; 1 specimen, dead.

The range in depth of this species appears to be from 127 to 351 fathoms; temperature, 45° to 61° F.; bottom, sandy, gravel or rock.

Type.—Cat. No. 20735, U.S.N.M.

Remarks.—Four species of *Cyathoceras* have previously been described, two by Moseley, *C. cornu* and *C. rubescens*, in the *Challenger* Deep Sea Corals, 1881; one, *C. portoricensis*, by myself in my report on the Stony Corals of the Porto Rican Waters, 1901; and one, *C. tydemani*, by Alcock in the *Siboga* Deep Sea Madreporaria, 1902. The form above described is most closely related to Moseley's *C. rubescens;* in fact, I hesitated to separate it from that species. Moseley says that the surface of *C. rubescens* is "glistening, but slightly roughened." The surface of the Hawaiian specimens is not glistening, and is granulated all over. The character of the surface may be variable, but it is constant in the eight specimens examined by me. There may be other differences not brought out by Moseley's description.

Genus CERATOTROCHUS Milne Edwards and Haime.

CERATOTROCHUS LAXUS, new species.

Plate VII, figs. 4, 4*a*, 4*b*.

Corallum short-cornute, attached by an expanded base, above which is a short, rather thick peduncle. Above this the corallum gradually increases in diameter with increasing height. Calice subcircular in outline. Greater diameter of calice 7 mm.; lesser 6.5 mm.; diameter of peduncle 3 mm.; height of peduncle about 2.5 mm.; height of corallum 11.5 mm.

Wall only moderately thick, naked. Flat, low, densely granulate, equal costæ correspond to all septa just below the calicular edge, and can be more or less distinctly traced farther down on the corallum by the granulations. The granulations are rather often arranged transversely to the longitudinal axes of the costæ.

Septa in three complete cycles, and members of the fourth cycle present five half systems, 34 septa in all. The members of the first are the largest, those of the other cycles smaller, according to the cycle, the youngest cycle of any half system almost rudimentary. The first and second cycles have slightly exsert margins, the margins of the third and fourth not prominent. Outer ends of the septa somewhat thickened, inner portions thin and delicate. Interseptal loculi very open. Septal faces beset with irregular, low granulations.

Columella very poorly developed, composed of two very thin, more or less contorted ribbons.

Calicular fossa deep, narrow, bounded by the perpendicular inner ends of the first cycle of septa.

Locality.—South coast of Molokai Islands, Station 3827; depth, 319–371 fathoms; bottom, light gray brown mud; temperature of bottom, 42.1° F. (1 specimen.)

Type.—Cat. No. 20764, U.S.N.M.

Remarks.—This species is especially characterized by the very poorly developed columella and its much expanded base.

Family ANTHEMIPHYLLIIDÆ, new family.

Type-genus.—*Anthemiphyllia* Pourtalès.

Diagnosis.—Corallum with imperforate tissues, simple.

Septal margins with long teeth. Interseptal loculi open.

Remarks.—The little genus *Anthemiphyllia* has puzzled every student of the classification of corals since Pourtalès first described it.[a] It looks at first sight like a disc-shaped trochocyathoid coral, but the long, septal teeth immediately show that it is not closely related to the Caryophylliid genera. It then recalls some of the species referred to *Antillia* or *Syzygophyllia.* The septal margins of *Antillia* are dentate, but the dentations are low, small, and rounded; while those of *Syzygophyllia* are large and coarse like saw teeth; furthermore, both of these genera have highly developed endotheca and some exotheca. I do not know another genus of corals that has the wall and interseptal loculi of the Caryophylliidæ and septal margins with long dentations. I am therefore proposing the family Anthemiphylliidæ, which at present contains only the type genus.

Genus ANTHEMIPHYLLIA Pourtalès.

ANTHEMIPHYLLIA PACIFICA, new species.

Plate VII, figs. 5, 5*a*.

Corallum small, bowl-shaped, base rounded, showing by a scar former attachment. Cross-section circular. Diameter, 8.5 mm.; height, 3.5 mm.

There are shreds of an incomplete epitheca. The wall is externally costate, but the costæ are not large, those corresponding to the first and second cycles of septa slightly more prominent than those corresponding to the third and fourth.

Septa distant, with open interseptal loculi, in four complete cycles, those of the first and second cycles equal in size and with moderately exsert margins; the tertiaries are less prominent; the quaternaries the least prominent. There are distinct septal groups. The primaries are free; the tertiaries fuse near the columella to the secondaries; the inner ends of the quaternaries appear to be free. The septal margins are very spinulose, the spines tall, with rounded summits. The diameter of the spines is greater parallel to the septal faces than transverse to them. There are granulations both on the septal faces proper and on the spines.

Columella somewhat sunken, not large, upper surface papillate.

Calicular fossa not deep, calice shallow, or superficial.

[a] Bull. Mus. Comp. Zool., V, 1878, p. 205, pl. I, figs. 14, 15.

Localities.—South coast of Molokai Island: Station 3838; depth, 92–212 fathoms; bottom, fine gray-brown sand; temperature of the bottom, 67° F. Station 3855; depth, 127–130 fathoms; bottom, fine brown sand, gravel; temperature, 65.5° F.; 1 specimen.

Pailolo Channel, between Molokai and Maui islands: Station 3856; depth, 127 fathoms; bottom, fine sand, yellow mud; temperature, 66.5° F.; 1 specimen. Station 3857; depth, 127–128 fathoms; bottom, fine sand, yellow mud; temperature, 62.5° F.; 1 specimen. Station 3858; depth, 128 fathoms; bottom, fine sand, yellow mud; temperature, 61.5° to 61.8° F.; 1 specimen (type).

Type.—Cat. No. 20765, U.S.N.M.

Remarks.—This species is decidedly different in minor characters from *Anthemiphyllia patera* Pourtalès from the Antillean seas. *A. pacifica* has thinner septa, the septal spines are not compressed transversely to the plane of the septal faces, and there is not that compacting of the columella and inner ends of the septa by secondary calcareous deposit which at least often occurs in *A. patera*. The number of septa is about the same. Septal grouping is not so distinct in *A. patera*. The two species, however, seem to be very closely related. Pourtalès's species was dredged off Havana in from 250 to 400 fathoms of water.

The *Albatross* obtained five specimens of *A. pacifica*. There is practically no difference between the specimen from Station 3856 and the type, except that the former has a diameter of 9.5 mm. and there are two septa of a fifth cycle. The specimen from Station 3857 was attached to a *Glycymeris* (*Pectunculus*) shell. Its base is not uniformly rounded, there being two constrictions, indicating intermittent growth. The calice of this specimen is 9.5 mm. in diameter and the corallum 6.5 mm. tall.

Family OCULINIDÆ Milne Edwards and Haime.

Genus MADREPORA Linnæus.

1758. *Madrepora* (part) LINNÆUS, Syst. Nat., 10th ed., p. 793, and of various writers before 1801.
1815. *Matrepora* (part) OKEN, Lehrb. Naturg., p. 72.
1816. *Oculina* (part) LAMARCK, Hist. Nat. Anim. sans Vert., II, p. 283.
1849. *Lophelia* MILNE EDWARDS and HAIME, Comptes rendus, XXIX, p. 69.
1849. *Amphelia* MILNE EDWARDS and HAIME, Comptes rendus, XXIX, p. 69.
1850. *Diphelia* MILNE EDWARDS and HAIME, Brit. Foss. Corals, Introd., p. XXI.
1857. *Lophohelia* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 116.
1857. *Amphihelia* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 118.
1857. *Diplohelia* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 120.
1902. *Madrepora* VERRILL, Trans. Conn. Acad. Sci., XI, p. 110 (with Synonymy).

Not *Madrepora* LAMARCK, 1801, nor of subsequent authors, excepting Oken, 1815, and Verrill, 1902.

Brook pointed out in his catalogue of the genus *Madrepora*[a] that the *Madrepora* of authors beginning with Lamarck, 1801, was not originally included by Linnæus in that genus, but in *Millepora*. In the twelfth edition of the Systema Naturæ, Linnæus corrected the error of the tenth edition, transferring *Millepora muricata* to *Madrepora*. Lamarck in 1801, when he undertook the first subdivision of the Linnæan *Madrepora*, unfortunately selected *Madrepora muricata* for the type of the genus as restricted by him. Although Brook knew this history of the usage of

[a] Cat. Madrepor., Brit. Mus. (Nat. Hist.), I, 1893.

the name, and also knew that it was against the rules of nomenclature to make a species inserted into a genus subsequent to its original characterization the type-species, he decided to follow the usage established by Lamarck, Dana, Milne Edwards and Haime, and Duncan. In my Some Fossil Corals from Curaçao, Arube and Bonaire[a], I abandoned this use of the name and proposed substituting *Isopora*, Studer, 1878, but did not attempt to fix the type of the Linnæan *Madrepora*. Professor Verrill[b] pointed out that *Acropora* Oken, 1815, must be used for the Lamarckian *Madrepora*, and that following Oken's restriction of the Linnæan *Madrepora*, either *M. prolifera* or *M. oculata*, both of Linnæus, could become the genotype. For several reasons preference is given to *M. oculata*. Therefore *Madrepora oculata* Linnæus becomes the type of *Madrepora* Linnæus.

MADREPORA KAUAIENSIS, new species.

Plate VIII, figs. 1, 2, 2*a*.

Corallum with delicate branches. Asexual reproduction by budding from below the edge of the calice; rather often on each side of a calice, leaving the mother calice more or less immersed in the angle between the daughter calices. Such a sunken calice always occurs in the axis between two branches. When no bifurcation takes place gemmation is alternate, forming a row of calices on each side of the branch. Terminal calices are prominent, as much as 3.5 mm. in height, the corallite gradually enlarging toward the aperture. The lateral calices on young branches are moderately prominent; on older branches the cœnenchyma may extend upward and leave only a small portion of the corallites free.

Around the upper outer margins of young corallites there are distinct, often acute, costæ. Farther down on the wall they are low, but can be traced. They are minutely and densely granulated. On older portions of the corallum these costæ can not be traced, but flexuous, often coarse, cœnenchymal striations are present. The whole cœnenchymal surface is minutely granulated.

Septa in older calices in three complete cycles, the third cycle well developed; in young calices the last cycle is rudimentary, but traces of it can be seen; septal margins entire. The young calices are very deep, but the older ones are shallow, *the bottoms of the calices becoming solidly filled with stereoplasm.*

Columella very poorly developed in young calices, consisting of a few trabeculæ, which appear to be derived from the inner ends of the septa. The upper surface is usually papillate. In older calices it is much better developed and may be considerably compacted by calcareous deposit. A few outstanding papillæ often simulate pali.

Locality.—Vicinity of Kauai Island, Station 4136; depth, 294–352 fathoms; bottom, fine coral sand; temperature, 44.2° F.

Type.—Cat. No. 20780, U.S.N.M.

Remarks.—Duncan in his first paper on the *Porcupine* Expedition Madreporaria[c]

[a] Samml. Geolog. Reichs-Mus., Leiden, 2d Ser., II, Hft. I, p. 68.

[b] Trans. Conn. Acad. Sci., XI, 1902, p. 110.

[c] Proc. Roy. Soc. London, XVIII, 1870, p. 295.

identified from that collection *Amphihelia miocenica* Seguenza, *A. atlantica*, new species, and *A. ornata*, new species. In his second paper on these corals[a] he refers these three names and *Diplohelia profunda* Pourtalès[b] + *D. meneghiniana* + *döderleiniana* + *sismondiana* Seguenza[c] to the synonymy of *Madrepora ramea* Müller, basing this determination upon "a specimen of the *Madrepora ramea* of Müller, from off the Norwegian coast, found in moderately deep water," sent him by M. Sars. Lindström in his Contributions to the Actinology of the Atlantic Ocean[d] identifies a fragment of coral from off Salt Island as "*Amphihelia ramea* O. F. Mueller p. p." Alcock in his Deep Sea Madreporaria of the Siboga Expedition, p. 35, lists some "fine specimens" as "*A. ramea* Mueller sp."

In this connection the availability of the specific name *ramea* should be considered. O. F. Müller in his Zoologiæ Danicæ Prodromus, 1776, p. 252, cites under *Madrepora*, *M. ramea*, and credits it to Linnæus, Systema Naturæ, 12th edition, 1767. The *Madrepora ramea* Linnæus, 1758, is according to subsequent authorities the *Dendrophyllia ramea* (Linnæus) Blainville, of the Mediterranean. Linnæus in his original description of *Madrepora ramea* refers to two previously published figures, one by Petiver which I have not seen, the other by Marsigli,[e] which I have seen. The latter reference is given by Milne Edwards and Haime in their synonymy of the species, and represents the common *Dendrophyllia ramea*. There is no reason to doubt the correctness of the identification of Pallas, Ellis and Solander, and Milne Edwards and Haime. It seems that Müller never proposed *Madrepora ramea* as a new specific name. If he had, his name would be a homonym of the previously established *Madrepora ramea* Linnæus, and therefore invalid.[f]

The *Diplohelia profunda* Pourtalès is an Eupsammid coral and not a *Diplohelia*, as Pourtalès himself discovered and published in 1878. Should the other forms cited by Duncan under the synonymy of *Diplohelia ramea* really belong together, as he contends, the name would be *Madrepora miocenica* (Seguenza), but Duncan's discussion of the forms is not satisfactory, and until someone carefully studies the *Porcupine* collection and makes comparisons with Italian Tertiary material, it is not possible to reach any decision regarding the affinities of the recent species to those from the Tertiaries of Italy.

Duncan in his article in the eighth volume of the Transactions of the Zoological Society of London, redefines the genus *Amphihelia*, stating that "the corallites do not fill up from below." I have looked the matter up on specimens of *A. oculata* and find that the corallite cavities in their lower portion may be practically obliterated by stereoplasmic deposit.

The coral that I am here denominating *Madrepora kauaiensis* apparently differs from the material that Duncan had by having the bottoms of the corallite cavities

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[a] Trans. Zool. Soc. London, VIII, 1873, p. 326.

[b] Bull. Mus. Comp. Zool., I, No. 6, 1867, p. 114; Mem. Mus. Comp. Zool., II, Illustr. Cat., No. 4, 1871, p. 25, pl. VI, figs. 6, 7; *Dendrophyllia profunda* Pourtalès, Bull. Mus. Comp. Zool., V, No. 9, 1878, p. 208, pl. I, figs. 6–8.

[c] Corall. Foss. Terziar Dist. Messina, Pt. 2, Torino, 1874, pp. 101–105, fig. on plate XII.

[d] Svensk. Vet. Akad. Handl., XIV, No. 6, 1877, p. 14.

[e] Histoire Physique de la Mer, 1825, pl. XXX, fig. 136, and pl. XXXI, fig. 144.

[f] Marenzeller publishes this same conclusion. Stein-Korallen, Valdivia Expedition, p. 308.

solidly filled. Whether this character is or is not of value I can not determine. However, I believe that by pointing out the tremendous confusion in Duncan's work and by attaching a name to something definite, a start may be made toward unraveling the tangle of the "*Amphiheliæ*" (*Madreporæ*) *striatæ*.

Family STYLOPHORIDÆ Verrill.

Genus MADRACIS Milne Edwards and Haime.

MADRACIS KAUAIENSIS, new species.

Plate IX, figs. 1, 2, 2*a*, 3.

Corallum ramose, branches slender, coalescing abundantly, tips attenuate. The longest branch in the type material is 92 mm. long (tip broken off); diameter at lower end, 6 mm.; diameter about the middle, 6 mm.; of broken upper end, 3 mm. Length of one young branch, 22 mm.; diameter of lower end, 3 mm.; at tip, 1.5 mm. In cross section the branches are subcircular or slightly flattened. The angle of divergence of branches at points of bifurcation is very variable, from decidedly acute angle to almost 180°.

Calices shallow, diameter from 1 to 1.5 mm. On the very tips of the young branches they are crowded, but immediately below the tips they are rather distant, separated by about the diameter of a calice; on older portions of the corallum they are still more distant, from once to twice the diameter of a calice. The calices are not elevated and there is no projecting thecal rim.

There are ten principal septa, which extend from the wall to the columella. They are moderately exsert, rather thick, and form a crown around the calicular opening. Between each pair of principal septa a rudimentary septum can usually be seen. There are costæ corresponding to both the large and the small septa.

The coenenchyma is very dense. There are twenty costæ around each calice, as above noted. Outside of the costate area are rather coarse granulations, often so arranged as to appear to be continuations of the costæ.

Columella very large, filling the bottom of the calicular cavity. Its upper surface may rise toward the center and form a dome, or there may be a thick rounded style in the center.

Localities.—South coast of Molokai Island: Station 3833; depth, 88–142 fathoms; bottom, sand, pebbles, broken shells, rock; temperature of bottom, 63° F. Station 3838; depth, 92–212 fathoms; bottom, fine gray-brown sand; temperature of bottom, 67° F.

Vicinity of Kauai Island: Station 3982; depth, 40–233 fathoms; bottom, coarse broken coral, sand, shells; temperature of bottom, 48.5° F. [cotypes]. Station 4135; depth, 225–294 fathoms; bottom, fine coral sand; temperature of bottom, 51.4° F.

Northeast coast of Hawaii Island: Station 4061; depth, 24–83 fathoms; bottom, coral sand, coralline nodules, foraminifera.

Cotypes.—Cat. No. 20769, U.S.N.M.

Remarks.—This species is very closely related to *Madracis mirabilis* (Duchassaing and Michelotti) from the West Indies. The most important differences seem to be that in *M. mirabilis* the calices are bounded by a short thecal rim which projects above the coenenchyma and is especially noticeable on the young branches. I have not seen it on any specimen of *M. kauaiensis*. The septal margins in *M. mirabilis* are much more exsert than in the Hawaiian species, and it presents a decidedly smoother aspect than *mirabilis*.

M. kauaiensis shows a considerable amount of variation. The types, five specimens, counting fragments, Station 3982, were selected from a rather large amount of material, which may all belong to one colony. These specimens are rather constant. The calices vary in size as expressed in the description, and sometimes they are sunken or they may occasionally be somewhat swollen around the base. The specimens from Station 3838 have the calices rather constantly swollen at the base, but they are not prominent and there is no elevated thecal rim.

Some of the specimens from Station 3833 apparently should be varietally separated from the other specimens.

MADRACIS KAUAIENSIS var. MACROCALYX, new variety.

Plate IX, figs. 4, 4*a*.

This variety usually has larger calices than typical specimens of the species, the diameter is frequently as much as 2 mm. and sometimes may be 2.5 mm. The calices may be swollen at the base, sometimes are elevated; they are also often crowded. The secondary septa may be very well developed.

These specimens are only aberrant individuals of *M. kauaiensis*, as every intermediate variation is in the collection.

Locality.—South coast of Molokai Island, Station 3833; depth, 88–142 fathoms; bottom, sand, pebbles, broken shells, rock; temperature of bottom, 63° F.

Type.—Cat. No. 20777, U.S.N.M.

Family POCILLOPORIDÆ Verrill.

Genus POCILLOPORA Lamarck.

Including the specimens collected by the *Albatross* expedition of 1902 and specimens received from Prof. W. T. Brigham, of the Bishop Memorial Museum of Honolulu, there are in the United States National Museum over 75 specimens of *Pocillopora* from the Hawaiian Islands. In addition to this material, I have, through the courtesy of Professor Verrill, been able to study the collection belonging to Yale University, and he has generously let the United States National Museum have fragments of those species not previously represented in it. In making comparisons with species from the Panamic, South Pacific, and Indian Ocean regions I have utilized the old collections of the United States National Museum, which possesses most of Dana's types, and the *Albatross* collections of 1899–1900 and 1904–5. I have therefore been able to study many hundreds of specimens.

Professor Dana, in his Zoophytes of the Wilkes Exploring Expedition, reported the following species of *Pocillopora* from Hawaiian Islands:

P. cespitosa Dana, described from the Sandwich Islands.
P. brevicornis Lamarck, reported from the Sandwich Islands.
P. favosa Ehrenberg, reported from the Sandwich Islands.
P. verrucosa (Ellis and Solander), reported from the Sandwich Islands.
P. ligulata Dana, described from the Sandwich Islands.
P. meandrina Dana, described from the Sandwich Islands.
P. plicata Dana, described from the Sandwich Islands and the Fijis.
P. informis Dana, described from the Sandwich Islands.

Professor Verrill, in his Polyps and Corals of the North Pacific Exploring Expedition, 1869, revised the Hawaiian species of *Pocillopora*. He placed Dana's *P. brevicornis* from there with *P. cespitosa*. For the specimens of Dana's *P. favosa* and *P. plicata* from the Hawaiian Islands he proposed the name *P. aspera*. For Dana's *P. verrucosa*, from the same locality, he had proposed *P. nobilis* in 1864. The names of the Hawaiian species of this genus, according to Verrill, then were:

P. cæspitosa Dana.
P. aspera Verrill.
P. nobilis Verrill.
P. ligulata Dana.
P. meandrina Dana.
P. informis Dana.
P. frondosa Verrill, described as new.

Quelch in his *Challenger* Report, 1886, again reports *P. verrucosa* Lamarck from the reefs at Honolulu and recombines Verrill's *P. aspera* with *P. plicata* Dana.

In the present memoir seven species of *Pocillopora*, two of which are described as new, and five varieties are recognized from the Hawaiian Islands. The revised list of the species and varieties of the genus is as follows:

P. cespitosa Dana. A.
P. cespitosa var. *tumida*, new variety.
P. cespitosa var. *laysanensis*, new variety. A.
P. cespitosa var. *stylophoroides*, new variety. A.
P. molokensis, new species. A.
P. modumanensis, new species. A.
P. ligulata Dana (+ *P. aspera* Verrill). A.
P. frondosa Verrill.
P. meandrina Dana (+ *nobilis* Verrill). A.
P. meandrina var. *nobilis* Verrill. A.
P. meandrina var. *tuberosa* Verrill. A.
P. informis Dana.

The species whose names are followed by an "A" were collected by the *Albatross*. Every species is represented in the United States National Museum.

SYNOPSIS OF THE HAWAIIAN SPECIES AND VARIETIES OF POCILLOPORA.

Corallum forming small clumps (less than 15 cm. in diameter), septa and columella variable in development .... 1. *P. cespitosa*.
Branchlets slender, clumps uniformly rounded above, septa rudimentary or obsolete, no columellar style; calices, 1 mm. in diameter .... 1*a*. *P. cespitosa* (typical).
Branchlets short, with swollen ends; septa and columella rudimentary or obsolete; calices, 0.4 to 0.8 mm. in diameter .... 1*b*. *P. cespitosa* var. *tumida*.
Branchlets terete or flattened, clumps irregular in shape; septa and columella variable in development; calices, 0.4 to 0.5 mm. in diameter .... 1*c*. *P. cespitosa* var. *laysanensis*.
Branches compressed, branchlets often verruciform; septa and columella distinct; calices, 0.6 to 0.8 mm. in diameter .... 1*d*. *P. cespitosa* var. *stylophoroides*.
Corallum forming rather large, bushy clumps, branches subterete, bending outward.
Septa and columella obsolete or rudimentary.
Verrucæ obsolete below, irregularly developed on and near the ends of the branches
2. *P. molokensis*.

Corallum forming rather large clumps (15 cm. or more in diameter); branches compressed, separate.
Septa well developed.
Columella styloid.
Verrucæ perpendicular to surface of branches and uniformly distributed .... 3. *P. modumanensis.*
Verrucæ appressed, often forming carinæ, irregularly distributed........ 4. *P. ligulata.*
Verrucæ obsolete.. 5. *P. frondosa.*
Septa rudimentary or obsolete, columella absent or a central compressed dome.
Verrucæ, usually uniformly distributed, regular or rather regular in size.... 6. *P. meandrina.*
Branches meandroid, summits naked........................ 6*a*. *P. meandrina* typical.
Branches compressed, summits verrucose.................. 6*b*. *P. meandrina* var. *nobilis.*
Branches with distally swollen verrucæ.................. 6*c*. *P. meandrina* var. *tuberosa.*
Corallum glomerate-cespitose, massive at base, with irregularly flattened and compressed branches above. Septa obsolete, columella styloid .... 7. *P. informis.*

1. POCILLOPORA CESPITOSA Dana.

Plate X, figs. 1, 1*a*, 2, 2*a*; Plate XI, figs. 1, 2 (typical form).

1846. *Pocillopora cespitosa* DANA, Zooph. Wilkes Expl. Exped., p. 525, pl. XLIX, figs. 5, 5*a*.
1846. *Pocillopora brevicornis* (part) DANA, Zooph. Wilkes Expl. Exped., p. 526.
1860. *Pocillopora cespitosa* MILNE EDWARDS, Hist. Nat. Corall., III, p. 303.
1869. *Pocillopora cæspitosa* VERRILL, Proc. Essex. Inst., VI, p. 91.
1886. *Pocillopora cespitosa* QUELCH, Reef Corals, Challenger Repts., p. 66.
1901. *Pocillopora cæspitosa* STUDER, Zool. Jahrb., Syst., XL, p. 399.

Original description.—This is as follows:

Low and even-topped cespitose, much and crowdedly branched, branches much shorter than in the *acuta*, tortuous, 2 to 3 lines thick, and stouter at base; summit branchlets verruciform, 2 lines long, and often subacervate. Corallum having the cells large (½ a line broad), and without star or columella.

* * * * * * *

The clumps are neat, low-convex, and much branched; the branches are crowded to within one-third to half an inch of one another, and are mostly a fourth of an inch or less in thickness. The cell is large and shallow, and has a flat bottom; those low on the stem are rather distant, and a delicate line may be traced around them, as in some Seriatoporæ. The species most resembles the *damicornis*, of which I had considered it a dwarf variety; but it is a much neater and more slender species, and has larger cells.

As this species shows a bewildering amount of variation, apparently its characters can be best expressed by describing the typical specimens and then indicating the lines along which variation takes place. In addition to the typical form, three varieties are recognized. After describing these and showing how they intergrade, an attempt will be made to point out the characters that bind all together.

1 a. POCILLOPORA CESPITOSA (typical).

Plate X, figs. 1, 1*a*, 2, 2*a*; Plate XI, figs. 1, 2.

I am referring 21 specimens to typical *P. cespitosa*, although they show considerable variation. Of these specimens, 2 are original specimens of Dana, 7 had subsequently been added to the United States National Museum collections, 7 were collected by the *Albatross* in 1902, and 5 were sent me by Dr. W. T. Brigham.

The general form of the colony is as Dana described it. However, the distance apart and the attenuateness of the summit branchlets varies considerably. In one specimen, No. 2184,[a] some of these may be nearly 1 cm. long and 3 mm. in diameter.

[a] These numbers refer to United States National Museum Catalogue.

They are numerous and crowded. Specimen No. 681 (one of Dana's originals, which bore the name *P. damicornis* ?) has the ends of the main stems not so profusely branched, and the summit branchlets more distant, shorter, and thicker. Specimen No. 2186 has still thicker branches, and their terminals are sometimes swollen. Two specimens, No. 722 (one of Dana's specimens) and No. 2186, are figured to show this variation, Plate X, figs. 1, 1*a*, 2, 2*a*; the intermediate specimens are not figured.

The calices are rather large, about 1 mm. in diameter; they may be a small fraction more or less. They are with rare exceptions crowded, the walls between them being less than their diameter. The septa are only poorly developed or may be obsolete; the columella is a low, elongated or rounded, granulated dome. A number of the calices show distinct bilaterality, as the septa at their opposite ends are more developed and connect in the bottom with the columella. The surface of the cœnenchyma is covered with small, pointed granulations.

Two of the specimens collected by the *Albatross* expedition of 1902 are figured, Plate XI, figs. 1, 2. The calices of these specimens average smaller than in the type material, and the septa in the calices near the ends of the branches are somewhat more developed.

Localities.—Reef at Honolulu, 1 small, young specimen; reef at Kaunakakai, Molokai Island, 4 specimens; Hawaiian Islands, no definite locality, 2 small young specimens; collection U. S. Fish Commission steamer *Albatross*, Hawaiian Islands. No definite locality, 9 specimens; United States National Museum collections. Kahana, Oahu, 3 specimens; Pukoo, Molokai, 2 specimens, depth 3 to 6 feet; W. T. Brigham. Pukoo, Molokai, and Waikiki, Oahu, J. E. Duerden, collector. Laysan, Studer.

Remarks.—Variation is along five directions:

1. Form. Branchlets, elongate and slender to stumpy with swollen ends; from terete to compressed and frondose. The upper surface of the corallum may be neatly rounded, or the branches may be divergent and straggly.
2. Verrucæ. They are absent on the delicately branched forms, and may or may not be absent on the frondose varieties.
3. Ornamentation of the cœnenchymal surface. From subglabrous, with minute spinules to coarsely spinulose.
4. Distinctness of septa. From obsolete to comparatively well developed.
5. Distinctness of columella. From entirely absent to stylophoroid.

In discussing what is considered typical *P. cespitosa*, it has already been stated that for the typical form some latitude is allowed in the variation of the attenuateness of the branchlets and the comparative development of the septa and columella. The surface granulations of the cœnenchyma vary considerably in both prominence and size. The three varieties recognized are especially characterized as follows:

P. cespitosa var. *tumida* has short branches with swollen ends.

P. cespitosa var. *laysanensis* has spreading, straggly, terete or compressed branchlets; when the branchlets are compressed, verrucæ are almost entirely absent. Cœnenchymal granulations rather coarse. Septa and columella may be distinct.

P. cespitosa var. *stylophoroidea* has frondose branches, with irregularly developed verrucæ. Cœnenchymal granulations coarse. Septa and columella usually strongly developed.

1b. POCILLOPORA CESPITOSA var. TUMIDA, new variety.

Plate XII, fig. 1.

Corallum growing in low clumps. The branchlets are short, rather thick, swollen on the ends. Only the upper 21 mm. of the type of this variety are alive.

The measurements of the three specimens referred to this variety are:

Specimen	No. 1.	No. 2.[a]	No. 3.
	mm.	*mm.*	*mm.*
Greater distance across	70	106	97
Lesser distance across	46	75	85
Height	56	77	40

[a] Type.

Calices of the type small, 0.4 to 0.5 mm in diameter on the sides of the branches, 0.5 to 0.6 on the ends; on specimen No. 3 of the table, some of them measure as much as 0.8 mm. Distance apart variable, from less than, to several times more than their diameter.

Cœnenchymal granulations rather coarse.

Septa and columella absent, rudimentary or poorly developed.

Localities.—Prof. W. T. Brigham has sent us 1 specimen from Kahana, Oahu, and 2 from Pukoo, Molokai, all obtained in 3 to 6 feet of water.

Type.—No. 20870, U.S.N.M.

Remarks.—The following notes, published by Professor Verrill,[a] are probably, based on a specimen belonging to this variety:

"One specimen from the United States Exploring Expedition, labeled *P. brevicornis* by Dana, differs from the ordinary form in having the branches shorter and thicker, with the branchlets shorter and more crowded upon their enlarged ends, thus producing a thicker and lower clump than usual. But in the series there are various intermediate forms between this and those with long branches and slender, spreading branchlets. Like most specimens from the Hawaiian Islands, it has the large, flat, open bulbs made among its branches by *Harpalocarcinus marsupialis* Stimpson, which renders it probable that this specimen was from that locality."

P. cespitosa var. *tumida* grades on one side into the typical form of the species, on the other into var. *stylophoroides*.

1c. POCILLOPORA CESPITOSA var. LAYSANENSIS, new variety.

Plate XIII, figs. 1, 2, 3, 3*a*.

Corallum, growing in low clumps, attached by a basal expansion, above which rise irregularly shaped, spreading branches. The greatest width of one colony is 78 mm.; lesser diameter of colony, 57 mm.; height, 60 mm.

The branches vary much in size and shape; a few are short, slender, straight, and subterete, but usually they are flattened and crooked. Some are narrow, with irregularly spaced lateral protuberances, that may bear verrucæ, incipient branchlets,

[a] Proc. Essex Inst., VI, 1869, p. 91.

or branchlets. Other branches may be 11 mm. wide, with irregularly disposed verruciform processes. One broken branch is 23 mm. wide near its upper end, much compressed, 9 mm. thick on its lower end, 7 mm. near its upper end; verrucæ on one side small, irregularly developed, and scattered; on the other side they are almost obsolete. As can be gleaned from the foregoing, the verrucæ are irregular in development, sometimes almost entirely suppressed; they may or may not be present on the ends of the wider, more compressed branches.

Calices small, 0.4 to 0.5 mm. in diameter, distant from once to twice their diameter; on the summits of the branches and on the tips of the verrucæ they are larger, up to 0.7 mm. in diameter, and may be separated by only a very thin wall. Septa variable in development, in some instances rudimentary, tending to become obsolete, in others well developed, with two cycles present. They are usually especially well developed on the basal expansion. Columella terminated by a pointed style connected to an elongated septum.

The surface of the coenenchyma is thickly beset with small, erect spines of very even length.

Localities.—Vicinity of Laysan: Station No. 3955; depth, 20–30 fathoms; bottom, coral rock, algæ; temperature, 74° F.; 3 specimens (the 2 cotypes and a broken branch).

French Frigate shoal Station: No. 3968; depth, 14.5 to 16.5 fathoms; bottom, coarse sand, coral; temperature at surface, 75° F.; 1 specimen.

Cotypes.—Cat. No. 20871, U.S.N.M.

Remarks.—The specimen from Station 3968 is somewhat larger and more ragged in appearance than the types. Some of the calices on the expanded base are typically stylophoroid, there are two cycles of septa, alternately longer and shorter, and a styliform columella. On the branches the septa are usually, but not always, distinct. The septa are very well developed in some of the calices of the type specimens, but not so much as in some calices of the specimens from Station 3968.

This variety grades on one hand into typical *P. cespitosa;* on the other into *P. cespitosa* var *stylyphoroides*. From the former it is separated by its more irregular shape, its usually smaller and more distant calices, and its better developed septa and columella. The compression of some of its branches furnishes an additional difference. The difference between var. *laysanensis* and var. *stylophoiroides* is solely one of degree. The branches of var. *laysanensis* are usually slenderer, more irregular and spreading. The calices average smaller, and the septa and columella are not so strongly developed.

1d. POCILLOPORA CESPITOSA var. STYLOPHOROIDES, new variety.

Plate XII, fig. 2; Plate XIII, fig. 4; Plate XIV, figs. 1, 2.

The corallum forms a low clump; type, 20 cm. long, 9 cm. wide, and 8 cm. tall. Branches growing as plates rising from a common base. One plate is 59 mm. wide, upper edge trilobed, others not more than 28 mm. in width, the narrowest is 15 mm. wide; thickness, excluding the verrucæ, about 6 mm. The upper edges of the plates rather distant, 12 to 18 mm. There are some branches around the base that do not form definite plates. On the sides of the plates are distinct verrucæ, 2 to 5 mm.

tall, as much as 3.5 mm. in diameter at the base, somewhat appressed, and decreasing in diameter toward the apex. Calices on the verrucæ not different from the others except they are closer together. The summits of the plates may or may not bear verrucæ.

Calices on the inner portion of the corallum small, 0.6 mm. in diameter, on the outer surfaces larger, 0.8 mm. in diameter. They are distant at least once their diameter, maybe twice, excepting near the ends of the branches or on the verrucæ; on the very tips they are separated by very thin walls. Septa usually distinct, but short, in two complete cycles; all may be of the same length, occasionally more than twelve. One septum is longer than the others and marks a plane of symmetry. The columella is distinct, terminated by a small style, separated by a notch from the elongated septum or directly joined to it. Surface of the cœnenchyma minutely and regularly granulate.

A second specimen, which I am classifying with the one above described, has stubby, more or less compressed branches, the summits flattened or verrucose. The widest terminal in this specimen is 15 mm. The verrucæ grade into lateral branches which, though short, are divided into several short fingers. On the outside of the corallum are some rather attenuate finger-like branches. In form these two specimens just overlap. The calices in the second will average slightly smaller than in the first. The second specimen in form grades into specimens of *P. cæspitosa* with thickened branches.

Both of the specimens above described have basal expansions that deserve further notice. On these the septa and columella are very well developed. The columella is tall and pointed. It is connected with an elongated septum, and frequently there is an enlarged, but not so prominent, septum on the opposite side of the calice. The well-developed septa and columella give these calices a distinctly stylophoroid appearance.

Localities.—Vicinity of Laysan Island, Station No. 3959; depth, 10 fathoms; bottom, white sand, coral; temperature at surface, 78° F. Cotypes, 2 specimens; U. S. Fish Commission steamer *Albatross*. Kahana, Oahu, 2 specimens; Pukoo, Molokai, 2 specimens; depth, 3 to 6 feet; W. T. Brigham.

Cotypes.—Cat. No. 20852, U.S.N.M.

Remarks.—This variety grades into the typical form of the species, into var. *tumida* and var. *laysanensis*. The most characteristic feature of the variety is the wide, compressed branches. The cotypes are further characterized by a roughly and rather coarsely echinulate cœnenchyma, and strongly developed septa and columella. By varying toward forms with smaller branches a passage to typical *cæspitosa* is effected; by increasing irregularity in form it intergrades with var. *laysanensis;* by reduction in the length of its branches it passes into var. *tumida*. The specimens referred to the variety, but not considered typical of it, show direct passage from calices with strongly developed septa and columella to calices in which those structures are absent or only rudimentary.

CONCLUDING REMARKS ON POCILLOPORA CESPITOSA.

Following an account of the variation, those characters which all of the specimens have in common should be indicated.

The first common character is size. The colony always forms a small clump, the largest individual of which is scarcely 10 cm. tall. The verrucæ when present are irregular in development, having the appearance of branchlets that failed to develop, and there is abundant intergradation between verrucæ and branchlets. The cœnenchymal surface is granulate, the coarseness of the granulation variable. The calices vary in diameter from 0.4 to about 1 mm. The septa and columella vary from obsolescent to distinct. It will therefore be seen that the specific characters consist in the size of the corallum and the character of the branchlets or verrucæ.

This species has been reported by Quelch[a] from Tahiti; by Ortmann[b] from Ceylon; and by Gardiner[c] from Wakaja, Fiji Islands. References to these determinations have been omitted from the synonymy given in this memoir.

The *Albatross* expedition of 1899–1900, in charge of Dr. Alexander Agassiz, collected 16 specimens which I am referring to *P. cespitosa*. The localities whence they were obtained are as follows: Niau Island, Paumotu group, 4 specimens; Fakarava Island, Paumotu group, 10 specimens; Makemo Island (reef in lagoon), Paumotu group, 1 specimen; Motee Uta reef, Papeeti Harbor, Tahiti, 1 specimen. In form these specimens show a range in variation somewhat similar to those from the Hawaiian Islands. The terminal branchlets of the former, however, are in no instance so slender as those of the slenderest branches from the latter locality. The South Pacific specimens are small, rounded clumps, with moderately stout branches, rounded on the ends, or assume the growth form of the variety here called *stylophoroides*. The calicular characters of the South Pacific specimens are decidedly more constant than those of the Hawaiian specimens, the septa and columella are uniformly obsolete or very rudimentary. The calices on the sides of the branches and near the base are smaller and rather distant, similar in type to those of var. *laysanensis*. A most careful comparison of the specimens from the two regions failed to reveal any characters by which they could be separated, the South Pacific specimens falling within the range of variation of those from the Hawaiian Islands, but the former, judging from the material studied, are less variable.

2. POCILLOPORA MOLOKENSIS, new species.

Plate XV; Plate XVI, figs. 2, 2*a*.

Corallum bushy, of moderate size; a broken specimen has a greater diameter of 20 cm.; lesser, 16 cm.; height, 12.5 cm. The branches are crooked and irregular in shape, bend outward, and ultimately come to lie almost in a horizontal plane. They look as if they had been pushed down from above, and therefore have an upper and an under side. Their cross section is in some instances subcircular, but usually it is elliptical. They are larger at the base, the lesser diameter as much as 18 mm., or even more, becoming smaller distally. The tips may or may not be compressed.

[a] Reef Corals, Chall. Rept., p. 66.
[b] Zool. Jahrb., Syst., IV, 1889, p. 533.
[c] Proc. Zool. Soc. London, 1897, p. 943.

No instance of coalescence was observed; distance between the ends usually about 15 mm.

Verrucæ irregularly developed, absent on the basal portion of the corallum, tending to be obsolete on the under sides of the branches except near the ends, where they are better developed on the upper than on the lower surfaces. Summits of the branches with or without verrucæ. In size the verrucæ vary from almost imperceptible warts on the surface to protuberances 5 mm. tall and 3.5 mm. in diameter; 2.5 mm. tall and 2 mm. in diameter is probably about an average, but they are of all sizes between the limits just given. The larger verrucæ grade into the small, stumpy branchlets. They decrease but little in diameter toward the summit; in fact, rather often their ends are swollen. The distance apart is extremely variable. On the upper surfaces of the terminal branchlets they are crowded, about 2 mm. apart, but they become more distant, ultimately disappearing, as the branch is followed toward the base. Usually they stand perpendicular to the surface of the branch, are rarely somewhat inclined or are appressed to the surface; there is greater obliqueness on the lower than on the upper surface.

Calices on the basal portion of the corallum from 0.8 to 1.1 mm. in diameter, separated by about once their diameter of cœnenchyma; near the ends of the branches somewhat larger, up to 1.3 mm. in diameter, and more crowded; on the summits about 1 mm. in diameter and separated by still thinner walls. They are shallow, from 0.6 or 0.7 mm. deep, to almost superficial. Septa poorly developed, often or usually obsolete. Bottoms of the calices usually flat, sometimes arched upward, but there is no columella style.

Cœnenchyma solid, surface covered with small, erect, pointed spinules, a circle of which surrounds each calice; between the calices one or more concentric circles, or they may be irregularly distributed. The upper portion of the corallite cavities may be filled solidly with internal deposit or tabulæ may be present to the periphery; between the tabulæ there may be plugs of internal deposit. The corallum is relatively light and porous, not nearly so solid as in *P. ligulata.*

Locality.—South coast of Molokai Island, Station 3847; depth, 23–24 fathoms; bottom, sand, stones; temperature at surface, 76° F.; 2 specimens, which may be portions of the same colony.

Cotypes.—Cat. No. 20996 U.S.N.M.

Remarks.—This species does not group with any of the previously described *Pocilloporæ* from the Hawaiian Islands. Its calices resemble somewhat those of *P. nobilis*, but its mode of growth and verrucæ are entirely different. Its calices are utterly different from those of the *P. ligulata* group of species, besides it differs in the form and character of the verrucæ. *P. frondosa* has the verrucæ nearly obsolete, but has deep, crowded calices, with distinct septa and a distinct columella. Its nearest relative is *P. solida* Quelch, from Tahiti, and they may prove to be growth forms of the same species. Quelch's figure[a] of the branches indicate that the ends of the branches of *P. solida* are thick and swollen, whereas in *P. molokensis* they are nearly always decidedly small. At all events, the Hawaiian specimens can not now be identified with Quelch's species.

[a] Reef Corals, Challenger Repts., pl. I, fig. 4.

3. POCILLOPORA MODUMANENSIS, new species.

Plate XVII, figs. 1, 1*a*.

Corallum composed of ascending, rather distant, rather wide or almost terete branches; upper surface of colony rounded. The width of the upper end of the widest branch is 57 mm.; thickness, between 9 and 10 mm.; the greater diameter of the upper end of the smallest branch is 14 mm.; lesser, 12 mm. Surface of the branches, with numerous, regularly spaced verrucæ, which stand perpendicular to the surface of the branches, near the upper ends somewhat but not greatly inclined, and are strikingly uniform in size. They average about 2 mm. in diameter at the base and are about 2 mm. in height, the diameter decreasing toward the rounded or subacute apices. The distance between them from slightly less than 2 mm. to 3.5 mm. The summits of the branches may or may not be verrucose.

Calices moderately deep, on the sides of the branches rather small, about 0.7 mm. in diameter, crowded among the bases of the verrucæ, usually less than their diameter apart; they may be separated by only a thin wall, or the wall may sometimes be as much as 0.9 mm. thick. On the ends of the branches the diameter is often as much as 1 mm., in some instances it is more; here the walls are very thin. The calices on the verrucæ are separated by narrow walls. The septa, except on the summits of the branches, are well developed, 12 in number, usually distinctly divided into two cycles. One septum is elongate and connects with the columella. Although the septa are distinct and, excepting the elongated one, are narrow above; their edges are dentate, the dentations, small spines, projecting horizontally inward. Columella prominent, terminated by a style.

The broken lower end of the specimen shows a compact cœnenchyma, and as the corallite cavities are filled by internal deposit, the substance of the corallum is almost as compact as in *P. ligulata;* but in cross sections of branches higher up, the series of tabulæ may continue almost to the outer surface of the branch, a tabula sometimes forming the bottom of a calice. On the surface of the cœnenchyma, on the sides of the branches, are single, double, or treble rows of granulations between the calices, depending upon their distance apart. The granulations are small in diameter at the base, rather tall and pointed. Around the edges of the calices on the verrucæ there are rather frequently tall spiniform granulations or thin plates.

Locality.—Vicinity of Modu Manu or Bird Island, Station 4169; depth, 21 to 22 fathoms; bottom, coral; temperature, 78.3°; 1 specimen and another fragment.

Type.—Cat. No. 20984, U.S.N.M.

Remarks.—This species is separated from *P. meandrina* Dana by possessing distinctly developed septa and a styliform columella; from the *P. ligulata* by the regular size and uniform distribution of the verrucæ, which are nearly perpendicular or only slightly inclined to the surface of the branch; they are not appressed and do not tend to form carinæ. The calices are more crowded, and the corallum is lighter. *P. modumanensis* is more closely related to *P. ligulata* than to any of the other species of the genus from the Hawaiian Islands.

The following species from the South Pacific and Indian oceans are related: *P. plicata* Dana, *P. eydouxi* Milne Edwards and Haime, *P. elongata* Dana (of which *P. eydouxi* is probably a synonym), *P. coronata* Gardiner (also probably a synonym of *P. elongata*), and *P. rugosa* Gardiner. Each of these presents marked differences in the verrucæ, or in the calicular characters.

4. POCILLOPORA LIGULATA Dana.

Plate XVI, figs. 1, 1*a*; Plate XVII, figs. 2, 2*a*; Plates XVIII, XIX, XX, XXI.

1846. *Pocillopora favosa* (part) DANA, Zooph. Wilkes Expl. Exped., p. 528 (not Ehrenberg; Milne Edwards).
1846. *Pocillopora ligulata* DANA, Zooph. Wilkes Expl. Exped., p. 531, pl. L, figs. 2, 2*a*.
1846. *Pocillopora plicata* (part) DANA, Zooph. Wilkes Expl. Exped., p. 534.
1860. *Pocillopora ligulata* MILNE EDWARDS, Hist. Nat. Corall., III, p. 306.
1864. *Pocillopora ligulata* VERRILL, Bull. Mus. Comp. Zool., I, p. 59.
1869. *Pocillipora aspera* VERRILL, Proc. Essex Inst., VI, p. 93.
1869. *Pocillipora aspera* var. *lata* VERRILL, Proc. Essex Inst., VI, p. 94.
1869. *Pocillipora ligulata* VERRILL, Proc. Essex Inst., VI, p. 95.
1886. *Pocillopora ligulata* QUELCH, Reef Corals, Challenger Rept., p. 68.
1886. *Pocillopora plicata* QUELCH, Reef Corals, Challenger Rept., p. 68.
1901. *Pocillopora ligulata* STUDER, Zool. Jahrb., Syst., XL, p. 400.
1901. *Pocillopora aspera*, STUDER, Zool. Jahrb., Syst., XL, p. 401.

The original description of *P. ligulata* according to Dana is as follows:

Hemispherical, branches subdivided, rather remote, straight, thin (2 to 3 lines), much compressed and complanate, ¼ to 1¼ inches wide, verrucæ small, ascending, and appressed to the branch, obsolete at apex. Corallum having the cells short stellate, columella very distinct, and united by one of the lamellæ to the side of the cell.

* * * * * * *

This species is peculiar in its thin-compressed branches, and small appressed verrucæ, rather distant and sometimes running in longitudinal carinate lines. The intervals between the branches are from ½ to ¾ of an inch wide, and give an open appearance to the clumps. It has the habit of the *plicata* in its distant verrucæ and cell, but the branches are very much narrower.

Professor Verrill in 1869 published a redescription of the type specimen of the species. His description is:

In mode of branching and form of the verrucæ they resemble some forms of *P. aspera*, though the branches are more regular and unusually divergent and distant. The longer branches are much compressed, thin, and mostly dilated at the ends, 0.4 of an inch to 1.5 broad, and 0.3 to 0.4 thick. The larger branches have very cellular naked summits; some of the younger branches are strongly verrucose at the end. The lateral verrucæ are well developed, not crowded, ascending, and mostly partially appressed to the surface. The lateral cells are rather distant, quite small, mostly stellate, with twelve well-developed septa, one of which joins the small prominent columella. The cœnenchyma is firm, between the cells covered with small spinule-like grains. The specimens are about 6 inches high and broad.

Hawaiian Islands, Rev. Mr. Baldwin.

This species is evidently closely allied to *P. aspera*, from which it differs chiefly in its smaller and more distant cells, more fully developed septa, and the finer granulation of the cœnenchyma. With a larger series of specimens it might perhaps be possible to unite the two, but as yet I have observed no intermediate forms.

The original description of *P. aspera*, by Verrill, is as follows:[a]

Corallum branching much as in the preceding [*P. danæ* Verrill], forming dense hemispherical clumps, often more than a foot in diameter, often having a rather rough ragged appearance, owing to irregularity of the branches and prominence of the verrucæ. Branches very variable in different examples, and often even in the same specimen; sometimes quite slender and not more than half an inch in breadth and varying in length from 1 to 4 inches, strongly compressed at the ends, or even tapering; more commonly much and irregularly subdivided, the ends enlarged and variously lobed, and often conspicuously verrucose at summit; sometimes the branches are stouter, less subdivided,

[a] Proc. Essex. Hist., VI, p. 94.

compressed, 1 or 2 inches in breadth, 3 to 6 thick [*sic*, probably intended to be 0.3 to 0.6] and 3 to 5 long, some with ends verrucose, others scarcely so. The lateral verrucæ are generally distant, irregular, often elongated, rising very obliquely, or more or less appressed to the surface; in other cases small, but little prominent, or even subobsolete, especially below. Cells large, those at the summit much crowded, deep, separated by thin walls; the lateral ones mostly circular, not distant, usually with a prominent columella and twelve distinct septa, one of which is wider and joins the columella. Cœnenchyma between the lateral cells not very abundant, the surface thickly covered with very rough, coarse, spinulose grains.

The largest specimens are more than a foot in diameter.

Hawaiian Islands, Horace Mann, W. T. Brigham, J. D. Dana.

The original description of *P. aspera* var. *lata*, is as follows:

One specimen (referred to *P. plicata* by Dana) has the branches stouter 0.3 to 0.5 of an inch thick, and 1 to 3 inches or more broad, variously plicate, with the summits lobed and mostly naked, the smaller ones often verrucose, but in the characters of the lateral verrucæ and cells it scarcely differs from the large specimens of the ordinary variety. The lateral cells, however, generally have the septa less developed, and the surface between them is not so strongly spinulose. But some of the outer branches have the stellate cells and rough surface of the ordinary form. The lateral verrucæ are rather distant, not very prominent, very oblique, and somewhat appressed to the surface. The naked ends of the branches are covered with large, crowded, deep cells, separated by thin walls. The summits of the branches are separated by quite regular intervals, 0.3 to 0.4 of an inch broad. The specimen is about 12 inches broad and 6 high.

Hawaiian Islands, Rev. Mr. Baldwin, Museum of Yale College.

The remarks of Professor Verrill on the close relationship between *P. ligulata* Dana and *P. aspera* Verrill have already been quoted. Professor Studer expressed the opinion that *P. aspera* should be united to *P. ligulata;* he, however, separated them, saying, "At all events the granulations of the cœnenchyma are coarser, the granules are thick, and with a rough surface in the specimens that I consider *P. aspera*."

I have been able to study the types of *P. ligulata*, *P. aspera*, and *P. aspera* var. *lata* in the Yale University Museum. There are four specimens belonging to the older United States National Museum collections; the *Albatross* obtained in 1902 one specimen, Plate XVII, figs. 2, 2*a*, that can be referred to *P. ligulata*, and one, Plate XVI, figs. 1, 1*a*, that can be referred to *P. aspera;* and Prof. W. T. Brigham has sent me nine additional specimens, two of which are figured. Plates XX, XXI represent two views of a specimen that can more appropriately be placed in *P. ligulata*. The surface of its cœnenchyma is minutely spinulose, the spinules are larger than those of the specimen represented by Plate XVII, fig. 2*a*, but they are not so coarse as those in the specimen represented by Plate XVI, fig. 1*a*. The second specimen of Professor Brigham's collection, represented by Plates XVIII, XIX, is typical *P. aspera* var. *lata*.

P. ligulata and *P. aspera* are separated solely by the relative coarseness of the cœnenchymal granulations. A careful study of the specimens submitted to me has convinced me that they are not specifically distinct. The width of the branches is variable in both the forms with the *ligulata* and the *aspera* type of cœnenchymal surface.

Professor Verrill, in his redescription of the type specimen of *P. ligulata*, has admirably expressed the specific characters. They consist in the character of the verrucæ, the well-developed septa and styliform columella, and the surface granu lations, which vary in coarseness. One additional characteristic of the septa deserves notice: They are narrow in their upper portion, seeming to originate down in the calice, a short distance below the edge of its mouth.

Quelch, in 1886,[a] reunited *P. aspera* and *P. plicata*, after Verrill had retained the name *P. plicata* for the Fijian specimens, conferring the name *P. aspera* var. *lata* on those from the Hawaiian Islands included by Dana in his *P. plicata*. Quelch's specimens came from the reefs at Honolulu at depths of 1 to 2 fathoms. Gardiner, in his On some Collections of Corals of the Family Pocilloporidæ from the S. W. Pacific Ocean,[b] says: "Although I have only had the opportunity of examining a very limited number of specimens, as I can find no distinctive characters, I have no hesitation in combining *P. aspera*, *P. danæ*, *P. ligulata*, and *P. plicata* under one species with three varieties." *P. aspera* must be placed in the synonomy of *P. ligulata*. *P. danæ*, type Cat. No. 696 U.S.N.M., is not closely related to *P. ligulata*, but is very close to *P. damicornis* (Esper) (I seriously doubt the existence of any valid differences between them) and is somewhat intermediate between that species and *P. verrucosa*. Verrill says, concerning *P. plicata* (from the Fijis): "This species may best be distinguished from *P. aspera* var. *lata* by the more distant cells, more highly developed septa, the finer and more even granulation of the surface, and the more porous texture." Dana's figure of the calice of *P. plicata* (plate L, fig. 7*b*) is so similar to the calice of *P. ligulata* or *P. aspera* that it could serve for the latter species. The differences pointed out by Verrill do not seem to me to be important. I am therefore inclined to agree with Dana, Quelch, and Gardiner in considering the Hawaiian and Fijian specimens as belonging to the same species, but as I have not carefully compared specimens from the two regions, I prefer not to record a positive opinion.

Localities.—French Frigate Shoal, Station 3968; depth, 14½ fathoms; bottom, coarse sand, coral; temperature at surface, 75° F.; and Laysan, *Albatross*, 1902. Kahana, Oahu, W. T. Brigham. Reefs, Honolulu; depth, 1 to 2 fathoms (*Challenger* expedition). Waikiki, Oahu, and Pukoo, Molokai, J. E. Dunden, collector. Laysan, Studer.

5. POCILLOPORA FRONDOSA Verrill.

1869. *Pocillipora frondosa* VERRILL, Proc. Essex Inst., VI, p. 96.

Original description.—Verrill describes this species as follows:

Corallum light and unusually porous, forming hemispherical clumps, consisting of numerous elongated, irregular, often crooked, compressed, frond-like branches, with expanded and variously lobed and plicate ends. The branches are from 0.3 of an inch to 1.5 broad, and 0.3 to 0.5 thick, except at the summits, which are scarcely 0.25. The verrucæ are nearly obsolete, both upon the sides and ends of the branches, being represented upon the lateral surfaces only by distant and slightly elevated, irregular prominences and low ridges, which are often wholly wanting. Cells large and deep, rather crowded, the spaces between seldom equal to half their diameter even low down on the sides of the branches. Septa twelve, quite distinct, though narrow, one of them joining the columella, which is usually distinct, but low down in the cell; surface of the cœnenchyma rough, thickly covered with rather coarse spinules.

Hawaiian Islands, W. T. Brigham.

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[a] Reef Corals, Challenger Rept., p. 68.
[b] Proc. Zool. Soc. London, 1897, p. 948.

This species is nearly allied to *P. aspera* by the structure of the cells and surface of the cœnenchyma, but is remarkable for its peculiar frond-like branches, destitute of distinct verrucæ. It is possible, however, that it may eventually prove to be only an extreme variety of that species. *P. informis* Dana differs in its irregular mode of growth and in the absence or rudimentary condition of the septa.

Remarks.—In growth form this species resembles the large clumps of *P. ligulata*, but is distinguished by the obsolescence of the verrucæ. In places there are moderately developed verrucæ, bringing *P. frondosa* very close to *P. ligulata*. The calices in the former are slightly larger and more open; the septa, except the one that joins the columella, are not so strongly developed.

I have seen only the type of *P. frondosa*, No. 1276, Yale University Museum, a fragment of which is in the United States National Museum. No specimens connecting it with *P. ligulata* have come to my notice, but it may ultimately prove to be a form of that species, in which the verrucæ are almost suppressed.

6. POCILLOPORA MEANDRINA Dana.

Plates XIV, figs. 3, 4; Plate XXII, figs. 1, 1*a*, 2, 2*a*; Plate XXIII.

1846. *Pocillopora verrucosa* (part) DANA, Zooph. Wilkes Expl. Exped., p. 529, pl. L, figs. 3, 3*a*. (Not *Madrepora verrucosa* Ellis and Solander).
1846. *Pocillopora meandrina* DANA, Zooph. Wilkes Expl. Exped., p. 533, pl. L, figs. 6, 6*a*, 6*b*.
1860. *Pocillopora meandrina* MILNE EDWARDS, Hist. Nat. Corall., III, p. 307.
1864. *Pocillopora nobilis* VERRILL, Bull. Mus. Comp. Zool., I, p. 59.
1869. *Pocillipora nobilis* VERRILL, Proc. Essex Inst., VI, p. 97.
1869. *Pocillipora nobilis* var. *tuberosa* VERRILL, Proc. Essex Inst., VI, p. 98.
1869. *Pocillipora meandrina* VERRILL, Proc. Essex Inst., VI, p. 98.
1886. *Pocillopora nobilis* QUELCH, Reef Corals, Challenger Rept., p. 68.
1886. *Pocillopora verrucosa* QUELCH, Reef Corals, Challenger Rept., p. 69.
1888. *Pocillopora nobilis* FOWLER, Quart. Jour. Micros. Sci., n. s., XXVIII, p. 425.
1901. *Pocillopora nobilis* STUDER, Zool. Jahrb., Syst., L, p. 400.
1901. *Pocillopora nobilis* var. *tuberosa* STUDER, Zool. Jahrb., Syst., L, p. 400.
1901. *Pocillopora meandrina* STUDER, Zool. Jahrb., Syst., L, p. 400.

The original description of *P. meandrina* is as follows:

Cespitose, neatly hemispherical; branches lamellar, often sinuous, nearly simple, ⅓ to ½ an inch thick, 1 to 3 inches broad, neatly verrucose, summits naked. Corallum with the verrucæ a little oblong, angular, sometimes proliferous, with the cells of the same quite large (often ⅔ of a line); star and columella indistinct.

* * * * * * *

This species resembles the *grandis* and *elegans*, but has more angular verrucæ arising from the fewer and much larger cells that constitute them. The texture, moreover, is lighter and more cellular. It forms neat hemispherical clumps, 6 inches in diameter, with broad, naked, meandering summits to the folia, separated by intervals of about a third of an inch. The verrucæ are very nearly even and cover the sides of the branches nearly or quite to their bases.

I have been able to study the type of *P. meandrina*, No. 1970, in the Yale University Museum, and Prof. W. T. Brigham has sent one practically typical specimen to the United States National Museum.

Professor Verrill so long ago as 1869 recognized the close affinities between his *P. nobilis* and Dana's *P. meandrina*, remarking concerning the latter, "It is closely allied to *P. nobilis*, but has mostly broad, plicated and convoluted, short, frond-like branches, with nearly naked summits. The verrucæ are rather small and closely crowded. The cells are somewhat smaller than is usual in *P. nobilis*, and the septa are in general very narrow, or scarcely apparent. The surface is finely granulous. Its resemblance to *P. nobilis* is so great as to suggest the possibility that it may be only an extreme variety of that species."[a] Professor Studer, in 1901, expressed a similar opinion.[b]

The *Albatross* expedition of 1902 obtained 8 specimens and several fragments of Verrill's *P. nobilis*, and there were already 4 specimens of it in the United States National Museum. Prof. W. T. Brigham has sent 4 additional specimens of var. *nobilis* and 1 of var. *tuberosa*. I have thus been able to study over 20 specimens of *P. meandrina* and its varieties.

Typical *P. meandrina* lies at the periphery of the species, while Verrill's *P. nobilis* is the center. The branches of *P. nobilis* are very variable in form, sometimes becoming contorted plates (Plate XIV, fig. 4), but in other characters they are typical for that variety. The only criterion for its separation from *P. meandrina* would consist in the verrucose summits of the branches. The type of *P. meandrina* shows, in places, obscure summit verrucæ; on the specimen of typical *P. meandrina*, from Professor Brigham, summit verrucæ are distinct on the peripheral branches. There is complete overlapping in this character. Therefore *Pocillopora nobilis* Verrill can be regarded as only a variety of *P. meandrina* Dana.

6b. POCILLOPORA MEANDRINA var. NOBILIS Verrill.

Plate XIV, figs. 3, 4; Plate XXII, figs. 1, 1*a*, 2, 2*a*; Plate XXIII.

1846. *Pocillopora verrucosa* (part) DANA, Zooph. Wilkes Expl. Exped., p. 529, pl. L, figs. 3, 3*a*. (Not Ellis and Solander.)
1864. *Pocillopora nobilis* VERRILL, Bull. Mus. Comp. Zool., I, p. 59.
1869. *Pocillipora nobilis* VERRILL, Proc. Essex Inst., VI, p. 97.
1886. *Pocillopora nobilis* QUELCH, Reef Corals, Challenger Rept., p. 68.
1886. *Pocillopora verrucosa* QUELCH, Reef Corals, Challenger Rept., p. 69.
1888. *Pocillopora nobilis* FOWLER, Quart. Jour. Microscop. Sci., XXVIII, n. s., p. 425.
1901. *Pocillopora nobilis* STUDER, Zool. Jahrb., Syst., L, p. 400.

Verrill's description published in 1869 is as follows:

Corallum firm and dense, forming large round-topped or hemispherical clumps, often a foot or even 18 inches in diameter. Branches nearly equal in length, separated by regular intervals of 0.4 to 0.5 of an inch, elongated, often nearly round, 0.6 to 0.75 of an inch in diameter, regularly forking and not enlarged at the obtusely rounded ends; in other cases, even in the same specimen, dilated at the ends to a breadth of 2 or 3 inches and more or less plicated. Summits of the branches generally strongly verrucose, the verrucæ similar to those of the sides, but usually smaller and more crowded. Lateral verrucæ very numerous, rather crowded, the intervals being usually less than their diameter; small, regular, spreading obliquely or even standing at right angles to the surface; tapering and somewhat rounded at the end, but angular and containing but few quite large cells. Between the verrucæ the cells are rather large, numerous, usually less than half their own diameter apart. Septa but little developed, very narrow, usually indistinct or wholly obsolete. Columella very small or wanting. Surface of the cœnenchyma regularly covered with rather small spinuliform granules. Color of the unbleached coral deep yellowish brown.

Hawaiian Islands, J. D. Dana, Rev. Mr. Baldwin, A. Garret, Horace Mann, W. T. Brigham.

[a] Proc. Essex Inst., VI, 1869, p. 98.
[b] Zool. Jahrb., Syst., L, 1901, p. 400.

Localities.—Reef at Kaunakakai, Island of Molokai, 8 colonies and several broken branches; Penguin Bank, south coast of Oahu, Station 4031; depth, 27–28 fathoms; bottom, fine coral sand, foraminifera, coral; temperature at surface, 76° F.; 3 branches, probably from the same colony, *Albatross* 1902. Kahana, Oahu, 2 specimens; Pukoo, Molokai, 1 specimen; 2 specimens without definite localities; depth, 3 to 6 feet; received from W. T. Brigham; Honolulu Reefs, 10 to 40 fathoms, Quelch. Waikiki, Oahu, J. E. Duerden, collector, Laysan, Studer.

Remarks.—The United States National Museum has in its older collections three excellent specimens of this variety, one of them coming from the Wilkes Exploring Expedition collection. The specimens from the reef at Kaunakakai are typical, judged both by Verrill's description and the specimens in the National Museum. Diameter of calices between verrucæ, 7 mm.; on verrucæ, 1 mm.; on incrusting base, 0.7 to 0.9 mm. Some of the branches in the *Albatross* material are wide (see Plate XIV, fig. 4), resembling in form typical *P. meandrina.*

The branches in the specimens from Station 4031 are not typical; they are less crowded than in the typical form; the verrucæ are smaller and uniformly stand more nearly perpendicular to the surface of the branches, and the corallum is much lighter. Other than these, no differences of importance were detected. The lightness of the corallum may be corellated with the greater depth at which these specimens grew; it was not necessary for them to be so strong as the specimens growing in shallower water. The tips of the verrucæ in typical *nobilis* usually inclining toward the ends of the branches may be determined by the branches standing nearer together. Verrill in his description of *nobilis* says that the verrucæ may be perpendicular.

I believe that the specimen and fragments from the Hawaiian Islands referred by Quelch to *P. verrucosa* constitute only a form of Verrill's *nobilis*, as in some instances the septa may be distinct and the columella a central dome.

6c. POCILLOPORA MEANDRINA var. TUBEROSA Verrill.

1869. *Pocillipora nobilis* var. *tuberosa* VERRILL, Proc. Essex Inst., VI, p. 98.
1901. *Pocillipora nobilis* var. *tuberosa* STUDER, Zool. Jahrb., Syst., L, p. 400.

Verrill's original description is as follows:

> One specimen, which I refer with doubt to *P. nobilis*, is peculiar in having much larger and more prominent verrucæ, which are rounded and often swollen at the end, or even obovate. Toward the base the verrucæ are less prominent and even hemispherical. The ends of the branches are enlarged, often lobed, and thickly covered with verrucæ. The lateral cells are of medium size, not crowded, with the septa and columella but little developed. Surface between the cells closely granulous.
>
> Hawaiian Islands, W. T. Brigham.

Remarks.—The type, No. 1270, Yale University Museum, was examined. The corallum is about 16 cm. tall, and the branches are not so crowded as is usual in *P. nobilis.* The verrucæ becomes obsolete toward the base.

Prof. W. T. Brigham has sent one specimen of this variety to the United States National Museum. It differs from variety *nobilis* by having large verrucæ, usually swollen on the ends. The locality label was unfortunately lost.

P. meandrina is extremely close to *P. verrucosa;* in calicular characters they overlap. The verrucæ of the latter are larger and more irregular in size, causing the corallum to have a very rough, even a ragged appearance. *P. damicornis, danæ, verrucosa, meandrina*, and *elegans* form a series so indistinctly broken that one is led to suspect that they are really continuous. It is probable that *P. brevicornis* and *P. lobifera* are a part of the same series.

P. meandrina, typical or as the form called *nobilis*, is widely distributed. The *Albatross* south Pacific expedition of 1899–1900 obtained 15 specimens and 2 fragments that I have labeled *P. meandrina.* They were obtained from the following localities: Reef, Lagoon, Makemo, Paumotus, 8 specimens; Reef, Lagoon, Apataki, Paumotus, 2 specimens; Reef, Funafuti, Ellice Islands, 2 specimens; Papeeti Harbor, Tahiti, 1 specimen; Rangiroa, 2 specimens, and locality labels lost, 2 specimens.

The general character and range in variation of these specimens are so similar to those from the Hawaiian Islands that no notes of importance can be made.

7. POCILLOPORA INFORMIS Dana.

Plate XXIV, figs. 1, 1*a*.

1846. *Pocillopora informis* DANA, Zooph. Wilkes Expl. Exped., p. 535, pl. LI, figs. 3, 3*a*.
1860. *Pocillopora informis* MILNE EDWARDS, Hist. Nat. Corall., III, p. 307.

Original description.—Dana describes this species as follows:

Glomerate-cespitose, solid at base, branching irregular, often gibbous and acervate, in part naked, in part remotely and irregularly verrucose. Corallum having the cells small (⅓ of a line), a slender columella, and one lamella very distinct.

* * * * * * * * *

Forms rough-looking clumps, often a foot through, which are massive at base, and very irregularly subdivided above. The surface is often bare of verrucæ in many parts, and in others is very uneven, and gives off rudimentary branchlets or protuberances of various shapes.

Type.—Cat. No. 441, U.S.N.M., from the "Sandwich Islands," Wilkes Exploring Expedition.

Dana's description, so far as it goes, is excellent, and gives the most striking characteristics of the species. His figures also are good. It is desirable, however, to have certain features described in greater detail. The calices vary in diameter from 0.6 to 0.9 mm.; they are deep, 1.3 to 2 mm.; separated by narrow walls, rarely exceeding 0.6 mm. across and usually less. The septa, excepting one, are usually rudimentary or obsolete, but are sometimes distinct, when they are small and narrow. Columella tall, styliform, attached to an elongated septum.

The cœnenchyma between the calices is solid, its surface densely granulate, the granulations rather coarse. The corallite cavities may or may not be filled with internal deposit, sometimes there is a succession of tabulæ to the bottoms of the calices, again a corallite cavity is solidly filled for a space and then the succession of tabulæ is resumed. It is interesting to note in longitudinal sections that the principal septum (to which the columella is attached) may be continuous across several tabulæ, then it may be absent across several, and appear again.

This species is so very distinct that extensive critical remarks on its affinities are not necessary. Its growth form immediately separates it from the other Hawaiian *Pocilloporæ*. Its styloid columella and obsolescent septa are additional characters.

Family ORBICELLIDÆ Vaughan.

Genus LEPTASTREA Milne Edwards and Haime.

Previous to the present time only one species of *Leptastrea* had been recognized from the Hawaiian Islands, namely, *L. stellulata* Verrill. Two forms that do not agree with *L. stellulata* are here added. These, although they are closely related, do not intergrade with each other.

SYNOPSIS OF THE HAWAIIAN SPECIES OF LEPTASTREA.

Calices 6 mm. in diameter:
- Septa in 4 cycles .... *L. stellulata.*

Calices 2.5 to 4.5 mm. in diameter:
- Septa in 3 cycles, a few quaternaries.
- Primaries usually decidedly exsert; primaries and secondaries reaching the columella.. *L. agassizi.*

Calices about 2 mm., rarely 3.5 mm., in diameter:
- Septa in 3 cycles. Primaries somewhat exsert; primaries and a few secondaries reaching the columella .... *L. hawaiiensis.*

LEPTASTREA STELLULATA Verrill.

1867. *Leptastrea stellulata*, VERRILL, Proc. Essex Inst., V, p. 36.

Original description.—This species was originally described by Verrill, as follows:

Corallum convex, incrusting, with irregular prominences, lower surface where free covered with a thin epitheca. Cells large, often 0.25 inch, with many small ones between them, which are usually considerably exsert, and arise by lateral or marginal budding. Septa in four cycles, broad, with truncate, nearly entire summits, but finely denticulate below. The six primary septa are the largest, and thickened toward the center of the cells. The others coalesce at their inner edges. Costæ much thickened but scarcely prominent above the surface of the interstitial spaces. Texture very compact.

Sandwich Islands, Yale College Museum.

Professor Studer[a] identified as *L. stellulata* two small young colonies from Laysan. They were attached to a specimen of *Favia rudis*, over which his type of *Porites lanuginosa* had grown (see Plate LXXXVII). The calices of these specimens are smaller than in the type, 5 mm. in diameter, and there are only three cycles of septa, whereas there are four in the type. Professor Studer regards his colonies as immature. I somewhat doubt the correctness of the determination.

LEPTASTREA AGASSIZI, new species.

Plate XXV, figs. 2, 2*a*, 3, 3*a*.

Corallum forming a thin incrustation or small, rounded masses. The corallites project to a variable extent above the intercorallite areas, in some instances as much as 1.5 mm. Subequal, wide, low, granulate costæ present on both the free limbs of the corallites and across the intercorallite area.

Calices slightly excavated or moderately deep. Diameter from 2.5 to 4.5 mm.; average about 3.5 mm. Distance apart usually somewhat less than the diameter.

Septa in three complete cycles, with a few quarternaries. The primaries and secondaries reach the columella. The primaries are the thickest in thecal ring; their

[a] Zool. Jahrb. Syst., XL, 1901, p. 402, pl. XXIX, fig. 9.

margins are exsert, often decidedly prominent, sometimes as much as 2 mm. Secondaries thinner than the primaries; tertiaries shorter and thinner than the secondaries, their inner edges usually free, but sometimes fused to the sides of the secondaries. Septal margins denticulate, denticulations coarser near the columella. Septal faces densely granulate. Endothecal dissepiments present, scanty; exotheca solid.

Columella false, formed of trabeculæ inclined inwardly from the inner ends of the septa.

Asexual reproduction by budding on the intercorallite areas.

Localities.—Kaneoke, Oahu, 1 specimen; Waikiki, Oahu; depth, 3 to 6 feet; received from W. T. Brigham.

Cotypes.—Cat. Nos. 21633, 21634, U.S.N.M. (5 specimens).

Remarks.—One of the specimens of this species is interesting because of the way in which portions of it have incrusted some small *Serpula* tubes. The specimen looks as if it were ramose, one projection having a height of about 13 mm. and a basal diameter of 4 mm. In the center of the piece is a worm tube less than 0.5 mm. in diameter. There is a considerable number of these projections, of varying height and thickness, and a worm tube can be seen in each one.

The United States National Museum has obtained one additional specimen of this species, also from Kaneoke, from the Duerden collection of Hawaiian corals.

Critical notes on *L. agassizi* and *L. hawaiiensis* will follow the description of the latter species.

LEPTASTREA HAWAIIENSIS, new species.

Plate XXV, figs. 1, 1*a*.

The corallum grows as a thin incrustation over objects, its upper surface showing irregularities corresponding to those of its basal support.

The corallites possess free upper portions, which decrease in size from their bases to the calicular margins and project from 1 to 1.5 mm. above the intercorallite areas. The free portions are externally beset with low, equal, granulate, flattish costæ that become smaller toward the bases and on the intercorallite areas.

The calices are moderately deep, circular or subcircular in cross section. They are about 2 mm. in diameter and are separated by intervals of 1 to 2 mm.

The septa form three complete cycles. They are all of approximately the same thickness in the thecal ring, but their margins vary in prominence according to the cycles. The primaries are moderately exsert, and all of them extend to the columella. Near the wall they are considerably thickened, but become suddenly thinner near the columella. The secondaries have less exsert margins and are thinner than the primaries, but two of them, those in the median lateral systems, usually, and others occasionally, extend to the columella. The tertiaries have slightly exsert margins. They are thin and short and have free inner margins. The margins of all the septa are finely denticulate; paliform lobes often occur on the larger septa. The septal faces are finely granulate, with some perforations near the columella. A few endothecal dissepiments present; exotheca dense.

The columella is spongy, false, composed of lobes from the inner ends of the principal septa.

Asexual reproduction by gemmation between the calices and around the margin of the spreading edge.

Locality.—Pukoo, Molokai; depth, 3 to 6 feet; received from W. T. Brigham.

Type.—Cat. No. 21632, U.S.N.M.

The United States National Museum has obtained four additional specimens from the Duerden collection of Hawaiian corals, one of them from Pukoo, Molokai, the three others from Waikiki, Oahu. The salient differences between *L. agassizi* and *L. hawaiiensis* are well shown by the enlarged figures of their respective calices and are indicated in the synoptic table of the specific characters. The septa of the former are more nearly equal in thickness and are more crowded, particularly around the columella, which is more developed than in the latter species. Five specimens of each species have been carefully compared, and there is no suggestion of intergradation.

Genus CYPHASTREA Milne Edwards and Haime.

CYPHASTREA OCELLINA (Dana).

Plate XXV, figs. 4, 5, 5*a*, Plate XXVI, fig. 1.

1846. *Astræa (Orbicella) ocellina* Dana, Zooph. Wilkes Expl. Exped., p. 218, pl. x, fig. 10.
1850. *Cyphastrea? ocellina* Milne Edwards and Haime, Ann. Sci. Nat., 3ième sér., XII, p. 115.
1857. *Cyphastræa? ocellina* Milne Edwards, Hist. Nat. Corall., II, p. 487.
1866. *Cyphastrea ocellina* Verrill, Proc. Essex Inst., V, p. 37.
1901. *Cyphastræa ocellina* Studer, Zool. Jahrb., XL, p. 402, pl. xxx.

Original description.—Dana's original description is as follows:

Glomerate and lobed, often incrusting; polyps scarcely a line in breadth, lamellæ 24. Corallum with the calicles globoso-cylindrical, as in the *microphthalma*, but smaller, with 12 minute lamellæ equally exsert; interstices nearly naked; cells deep; in a transverse section, septa nearly solid and stars few-rayed.

Professor Dana adds further information in his remarks on the species, and Professor Studer has published an excellent and very detailed description. Four figures are given in the present memoir.

The corallum begins growth as an incrustation on stones, pieces of dead coral, etc. In some instances there is a projecting free edge, whose lower surface is epithecate. As growth proceeds the upper surface becomes lobed and glomerate. The larger of the coralla that I have seen are about the size of a man's fist.

Calices deep; from 1 to 1.5 mm., or 1.75 mm. in diameter. The calicular margins may or may not be prominent, on the thin incrusting portions of the corallum they usually are low, on the lobate portions they may project as much as 1.5 mm. The free portions of the corallites are rather strongly costate; no costæ on the intercorallite areas. Both the costæ and the intercorallite areas rather coarsely granulate.

Septa 24 in number. The primaries and secondaries reach the columella and have decidedly exsert margins; the former are slightly thicker and a little more exsert. The tertiaries are thin and have free inner margins. Arches of the septal margins microscopically dentate, subentire; inner margins distinctly dentate, the dentations becoming coarser toward the columella, sometimes simulating pali; septal lamellæ perforate near their inner edges. Septal faces minutely granulated. Endothecal dissepiments abundant, but very delicate. Exotheca composed of thin, vesicular dissepiments that surround the corallites.

Columella moderately developed, false, composed of fused septal trabeculæ.

Localities.—"Sandwich Islands," Dana; Laysan, Studer.

Reefs, Kaunakakai, Island of Molokai (2 specimens); and Hawaiian Islands, no more definite locality (1 specimen), *Albatross*, 1902.

Kahana, Oahu, 2 specimens; Pukoo, Molokai, 2 specimens; Kaneohe, Oahu; 1 specimen without locality label; depth, 3 to 6 feet; received from W. T. Brigham: Waikiki, Oahu, and Pukoo, Molokai, J. E. Duerden, collector.

There are 16 specimens in the United States National Museum, and I was able to examine other specimens in the Yale University Museum.

Family FAVIIDÆ Gregory.

Genus CŒLASTREA Verrill.

1866. *Cœlastrea* VERRILL, Proc. Essex Inst., V, p. 32.

Original description of the genus.—According to Verrill this was as follows:

Corallum massive, cellular, fasciculate, formed by prismatic corallites intimately united by their walls, which are thin and simple. The exterior of the corallum is destitute of an epitheca, lobed, and distinctly costate like that of *Metastrea*. The cells are polygonal, often closed below by the dissepiments, which, occurring at the same level, unite from all sides, forming thus transverse septa. In a transverse section traces of a very rudimentary and loose columella are seen in some cells. Septa in three or four cycles, unequal, the inner edges prolonged into strong paliform teeth.

The polyps increase by fissiparity, and near the margin by disk-budding. This genus appears to bear the same relation to *Goniastrea* that *Metastrea* does to *Prionastrea*, differing from it in the absence of epitheca and the lobed and striated exterior, thinness of the walls, and rudimentary columella. From *Metastrea* it differs in the last character, and in its mode of increase as well as in the coincidence of the dissepiments and the strong pali.

As this genus is based on a single species, which supposedly came from the Hawaiian Islands, the generic description is given.

CŒLASTREA TENUIS Verrill.

Plate XXVI, figs. 2, 2*a*.

1866. *Cœlastrea tenuis* VERRILL, Proc. Essex Inst., V, p. 33.

Original description.—This species was originally described by Verrill as follows:

Corallum somewhat columnar or turbinate, flat at top, attached by a narrow base; the sides are marked by lobes corresponding to the marginal corallites, and striated even to the base; the ribs a little prominent, finely echinate near the cells. Cells unequal, irregularly polygonal, mostly closed by a complete floor below. Walls very thin, forming a zigzag line between the septa. Septa very narrow, thin, finely serrate, the inner edges perpendicular, little exsert, not crowded, in four cycles, the last often incomplete. Pali prominent, wide, thicker than the septa, situated before all the cycles except the last. Columella not apparent except in a section, where it appears very rudimentary. Dissepiments horizontal, about a tenth of an inch apart, mostly coincident, so as to form complete tranverse floors.

Height, 2 inches; diameter, 3; the average width of cells, 2.

Sandwich Islands? Prof. J. D. Dana, U. S. Expl. Exp.

Type.—Cat. No. 476, Yale University Museum.

Remarks.—Professor Verrill has kindly loaned the type of this species. As his description is excellent, I will add only measurements of the calices and emphasize a few characters.

MEASUREMENTS.

Calice	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
Greater diameter	3.7	5.7	6.2	8.2	9.3
Lesser diameter	3	3.2	4.5	6.3	4.2

Calice No. 1 is young; fission is in process in No. 5.

The most striking features of the specimen are the lightness of the corallum, the very poor development or the absence of the columella, and the tabuliform dissepiments that form floors for the bottoms of the calices.

Genus FAVIA Oken.

FAVIA HAWAIIENSIS, new species.

Plate XXVI, figs. 3, 3*a*.

Corallum is incrusting, and may cover rather large surfaces, as much as 21 cm. across. The upper surface is extremely uneven, corresponding to the configuration of the object of attachment, frequently with irregular projections. Its thickness usually is only a few millimeters, but sometimes there may be protuberances several centimeters in height.

The calices are irregularly polygonal, subelliptical, or subcircular. They are very variable in size, from about 2 to 6 mm. in diameter. The size of the calices does not seem to depend upon position on the surface, though the more hidden ones are often smaller, probably because of diminished food supply. The depth is considerable, about 2 mm. The walls between the corallites are solid, varying in thickness from a very narrow edge to 1.5 mm. Usually a furrow on the top of the wall indicates the boundaries of adjoining corallites.

There are three complete cyles of septa and a variable number of the fourth, but the last seems never to be complete. They are somewhat thicker in the wall, thinner inwardly. Their upper edges are rather exsert, terminating abruptly at the furrow marking the outer limits of the corallites; the inner edges fall steeply to the columellar area. Both the arched and descending portions of the septal margins are finely denticulate. Near the columella are larger and coarser teeth, which are sometimes paliform. Endothecal dissepiments present in the longer corallites.

The columella is well developed, spongy, formed by the fusion of septal processes which project above its upper surface, giving to the surface a papillate appearance.

A sexual reproduction normally by fission; it appears that there occasionally may be budding around the growing edge and in the angles between the corallites.

Localities.—Pukoo, Molokai, 2 specimens; Waikiki, Oahu, 1 specimen; depth, 3 to 6 feet; received from W. T. Brigham.

Type.—United States National Museum, No. 21635.

The following two species of *Favia* are supposed to be found in the Hawaiian Islands. The first is based on a specimen presumably from there; the second was doubtfully reported from there by Professor Verrill.

FAVIA RUDIS Verrill.

Plate LXXXVII.

1866. *Astrea* (*Favia*) *rudis* VERRILL, Proc. Essex Inst., V, p. 34.
1901. *Astræa rudis* STUDER, Zoolog. Jahrb., Syst., XL, p. 401.

Original description.—This species was originally described by Verrill as follows:

Corallum massive, convex or hemispherical, cellular. Corallites a little prominent, oval or oblong, unequal, rather close together at the margin, crowded at the center, with concave interstices striated by the thin, salient costæ. Cells deep, conical, with three cycles of septa, which are narrow, thin within but strongly thickened near the walls, considerably exsert, the upper part divided into strong spinose teeth, the inner edges with more slender sharp ones; paliform teeth little marked. Columella fine spongy.

Diameter of coral, 5 inches; of largest cells, 0.38; depth as much.

Sandwich Islands (?), Prof. J. D. Dana.

FAVIA HOMBRONI (Rousseau)?

1854. *Parastræa hombronii* L. ROUSSEAU, Voy. au Pôle Sud de Dumont-d'Urville, Zool., V, p. 122, Zooph., pl. XXVIII, fig. 3.
1857. *Favia hombroni* MILNE EDWARDS and HAIME, Hist. Nat. Corall., II, p. 435.
1866. *Astrea* (*Favia*) *hombroni* VERRILL, Proc. Essex Inst., V, p. 33.

Verrill's description is as follows:

Corallum incrusting at base; the surface, when free, naked and striated, rising at center into a convex, lobed mass. At the margin and about the base the cells are oval or circular, and separated by a space equal to their own diameter, while at the top they become crowded, polygonal, and intimately united by thin walls. Cells of medium size, rather deeper than wide, with about 18 septa in three cycles, the last incomplete in part of the systems. Septa narrow, considerably exsert, acute at summit, toothed with small sharp spines, a little thickened at the walls, not crowded. Paliform teeth, prominent, slender, placed before the two first cycles. Columella well developed, spongy. Costæ, where the cells are separated, thick and prominent, scabrous. Exotheca compact.

Height of coral, 4 inches; diameter about the same; width of cells, 0.12.

Sandwich Islands?, Prof. J. D. Dana.

In "box 820," with *Montipora capitata*, *Porites lobata*, *Coelastrea tenuis*, *Favia rudis*, *Pocillopora* (Coll. Smithsonian Institution).

Family MUSSIDÆ Verrill.

Genus MUSSA Oken.

MUSSA? sp. young?

Plate VIII, figs. 3, 3*a*.

A simple mussoid coral was growing attached to *Madrepora kauaiensis* Vaughan at station 4136. It is represented by Plate VIII, figs. 3, 3*a*, but no name is attached to it.

Locality.—Vicinity of Kauai Island; depth, 294–352 fathoms; temperature of the bottom, 44.2° F.; bottom, fine coral sand.

MADREPORARIA FUNGIDA.

In a review of Mr. J. Stanley Gardiner's Fungid Corals of the Maldive and Laccadive Archipelagoes,[a] I published the following note on the fungids of the Hawaiian Islands:

I have just completed a study of the Hawaiian Fungida, and may be pardoned for comparing them with those from the Indian Ocean. The following is a list of the species, with notes on their occurrence elsewhere: *Fungia* (*Cycloseris*) *patella* (Ell. and Sol.), east coast of Africa, etc.; *Fungia* (*Diaseris*) *fragilis* (Alcock), Indian Ocean; *Fungia scutaria* var. *dentigera* Leuckart, Indian Ocean, etc.; [*Fungia oahensis* Döderlein; *Fungia paumotensis* Stutchb. (*fide* Quelch), Philippines, etc.; *Fungia echinata* (Pallas) (*fide* Studer), Indian Ocean, etc.]; *Bathyactis stephana* Alcock, Indian Ocean; *Stephanaria stellata* Verrill, Panama; *Stephanaria* n. sp.; *Pavona varians* Verrill, aff. *P. repens* Brüggemann; *Pavona* n. sp.; *Leptoseris* (1) n. sp., aff. *L. fragilis* M. Ed. and H.; *Leptoseris* (2) n. sp.; *Leptoseris* (3) n. sp., aff. *L. papyracea* (Dana); *Leptoseris* (4) n. sp.; *Psammocora*, aff. *P. superficialis* Gardiner.

Further study of the material at my disposal has caused me to modify the determinations there given. The following is the revised list of the species placed in the Fungida, following the order in the article just quoted:

Fungia patella (Ellis and Solander).
Fungia fragilis (Alcock).
Fungia scutaria Lamarck.
Fungia oahensis Döderlein.
Fungia paumotensis Stutchbury (*fide* Quelch).
Fungia echinata (Pallas) (*fide* Studer).
Bathyactis hawaiiensis, new species.[b]
Stephanaria stellata Verrill.
Stephanaria brighami, new species.
Pavona varians Verrill.
Pavona duerdeni, new species.
Leptoseris hawaiiensis, new species.
Leptoseris scabra, new species.[c]
Leptoseris digitata, new species.[d]
Leptoseris tubulifera, new species.[e]
Psammocora verrilli, new species.

Of the 16 species recognized, there are two, cited on the authority of other students, whose occurrence in Hawaiian waters I consider doubtful. These 16 species are distributed among 6 genera; but it should be stated that the generic separation of *Leptoseris* from *Pavona* is doubtful. These 6 genera are considered to represent two families: The Fungiidæ, represented by *Fungia*; and the Agariciidæ, to which *Pavona*, *Leptoseris*, *Bathyactis*, *Stephanaria*, and *Psammocora* are referred.

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[a] Science, n. s., XXI, June 30, 1905, pp. 984–985.
[b] Referred to *B. stephana* Alcock.
[c] Referred to as *Leptoseris* (2), new species.
[d] Referred to as *Leptoseris* (3), new species.
[e] Referred to as *Leptoseris* (4), new species.

Family FUNGIIDÆ Dana.

1846. *Fungiæ* (part) DANA, Zooph. Wilkes Expl. Exped., p. 283.
1849. *Fungiæ* MILNE EDWARDS and HAIME, Comptes rend. Acad. Sci., Paris, XXIX, p. 71.
1884. *Fungiidæ* DUNCAN, Jour. Linn. Soc. London, Zool., XVIII, p. 141.
1905. *Fungiidæ* VAUGHAN, Proc. U. S. Nat. Mus., XXVIII, p. 379.

In the last paper[a] cited in this synonymy, this family was defined as follows:

Corallum simple or colonial, depressed or mitroid in form, septa of higher cycles usually perforate, those of the lower cycles perforate or solid. Synapticula, but no dissepiments, present. Wall in the adult perforate or compact. No epitheca.

The above diagnosis of the family probably should be supplemented by the following: The embryo becomes attached and forms a trophozooid,[b] which gives rise to buds antholblasts); the latter, by lateral growth, develop into anthocyathi; these by detachment form free individuals. The free anthocyathi may remain simple (the genus *Fungia*) or, by asexual reproduction, become colonial. The following remarks were added:

The mode of formation of the "anthocyathi" of *Fungia* has been known for many years, Stutchbury having first described it in 1830.[c] Bourne has made the mode of reproduction of *Fungia* the subject of very detailed investigations. It has been proved for nearly every known species of the genus that the free disks are produced by buds, which become detached from a parent stock (originally a trophozooid).

J. Stanley Gardiner, in his Fungid Corals collected in the South Pacific,[d] published the extremely interesting observation concerning *Halomitra* (*H. irregularis* Gardiner) that

the free corallum seems, from my specimens (2), to have been formed in a somewhat similar manner to that of the genus *Fungia*—by the breaking off of disks from an attached stock. At first there is one large central polyp with radiating septa; then, as growth proceeds, a number of calicular fossæ appear around this. On becoming free the central polyp may perhaps persist or, as in my specimens, may become indistinguishable from the daughter polyps, the septa gradually losing their regular radiating arrangement in the center of the colony.

In order to discover how generally the compound genera of the Fungiidæ might show evidence of having originally been trophozooids, I examined specimens of five of the genera:

Halomitra philippinensis Studer, young. Shows a very distinct scar of detachment.

Zoopilus echinatus Dana (probably type specimen). Shows a very distinct scar of detachment. This genus is scarcely more than a *Halomitra* with very few calices, and these are near the central corallite.

Cryptabacia talpina (Lamarck). There is some suggestion of a detachment scar, but the evidence is not positive.

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[a] A critical review of the literature on the simple genera of the Madreporaria Fungida, with a tentative classification. Proc. U. S. Nat. Mus., XXVIII, 1905, pp. 371–424.

[b] G. C. Bourne, On the postembryonic development of Fungia, Sci. Trans. Roy. Dublin Soc., V (2d ser.), 1893, p. 206.

[c] Trans. Linn. Soc. London, XVI, 1830, pp. 493–498.

[d] Proc. Zool. Soc. London, 1898, pp. 527–528.

Herpetolitha limax (Esper) and *H. stricta* Dana. Evidence of detachment scar very vague. Young specimens of *H. foliosa* [a] Ehrenberg, however, show as distinct a scar as any species of *Fungia*.

Lithactinia galeriformis (Dana), one of Dana's specimens. No evidence of a detachment scar.

The evidence, though not positive, is distinctly in favor of the coralla of all the Fungiidæ originating as trophozooids, and that the adult forms of the compound genera are due to asexual reproduction.

Quelch,[b] Gardiner,[c] and Studer[d] have called attention to the close relationship between *Fungia* and *Halomitra*, both Quelch and Studer considering *Fungia* the primitive form.

The *Albatross* obtained a good suite of *Fungia scutaria*, including trophozooids, from Laysan. Prof. W. T. Brigham has sent me five adult specimens and a photograph of six others. One of the specimens sent is dead and has attached to it five trophozooids. This material presents some important facts. As Bourne has described the postembryonic development of *Fungia* in so much detail, I will call attention to only a few features.

The trophozooid of *Fungia* might, if there were no further development, be referred to the genus *Trochoseris*, apparently warranting the conclusion that the ancestral form of Fungia was a simple Agariciid closely related to *Trochoseris*. The wall and septa are imperforate and a papillary columella is usually present.

The most primitive genus of the Fungiidæ undoubtedly is *Fungia*, and it seems probable that Döderlein is correct in considering the *F. patella* group the oldest species of the genus. Plate XXIX, fig. in lower left hand corner, represents a specimen of *F. scutaria* in which there is budding on the disk; in fact, the specimen could easily be referred to *Halomitra*.

To summarize the conclusions regarding the ancestry and phylogeny of the Fungiidæ;

1. The Fungiidæ are descended from the Agariciidæ.
2. The genus *Fungia* is the most primitive member of the family.
3. The other genera of the family are derived from *Fungia* by new calices arising asexually on the disk. (*a*) In *Halomitra*, the secondary calices possess distinctly radiating septa; (*b*) in *Cryptabacia*, the axial calices have distinctly radiating septa, but in the lateral calices the radiate arrangement, although evident, is often not so pronounced; (*c*) in *Herpetholitha* and *Polyphyllia*, the axial but not the lateral calices have radiating septa; (*d*) in *Lithactinia*, calices with radiating septa can not be distinguished on the adult corallum.

These genera present a series of forms in which the radiate arrangement of the septa becomes progessively less distinct. However, the series is probably not genetic. *Halomitra* may have been derived from one species of *Fungia; Herpetolitha* from another; and *Cryptabacia*, *Polyphyllia*, and *Lithactinia* from another.

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[a] Submitted to me for identification by Dr. Charles Gravier, of the Muséum d'Histoire Naturelle, Paris.

[b] Reef Corals, Challenger Rept., p. 139.

[c] Proc. Zool. Soc. London, 1898, pp. 527, 528.

[d] Zool. Jahrb., Syst., XL, p. 408.

Genus FUNGIA Lamarck.

1801. *Fungia* LAMARCK, Syst. Anim. sans. Vert., p. 369.
1902. *Fungia* DÖDERLEIN, Die Korallengattung Fungia, Senckenberg. naturforsch. Gesellsch., Abhandl., XXVII, Pt. 1, pp. I–III, 1–162, pls. I–XXV.
1905. *Fungia* VAUGHAN, Proc. U. S. Nat. Mus., XXVIII, p. 380.

The following remarks on the synonymy of *Fungia* appeared in the last paper cited above:

Original generic diagnosis.—"Corallum stony, free, orbicular, or hemispherical, or oblong, convex, and lamellate above, with a furrow or depression in the center, concave and rough below.

"A single lamellate, subproliferous star. Lamellæ dentate or spinose laterally."

Type-species.—*Fungia agariciformis* Lamarck = *Madrepora agaricites* Linnæus.[a] Lamarck originally referred six species to the genus, namely:

1. *Fungia agriciformis* LAMARCK = *Madrepora fungites* Linnæus.
2. *Fungia scutaria* LAMARCK, based on Seba, Thes., III, pl. CXII, figs. 28, 29, 30.
3. *Fungia limacina* LAMARCK = *Madrepora pileus* Ellis and Solander, pl. XLV.
4. *Fungia talpina* LAMARCK, based on Seba, Thes., III, pl. CXI, fig. 6, and pl. CXII, fig. 31.
5. *Fungia patellaris* LAMARCK = *Madrepora patella* ELLIS and SOLANDER, pl. XXVIII, figs. 1–4.
6. *Fungia pileus* LAMARCK = *Mitra polonica* RUMPHIUS, Herb. Amb., VI, pl. LXXXVIII, fig. 3.

Lamarck confused in his *Fungia* corals now considered to represent four different genera.

Fungia limacina Lamarck, now = *Herpetolitha limax* (Esper) Eschscholtz, 1825.

Fungia pileus Lamarck, now = *Halomitra pileus* (Pallas) Dana, 1846.

Fungia talpina Lamarck, now = *Cryptabacia talpina* (Lamarck) Milne Edwards and Haime, 1849.

This leaves in *Fungia* proper, *F. agariciformis* Lamarck (= *fungites* Linnæus), *F. scutaria* Lamarck, and *F. patella* (Ellis and Solander).

Leuckart in 1841[b] cites *Fungia agariciformis* Lamarck as "Typus," fixing the type.

Milne Edwards and Haime in 1849[c] cite under *Fungia*, *F. agariciformis* and *patellaris* Lamarck. In 1850, in their Monograph of the British Fossil Corals[d], *Fungia patellaris* Lamarck is definitely given as the type-species. *F. patellaris* Lamarck (*Madrepora patella* Ellis and Solander) can not be the type-species, as *F. agariciformis* Lamarck had already been so designated. In the third volume of the Histoire Naturelle des Coralliaires, pages 6, 7, Milne Edwards accepts the latter species as the type, using for it the Linnæan name *Madrepora fungites*.

Remarks.—Prof. Ludwig Döderlein has published an elaborate monograph, Die Korallengattung Fungia[e], in which the various skeletal parts of the genus are described in much detail. A bibliography is also given. A discussion of the genus will not be attempted here, as the work of Professor Döderlein can be consulted.

[a] See Döderlein, Senckenb. naturforsch. Gesellsch., Abhandl., XXVII, 1902, p. 136–156, pls. XX–XXV.
[b] Observ. Zoolog. de Zooph. Corall., spec. de Gen. Fungia, p. 42, pl. IV, figs. 1–4.
[c] Comptes rend. Acad. Paris, XXIX, 1849, p. 72.
[d] Introduction, p. xlvi.
[e] Senckenberg. naturfor. Gesellsch., Abhandl., XVII, Pt. 1, 1902, pp. i–iii, 1–162, pls. xxv.

Fungia has several synonyms, which are as follows[a]:

CYCLOSERIS Milne Edwards and Haime, Comptes rend. Acad., Paris, XXIX, 1849, p. 72.

The genus was placed by its authors in their "Lophoserinæ," which was characterized by having "the plateau without epitheca or echinulations, and with imperforate tissues."

Original generic diagnosis.—"Corallum simple, free. Septa very numerous, uniting by their inner margins."

Type-species.—*Fungia cyclolites* Lamarck, Hist. Nat. Anim. sans Vertèbres, II, p. 236: Döderlein, Korallengat. Fungia, pp. 77–79, pl. IV, figs. 7–9, pl. V, figs. 5, 5*a*.

Distribution.—Recent, China Seas and Philippines eastward to the mid-Pacific.

ACTINOSERIS d'Orbigny, Note sur des Polyp. foss., p. 12, 1849.

Original generic diagnosis.—"It is a circular *Cycloseris*, whose columella is central, round, and not in an elongated furrow."

Type-species.—*A. cenomanensis* d'Orbigny, Note sur des Polyp. foss., nom. nud.; Prod. de paléontol., II, p. 180: Milne Edwards and Haime, Hist. Nat. Corall., III, p. 53.

Distribution.—"Groupe de la craie tuffeau, Le Mans."

Milne Edwards[b] refers *Actinoseris cenomanensis* to the genus *Cycloseris*, making d'Orbigny's *Actinoseris* a synonym of their *Cycloseris*. The septal structure of d'Orbigny's genus should be investigated, and it may be well to reinvestigate the Tertiary and Cretaceous species of *Cycloseris;* they may not be congeneric with *Fungia* (*Cycloseris*) *cyclolites* Lamarck. It is of especial importance to determine whether the free disks of these corals placed in *Cycloseris* originate as anthocyathi, as in *Fungia*.

DIASERIS Milne Edwards and Haime, Comptes rend. Acad., Paris, XXIX, 1849, p. 72.

This genus was placed by its authors in their "Lophoserinæ," characterized by having "the plateau without epitheca and echinulations, and with imperforate tissues."

Original generic diagnosis.—"Differs from the preceding [*Cycloseris*] in that, when young, it is composed of separate parts that unite later."

Type-species.—*Fungia distorta* Michelin, Mag. de Zool., 2d ser., V Année, Zooph., pl. V: Döderlein, Korallengat. Fungia, pp. 74–77, pl. III, and pl. V, figs. 3, 3*a*.

Distribution.—Philippines.

Remarks.—Duncan in his "Revision of the Genera and Families of the Madreporaria"[c] places *Ecmesus* Philippi[d] and *Hemicyathus* Seguenza[e] in the synonymy of *Diaseris*. *Ecmesus* is a doubtful coral, but probably is an imperfect specimen of a trochocyathoid species. The *Hemicyathus* of Seguenza certainly belongs in that group.

[a] All of these excepting *Actinoseris* d'Orbigny are discussed by Döderlein, in his Die Korallengattung Fungia. For further discussion consult that work.

[b] Hist. Nat. Corall., III, p. 53.

[c] Jour. Linn. Soc. London, Zool., XVIII, 1884, p. 150.

[d] Neues Jahrb. für Mineral., Jahrg. 1841, p. 665, pl. XIB, figs. 1 *a–e*.

[e] Corallarii fossili del. rocce terz. del dist. Messina, 1864, Pt. 2, p. 67.

PLEURACTIS Verrill, Bull. Mus. Comp. Zool., I, 1864, p. 52.

Type-species.—*Fungia scutaria* Lamarck, Hist. Nat. Anim. sans Vert., II, p. 236: Döderlein, Korallengat. Fungia, pp. 91–97, pl. VIII, figs. 1–6.

A type-species was designated, but no description was published. The genus was intended to embrace more or less elongate flat *Fungiæ*, without tentacular lobes on the septa.

LOBACTIS Verrill, Bull. Mus. Comp. Zool., I, 1864, p. 52.

Type-species.—*Fungia dentigera* Leuckart, De Zooph. Corall. et spec. Gen. Fungia, pp. 48–49, pl. III, figs. 1, 2; cf. Döderlein, Korallengat. Fungia, pp. 91–97.

There was no original description; only a type-species was cited. This group is composed of somewhat elongate, flat species, in which the tentacular lobes of the septa are greatly developed.

CTENACTIS Verrill, Bull. Mus. Comp. Zool., I, 1864, p. 51.

Type-species.—*Madrepora echinata* Pallas, Elench. Zooph., p. 284: *Fungia echinata*, Döderlein, Korallengat. Fungia, pp. 101–105, pl. X, figs. 1–5.

No diagnosis of the genus was published. It was established for the very large, elongate *Fungiæ*, the largest known, in which the septal margins are strongly dentate, the dentations resembling, as the name implies, the teeth of a comb.

HALIGLOSSA (part) Ehrenberg, Akad. Wissensch. Berlin, Abhandl., 1832, p. 274, 1834.

Original generic diagnosis.—[Fungids] compound (polystomatous), base expanded, stoloniferous, extended in two directly opposite directions (its oblong form recalling a tongue = *Manicinæ liberæ*).

To this genus he refers five species:

1. *Madrepora echinata* Pallas.

2. *Fungia limacina* Lamarck = *Madrepora pileus* Ellis and Solander.

3. *Haliglossa interrupta* Ehrenberg = *Madrepora pileus* of Linnæus and Pallas = *Fungus pileus oblongus*, Seba, Thes., III, pl. CXI, fig. 5.

4. *Haliglossa foliosa* Ehrenberg = *Madrepora pileus* Linnæus and Pallas: Seba, Thes., III, pl. CXI, fig. 3.

5. *Haliglossa stellaris* Ehrenberg = *Madrepora pileus* var. Esper, pl. LXXIII.

No. 1 was considered by Leuckart to be wrongly identified, and was named *Fungia ehrenbergi* by him.[a] Professor Döderlein, in his Die Korallengattung Fungia,[b] places Leuckart's *Fungia ehrenbergi* in the synonymy of *Fungia echinata* (Pallas). Milne Edwards and Haime refer the four others[c] to the synonymy of *Herpetolitha limax* (Esper) Eschscholtz, 1825.

Therefore the genus *Haliglossa* contained two genera, one part of which belongs to *Fungia* Lamarck, 1801, the other to *Herpetolitha* Eschscholtz, 1825,[d] and consequently must lapse.

[a] De zooph. corrall. et gen. Fungia, 1841, p. 52, pl. II.

[b] Senckenberg. naturfor. Gesellsch., Abhandl., XXVII, 1902, p. 101.

[c] Ann. Sci. nat., 3ième sér., Zool., XV, p. 94.

[d] Eschscholtz's *Herpetolitha* (Isis, XVI, 1825, p. 746), originally contained two species, *Fungia limacina* and *Fungia talpa*, of Lamarck. Milne Edwards and Haime, in 1849 (Comptes rend., XXIX, p. 71), restricted *Herpetolitha* to the first mentioned species (citing *Madrepora pileus* Ellis and Solander, pl. XLV) and proposed the genus *Cryptabacia* for the second.

Mr. J. Stanley Gardiner does not accept the reference of *Cycloseris* and *Diaseris* to the synonymy of Fungia.[a] He says regarding *Cycloseris:* "The successive fusion of the septa of the higher cycles (24 or 48) and the elevation of the edges of the intervening septa to the same level as those of the larger septa (i. e., the lower cycles) immediately after this fusion has taken place is further a most characteristic feature of the genus."

Gardiner previously[b] had considered *Cycloseris* separable from *Fungia* because "the primary septa in *Cycloseris* are very definitely six in number, the secondaries not reaching quite so far into the calice and having the tertiaries fused to them. In the youngest instar that I examined there are six thick, subequal septa, and in the youngest *Fungia* found by Bourne 'twelve septa are present, of which six are distinctly larger than the others.'"

On page 172 of the paper cited, Gardiner says: "*Cycloseris* differs from *Fungia* as described by Duncan mainly in the fact that the theca in the former is imperforate."

The differences between *Cycloseris* and *Fungia* are therefore: (1) The wall in *Cycloseris* is imperforate, in *Fungia* perforate. (2) In *Cycloseris* there are originally only six septa, whereas in *Fungia* there are twelve. (3) There is the supposedly peculiar fusion of the septa.

There has been considerable controversy concerning the generic validity of *Diaseris*. Mr. Gardiner, in his Madreporaria of the Maldive and Laccadive Islands,[c] says: "The division of the corallum into segments, each of which includes a part of the axial fossa, seems to be in certain species of Fungids a regular and normal method of reproduction by asexual means." Quelch, in his report on the reef corals of the *Challenger* expedition (p. 119), states emphatically that he had specimens of *Diaseris freyceneti* that were of the *Cycloseris*-form. Döderlein, in his Korallengattung *Fungia*, says that he had *Diaseris*-form specimens of *Cycloseris patella* and *Cycloseris*-form specimens of *Diaseris distorta*.

I decided to make a careful examination of all the material in the United States National Museum in order to test the supposed validity of the three genera, *Cycloseris*, *Diaseris*, and *Fungia*, and have presented the data obtained under three headings, *Cycloseris*, *Diaseris*, and *Fungia*. Under each of these headings I have compiled from Döderlein the specific names that have been applied to forms belonging to each group, then I have listed the species recognized by him as valid, summarizing under each the synonymy given by him, and have called attention to some specific names that are not recognized, but were not placed in any synonymy. This summary and remarks are followed by a list of the species in the United States National Museum. Then I give a tabular statement of the results of a macroscopic study of the wall and septa of each species.[d]

[a] Fauna and Geography of the Maldive and Laccadive Archipelagoes, II, Sup. I, pp. 944, 945.

[b] Willey's Zoological Results, p. 175.

[c] Fauna of the Maldive and Laccadive Archipelagoes, II, Sup. I, p. 945.

[d] The descriptions and figures of the three species of which I am the author were published in my Three New Fungiæ, with a description of *Fungia granulosa* Klunzinger and a note on a specimen of *Fungia concinna* Verrill, Proc. U. S. Nat. Mus., XXX, 1906, pp. 827–832, pls. LXVII–LXXIV.

It seemed to me that a study of this kind would be important in possibly throwing light on the value of characters supposed to be of family or generic value. Somewhat more than 400 specimens were studied; of these about 45 were received from Dr. Charles Gravier, of the Muséum d'Histoire Naturelle, Paris, the others are the property of the United States National Museum. This amount of material probably may appear large, but it is entirely insufficient for the working out of the variations and the delimitation of the different species. In spite of the insufficiency of the material, however, I trust that data of value have been procured through its careful study.

CYCLOSERIS.

DESCRIBED SPECIES OF CYCLOSERIS.

Madrepora patella Ellis and Solander.
Fungia cyclolites Lamarck.
Fungia tenuis Dana.
Fungia glans Dana.
Fungia hexagonalis Milne Edwards and Haime.
Cycloseris sinensis Milne Edwards and Haime.
Fungia elegans Verrill.
Cycloseris discus Quelch.
Cycloseris mycoides Alcock.
Fungia erosa Döderlein.
Fungia costulata Ortmann.

Döderlein does not recognize *Cycloseris* as a valid genus, considering it a synonym of *Fungia*. He does, however, recognize a *patella* group of species and refers to it all the species of *Cycloseris* and *Diaseris*. He refers 6 species to the group, viz:

F. patella (Ellis and Solander) (>*F. tenuis* Dana+*F. hexagonalis* Milne Edwards and Haime+*Diaseris fragilis* Alcock).
F. erosa Döderlein.
F. distorta Michelin (type of *Diaseris*).
F. cyclolites Lamarck (type of *Cycloseris*) (>? *Diaseris mortoni* Tenison-Wood).
F. elegans Verrill.
F. costulata Ortmann.

The following species, originally based on the *Cycloseris* form, are said to possess a *Diaseris* form:

F. patella (Ellis and Solander).
F. cyclolites Lamarck.

The following specific names are not recognized, nor are they placed in any synonymy:

Fungia glans Dana.
Cycloseris sinensis Milne Edwards and Haime.
Cycloseris discus Quelch.
Cycloseris mycoides Alcock.

List of the species of *Cycloseris*, *Diaseris*, and *Fungia* in the United States National Museum:

Cycloseris, 1 sp., Philippine Islands.
Cycloseris, 2 sp., Philippine Islands.
Cycloseris patella (Ellis and Solander), Hawaiian Islands, and east coast of Africa.
Cycloseris elegans (Verrill), Gulf of California.
Cycloseris tenuis (Dana), Pacific Ocean, probably Paumotus.

The macroscopic structure of Cycloseris.

Species.	Wall.		Septal.			Columella.
	Young.	Adult.	Arrangement.	Margins.	Structure.	
C. 1 sp. Philippines (5 specimens).	....	Solid ..	Primaries slightly more pronounced than secondaries.	Entire or very minutely dentate.	1st, 2d, 3d cycles solid; higher cycles slightly perforate.	A few weak, tortuous axial trabeculæ.
C. 2 sp. Philippines (7 specimens).	....	Solid ..	Primaries slightly more pronounced than secondaries.	Pectinate, a tooth for each septual trabecula.	Primaries slightly perforate; the higher cycles increasingly more perforate; the highest often a latticework. Perforations between trabeculæ.	Small, finely papillary.
C. patella (Ellis and Solomber) (59 large + 60 + young).	Solid ..	Solid ..	Primaries more pronounced than secondaries.	Minutely dentate, dentations of lower cycles serrate.	Primaries and secondaries solid; 3d, inner edges somewhat perforate; the higher cycles increasingly more perforate.	Moderately developed, papillary.
C. elegans (Verrill) (10 specimens).	Solid ..	Solid ..	Primaries more pronounced than secondaries.	Finely dentate.	Solid; no perforations on even the smallest.	Not much developed, papillary.
C. tenuis (Dana) (1 specimen).	....	Solid ..	Primaries slightly more pronounced than secondaries.	Finely dentate.	1st, 2d solid; higher with perforate inner portions.	Moderately developed, spongy.

To summarize the results obtained from this comparative study:

The wall in all the forms studied is imperforate. The primaries septa are persistently differentiated from the secondaries by slightly greater length, and are usually somewhat taller. The septal margins are always finely dentate. The columella varies in size, it is composed of interlacing, fused, small trabeculæ, and usually has a papillary upper surface. The greatest variation in structure commonly considered of importance is in the perforateness of the septa. The species form a continuous series from *C. elegans* with entirely solid septa to *C. 2 sp. Philippines*, in which the septa have cyclolitoid structure.

The species symbolized by *C. 2 sp. Philippines*, deserved further consideration. I at first labeled the specimens *Fungia distorta* Michelin, and am by no means sure that they do not belong to that species. The septal margins and septal structure are identical with *F. distorta*, the number of septa in each to 5 mm. (18 or 19) is the same, and there is no difference in the costæ of the base. The specimens referred to *Cycloseris* are thicker in the oral region. One of the *Cycloseris* specimens has several sharply indented lines radiating from the base, and there are indications of these lines on the upper surface. This specimen looks as if its division into *Diaseris* segments had been initiated, but the process not completed. The segments have remained attached, but indications of the arrested division still persist. There are suggestions in some of the other specimens of lines along which division might take place. These *Cycloseris* specimens seem to me to be the *Cycloseris*-form of *Fungia distorta*, the only distinguishing character that I can discover consisting in a few millimeters difference in thickness in the oral region. Several of these specimens possess small secondary mouths on their oral surfaces.

Cycloseris 1 sp. Philippines, may be small specimens of *F. cyclolites* Lamarck. They are damaged, and I should not like to identify them specifically.

DIASERIS.

DESCRIBED SPECIES OF DIASERIS.[a]

Fungia distorta Michelin (geno-type).
Diaseris freyceneti Milne Edwards and Haime.
Diaseris pulchella Verrill.
Diaseris mortoni Tenison-Wood.
Diaseris fragilis Alcock.

The following species originally based on the *Diaseris*-form are said to possess a *Cycloseris*-form:

Fungia distorta Michelin (*fide* Döderlein).
Diaseris freyceneti Milne Edwards and Haime (*fide* Quelch).
Diaseris mortoni Tenison-Wood (<? *F. cyclolites* Lamarck).
Diaseris fragilis Alcock (<F. patella (Ellis and Solander)).

The specific name *Diaseris pulchella* Verrill is ignored by Döderlein, i. e., the species is not recognized, and the name is not placed in the synonymy of any species.

[a] The species described by Pourtalès from the Atlantic are purposely omitted.

Species of *Diaseris* in the United States National Museum:

Diaseris distorta (Michelin) (geno-type) Philippine Islands.
Diaseris freycineti Milne-Edwards and Haime (synonym of the preceding).
Diaseris, sp., Philippine Islands.
Diaseris japonica Vaughan, Tertiary, Yezzo, Japan.
Diaseris pulchella Verrill, Oushima, Japan.
Diaseris fragilis Alcock, Hawaiian Islands.
Diaseris, sp., Gulf of California.

The macroscopic structure of Diaseris.

Species.	Wall.		Septal.			Columella.
	Young.	Adult.	Arrangement.	Margins.	Structure.	
D. distorta (Michelin) (26 + specimens including isolated segments).	Solid in the smallest specimens examined.	Solid, except occasionally there are a few peripheral synapticula.	The various cycles not distinguishable.	Finely pectinate.	Perforate, especially the last and penultimate cycles, which may form a latticework.	Very poorly developed.
D. sp. Philippines (3 segments).	....	Solid for the most part, synapticulate in places.	A variable number of most prominent septa, primaries, and secondaries not differentiated from each other.	Finely serrately dentate.	Perforations rarely on inner ends of the last and penultimate cycles; septa otherwise solid.	Absent.
D. japonica Vaughan (2 specimens).	....	Solid, except a few peripheral perforations.	Primaries and secondaries not distinctly differentiated from each other.	Minutely dentate.	1st and 2nd cycles slightly perforate near the margins; higher cycles more perforate.	Small, poorly developed.
D. fragilis Alcock (2 specimens).	....	Solid, except very rarely synapticulate on the very periphery.	Primaries and secondaries more pronounced, subequal.	Finely pectinate.	1st and 2nd cycles solid; higher cycles more or less perforate. Last cycle and penultimate tend toward latticework pattern.	Small, papillary.
D. pulchella Verrill (2 specimens).	....	Solid, very rarely synapticulate on edge.	Primaries most pronounced of the septa.	Finely pectinate.	All septa perforate; higher cycles tend toward latticework pattern.	Poorly developed or absent.
D. sp. Gulf California (23 specimens, including segments).	....	Solid	Primaries and secondaries more prominent, subequal.	Finely pectinate.	1st solid, 2nd occasional perforations on inner ends; others abundantly perforate between septal trabeculæ.	Very poorly developed, if not altogether absent.

Summary of the results of the comparative study:

The corallum wall is solid, except in some instances it may be synapticulate at the periphery; because of the habit of the corallum of breaking into segments and subsequently being added to, the easy recognition of the different septal cycles is not expected; but in a specimen like one of those of *D. pulchella*, in which the segments have not as yet become dissociated, the primaries are more pronounced than the secondaries; the septal margins are finely dentate; the septal lamellæ show precisely the same variation as in *Cycloseris*, from cribriform to solid.

The close relationship between *Cycloseris 2 sp. Philippines* to *Diaseris distorta* has been pointed out. *Diaseris sp. Philippines* may be undescribed, but with no more material for comparison I would not name it. One specimen of *Diaseris pulchella* Verrill is intensely interesting. In handling the specimen a segment was broken out, but the specimen originally was circular. When it is taken in connection with *Cycloseris 2 sp. Philippines*, strong evidence is adduced against *Diaseris* being generically separable from *Cycloseris*.

The specimens from the Gulf of California are very similar to Döderlein's *Diaseris*-form of *Fungia patella*.

FUNGIA.

DESCRIBED SPECIES OF *FUNGIA*.

F. actiniformis Quoy and Gaimard.
>*F. crassitentaculata* Quoy and Gaimard.
F. diversidens Milne Edwards and Haime.

Döderlein recognizes five varieties: *singapurensis*, *suluensis*, *crassitentaculata*, *patawensis*, and *salawattensis*.

F. paumotensis Stutchbury.
>*F. charcharias* Studer.

F. charcharias Studer is recognized as a variety.

F. scutaria Lamarck.
>*F. dentigera* Leuckart.
Lobactis danæ Verrill.
Lobactis conferta Verrill.
F. placunaria Klunzinger.
F. tenuidens Quelch.
F. verrilliana Quelch.

Döderlein recognizes under *F. scutaria* three varieties: *danai*, *placunaria*, and *dentigera*.

F. oahensis Döderlein.
F. proechinata Döderlein.
F. echinata (*Pallas*) [as *Madrepora*.]
>*F. pectinata* Ehrenberg.
Herpetolithas ehrenbergi Leuckart.
Herpetolithas rüppellii Leuckart.
F. gigantea Dana.
F. asperata Dana.
F. crassa Dana.

Döderlein recognizes three varieties: *gigantea*, *parvispina*, and *undulata*.

F. granulosa Klunzinger.
F. scabra Döderlein.
F. plana Studer.
F. concinna Verrill.
?>*F. serrulata* Verrill.

Döderlein considers *serrulata* as a variety.

F. repanda Dana.
>*F. linnæi* Milne Edwards and Haime.
F. acutidens Studer.
F. horrida Dana.
F. klunzingeri Döderlein.
F. valida Verrill.
F. subrepanda Döderlein.
F. danai Milne Edwards and Haime.
>*F. lobulata* Ortmann.

Döderlein recognizes one variety: var. *vitiensis*.

F. corona Döderlein.
F. scruposa Klunzinger.

Döderlein recognizes one variety: *ternatensis*.

F. fungites (Linnæus) [as *Madrepora*.]
>*F. agariciformis* Lamarck.
F. discus Dana.
F. dentata Dana.
F. confertifolia Dana.
F. tenuifolia Milne Edwards and Haime.
F. crassilamellata Milne Edwards and Haime.
F. haimei Verrill.
F. papillosa Verrill.
F. lacera Verrill [type U. S. National Museum, belongs to *danai* group].
F. pliculosa Studer.

Döderlein recognizes thirteen varieties of this species: *discus*, *plicata*, *haimei*, *incisa*, *agariciformis*, *crassilamellata*, *indica*, *papillosa*, *grandis*, *dentata*, *confertifolia*, *stylifera*, and *columnifera*.

SPECIES OF FUNGIA IN THE UNITED STATES NATIONAL MUSEUM.

Döderlein's arrangement into groups is followed in the list given below.

F. ACTINIFORMIS GROUP.

F. actiniformis Quoy and Gaimard. Philippine Islands.

F. SCUTARIA GROUP.

F. paumotensis Stutchbury.
F. scutaria Lamarck.
F. scutaria var. *dentigera* Leuckart.
F. sp. 1. Philippines.
F. sp. 2. Philippines.

F. ECHINATA GROUP.

F. echinata (Pallas) (at least 3 varieties or variations).

F. REPANDA GROUP.

F. granulosa Klunzinger.
F. scabra Döderlein.
F. plana Studer.
F. concinna Verrill.
F. repanda Dana.
F. samboangensis Vaughan.

F. DANAI GROUP.

F. horrida Dana.
F. subrepanda Döderlein.
F. danai Milne Edwards and Haime.
F. madagascarensis Vaughan.

F. FUNGITES GROUP.

F. fungites (Linnæus).

Of the species recognized by Döderlein, the following are not represented by specimens in the United States National Museum:

F. oahensis Döderlein.
F. proechinata Döderlein (doubtfully represented).
F. acutidens Studer.
F. klunzingeri Döderlein.
F. valida Verrill.
F. corona Döderlein.
F. scruposa Klunzinger.

The macroscopic structure of Fungia.

Species.	Wall.		Septal.			Columella.
	Young.	Adult.	Arrangement.	Margins.	Structure.	
F. actiniformis Quoy and Gaimard (7 anthocyathi, 3 recently detached, 1 anthocormus with 1 anthocyathus not yet detached).	Solid	With more or less numerous slits and perforations or solid.	Primaries distinct in attached anthocyathus. In free adult variable number of equal principal septa. Primaries not especially differentiated.	Coarsely serrately dentate.	Mostly imperforate. Highest cycles have some irregular perforations along the upper margins near their inner edges.	Poorly developed, scant, papillary.
F. paumotensis Stutchbury. (18 specimens.)		With slits especially near periphery.	Primaries, secondaries and most of the tertiaries reach the fossa and are equal. (The septa in specimens from both Tahiti and Philippines in from 5 to 6 sizes).	Dentate, or subentire.	Specimen from Tahiti: principal septa solid, the next in size solid, the last abundantly perforate near the margins. Specimen from Philippine Islands: principal septa and those next in size may be slightly perforate near the margin; inner portion of the next in size perforate; last cycle as in Tahiti specimen.	Very poorly developed, almost absent.
F. scutaria Lamarck. (12 specimens, 7 small free anthocyathi with detachment scar, 2 attached small anthocyathi).	Solid	Perforate	About 3 cycles of principals, primaries not differentiated.	Dentate	Imperforate	Very poorly developed, or absent.
F. scutaria Lamarck. (27 specimens, 19 adults, 1 anthocormus, 7 attached single anthocyathi) (Hawaiian Islands and Laysan).	Solid	Perforate	Primaries distinguishable in the attached anthocyathi. More than 3 cycles of principals, primaries not differentiated in the adult.	Dentate	Imperforate	Very poorly developed, or absent.
F. aff. scutaria Lamarck. (2 specimens, Philippines).		Perforate	More than 3 cycles of principals; primaries not differentiated.	Dentate, sometimes incised.	The prolongation from the inner ends of higher cycles perforate.	Almost absent.

The macroscopic structure of fungia—Continued.

Species.	Wall.		Septal.			Columella.
	Young.	Adult.	Arrangement.	Margins.	Structure.	
F. aff. scutaria Lamarck (1 specimen, Philippines).	....	With slits near the periphery, mostly solid.	More than 3 cycles of principals.	Dentate, or subentire somewhat undulate.	Two highest cycles more or less perforate.	Very poorly developed.
F. echinata (Pallas) (14 specimens, covering several variations).	....	Very perforate.	Many principals; primaries not recognizable.	Coarsely pectinate or very coarsely dentate.	Principals nearly always solid; higher cycles perforate.	Very poorly developed, or absent.
F. granulosa Klunzinger (1 specimen).	....	With a very few perforations.	More than 2 cycles of principals; primaries not differentiated.	Dentate; dentations rather coarse and somewhat irregular.	Principals and the next in size solid; higher cycles, especially the prolongations of the inner ends, perforate.	Scarcely developed.
F. scabra Döderlein (4 specimens and 3 other young detached anthocyathi that probably also belong to the species).	Solid	Solid	Primaries easily distinguishable in the young free anthocyathi; also in the adults, but in the latter the median lateral secondaries equal the primaries in size.	Finely dentate.	Solid, except the last cycle and the inner prolongation of the penultimate.	Slightly developed, papillary.
F. plana Studer (12 specimens, 1 recently detached anthocyathi).	Solid	Solid	Primaries easily distinguishable, slightly exceeding in length the secondaries except the median lateral ones. In the young detached anthocyathus the six primaries are very distinct.	Dentate; dentations rather small and usually rather regular.	Solid, except the highest cycles (about 4), especially their inner prolongations, which are perforate.	Moderately developed, papillary.
F. concinna Verrill (32 specimens, including 4 recently detached anthocyathi).	Solid	With a few slits.	Primaries distinctly differentiated in the young, free anthocyathi; in the adult the median lateral secondaries equal the primaries in length.	Coarsely dentate.	1st-4th solid; only last cycle perforate near wall; inner prolongations from septal groups perforate.	Moderately developed.

F. repanda Dana (14 specimens).	....	Perforate	The tendency for the secondaries or even a few tertiaries to equal the primaries in length is more pronounced than in the three preceding species.	Dentate, dentations vary greatly in size.	Inner septal prolongation perforate, otherwise appear solid.	Poorly developed.
F. samboangensis Vaughan (1 specimen).	....	Perforate	Primaries very slightly more pronounced than the secondaries.	Dentate	Two highest cycles more or less perforate; 1st, 2nd, 3rd, 4th solid; probably 5th also. Perforations mostly or entirely confined to the inner prolongations.	Moderately developed.
F. horrida Dana (1 specimen).	....	With long slits around the periphery.	Primaries and secondaries not clearly differentiated.	Largest septa very coarsely dentate.	Highest cycle and inner prolongations of the next three or four perforate.	Rather well developed.
F. subrepanda Döderlein (2 specimens).	....	With slits and perforations.	Median lateral secondaries equal the primaries in length.	Dentate, dentations variable in size, rather coarse.	Three lowest cycles imperforate; highest cycle perforate to periphery; intermediates have the inner prolongations perforate.	Poorly developed, papillary.
F. danai Milne Edwards and Haime (7 specimens).	....	Perforate	Primaries rather distinct or equaled by the secondaries.	Dentate	Last cycle and inner prolongations of the next three or four perforate.	Poorly developed.
F. madagascarensis Vaughan (1 specimen).	....	Perforate	1st three cycles equal...	Coarsely dentate.	Lower cycles solid; higher (the last three) perforate.	Practically absent.
F. lacera Verrill.........	....	Very perforate .	Median lateral secondaries equal the primaries.	Coarsely and jaggedly dentate, often deeply incised.	Lower cycles solid, last perforate, also inner prolongations of the next two.	Poorly developed.
F. fungites (Linnæus). (100 + specimens.)	Anthoblast wall solid.	Perforate	In young attached and detached anthocyathi primaries more prominent, secondaries subsequently equaling the primaries, in large and older specimens all the tertiaries and some quaternaries equal the primaries.	Dentate, dentations vary enormously in size.	Lower cycles usually solid; higher more or less perforate.	Poorly developed.

I desire to change Döderlein's order of the discussion of the species of *Fungia* for the purposes of this paper, preferring the following order:

F. scabra Döderlein.
F. plana Studer.
F. concinna Verrill.
F. repanda Dana.
F. granulosa Klunzinger.
F. samboangensis Vaughan.
F. actiniformis Quoy and Gaimard.
F. horrida Dana.
F. subrepanda Döderlein.
F. danai Milne Edwards and Haime.
F. madagascarensis Vaughan.
F. lacera Verrill.
F. fungites (Linnæus).
F. scutaria Lamarck.
F. paumotensis Stutchbury.
F. echinata Pallas.

These 16 so-called species are represented in the collections in my hands. Probably *F. plana* Studer, *F. concinna* Verrill, and *F. repanda* Dana form a continuous series.

As the relationship between *Cycloseris* and *Diaseris* has already been sufficiently considered, only the relationship between *Cycloseris* and *Fungia* will now be discussed.

1. The wall in *Cycloseris* is imperforate; so is the wall in *F. scabra* and *F. plana*, *F. plana*, *F. concinna*, and *F. repanda* form a closely related, or even a continuous series, with a passage from a solid wall to one that is abundantly perforate. *Cycloseris* can not be separated from *Fungia* on mural characters. In the trophozooid stage of all *Fungiæ* in which that stage is known, also in the antholblast stage, and in that part of the anthocyathus near the anthocaulus, the wall is solid. The wall may continue to be solid, or it may be interrupted in its development, leaving pores or slits. The pores or slits may remain open or be subsequently filled by a deposit of stereoplasm. A compact wall is primitive in *Fungia* and its allies; the perforate wall a later development.

2. *Cycloseris* in its youngest stage has six septa, *Fungia* twelve. Mr. Gardiner in his study of the very young trophozooids of *Cycloseris hexagonalis* found originally only six primary septa; Mr. Bourne in his study of *Fungia* found in his youngest specimens twelve entocœlic septa, six of which were larger than the others. In testing the observations of Mr. Gardiner and Mr. Bourne, I have never found either observer in error, but I do not consider that Mr. Bourne has proved that *Fungia* originally has twelve entocœlic septa. He did not work with larvæ in which he could watch the actual beginning of the formation of the septa, but worked with young specimens sent him by Professor Haddon. It is well here to bear in mind the work of von Marenzeller and von Koch on *Flabellum*. Von Marenzeller contended

that *Flabellum* originally had twelve septa; von Koch, however, later showed that it begins with six.

3. The persistence of six more pronounced primary septa and the peculiar fusion of the septa in *Cycloseris* are stated correctly by Mr. Gardiner. The first character is persistent throughout all of the species of *Cycloseris* known to me, including *Fungia elegans* Verrill. The mode of fusion of the septa described by Mr. Gardiner occurs in all the species of *Cycloseris* with which I am familiar, but it is not confined to them. He is mistaken, however, when he says that the margins of the higher cycles invariably become equal in height to those of the lower cycles immediately after fusion.

Bourne emphasizes his assertion that six of the twelve septa are more prominent in young *Fungiæ*. In all of the young *Fungia* that I have seen the primaries are easily distinguished. In a number of species (*F. scabra*, *F. plana*, etc.) they are distinct in the adults. As the specimens of a particular species increase in size, or as a species is of larger size, septa of higher cycles extend to the columella, so that in large specimens or large species, septa of several cycles reach the axis. All species referred to *Cycloseris* are small.

The successive fusion of the higher to the lower cycles of septa can not be considered characteristic of *Cycloseris*, unless the greater number of known species of *Fungia* be placed in *Cycloseris*. We should have to begin with *F. horrida*, *F. danai*, etc.

After having made an extensive study to discover if there are characters by which *Diaseris* can be separated from *Cycloseris* and *Cycloseris* from *Fungia*, I feel convinced that they should not be separated. There is simply no difference between *Cycloseris* and *Fungia*. The peculiar mode of reproduction in *Diaseris* may in some instances furnish an aid to specific determination.

In my paper,[a] already cited, I said:

> I have distributed the genera considered in this paper among four families and have five headings for genera that are not referred to families. This classification, which embodies nothing new, except making a family, Micrabaciidæ, is only an attempt, and should be subjected to the most searching criticism to determine the validity of the characters used in differentiating the families. The Leptophylliidæ[b] are very doubtfully separable from Gregory's Thamnastræidæ, though they probably should be kept separate. The Micrabaciidæ have solid septa and perforate walls. The Anabraciidæ are characterized by having a very pronounced and regular trabecular septal structure, but in some genera the basal pores between the trabeculæ are filled with stereoplasm, bringing this family and the Leptophylliidæ very close together.
>
> Before the synonymy of the proposed genera can be determined they must be accurately defined, and here I will repeat *that the generic definitions must be based primarily upon a type-species.* After this has been done the study of variation can be undertaken in order to determine the value of characters supposed to be of generic importance.

As a considerable number of species and a rather large number of specimens of *Fungia* were available for study, I decided to make a comparative study of them, especially for the purpose of testing the validity of those characters supposed to be

[a] A Critical review of the literature on the simple genera of the Madreporaria Fungida.

[b] The same as Gregory's Ethmotidæ, which is abandoned, as it was not derived from a genus name.

of generic and family value. The families of the *Fungida* have been based on mural and septal structure. In my paper just quoted, I remarked:

The larger divisions are based upon septal structure; that is, whether the septa are solid or perforate; if perforate, whether they are more pronouncedly laminar or trabecular in composition, and I have also utilized in defining the families the character of the wall, whether normally perforate, even if only slightly, or whether normally solid.

Sufficient evidence has, I believe, been presented to show that species ranging from *Fungia elegans* Verrill, with a solid wall and solid septa, to species like *F. distorta*, which has a solid wall, but extremely cribriform septa, and *F. fungites*, which has a very perforate wall and more or less perforate septa, form a continuous series within generic limits. This series shows that the solid or perforate wall for these corals is not of generic, much less of family, value. *F. elegans* Verrill is a typical member of the Lophoseridæ (Agariciidæ), if the peculiar mode of asexual reproduction from the trophozooid is left out of consideration. The size of the septal dentations possesses no value as a generic character. The septal structure varies from imperforate to extremely cribriform, covering four other families of the *Fungida*, namely, the Agariciidæ, with solid septa, the Thamnasteriidæ and Leptophylliidæ, with septa that are solid or perforate, but which are always more pronouncedly lamellar than trabecular, and the Anabraciidæ, whose septa are composed of a trabecular latticework.

This study throws doubt on all the attempts to subdivide the Fungida into families. For the family Fungiidæ, the only differential character left is the mode of reproduction. Should its supposed value be proven erroneous, the consideration of the Fungiidæ as a family separate from the other Fungida must be abandoned.

The data presented in the foregoing discussion are suggestive and not conclusive. They emphasize, however, the need for the careful comparative study of large series of species to determine what characters are of actual value in establishing the higher systematic divisions.

Application is here made of the knowledge of septal structure derived from this study of *Fungia* by placing in *Leptoseris* a species with perforate septa next to one whose septa are solid, and as a result only two families are recognized among the Hawaiian Fungida.

FUNGIA PATELLA (Ellis and Solander).

Plate XXVII, figs. 2, 2*a*, 3, 3*a*. Plate XXVIII, figs. 2, 2*a*.

1786. *Madrepora patella* ELLIS and SOLANDER, Nat. Hist. Zooph., p. 148, pl. XXVIII, figs. 1–4.
1902. *Fungia patella* DÖDERLEIN, Senckenb. naturfor. Gesellsch. Abhandl., XXVII, p. 65, pls. I, II (all figs.); pl. V, figs. 1, 2 (Synonymy.)

The *Albatross* obtained a large number of specimens of this species, and these are used as a basis for the following description and table:

Corallum nearly circular, slightly elliptical, somewhat arched above, subplane or excavated in central portion; central scar indistinct or not visible.

Measurements.

Specimen number.	Station number.	Greater diameter.	Lesser diameter.	Height.
		mm.	*mm.*	*mm.*
1	3850	23	22	5
2	3850	30	30	9
3	3850	44.5	43.5	15
4	3850	50	49	13
5	3850	52	51	17
6	3850	54	51	15
7	3850	54.5	53	14
8	3848	[a] 55	....	23
9	3848	56.5	50.5	14
10	3848	59	57.5	13.5
11	3849	59.5	56.5	14.5
12	3849	64	62.5	18.5
31	3849	71	67.5	18.5
14	3849	83	77	23

[a] Specimen broken on one edge, diameter measured along diagonal.

Specimen No. 8 has a very much excavated base.

The wall is imperforate. Costæ very fine and equal in central portion of the base; beyond this area first twelve, then twenty-four, become more prominent than the others; around the edge every fourth costa is more prominent than the intervening ones, while there are usually from 12 to 24 that are dominant. The costal margins are entire or microscopically dentate. The outline of the detachment scar is preserved on the smallest specimen.

The number of septa depends upon the size of the corallum. Specimen No. 9 has seven complete cycles, while No. 14 has some members of the eighth. The first are easily distinguishable by being slightly longer than the second, the second are slightly longer than the third, and the inner ends of the third are more prominent than those of the fourth. At the periphery every fourth septum is approximately equal in prominence, with three decidedly smaller septa between, the penultimate septa being slightly more prominent than the last cycle. The smaller septa are decidedly perforate. The margins of the large septa may be gently or rather suddenly arched in the fossular region. Weak tentacular lobes are sometimes present. The fossa is moderately elongate. Depth in specimen No. 9, 5.5 to 6 mm.; in specimen No. 14, 10.5 mm. The septal dentations are fine, may be submicroscopic, sometimes lacerate. Septal faces minutely and densely granulate; sometimes there are also fine striæ. Synapticula rather abundant, not very thick.

Localities.—South coast of Molokai Island: Station 3848; depth between 44 and 73 fathoms; temperature of bottom, 67.6° to 71.1° F. (specimens Nos. 8–10 of table). Station 3849, depth between 43 and 73 fathoms; temperature of bottom, 67.6° F.; 4 dead specimens, Nos. 11–14 of table, and 13 others, 17 in all. Station 3850, depth

43–66 fathoms; temperature, 71.7° F.; coarse sand, broken shells, corals; 24 specimens, including Nos. 1–7 of table.

Vicinity of Kauai Islands, Station 4128; depth, 68–253 fathoms; 2 specimens. No locality, 2 specimens. Total, 48 specimens.

Dr. Charles Gravier, of the Muséum d'Histoire Naturelle, Paris, has sent to me, in a lot of material submitted for identification, 12 specimens collected at Djibouti, French Somaliland, east coast of Africa. These specimens and those from the Hawaiian Islands are in some instances so similar that if mixed they could not be separated.

It is doubtful whether Professor Döderlein's *Fungia erosa*[a] can be kept distinct from *F. patella.*

FUNGIA FRAGILIS (Alcock).

Plate XXVIII, figs. 1, 1*a*.

1893. *Diaseris fragilis* ALCOCK, Jour. Asiatic Soc. Bengal, LXII, Pt. 2, No. 2, p. 148, pl. v, fig. 11.

Corallum *Diaseris*-form, very slightly arched adorally, outer edge rather thin, base imperforate, almost flat or slightly concave. Two specimens were obtained, 1 consisting of a single segment, the other of two united segments.

The measurements are:

Specimen.	Length of radius.	Greatest breadth.	Thickness at mouth.	Thickness at periphery.
	mm.	*mm.*	*mm.*	*mm.*
No. 1, single segment	14.5	20	3.5	1.5
No. 2:				
First segment	17	[a]22	3	1.5
Second segment	18	[a]24	3	1.5

[a] Greatest diameter, 30 mm.

Costæ low, crowded, fine, minutely granulated along their edges, subequal or slightly alternating in size. They may be continuous from the periphery to the apex of the segment or may be confined to a peripheral zone, the inner portion of the base showing crowded, irregularly disposed small granulations.

Septa very numerous, 184 in the smaller segment of specimen No. 2; in the larger specimen between 7 and 8 cycles, crowded, varying in thickness, rather thin in specimen No. 1, rather thick in specimen No. 2. When the edge of the corallum is looked at in profile, all are of equal prominence, but immediately within they usually alternate in height. The smaller fuse to the sides of the larger. Those representing the first and second cycles are more prominent adorally than the others. The septal margins are finely dentate, the dentations irregular in size and shape, sometimes two-pointed. The septal faces are beset with very numerous, very crowded, prominent blunt granules.

Locality.—South coast of Molokai Island, Station 3850; depth, 43–66 fathoms; bottom, coarse sand, broken shells, corals; temperature, 71.7° F.; associated with *Fungia patella* (Ellis and Solander).

[a] Senckenberg. naturfor. Gesell., Abhandl., XXVII, 1902, p. 73, pl. IV, figs. 1–1*b*; pl. V, figs. 4, 4*a*.

Remarks.—Professor Döderlein places *Diaseris fragilis* Alcock in the synonymy of *Fungia patella*, and he may be correct. The two specimens from the Hawaiian Islands, however, are so different from the specimens of *F. patella* that I prefer to keep them apart, at least for the present. The only difference that I can discover between the Hawaiian specimens and Doctor Alcock's from the Indian Ocean is the thicker septa of one of the former specimens.

FUNGIA SCUTARIA Lamarck.

Plate XXVIII, figs. 3, 3a, 3b; Plates XXIX, XXX, XXXI, XXXII.

1801. *Fungia scutaria* LAMARCK, Syst. Anim. sans Vert., p. 370.
1902. *Fungia scutaria* DÖDERLEIN, Senckenb. naturfor. Gesellsch., Abhandl., XXVII, p. 91, pl. VIII, figs. 1–6 (Synonymy.)

Description of a specimen without tentacular lobes, from Laysan.—Corallum oval, margins rounded, upper surface very slightly arched, almost flat, base practically flat, somewhat irregular. Length, 81.5 mm.; width, 56; height, 18.5 mm. Lobation of the edge very slight.

Underside costate, the costæ equal or subequal in size, with irregularly dentate margins, teeth sometimes forked, granulations on both the teeth and the sides of the costæ. Middle of the base damaged. Mural perforations very scarce.

Septa equal at the periphery of the corallum. A little over forty bound the fossa with their inner margins; about the same number are only slightly shorter; the septa next in size extend half, or more, of the distance to the axis from the periphery, drop down suddenly, and are continued adorally by a thinner, lower portion. In a system there are one or two still shorter sets of septa. Their courses are somewhat undulate. The septa are rather thin. Septal margins finely dentate, or subentire. *Tentacular lobes weakly developed or absent.* Septal faces rather closely and finely granulate. Just below the margin rather frequently there are knife-edge ridges running perpendicular to the margin and corresponding in position to septal dentations.

Locality.—Laysan Island, 1 specimen.

Remarks.—This specimen is *F. scutaria typica*, according to Döderlein's description.[a]

He says:

> The typical *Fungia scutaria* Lamarck possesses only an indistinct or weak tentacular lobe, which can be recognized only through the thickening of the corresponding places on the septa; the underside is usually thickly spinulose, the disk is flat or arched.
>
> As a rule the septa of the specimen just described are somewhat thickened, but not greatly; in the places corresponding to the tentacular lobes, however, distinct lobes are commonly absent.

The Bureau of Fisheries steamer *Albatross* fortunately obtained some young *Fungiæ*, probably *F. scutaria*, although it can not be positively decided that they are not *F. paumotensis* Stutchbury. One specimen is represented by three views on Plate XXVIII, figs. 3, 3*a*, 3*b*. It is an anthocormus, consisting of three anthoblasts, one of

[a] Senckenb. naturfor. Gesellsch., Abhandl., XXVII, 1902, p. 95, pl. VIII, figs. 4, 4*a*.

which is in the anthocyathus stage and is ready to become detached from the anthocaulus.[a] There is also a detached young individual, which is a trophozooid or an anthoblast. It does not seem desirable to describe these young in detail, but the difference between them and *Caryophyllia* should be noted. The smallest anthoblast in figure 3*b* of Plate XXVIII is distinctly a *Fungia* and bears little more resemblance to *Caryophyllia* than does the adult *Fungia*. The septal margins are dentate, some are lacerately dentate, and even in that stage synapticula are present. These specimens do not even suggest any very close affinity to the Caryophylliid corals, but they do resemble *Trochoseris* or the young of *Agaricia*.

Description of the form in which the tentacular lobes are developed.—These specimens are distinguished from the typical form of the species principally by the possession of strong tentacular lobes rounded at the summits and projecting beyond the level of the upper edges of the neighboring septa. Such specimens have been named *F. dentigera*, *F. verrilliana*, etc., but the tentacular lobes are too variable in development to furnish specific criteria.

There is another difference between the Laysan specimens and the typical form; the spines on the costæ are simple, rather pointed, and their surface is not nearly so roughly granulated as in the specimen described as typical; minute granulations, however, occur on the surface of the spines.

The measurements are:

Specimen number.	Length.	Width.	Height.	Thickness.
	mm.	*mm.*	*mm.*	*mm.*
1	84	61	25	
2	106	73	29	
3	123	86	30	
[a]4	108	92	ca. 35	
[b]5	117	92	55	31

[a]Specimen deformed.
[b]Specimen received from Prof. W. T. Brigham. The tentacular lobes are unusually strongly developed.

Localities.—Laysan, 14 specimens, *Albatross*. Pukoo, Molokai, 1 specimen; Kaneohe, Oahu, 3 specimens; no definite locality, 1 dead specimen with 5 trophozooids attached; depth 3 to 6 feet; received from W. T. Brigham. Duerden also collected specimens at Pukoo and Kaneohe.

Remarks.—Additional observations on this species can be found on page 109, in the discussion of the family Fungiidæ.

[a]Cf. G. C. Bourne, The anatomy of the Madreporarian Coral *Fungia*, Quart. Jour. Micros. Sci., XXVII, 1887, pp. 293, 324, pls. XXIII–XXV: On the post-embryonic development of *Fungia*, Sci. Trans. Roy. Dublin Soc., 2d ser., 1893, V, pp. 205–238, pls. XXII–XXV.

FUNGIA OAHENSIS Döderlein.

Plates XXXIII, XXXIV.[a]

1901. *Fungia oahensis* DÖDERLEIN, Zoolog. Anzeig., XXIV, p. 357.
1902. *Fungia oahensis* DÖDERLEIN, Senckenb. naturfors. Gesellsch., Abhandl., XXVII, p. 97 pl. IX, figs. 3–5.

The following is a translation of the description of this species published in 1902:

Disk oval, decidedly thick and heavy, very strongly arched above, rather flat below. On the central solid part of the under side are irregular, large humps; the outer portion is costate, ribs equal, prominent, there are some perforations and slits; the humps and the ribs bear short spinules and granulations of equal size. Septa of equal height, somewhat thickened, with sharp edges, very finely toothed, straight or very irregularly sinuous. Oral slit covered by the overreaching septa. Margin of the disk much lobed. Attains a length of about 130 mm.

Occurrence of the specimens before me: Sandwich Islands, Oahu (Mus. Berlin); ? Jaluit (Mus. Berlin).

	Oahu.		? Jaluit.
	mm.	*mm.*	*mm.*
Length	130	112	65
Breadth	105	95	57
Height	67	51	22
Thickness	43	41	18

Both of the large specimens before me from Oahu agree completely. They are oval, very thick, the under side rather flat, the upper side arched high.

The under side of these specimens is unusually striking; the central portion is covered by a great number of round humps, more or less sharply set off one from another, their diameter, 6–15 mm. This humpy middle area is solid and sharply divided from the marginal area, in part by a deep furrow. The marginal area, whose width is about half a radius, bears well-developed, somewhat crowded, equal prominent ribs, which usually end suddenly at the margin of the central area; between them are some perforations and slits. Furthermore, the entire marginal area is divided by incisions of greater or less depth into a great number of lobes, such, for example, as are present in *Fungia scutaria*, but are not there developed with such sharpness.

The whole lower surface, both the ribs taken collectively and the humpy middle area, are uniformly thickly covered with short spinules or granulations of somewhat similar size, which are blunt or pointed and in part are distinctly granulate, but frequently appear smooth.

The septa as a whole are of equal height from the margin of the disk, therefore appearing rather crowded. The smaller septa drop suddenly and steeply toward the center, only very exceptionally is a very weak tentacular lobe previously developed; the neighboring high septa, however, often make at this place a small outward flexure through which a sinuous but not regular curve of the septa is brought about, somewhat recalling *F. scutaria.* As in *F. scutaria*, one finds at most between each two tall septa only the inner and very thin adoral portion of a small septum.

The tall septa are somewhat thickened, but throughout their courses possess acute edges. The septal margins are very finely, but relatively deeply, and in places almost lacerately, dentate; about 15–20 teeth to 1 cm.

The septa from both sides project so near together over the oral furrow that the mouth is entirely covered.

After this follows a description of the specimen from Jaluit. It contains some interesting facts, but as the characters of the species have been given in the translation, the remarks on that specimen, whose identification is doubtful, are omitted.

[a] Figures from photographs kindly furnished by Professor Döderlein.

FUNGIA PAUMOTENSIS Stutchbury.

Plate XXXV.

1833. *Fungia paumotensis* STUTCHBURY, Trans. Linn. Soc. London, XVI, p. 485, pl. XXXII, fig. 6.
1886. *Fungia paumotensis* QUELCH, Reef Corals, Challenger Rept., p. 30.
1902. *Fungia paumotensis* DÖDERLEIN, Senckenb. naturf. Gesellsch., Abhandl., XXVII, p. 88, pl. VII, figs. 1–5. (Synonymy.)

Professor Döderlein gives the following as the salient characters of this species:

Disk oval, only slightly arched; wall perforate, with the exception of a large area in the center. Ribs equal in size, represented by rows of rough granulations or short spines of the same size, which also usually occur on the central area. Septa unequal in height, straight or irregularly sinuous, margins entire, finely toothed or jagged, seldom with a few elongate spiniform teeth; no tentacular lobes. Attains a length of 200 mm.

Quelch[a] reports this species from the Hawaiian Islands. I have not seen it from there. In order to illustrate the species, however, a specimen from the Philippine Islands is figured on Plate XXXV. *F. paumotensis* differs from *F. scutaria* by having the septa unequal in height at the margin of the disk, whereas in the latter they are equal.

FUNGIA ECHINATA (Pallas).

Plates XXXVI, XXXVII.

1766. *Madrepora echinata* PALLAS, Elench. Zoophyt., p. 284.
1901. *Fungia echinata* STUDER, Zool. Jahrb., Syst., XL, p. 405.
1902. *Fungia echinata* DÖDERLEIN, Senckenb. naturf. Gesellsch., Abhandl., XXVII, p. 101, pl. X, figs. 1–5. (Synonymy.)

There is no specimen of this species from the Hawaiian Islands in the United States National Museum, nor did the *Albatross* expedition of 1902 procure any. Professor Studer says:[b]

A large specimen of this species, from the Hawaiian Islands, is in the Natural History Museum in Berne. It was collected by Mr. Bischoff, to whom the Museum is indebted for still other corals from that group of islands, such as *Fungia verrilliana*, *Pavonia varians*, and others, so that there can be no doubt as to the correctness of the locality.

Description (after Döderlein).—"Disk very much longer than broad; oral furrow exceeds in length the width of the disk; wall with pores and slits nearly to the middle. Underside rather uniformly and thickly covered with most strikingly thorny, elongate spines; septa at the edge of the disk of unequal height, with large, tall teeth, which are very roughly granulated or wavy. Reaches a length of about 400 mm."

The United States National Museum possesses a fine suite of specimens of this species from the Philippine Islands. I am using one of them for the illustrations, Plates XXXVI, XXXVII.

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[a] Reef Corals, Challenger Report, p. 30.
[b] Zool. Jahrb., Syst., XL, p. 405.

Family AGARICIIDÆ Verrill.

Genus PAVONA Lamarck.

PAVONA VARIANS Verrill.

Plate XXXVIII, figs. 1, 1*a*.

1864. *Pavonia varians* VERRILL, Bull. Mus. Comp. Zool., I, p. 55.

Original description.—Verrill's original description was as follows:

> Corallum incrusting, varying in form according to the object upon which it grows, at times glomerate, massive, and gibbous, with short, angular, or convoluted crests rising from the surface. These sometimes become more elevated, with an acute edge, or, by incrusting the tubes of *Serpulæ*, rise into irregular ramose forms. Septa from 12 to 16, the primary ones thickened, strongly granulated. Cells rather small, open; columella small, papilliform often wanting.—Sandwich Islands; A. Garrett.

Plate XXXVIII, figures 1, 1*a*, gives views of a specimen and render unnecessary a more lengthy description of the form of the corallum. Rather often the margin of the corallum may be free and project a centimeter or somewhat more beyond the object of attachment. The under surface of the free edge is covered with sinuous granulated striæ and is furrowed, the furrows corresponding to the collines of the upper surface; there are shreds of epitheca, in fact it is probable that there is a fairly complete epitheca between the colony and the object of support. An epithecal edge is visible for considerable distances.

The usual number of septa to a calice is larger than that given by Professor Verrill, about 24, with 6 or 8 larger than the others. Synapticula well developed, moderately abundant, and there are some, though not very numerous, dissepiments.

The columella when present is poorly developed, a single tubercle, but usually it is absent.

Localities.—Northeast coast of Hawaii Island, Station 4053; depth, 26–29 fathoms; bottom, fine gray sand; 1 dead specimen. Reef at Kaunakakai, Molokai Island; 2 specimens. Two other specimens, without locality labels, were probably obtained there. Pukoo, Molokai, 4 specimens; Kahana, Oahu, 1 specimen; Kaneohe, Oahu, 1 specimen; Waikiki, Oahu, 1 specimen; depth, 3 to 6 feet; received from W. T. Brigham. Professor Duerden collected the species at Kaneohe.

Remarks.—This species closely resembles *Pavona repens* Brueggemann, the most noteworthy difference is that the latter possesses a distinct papillary columella.

PAVONA DUERDENI, new species.

Plate XXXVIII, figs. 2, 2*a*, 3.

The corallum grows in the form of plates a centimeter thick, or somewhat more, or as an irregularly nodose mass.

The calices are small, and although distinctly delimited, occur in rather definite rows, which roughly parallel the growing edge. The calices in one row are separated by narrow walls; adjoining rows are separated by flat collines. The distance between calicinal centers in the same row is about 1.5 mm.; between opposite centers across a colline, about 2 mm.

The collines are, as has been said, flattened, there are no crests, and are crossed by the septa-costæ, which are crowded and regularly alternate in height.

The usual number of septa for each calice is twelve, two cycles, of which the six primaries are decidedly the larger and more prominent, and join the columella by their inner ends. In some calices two, or even more, of the secondaries may reach the columella; where this condition prevails septa of the third cycle are present. The edges of the septo-costal portions of the septa lie in a plane, and are microscopically denticulate; the inner margins fall abruptly to the bottom of the calicular fossa and appear to be entire. The faces of the septa and of the septo-costæ are minutely granulated. Both synapticula, which are rather scarce, and thin dissepiments, which are abundant, occur in the interseptal loculi. The texture of the corallum is light.

The columella is compressed, often lamellate, and situated in the bottom of a narrow, rather deep calicular fossa.

Locality.—Pukoo, Molokai, 2 specimens; depth, 3 to 6 feet; received from W. T. Brigham.

Cotypes.—Two specimens, Nos. 21630 and 21631, U.S.N.M.

Remarks.—There is a decidedly puzzling group of species, apparently belonging to the genus *Pavona*, which comprises *Pavona clavus* Dana; 2 undescribed species represented by specimens in the United States National Museum, one from Funafuti and the Paumotus, the other from the Galapagos Islands; *Pavona clivosa* Verrill, from Panama, and the species here described. It is almost certain that *S. maldivensis* Gardiner belongs with them, and most probably some of the specimens from the Paumotus in the United States National Museum which I have tentatively referred to *P. latistellata* Dana. These species are characterized by having distinct, continuous, corallite walls, which on the growing edges or the apices of the coralla often exist separately. In these areas synapticula may be present, both exothecally and endothecally. Subsequently, by the deposition of stereoplasm, the individual corallite walls and the synapticula are united into a compact wall. *Pavona gigantea* Verrill, from Panama, has around its older calices walls similar to those around the older calices of the previously mentioned species, but along its growing edge the walls can be seen to originate as synapticula, peripherally placed around the corallite cavity, which later fuse, forming a kind of theca. The corallite walls of *P. gigantea* are morphologically the same as in *P. cristata* (Ellis and Solander), *P. lata* Dana, *P. crassa* Dana, *P. prætorta* Dana, etc.

Two of these species, *P. clavus* Dana and *Siderastrea maldivensis* Gardiner, have been referred to the genus *Siderastrea*, type-species *Madrepora radians* Pallas; and they superficially resemble that genus. Upon closer scrutiny an additional resemblance is found in the distinct, continuous corallite walls, but there are important differences. The septal margins of the species discussed in the foregoing remarks are entire or microscopically dentate, and the septal lamellæ are absolutely solid. In the 5 or 6 species, specimens of which I have studied, there is persistently a lamellate columella or a compressed styliform columella. *The septal margins of Siderastrea are pronouncedly dentate*, the dentations rounded, one dentation corresponding to each septal trabecula. *The younger septa are distinctly perforate, the perforations not being confined to the inner edges.* According to the valuation of characters at present accepted for the Fungida, the species typified by *P. clavus* Dana, etc., would not belong to the same family as *Siderastrea*. *Siderastrea* is a relative of *Thamnasteria*,[a] at least they possess rather similar septal structure. The principal differences are that the septo-costæ of the latter genus are confluent and that corallite walls are absent. *Siderastrea* belongs to the family Thamnasteriidæ.[b] The species with which *Pavona duerdeni* groups belong to the Agariciidæ.

The reference of the *P. clavus* group of species to *Pavona* now deserves further consideration. For some time I was inclined to separate them from *Pavona* and propose a new genus for them. The principal generic character would have consisted in the continuous imperforate corallite wall. The corallite walls of *Pavona* are of synapticulate origin. The same is true of *Pavona gigantea* Verrill, which appears to connect the species typified by *P. clavus* with typical *Pavona* (type species, *P. cristata* (Ellis and Solander)). I have not been able to study the development of the wall in the massive Pavonæ as carefully as is desirable, but in *P. gigantea* I could study it, and have already given its nature. The same is true of *P. duerdeni*. The wall is originally synapticulate, the synapticula later forming a continuous imperforate wall. I am inclined to think that the same process will be found to occur in the other species—this is, of course, reasoning from similarity in other characters.

The *Pavonæ*, in my opinion, can be divided into three groups, based on mode of growth, the frondose, the incrusting, and the massive species. Those that have just been the object of special consideration belong to the massive species.

Genus LEPTOSERIS Milne Edwards and Haime.

1849. *Leptoseris* MILNE EDWARDS and HAIME, Comptes rendus Acad. Sci., Paris, XXIX, p. 72.
1892. *Folioseris* REHBERG, Neue und wenig bekannte Korall., p. 26.

Rehberg's *Folioseris* is only a digitate *Leptoseris*. It is doubtful whether Quelch's *Domoseris* is generically different. Mr. J. Stanley Gardiner says concerning the relation of *Domoseris* to *Leptoseris:*

> In fact, the examination of the young forms [of *Leptoseris incrustans* Gardiner] and that of the original specimens [of *Domoseris*] causes one to suspect the generic separation of *Domoseris* Quelch from the genus under consideration [*Leptoseris*].[c]

LEPTOSERIS HAWAIIENSIS, new species.

Plates XXXIX, XL.

Corallum thin. The form is extremely variable. The young corallite attaches itself, then it may grow into a thin funnel-shaped corallum, or may extend itself on all sides very nearly in a plane. The largest specimen has a greater diameter of 165 mm. The margin may be gradually curved, or may be lobate and crispate.

Calices unifacial; a central calice can usually be recognized, the other calices are irregularly scattered, frequently distant, occasionally more or less definitely concentric when several are close together; but even then they are distinct, never forming continuous valleys. They may be circular in cross section or may be elliptical, the longer axis transverse to the direction of the septo-costæ. The diameter of

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[a] Usually wrongly given as *Thamnastræa*.

[b] I doubt the validity of a family Thamnasteriidæ, but in the present uncertain state of our knowledge it can be used in discussion.

[c] Fungid Corals, Fauna and Geography of the Maldive and Laccadive Archipelagoes, p. 948.

the circular calices is from 1.5 to 2.5 mm. The elliptical ones may have a greater diameter of 4.5 mm. and a lesser of about 3 mm. There are no collines.

The under side of the corallum is finely striate, the striæ delicately granulated, equal or slightly alternating in size. The septo-costæ of the upper side are fine, delicately granulated, straight or slightly flexuous, equal or slightly alternating in size. Rather frequently on the proximal side of a calice they may be irregularly zigzag. The faces of the septo-costæ show no perforations.

The number of the septa to a calice varies from 14 to 26, the calices near the center usually having fewer than those near the periphery. There is no definite cyclical arrangement, but sometimes there is a fairly regular alternation of larger and smaller, with occasional rudimentary septa. The septa around the outer edge of the calice are thicker than the septo-costæ. Their inner edges are thinner. All septa imperforate, apparently the inner portions of the margins entire; faces minutely granulate.

There are occasional dissepiments in the basal portion of the corallum; synapticula abundant. Calicular fossa narrow, moderately deep. Columella usually well developed, solid, composed of one or two papillæ.

Localities.—

On the south coast of Molokai Island:

Station 3823; depth, 78-222 fathoms; bottom, fine sand and pebbles; temperature, 69.0° F.; 2 good specimens.

Station 3845; depth, 60-64 fathoms; bottom, coarse sand, pebbles, shells; temperature, 71° to 71.5° F.; 4 specimens, including the largest one found.

Station 3848; depth 44-73 fathoms; bottom, sand, gravel; 7 specimens, very good ones.

Station 3849; depth 43-73 fathoms; bottom, coarse sand, broken shells, coral; several very good specimens. The margins of the coralla lobed, the lobes much contorted.

Vicinity of Kauai Island:

Station 4024; depth 24-43 fathoms; bottom, coarse coral sand, foraminifera; temperature, 73.7° F.; 2 small specimens.

Station 4128; depth, 68-253 fathoms; bottom, coarse broken coral sand, foraminifera; temperature, 47.8° F.; 3 young or very small specimens.

Station 4132; depth, 257-312 fathoms; bottom, fine gray sand, mud; temperature, 46.8° F.; 1 young or stunted specimen.

Northeast coast of Hawaii Island:

Station 4053; depth, 26-29 fathoms; bottom, fine gray sand; several fairly good specimens.

Station 4054; depth, 26-50 fathoms; bottom, coarse coral sand, corallines; several good specimens.

Station 4055; depth, 50-62 fathoms; bottom, fine gray sand, foraminifera; specimens much broken, but originally were large.

Pailolo Channel, between Maui and Molokai Islands:

Station 4100; depth, 130-151 fathoms; bottom coral sand, shells, foraminifera; temperature, 61.0° F.; 1 small specimen.

This species was collected at 11 stations around the Hawaiian Islands, the sounding showing a range from 29 to at least 257 fathoms, but all the specimens collected in deep water and at a temperature as low as 61° F., are small, being either young or stunted in their growth. The most favorable conditions for growth are a depth between 26 and 73 fathoms, a temperature of about 70° F., a clear bottom of sand, pebbles, or shells.

Cotypes.—The characterization of the species is not based upon a single specimen, but upon a number of specimens that give some idea of its variation. They are, with the numbers they bear in the United States National Museum, as follows: Four specimens, Cat. Nos. 20843, 20873, from Station 3845; 4 specimens, Cat. Nos. 20844, 20876, from Station 3848; 5 specimens, Cat. Nos. 20845, 20875, from Station 3849; 2 specimens, Cat. No. 20874, from Station 4055.

LEPTOSERIS SCABRA, new species.

Plate XLI, figs. 1, 1*a*, 2.

This species bears considerable resemblance to the preceding, therefore to a certain degree the following diagnosis is comparative.

The young corallum is bowl-shaped or somewhat explanate, with the attachment at the center of the base. Later the margins may be reflected and irregularly undulated. The diameter may reach 100 mm.; the corallum is relatively thicker than in *L. hawaiiensis*.

Calices unifacial; central calice distinct in young colonies, but may be obscured in older ones, the other calices may be irregularly scattered, but usually concentric arrangement is pronounced. The proximal sides of the calices are almost invariably swollen and elevated, producing, when several calices are situated close together in a row, a more or less continuous ridge below the calicular openings. *L. hawaiiensis* often has the proximal sides of the calices somewhat swollen, but a row of calices bounded below by a ridge was not observed. The transverse outlines of the calices are usually elliptical, the shorter axis parallel to the course of the septo-costæ. Greater diameter, 3 to 5 mm.; lesser, 2 to 4 mm.

Outer side of the corallum striate, the striæ very fine, acute, often blade-like, and distant, their edges microscopically serrate. The septo-costæ are in comparison with *L. hawaiiensis* coarse, usually distinctly alternating in size. The edges are very irregularly dentate, the dentations having smaller secondary dentations and microscopic spines. The dentations are not very prominent, are longer than broad, and have a rough surface. The extreme roughness of the whole calicular surface is the most striking difference from *L. hawaiiensis*. In the vicinity of the calices, and especially on their proximal side, the septo-costæ increase in size and prominence. The faces of the septo-costæ show numerous perforations. The septo-costæ in *L. hawaiiensis* are imperforate.

The number of septa to a calice varies from about 16 to 26, excepting the central calice, which may have as many as 36. Usually no definite cyclical arrangement can be recognized. Inner portion of the margin entire; the septal faces very minutely and densely granulated.

Synapticula very abundant between the septo-costæ, and there are some dissepiments. Calicular fossa, narrow, rather deep. Columella poorly developed, composed of a few papillæ or may be absent.

Localities.—

South coast of Molokai Island:

Station 3823; depth, 78–222 fathoms; bottom, fine sand, pebbles; temperature, 69° F.; 1 specimen.

Station 3848; depth, 48–73 fathoms; bottom, sand, gravel; temperature, 71.1° F.; 1 specimen.

Auau Channel, between Maui and Lanai islands:

Station 3876; depth, 28–43 fathoms; bottom, sand, gravel; temperature, 74° F.; 3 specimens, 2 of which have a considerable number of young attached to their bases.

Northeast coast of Hawaii Island:

Station 4053; depth, 26–29 fathoms; bottom, fine, gray sand; 1 dead specimen with unusually large calices, and 2 broken young specimens.

Station 4054; depth, 26–50 fathoms; bottom, coarse coral sand and corallines; 1 young specimen.

The conditions of life most favorable to this species are a depth of water between 26 and 40 or 50 fathoms, a temperature a little over 70° F., and a clean, sandy or pebbly bottom.

Types.—Three specimens and attached young, Station 3876, Cat. No. 20885, U.S.N.M., and 1 specimen, Station 3823, Cat. No. 20886, U.S.N.M.

Remarks.—This species is to be differentiated from *I. hawaiiensis* chiefly by the rougher margins and the very perforate character of its septo-costæ.

LEPTOSERIS DIGITATA, new species.

Plate XLII, figs. 1, 2.

Corallum small, digitiform. The young corallum possesses a single calice, and is inversely conical in shape. The margin of the uni-caliculate corallum becomes lobate, each lobe having a width of about 3 mm. As these lobes grow they become secondarily lobed and crispate, the inner surfaces concave, the outer convex. The first formed lobes in the larger specimens may be as much as 2 mm. or a little more in thickness, but are very thin and fragile at the edge.

Measurements.

Specimen No.	Height.	Greatest width.	Notes.
	mm.	*mm.*	
1	16	27	Initial calice preserved.
2	33	55	Do.
3	37	44	Broken at the base.
4	32	44	Do.
5	48	28	Do.

Calices unifacial. The primitive calice of the colony has already been mentioned; the subsequent calices are usually solitary, as the lobes are narrow, but two may occur alongside one another at the same level. The distance between the calices along a face varies from 2 to 5 mm. The lower sides of the calices are very slightly enlarged, even where two occur alongside one another no distinct ridge is present on the lower side. Diameter 1.5 to 2 mm.

Outer surface of the corallum minutely costate, the costæ low, subequal, flexuous, finely granulate, edges rather acute and microscopically dentate. Septo-costæ, small, but still rather large for the size of the corallum, subequal or alternating in size, somewhat more prominent around the calices, slightly thicker than the spaces between, imperforate. Margins microscopically dentate; faces with extremely minute granulations.

Septa from about 16 to 20 to a calice, subequal or alternating in size. The inner portions of the margins appear entire, sides minutely granulated. Calicular fossa, shallow, usual diameter 1 to 1.5 mm.

Columella, well developed, large, filling very nearly the whole of the bottom of the calice, composed of several fused processes that may be more or less twisted.

Localities.—

South coast of Molokai Island:

Station 3847; depth, 23–24 fathoms; 7 specimens.

Auau Channel, between Maui and Lanai islands:

Station 3871; depth, 13–43 fathoms; bottom, fine white sand; 1 specimen.

Station 3872; depth, 32–43 fathoms; bottom, yellow sand, pebbles, corals; temperature, 74.6° F.; 17 fragments.

Station 3876; depth, 28–43 fathoms; bottom, sand, gravel; temperature, 74° F.; 14 specimens, including 8 fragments.

Cotypes.—Five specimens from Station 3847, Cat. Nos. 20892, 20896, U.S.N.M.

Remarks.—The only noteworthy variation shown by specimens of this species is that the lobes in those from Station 3872 may be as much as 3.5 mm. thick.

This species somewhat resembles *Leptoseris papyracea* (Dana).

LEPTOSERIS TUBULIFERA, new species.

Plate XLII, fig. 3; Plate XLIII, fig. 1.

Corallum thin and rather small, very irregular in shape, folded, with hollow, tubular protuberances on the upper surface, in some instances ramose in appearance. The specimens unfortunately are broken. One measures: Greater distance across base, 37 mm.; height, 36 mm.; another corallum measures 42 mm. across. A third, of ramose form, is 64 mm. long; greater diameter of tube near the base, 5 mm.; lesser, 3 mm. The tubes seem to arise on the edge of the corallum by the margins bending outward, meeting and fusing. The corallum then grows upward retaining the axial cavity. The tubes may bifurcate.

The calices are unifacial. A young specimen shows that the colony begins with a single central calice, those next succeeding in age, though scattered, occur in a more or less definite circle. In older specimens the calices are rather irregularly distributed, but still there is a more or less concentric arrangement. They show grouping in concentric curves, several calices standing near together in succeeding curves. The calices in these curves are bounded below by a ridge, and usually on the lower side of each calice there is a tooth-like projection. Isolated calices very commonly have the lower side thickened, elevated, and subacutely terminated. The calices are small, 2 mm. or less in diameter.

The under side of the corallum is finely costate; the costæ are granulated, low, acute along the summit, their bases touching, equal or slightly alternating in size. The interior of the tubes, described in the preceding remarks, is the morphological equivalent of the lower surface of the corallum. Septo-costæ fine, usually thicker than the intervening space; edges acute and microscopically serrate; sides very minutely and very densely granulated; perforations never or rarely present.

Septa about 14, subequal; there may be alternation in size among some. The inner portions of the margins often dentate; faces minutely granulate. Synapticula and dissepiments, if present, are rare.

Calicular fossa very small, about 0.75 mm. in diameter, and shallow.

Columella well developed, filling practically the whole bottom of the calice; appears to be composed of several more or less twisted pieces that have fused.

Locality.—Auau Channel, between Maui and Lanai islands, Station 3876; depth, 28–43 fathoms; bottom, sand, gravel; temperature, 74° F.; about 20 specimens.

Cotypes.—Cat. no. 20891, U.S.N.M.

Genus STEPHANARIA Verrill.

1866. *Stephanocora* VERRILL, Proc. Bost. Soc. Nat. Hist., X, p. 330 (not Ehrenberg, 1834).
1867. *Stephanaria* VERRILL, Trans. Conn. Acad. Sci., I, p. 340.
1870. *Stephanaria* VERRILL, Trans. Conn. Acad. Sci., I, p. 545.
1884. *Stephanaria* DUNCAN, Jour. Linn. Soc. London, Zool., p. 160.
1886. *Stephanaria* QUELCH, Reef Corals, Challenger Rept., p. 129.

Description.—The description by Verrill in 1870 is as follows:

Coralla compound, consisting of irregular, short lobe-like branches. Cells moderately large, with two or three cycles of septa which are denticulate on the edge, well developed, and mostly confluent with those of adjacent cells. Walls indistinct or wanting, the divisions between the cells indicated only by small, granular points, which sometimes interrupt the septa of adjoining cells. Columella papillose. Paliform papillæ before all the principal septa, the inner ones becoming confounded with the columella.

STEPHANARIA STELLATA Verrill.

Plate XLIII, figs. 2, 2*a*, 2*b* (one of Verrill's types), 3, 3*a* (from Pukoo, Molokai).

1866. *Stephanocora stellata* VERRILL, Proc. Bost. Soc. Nat. Hist., X, p. 330.
1870. *Stephanaria stellata* VERRILL, Trans. Conn. Acad. Sci., I, p. 545, pl. IX, figs. 4, 4*a*.
1886. *Stephanaria stellata* QUELCH, Reef Corals, Challenger Rept., pp. 129, 179.

Description.—Verrill's description published in 1870 is as follows:

Coralla forming rounded clumps of short, irregularly lobed and contorted branches, which are unequal in size and form; sometimes nearly simple and angular, with a large cell at the top; at other times, even on the same clump, having the summit very much expanded, so as to form flattened, contorted lobes, with acute summits and lateral crests, or even meandriniform lobes. The branches are usually about an eighth of an inch distant, sometimes more, the sides covered with rather large, star-like, shallow cells, one, or several, larger than the others often terminating the branches, which appear to increase by the upward extension of one of the edges of these cells by submarginal budding. Septa

12 to 20, often with other rudimentary ones, rather thick and strong, with sharp, spiny granulations or teeth on the sides and edges, and mostly confluent with those of adjacent cells. Color of the unbleached coral ash gray or yellowish gray.

Height of coral 3 inches; length of living portion of branches 0.25 to 0.45; the diameter of the larger cells 0.1 of an inch.

Panama and Pearl Islands, F. H. Bradley; La Paz, Gulf of California, J. Pedersen.

Quelch in his Challenger Reports gives the Hawaiian Islands, reefs at Honolulu, and the Fiji Islands as additional localities.

The United States National Museum possesses 3 specimens from Panama, presented by Professor Verrill. These specimens are all small, smaller than the largest specimen described by Professor Verrill. Their measurements are:

Measurements.

Specimen No.	Length.	Width.	Height.
	mm.	*mm.*	*mm.*
1	28	12	20
2	30	19	[a] 17
3	32	17	21

[a] Base broken.

The living portion of the corallum is margined by a thin, pellicular, easily detachable, concentrically minutely striate and wrinkled epitheca, remnants of which may be seen on the lower dead portion, but if it were once complete it has now been mostly broken away.

The general description of Professor Verrill is as good as can be desired. The septa are almost imperforate, occasionally, but very rarely, a pore could be discovered. Stout synapticula well developed. There are also a few thin dissepiments.

Dr. W. T. Brigham has sent to the United States National Museum 2 specimens of a *Stephanaria*, from Pukoo, Molokai, depth 3 to 6 feet, that I am unable to differentiate from *S. stellata*. The specimens from the Hawaiian Islands often, or usually, have somewhat narrower septo-costæ and the synapticula between them are more numerous and more visible than in the Panama specimen. It seems, however, that no specific difference can be based on these characters, as the specimens from both localities show variation.

Professor Dunden obtained specimens at Waikiki, Oahu.

STEPHANARIA BRIGHAMI, new species.

Plate XLIII, figs. 4, 4*a*, 5.

Corallum forming a rounded clump of stubby branches; height, 47 mm.; greater diameter, 72 mm.; lesser, 66 mm. The branches are crowded, almost touching, in form subterete or somewhat compressed, diameter below terminal divisions 6 to 8 mm. Lower edge of living portion epithecate; living portion measures 10 to 13 mm. in length. Terminal branchlets or lobes of very unequal size, varying from indistinct lobations to 7 mm. in length.

Calices very shallow; in fact, they are superficial. They possess no distinct boundaries, but are connected by confluent septo-costæ. Distance between centers 2 to 2.5 mm. There are from 20 to 24 septa to each calice; 7 or 8 of these extend to the calicular fossa and bear small paliform lobes. The columella is a styliform tubercle, occasionally more than one tubercle. There is a circular space surrounding the tubercle and separating it from the inner ends of the septa. The septa are solid, thick; decidedly thicker than the width of the interseptal loculi. Septal margins coarsely and roughly denticulate, the denticulations of the different septa equal in height. Septal faces finely granulate. Both synapticula and thin dissepiments present.

Locality.—Kahana, Oahu; depth, 3 to 6 feet; 1 specimen, received from Prof. W. T. Brigham.

Type.—Cat. No. 21629, U.S.N.M.

Remarks.—*S. brighami* differs from *S. stellata* Verrill by having its calices superficial instead of slightly excavated, by its coarser and more irregular septal dentations, and by having in most calices a single columella tubercle instead of several papillæ.

A young, solitary individual of this species was attached to the lower portion of the colony. The calice of this is represented by Plate XLIII, figure 5. It exhibits no characters worthy of special notice except that the wall of the primitive cup is composed of epitheca only. There are in the interseptal loculi peripheral synapticula, but the ends of the septa are not fused.

Genus PSAMMOCORA Dana.

PSAMMOCORA VERRILLI, new species.

Plate XLIV, figs. 1, 1a.

The corallum is incrusting, rather thin, a few millimeters in thickness; the upper surface is very irregular. In addition to the irregularities caused by conforming to the object of attachment, there are numerous monticules, small crests, and variously shaped eminences and projections.

The calices possess definite centers, but they usually have indefinite boundaries, and are variable in both size and shape. Their arrangement, also, is indefinite, but there is a frequent tendency for them to occur in series of variable length, separated by collines of variable height. A large calice measures 2.5 mm. in diameter; a medium sized one, 2 mm.; in one series, within a distance of 8 mm., 7 centers were counted. The range in diameter therefore, is from 1.3 to 2.5 mm. The distance between calicinal centers on opposite sides of a colline varies from 2 to 3.5 mm. The length of a colline varies from the diameter of a calice to a centimeter; its height from a mere upward swelling of the surface to 2 mm. There may be taller protuberances, one is 6 mm.; these bear calices on their surfaces.

The septa are thick, with narrow interspaces, forming between two and three cycles. Usually several extend directly to the columella; the others occur in anastomosing groups of from two to five. A definite septal formula could not be determined. The margins of both the septa and the septo-costæ are minutely dentate. One noteworthy peculiarity is the occurrence of a more or less definitely delimited and rather prominent thickening of the septa or septo-costæ. These thickenings are not definite in occurrence, but are most frequent peripherally. The septal faces are minutely granulate. Distally, between the septo-costæ, synapticula are very abundant, readily visible when the corallite is viewed from above. The septa are originally finely trabeculate and fenestrated, but become almost or entirely solid by subsequent stereoplasmic deposit.

The columella consists of a single, minute tubercle, situated in a small, shallow central pit.

Locality.—Kalaeloa, Molokai; depth 3 to 6 fathoms; 2 specimens received from W. T. Brigham.

Cotypes.—Cat. No. 21637, U.S.N.M.

Genus BATHYACTIS Moseley.

BATHYACTIS HAWAIIENSIS, new species.

Plate XXVII, figs. 1, 1*a*.

1905. *Bathyactis stephana* VAUGHAN, Science, n. s., XXI, p. 984 (not *Bathyactis stephana* Alcock, 1893).

Corallum with a subcircular, slightly concave base; diameter, 25 mm. The wall is extremely thin, translucent, and imperfect in places. Distant, thin, plate-like, but low, costæ correspond to all septa, those corresponding to the last cycle less prominent than the others. Costal edges finely serrate. In the center there is a small scar, 1.5 mm. in diameter, resembling a detachment scar.

The calice is superficial. Septa extremely thin, in five complete cycles, forming six septal groups, one group between each pair of primaries. The tertiaries fuse by a calcareous membrane to the included secondary, the quaternaries fuse nearer the wall by their inner margins to the included tertiary, and the quinaries to the included quaternary. The primaries and secondaries are tall, projecting 8.5 or 9 mm. above the base. The outer edges of the margins descend perpendicularly and connect with the costal ends beyond the limit of the wall. The tertiaries and quaternaries are not nearly so prominent as the first two cycles, the quinaries are relatively low. The margins are irregularly, rather bluntly dentate, but are not lacerate. The inner portion of the margins of the primaries and secondaries is frequently divided by a sinus from the outer, forming a broad paliform lobe. The septal faces are fluted, with carinæ bearing spinules along the flutes. There are on the larger septa about seven flutes in 5 mm. From five to six synapticula occur in an interseptal loculus. They are membraniform and are connected with the septal carinæ.

The inner ends of the septa are united by a calcareous membrane, about 2.5 mm. in diameter, whose central portion is depressed and through which a few slender spines from the inner ends of the septa project.

Locality.—Kaieie Channel, between Oahu and Kauai islands, Station 4125; depth, 963–1124 fathoms; bottom, brown mud, radiolaria, and foraminifera; temperature of the bottom, 36.4° F.

Type.—Cat. No. 20834, U.S.N.M.

Remarks.—There are according to Alcock[a] 3 species of *Bathyactis* that have five complete cycles of septa, namely: *B. sibogæ*, *B. stephana*, and *B. palifera*, all of Alcock. *B. sibogæ* differs from *B. symmetrica* (Pourtalès) by having one more cycle of septa, by the more delicate texture of its corrallum, and its greater size, attaining a diameter of 57 mm. *B. hawaiiensis* differs in form from *B. symmetrica* by the decidedly elevated margins of its primary and secondary septa, and *B. symmetrica* has only four cycles of septa. *B. stephana*, with which I at first identified this species, has a very concave base and still taller septa. Alcock's figure[b] indicates another and probably more important difference. In *B. stephana* the septal margins are distally narrow or even excavated, and are elevated near the calicular fossa. As pointed out in the description of *B. hawaiiensis*, the outer edges of its septal margins descend perpendicularly and connect with the costal ends beyond the limit of the wall. *B. palifera* possesses six distinct, thickened pali before the secondary septa. The paliform lobes of *B. hawaiiensis* are distinct before some but not all of the primary and secondary septa, they are inconstant in development, they are, when present, wider than in *B. palifera*, and are not thickened.

I have recently described another species of *Bathyactis*, *B. marenzelleri*, collected by the Bureau of Fisheries steamer *Albatross* at Station 4721, between the Galapagos Islands and Barrett Ridge, at a depth of 2,084 fathoms. This species possesses only four cycles of septa, and differs from the Hawaiian species in other notable particulars.

MADREPORARIA PERFORATA.

Family EUPSAMMIDÆ Milne Edwards and Haime.

Genus STEPHANOPHYLLIA Michelin.

STEPHANOPHYLLIA FORMOSISSIMA Moseley.

Plate XLIV, figs. 2, 2*a*.

1876. *Stephanophyllia formosissima* Moseley, Proc. Roy. Soc., 1876, p. 561.
1881. *Stephanophyllia formosissima* Moseley, Deep-Sea Madreporaria, Challenger Rept., p. 201, pl. iv, fig. 11; pl. xiii, figs. 6, 7; pl. xvi, figs. 8, 9.
1902. *Stephanophyllia formosissima* Alcock, Deep-Sea Madreporaria, Siboga Exped., p. 39.

A considerable number of specimens of this species were obtained. The only noticeable difference from Moseley's original description is, the Hawaiian specimens are smaller than those obtained by *Challenger* expedition, the largest measuring 27 mm. in diameter. Often, or usually, the first and second cycles of septa are as tall as those of the younger cycles.

Moseley's specimens came from off the Ki Islands, and off Zebu, Philippine Islands. Alcock reports specimens from 4 stations of the Siboga expedition.

Localities.—

South coast of Molokai Island:

Station 3838; depth, 92–212 fathoms; bottom, fine, gray, brown sand; temperature, 67° F.; 3 specimens.

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[a] Deep-Sea Madreporaria of the Siboga Expedition, p. 37.
[b] Investigator Deep-Sea Madreporaria, pl. iii, fig. 5*a*.

Station 3855; depth, 127–130 fathoms; bottom, fine brown sand, gravel; temperature, 65.5° F.; 6 specimens (the largest number obtained at any one station).

Pailolo Channel, between Molokai and Maui islands:

Station 3856; depth, 127 fathoms; bottom, fine sand, yellow mud; temperature, 66.5° F.; 2 specimens.

Station 4101; depth, 122–143 fathoms; bottom, coral sand, shells, foraminifera; temperature, 59.7° F.; 1 specimen.

North coast of Molokai Island:

Station 3906; depth, 66–96 fathoms; bottom, gray sand, shells, pebbles; temperature, 72° F.; 1 specimen.

West coast of Hawaii Island:

Station 4045; depth, 147–198 fathoms; bottom, coral sand, formanifera; temperature, 49° F.; 3 specimens (including the largest collected).

Northern coast of Maui Island:

Station 4080; depth, 178–202 fathoms; bottom, gray sand, formanifera; temperature, 56.4° F.; 1 specimen.

In its conditions of life, this species may range in depth from 66–212 fathoms; the bottom in each instance was sandy; the temperature ranges from 49° to 72° F.

Genus ENDOPACHYS Lonsdale.

1845. *Endopachys* (part) LONSDALE, Quart. Jour. Geol. Soc. London, I, p. 214.
1848. *Endopachys* MILNE EDWARDS and HAIME, Ann. Sci. Nat., 3ième sér., Zool., X, p. 81.
1857. *Endopachys* MILNE EDWARDS, Hist. Nat. Corall., III, p. 97.
1884. *Endopachys* DUNCAN, Jour. Linn. Soc. London, Zool., XVIII, p. 176.
1900. *Rhectopsammia* VAUGHAN, Mon. XXXIX, U. S. Geol. Survey, p. 183.
1900. *Endopachys* VAUGHAN, Mon. XXXIX, U. S. Geol. Survey, p. 186.
1903. *Endopachys* VAUGHAN, Proc. Biol. Soc. Washington, XVI, p. 101.

In the last reference cited, I published the following note:

My genus *Rhectopsammia* was based on the young of *Endopachys maclurei* (Lea), but I discovered my mistake after the publication of the Monograph. The genus *Endopachys* has been characterized as showing no evidence of attachment. My *Rhectopsammia* is the attached young of *Endopachys*. These young individuals often attain a height of 6 mm., then the upper portion of the corallum becomes separated from the pedicel. Indications of the detachment scar may frequently be seen quite late in the life of some specimens. Usually it is ultimately completely obliterated by the deposition of calcareous substance over it by the edge zone of the coral extending downward, enveloping the base.

ENDOPACHYS OAHENSE, new species.

Plate XLIV, figs. 3, 3*a*.

Corallum subcuneate, sides curving gradually to the apex of the base, edge of the base obtuse, rounded. There are no facial tubercles or lateral crests. Basal scar obliterated. Transverse outline elliptical. Greater diameter of calice, 16.5 mm.; lesser, about 12 mm. (one side of the calice is broken, this measurement is therefore only an approximation); height of the corallum, 17 mm.

The wall is externally costate, costæ corresponding to all septa, more distinct near the margin of the calice, indistinct near the base. They are low, comparatively wide, subacute or rather rounded on the edge, granulate and perforate, subequal or equal in size, occasionally showing alternation in size. Intercostal furrows narrow.

Septa in four complete cycles, with members of the fifth present in 13 quarter systems. Their inner ends tend to be free, septal groups are not so definite as is usually the case in the genus. The members of the fifth cycle ultimately fuse to the sides of the fourth. It might be noted, although this is not a specific character, that the fifth cycle originates as a pair of septa in the interseptial loculus between the third and fourth cycle. According to the usual notation of the septa, one of the fifth is really a member of the preceding cycle, while a member of the fifth is called the fourth. Septal margins only slightly exsert, those of the primaries and secondaries equally prominent and more elevated than those of the higher cycles. Margins of the other cycles equal in prominence. The smaller septa are rather coarsely dentate, the inner margins of the larger unfortunately are broken. Septal faces often transversely undulated, and striate, elongate granulations forming the striæ.

Calicular fossa elongate, narrow, deep, 6 mm. long and 0.75 mm. wide.

Columella very poorly developed, composed of a few septal trabeculæ.

Locality.—South coast of Oahu Island, Station 3810; depth, 53-211 fathoms; bottom, fine coral sand; temperature, 47.7° F.; 1 specimen.

Type.—Cat. No. 20822, U.S.N.M.

Genus BALANOPHYLLIA Searles Wood.

BALANOPHYLLIA HAWAIIENSIS, new species.

Plate XLIV, figs. 4, 4*a*, 5.

Corallum firmly attached, elongate, curved. Transverse outline broadly elliptical or circular.

Measurements.

Specimen No.	Greater diameter of calice.	Lesser diameter of calice.	Height of corallum.	Remarks.
	mm.	*mm.*	*mm.*	
1	11	10.5	28.5	Base 8 mm. in diameter.
2	14	14	33.5	Attached to the calice of what appears to have been a dead corallum of the same species, but it might be a case of rejuvenesence. The younger corallum has been repeatedly damaged and undergone repair.
3	[a] 17	15	40+	Base broken.

[a] Approximate.

Wall entirely naked, perforate, frequently rather thick and vesiculate, in the lower portion of the corallum it becomes secondarily compacted. Costæ corresponding to all septa, subequal, distinct, but not prominent, with coarse granulations, edges obtusely rounded, bases wide, the intercostal furrows narrow with rather frequent perforations.

Septa, four complete cycles and about half the members of the fifth. There is the usual balanophyllioid grouping about the members of the third cycle, but the inner edges are not fused together above the level of the bottom of the calice.

Upper margins only slightly exsert, those of the first and second cycles and most of the third equal in prominence, those of the other cycles less prominent; edges entire or delicately crenulated. Faces with minute undulations, some elongated sharp-edged granulations along their courses. Inner margins fall perpendicularly to the bottom of a deep, well-like calicular fossa.

Columella, poorly developed, small spongy, standing up in the bottom of the fossa, and free from the edges of the septa.

Locality.—Northeast coast of Hawaii, Station 4059; depth, 190–291 fathoms; bottom, rocky; temperature, 44° F.; several specimens, 4 rather large coralla, 2 of them dead. Young indviduals frequently attach themselves to dead specimens, or to the lower portions of living ones. There are more than a dozen of these young.

Cotypes.—Three specimens, Cat. No. 20823, U.S.N.M.

Remarks.—This coral may be only a variation of *Balanophyllia cornu* Moseley, but *B. cornu* has a better developed columella. One of the specimens of *B. hawaiiensis* has practically no columella, that structure being represented by a single weak septal trabecula. The columella is very poorly developed or almost absent in the others. Moseley describes *B. cornu* as being more compressed than this Hawaiian species.

BALANOPHYLLIA DESMOPHYLLIOIDES, new species.

Plate XLV, figs. 1, 1*a*.

Corallum flabellate, attached by a rather large base. Transverse outline of calice elliptical or may be somewhat constricted in the plane of the shorter diameter.

Measurements.

Specimen No.	Greater diameter of calice.	Lesser diameter of calice.	Diameter of base.	Height of corallum.
	mm.	*mm.*	*mm.*	*mm.*
1	15	6	9	24
2	8	6	6	10.5

Above the base is a stout stalk, almost circular in cross section; above the stalk the corallum becomes compressed. In specimen No. 1, the diameter of the stalk is 6.5 mm.; in specimen No. 2, greater diameter, 4.5 mm.; lesser, 4 mm.

Wall naked or with some epetheca on the basal portion. Costæ corresponding to all septa, low, subequal or equal, occasional alteration in size, continuous to the base; densely granulated, a row of principal granulations along the summit, some smaller granulations. Their edges present a crenate or roundedly dentate appearance; Transverse profile rounded. Intercostal furrows narrow, with numerous perforations.

Septa in specimen No. 1, five complete cycles and a few members of the sixth. The usual balanophyllioid grouping. The septa of the last cycle fuse in front of those of the penultimate cycle very near the upper margin of the calice; in the systems at the ends of the calice, prolongations from the groups of higher cycles fuse in front of the third cycle near the level of the upper surface of the columella.

Upper septal margins usually entire; they are not exsert at one end of the calice and are moderately exsert at the other. Inner margins irregularly and coarsely dentate. Septal faces minutely striate, small granulations along the striæ.

Calicular fossa elongate, narrow, and deep.

Columella moderately developed, trabecular, and spongy.

Localities.—South coast of Molokai Island: Station 3823; depth, 78–222 fathoms; bottom, fine sand, pebbles; temperature, 69° F.; specimen No. 2 and 2 young.

Northeast coast of Hawaii Island: Station 4061; depth, 24–83 fathoms; bottom, coral sand, corallines, nodules, foraminifera; temperature, at the surface, 77° F; specimen No. 1 and 1 attached young.

Type.—Station 4061, Cat. No. 20824, U.S.N.M.

Remarks.—This coral is so extremely close to *Balanophyllia desmophyllum* Milne Edwards and Haime of the English Eocene, and also very abundant in the Eocene of the United States, that I can not point out very satisfactory differences. The size, shape, and the number of the septa are the same in both. The columella in *B. desmophyllum* is better developed, and its costæ and septa are thinner. These differences could very easily be obliterated by only moderate variation. In *B. desmophyllioides* the principal septa (first, second, and third cycles) are simple laminæ; in *B. desmophyllum*, near the wall, they become thickened and very vesiculate. In the former there is tendency toward the same phenomenon, but it does not seem to be carried so far.

A greater number of specimens of the Hawaiian coral may show more satisfactory differential characters, or may show that the Eocene species has persisted to recent time. Whichever may ultimately be found true, it is interesting to obtain a recent species so closely related to one that is an Eocene fossil.

This species also seems closely related to the recent *B. bairdiana* of Milne Edwards and Haime.

BALANOPHYLLIA LAYSANENSIS, new species.

Plate XLV, figs. 2, 2*a*, 2*b*.

Corallum evidently attached by a broad base (the base is broken off), above which is a thick, solid stalk; above this the corallum expands gradually. Transverse outline elliptical. Greater diameter of calice, 16.5 mm.; lesser, 13 mm.; height of corallum, 17+ mm.

Wall entirely devoid epitheca, thick, very perforate, both on the costæ and in the intercostal furrow. Costæ of two sizes, those corresponding to the first and second cycles of septa decidedly the larger and of equal size; those corresponding to the third cycle not so prominent, but are well developed. The distal ends of the fourth cycle of septa are easily traced, but form flat areas between the costæ. The costæ are wide, round or flattish in profile, and very perforate. They are more prominent near the calice and disappear on the stalk above the base.

Septa in four complete cycles, very regular in their arrangement. All are thickened in the thecal ring, where they are spongy, becoming thinner toward the center. The first and second cycles of equal size and independent of septal groups. The members of the fourth bend toward one another in front of those of the third;

their inner margins may fuse or may be merely close together. From each septal group there is a prolongation to the columella; occasionally both septa of the fourth cycle may reach the columella. The upper margins of the first and second cycles are equal in prominence and exsert; those of the third cycle the least exsert, while those of the fourth reach a level halfway between that attained by the third and the first two cycles. The edges of the septa are entire, except near the columella there may be some irregular dentations. Inner portions of the septal faces minutely striate and granulate. Interseptal loculi in the basal portion filling solidly with stereoplasm.

Calicular fossa elongate, rather large, moderately deep.

Columella well developed, compressed, vesiculate, projecting in the bottom of the bottom of the fossa.

Locality.—Vicinity of Laysan, Station 3937; depth, 130–148 fathoms; bottom, white sand, small shells; temperature, 63° F.; 1 specimen.

Type.—Cat. No. 20901, U.S.N.M.

BALANOPHYLLIA DIOMEDEÆ, new species.

Plate XLV, figs. 3, 4, 4*a*, 5.

Corallum attached by a rather wide base, rather elongate, increasing in diameter very slowly, cross section broadly elliptical or almost circular.

Measurements.

Specimen number.	Greater diameter of calice.	Lesser diameter of calice.	Greater diameter just above base.	Lesser diameter just above base.	Diameter of base.	Height of corallum.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1	7.5	7	6	5.5	8.5	20
2	7.5	7	6	6	9	14.5

Specimen No. 2 is rather sharply constricted immediately above the base. About midway between the base and the calice it has a greater diameter of 8 mm. and a lesser of 7.5 mm.

There is always some epitheca on the basal portion of the corallum. It is thin, incomplete, and usually extends about half way up the wall. The wall is thick and vesiculate. Costæ indistinct, low, flat, equal, intercostal furrows narrow and shallow, both costæ and furrows with numerous perforations. Where costæ can be distinguished, the whole surface shows numerous perforations.

Septa usually in four complete cycles; occasionally some members of the fourth are lacking in a quarter system. The first cycle decidedly thicker than the other septa, these extend directly to the columella and take no part in the septal groups. The septa of the fourth cycle standing next the first in any system, or those of the third, when the fourth is incomplete, bend away from the first and toward the included septum of the second cycle, often meeting in front of it and inclosing it. The members of the fourth cycle, standing next the member of the second cycle in any system, bend away from the second, around the ends of the members of the third cycle, approaching very near the sides of the outer members of the fourth, or actually fusing to them. The members of the second cycle are straight, at the wall considerably thicker, within the calice slightly thicker than the septa of the higher cycles. Plate XLV, figure 4*a*, shows the relations of the septa. First and second cycles slightly exsert, the first the more prominent. Margins of the first two cycles entire in adult specimens. Those of the higher cycles show crenate dentations along their inner portions. First and second cycles imperforate; the higher cycles sometimes with large and rather numerous perforations. The septal faces are almost smooth, a very few weak striæ and occasional small granulations. Both septa and wall become secondarily much thickened by stereoplasm.

Calicular fossa shallow, about 1.5 mm. from upper termination of the columella to the tops of the highest septa.

Columella well developed, strong, vesiculate, projecting in the bottom of the calice. In transverse outline it is cruciform, a long piece coinciding with the longer axis of the calice, and a shorter one opposite the inner ends of the medially situated septa of the second cycle. The outer members of the last cycle in each of the two medial systems bend toward one another, pass in front of the member of the second cycle, and fuse separately to the shorter arms of the cross, but the member of the second cycle usually does not, it is a little too short.

Locality.—North coast of Maui Island, Station No. 4098; depth, 95–152 fathoms; bottom, coral sand, foraminifera, rock; temperature, 64.8° F.; 3 specimens.

Cotypes.—No. 20825 U.S.N.M.

Remarks.—This species is closely related to *Balanophyllia redivira* Moseley. The view of the calice from above given by Moseley, would serve for the species here described, but Moseley represents his species as having much more distinct costæ and a decidedly deeper calice, giving 6 mm. as its depth, and it seems that *B. redivira* is uniformly larger.

A specimen dredged in the vicinity of Kauai Island, Station 3999; depth not definitely given, between 7–148 fathoms; bottom, coral sand, shells; is referred to this species. This specimen (see Plate XLV, fig. 5) consists of three individuals of three different ages. The second in age is attached to the inside of the calice of the oldest individual, and the youngest individual is attached to the second, not far above its base. These specimens show nothing noteworthy in size or form. The measurements are:

Specimen number.	Lesser diameter of calice.	Greater diameter of calice.	Height.
	mm.	*mm.*	*mm.*
1	8.5	7.5	18
2	7	6.5	9
3	6	5.5	10

Remnants of a very thin, fragile, and readily detachable epitheca can be seen up to very edge of the calice. Excepting on the bases of the oldest and the youngest specimens there are no costæ, where they are present they are as in the cotypes of the species. The greater portion of the outer surface of the wall, beneath the epitheca, is granulate and reticulate. The septa preserve the same general scheme of arrangement as in the cotypes, except the fourth cycle is not so much developed and the second cycle remains small. There are very few or no septal perforations; the septal faces are distinctly striate. The calicular fossa is moderately deep, 2 mm. and 2.5 mm. in the youngest and the next to the youngest, respectively. The columella is similar to that of the types, except it is looser in texture; not so compact.

This specimen is, or these three specimens are, interesting because they combine the mural ornamentation of the types of the species and of the variety *mauiensis* next to be described.

BALANOPHYLLIA DIOMEDEÆ var. MAUIENSIS, new variety.

Plate XLV, figs. 6 6*a*.

Corallum attached by a widely expanded base above which it is constricted and then gradually increases in size toward the calice. Transverse outline of calice broadly elliptical. Greater diameter of calice, 9.5 mm.; lesser, 8.5; greater diameter just above base, 8 mm.; lesser, 6.5 mm.; greatest diameter of basal expansion, 15 mm.; height of corallum, 13.5 mm. The thickest portion of the corallum is about 4 mm. below the upper edge of the wall, here the greater diameter is 10.5 mm.; lesser, 9.5 mm.

The lower portion of the corallum is covered by a very thin, wrinkled, fragile and easily detachable epitheca, which apparently did not extend very high up. There are no vestiges of costæ, the outer surface of the wall minutely perforate and finely granulate, the granulations sometimes occurring in definite longitudinal lines along striæ. In other instances the wall seems to be an indefinite, perforated network. The theca is thick, and spongy in appearance when viewed from above.

Septal arrangement precisely as in typical *B. diomedeæ*. The fourth cycle is incomplete in four quarter systems in the type, the only specimen. The first cycle is decidedly thicker than the other septa and is slightly exsert, the other septa scarcely exsert. The second cycle usually thicker than those of the two higher cycles. Margins of the first and second cycles entire, those of the other cycles entire or faintly crenate. The ornamentation of the septa consists of weak, faint striæ, with small granulations along them. Excepting immediately at the wall, no septal perforations could be discovered.

Columella precisely the same as in typical *B. diomedeæ*.

Calicular fossa moderately deep, 2.5 mm. from upper end of columella to the summits of the tallest septa.

Locality.—Pailolo channel, between Maui and Molokai islands, Station 4101; depth, 122–143 fathoms; bottom, coral sand, shells, foraminifera; temperature, 59.7° F.; 1 specimen.

Type.—Cat. No. 20826, U.S.N.M.

Remarks.—This variety is shorter and thicker than the type specimens of *B. diomedeæ*, it is entirely without costæ, there are no septal perforation except immediately along the line of the wall, and its calice is deeper.

Genus DENDROPHYLLIA de Blainville.

DENDROPHYLLIA OAHENSIS, new species.

Plate XLVI, figs. 1, 1*a*, 1*b*.

Corallum elongate, worm-like, irregularly constricted from place to place, lower end broken off. Cross section circular or broadly elliptical. Length of specimen, 37 mm.; greater diameter of lower end, 7 mm., lesser, 6 mm.; greater diameter in most constricted portion, 5.5 mm., lesser, 5 mm.; greater diameter of calice, 8 mm., lesser, 7 mm. On the sides are irregularly distributed lateral buds. The figures show their distribution on the surface. At first they were thought to be attached young; a vertical section, however, through one of them showed that the wall of the axial corallite was not continuous beneath the young corallite, but that the interseptal loculi of the older and younger corallites were in communication. These young corallites are all comparatively small, the largest has a greater diameter of 4 mm.; the smallest, 2.5 mm. There is an attached very young coral, with six primary septa, the second cycle not complete, which measures only 1 mm. in diameter. This individual most probably had settled on the specimen, and does not belong to the colony.

There are disconnected, encircling bands of epitheca to within 9 mm. of the calice of the axial corallite. Several young corallites occur above the upper limit of the epitheca. There is also epitheca around the bases of all the young corallites except one. The wall is spongy and moderately thick. Costæ distinct very nearly the whole length; sometimes they are resolved into mere granulations, and sometimes are obscured by the epitheca. Where clearly seen, which is usually the case, they are low, rather wide, flattened above, equal, granulate, and perforate. The granulations rather tall, sometimes in two rows, but usually irregularly distributed. Intercostal furrows shallow and narrow, perforate.

Septa of the calice of the axial corallite in four complete cycles. All septa thin and distant, slightly thicker near their inner ends. Those of the first and second cycles and the outer members of the fourth in each system nearly equal in thickness and length: those of the second may be a little shorter. The shortest and thinnest are the septa of the third cycle. The arrangement for each system is: The members of the first and second cycles extend directly to the columella and fuse to it; the septa of the second are rather often a little shorter than those of the first. The two outermost members of the fourth cycle bend away from the primaries and toward the included secondary, but do not fuse to it, extending to the columella. The quaternaries standing on each side of the included secondary bend outward away from it, extend beyond the ends of the tertiaries, and their inner ends approach very closely the outer quaternaries. The tertiaries extend about one-half the distance from the wall to the columella. The inner margins of all the septa are free above the bottom of the calice, but at a lower level, as the broken lower end of the specimen shows, they fuse into groups according to the scheme above outlined. None of the septa are exsert. Their inner ends usually strongly undulated, the septal faces show small obliquely ascending undulations or striæ with granulations along them. Apparently there are only peripheral perforations.

Calice shallow.

Columella rather large, elliptical, spongy, texture loose, composed of numerous thin, twisted, anostomosing band-like trabeculæ, which do not project upward into the bottom of the calice.

Locality.—Northwest coast of Oahu Island, Station 4114; depth, 154–195 fathoms; bottom, coral sand, foraminifera; temperature, 60.7° F.; 1 specimen.

Type.—Cat. No. 20827, U.S.N.M.

DENDROPHYLLIA SERPENTINA, new species.

Plate XLVI, figs. 2, 2*a*, 3, 4, 5.

Corallum long, cornute, variously curved and twisted. The initial corallite, which becomes the axial corallite, is attached by a more or less expanded base, above which it often grows as a small, irregularly curved tube to a height of 12 mm. or more. The wall of the main corallite is irregularly constricted from place to place.

Measurements.

Specimen No.	Diameter at base.	Diameter 12 mm. above base.	Greater diameter of calice.	Lesser diameter of calice.	Length.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
1	1.5	3	7	6	24
2	3	3.5	([a])	7	32
3	([a])	....	7	6	41

[a] Broken.

The secondary corallites are irregularly scattered over the outer surface, their bases from 2 to 2.5 mm. in diameter. They are slender and may grow to a considerable height, reproduce asexually, and become the axes of new branches, producing an irregularly branched or bush-shaped colony.

No vestige of epitheca was seen on any specimen. The wall in its upper portion is thin, fragile, and very perforate; lower down it is secondarily thickened and more compact. There are no costæ. Near the calice the surface of the wall is very rough, with numerous, irregularly distributed, small, spinose granulations, among which are many pores. Farther down the surface is densely granulate; the granulations sometimes showing a striate arrangement.

Septa in five cycles, the last not always complete; the usual dendrophyllioid arrangement. The tertiaries are very short, as are also the inner quaternaries of any system. When the latter are long enough, they pass in front of the tertiaries and fuse near the wall to the sides of the outer quaternaries. All the septa are rather thin and fragile, the primaries somewhat thicker; the secondaries and outer quaternaries about equal in thickness, but of these septa the former are usually the shorter. Primaries slightly exsert, the secondaries have corresponding to them a faint tooth on the margin of the calice. Margins of the larger septa entire or microscopically crenate; those of the higher cycles may be jaggedly dentate. The septal faces possess delicate striæ and granulations. There may be perforations some distance from the wall.

Calice deep.

Collumella rather large, spongy; texture, lax.

Locality.—West coast of Hawaii Island, Station 4045; depth, 147-198 fathoms; bottom, coral sand, foraminifera; temperature, 49° F.; 6 specimens.

Cotypes.—Cat. No. 20828, U.S.N.M., 4 specimens.

DENDROPHYLLIA MANNI (Verrill).

Plate XLVI, figs. 6, 6*a* (one of Verrill's types), 7, 7*a* (from Kaneohe, Oahu).

1866. *Cœnopsammia manni* VERRILL, Proc. Essex Inst., III, p. 30.

Original description.—Professor Verrill's description is as follows:

Corallum encrusting rocks, forming clusters of crowded cups, about an inch high; some of the corallites are laterally united even to the top, others are separated about an eighth of an inch and rise nearly a quarter of an inch above the cœnenchyma. The exterior of the corallites is obscurely and closely costate, and covered closely with rough granulations. Septa in four cycles, the last imperfectly developed. Primaries much thicker than the others, very narrow at the top and not projecting above the wall, which is much thickened, on their inner edges slightly concave, and increasing somewhat in width toward the bottom of the cell, where they join the columella. The secondaries are still narrower and thinner, but also join the columella. Those of the third order are ex.remely narrow and often do not reach the margin of the wall, and do not join the columella. Those of the fourth order are merely slightly raised costæ, very thin and uneven. Columella well developed, spongy, nearly half as broad as the cell.

Cells slightly oval, the larger ones about 0.35 of an inch in diameter, and nearly the same in depth.

Color of living polyps, vermilion red.

Sandwich Islands, at low-water mark. Horace Mann.

Prof. W. T. Brigham has sent 2 specimens of a *Dendrophyllia* (*Cœnopsammia*) from Kaneohe, Oahu, depth 3 to 6 feet, that differ from the type of *D. manni* by their very exsert corallites and poorly developed columella (Plate XLVI, figs. 7, 7*a*). However, the costæ are similar on corallites of the same length, and I therefore believe that they belong to the same species.

Genus ANISOPSAMMIA von Marenzeller.

ANISOPSAMMIA AMPHELIOIDES (Alcock).

Plate XLVII, figs. 1, 2.

1902. *Dendrophyllia* (*Cœnopsammia*) *amphelioides* ALCOCK, Deep Sea Madrepor., Siboga Exped., p. 43, pl. v, figs. 37, 37*a*.

Original description.—According to Alcock this species is described as follows:

Colony dendroid, gemmation taking place near the calicular margin and being alternately distichous or, more commonly, dichotomous leaving the parent calicle immersed and more or less compressed between the two branches, as in *Cyathohelia*. The openings of the calicles all tend to face one way, and are commonly circular (except in the axils).

Costal striations all equally distinct, in the form of finely scabrous vermicular ridges traversing the whole length of the colony.

The calicles after budding are little prominent, or even almost immersed: they are deep and empty looking, owing to the shallowness of the septa.

Septa approximately equal, elegantly notching the somewhat tumid margin of the calicle but not exsert, not encroaching on the calicular fossa. They are in six regular systems and three cycles:

those of the third cycle usually unite with those of the second near the columella, but those of the first cycle usually remain independent.

Columella deep-seated, always present, but variable in size, spongy and crisp.

Diameter of calicles about 4 mm.

Neither a lengthy discussion nor a further description of this species is necessary. The *Albatross* material consists of a number of broken branches, some of which are typical, but others have the calicular margins moderately prominent and grade into the variety *cucullata*, described below.

Locality.—Kaiwi Channel, between Molokai and Oahu islands, Station 3893; depth, 220–346 fathoms; bottom, fine white sand, rock; temperature, 47° F.

DENDROPHYLLIA AMPHELIOIDES var. CUCULLATA, new variety.

Plate XLVII, fig. 3; Plate XLVIII, figs. 1, 2, 3, 4.

This variety is separated from the typical form of the species by having moderately prominent or very prominent calices; the lip on the proximal side is often produced and curved over the calicular orifice, forming a hood. The back of the hood is sometimes carinate. The intergradation between the two varieties is perfect.

Localities.—

South coast of Molokai Island:

Station 3827; depth, 319–371 fathoms; bottom, light gray brown mud; temperature, 42.1° F.; 1 fine branch (Plate XLVII, fig. 3, Plate XLVIII, fig. 4).

South coast of Oahu Island:

Station 3922; depth, 281–369 fathoms; bottom, light gray sand, broken shells, corals, rock; temperature 44.5° F.; several broken pieces (Plate XLVIII, figs. 1, 2).

Vicinity of Kauai Island:

Station 3982; depth, 233–240 fathoms; bottom, coarse brown coral sand, shells; temperature, 48.5° F.; 1 broken branch (Plate XLVIII, fig. 3).

Cotypes.—Cat. Nos. 20830, 20831, 20832.

Family ACROPORIDÆ Verrill.

Genus ACROPORA Oken (restr. Verrill).

1801. *Madrepora* (part) LAMARCK, Syst. Anim. sans Vert., p. 371 (not of Linnæus, 1758).
1815. *Acropora* OKEN, Lehrb. Naturgesch., p. 66.
1834. *Heteropora* EHRENBERG, Acad. Wissensch. Berlin, Abhandl. for 1832, p. 333 (not of de Blainville, 1830).
1878. *Isopora* (as subgenus) STUDER, Acad. Wissensch. Berlin, Monatsber., p. 535.
1893. *Madrepora* BROOK, The Genus Madrepora, Cat. Madrepor., Brit. Mus. (Nat. Hist.), I.
1901. *Isopora* VAUGHAN, Geolog. Reichs-Mus. Leiden, Samml., 2nd ser., II, p. 68.
1902. *Acropora* VERRILL, Conn. Acad. Sci., Trans., XI, pp. 164, 208.

The *Madrepora* of Lamarck, Dana, Milne Edwards and Haime, and all authors to within a few years was not the *Madrepora* Linnæus, 10th ed. *Acropora* Oken is, as Verrill has shown, the first available name.

ACROPORA ECHINATA (Dana).

Plates XLIX, L; Plate LI, fig. 1.

1846. *Madrepora echinata* Dana, Zooph., U. S. Expl. Exped., p. 464, pl. xxxvi, figs. 1, 1a.
1893. *Madrepora echinata* Brook, Cat. Genus Madrepora, p. 185.
1901. *Madrepora echinata* Studer, Zool. Jahrb., Syst., XIV, p. 416, pl. xxix, fig. 8.

This species has been separately reported from the Hawaiian Islands by both Brook and Studer. I have seen no specimens of it from there.

Professor Studer says:

> The specimen before me is attached by a wide, flat base to the shell of a pearl mussel. Unfortunately it is damaged, the tips of the branches being broken off. However, an identification of the species with the descriptions and figures of Dana, Milne Edwards, and Brooks can be made, only the specimen is smaller in all dimensions than Dana's typical specimens, which come from the Fijis. The undivided tubular calices never attain a length of 20 mm., but at most only 7–8 mm.; if they are longer they always possess short lateral ends.

Some interesting observations on the expanded base of this specimen and its bearings on the affinities of *Acropora* and *Astreopora* follow.

Locality.—Hawaii.

Remarks.—Through the courtesy of Professor Studer I am able to reproduce a photograph of the specimen on which he based the preceding remarks (Plate LI, fig. 1). I am also giving figures of Dana's type of *Madrepora echinata* (Plates XLIX and L).

Genus MONTIPORA Quoy and Gaimard.

Until 1901 only three species of *Montipora* had been reported from the Hawaiian Islands. They were *M. verrucosa* (Lamarck), *M. capitata* (Dana), which is a synonym of the preceding, and *M. patula* Verrill. Professor Studer, in 1901, added two more species, *M. dilatata* and *M. flabellata*, raising the number to four. The collection made by the U. S. Fish Commission expedition in 1902 appears to contain five species, only one of which could be identified with one previously described. Professor Brigham has sent me 22 specimens representing three species, *P. verrucosa*, *P. dilatata*, and another that is here described as new, but which was also collected by the *Albatross*. I have therefore described four as new, which brings the number up to eight. It may be that there are not so many species as are here recognized; however, from the present collections and the present status of the literature, as these eight appear well characterized, it seems probable that the number can not be reduced before more extensive collections have been made.

In preparing the following descriptions and in arranging the species extensive use has been made of Bernard's excellent work, The Genus Montipora, in Volume III of the Catalogue of Madreporarian Corals in the British Museum (Natural History). In this work five principal subdivisions, based upon the character of cœnenchyma, are recognized in the genus. The nomenclature of his categories is employed in the following synopsis and in the subsequent descriptions. I am not altogether positive of the position of *M. dilatata*, but it appears to belong where I have put it.

SYNOPSIS OF THE HAWAIIAN SPECIES OF MONTIPORA.

I. Glabro-foveolate:
Corallum a horizontally expanded, thin, laterally attached lamina............1. *M. dilatata.*
II. Papillate:
Papillæ nipple-shaped.
Corallum, presenting a variety of growth forms...........................2. *M. verrucosa.*
Papillæ as hoods below the calices.
Corallum ramose.
Branches slender, papillæ not prominent...........................3. *M. tenuicaulis.*
Branches thicker, papilla prominent.................................4. *M. bernardi.*
Corallum laminate or foliaceous.
Under surface with little epitheca, calices occurring at the base of the outward steep slope of the papillæ..5. *M. flabellata.*
Under surface entirely covered with epitheca, calices frequently occurring on the outer end or upon the papillæ.......................................6. *M. studeri.*
III. Tuberculate:
Corallum with wide, free edge, calices sunken..................................7. *M. patula.*
Corallum with a narrow or no free edge, calices frequently elevated............8. *M. verrilli.*

I. GLABRO-FOVEOLATE.

1. MONTIPORA DILATATA Studer.

Plate LII, fig. 1; Plate XCII.

1901. *Montipora dilatata* Studer, Zool. Jahrb., Syst., XIV, p. 419, pl. xxx, fig. 11.

Description.—The original description is as follows:

The coral builds a horizontally expanded thin lamina, which is attached laterally. The under side is covered by an epithecal coating, which leaves a thickened free edge not measuring more than 10 mm. across; the calices are very small, 0.5 mm. in diameter, and are sunk in the reticulate cœnenchyma. On the upper side the calices are 0.8 to 1 mm. in diameter, more or less crowded, separated by a reticulate cœnenchyma, beset with fine, branched spinules, which stand close around the calices, so that in some instances the calices appear surrounded by a wall. The calices often contain a second incomplete cycle.

Studer possessed two specimens of this species and added the following notes on them:

One colony is a flat, expanded, fan-shaped lamina, whose inner attached portion is dead and covered by a white coat; the living part shows on the upper surface concentric, wave-like elevations and depressions, the first ones of these again show irregular elevations, on which, when the calices are closely crowded together, the cœnenchyma is more pushed up and surrounds the calices with a projecting wall. The lamina is 3 mm. thick on the edge; toward the base, 4 mm.

A second colony, a laterally attached lamina, 45 mm. across from the edge to the place of attachment and 125 mm. in breadth, is dead, but a great portion of it (in three places) has subsequently been covered by a new living layer, which extends over half of the old lamina and projects beyond its edge. The old dead colony has *Serpula* tubes growing through it and projecting above its surface. These have been overgrown by the new layer, which is consequently thrown into numerous rounded protuberances that may be as much as 10 mm. tall. The calices on these are brought nearer together through the changed mode of growth, and the cœnenchyma between them pushes upward, or the calicular mouths are elevated, the calices rising above the general level of the surface. In a third and similar case, where the lamina appears much folded, the protuberances caused by the *Serpula* tubes of the substratum or by an attached cirrepede (*Pyrgoma*) are cylindrical or club shaped, and may be 16 mm. tall. Here the calices are closely crowded, and the intervening cœnenchyma rises like a wall above the calicular mouths, producing what may be called foveolate structure, using the language of Bernard.

Locality.—Laysan.

Remark.—Prof. J. E. Duerden collected 1 specimen of a *Montipora* that seems to belong to this species. A view of the specimen is given on Plate XCII; a description does not seem necessary.

II. PAPILLATE.

2. MONTIPORA VERRUCOSA (Lamarck).

Plates LIII, LIV, LV, LVI, LVII, LVIII, LIX (all figs.).

1816. *Porites verrucosa* LAMARCK, Hist. Nat. Anim. sans Vert., II, p. 271.
1846. *Manopora capitata* DANA, Zooph. Wilkes Expl. Exped., p. 504, pl. XLVII, fig. 4.
1846. *Manopora verrucosa* DANA, Zooph. Wilkes Expl. Exped., p. 506.
1886. *Montipora verrucosa* QUELCH, Reef corals, Challenger Repts., p. 176.
1886. *Montipora capitata* QUELCH, Reef corals, Challenger Repts., p. 176.
1897. *Montipora verrucosa* BERNARD, Cat. Madr. Corals, Brit. Mus. (Nat. Hist.), III, p. 103, pl. XIX, fig. 2 (Synonymy).
1901. *Montipora verrucosa* STUDER, Zool. Jahrb., Syst., XL, p. 417.

Not—

1830. *Montipora verrucosa* DE BLAINVILLE, Dict. Sci. Nat., LX, p. 355 (=*M. obtusata* QUELCH).
1833. *Montipora verrucosa* QUOY and GAIMARD, Voy. Astrolabe, Zool., IV, p. 247 (=*M. foveolata* DANA).
1879. *Montipora verrucosa* KLUNZINGER, Korallth. Roth. Meer., Pt. 2, p. 35, pl. V, figs. 14, 15; pl. VI, fig. 10; pl. X, fig. 7 (=*M. venosa Ehrenberg*).

Bernard has published an excellent description of this species. As he has had so much experience with this genus I prefer quoting what he says to drawing up a new one.

Description.—Corallum may be either thick, explanate, and incrusting, or massive, the thick but narrow free edge being supported by an epitheca. The former method of growth, by the continued incrusting of previous irregular growths, may result in the formation of clumps of irregular, stout, branching processes; or, again, by the edge creeping under the growing mass, free, rounded coralla are formed, without definite points of attachment, and completely covered by the coral. In the massive method of growth the corallum thickens by the steady growth of the cœnenchyma in the more central regions of the colony.

Calicles numerous, conspicuous as open holes, large (about 1.0 mm.), deeply immersed, except near the growing edges or on surfaces which have grown in unfavorable positions; in these cases the calicles are smaller and open on the smooth surface of the coenenchyma. Two and sometimes three cycles of short, thick septa, more or less equally developed, projecting but a very little way into the polyp cavity, and leaving a large open fossa, in the depths of which the septa fuse to form an irregular columella. Adjoining calicles are sometimes separated from one another by a single thin, perforated plate. Tabulæ may be formed in the lengthening calicles of massive growths.

The cœnenchyma shows the usual streaming layer, which bends upward toward the surface, attaining in the massive forms a great thickness (6 to 7 cm.). This reticulum is slightly echinulate at the surface. The interstices usually swell up into nearly symmetrical, nipple-shaped papillæ from 2 to 3 mm. high and 2 mm. thick. These papillæ exactly fill up an interstice, their walls descending directly into the polyp cavities. They are variously developed, sometimes crowded, and irregularly swollen and fused. As the corallum thickens in the massive forms the polyp cavities fill up with a very loose open tissue (columella formation) which is in marked contrast to that of the solid reticulum, which streams so directly upward as here and there almost to suggest the presence of trabeculæ.

Localities.—Vicinity of Kauai Island:

Station 3999; depth, between 7 and 148 fathoms; bottom, coral sand, shells; 1 specimen.

Northeast coast of Hawaii Island:

Station 4054; depth, 26–50 fathoms; bottom, coarse coral sand, corallines; 1 specimen.

Vicinity of Modu Manu, or Bird Island:

Station 4147; depth, 26 fathoms; bottom, corals, corallines; temperature, 77.9° F.; 4 specimens, small but good.

Station 4158; depth, 20–30 fathoms; bottom, corals, corallines; temperature, 78.3° F.; 1 specimen, a fragment.

Station 4163; depth, 24–40 fathoms; bottom, corals; temperature, 78.1° F.; 2 specimens, small but good.

Island of Molokai, reef at Kaunakakai; 4 specimens, 1 of which is large, 22 cm. tall.

Dr. W. T. Brigham has sent specimens from the following localities:

Island of Oahu: Kahana, 4 specimens; Kaneohe, 7 specimens; Island of Molokai: Pukoo Bay, 4 specimens.

Laysan: Studer.

In addition to these specimens there are in the United States National Museum 3 specimens, two labeled "*Manopora capitata* Dana, Sandwich Islands," and the other, although without a locality label, is probably from the same locality.

Professor Duerden collected the species at Kaneohe and Waikiki, Oahu.

Therefore, I have been able to study more than 40 specimens of the species from the Hawaiian Islands.

Remarks.—The variations presented by *Montipora verrucosa* are bewildering, and it appears, as do other species from the same region, capable of only generic characterization. An attempt is made to classify the variations and to discover if they bear any relation to the physical environment under which they grew; and rather elaborate figures are presented, so as at least to show the principal variations.

Four principal lines of variation can be recognized:

1. Form and size of the corallum, and the extent of the basal epitheca.
2. Coarseness of the reticulum of the cœnenchymal surface.
3. Size and erectness or obliquity of the papillæ.
4. Size of the calices.

The size of the calices did not seem to promise any adequate return for a detailed study; they vary too much on the same corallum.

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Different forms assumed by the coralla:

a. A horizontally extended lamina, with wide, free edge, base epithecate or not. (Plate LIII, figs. 3, 4, 2 specimens with epithecate bases; Plates LIV, LV, two views of the same specimen, calices bifacial.)

b. Incrusting, upper surface irregularly nodose. (Plate LIII, fig. 1.)

c. Incrusting, with the nodulations of the upper increasing in height.

d. Base incrusting, but sending up stout columnar processes. (Plate LVI.)

e. Base incrusting, the ascending processes of smaller size, but much fused at the tops. (Plates LVIII, LIX.)

f. Base small, incrusting, small ascending processes originating at an early stage, but even then there is a pronounced tendency for the upper ends to coalesce.

Specimens of the growth form designated "*a*," with the epithecate base, were found at Stations 3999, in the vicinity of Kauai Island, and 4054, off the northeast coast of Hawaii Island, at a depth between 26 and 50 fathoms. Specimens of this particular form were not collected elsewhere, and the greater depth may have had some influence. The specimen with bifacial calices, the growing edge having been reflexed over the base, was collected in shallow water, 3 to 6 feet, at Kaneohe, Oahu.

Those of growth form "*b*" were obtained at Stations 4147, 4158, and 4163, in the vicinity of Modu Manu, at depths between 20 and 40 fathoms. All of these specimens are small, and the greater depth may have exerted an influence.

Growth form "*c*" is represented by the specimens from Pukoo, Molokai, depth 3 to 6 feet.

Growth form "*d*" is represented by specimens from Kanaha and Kaneohe, Oahu, and Kaunakakai, Molokai.

Growth forms "*e*" and "*f*" are from Kaneohe, Oahu.

Four localities have more or less peculiar growth forms, namely, the vicinity of Kauai Island, the northeast coast of Hawaii Island ("*a*," epithecate base); vicinity of Modu Manu Island "*b*"; Pukoo, Molokai "*c*". Pukoo can be thrown out, as form "*c*" grades directly into "*d*." As already intimated, the greater depth at the other localities may have retarded the growth and may be responsible for the smaller size.

Variation in the coarseness of the cœnenchymal surface reticulum:

The reticulum of the cœnenchymal surface may be fine and somewhat compact, or rather coarse and open. There is absolutely no correlation between the fineness or coarseness of the reticulum and growth form. Every kind of growth form appears with either kind of reticulum; they may grow alongside one another, and some specimens show an intergradation from one kind of reticulum to the other.

Variation in the papillæ:

The papillæ on flat surfaces, except on the terminals of fused processes, are nipple shaped, and in general precisely fill an interspace between calices, as remarked by Bernard. Near the growing edge of a lamina they usually incline outward, and the outer end may fall abruptly into a calicular fossa. On the sides of processes, especially the more slender ones, the papillæ frequently assume the form of hoods or lower lips to the calices.

The papillæ on the fused terminals of the processes, if the cœnenchymal reticulum is fine, are compressed nodules, with steep sides and rounded upper surfaces, the calices occurring in the depressed intervening areas. If the reticulum is of coarse and open texture, probably because of rapid growth, the terminal papillæ may be rather large nipples.

Measurements of these structures are not given, as the figures are natural size, and they convey a correct idea.

Repeated attempts were made to split this series of specimens into several species, but every attempt led to the same result. There is one possibility by which a separation might be affected. Those specimens that have only a small incrusting base and early begin to produce ascending processes, and in which the papillæ have a more pronounced tendency to assume the form of hoods, might be separable. But the possibility of making such a separation is extremely doubtful.

Practically all of the variations of this species grow alongside one another, as at Kaneohe, Oahu, therefore, so far as one can judge from the data at hand, the only variation induced by environment is that greater depth retards growth.

3. MONTIPORA TENUICAULIS, new species.

Plate LX, figs. 1, 1*a*, 2.

Corallum ramose; branches slender, terete or slightly compressed, of very nearly the same diameter throughout their length, frequently anastomosing, tips tapering or somewhat swollen and blunt or flattened; when flattened, the tips give off lobes, on which new calices appear, these lobes are incipient new branches. There is some epitheca on the base of the branch used as the type. Length of specimen, 81 mm.; diameter at lower end, about 5.5 mm.; greater diameter at tip, 3.5 mm.

Calices small; may or may not be conspicuous; about 0.5 mm. in diameter; distant, 1.5 mm. Septal arrangement irregular. Often the primary on the lower side is the most conspicuous septum, while the primary opposite may be next in size. The calices frequently are plainly bilateral. There are usually two cycles; the cycles, however, are not well differentiated, the greater number of the primaries may be small, sometimes a few secondaries may be large. In some instances, however, there are two regular cycles, a large and a small septum alternating. The septa are composed of spines arranged in series one above another; the directive primaries may be dentate lamellæ.

Cœnenchyma on the tips of the branches loose, very porous; away from the actively growing portion, with some pores but rather compact. The transverse section of the lower end of the branch shows an inner, axial, very porous portion, and an outer, rather dense cortical portion, about 0.75 mm. in diameter. The surface of the cœnenchyma is uneven, usually forming a lip or hood on the lower side of each calice. These hoods normally are low, about 0.5 mm in height, diameter of the base 1.5 mm. Sometimes the surface may be plane; occasionally there may be a papilla, round at the summit, 2.5 mm. tall, and 2 mm. in diameter at the base. These tall papillæ appear to be incipient branches. The cœnenchymal surface, examined more minutely, is found to be delicately and crowdedly spinulose. The spinules are slender, wider at the base, the tips pointed or bifurcated. Near the ends of the branches they are more delicate than on the older portions of the corallum.

Localities.—

South coast of Molokai Island, Station 3847; depth, 23–24 fathoms; bottom, sand, stones; 3 specimens and 10 fragments.

Auau Channel, between Maui and Lanai islands, Station 3872; depth, 32–43 fathoms; yellow sand, pebbles, coral; temperature, 74.6°; 1 specimen, 2 fragments.

Cotypes.—Two specimens, from Station 3847. Cat. No. 20811, U.S.N.M.

Remarks.—The specimen from Station 3872 has the lower lip to the calices almost or actually obsolete, the tips of the branches are clavate, and the calices are conspicuous. The larger type specimen has the lower lip to the calices rather constantly present, the tips of the branches may be flattened, but they still taper to the summit, and the calices are inconspicuous. The smaller of the type specimens combines in one specimen the differences above noted; on one side there is no lower lip to the calices, on the other it is present, the conspicuousness of the calices is correlative with the absence of the lip; while the ends of the branches are intermediate in character.

4. MONTIPORA BERNARDI, new species.

Plate LX, figs. 3, 4.

Corallum ramose; branches thick in comparison with *M. tenuicaulis*, main stem, leaving out of account the papillæ, subcircular or elliptical in cross-section, sometimes compressed at the tips; diameter diminishing but little with increasing height. Specimen No. 1 is bifurcated; angle between the branches very acute; length, 63 mm.; greater diameter of stem at lower end, 8 mm.; lesser, 6 mm. Specimen No. 2 is bifurcated near the upper end, and there are several irregular branches below; length, 76 mm.; greater diameter of stem at lower end, 8 mm.; lesser, 6.5 mm. Specimen illustrated on Plate LX, figure 3, is 153 mm. long. Near the tips the branches taper gradually. They may be round or flattened. The terminal surface is obtusely rounded. The flattened ends are dividing, bifurcating or trifurcating to form new branches.

Calices rather small, 0.5 to 0.75 mm. in diameter, 1.5 to 3 mm. apart, usually conspicuous. There are, as a rule, six more prominent septa; of these a directive pair more developed. Quite often two secondaries, one each side of the lower directive, nearly equal the primaries in size. The length of these larger septa is about one-third the diameter of the calices. The second cycle is complete; sometimes excepting the two above mentioned, they are small, even rudimentary. The smaller septa are composed of vertical series of horizontal spines; the larger often are dentate lamellæ. On the lower sides of many calices are prominent papillæ, usually broadly elliptical in cross-section, projecting outward at right angles from the surface or somewhat inclined toward the tips of the branches; summits rounded. The greater diameter at the base varies from 1.5 to 2.5 mm.; the lesser diameter from 1.5 to 2 mm.; height from 1.5 to 2.5 mm. There are no papillæ below some calices; below others there are only low swellings of the surface. The minute characters of the surface are the same as in *M. tenuicaulis*.

Locality.—South coast of Molakai Island, Station 3847; depth, 23–24 fathoms; bottom, sand, stones; 2 branches, probably broken from the same specimen; 3 other specimens and several fragments.

Cotypes.—Cat. No. 20812, U.S.N.M.

Remarks.—This species is separated from *M. tenuicaulis* by, first, its less attenuate branches; second, its slightly larger calices; third, the much more elevated subcalicular papillæ. It occurs associated with *M. tenuicaulis.*

The specimens of *M. verrucosa*, with the more elongate processes, approaches *M. bernardi* very closely.

4a. MONTIPORA BERNARDI var. SUBGLABRA, new variety.

Plate LX, figs. 5, 5*a*.

This variety is based on a single specimen, broken at both ends. It is 79 mm. long; greater diameter of lower end, 6.5 mm., lesser, 6 mm.; above the lower end in places the greater is 7 mm.; diameter just below the bifurcating upper end, 5.5 mm. On one side of the specimen the papillæ are suppressed, on the other they are irregularly developed.

Locality.—Northeast coast of Hawaii Island, Station 4054; depth, 26–60 fathoms; bottom, coarse coral sand, corallines; 1 specimen.

Type.—Cat. No. 20813, U.S.N.M.

Remarks.—This specimen stands almost between the specimens that I have divided into two species and named *M. tenuicaulis* and *M. bernardi*, respectively. The papillæ on the side on which they are well developed are distinctly like those of the latter, and the branch, although somewhat more slender than those of that species, still corresponds more closely to it than to the former. It may be that what I am here considering two species, are in reality only variations of one; but as the specimens obtained at one station differ considerably, the types of both coming from the same station, it seems likely that these differences may prove constant.

5. MONTIPORA FLABELLATA Studer.

Plate LII, fig. 2; Plate LXI, figs. 1, 1*a*, 1*b*.

1901. *Montipora flabellata* STUDER, Zool. Jahrb., Syst., XIV, p. 418, pl. XXXI, fig. 15.

The original description of this species by Studer is as follows:

The colony builds a horizontally expanded, nearly semicircular lamina, which is attached by one side and measures 70 mm. in width along the attached surface, its greatest width is 83 mm., and it rises 46 mm. perpendicular to the base. The thickness on the edge is 5 mm., toward the base as much as 10 mm.

Only a small portion of the underside is covered with epitheca, the greater portion is naked. The cœnenchyma of this side is reticulate and is beset with fine, prominent spinules. The calices are sunken and measure 0.4 to 0.5 mm. in diameter, and each contains only six septa.

The upper surface is uneven, showing wavy elevations which radiate from the middle portion of the attached side and extend to the edge. The calices are small, 0.6 to 0.8 mm. in diameter. There are two cyles of septa, the first six project deeper into the calicular cavity. The loosely reticulate cœnenchyma is elevated between the crowded calices into papillæ as much as 1 mm. tall. Usually each papilla projects over the inner margin of a calice in such a manner that its outer edge falls abruptly into the calicular cavity. The whole cœnenchyma is covered with fine branching spinules.

Laysan.

According to Professor Studer's figure the papillæ may sometimes fuse together laterally, thus forming short, more or less concentric ridges. The arrangement of the papillæ is more strikingly concentric than radial in the illustration.

Prof. W. T. Brigham has sent me one specimen from Kahana, Oahu, and another from Pukoo, Molokai, obtained at a depth between 3 and 6 feet.

6. MONTIPORA STUDERI, new species.

Plate LXII, figs. 1, 2; Plate LXIII, fig. 1.

Corallum a thin lamina. The larger specimen shows no sign of having been attached, the smaller is broken along one edge, and may have been detached from an object of support. The margin of the lamina is more or less scalloped, and may be somewhat bent. Greater distance across larger specimen, 114 mm.; width of median portion, 80 mm.; length of smaller specimen, 59 mm.; width, 31 mm. Thickness of the edge of larger specimen, 2 to 2.5 mm.; in central portion, about 6 mm.; of small specimen, at free edge, 2 mm.; thickest part of broken edge, 4 mm.; in other places along that edge, 1 to 2.5 mm. The upper surface is somewhat humpy and undulated; the lower surface shows, inversely, the same irregularities. Under side covered by an epitheca that extends to the edge of the lamina, with only a very narrow peripheral margin not invested by the epitheca. The epithecal surface is very minutely concentrically striate.

The calices are almost entirely confined to the upper surface; in some places a few may be crowded in between the growing edge of the corallum and the edge of the epitheca, but when these are present they present no special peculiarities. Calices of the upper surface minute, 0.5 to 0.6 mm. in diameter, not hidden, 2 to 4.5 mm. apart. There are two larger directives septa, one standing opposite the other, four smaller primaries, and very often, if not usually, the second cycle is complete. The length of the larger septa is about one-fourth the diameter of the calice. The directives sometimes meet in the bottom of the calice, which is rather deep. The calicular mouths may occur on the flat cœnenchymal surface; they may be situated on the distal end of a papilla or, in a few instances, are on the ends of tubular elevations.

The cœnenchymal surface has flat areas and papilliform protuberances. The papillæ radiate outward, their outer ends falling abruptly to the level of the general surface, while the slopes on their inner sides are gradual. In the larger specimen, at the apparent center of the corallum some of the papillæ rise perpendicular to the surface. The same may occur on the humps. The length and height of the radiating papillæ are very variable; one measured 9.5 mm. in length and was only 1 mm. high at the distal end; 2.5 mm. is about the maximum height, 1.5 to 2 mm. probably the average. The papillæ have a rather indefinite concentric as well as a radial arrangement; in some instances they are rather close together, the intervening cœnenchyma rising to a higher level, making a short transversely corrugated ridge. The papillæ are in close relation to the calices. A calice occurs at the distal end of every one, sometimes at the foot of the abrupt downward slope of the outer end, but very often one is situated above the level of the general cœnenchymal surface and may occur on its most elevated portion. Those calices situated on the summits of cylindrical elevations have probably been developed at the summits of upright cylindrical papillæ. The whole cœnenchymal surface is densely beset with fine, rather low, delicate spinules, which usually are pointed, though some are forked. The reticulum may be almost solid or porous, but in the latter case the trabeculæ have evidently been considerably thickened.

The transverse section of the cœnenchyma shows three layers: the very porous and thickest middle streaming layer; a thin but compact layer resting on the epitheca; and a cortical layer which in some instances is 0.8 mm. thick. This last layer appears almost solid in cross-section; a few minute holes can be seen; it is in strong contrast to the very porous streaming layer.

Locality.—Vicinity of Kauai Island, Station 4024; depth, 24–43 fathoms; bottom coarse coral sand, foraminifera; temperature, 73.7° F.; 2 specimens.

Cotypes.—Cat. No. 20817, U.S.N.M.

Remarks.—These specimens were very puzzling, as it was difficult to decide whether they should be referred to *M. verrucosa* or *M. flabellata*, or be described as a new species. The last mentioned course has been followed. I have been able to study over 30 specimens of *M. verrucosa*. It is, as Bernard has said, a tremendously variable species, but not one of those specimens exhibits the most striking characteristics of what I am calling *M. studeri*. These characteristics of *M. studeri* are: the radially arranged papillæ, which are elongate, sloping upward and outward, with the calices often occurring on them. According to Professor Studer, his *M. flabellata* has very little epitheca on the base, while the whole of the base of *M. studeri* is covered by epitheca. He does not mention calices as occurring on the papillæ; his illustration represents a corallum with much more crowded calices and with papillæ more pronouncedly concentric in arrangement.

This species is dedicated to Professor Studer.

III. TUBERCULATE.

7. MONTIPORA PATULA Verrill.

Plate LXV, figs. 1, 1*a*, 1*b*, 1*c*.

1869. *Montipora patula* VERRILL, Proc. Essex Inst., VI, p. 87.
1897. *Montipora patula* BERNARD, Cat. Madreporarian Cor., Brit. Mus. (Nat. Hist.), III, p. 144.
Not
1886. *Montipora patula* QUELCH, Reef Cor., Challenger Rept., p. 174 (= *M. peltiformis* Bernard).

Original description.—Professor Verrill's original description was as follows:

Corallum thin, partially explanate, attached and incrusting at the center, the edges free and nearly horizontal for a width of 4 inches or more. The corallum at half an inch from the edge is 0.15 of an inch [3.75 mm.] thick; at 3 inches, 0.30 [7.5 mm.]; texture very porous, but tolerably firm. The lower surface is destitute of papilliform processes, and nearly even, composed of a very porous spongiform tissue, roughened with minute sharp points. The cells are very small (0.01 in. =0.25 mm.), regular, wholly immersed, surrounded by a circle of small spinules, thickly scattered over the surface, except toward the edge, when they are generally more distant and often larger, usually with 12 very small, rudimentary septa. Upper surface very porous, somewhat undulated, a little uneven, thickly covered with small, unequal prominent, round-topped papillæ, which have a very open spongiform texture, their surface covered with rough projections. Sometimes these papillæ are less developed and appear like small rounded clusters of spongy trabiculæ, which project all over the surface, and are lacerately divided. Cells thickly scattered over the surface, each usually surrounded by a cluster of four or five of the larger papillæ, considerably larger than those of the lower side (about 0.03 of an inch=0.75 mm.), with six quite distinct septa, which extend about one-fourth across the cells. Toward the central parts of the coral the cells are generally somewhat larger and have 12 septa, six very narrow ones of the second cycle alternating with the six larger primary ones.

Close to the edge the papillæ sometimes form radiating rows, or unite into short, thin ridges. The largest papillæ are scarcely 0.02 of an inch [0.5 mm.] in diameter, and about 0.04 [1 mm.] in height.

Hawaiian Islands. Museum of Yale College. Numerous specimens are also in the Museum of Comparative Zoology, which were collected by Mr. A. Garret.

Bernard[a] places this species in his *tuberculate* section of the genus.

Professor Verrill has kindly loaned me the type specimen of this species, Plate LXV, figs. 1, 1*a*, 1*b*, 1*c*. Critical notes on the differences between *M. patula* and *M. verrilli* are made after the description of the latter species. An additional difference is found in the smaller tubercles on the surface of *M. patula*. They are much larger and coarser in *M. verrilli*.

The tuberculate *Montiporæ* of the South Pacific, *M. incognita* Bernard, *M. effusa* Dana, etc., are closely related to those from the Hawaiian Islands, and it is not unlikely that the same species may occur in both regions. I have not been able to study sufficiently large collections to warrant the expression of a positive opinion.

Professor Studer[b] identified a specimen from Laysan as doubtfully belonging to *M. patula*. It probably is a different species. An illustration of it, from a photograph furnished by Professor Studer, is given on Plate LI, fig. 2.

8. MONTIPORA VERRILLI, new species.

Plate LXIII, figs. 2, 2*a*, 2*b*; Plate LXIV, figs. 1, 1*a*.

Corallum incrusting an irregular surface, completely attached up to the edge on one side, on the other side the edge projects nearly 30 mm. beyond the attached portion. Greatest distance across colony 147 mm.; least, 105 mm. Edges thin or rather thick, near the center the thickness may exceed 20 mm. The upper surface thrown into hillocks with valleys between, following the irregularities of the surface to which it is attached.

Where the corrallum is projecting and free, calices occur on the underside, further within, however, there appears to be a basal epitheca. The lower surface of the free portion is almost even, with the mouths of the calices approximately level with the cœnenchyma, sometimes slightly elevated, small, 0.3 to 0.6 mm. in diameter, and distant from once to twice their diameter. Even in these very small calices two complete cycles of septa are often present. Here the ornamentation of the cœnenchyma consists of small, simple spines, prolongations of the reticular trabeculæ. On the upper surface there are two kinds of calices, not elevated and elevated, in some instances raised as much as 3 mm., of all heights between 0 and 3 mm. Not infrequently two or more calices may project in a bunch, making the surface very uneven. The free portion of the walls of the projecting calices is polygonal in cross section, often pentagonal; it is very rough and more or less spongy. The elevated calices are from 0.7 to 0.9 mm. in diameter; the lower ones from 0.4 to 0.6.

[a] Cat. Madreporarian Cor. Brit. Mus., III, 1897, p. 144.
[b] Zool. Jahrb., XL, p. 420, pl. xxx, fig. 13.

There are two cycles of septa, the secondaries smaller or rudimentary, of the primaries the directives are the more developed.

The cœnenchymal surface is what Bernard calls tuberculate. Over the surface, but especially around the calices, are tubercles varying in size, frequently 1 mm. or more in height and 0.4 mm. in diameter, the summits are rounded, the whole surface minutely spinulose, texture spongy. A ring of three to six of these tubercles often surrounds a calicular mouth. It appears that the tube of the elevated calices has been formed through the fusion of the tubercles in a ring and that they have carried the calicular mouth upward. The cœnenchymal surface is further roughened by minute branched spinules between the tubercles.

The extremely rough character of the upper surface of this species is its most striking feature: First, its surface is undulated by irregularities of growth; second, some calices are elevated, while others are not at all; third, there are numerous tubercles that have rough surfaces; fourth, between the papillæ are numerous branched spinules.

The surface of the reticulum is loose and porous. In a cross section, the layer in which the trabeculæ bend upward from the streaming layer is distinguishable, but the upper layer shows very little compacting.

Localities.—Reef at Kaunakakai, Molokai, *Albatross*, 1902; Kahana and Kaneohe, Oahu, W. T. Brigham.

Cotypes.—Cat. Nos. U.S.N.M. 20819, U. S. Fish Commission, and 21628, W. T. Brigham.

Remarks.—This species groups with *M. patula* Verrill. Professor Verrill states that in that species the calices are all sunken, whereas in *M. verrilli* there are numerous elevated calices. The mode of growth also is different, *M. patula* having "the edges free and nearly horizontal for a width of four inches or more," while practically the whole lower surface of *M. verrilli* is incrusting.

Family PORITIDÆ Dana.

Genus PORITES Link.

1807. *Porites* LINK, Beschreib. Natur. Samml. Rostock, p. 162.
1816. *Porites* LAMARCK, Hist. Nat. Anim. sans Vert., II, p. 267.
1899. *Porites* BERNARD, Jour. Linn. Soc. London, Zool., XXVII, pp. 127–149.
1900. *Porites* BERNARD, Jour. Linn. Soc. London, XXVII, pp. 487–503, pl. xxxv.
1902. *Porites* DUERDEN, Mem. Nat. Acad. Sci., Washington, VIII, pp. 426, 466, 474, 513, 549.
1905. *Porites* BERNARD, Porites of the Indo-Pacific Region, Cat. Madrep., Brit. Mus. (Nat. Hist.), V.

Within the last few years the researches of Bernard and Duerden have thrown much light on the morphology of the calices of *Porites;* but as it would require too much space to give a complete summary of the results obtained through their investigations the reader is referred to their memoirs, especially to Bernard's *Porites* of the Indo-Pacific Region, pp. 12–22.

Bernard distinguishes two mural types in *Porites:*

First. Calices in which there is one septal granule between a palus and the wall. In calices of this type, according to Bernard, there is outside the columellar tangle a vertical trabecula, terminating in a palus, a second vertical trabecula ending on the septal margin in a septal granule, beyond the septal trabecula is a vertical wall trabecula.

Second. Calices in which there are two or more granules between the palus and the apparent wall, with a zone of synapticula next the latter.

Bernard considers that the peripheral ring of synapticula represents the wall, while the portions of the septa outsides this ring are in reality costæ. In his diagrams the trabeculæ are represented as vertical.

From a study of the series of specimens referred to *Porites compressa*, and its various formæ, and of *P. duerdeni*, I became convinced that the septal trabeculæ of *Porites* are not vertical, but inclined inward, usually at so very slight an angle that unless the longitudinal sections of the corallites extend over considerable lengths the trabeculæ appear vertical and parallel. *Porites duerdeni*, of the forms studied, shows most clearly that its septa are composed of inwardly inclined trabeculæ (see p. 193, Plate LXXVIII, fig. 3, and Plate LXXIX, figs. 1, 1*a*).

The wall trabecula in these species is constantly vertical. The number of septal granules therefore varies, and is a function of the angle of inclination of the septal trabeculæ. The septal structure of the Poritids is therefore entirely homologous with that of other Madreporaria, in which the line of trabecular divergence corresponds in position with the wall. In those species that I have studied the portion of the septum exterior of the wall is suppressed, while the inner portion is developed. It is probable that trabeculæ diverging outwardly from the wall are developed in the cœnenchymatous forms.

The septa of *Porites* are therefore structurally very similar to those of the compound, perforate Fungids. The recognition by Duerden and Bernard of the bilaterality of the Poritid calices, and the discovery by Bernard of the palar formulæ, marked great advances in our knowledge of this group of corals. The clear recognition of the essential similarity of their septal structure to that of other Madreporaria may render additional aid in unraveling their systematic affinities.

The genus *Porites* is richly represented in the Hawaiian waters. Judging from Bernard's Porites of the Indo-Pacific Region, only the Great Barrier Reef of Australia has furnished a comparably great number of forms.

Professor Dana, in his Zoophytes of the Wilkes Exploring Expedition, described from there *P. mordax*, *P. mordax* var. *elongata*, *P. compressa*, and *P. lobata*. Professor Verrill, in 1864, in his List of Corals and Polyps Sent in Exchange by the Museum of Comparative Zoology, added another species under the name of *Synaræa irregularis*. Quelch, in his Report on the Reef Corals of the Challenger Expedition, 1886, described *P. bulbosa* from the reefs of Honolulu; he identified one Hawaiian species with *P. lichen* Dana, from the Fiji Islands, and another with a species from the Riu Kiu Islands, *P. tenuis* Verrill. These identifications of Quelch are erroneous. Professor Studer, in his Madreporarier von Samoa, den Sandwich-Inseln und Laysan, 1901, added *P. quelchi*, *P. lanuginosa*, *P. discoidea*, and *P. schauinslandi*. Nine species and one variety of *Porites* have been described and two extraneous species have been identified from the Hawaiian Islands (including Laysan).

The last published account of the Hawaiian Poritidæ is by Bernard.[a] He, in order to escape expressing an opinion as to the probable specific value of the various forms described by him, attaches to each one a number, preceded by an adjective indicating the locality. The following list is compiled from his memoir:

P. hawaiensis prima = *P. mordax* Dana.
+ *P. mordax* var. *elongata* Dana.
P. hawaiensis secunda = *P. compressa* Dana.
+ ? *P. compressa* Quelch.
P. hawaiensis tertia = *P. lobata* Dana.
P. hawaiensis quarta = *Synaræa irregularis* Verrill.
P. hawaiensis quinta, B. M. N. H.[b] = *P. bulbosa* Quelch.
P. hawaiensis sexta, B. M. N. H.[b] = *P. lichen* Quelch (not Dana).
P. hawaiensis septima, B. M. N. H.[b] = *P. compressa* Quelch (not Dana).
P. hawaiensis octava, B. M. N. H.[b] = *P. tenuis* Quelch (*part*) (not Verrill).
P. hawaiensis nona = *P. quelchi* Studer.

From Laysan, Bernard recognizes the following forms:

P. laysana prima = *P. lanuginosa* Studer.
P. laysana secunda = *P. schauinslandi* Studer.
P. laysana tertia = *P. discoidea* Studer.

Apparently only those *Porites* from the Hawaiian Islands considered by Quelch in his report on the Challenger Reef Corals are represented in the British Museum. The United States National Museum now has a fairly good collection of this genus from these islands. It is here necessary to refer only to those forms previously recorded by Quelch, and allude to *P. mordax* var. *elongata* Dana. The last is not even closely related to *P. mordax*, but is a varietal form of *P. compressa*. *P. bulbosa* Quelch is treated in this memoir as a forma of *P. compressa*. *P. lichen* Quelch is the young of a form of *P. lobata*; the *P. compressa* of Quelch is correctly identified; *P. tenuis* Quelch (not Dana) is a form of *P. lobata*.

The United States National Museum is fortunate in possessing the original type specimens of the three species and one variety described by Dana from these islands, and the types of his *P. lichen* and *P. reticulosa* and Verrill's *P. tenuis*. I have therefore redescribed these types of Dana and Verrill, and have included the descriptions of Studer and the description of *P. irregularis* Verrill (originally as *Synaræa*), as well as describing all the material collected by the *Albatross* in 1902, a series of 52 specimens sent me by Dr. W. T. Brigham, a number of specimens collected by Dr. J. E. Duerden, donated to the United States National Museum by the Carnegie Institution, and a large amount of material belonging to the American Museum of Natural History, also collected by Doctor Duerden, and kindly loaned for study. The treatment of the species is only tentative, but it is felt that it is the best that is at present possible. As the septal arrangement in *P. discoidea*, *P. schauinslandi*, and *P. irregularis* could not be ascertained, the following synopsis of the species of the genus is not altogether satisfactory.

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[a] Catalogue of the Madreporarian Corals, Brit. Mus. (Nat. Hist.), V, Porites of the Indo-Pacific Region, 1905, pp. 99–106.

[b] The designations followed by B. M. N. H. are represented in the British Museum (Natural History).

By a comparison of the data later presented with Bernard's tables, or even Bernard himself had sufficient data to bring out this fact, forms of *Porites* closely related to those from the Hawaiian Islands occur in the Southwest Pacific and the Indian Ocean. As I did not have the material at hand for making detailed comparisons, the subject of the relationships of the members of the genus must be passed with this general remark.

SYNOPSIS OF THE HAWAIIAN SPECIES OF PORITES.

A. Without cœnenchyma.

I. Form ramose.[a]

- Skeletal structures coarse and rough, irregular in arrangement, pali irregular in development, of no definite shape or size, 1 septal granule .... 1. *P. mordax.*
- Skeletal structures regular in arrangement, pali well developed, definitely arranged, 1 or 2 septal granules .... 2. *P. compressa.*[b]
- Pali, low, small; 2 to 4 septal granules .... 3. *P. duerdeni.*

II. Corallum composed of columniform lobes.

- Calices shallow or superficial; pali, 5 to 8, usually 6; distal ends of septa split; a very prominent septal granule .... 4. *P. evermanni.*
- Calices excavated; palar formula complete .... 5. *P. pukoensis.*

III. Corallum massive.

- Surface lobate, glomerate, or mammilate, young explanate or incrusting, calices excavated, palar formula complete, interseptal loculi open .... 6. *P. lobata.*
- Surface glomerate, calices excavated, palar formula complete, interseptal loculi filling up with synapticula, texture dense .... 7. *P. quelchi.*
- Flattened above, or lobate, calices very deep; fossa narrow; pali poorly developed, usually 4. 8. *P. brighami.*
- Surface glomerate, covered with branched spinules, calices very shallow, wall loose, reticular, inner ends of triplet free .... 9. *P. lanuginosa.*
- Corallum small, subspheroidal, calices excavated, palar formula usually complete. 10. *P. studeri.*
- Corallum small tuberose, incrusting nodules, calices superficial, surface densely spinulose, inner ends of triplet fused .... 11. *P. bernardi.*
- Corallum small, subspheroidal, surface somewhat glomerate, inner ends of triplet fused. 12. *P. tenuis.*

IV. Corallum more or less foliaceous.

- Corallum a free lamina, upper surface flat, calices 1 mm. in diameter....... 13. *P. discoidea.*
- Corallum a thick lamina, upper surface uneven, calices 1.3 to 1.5 mm. in diameter. 14. *P. schauinslandi.*
- Corallum a small lamina, calices small, 0.75 to 1 mm. in diameter, tending to form series. 15. *P. lichen.*
- Like *P. lichen*, but corallum larger, calices larger, 1 to 2 mm. in diameter..16. *P. reticulosa.*

B. With cœnenchyma.

- Form ramose, branches crowded, angular, clavate, uneven .... 17. *P. irregularis.*
- Corallum incrusting, upper surface undulate .... 18. *P. hawaiiensis.*

[a] All of these forms typically have the inner ends of the septa of the triplet free.

[b] No attempt is made in this synopsis to distinguish the "formæ" of *P. compressa* and *P. lobata.*

1. PORITES MORDAX Dana.

Plate LXVI; Plate LXXIII, figs. 3, 3*a*.

1846. *Porites mordax* DANA, Zooph. Wilkes Expl. Exped., p. 552, pl. LIII, figs, 3, 3*a*.
1887. *Porites mordax* RATHBUN, Proc. U. S. Nat. Mus., X, p. 364.
1905. *Porites hawaiensis prima* BERNARD, Porites of the Indo-Pacific, p. 99.

Original description.—Dana's original description is as follows:

Cespitose, alive for 3½ to 4 inches; branches subsimple and somewhat compressed below, often coalescing into a plate, branchlets 1½ to 2 inches long, one-third of an inch thick, and one-third to 1 inch broad, plano-rotund at apex. Corallum strong and firm, with the surface harsh; cells large (three-fourths of a line), deep, and conical; septum acute, scabrous.

* * * * * * *

Forms rather open clumps, 10 inches broad and 6 to 8 high, consisting of stout branches, often united below into thick plates or cavernous masses. The texture is firm and the surface peculiarly rough and harsh, being pitted with large deep cells, having septa, often with the angles prominent There are seven or eight cells in a breadth of half an inch. Some specimens are massive and sublamellar, with obtuse lobes above, instead of proper branches.

There is one of Dana's original specimens in the United States National Museum, No. 710. It fulfills well the requirements of his description and corresponds with his figure, but apparently is not the figured specimen. The dimensions of this specimen are: Length, 24 cm.; width, 14 cm.; height, 13 cm. The general aspect is as Dana described it.

The calices are rather large, 1.5 mm. in diameter, except in the angles between branches and on depressed portions, where they usually are much smaller. The walls are distinct, simple, and rather thick; composed of vertical trabeculæ, bound together by synapticula. These synapticula usually are rather stout bars; the wall therefore looks rather thick and solid when viewed from above; in places they may not extend to the tops of the septa, then the walls appear interrupted. Sometimes there are synapticula near the wall in the interseptal loculi, but they are irregular, not forming a definite, constant ring as in other species. The edge of the wall and the septal knots on it are almost glabrous; the absence of the minute spinulations, so common in many species of *Porites*, was so striking that at first it was thought the surface ornamentation was worn away. The corners of the walls between the calices are frequently somewhat elevated. The depth of the calices is moderate.

Normally there are twelve septa, the dorsal directive, four lateral pairs, with the inner ends of the ventral triplet free or only loosely fused. The septa are coarse, rather thick, rarely straight; each has, including the paliform tooth, a few coarse, irregular dentations; the fusion of the inner septal ends is not according to any definite scheme. There are no minute granulations, but on the faces are a few large, irregular ones. The pali are extremely irregular in development, sometimes present, sometimes absent; when present they are knots of no definite shape or size. Outside of the palar ring each septum usually has a single coarse dentation near the wall. Each septum possesses between the palus and the wall one trabecula. The trabaculæ are irregular in size, usually coarse, and are joined to those of neighboring septa by coarse, irregularly shaped synapticula. The largest synapticula are those in the wall. Occasionally spines projecting subborizontally inward can be seen near the wall in a calice. These spines join radially the trabeculæ of the same septum. Very delicate tabulæ rather abundant.

The columella is lax, formed by the irregular fusion of the inner septal ends. A small terminal tubercle usually present.

Locality.—Hawaiian Islands, Wilkes Exploring Expedition.

Remarks.—This coral has a very striking facies, but it is extremely difficult to give an adequate description. The characters seem to lie in the coarse, rough texture and the general irregularity of most of the skeletal elements. The preceding more or less unsatisfactory description, taken in connection with the figures, will it is hoped render the species determinable.

2. PORITES COMPRESSA Dana.

Plate LXVII; Plate LXVIII, fig. 3 (from Dana's type).

1846. *Porites mordax* var. *elongata* DANA, Zooph. Wilkes Expl. Exped., p. 553, pl. LIII, fig. 4.
1846. *Porites compressa* DANA, Zooph. Wilkes Expl. Exped., p. 553, pl. LIII, figs. 5, 5*a*.
1852. *Porites compressa* MILNE EDWARDS and HAIME, Ann. Sci. Nat., 3ième sér., Zool., XVI, p. 31.
1860. *Porites compressa* MILNE EDWARDS, Hist. Nat. Corall., III, 176.
1886. *Porites bulbosa* QUELCH, Reef Corals, Chall. Rept., p. 180, pl. XI, figs. 7, 7*a*.
1886. *Porites compressa* QUELCH, Reef Corals, Chall. Rept., p. 180.
1887. *Porites compressa* RATHBUN, Proc. U. S. Nat. Mus., X, p. 361.
1905. *Porites hawaiensis secunda* BERNARD, Porites of the Indo-Pacific, p. 100.
1905. *Porites hawaiensis quinta* BERNARD, Porites of the Indo-Pacific, p. 101, pl. IX, fig. 8.
1905. *Porites hawaiensis septima* BERNARD, Porites of the Indo-Pacific, p. 104, pl. X, fig. 1; pl. XII, fig. 6.

Original description.—According to Dana this species was as follows:

Cespitose, alive for 1½ to 2 inches, sublamellate and erect, coalescing below, lobed above or lobato-ramose, lobes compressed, one-half to three-fourths of an inch broad (rarely 1½ inches), short (one-half an inch), subtruncate at summit, and to 3 to 4 lines thick, not at all clavate. Corallum firm; cells one-half a line broad, neatly polygonal, quite shallow, plano-conical; septa acute and very thin.

* * * * * * * *

The clumps are 6 inches or more broad and 4 high, but are alive only at summit for 2 inches or less. Below it is very coalescent, almost forming a solid mass, with a few large vacuities. In some specimens the broad lamellate structure is scarcely apparent. The depth of the conical cells scarcely exceeds one-fourth the breadth, and the septa are very thin.

The following description is based on Dana's type, Cat. No. 711, U.S.N.M.

The corallum is composed of ascending, truncate, compressed, plate-like branches, that by fusion form wide, irregular plates. The base is broken, but it can be seen that branching begins early, the branches largely fusing one to another in the lower portion of the corallum. Height, 10.35 cm.; length, 14.4 cm.; breadth, 8.35 cm.

Calices polygonal, 1–1.75 mm. in diameter, with about 1.4 mm. as an average, moderately deep, as much as 0.6 mm. The walls near the upper ends of the branches are simple, rather tall, thin, and often zigzag; near the lower limit of the living portions they are not so tall, or even may be obscured; they are composed of vertical trabeculæ, joined together by thin synapticula, which may be rather wide in a vertical plane; perforations may be scarce, but usually are abundant. The upper mural edge is somewhat irregularly but not coarsely dentate; denticles may correspond to the outer ends of the septa; some of them may fork and present a delicately spinulose appearance.

Between a palus and the wall there normally is one trabecula, which terminates on the septal margin in a septal granule, slightly removed from the wall and of moderate prominence. Near the lower edge of the living portion the calices are shallower, and rather often there are two granules on the septal margins between the palus and the wall. The trabeculæ next the wall are very rarely connected by a complete ring of synapticula, but one is nearly always partially represented. The synapticula may be free from the wall or more or less fused with it. There is no complete and persistently developed mural shelf between the septal granules and the wall, but one is often present in parts of calices. In thickness the septa equal or somewhat exceed the width of the interceptal loculi; the outer ends are thicker than the inner portions.

The pali are moderately wide and rather tall; the formula is usually complete, but the palus is often small and sometimes absent on the ventral directive. They are joined together by a palar ring of synapticula, which is not always complete.

The columella consists of a compressed, thin, rather prominent tubercle, connected by 6 more or less definite rays to the inner ends to the septa. The columellar tangle is often considerably compacted by stereoplasmic deposit.

The skeletal surfaces are covered by low, blunt, somewhat crowded granulations.

The preceding description is based on Dana's type, as has already been stated. Forty-six specimens and a few fragments belonging to the United States National Museum are referred to *P. compressa*. Of these, 3 have belonged in the institution for some time; 7 were collected by the *Albatross* expedition of 1902; 36 were received from Dr. W. T. Brigham, of Honolulu. These specimens present a wide range of variation, so wide that it was very difficult to devise a scheme by which the facts obtained from studying them could be intelligibly placed on record. Sixteen principal types and 4 subordinate types of variation are recognized. The variation appears to be continuous, but with a number of definite secondary modes, should they be plotted into a specific curve. What the physiologic meaning of this variation is, it is at present entirely impossible to say. We have no facts by which it could be ascertained whether the differences are of gametic or vegetative origin. It was therefore decided to designate the different types of variation represented as "formæ," the subordinate types as "subformæ" of "formæ." Latin names are attached to the forms and subforms. They are intended principally as descriptive terms to enable writing or speaking of the types of variation, and probably will not be considered of particular importance except by those who are making detailed studies of variation. I prefer naming to Bernard's number system.

Before proceeding to a consideration of the variations of the species, a statement of the fundamental plan underlying all of them will be made.

Specific description of P. compressa.- The corallum has a slightly expanded or incrusting base, above which it soon becomes ramose, producing crests or branches, usually more or less compressed. The branches near the base may be much fused one to another or free; the same remark applies to the condition in the upper part of the corallum, the branches, plates, or crests may be separate or fused into plates of varying width. The terminals or upper edges are almost invariably truncate; the ends of the branches are frequently clavate.

The calices are polygonal, separated by definite, continuous walls. The range in diameter is from slightly less than 1 mm., the smallest calices on some specimens, to about 2.25 mm., the largest calices on other specimens. The average diameter for specimens ranges from about 1.4 to about 1.75; probably 1.5 mm. is the average for the species as a whole. The depth of the calices is variable, from superficial to deep.

The septa vary much in thickness. There is usually a single trabecula between the palar and mural trabeculæ, emerging on the septal margin and producing a septal granulation. Near the lower edge of the living portion of the colony and where calices have prolonged corners, frequently there are two trabeculæ between the palus and the wall, which correspondingly produce two granules on the septal margin. On some specimens many or most of the septa are composed of two septal trabeculæ. These trabeculæ, when there is only one ring, or the outer septal trabecula when there are two, are more or less completely united by a ring of synapticula. The septal trabeculæ next the wall and their circular connections may or may not produce a mural shelf.

The pali are always distinctly developed, and the formula is normally complete; that is, there are 8 pali. Occasionally the palus is suppressed on the dorsal directive, and frequently there is variation in the triplet; the ventral directive is often shorter than the laterals of the triplet, and the palus on it may be obsolete. The pali are nearly always united by a ring of synapticula.

The columella is a compressed style, joined by radial connections to the inner terminations of the septal groups.

The skeletal surfaces are always granulate or frosted, with considerable variation in the thickness, length, shape, and proximity one to another of the granulations.

The preceding description will show that there is a fundamental scheme underlying all of the variations and that each structural element is variable, but the variation is within limits. In defining the variations subsequently described, the following factors are taken into account:

1. The form of the corallum, which is considered of minor importance.
2. The size of the calices.
3. The depth of the calices.
4. The character of the wall, particularly the mural denticles.
5. The number of the septal trabeculæ between a palus and the wall, and the dentations or granules on the septal margins. The relation between the granule next the wall and the wall is of decided importance.
6. The pali, especially the tendency to deviate from the complete formula.
7. The synapticular rings, whether complete or incomplete, and the degree of fusion with, or aloofness from the wall.
8. The columella.
9. The character of the granulation or frosting of the skeletal surfaces.

PORITES COMPRESSA forma ANGUSTISEPTA, new.

Plate XLVIII, figs. 1, 1*a*; Plate XCIII, figs. 1, 2, 3.

Description of type specimen of the forma.—Corallum composed of ascending, obtuse, or clavate branches, a number of which coalesce to form plates. Height of specimen, 13 cm.; depth of living portion from 1.3 to 4.6 cm.; length of free portion of branches from 1.6 to 3.6 cm.; lesser diameter of branches, 1.2 cm.; greater, from 1.35 to 2.5 cm.; width of plate of five fused branches, 8 cm.

Calices from 1.5 to 2 mm. in diameter, average about 1.75; deep, except at the lower edge of the living layer; separated by definite continuous walls, decidedly elevated, as much as 0.5 mm., except near the lower edge of the living layer. Walls rather thick, and present a relatively solid appearance. The mural denticles around a calice are about twice as numerous as its septa; they are rather thick and covered with closely set, thick granulations.

The septa begin some distance below the upper edge of the wall. They are rather thick, usually thicker than the width of the interseptal loculi, their outer ends thicker than the inner. Between a palus and the wall there is usually one, sometimes two, septal trabeculæ, with corresponding dentations on each septal margin.

The septal granules are only slightly removed from the wall; in fact, they are actually or very nearly adherent to the wall by their outer edges. The outer ring of synapticula is never complete, but it is almost invariably partially represented; those present are only slightly distant from the wall and often fuse with it.

The pali are prominent, those before the lateral pairs the most prominent, formula invariably complete; palar ring of synapticula usually or nearly always complete.

Columella a narrow lamella, rising from the bottom of a deep well-like fossa, radially connected with the inner ends of the septa. The lamella and its radial projections may be considerably compacted by stereoplasmic deposit.

The skeletal surfaces are thickly set with rough granulations of irregular shape and of unequal sizes.

Localities.—Kahana, Oahu, type and 3 other specimens; Pukoo, Molokai, 3 specimens, all received from Dr. W. T. Brigham; depth, 3 to 6 feet.

Type.—Cat. No. 20915, U.S.N.M.

Remarks.—The 3 other specimens from Kahana, Oahu, all so closely agree with the type and with one another in essential characters that they deserve no special consideration. The branches or plates vary in width and height, but do not differ widely from the type. The 3 specimens from Pukoo, Molokai, however, show considerable differences among themselves and from the Kahana material. One of these is composed of three branches, the median bifurcating, fused into a zigzag corrugated plate 6 cm. wide and 2.15 cm. thick. The branches taper somewhat, are distally free from 1 to 2.3 cm., and have obtusely rounded, not truncate, ends. The branches of another specimen are divergent; they are not fused at all. The third specimen is immature. It is composed of two ascending, more or less compressed branches, one of which is bifurcating, the other trifurcating. Height, 4.6 cm. The calices average smaller than in the other specimens, about 1.5 mm. The wall on the upper portion of the corallum is elevated, but near the base it is reduced in height, and the septal granules are tall, sometimes almost equaling the wall in height, and the outer ring of synapticula may be almost complete.

This forma is in its calicular characters scarcely to be separated from *Porites pukoensis*, new species (see Plate XCIV and Plate XCV, figs. 1, 2, p. 195). The columns of the latter are thicker, but the resemblance in other features is so similar that their being different growth forms of the same species is strongly suggested.

Dr. J. E. Duerden obtained at Waikiki, Oahu, a suite of over thirty specimens of a *Porites* that seems to be a modification of *P. compressa* forma *angustisepta;* the form of the corallum, however, is usually rather different. A description of the development of the corallum will most clearly bring out the essential characters.

The corallum in its early stages forms over various objects an incrusting layer, with gibbosities on its upper. Subsequently low crests and nodules appear. The crests may develop into elevated plates, the nodules into stumpy, incrassate, much fused branches. The intergradation from the corallum that is only a surface incrustation to the more ramose form of the forma is complete. A careful comparison of the calices of the various specimens showed no important differences (see Plate XCIII, figs. 1, 2, 3).

PORITES COMPRESSA forma ANGUSTISEPTA subforma DELICATULA, new.

Plate LXVIII, fig. 2; Plate LXIX, fig. 1.

This subforma differs from forma *angustisepta* by its more delicate pali and the crowded, fine, long spinulations of the skeletal surfaces. Otherwise there is no noteworthy difference. The sides of the branches or plates possess rounded gibbosities, but no particular importance can attach to them.

Locality.—Pukoo, Molokai; received from W. T. Brigham; depth, 3 to 6 feet.
Type.—Cat. No. 20929, U.S.N.M.

PORITES COMPRESSA forma ANGUSTISEPTA subforma PAUCISPINA, new.

Plate LXIX, figs. 2, 2*a*.

This subforma is based on a single specimen, composed of several fused and flexed plates, with nodose upper edges. Height, 5.45 cm.; length, 7 cm.; width, 6.9 cm.; depth of living portion, from 1.75 cm. to 4.65 cm.; thickness of plate, 1.2 cm.

The difference between this specimen and forma *angustisepta* consists in the sharper and more scattered septal granulations and a generally more ragged appearance of the skeletal parts. The calices average somewhat smaller, ranging in diameter from 0.8 to 1.75, with about 1.5 as an average.

Locality.—Pukoo, Molokai; received from W. T. Brigham; depth, 3 to 6 feet.
Type.—Cat. No. 20942, U.S.N.M.

PORITES COMPRESSA forma FRAGILIS, new.

Plate LXX; Plate LXXI, figs. 1, 1*a*.

Corallum forming a head, 16 cm. across, composed of sinuous, anastomosing plates, or compressed knobs, with truncated or rounded upper edges. Lesser diameter of a knob, 18.5 mm.

Calices polygonal, with very definite boundaries; on the summits and sides of the living portions deep, near the lower edge shallow. The diameter ranges from 0.8 to 2 mm., usually about 1.5 mm.

The wall is elevated, thin, continuous, frequently zigzag. The mural denticles are delicate, often long, spinulose, about 24 to a calice.

The septa are thin and fragile, the outer ends thicker; interseptal loculi wide and open. Between a palus and the wall, from one to three septal trabeculæ, depending upon the length of the septum; two is the usual number. Each of these trabeculæ is terminated on the septal margin by a delicate dentation. The outermost tooth stands from one-fourth to one-third the length of the septum away from the wall, which projects considerably beyond its upper end. The outer teeth coincide in position with an incomplete ring of synapticula. A second synapticular ring joins the pali together.

The pali are thin, fragile, of moderate height, pointed or truncate; the formula is complete. They surround a deep, well-like depression, from the bottom of which rises a delicate, narrow, spinose, lamellar columella. The upper end of the columella is much lower than the level of the ends of the pali.

The skeletal surfaces are beset with numerous slender spines of variable length and shape, pointing in many directions, and producing a very rough and ragged appearance.

Locality.—Pearl Harbor, Oahu; depth, 3 to 6 feet.

Type.—Bishop Museum, Honolulu; fragment, Cat. No. 20928, U.S.N.M.

Remarks.—This forma is especially characterized by its fragile skeletal parts and the peculiar nature of their ornamentation. It is closely related to forma *angustisepta*, being separable from that forma by its more delicate skeletal structures.

PORITES COMPRESSA forma CONJUNGENS, new.

Plate LXXI, figs. 2, 2*a*.

Corallum composed of ascending, irregularly constricted nodulose columns, rising from a ramose base. As the columns grow upward they become compressed, widen and divide into thick branches. There is considerable fusion between the branches, even near the base, but in the upper part of the corallum they frequently form wide plates. The columns and plates in the interior of the corallum are dead to near their summits; but on the outside the living portion, or disconnected live areas, may extend more than halfway to the base. The lower edge of the living portion frequently creeps downward over the surface of the dead part, and further down there are disconnected live patches, occurring as incrustations. Height of corallum, 28 cm.; diameter of branches from 1 to 4.5 cm.; width of plates from 2 to 15 cm.

Calices polygonal, 1 to 2 mm. in diameter, usually about 1.75 mm.; moderately deep near the summits, shallow or superficial near the lower edge of the living portion; separated by slightly elevated, continuous, straight walls. There are more than 24 small, irregularly shaped mural denticles to a calice.

The septa are of variable thickness. They may be thicker than, or narrower than the interseptal loculi; the outer ends decidedly thicker than the inner. Between a palus and the wall there is one septal trabecula, except near the lower limit of the living part, where there are occasionally two, the outer arising in the angle between the wall and the next more inwardly situated trabecula, which inclines toward the columella. Septal granules correspond to the septal trabeculæ; usually there is only one, which is detached from the wall, standing about halfway between it and the palus. They vary both in prominence, size, and shape. When the calices are deep they are not so tall as the wall; when the calices are shallow they are of about the same height. They may be irregularly shaped granules, narrow teeth, or platelike. The septal trabeculæ when there is only one ring, or the outer trabeculæ when there are two rings, are united by synapticula, extending high up in the calice, and detached from or fused to the wall, thus forming on the older portions of the corallum a distinct mural shelf.

The pali are often small, those before the lateral pairs the larger, rather thin; but they may be rather wide and tall. The formula is persistently complete. Palar ring of synapticula complete.

The columella is usually a rather wide, thin lamella, of moderate height, rising from the flat bottom of the fossa, which is surrounded by the perpendicular inner edges of the pali. There is considerable compacting around its base.

The skeletal surfaces are covered with closely set, short, blunt granulations.

Locality.—Reef at Kaunakakai, Molokai, *Albatross*, 1902.

Type.—Cat. No. 21276, U.S.N.M.

Remarks.—This forma is in most respects the center of the species, binding together the various formæ that compose it. Its relations to the other formæ are discussed in the concluding remarks on the species.

PORITES COMPRESSA forma PROFUNDICALYX, new.

Plate LXXII, figs. 1, 1*a*, 1*b*.

Corallum composed of ascending, truncate, compressed branches, coalescing abundantly and forming irregular plates of considerable width.

This forma is based on four fragmentary specimens, all of which may belong to the same corallum.

MEASUREMENTS.

Specimen number.	Height.	Free portion of branches.			Plates.		Depth of living portion.
		Length.	Width.	Thickness.	Thickness.	Width.	
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1.......	4.6	0.5 -1	1.1-1.55	0.95-1.05	1.65	5.15	4.9
2.......	10.9	.6 -2.35	1.4-2.2	.9 -1.15	1.35	3.5	2.85-8.4
3.......	10.8	1.55-2.8	1.5-2.8	1.05-1.4	1.8	5.1	3.6 -9.6
4[a].....	14.3	up to 2	1.1-2.75	.8 -1.25	1.3	3.35	1 -8.6

[a] Type, figured specimen.

Calices polygonal, 1 to 2.5 mm. in diameter, usually about 1.5 mm.; excavated and decidedly deep near the branch summits and for considerable distances down on the sides; separated by elevated, continuous, unusually compact walls, thin on the edge, but thicker below, also thicker on the lower than on the upper portion of the corallum. There are about twice as many delicate, frosted, mural denticles to the calice as there are septa.

The septa are rather thicker, usually slightly thicker than the width of the narrow, but open, interseptal loculi. The septal margins usually begin an appreciable distance below the upper edge of the wall; if continued upward, they are very narrow. Between a palus and the wall there is normally one trabecula, which forms a granule on the septal margin. The relation of this granule to the wall is variable, it may be very close, actually adherent, or detached; where the latter condition obtains, the intervening portion of the septal margin is excavated. The granules are not very prominent, they are irregular in size, frosted, joined by a more or less incomplete synapticular ring. There is no definitely developed mural shelf, but there are rudiments of one. In some instances there are two septal trabeculæ, and correspondingly two septal granules. The synapticular ring connecting the septal trabeculæ may fuse with or be separate from the wall.

The pali are well developed, pointed or truncate, not very tall, those before the lateral pairs larger and more prominent; the formula nearly always complete. The palar ring of synapticula is normally complete.

The columella is a thin and relatively wide lamella, rising from the bottom of a pit, bounded by the perpendicular inner edges of the pali, and joined by radial connections to the inner terminations of the septa.

The skeletal surfaces are covered with closely set, rough granulations.

Locality.—Reef at Kaunakakai, Molokai, *Albatross*, 1902, 4 specimens.

Type.—Cat. No. 21277, U.S.N.M.

Remarks.—This forma intergrades in calicular characters with both forma *conjungens* and forma *angustisepta*.

PORITES COMPRESSA forma PILOSA, new.

Plate LXXII, figs. 2, 2*a*.

Corallum ramose, branches ascending, compressed; coalescing extensively, leaving short, obtusely rounded or truncated, protuberant ends.

MEASUREMENTS.

Specimen number.	Height of corallum.	Branches. Length.	Branches. Width.	Branches. Thickness.
	cm.	*cm.*	*cm.*	*cm.*
1	11.8	1.3[a]	1.3–2.8	0.75–1.8
2	10.5	1.3[a]	1 –2.5	.9 –1.25

[a] The free portion.

These two specimens are portions of coralla.

Calices polygonal, with definite boundaries, with diameters between 1.5 and 1.75 mm.; the calicular cavity shallow, or even superficial.

The wall is thin, distinct, usually continuous; only slightly elevated on the lower portion of the corallum, distally more elevated, but not especially prominent. Mural denticles fine, delicately frosted, about twice as numerous as the septa.

The outer ends of the septa are thicker than the inner ends; the septa as a whole rather thick, their thickness exceeding the width of the interseptal loculi; the latter very narrow on the basal portion of the corallum. Between a palus and the wall there appears to be a single septal trabecula, but on the septal margin there are several, two or three, delicate, minutely and very delicately frosted dentations or spinules, which are almost as tall as the wall. Each of these denticles apparently does not coincide with a trabecula, but several may originate from the same trabecula. The outermost septal denticle often stands slightly away from the wall. The inner or palar synapticular ring is normally complete; the outer or mural ring is sometimes complete, and is slightly separated from the wall.

The pali are rather tall and narrow, finely frosted, formula usually complete.

The columella is a thin, compressed tubercle.

All the skeletal surface are delicately and thickly spinulose, producing a rather wooly appearance.

Locality.—Kabana, Oahu; depth, 3 to 6 feet; received from W. T. Brigham.

Cotypes.—Cat. Nos. 20911, 20914, U.S.N.M.

Remarks.—This forma intergrades with forma *densimurata.*

PORITES COMPRESSA forma DENSIMURATA, new.

Plate LXXIII, figs. 1, 1*a*.

Corallum ramose, branches compressed, of variable width, superiorly spreading somewhat or coalescent, the upper ends are truncate and may be swollen, of flabellate or clavate form.

MEASUREMENTS.

Specimen number.	Height of corallum.	Branches. Length.	Width.	Thickness.
	cm.	*cm.*	*cm.*	*cm.*
1.........	4.7	1.65	0.95–2.6	0.7–0.85
2.........	11.6	3	1.45–2.85	1.1–1.45
3.........	A piece.	3	3	.5–1.1

The three specimens here grouped together are all broken portions of coralla. The branches of No. 1 coalesce distally, while those of the two other specimens are free.

Calices polygonal, with definite boundaries, ranging in diameter from 1 to 1.75 mm., with an average of about 1.4, slightly less than 1.5 mm. The depth is only moderate.

The wall on the upper and median portions of the branches is slightly elevated, sharp, and definite. The mural denticles are relatively large, often coarse, usually more than 12, but less than 24 in number. Near the base, the wall may be obscured by the thickened distal ends of the septa; because of these thickened septal ends, at the level of the base of the septal granules, it appears thick and solid.

The septa uually are thicker than the interseptal loculi; the latter, however, are as a rule open. Most commonly one septal trabecula emerges between the palus and wall, occasionally two. The columellar, palar, septal, and mural trabeculæ are almost parallel in their courses. The septal granule stands a slight distance away from the wall, and is moderately prominent, but does reach the level of the edge of the wall. Both synapticular rings are imperfectly developed, especially the outer or the mural; those belonghng to the latter rihg are close to the wall and are frequently fused to it.

The pali are prominent, thick, and coarse; the formula may be complete, but frequently there is none on the ventral directive.

The columella is a compressed, small or rather stout style.

The skeletal structures are covered with short, blunt, coarse granulations.

Locality.—Pukoo, Island of Molokai; depth, 3 to 6 feet; received from Dr. W. T. Brigham.

Cotypes.—Cat. Nos. 20945, 20946, 20947, U.S.N.M.

Remarks.—Forma *densimurata* intergrades on the one hand with forma *pilosa*, on the other with forma *granimurata.*

The specimen described in the succeeding note was not referred to any forma, because of its intermediate characters.

Corallum composed of truncated compressed branches or coalescent plates, free for only a small portion of their length. Height of corallum, 4.9 cm.; branches free for 0.9 cm.; width, 0.8–3.1 cm.; thickness, 0.65–1.1 cm. The specimen is perfect.

The calices are shallow, polygonal, definitely delimited, ranging in diameter from 1 to 2 mm., with about 1.5 mm. as an average.

The wall is distinct, slightly elevated on the upper portion of the corallum, with coarse mural denticles somewhat more numerous than the septa; on the basal portion it may be obscured.

In its septal characters and its surface ornamentation this specimen combines forma *pilosa* with forma *densimurata;* it is precisely intermediate.

PORITES COMPRESSA forma GRANIMURATA, new.

Plate LXXIII, figs. 2, 2*a*.

Corallum composed of branches of small diameter (8 by 11 mm.), free distally for from 12.5 to 17.5 mm., the ends truncate and clavate, coalescing below the summits into plates. Height of larger pieces, 7 cm.

Calices shallow, definitely delimited, ranging in diameter from 1 to 2.5 mm., average diameter about 1.5.

Wall slightly elevated, usually continuous, 15–20 irregularly shaped mural denticles to the calice.

The septa are thick, with intervening narrow but open interseptal loculi. Between the palus of a septum and the wall is one septal trabecula terminating superiorly in a septal granule slightly distant from the wall, a shelf running around the inside of the wall between it and the ring of granules.

The pali are pointed, rough, and somewhat irregular. The formula is often complete.

There are two rings of synapticula, the outer or mural usually not complete and often fused to the wall.

The columella is a small tubercle.

The skeletal ornamentation consists of rather crowded, short, thick, blunt granulations.

These specimens, two, have a peculiarly rough irregular texture, unlike that of any of the other Hawaiian specimens.

Locality.—Kaneohe, Oahu; depth, 3 to 6 feet; received from W. T. Brigham.

Cotypes.—Cat. Nos. 20936, 20951, U.S.N.M.

Remarks.—This forma intergrades on one hand with forma *densimurata*, on the other with forma *abacus*.

PORITES COMPRESSA forma CLAVUS, new.

Plate LXXIV, figs. 1, 1*a*.

This form is represented by a single clavately shaped column, the basal part of which incrusts a dead fragment of the same species. Height, 62 mm.; lesser diameter of base, 15.5 mm.; greater diameter of middle portion, 18 mm., lesser, 14.5; greater diameter of upper end, 33 mm., lesser, in constriction, 17.5, greatest width of end lobe, 28.

Calices polygonal, separated by stout, continuous, elevated walls, about 19 or 20 mural denticles to a calice. Diameter, from 1.25 to 2 mm., 1.5 mm. the average size.

The septa are slightly thicker than the interseptal loculi, which are open. Between a palus and the wall there is one trabecula terminating on the septal margin in a tooth of variable width and prominence, near or slightly removed from the wall. There is no distinctly developed mural shelf. The palar synapticular ring is often or usually complete; the outer ring is very rarely complete, but never entirely absent.

The pali are rather thick, not very prominent, more or less pointed, range in number from six to the complete formula, the latter condition, however, is rare.

The columella is a compressed style, not so tall as the pali.

The skeletal surfaces with rather few granulations, therefore presenting a smooth appearance.

Locality.—Pukoo, Molokai; depth 3 to 6 feet; received from Dr. W. T. Brigham.

Type.—Cat. No. 21271, U.S.N.M.

Remarks.—The particularly solid and smooth appearance of both the wall and septa of this form are especially noteworthy.

PORITES COMPRESSA forma COMPACTA, new.

Plate LXXIV, figs. 2, 2*a*.

Corallum composed of rather slender, compressed branches, with obtuse or flabelliform ends. Some branches fuse and form rather wide plates. Height, 12.2 cm.; length of free portion of branches, 1.3–4.7 cm.; width, 1.–2.4 cm.; thickness, 0.75–0.9 cm.; width of plate formed by the fusion of branches, 4.5 cm.

Calices polygonal, average diameter about 1.5 mm., of moderate depth, especially on the upper part of the branches; separated by slightly or considerably elevated walls, which are thin on the edge, thicker below; with about twice as many rather delicate, granulated mural denticles as there are septa.

The septa are moderately thick, often equaling or slightly exceeding in thickness the width of the interseptal loculi. Between a palus and the wall there is normally a single septal trabecula, which forms on the septal margin a prominent tooth, which is either an irregular granule, or is rather wide and lamellate and almost as tall as the wall, from which it is considerably removed. Between this tooth and the wall is a rather deep and persistently present sinus. Extending around each calice and reaching the level of the bases of the teeth is a ring of synapticula, usually almost or entirely complete. The outer edge of the synapticular ring is slightly exterior to the outer edge of the septal teeth, but it is usually detached from the wall, thus dividing the interseptal loculi into two parts, an outer shorter and an inner longer one. The outer ends of the septa are thicker than the inner. It is the thickened outer ends of the septa, with their synapticular connections, that give this forma its rather compact texture, and have suggested the name that is attached to it.

The pali are thick pointed and prominent, reaching to the level of the upper edges of the septal tooth. Six is the most common number, present before the lateral pairs and the two directives, but there is considerble variation. The one before the dorsal directive is sometimes suppressed, leaving only five; frequently they are present not only before the lateral pairs and the dorsal directive, but before each lateral of the triplet, the one before the ventral directive being suppressed; in some calices the formula of eight pali is complete. The palar ring of synapticula is very constantly complete.

The columella rises from the bottom of a deep fossa, bounded by the perpendicular inner edges of the pali, to which it is joined by radial connections. It is a compressed lamella, and is prominent, but not so tall as the pali.

The skeletal surfaces are covered with rough, rather course, irregular, but not very closely set granulations.

Locality.—Kahana, Oahu; received from W. T. Brigham; depth, 3 to 6 feet.

Type.—Cat. No. 21270, U.S.N.M.

Remarks.—Forma *compacta* differs from the subsequently described forma *abacus* by its more compact skeletal structures and the greater frequency of incompleteness in the palar formula.

PORITES COMPRESSA forma DIVARICANS, new.

Plate LXXV, figs. 1, 1*a*.

Corallum composed of compressed, divergent branches, with truncate and somewhat swollen ends, nodulose on the sides. Height of specimen, 10.85 cm.; greatest spread (across three branches), 10.95 cm.; length of longest branch, 6.55 cm.; greater diameter of base, 3.2 cm.; lesser, 1.5 cm.; greater diameter of swollen tip, 1.1 cm.; lesser, 0.7 cm.; depth of living portion, 0.55 cm. to 10.75 cm.

The calices are rather large, from 1.25 to 2 mm. in diameter, usually about 2 mm.; shallow, or even superficial, separated by rather definite, low, ragged, thin walls. The mural denticles are very rough, irregular, compressed, or twisted, and about twice as numerous as the septa.

The septa are thick, thicker than the width of the interseptal loculi. Between a palus and the wall there may be either one or two septal trabeculæ. It is difficult to decide which is the prevalent number, each is frequent, two is probably the commoner in large calices. The trabeculæ have corresponding granules on the septal margins. The outer granule when two are present, or the single granule when there is only one, is detached from the wall and separated from it by a sinus; the ring of granules is usually joined by a complete ring of synapticula, ordinarily slightly distant from the wall. The outer ends of the septa, beyond the synapticula, are frequently bifurcated. The upper edges of the septal granules and the pali reach the same plane and are almost as tall as the wall.

The pali are rather thick, not very tall, although their upper ends reach so high a level. Seven is the usual number. They are present before the lateral pairs, the dorsal directive, and each lateral of the triplet. The formula is occasionally, but rarely, complete. The palar ring of synapticula is constantly complete.

The columella is a narrow, compressed style, not so tall as the pali, to which it is joined by thick radii.

The interseptal loculi are extremely narrow, because of the thickening of the different skeletal structures.

The skeletal surfaces are roughly and coarsely granulated.

Locality.—Kahana, Oahu; received from W. T. Brigham; depth, 3 to 6 feet.

Type.—Cat. No. 21269, U.S.N.M.

Remarks.—Forma *divaricans* is characterized chiefly by its shallow or superficial calices, of somewhat greater diameter than is usual in the species, and the frequency of two septal granules.

PORITES COMPRESSA forma ELONGATA Dana.

Plate LXXVI, figs. 1, 1*a*.

1846. *Porites mordax β elongata* DANA, Zooph. Wilkes Expl. Exped., p. 553, pl. LIII, fig. 4.

Original description.—Dana's original description is as follows:

> This figure [cited above] represents a specimen eight inches high, consisting of three or four stout stems from a common base, which is two inches through and sparingly branched above. The upper branches are two to three inches long, an inch thick at base, and half an inch at apex. The cells are very similar to those of the above [*P. mordax*], yet a little smaller, about ten being counted in half an inch.

One of Dana's specimens is in the United States National Museum, it agrees closely with the original description, but evidently is not the one that he figured.

The following description is based upon it.

The corallum consists of several rather stout branches rising from a common base and girdled by irregular constrictions. Height, 16.2 cm.; distance between divisions of branches, 2.3 cm. to 4.5 cm.; length of terminals, 2.5 cm. to 4.9 cm.; greater diameter of a main stem at base, 2 cm., lesser, 1.5 cm.; greater diameter of a terminal at base, 1.2 cm., lesser, 1 cm.; greater diameter of terminal at tip, 0.9 cm., lesser, 0.7 cm. The ends of the branches are truncate, or obtusely rounded.

Calices from 1 to 2 mm. in diameter, with between 1.5 and 1.6, slightly more than 1.5, as average, excavated, but shallow low down on the corallum, moderately deep high up on the branches; separated by distinct, continuous walls, which on the upper portion of the branch are tall, sharp-edged, and membraniform, with remarkably few perforations. Mural denticles to a calice about twice as numerous as the septa.

The septa are of only moderate thickness or are even thin; usually slightly narrower than the interseptal loculi. Between a palus and the wall there is usually one septal trabecula, except near the lower edge of the living portion where two is of frequent occurrence. Granules on the septal margins correspond to the trabeculæ. The single, or the outer granule if two are present, is detached from the wall, being separated from it by a sinus. The granules are tall, but usually do not reach the level of the edge of the wall. A ring of synapticula, usually detached from the wall, extends to their bases and binds them together.

The pali are well developed, but not so tall as the septal granules, thus giving an excavated appearance to the central part of the calices. The formula is normally complete. A complete ring of palar synapticula is usually present.

The columella is a rather small, compressed tubercle, situated in a rather shallow pit, bounded by the inner edges of the pali. It is joined to the pali by radial connections. There may be considerable stereoplasmic deposit around the axial structures, rendering them rather compact.

The interseptal loculi are so cut up by the two synapticular rings, the thickened axial structures, and the rough sides of the septa that they are narrow, in spite of the septa being thin on their upper edges.

The skeletal surfaces are roughly and rather coarsely granulate.

Locality.—Hawaiian Islands, U. S. Expl. Exped.; no more definite locality.

Specimen here described.—Cat. No. 707, U.S.N.M.

Remarks.—Dr. W. T. Brigham has sent me a specimen from Kaneohe, Oahu, that I am placing with this forma. It is 13 cm. long; greater diameter near lower end, 3.65 cm.; lesser, 2.7 cm.; bifurcation, 4.45 cm. below the summit. The branches show constrictions and swellings, and taper to an obtuse apex.

The calices average about 1.8 mm. in diameter; and there are usually two septal granulations between a palus and the wall. The skeletal structures are somewhat thinner than in the Dana specimen.

This forma, or "variety," to use Dana's expression, is not closely related to *P. mordax*, as Dana thought, but possesses the same structural characters as *P. compressa.*

Forma *elongata* may be considered a growth form of either forma *conjungens* or forma *abacus.*

PORITES COMPRESSA forma PROFUNDORUM, new.

Plate LXXVI, figs. 2, 2*a*, 3.

Corallum composed of a tall, subterete, rather crooked main branch, which is girdled by irregular swellings and constrictions, and on whose sides are distant, curved lateral branches. The ends of the branches are rounded, obtuse and compressed. The type material consists of several broken branches, some of which are almost entirely incrusted by nullipores, the largest, represented by Plate LXXVI, fig. 2, has both ends broken; length, 13 cm.; greater diameter of lower end, 1.9 cm., lesser, 1.7 cm.; the upper end is bifurcated, but both branches are broken off, greater diameter immediately below bifurcation, 2.4 cm.; lesser, 1.65 cm. A lateral is represented, natural size, by Plate LXXVI, fig. 3.

The calices are polygonal, shallow or superficial, ranging in diameter from 0.75 to 2 mm., with an average of about 1.5 mm.; separated from one another by walls, which are mostly indicated by low, rather thick rough mural denticles, that to a calice are more numerous than the septa. In some instances the outer ends of septa of adjacent calices connect across the wall and obscure it.

The septa are thick, with decidedly thick outer ends, leaving very narrow, slit-like interseptal loculi. Between a palus and the wall there is usually a single septal trabecula, rarely there may be two. On the septal margin, between a palus and the wall, there are usually two granules or dentations, the inner corresponds to the septal trabecula, while the outer seems to be only a radial process from the mural trabecula. When two septal trabeculæ are present, the one next the palus ends in a smaller granule than the outer one. The granules are frequently compressed transversely to the septal plane. The single, or the outer, septal granule is somewhat detached from the wall, with the connecting portion of the septal margin excavated. A ring of synapticula usually coincides with the outer edge of the septal trabeculæ, joining them together and reaching the level of the bases of the septal granules. These synapticula often fuse with the wall. The thickened outer ends of the septa, their synapticular connections, and the wall trabeculæ produce a very compact mural apparatus.

The pali are thick, pointed and tall, reaching almost to the level of the upper edge of the wall. The formula is usually complete, with those before the lateral pairs somewhat the larger; sometimes they are suppressed on the laterals of the triplet, and either the ventral or the dorsal directive may occasionally be without one. The palar synapticular ring is complete, with a floor extending across it.

The columella is a compressed, moderately prominent tubercle rising from the the floor across the palar ring of synapticula.

The skeletal surfaces are covered with closely set, very rough, coarse granulations.

Localities.—

French Frigate Shoal, Depth, 17–17½ fathoms (type); *Albatross*, 1902, Station 3970. Four broken branches.

Vicinity of Modu Manu, or Bird Island, Depth, 20 to 21 fathoms; *Albatross*, 1902; Station 4168. One branch.

Type.—Cat. No. 21272, U.S.N.M.

Remarks.—The specimen from Modu Manu is a branch 6 cm. long, from which a small lateral is given off 2.25 cm. from the lower end; upper end compressed and obtusely rounded, greater diameter, 1.6 cm., lesser, 0.85 cm. The skeletal parts are not quite so thick as in the type of the forma.

This forma is very close to forma *elongata*, differing from *elongata* by its shallower calices and decidedly thicker septa. The upper edge of the wall in *elongata* is more elevated, more definite and continuous.

Forma *breviramosa* has calices averaging smaller, and shorter, nodose branches.

PORITES COMPRESSA forma BREVIRAMOSA, new.

Plate LXXV, figs. 2, 2*a*.

The type specimen is a branch 11 cm. long, with several short, compressed tuberous branchlets and a considerable number of swellings, or tuberosities, on its sides. The ends of the side branches may be somewhat swollen, and show incipient bifurcation. For further details the figures are sufficient. In this forma the branches are free; they are not crowded together and fused in the lower portion of the colony.

A description of the calices would be almost a repetition of what has been said concerning forma *profundorum;* the characters are practically the same in both; in the latter the septa are somewhat thicker.

Locality.—Vicinity of Modu Manu, or Bird Island, Station 4169; depth, 21 to 22 fathoms; bottom, coral; temperature, 78.6° F.; 1 specimen, the type.

Type.—Cat. No. 21275, U.S.N.M.

PORITES COMPRESSA forma ABACUS, new.

Plate LXXVII; Plate LXXVIII, fig. 2.

The corallum is composed of ascending, compressed, truncate branches or flexed plates and crests, much fused one to another from near the base to near the upper edges. Height of the corallum, 22.7 cm. The branches vary in width from 1.15 cm. to 4.85 cm.; in thickness, from 0.9 cm. to 1.5 cm.

The calices are shallow, polygonal, from 1 to 2 mm. in diameter, average about 1.5 mm.; separated by definite, thin, more or less zigzag, slightly elevated walls. Mural denticles rather coarse, rough, nearly twice as many to a calice as there are septa. The thickness of the septa is moderate, approximately equal to the width of the interseptal loculi, which are open. Between a palus and the wall there is usually one trabecula, rarely two; likewise on the septal margin there is usually one, sometimes two, septal granules or dentations. The single septal granule, or the outer one, if two are present, is detached from the wall and is comparatively tall; it may be almost as tall as the wall.

A ring of synapticula, usually separate from the wall, unites the trabeculæ next the wall and extends upward to near the base of the septal granules. The septal granules form a crown within the wall; the synapticula form a kind of platform that often reaches nearer the wall than the outer edge of the granules and is slightly lower.

The pali are slender, prominent, and rough; the formula is usually complete; sometimes there is none on the ventral directive. The ring of palar synapticula is rarely complete, but it is nearly always almost complete.

The columella is a small, compressed, rough tubercle, more or less loosely connected with the inner ends of the septa.

The granulations of the skeletal surfaces are crowded and rather coarse.

Localities.—

Kaneohe, Oahu; depth, 3 to 6 feet; received from Prof. W. T. Brigham; 8 specimens, including the type.

Pukoo, Molokai; depth 3 to 6 feet; received from Prof. W. T. Brigham; 4 specimens.

One specimen, Cat. No. 653, U.S.N.M., one of Dana's original specimens; the locality given on the label is only "Sandwich Islands."

Type.—Cat. No. 20932, U.S.N.M.

Remarks.—The specimen selected as the type has a somewhat looser texture than most of the other specimens, and the synapticular rings are less uniformly complete.

This forma is represented by 13 specimens in all, and, as would be expected, shows considerable variation, especially in the width of the branches or plates, and the amount of their fusion. The forma is based on the generally light character of the corallum, the definite crown of septal granules that are detached from the wall, and the more or less complete shelf formed by the peripherally placed synapticula.

The chief difference between forma *abacus* and forma *conjungens* consists in the difference in form of the coralla; they can not be separated on calicular characters. The series of specimens indicates that this difference is not of specific value.

PORITES COMPRESSA forma TUMIDA, new.

Plate LXXVIII, figs. 1, 1*a*.

This forma is separated from forma *abacus* by its growth form. The corallum consists of thick nodular branches arising from a common base and much fused inferiorly, but projecting as short stubs on the upper surface. Height, 8.9 cm.; greater distance across top of corallum, 9.2 cm.; maximum length of a free portion of a branch, 2 cm. The ends of the branches are rounded or somewhat flattened; their bases are decidedly swollen, 2.3 cm. or even more in diameter; diameter of ends from 1 to 1.9 cm.

The calicular characters are the same as in forma *abacus*.

Locality.—"Sandwich Islands," one of Dana's specimens. Kaneohe, Oahu; depth, 3 to 6 feet; received from Prof. W. T. Brigham.

Type.—Cat. No. 651, U.S.N.M., United States Exploration Expedition.

Remarks.—This forma may be considered a growth form of either forma *conjungens* or forma *abacus*.

PORITES COMPRESSA forma BULBOSA Quelch.

1886. *Porites bulbosa* QUELCH, Reef Corals Challenger Repts., p. 180, pl. XI, figs. 7, 7*a*.
1901. *Porites bulbosa* STUDER, Zool. Jahrb., Syst., XL, p. 421.
1905. *Porites hawaiensis quinta* BERNARD, Porites of the Indo-Pacific Region, p. 101, pl. IX, fig. 8.

Description.—The following is Bernard's redescription of Quelch's type:

The corallum forms clusters of short, thick stems, diverging fairly uniformly at angles of 45°; they are 4 to 5 cm. long, and 2 to 2.5 cm. thick; about halfway up they are regularly constricted. Above the constriction they swell prior to forking. The forking tips are often quite flat across the top. The flat top sinks in along a furrow preparatory to forking. The consecutive forkings are at short distances apart. The living layer is 6 to 7 cm. deep.

The calicles are 1.5 mm. in diameter, crowded, shallow, polygonal where sharply separated by thin walls, subcircular where the walls are thicker. The former kind of wall, with sharp median ridges, occurs on the growing tops and on one side of stock, while on the other side they are thickened evenly and uniformly into a rather close granulated reticulum, often 0.5 mm. thick, and, to the naked eye, flat-topped, and making the calicles appear as sharp, circular punctures in the surface. The septa are thin, tend to be lamellate, commence just below the aperture, and appear ragged and irregular, with a ring of septal granules, just detached from the wall in the thin-walled calicles. In the thick-walled calicles the septa are more regular, the septal granules are on the edges of the wall, and the septa themselves fuse in the four principal pairs. The pali are rod-like, but appear as small, inconspicuous granules. The full formula can be usually seen, the lateral members of the ventral triplet being variable. A ragged columellar tubercle is usually present. The interseptal loculi are large and deep, but not sharply outlined, owing to the slight frosting of the sides of the septa. The calicles on the flat tops open in a spongy stroma, and are conspicuous from the large size of the columellar tangle, surrounded by rings of open interseptal loculi.

In sections of the stems the trabeculæ are well developed, but not crowded.

This coral is described by Mr. Quelch as being easily distinguished from the "*Porites mordax*" of Dana from the same locality. The growth form is different and the living layer is much less extensive. But there is evidently a strong family likeness between all of these Sandwich Islands forms. The calicles of this type, at least where the walls are thin, are very like those of *Porites Sandwich Islands 6* and 7, yet all differ in finer structural details. A strong family likeness between corals from the same locality has been frequently noticed in these catalogues.

It is worth noting that while the calicles opening in the stroma on the tops of the stems are separated by thick reticular walls those which are fully formed and ranged at the sides of the stem have their walls thin and sharp; when these again thicken and become reticular the reticulum is more rigid and seems here and there to show slight traces of its formation out of an inner synapticular wall, although the reticulum in thickening stems would usually be due to the appearance of intervening tissue.

This is one of the few Indo-Pacific *Porites* which show some approach to the characteristic method of branching seen in the West Indian forms.

REMARKS ON THE INTERRELATION OF THE FORMÆ OF PORITES COMPRESSA.

The formæ that exhibit the characteristics of the species in their least modified condition are *conjungens* and *abacus*. The calicular characters in these two are practically identical; there is some difference in form, and they respectively lead to divergent variations. Forma *elongata*, however, might as easily be derived from *conjungens* with separate branches as from *abacus;* and forma *tumida* might be considered *conjungens* with abbreviated branches, swollen below their ends.

Forma *conjungens* leads into forma *angustisepta* and forma *profundicalyx*. The septal and palar formulæ in these three are the same, the differences consisting in the relative development of the septal granules and the outer synapticular ring. In some calices of *conjungens* the outer synapticular ring is not complete, and the wall tall; if the septal granules are rather prominent, the characters of *angustisepta* are reproduced; if the septal granules are reduced in size, those of *profundicalyx* are presented. These three formæ interlock each with the other, but there are clearly recognizable average differences between the specimens.

Forma *angustisepta* has two subforms that differ in minor characters from the typical specimens. Forma *delicatula* has delicate pali and very delicately and thickly frosted skeletal surfaces; subforma *paucispina* has sharper and more scattered septal granulations and a generally more ragged appearance of the skeletal parts. These differences are so very slight that it is doubtful if they are of more than individual importance.

Forma *fragilis* may possibly represent a separate species, but as it presents all the fundamental structural characters of forma *angustisepta*, differing chiefly by its thinner skeletal parts, more delicate pali, and more delicate surface frostings, it probably belongs in the series.

Forma *pilosa* is especially characterized by its shallow calices and the delicately and thickly spinulose ornamentation of the skeletal surfaces, producing a wooly appearance. There are usually two or more septal dentations between a palus and the wall; it is doubtful, however, if they correspond to septal trabeculæ. Some of the calices of forma *conjungens* near the lower edge of the living portion present the same characters as do those of *pilosa*, except the granulations may be coarser. It will be shown that *pilosa* connects through *densimurata* and *granimurata* with *abacus*.

Forma *densimurata* has a rather thick, compact mural apparatus, relatively large, often coarse mural denticles, and detached septal granules. This forma and *pilosa* appear to represent opposite ends of the series, their differences are so great, but there is a specimen that combines the characters of both; they intergrade absolutely.

Forma *granimurata* has a compact mural apparatus with irregularly shaped frosted grains along the top. It has a peculiarly rough, irregular texture. It intergrades on one hand with *densimurata*, on the other with *abacus*.

Forma *clavus* shows more evidence of separateness than any other form placed in the series. The compactness of its walls and septa and the depth of the calice are similar to forma *profundicalyx*; but the usually incomplete palar formula recalls *densimurata* or *compacta*. It differs from the latter by the absence of a complete ring of synapticula binding the septal trabeculæ together. As all the skeletal elements found in *clavus* occur in other formæ I think is not a valid species.

Forma *compacta* is only a more solid form of forma *abacus*, with the palar formula not so generally complete.

Forma *divaricans* is based partly on form, partly on its shallow calices. It is close to *compacta* and *abacus*.

Formæ *elongata* and *tumida* are growth forms of *conjungens* or *abacus*. There are specimens showing connection with the latter.

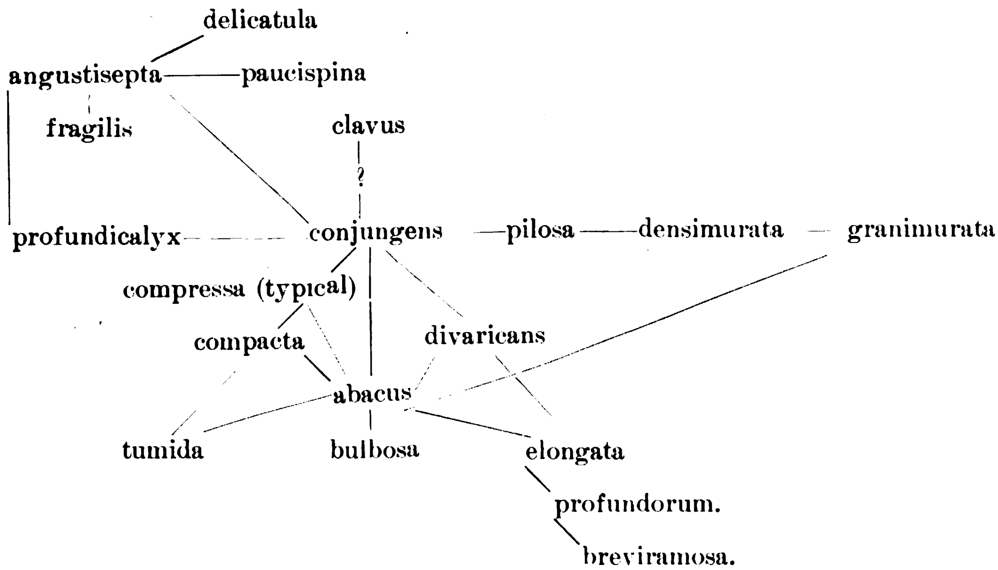
Forma *profundorum* is practically the same as forma *elongata*, but with thicker septa.

Forma *breviramosa* differs from *profundorum* by its shorter, more nodular, branches.

Quelch's *Porites bulbosa*, judging from the original description and Bernard's subsequent remarks and figures, presents the same calicular characters as *abacus*, and can be separated only by its growth form.

Dana's type of *P. compressa* is a peripheral form; it is not near the center of the species as formæ *conjungens* and *abacus* are. *P. compressa* typical has a compact looking wall, rather compact septa, and a very imperfectly developed outer ring of synapticula. The typical form, however, intergrades with forma *abacus*.

Diagram to illustrate the interrelation of the formæ of *Porites compressa:*



3. PORITES DUERDENI, new species.

Plate LXXVIII, fig. 3; Plate LXXIX, figs. 1, 1*a*.

Corallum ramose, branches much fused below, irregular in shape, with numerous constrictions and swellings, ends often clavate and more or less fused one to another. Height, 15 cm.; length of branches, up to 7 or 8 cm.; diameter, 2 to 3 cm.

Calices excavated, with a deep central fossa, polygonal, large, from 1 to 2.5 mm. in diameter, usually about 1.8 mm.; separated by an elevated, prominent, thin, continuous wall. Mural denticles of variable prominence, flattened parallel to the wall, the number to a calice more numerous than the septa.

Septa rather thick, with thicker outer ends, therefore wedge-shaped; composed of trabeculæ directed obliquely upward and inward, their ends producing between the pali and the wall from two to four rather blunt dentations. The outer one attached to or slightly detached from the wall. An incomplete peripheral ring of synapticula, somewhat detached from the wall, is present.

The pali are only the inner septal teeth, which are the upper ends of the inwardly inclined septal trabeculæ; they are small, low, and narrow. By the fusion together of the inner ends of the lateral pairs of septa, only a single tooth may stand before a pair, but in some instances a tooth may be before each septum of a pair. Usually there is a tooth before, or on the inner end of each lateral pair, of the dorsal directive, and of each member of the triplet; sometimes, however, there is none on the ventral directive. These teeth become merged with the columellar tangle.

The columellar tangle is relatively large, about 0.75 mm. in diameter, occupying about one-half the calicular cavity, surrounded by a ring of synapticula. Its upper surface is depressed below the level of the paliform dentations and bears one or several small papillæ. No definite columellar trabecula could be discovered in the longitudinal sections of the corallites. The inward inclination of the septal trabeculæ ultimately brings their inner ends into an axial position, i. e., the columellar papillæ terminate trabeculæ which lower down occur in the septa. It therefore follows that there is some confusion between the pali and the papillæ. There is fusion among the axial teeth by means of lateral processes, and there is some sclerodermic compacting of the mass.

The skeletal surfaces bear a few, but not abundant granulations, in general presenting a rather smooth appearance.

Locality.—Kaneohe, Oahu; depth, 3 to 6 feet; received from W. T. Brigham; also another specimen, collected by Dr. J. E. Duerden at the same locality.

Type.—Cat. No. 20954, U.S.N.M.

Remarks.—This species differs utterly in its septal composition, its pali, and its columellar characters from any other Hawaiian *Porites*. No other species shows so definitely that its septa are composed of inwardly inclined trabeculæ. Its septal structure first led me to think that Bernard's elucidation of the morphology of the Poritid septum should probably be modified. An examination of sections of other species, broken parallel to the septal surface, showed that in other species, although the septal, mural, and palar trabeculæ may run for long distances in parallel courses, from place to place a septal trabecula bends inward and a new one is introduced between the older one and the wall. In these Poritids, that portion of the septum exterior to the line of divergence of the trabeculæ is suppressed, while the inner portion is developed. In *Porites duerdeni* the angle of divergence of the trabeculæ is relatively large (the upper angle between the wall and the trabecula); in other species, as *P. compressa*, the angle is extremely acute. The septal structure of the Poritids is therefore entirely homologous with that of other corals. The septa are composed of ascending trabeculæ, between which are numerous perforations. The central corallite of Plate LXXIX, fig. 1*a*, shows the inward inclination of the trabeculæ.

4. PORITES EVERMANNI, new species.

Plate LXXX; Plate LXXXI, fig. 2.

Description of type.—Corallum forming compressed or columniform lobes, nodose around the base.

The calices are shallow or superficial, with pali, except on and near the summits, reaching the level of the upper edge of the wall; outlines polygonal; diameter, from 1 to 1.5 mm. Corallite walls very distinct, membraniform, forming narrow ridges circumscribing the calices, rendered more prominent by the excavation of the distal ends of the septa.

The septa show the typical poritid bilaterality: the usual arrangement is, a solitary directive, two lateral pairs on each side of the plane of symmetry, and a ventral directive with the lateral septa fused to it by their inner edges. The principal variation occurs in the directive triplet. The arrangement was studied in 60 calices with the following result: Calices with five pali, 1; with six pali, 47; with seven pali, 9; with eight pali, 3; that is, 4 calices in 5 have six pali, or only one palus before the ventral triplet; about 1 in 6 has two of the members of the triplet with separate pali; and about 1 in 20 has pali on each member of triplet. The palus on the dorsal directive may be much reduced in size. According to the data given above, 1 calice in 60 has the palus on this septum suppressed. Very near the wall many or most of the septa split, and the forks are continued to the wall; either directive may trifurcate. Over the point at which a septum splits is a dentation or granulate. The portion of the septum between this taller granulate and the palus may bear one or two minute granulations, these, however, may be absent, the portion between it and the wall is excavated. A circle of synapticula bind the outer ends of the large granulates together; a second circle of synapticula often binds the pali together. In center of the palar crown is the compressed, solitary columellar tubercle. There is no well-developed columella tangle.

Localities.—Kaneohe, Oahu, 1 specimen (type), W. T. Brigham, collector; Waikiki, Oahu, Dr. J. E. Duerden, collector, 6 specimens; Pukoo, Molokai, Dr. J. E. Duerden, collector.

Type.—Cat. No. 21627, U.S.N.M.

Remarks.—This species is so entirely distinct from any of the other species of *Porites* known from the Hawaiian Islands that critical notes are unnecessary. There is a feature, however, that deserves especial consideration, namely, the bifurcation of the septa near the wall. This condition suggests the genus *Goniopora* instead of *Porites;* but the bifurcation, or even trifurcation, of the directives is not Gonioporoid, basing a judgment upon Bernard's remarks and diagrams in his "Goniopora."[a] Mr. Bernard has kindly examined photographs of this coral for me and considers it a true *Porites*.

The United States National Museum has received through the Carnegie Institution 7 additional specimens, collected by Dr. J. E. Duerden. The calices of these specimens show no noteworthy difference from those of the type, but there is considerable variation in form. The corallum first forms an incrusting base, then grows upward, becoming variously lobate. The lobes may be more or less separate, as in the type; they may secondarily fuse and produce a glomerate upper surface; or the corallum may be massive, increasing in diameter as it rises above the base, have ridges and depressions down its sides, and a glomerate upper surface.

5. PORITES PUKOENSIS, new species.

Plate XCIV; Plate XCV, figs. 1, 2.

Corallum forming thick, irregular, compressed or subterete, nodose columns, on which humps or stumpy protuberances may occur. The columns rise from a common base, and are more or less fused throughout their length, except the free projecting ends, or in some instances they are fused both above and below, leaving intermediate open spaces. Two views, natural size of the type specimen, showing the habitus and size of the corallum are given on Plates XCIV, XCV. There are three other specimens: The largest is of nearly the same size as the type, the columns distally diverge more, their ends are truncate, and some of them are more compressed. One of the other specimens is young, incrusting a branch of a species of *Porites* and sending up columns from 24 to 42 mm. in height, tapering to rounded or truncate ends. The fourth specimen is composed of several lobes, tapering to rounded ends, and a twisted, truncate plate, all rising from a common base. It shows no notable difference from the third specimen.

[a] The genus *Goniopora*, Cat. Madrep. Corals, Brit. Mus. (Nat. Hist.), IV, 1903, p. 21.

Calices polygonal, excavated, rather deep, diameter from 1.25 to 1.5 mm.; separated by elevated, simple, perforate walls. Mural denticles rather tall, minutely frosted, about twice as many to a calice as there are septa.

The septa usually begin a slight distance below the upper edge of the wall. Between a palus and the wall, there is usually a single septal trabecula, terminating above in a septal granule, usually not prominent, and slightly detached from the wall. Rough radial denticles may be present on both the mural and septal trabeculæ. There is an incomplete peripheral ring of synapticula, no distinct mural shelf. Septal faces frosted, often rather densely and coarsely; interseptal loculi not not very wide, frequently tend to be decidedly narrow, and may appear closed.

Pali tall, slender, more or less lath-like; the formula complete; joined by a complete ring of synapticula.

Columella tall, a narrow lamella, joined by thick radii to the innei ends of the septal groups.

Locality.—Pukoo, Molokai: two specimens collected by Dr. J. E. Duerden; 1 specimen, also collected by Doctor Duerden, the locality label has been lost, but it probably comes from the same locality; 1 specimen, received from Dr. W. T. Brigham.

Type.—American Museum of Natural History, New York.

Paratypes.—United States National Museum and American Museum of Natural History.

Remarks.—The calicular characters of *P. pukoensis* are practically identical with those of *P. compressa* forma *angustisepta*. As was remarked in discussing the latter form, it is not at all unlikely that they may be only different growth forms of the same species. However, the specimens at my disposal for study do not show intergradation.

P. lobata forma *parvicalyx* (p. 200) is also closely related. It forms thicker columns, and its calices are smaller. The walls of the two are similar, but usually they are taller in *P. lobata* forma *parvicalyx*. Neither of the extreme conditions was seen in the calices of *P. pukoensis*. The septal granules of the latter are not so tall and are not so far removed from the wall; the pali are constantly present and the columella tangle does not become an indefinite mesh-work.

The three forms, *P. compressa* forma *angustisepta*, *P. pukoensis*, and *P. lobata* forma *parvicalyx* constitute a most interesting series. It may be that they all belong to the same species. Should they do so, they will show that the growth form of corals is of only slight systematic importance.

6. PORITES LOBATA Dana.

Plate LXXXI, figs. 1, 1*a*, 1*b*. (Dana's type.)

1846. *Porites lobata* Dana, Zooph. Wilkes Expl. Exped., p. 562, pl. LV, fig. 1.
1860. *Porites lobata* Milne Edwards and Haime, Hist. Nat. Corall., III, p. 177.
1886. *Porites lichen* Quelch (not Dana), Reef Corals, Challenger Rept., p. 181.
1886. *Porites tenuis* Quelch (not Verrill), Reef Corals, Challenger Rept., p. 184.
1887. *Porites lobata* Rathbun, Proc. U. S. Nat. Mus., X, p. 366.
1905. *Porites hawaiensis tertia* Bernard, Porites, Indo-Pacific Region, p. 100.
1905. *Porites hawaiensis sexta* Bernard, Porites, Indo-Pacific Region, p. 103, pl. IX, fig. 9; pl. XII, fig. 5.
1905. *Porites hawaiensis octava* Bernard, Porites, Indo-Pacific Region, p. 105, pl. X, fig. 2.

The following account of this species is based upon the detailed study of 100 specimens. The amount of variation is enormous and bewildering. The type specimen will be described first; subsequently the different variations will be considered and their interconnection indicated.

Dana's figured type is preserved in the United States National Museum, and on it the following description is based (Plate LXXXI, figs. 1, 1*a*, 1*b*):

The corallum consists of compressed, ascending columns, coalescing interiorly, terminated by short, truncated or obtusely rounded free ends. The two views on Plate LXXXI will give an idea of both the form and size. In one place there is a younger layer growing over a lower dead portion of the corallum; usually, however, the growth is continuous.

Calices polygonal; usual diameter, 1.5 mm.; shallow or of moderate depth. Walls distinct, continuous, perforate, membraniform, with acute edges. The membraniform walls, with their elevated, sharp edges, constitute one of the striking features of the specimen. Within each calice is a peripherally disposed ring of synapticula, usually separated from the wall by short portions of the interseptal loculi, sometimes, however, fused to it apparently by secondary thickening. The "trimurate" condition is frequently represented.

Each septum between the palus and wall normally has one trabecula, which terminates in a moderately prominent septal granule, detached from the wall, and standing either on the inner edge of or above the peripheral ring of synapticula. The septal faces are granulated; the interseptal loculi wide above, narrow below, divided into two parts by the outer synapticular ring.

The palar formula is complete, but because of the damaged condition of the corallum, a detailed description is not possible. There is a ring of palar synapticula.

The columella is a narrow lamella lying in the plane of the two directive septa, joined to these and the lateral pairs by six radii. The whole columella tangle may be considerably compacted.

The foregoing description of the calices and the calicular structures is based on the lateral calices, which show the various skeletal elements in their typical development. There is some variation from the typical calices both on the summits and near the base.

The summits may bear calices similar to the lateral ones, or they may be composed of a spongy reticulum, the corallites upon casual observation appearing not to be differentiated. Closer study shows that they are definite, and that the trabecular structure is in plan identical with that of the lateral calices; the various skeletal elements are thinner, the walls are not elevated, causing the calices to be superficial, the synapticular rings are not complete, and there is greater indefiniteness in the columella tangle. However, all the trabecular elements are present in the reticulum and can be distinguished, but, being immature, they have not assumed the definite arrangement of those in the lateral corallites.

On the lower portion of the corallum the calices are very shallow; frequently there are two dentations on a septal margin between a palus and the wall; usually, however, there seems to be only one septal trabecula. The upper edge of the wall consists of a row of more or less connected erect, frosted rods. Interseptal loculi narrow, with very irregular outlines.

Locality.—"Sandwich Islands," Dana; no more definite data.

Type.—Cat. No. 652, U.S.N.M.

Remarks.—Unfortunately the surface of the specimen is worn, and not all of the desired calicular details could be ascertained. The outer ends of the septa are narrow near the base, the septal granules are detached from the wall and separated from it by a sinus on the septal margin. There is no other specimen in the National collection coinciding in characters with this one.

The type-specimen is not central but peripheral. I have subdivided the species into six formae; the first is *P. lobata* (typical) represented by the type, and a few other specimens in the American Museum of Natural History; the others are designated forma *lacera*, *infundibulum*, *parvicalyx*, *centralis*, and *aperta*. Forma *centralis* is further divided into subformae: *alpha*, *beta*, *gamma*, *delta*, *epsilon*. Forma *centralis* subforma *gamma* is the most generalized of the subdivisions (see Plate LXXXIV, fig. 2, p. 203.)

PORITES LOBATA forma LACERA new.

Plate LXXXII, fig. 1; Plate LXXXIII, fig. 1*a*.

Two specimens are described in considerable detail: the first is figured.

Corallum composed of ascending columns distally giving rise by division to additional columns. Plate LXXXII, fig. 1, represents a specimen natural size, and gives a correct idea of its size and mode of growth. The base is not preserved.

The calices are excavated, of moderate depth, from 1 to 1.5 mm. in diameter, usually about 1.25. The walls are thin, with rather wide, truncated, rough mural denticles, whose character is such that the wall appears flat topped; this, however, is only an appearance.

Normally each septum has between the palus and the wall one trabecula, which continues upward into a tall, often slender, rough granule, detached from the wall. In some instances the widened mural denticle may fuse with the granule. The septal trabeculæ are joined by a more or less complete ring of peripherally placed synapticula, usually detached from the wall, but in some instances fused to it. The septal granule stands above or on the inner edge of the synapticular ring. In some instances there is a process above and another on the inner edge; the two processes, however, seem to arise from one trabecula. The septal faces are roughly and coarsely granulated; the interseptal loculi decidedly narrow.

The pali are tall and rough, thicker before the lateral pairs; formula complete; bound together by thick synapticula.

The columella is a narrow lamella, rising from a platform above which the pali stand. The palar synapticula, the radial connections of the columella to the septa, and the columellar lamella are so intimately fused that they form an almost solid axis.

The summits of the columns are more spongy in appearance than the sides. The arrangement of the skeletal elements, however, is precisely as that already described. The structure of the summits is identical with that of the summits in the type of *P. lobata*. The calices near the lower edge of the living portion usually have two denticles between a palus and the wall, sometimes one or three. Apparently, however, there is only one septal trabecula. These calices are deeper than in *P. lobata*, type.

Description of second specimen.—Corallum composed of thick plates, fusing by their edges into series and also fused laterally, upper edges obtusely rounded or flattened. One plate is 46 mm. wide by 26 thick; another, 63 wide by 26 thick; just below the rounded summit 13 thick. The free portion of the plates varies from 13 to 39 mm. in length. Secondary lobes appear on both the outer edges and outer flat surfaces of the plates. The base of the corallum unfortunately is not preserved. The growth usually is continuous; there are, however, instances of younger, living layers incrusting older dead portions of the corallum.

The calices are deep or shallow, polygonal in outline, from 1 to 1.75 mm. in diameter, usually about 1.25; they are rather small, separated by thin walls, whose margins are usually elevated and more or less ragged. The mural denticles are fragile and irregular in shape and development.

The septa vary much in thickness; they may be fragile or may be comparatively thick. The interseptal loculi vary accordingly in width, their outlines rendered irregular by the small and crowded frostings of the septal faces. Each septum typically possesses a single trabecula between the palus and the wall. The septal granule usually is detached from the wall; while the outer portion of the septum is a ridge near the upper edge of the wall, but in some instances it may be wide and connect by a plate with the septal granule. The septal trabeculæ are bound together by a ring of synapticula that may be more or less fused to the wall, or detached from it, producing, when the latter condition prevails, a trimurate appearance.

The palar formula normally is either complete or without a palus on the ventral directive. The pali are slender, usually rather tall, rounded above, and coarsely granulate, for their size; bound together by a ring of synapticula.

The columella is a delicate, narrow lamella, rising from the bottom of a depression, around which the pali stand. It is connected by radii with the septal groups.

The plate summits consist of a vesicular recticulum in which the skeletal elements do not show the definite differentiation and arrangement that they do on the sides of the corallum.

Locality.—Kahana, Oahu; received from Dr. W. T. Brigham; Waikiki, Oahu, J. E. Duerden, collector.

Type.—Cat. No. 22252, U.S.N.M.

Paratype.—Cat. No. 20909, U.S.N.M.

Remarks.—In growth form and in its septal arrangement and palar formula, these specimens resemble typical *P. lobata;* they differ, however, in the rough aspect of the surface and in the wider upper ends of the septa, which may give the upper edge of the wall a truncate appearance. Other specimens show intergradation with the type form of the species.

PORITES LOBATA forma INFUNDIBULUM, new.

Plate LXXXII, fig. 1*a;* Plate LXXXIII, fig. 1.

The following description is based on a specimen broken from the outside of a corallum.

Corallum composed of ascending thick columns or columniform lobes, with glomerate sides and flattened tops. Plate LXXXIII, fig. 1, represents the outside of the specimen natural size and gives both its size and mode of growth. On the other side, or inside, the free portion is only about 37 mm. in height. The tissues are continuous in growth, without indication of superimposed layers.

Calices polygonal, excavated, of moderate depth, from 1.25 to 2 mm. in diameter, 1.5 is probably the average; compared to those of the other closely related forms they are large; the calicular margins sharp edged. The walls really are rather thick, and are compact for *Porites*, but the outer ends of the septa are narrow and the margins slope to the pali. The edges of the walls are beaded by only moderately prominent denticles.

The sloping margins of the septa have been noted; between a palus and the wall are usually two or three, and sometimes four, rather obtuse denticles. A longitudinal section, however, shows that there is only one septal trabecula; one or two processes from this trabecula may produce dentations and the same may occur on the mural trabecula. In the undamaged calices a peripheral zone of synapticula can be indistinctly distinguished; when the calices have had their walls broken down, a clearly developed ring of peripheral synapticula, separated by interspaces from the wall, is seen. The septal faces are slightly rough; interseptal loculi narrow.

The pali present as slight, rather low thickenings on the inner ends of the septa; they are not prominent; the formula is complete, and they are united by a palar ring of synapticula.

The columella is a low-compressed style, situated in a pit surrounded by the inner edges of the pali; it is joined by radii to the septa, and the whole columella tangle is almost compact.

The summit calices show no noteworthy difference from those of the sides, except their walls are not so elevated, causing a flattening between the calicular cavities. The calices near the lower edge of the living portion present no special peculiarities.

Localities.—Kahana, Oahu, received from Dr. W. T. Brigham; Waikiki, Oahu, J. E. Duerden, collector.

Type.—Cat. No. 22243, U.S.N.M.

Remarks.—Notwithstanding the apparent distinctive differences between this forma and forma *lacera*, intermediate specimens exist, the two formæ grading into each other; it also passes into the typical form of the species.

PORITES LOBATA forma PARVICALYX, new.

The corallum is composed of connected, ascending, compressed, flat-topped lobes. The type consists of two lobes, with undulations and longitudinal ridges on their surfaces. The specimen has been broken from a larger mass and does not show the base. Height, 108 mm.; greatest width, 99 mm.; width of wider lobe, 74 mm.; width of narrower lobe, 71 mm. The wider lobe has a free end 13 mm. tall, the other has none.

Calices polygonal, deep, small, usually 1 mm., or may be somewhat less in diameter, separated by tall walls. The succeeding description is based upon some of the lateral calices and particularly some of those near the lower limit of the living portion, as these show the skeletal elements in their most developed condition.

The walls are straight, tall, rather thick, with rather thick, rather tall, regular, slightly frosted dentations corresponding to the septal ends. The septa begin a considerable distance below its upper edge, usually obsolete on the elevated portion.

Each septum has between the palus and the wall one trabecula, terminating superiorly in a septal granule, detached from the wall and of very variable height. Two processes may project from the septal trabecula, and there may be processes from the mural trabecula. There is always indication of a peripheral ring of synapticula joining the septal trabeculæ, but it is rarely or never complete. When present it is detached from the wall. The septal faces are roughly granulate; interseptal loculi open.

The pali may be tall, narrow plates, and occur in the complete formula· surfaces rough. Palar ring of synapticula sometimes complete.

Columella a narrow lamella, situated in a pit surrounded by the pali, joined to the septa by radii. The tangle usually open, not much compacted.

The condition described in the preceding remarks is the one in which the skelatal elements show their extreme differentiation and their greatest development. Other calices diverge considerably from the scheme presented.

The walls are uniformly tall and the mural denticles are very constantly as described, but frequently not only are the pali absent but the palar trabaculæ seem to be suppressed; the columellar lamella may be indistinct or absent, and the columella tangle represented by a loose indefinite meshwork. All of the intermediate stages between the definite arrangement first described and indefiniteness in the palar and columella development are exhibited on the same specimen. The summit calices have the intramural skeletal elements in their less developed state; the walls, however, are usually tall, and are smoother than near the lower edge of the living portion. The two rings of synapticula are partially represented, usually incomplete.

Locality.—Pukoo, Molokai, received from Dr. W. T. Brigham; Waikiki, Oahu, J. E. Duerden, collector.

Type.—Cat. No. 20923, U.S.N.M.

Remarks.—Forma *parvicalyx* passes into forma *lacera*. For a comparison with *P. pukoensis*, see page 196.

PORITES LOBATA forma CENTRALIS, new.

Plate LXXXII, fig. 2; Plate LXXXIII, figs. 2, 2*a*; Plate LXXXIV, figs. 1, 1*a*, 1*b*; Plate LXXXV, fig. 1; Plate XCVI, figs. 1, 2, 3.

1886. *Porites lichen* QUELCH (not Dana), Reef Corals, Challenger Rept., p. 181.

1886. *Porites tenuis* QUELCH (not Verrill), Reef Corals, Challenger Rept., p. 184.

1905. *Porites hawaiensis sexta* BERNARD, Porites Indo-Pacific Region, p. 103, pl. IX, fig. 9; pl. XII, fig. 5.

1905. *Porites hawaiensis octava* BERNARD, Porites Indo-Pacific Region, p. 105, pl. X, fig. 2.

A number of specimens are referred to this forma and as the foregoing synonymy shows, Quelch's *Porites lichen* and *P. tenuis* are placed in it. The forma is subdivided into five subformæ, which are given the names of the Greek letters. The *P. lichen* of Quelch belongs to subforma *alpha* and his *P. tenuis* to subforma *gamma*.

The corallum initially is explanate, thin, and either free or attached. The edges may, or may not bend under and by creeping invest the lower surface with a layer of living substance. Whether the edges do or do not bend under, gives rise to two types of corallum, which will be described later. The upper surface varies in conformation; it may be plane or mammillate. In subsequent growth successive layers with free or closely applied but distinct edges are formed one above another; the growth, however, appears to be continuous in the central portion. If the living edge bends downward, the base is rounded toward its center, but the successive growth layers are indicated; if the living edge is curved upward or is subhorizontal, the base shows concentric rims, or the corallum has collars one above another. The corallum in the later stages of growth may be a mass with a rounded or flattish upper surface, a head with deep lobations, a mass with a mammillate or humpy upper surface, or the surface may be studded with stumpy protuberances.

The calices are polygonal, from 1 to 2 mm. in diameter, average about 1.5, usually deep, separated by tall, straight walls or by distinct wall ridges, with dentate upper edges.

The septa are narrow above; there is one septal trabecula between a palus and the wall, with the septal granule variable in development, usually not specially prominent; when distinct it is detached from the wall. Although the granule may be indistinct, processes from the septal and mural trabeculæ may cause several dentations to appear on a septal margin. There is either a complete or an incomplete ring of peripheral synapticula, usually detached from the wall. When the ring is complete the wall frequently has a trimurate appearance. Septal faces granulate; interseptal loculi open, but often narrow.

The pali vary in form, lath-like or rounded; the formula is frequently or usually complete; when not complete, oftenest suppressed on one or more members of the triplet, less often on the dorsal directive. The inner ends of the triplet, when without pali, still remain separate from one another, that is, they do not meet and fuse in the apex of an angle. A palar ring of synapticula is present, and usually complete

The columella is rather constantly a narrow axial lamella, sometimes an axial papilla, rarely absent. It is joined by radii to the inner ends of the septa; the columella tangle, composed of the axial lamella or papilla and the radii from it, is loose in structure or rather compact.

PORITES LOBATA forma CENTRALIS subforma ALPHA, new.

Plate LXXXIII, figs. 2, 2*a*; Plate LXXXIV, figs. 1, 1*a*, 1*b*.

Corallum at first thin, explanate, incrusting or free, with a mammillate or humpy upper surface; later some of the mammillæ or humps may grow upward and form ascending lobes or crests.

The peripheral ring of synapticula is incomplete; the pali, compressed.

Localities.—Kahana, Oahu, W. T. Brigham; Pukoo, Molokai, W. T. Brigham, J. E. Duerden.

Cotypes.—Cat. Nos. 22241, 22242, U.S.N.M.

PORITES LOBATA forma CENTRALIS subforma BETA, new.

The edge of the living layer is bent under and creeps over a portion of the base; the upper surface of the corallum is irregularly domed and humpy.

The peripheral ring of synapticula is usually incomplete; pali, compressed.

The irregularly domed humpy upper surface and the down bending of the living edge separate subforma *beta* from subforma *alpha*.

Localities.—Waikiki, Oahu, J. E. Duerden, collector; Kahana, Oahu, W. T. Brigham.

Type.—Cat. No. 20927, U.S.N.M.

PORITES LOBATA forma CENTRALIS subforma GAMMA, new.

Plate LXXXIV, fig. 2.

1886. *Porites tenuis* QUELCH, part (not Verrill), Reef Corals, Challenger Repts., p. 184.
1905. *Porites hawaiensis octava* BERNARD, Porites Indo-Pacific Region, p. 105, pl. x, fig. 2.

The upper surface of the corallum is rounded or flattish, more or less undulate, but without humps.

The peripheral ring of synapticula is usually complete, the wall rising as a beaded ridge above and between the rings. Subformæ *gamma*, *delta*, and *epsilon* differ from each other chiefly in the configuration of the upper surface of the corallum.

The following is a somewhat detailed description of the specimen figured, Plate LXXXIV, figure 2:

Corallum attached, edges epithecate, rounded above, upper surface undulate. Greater distance across, 57 mm.; lesser, 52 mm.; thickness, 37 mm.

Calices moderately deep, polygonal, diameter from 0.9 to 1.7 mm., an average of 47 calices was 1.28 mm.; of the 47 measured, 22 had a diameter of 1.2 or 1.3 mm. In the depressions on the surface they are smaller 0.9, or even less, to 1.1 mm. in diameter; on the elevated portions of the surface they are larger, 1.5 to 1.6 mm. in diameter; with occasionally one as much as 1.7 mm. in diameter. The corallite walls are elevated, perforate, and usually thin; there is, however, frequent thickening in the corners of the calices. These thickened and often elevated areas constitute a striking character. Very near the wall there is a ring of synapticula and the septa are peripherally somewhat thickened.

The septal arrangement is as already described.

Localities.—Pukoo, Molokai, depth 3 to 6 feet, received from W. T. Brigham; Waikiki and Kaneohe, Oahu, Dr. J. E. Duerden, collector.

Type.—Cat. No. 21626, U.S.N.M.

Bernard has redescribed in detail the specimen referred by Quelch to *P. tenuis* Verrill under the designation of *Porites hawaiensis octava*. It is here placed in subforma *gamma*. The following is Bernard's description:

The corallum closely incrusts stones with a layer about 5 mm. thick. Successive layers of the same thickness cover one another, and can be scaled off. Edges closely adherent.

The calicles are superficial, polygonal, and 1.5 mm. across if taken from median ridge to median ridge, but round and 1.25 mm. if the circumference of the interseptal loculi is the periphery of the calicle. The wall has a low frosted or finely toothed median ridge, and a flaky shelf on each side of it. Here and there the shelf is very porous, and the wall appears to be reticular. The rows of the pores are sometimes nearly regular enough to suggest the trimurate condition. (See Introduction, p. 16.) The septa are symmetrical, but slightly roughened, and septal granules appear at the edges of the flaky shelf. The interseptal loculi are conspicuous and open. The pali form a neat ring, and are frequently complete. The columellar tubercle is granular and smaller than the principal pali and slightly below their level. Itself seldom flattened, it may frequently be seen to rise from a directive lamella running across the whole calicle.

This coral from Honolulu is represented by a spirit specimen and a cleaned fragment which has been scaled off the living layer. The growth form is peculiar and deserves separate description. From the other Honolulan *Porites* it differs not only in method of growth, but in its calicle formation. There are no high membranous walls, and the pali are conspicuous. But, on the other hand, it may be noted that the thin skeletal elements, the open interseptal loculi, and their symmetrical septal formula, is common to all these Honolulan corals.

The absence of high walls in this specimen may be an adaptation to a detached life (cf. *P. ceylon* 9). As the growth is all on one side, however, the stock, when collected, appears to have been stationary.

Mr. Quelch identified this form with *P. tenuis* Verrill. But *P. tenuis* was glomerate, whereas this, forming a rounded mass from incrusting a round stone, is really incrusting. The fact that layer covers layer with discontinuous growths separates this from true glomerate forms, in which the corallum thickens continuously. The rest of Doctor Verrill's description is so general that it might apply to almost any member of the genus.

PORITES LOBATA forma CENTRALIS subforma DELTA, new.

Plate LXXXII, fig. 2; Plate LXXXV, fig. 1.

Upper surface with lobes and mammilliform elevations, in this respect differing from subforma *gamma*, otherwise they are very similar.

The following description is based on the figured specimen:

Corallum a head-shaped mass, 137 mm. tall; greater diameter, 132 mm.; lesser, 130. Upper surface glomerate, with several deep lobations. The underside of the corallum shows successive growth layers, the edge of each one epithecate.

Calices polygonal, from slightly less than 1.5 mm. to 2 mm. in diameter, except in the bottoms of the depressions where they may be only 1 mm. Calicular cavities deep, the septa narrow above and falling abruptly to the bottom. Walls distinct, thin, straight.

Septa as in the general description of the species. The peripheral ring of synapticula constantly present, but may not always be seen unless the walls be broken down. Pali tall, slender, delicate, minutely spinulose; formula usually complete. Columella and columella tangle as already described.

This forma is represented by two other specimens. One of them shows no indication of attachment on the base, which flares up, and underneath shows by rims successive growth stages. In the other specimens the growth has been mostly upward, leaving successive collars below.

The walls in the specimen figured are relatively taller than in the other specimens. In the latter the peripheral ring of synapticula reaches higher up in the calices and tends to produce an intramural shelf. The calices of the figured specimen, however, are particularly interesting as they connect those of the unfigured specimen with those of subforma *alpha*. (See Plate LXXXII, fig. 2.)

Subforma *delta* is very slightly different from forma *epsilon*. The difference in the upper surface will be brought out in the description of the latter. The main difference consists in the pali, which are less developed and more rounded in subforma *epsilon*.

Localities.—Reefs at Kaunakakai, Molokai, *Albatross*, 1902; Waikiki and Kaneohe, Oahu, Pukoo, Molokai, Dr. J. E. Duerden; one specimen from Dr. W. T. Brigham, locality label lost.

Type.—Figured specimen, Cat. No. 22244, U.S.N.M.

PORITES LOBATA forma CENTRALIS subforma EPSILON, new.

Plate XCVI, figs. 1, 2, 3.

A fragment of a corallum. will be described first, and then a second specimen will be compared with it.

The corallum consists of ascending lobes, with mammillate surfaces and obtuse ends. Depth of living portion, 100 mm.; width of two lobes, 70 mm.; width of upper ends of lobes, 27 to 30 mm.; thickness just below ends, 9 to 13 mm. The lower broken portion shows successive overlapping layers, at least three of which can be seen, the under surfaces epithecate, edges flaring out. The growth along the axes of the lobes is continuous.

The calices are deep, polygonal, from 1.25 to 1.75 mm. in diameter, margined by straight walls varying in height, but always forming bounding ridges. The mural denticles are somewhat compressed perpendicular to the wall plane, granulate, slightly ragged, but still of fairly uniform size.

The upper ends of the septa are usually narrow, but sometimes have more or less plate-like connections with the mural denticles. Between a palus and the wall is one septal trabecula, the trabeculæ joined by a constantly present ring of synapticula, which reach higher up in the calice than the tops of the pali, and may be fused with the wall or are separate from it. The wall is frequently distinctly trimurate. The septal granules are indifferently developed, never prominent, and often not distinct. There are often several rather small denticles on a septal margin, one or two projecting from the mural, the others from the septal trabecula. In some cases the septal granule is represented by a thin plate, detached from the wall, and situated on the inner edge of the synapticular ring. Septal faces with a few small granulations; interseptal loculi open.

The pali are poorly developed. They are small, low, rounded knobs on the inner ends of the septa. The formula is sometimes complete, but there is often none on the dorsal direction, and usually none on one or more members of the triplet.

A compressed columella tubercle may or may not be present; columella tangle rather large, of loose or rather compact texture.

The calicular characters of the second specimen are so similar to those of the first that they need no additional description, but its habitus deserves notice. The base of the corallum is incrusting, over dead *Porites*. Greater diameter of base, 115 mm.; lesser, 70 mm.; height, 102 mm. The upper surface is thrown into lobes, or rises into stumpy protuberances, which may be 20 mm. tall, with a greater diameter of 20 mm.; lesser, 16 mm. The stumpy elevations of the upper surface are the features to which it was desired to call attention.

Locality.—Pukoo, Molokai, W. T. Brigham; Waikiki and Kaneohe, Oahu, J. E. Duerden, collector.

Type.—Cat. No. 22238, U.S.N.M., received from Dr. W. T. Brigham.

Paratypes.—22239, 22678, collected by Dr. J. E. Duerden.

The following is a detailed description of another specimen belonging to this subforma (Plate XCVI, figs. 1, 2, 3, Cat. No. 22678):

The specimen, which has been broken from a larger corallum, is composed of lobes and crests solidly fused in their lower portion. On the sides are longitudinal furrows, gibbosities, and lobes; on the upper surface thick, obtusely rounded crests and lobes. The crests are from 10 to 16 mm. thick; maximum height 16 mm.; the thickest lobe has a diameter of 23 mm.; height 20 mm. The base of the specimen is dead and was part of an older corallum; between the broken-off piece of the dead corallum and the living portion is a constriction. Total height, including dead base, 115 mm.; maximum depth of living portion, 66.5 mm.; greater diameter in constriction, 65 mm.; lesser, 43; greatest diameter above the constriction, 99 mm., lesser, 81 mm.

Calices polygonal, excavated, and moderately deep. Diameter from 1 mm. to 2 mm. Much smaller in the concavities; larger on the convexities, where they average about 1.6 mm. Separated by rather thin, somewhat elevated, perforated walls, on whose summits are about twice as many frosted mural denticles as there are septa to a calice.

Septa with the inner ends of the triplet not fused together. Palar formula complete. Between a palus and the wall usually two frosted granules, sometimes only one. Pali not very tall or thick, frosted. Two synapticular rings, the outer rather thick and more or less connected with the wall; the inner joining the pali. A septal granule is usually either above or just interior to the outer ring; therefore, there is a more or less distinct mural shelf. The septa are rather thick, with frosted sides; interseptal loculi almost closed.

Columella a delicate, compressed, frosted tubercle, situated in a pit, surrounded by the perpendicular inner edges of the pali, joined to the inner ends of the septal groups by radii.

Locality.—Kaneohe, Oahu, Prof. J. E. Duerden, collector.

PORITES LOBATA forma APERTA, new.

Three specimens of this forma are described: two from Pukoo, Molokai, received from Dr. W. T. Brigham, and one from Waikiki, Oahu, collected by Prof. J. E. Duerden. One of the specimens from Pukoo is young and shows the early mode of growth; the other probably represents the adult condition; they will be used as cotypes.

The corallum of the younger specimen is composed of successive caps, one above another, in contact or continuous in growth in the central portion, but around the edges they are distant and have the lower surfaces invested by epitheca, nullipores, etc. The layers are not thick, about 5 mm., thinner on the margins. Greater diameter of base, 97 mm.; lesser, 79; height, 59. The upper surface is thrown into irregular, thick humps of various sizes, the tallest about 21 mm. The other specimen is a thick lobe, with a corroded base, evidently derived from the outside of a corallum. Greater transverse diameter, 97 mm.; lesser, near base, 50 mm. Outside with several deep, longitudinal depressions, and intervening tall, rounded ridges; summit truncate. The calicular structure of both these specimens is the same, and the second could be derived from the first by the upward growth of one of the larger humps.

The remainder of the description will be based on the second specimen.

The calices are deep, from 1 mm. in diameter in the depressions to 2 mm. on the elevations, usually 1.5 mm. or slightly more. Separated by tall, straight walls. The mural denticles are rather coarse, and moderately regular in size.

The upper portions of the septal margins are usually narrow, forming ridges along the sides of the walls, or sometimes obsolete. Between the palar ends of the septa and the wall there is one trabecula. Frequently there is no distinct septal granule; one, however, is sometimes present as a thickened tooth, detached from the wall. As a rule a few denticles, processes from the trabeculæ, occur on the septal margins. A peripheral ring of synapticula is usually indicated, but it is very rarely even approximately complete. The septal faces are almost without granulations and present a strikingly smooth appearance. Interseptal loculi open. The septal arrangement is, dorsal directive, four lateral pairs, fused in pairs by their inner ends, and a directive triplet, its members not fused to one another. The pali are poorly developed, the formula is rarely complete, although the septal arrangement is in accord with its being complete. They are better developed on the ends of the pairs, and are often suppressed on the dorsal directive and on one or more members of the triplet. The inner ends of the septa joined by a ring of synapticula.

The columella is a narrow, thin lamella, joined to the inner ends of the septa. The columella tangle, open and loose.

The specimen from Waikiki shows no differences of importance from the second one from Pukoo.

Localities.—Pukoo, Molokai, 2 specimens received from Dr. W. T. Brigham; Waikiki, Oahu, 1 specimen, collected by Dr. J. E. Duerden.

Cotypes.—Cat. Nos. 20921, 20924, U.S.N.M.

Professor Studer in 1901 described from Laysan two species of *Porites*, having the massive glomerate mode of growth. His descriptions, rendered somewhat liberally into English, follow. I suspect that his *P. quelchi* is a synonym of *P. lobata*. The presence of only six pali in the former species and its denser texture are the characters that I can gather from his description by which the two are separated. The second one of his species, according to his description, possesses several characters that indicate distinctness. It is unfortunate that Professor Studer has described for his species neither the septal arrangement nor the relations of the pali to the septa, and has not given much-needed details concerning several other skeletal structures.

7. PORITES QUELCHI Studer.

Plate LXXXVI.

1901. *Porites quelchi* STUDER, Zool. Jahrb., Syst., XL, p. 422, pl. XXXI, fig. 14.

Description.—According to Professor Studer, this species has the following peculiarities:

The colony is massive, 156 mm. high and 146 mm. in diameter. The upper surface is uneven, divided into hillocks and lobes which are sometimes rounded, sometimes more elongated and compressed. Those of the last form have clearly originated from the fusion of several single hillocks. The whole mass, which is heavy and of a dense texture, consists of layers of coral substance laid down one above another. The outermost living layer is 3 mm. thick, and is separated from those lying below by epitheca.

At one place seven layers, one above another, can be recognized, each one of these being separated from the one beneath by a layer of epitheca.

The calices are small and are separated by thick, porous walls, which may be 0.5 to 0.8 mm. or even 1 mm. thick, but become acute at the edge.

The twelve septa extend for an equal distance into the calicular cavity. They are nearly solid, show 2–3 rough teeth, and especially lateral spines that are elongated down in the calice and at its bottom build a ring joining the ends of the septa together. From this structure a trabecular columella may be developed. Often the septa are fused together in pairs.

Pali six in number; in some calices more, in others less developed. The calices are not of the same size: on the hillocks larger, hexagonal, and 1.3 to 1.8 mm. in diameter; in the valleys smaller, often deformed, 1 mm. in diameter. The depth is small, scarcely 1 to 1.3 mm.

As the interseptal loculi are narrow, and as they are soon filled up by the synapticula between the septa, and the pores in both the walls and the septa are relatively small, the whole corallum has a compact, dense structure.

A piece that has been sawed from a specimen from Laysan appears, according to the structure of its calices, to belong to same species. It was a part of a massive corallum, whose upper surface shows a large number of laterally compressed elevations, 10 to 18 mm. high and 15 to 20 mm. in diameter. This specimen does not consist of layers one above another, but the section, 10 cm. wide and 20 cm. long, is homogeneous; only the still living portion can be separated from the dead, inner, white mass as a brown superficial layer 4 to 7 mm. in thickness. Toward the apex of the specimen the living layer is as much as 11 mm. thick. On one place near the base the living portion has been lifted above the underlying layer for a short distance and has built a thick epitheca on its underside.

This form is nearly related to *P. parvistellata* Quelch (Challenger Reef Corals, p. 187), which it also resembles in habitus.

In this [Quelch's] species, however, the columella appears always to be absent and the calices seem to be deep.

P. californica, Verrill, Trans. Connecticut Acad. Arts Sc., Vol. I, Part 2, 1867–1871, p. 504, also may be closely related; at least Verrill's description indicates a similar form.

Hawaii, Molokai.

Remarks.—Professor Studer has had the kindness to send me a photograph of this species. I can therefore add a few notes to those given by him. The septal formula is similar to that of *P. lobata*, the dorsal solitary directive, the four lateral pairs and the members of the ventral triplet with their inner ends not fused into a group, although united by the ring of palar synapticula. The wall appears to be constituted as in *P. lobata;* but they do not seem to be the same, as the skeletal parts of *P. quelchi* are thicker, the wall wider and more dense, the columella more compact, and the usual number of pali six, whereas in *P. lobata* eight is the usual number.

8. PORITES BRIGHAMI, new species.

Plate LXXXIV, figs. 3, 3*a*.

The corallum of the type specimen is attached, epithecate around the edge. The upper surface is flattened; sides sinuous. Dimensions, about 60 mm. long; 43 mm. wide; 15 mm. thick.

Calices deep, funnel shaped, polygonal in outline, usual diameter, 1.2 mm. The wall is slightly elevated above the summit of the septa, thin, and interrupted. The septa are distally much thickened and are joined together very near the wall by a circle of synapticula, thus forming a thick, almost compact mural apparatus.

The septal arrangement is a dorsal directive, four lateral pairs, and a directive triplet; in the triplet, the inner ends of the laterals approach the ventral directive but do not fuse to it by their inner ends; they are joined to it, however, by synapticula. The peripheral thickening of the septa has been mentioned; from this zone their margins fall almost perpendicularly to the bottom of a deep, narrow, calicular fossa. Pali are very poorly developed; four small ones, one before each lateral pair, are usually present; the dorsal directive may bear a weak palus, likewise each one of the members of the triplet. The poorly developed pali is one of the striking characters of the species. Each septal margin usually bears 4 or 5 inwardly projecting dentations between the palus and the upper end of the septum, but probably there is only one septal trabecula. The palar ring of synapticula is poorly developed; the spaces between the lateral pairs frequently are entirely open, the synapticula present being weak. The openness of the interseptal loculi within the circle of mural synapticula is very striking.

The columella consists of a single compressed tubercle; it seems often to connect the dorsal with the ventral directive, but usually is otherwise free.

Localities.—Pukoo, Molokai; depth, 3 to 6 feet; 2 specimens received from W. T. Brigham, 2 specimens collected by Dr. J. E. Duerden; Waikiki, Oahu, 5 specimens collected by Dr. J. E. Duerden.

Type.—Cat. No. 21625, U.S.N.M.

Remarks.—This species is similar to *P. lobata* in its septal arrangement, but differs by its more compact mural apparatus, its less developed pali, its poorly developed palar ring of synapticula, and its columella tubercle usually being attached only to the directives.

The principal variation shown by the suite of specimens is in the configuration of the upper surface. The corallum has an incrusting base; as it grows upward it may be flat topped, as the type, or lobed; it may form stout plates, or crests with rounded edges, or the surface may be glomerate in appearance. The largest specimens are the size of a man's fist, or somewhat larger. The calices in some instances may be 2 mm. in diameter, but usually are smaller. The deep, funnel-shaped calices are constant in character.

9. PORITES LANUGINOSA Studer.

Plate LXXXVII; Plate LXXXVIII, figs. 1, 1*a*.

1901. *Porites lanuginosa* STUDER, Zool. Jahrb., Syst., XL, p. 423, pl. XXIX, fig. 9.

Description.—Professor Studer's original description is as follows:

The corallum grows in head-shaped masses, and is attached by a narrow pedicel; the upper surface is uneven, with numerous, prominent, sometimes spherical, sometimes elongated, compressed hillocks. The habitus is therefore similar to that of the preceding species [*P. quelchi*], only the hillocks are lower and the whole colony appears more uniformly rounded. The height is 122 mm., diameter 191 mm., height of hillocks 20 mm., with an average diameter of 27 mm.

The calices are very shallow, however, clearly separated one from another by a very loose, reticular wall, whose component trabeculæ project on the surface as rough spines. There are 12 septa, their margins exsert, and small spines are on both their edges and their faces; the septa fuse sometimes in pairs, sometimes unite in the bottom of the calice to form a ring which surrounds the styliform columella. Around the columella are six pali, that can be recognized with the naked eye. Diameter of the calices, 1 mm. They are somewhat larger on the hillocks than in the valleys.

The loose, trabecular structure of the walls and the branched spinules that cover them gives the upper surface a soft, almost woolly appearance.

Perhaps this species belongs with *Porites porosa* Verrill, from the Gulf of California (l. c., p. 504), the description of which answers well for the specimen before me, but an identification without comparison appears too uncertain.

Laysan.

There is in the Yale University Museum an excellent specimen of this species, which Professor Verrill has kindly loaned me, and thus enabled me to present figures of it, Plate LXXXVIII, figs. 1, 1*a*. It has one, rarely two, trabeculæ between a palus and the wall, ending in a tall upright tooth.

Professor Studer has sent me a photographic print of his type of this species. It also possesses a septal arrangement similar to *P. lobata*. The inner ends of the septa of the ventral triplet do not fuse together, although they are joined by the palar synapticula. Pali appear to be present before the dorsal directive, the lateral pairs and the ventral directive. There are at least two rings of synapticula within the walls, the mural and the palar.

10. PORITES STUDERI, new species.

Plate LXXXVIII, figs. 2, 2*a*.

Corallum subspheroidal, the three diameters, 28 mm., 25 mm., and 20 mm., respectively; surface rounded; no scar of detachment.

Calices polygonal, diameter 1.5 to 2 mm., excavated but shallow. They are separated on the surface by a slightly raised moniliform wall, which is usually continuous and straight. When the flat surface is looked at closely perforations are discernible. Within the calice, very near the wall, is a zone of thickened synapticula forming a continuous ring. This zone of synapticula may equal the wall in thickness. A section near the level of the bottom of the calices shows that the wall between the calices and the synapticular zones, one on each side of it, may become so thickened that the three fuse together, very nearly obliterating any pores.

Septal arrangement is four lateral pairs, the solitary directive, and, although the inner ends of the laterals in the triplet approach the ventral directive near the columella, the usual condition is for their surfaces not to meet.

The septa are wedge shaped, with decidedly thick outer ends, becoming thinner toward the columella. Around the columella as a rule there is a second, an inner synapticular ring, and there is also much thickening of the septa below the bottoms of the calices. The interseptal loculi are narrow; below the calices in some instances they are almost obliterated.

The septal margins slope gently to the bottom of the calice, without a narrow upper and outer portion. On the wall is a dentation or knot corresponding to the outer end of each septum. The pali are small, crowded down around the columella, seven or eight in number; sometimes absent on the ventral directive. Outside of the palar ring and within the wall are from two to four dentations; two or three appear to be the usual number. These dentations are irregular in shape, and themselves are minutely spinulose; one seems to be the usual number of septal trabeculæ. Each septal face shows two or three granulations, usually with blunt ends, between the palar ring and the outer synapticular zone.

Columella not sunken, terminated by a very small compressed tubercle.

Locality.—Auau Channel, between Maui and Lanai islands, Station 3876; depth, 28 to 43 fathoms; bottom, sand, gravel; temperature, 74.0° F.; 1 specimen.

Type.—Cat. No. 21623, U.S.N.M.

Remarks.—This species needs only to be compared with *P. lobata*. It differs from that species, first, by its size and subspheroidal form; second, its shallower calices, its septa have not a narrow upper and outer portion, but slope gradually to the bottom of the calices; third, its septa are much thicker, and the interseptal loculi correspondingly much narrower; fourth, the pali are more insignificant, and are more closely crowded around the columella; fifth, the columella is not situated in a pronounced depression, as in *P. lobata*. There is still another difference which to be brought out necessitates an addition to the description. The laterals on the sides of the ventral directive in *P. lobata* very constantly have free inner margins; usually they do not even curve toward the directive. The usual condition for *P. studeri* has been described above, but there is some variation. The inner ends of the laterals in the triplet sometimes, or rather often, approach the ventral directive, and occasionally one of them fuses to it near the columella. There is in *P. studeri* some indefiniteness in the relations of the ventral directive and its two laterals; the condition is intermediate between the one in which the inner ends of the septa of the triplet are entirely free from one another and that in which they are definitely grown together.

11. PORITES BERNARDI, new species.

Plate LXXXV, figs. 2, 2*a*.

Corallum small, tuberose, incrusting nodules, which it ultimately completely envelops. A basal epitheca, extending to the growing edge, can be seen where the object to which the colony is attached has not been entirely covered. The following are the three dimensions of the largest specimens: 56 mm., 35 mm., 34 mm. There are two smaller specimens.

Calices superficial, small, 1 to 1.5 mm. in diameter. When the surface has not been damaged usually no definite bounding walls can be seen, septo-costæ connecting adjoining calices. Occasionally there is a discontinous raised line around a portion of a calice. In those places where the upper edges of the septa are broken down a thick compact wall, composed of the thickened outer ends of the septa and some synapticula is revealed. A careful examination of the surface shows that this thickened wall is composed of three vertical zones of synapticula; first, one marking the outer limits of each corallite; second, two zones of synapticula, one on each side of the first and very near it. The wall is morphologically similar to that of *P. studeri*, but has not the elevated edge of that species.

The septal arrangement is somewhat variable. The usual scheme is four lateral pairs, a dorsal directive, and a triplet, with its laterals fused to the ventral directive near the columella. This arrangement is fairly constant; sometimes, however, the laterals of the triplet appear not to fuse to the ventral directive. Normally there are six small but rather prominent pali crowded around the columella. These occur on the ventral directive, at the junctions of the lateral pairs and of the septa composing the triplet. Variation from this scheme is rare. Between the palar ring and the outer edge of the calice are two or three small but prominent, irregularly shaped, rough dentations; two is the usual number of septal trabeculæ. The septa are thick, especially distally; their inner ends also are thickened and fuse rather solidly around the columella. The septal faces are rough, with several comparatively large granulations on each. The interseptal loculi are narrow. In some instance the thickening of the septa and the enlargement of the lateral granulations may almost obliterate them.

Columella terminated by a small, compressed tubercle. The fossa around the tubercle is very shallow, i. e., the columella is not sunken. The thickening and fusion of the inner ends of the septa have been described.

Locality.—Auau Channel, between Maui and Lanai islands, Station 3876; depth, 28 to 43 fathoms; bottom, sand, gravel; temperature, 74° F; 3 specimens.

Cotypes.—Cat. No. 20820, U.S.N.M.

Remarks.—This species occurs along with *P. studeri*, but they are strikingly different; the most noticeable difference is in their form and the relative depths of their calices. The nearest relative of *P. bernardi* seems to be *P. lanuginosa* Studer from Laysan.

According to Professor Studer *P. lanuginosa* differs in habitus, and "the calices are * * * clearly separated one from another by loose reticular walls." From his figure the calices are shallow but not superficial. The surface of *P. bernardi* is very rough, and because of the many small spines looks woolly, as Professor Studer says is the case in his species.

12. PORITES TENUIS Verrill.

Plate XC, figs. 1, 1*a*.

1866. *Porites tenuis* VERRILL, Proc. Essex Inst., V, p. 25.
1886. ? *Porites tenuis* (*part*) QUELCH, Reef Corals, Challenger Rept., p. 184.

Verrill originally gave "Loo Choo Islands?" as the locality whence this species was obtained. Quelch subsequently reported it from Honolulu. Verrill's type is in the United States National Museum, Cat. No. 407, U.S.N.M., North Pacific Exploring Expedition. The following description is based upon this specimen:

Corallum subspherical, surface somewhat glomerate. Greater diameter, 63 mm., lesser, 54.

Calices shallow, polygonal, small, about 1.5 mm. in diameter, or slightly less, in depressions sometimes not over 1 mm. Wall thin, usually continuous, zigzag; however, it is often disconnected and imperfect. Septal arrangement shown in the enlarged view of the calices. The lateral septa of the triplet fuse to the sides of the ventral directive. The four principal pali are present, and also one on the ventral directive. Rather often a smaller palus is on the end of the dorsal directive. The pali are comparatively large and tall, and show small granulations. Usually there are two synapticular rings within the wall, one near the wall, the other surrounds the columella tangle. There are about three, or may be one or two more, minute denticles on the septal margins between the pali and their uppermost edge; as a rule one, occasionally two, septal trabeculæ and a similar number of septal granules. The columella consists of a compressed tubercle lying between, and in the plane of, the two directive septa. The septal ends, lying within the inner synapticular ring, which surrounds the columella, become much thickened, so that deep down in the corallite the columella is rather solid. Minute granulations on the septal faces.

Locality.—"Loo Choo Islands." The locality name for the specimen on which the above description is based, is not followed by an interrogation point.

13. PORITES DISCOIDEA Studer.

Plate LXXXIX, fig. 2.

1901. *Porites discoidea* STUDER, Zool. Jahrb., Syst., XL, p. 425, pl. XXXI, fig. 16.

Description.—Studer's description is as follows:

The corallum is a free plate, 3 mm. thick and 92 mm. in diameter; the upper surface is flat, showing only a single elevation, which was caused by *Serpula* tubes. One-half of the specimen is grown upon a second plate that is dead and in places projects beyond the edge of the overlying layer; the living portion is therefore spread over a dead lower layer.

The lower side shows a thick, firm, concentrically wavy epitheca, which gives to the whole plate a rock-hard, brittle constitution, while the layer bearing the calices is only 1–1.5 mm. thick. The margin is acute and forms an irregularly rounded contour. On one place it is somewhat elevated.

The calices on the upper surface are small, distinctly limited, pali and columella recognizable with the naked eye. The diameter of the calices is as much as 1 mm. The wall consists of loose, fused trabeculæ, which terminate above in fine, branched spinules. The septa are only slightly prominent; on their margins and faces are spiny ridges of loose texture, standing directly in relation with the system of mural trabeculæ, and from them the spiny pali surrounding the columella rise interiorly. As the calices are very shallow, the pali reach almost to the level of the mouths of the calices.

This species is separated from *P. lichen*, which possesses a similar habitus and was obtained in the Sandwich Islands by the *Challenger*, by its smaller and shallower calices and the strongly developed pali. These in *P. lichen*, according to Quelch, are only slightly prominent.

Laysan.

Remarks.—Later, in describing *P. lichen*, it will be pointed out that Quelch was wrong when he identified his specimens from the "Sandwich Islands" with that species (see pp. 214, 215). The very characters which Professor Studer says differentiate his *P. discoidea* from *P. lichen* are the same as in that species. However, *P. discoidea* is different from *lichen*. Professor Studer's figure shows none of the depressed rows of calices common in *P. lichen*, and a different septal formula is indicated. *P. discoidea* probably belongs in the *P. lobata* group.

Professor Studer has kindly sent me a photograph of his type of this species. The species is peculiar in the comparatively poor development of the concentric skeletal elements. The interseptal loculi appear decidedly open; even the ring of palar synapticula is usually only partially developed. The septal arrangement is a dorsal directive, four lateral pairs, and the ventral triplet with the inner ends of the laterals of the triplet directed toward or fusing to the inner end of the ventral directive. The normal number of pali is six. They are present on the inner ends of the dorsal and ventral directives and before the lateral pairs. The columella is a compressed tubercle, lamellar in character, and connects the ends of the two directives across the axis.

This species is very different from Dana's *P. lichen*, and is only superficially similar to Quelch's erroneously identified *P. lichen* from the Sandwich Islands,[a] which is a young corallum of *P. lobata*.

[a] Bernard, Porites of the Indo-Pacific Region, p. 103, pl. IX, fig. 9; pl. XII, fig. 5.

14. PORITES SCHAUINSLANDI Studer.

Plate LXXXIX, fig. 1.

1901. *Porites schauinslandi* STUDER, Zool. Jahrb., XL, p. 424, pl. XXX, fig. 12.

Description.—Professor Studer's description is as follows:

Colony incrusting, similar in habitus to *P. cribripora* Dana. It forms a thick lamina, whose upper surface is uneven and convex, edges revolute; consists of a living layer 1 mm. thick, separated by a thin epitheca from the lower dead layers. Five of these dead layers could be distinguished. Including them, the corallum is 15 mm. thick. The width in one direction is 69, in the other 63 mm.

The upper surface is covered with hexagonal calices, which are separated by distinct walls with acute edges. The usual form of the calices on the convex places is hexagonal. These are the most numerous; the diameter varies between 1.3 and 1.5 mm. Septa 12, falling abruptly into the calicular fossa, but little perforated, with 4 to 5 similar, rough teeth on the margin and small spinules on the faces. In the bottom of the calice is a small, often only rudimentary columella, surrounded by 3 to 6 small pali. Where the upper surface is depressed the calices are small, 0.6 to 1 mm. in diameter, deformed in one direction and irregular in outline. In isolated places among the larger calices, are calices 2.5 mm. in diameter, with 6 to 8 pali. The increase in size may indicate that fission occurs along with intercalicular budding. The former may take place by the cutting off of a portion of one of the enlarged calices.

Places are seen in which 2 or 3 calices are still connected, without being separated by walls. The dividing walls are first initiated by the fusion of two septa of the elongated calice.

* * * * * * * *

Laysan.

Remarks.—Professor Studer has also sent me a photograph of his type of this species, but I am unable to make out more detail than he has given in his figures and description. I could not be sure of the septal arrangement.

15. PORITES LICHEN Dana.

Plate XC, figs. 2, 2*a*, 2*b*.

1846. *Porites lichen* DANA, Zooph. Wilkes Expl. Exped., p. 566, pl. LVI, fig. 4.

Original description.—Dana's original description was as follows:

Incrusting, one-eighth of an inch thick, undulate, margin subacute, often flexed upward, and free for a third of an inch; under surface smooth, or obsoletely plicate. Corallum having the cells shallow, and often prominent in minute, thin ridges, which give the surface a reticulate appearance.

The type is a small specimen, 36 mm. tall, 40 mm. wide, and about 3 mm. thick; on the eminences it is thicker, edge thin. It is eccentrically attached, has a sinuous and crispate margin; upper surface uneven, more or less mammillate; lower surface epithecate, the epitheca extending to the edge. Beneath the living coral is a dead lamina, which extends almost to the outer edge of the growing portion.

The calices are shallow, small, from 0.75 to 1.5 mm. in diameter. The smallest calices are in depressions, the larger ones on convexities of the surface. Several calicinal centers often occur in an elongate series without any hint of a wall between them. (See Quelch's "*Napopora*," Chall. Reef Cor., p. 186.)

The walls present several different aspects. These can best be described by beginning with the asexual reproduction in the elongated calices to which reference has been made. In some instances it appears that two opposed septa become lengthened, meet, and fuse, forming two separate calices. In other instances it seems that first two calicinal centers, connected by septa extending from one to the other, are formed in the series. These two centers become separated by a wall, synapticular in character, developed between the connecting septa. The division of the elongate calice, it appears, can be brought about in either of these ways. However, it may be that both methods act together, in most instances one being more pronounced than the other. The walls bounding the series become considerably elevated and thickened by reticular tissue. When walls develop between the calicinal centers in the series, they are, at first at least, thin and not very prominent. In other places the calices do not show any tendency to the arrangement in valleys, but are uniformly distributed. In most instances the walls are thin and continuous. The frequency of perforations is variable. Sometimes mural pores are rare; in other instances perforations are frequent, the walls clearly being a vertical ring of synapticula joining of the peripheral ends of the septa. The walls are often secondarily thickened by reticular tissue.

The arrangement of the septa is shown in the enlarged view of the calices. The usual number of pali is five, four principals, and one on the ventral directive septum to which the lateral septa of the triplet fuse. The dorsal directive very rarely bears a palus. The pali themselves are slender, tall, reaching almost the level of the upper edge of the wall, and minutely granulated. Between the palus and the wall a single tooth can be seen on many septa; this tooth probably is constantly present. Wherever the upper edge of the wall is intact, even when thickened and reticular, there is a dentation or spine on it corresponding to the distal end of each septum. The septa usually are thickened at the wall and there is more or less thickening in the region of the columella, but a synapticular ring surrounding the columella is not constantly present. Septal fusion further than has been noted is not regular.

Usually the columella termination is styliform, the style prominent and slender; in a considerable number of calices there is no style, but it may have been broken off. The columella is reinforced by the irregular fusion and thickening of the inner ends of the septa.

Locality.—Fiji Islands, United States Exploring Expedition.

Type.—Cat. No. 666, U.S.N.M.

Quelch, in his Challenger Reef Corals, p. 181, cites this species from the Hawaiian Islands, reefs at Honolulu. If one may judge by his notes he never seized some of the essential characters of the species, the wall in places forming the prominent, thin ridges of Dana. The pali are not "small and often scarcely apparent," but as they have just been described. Quelch's specimens are young, and belong in the *P. lobata* series.

16. PORITES RETICULOSA Dana.

Plate XC, fig. 3; Plate XCI, figs. 1, 1*a*.

1846. *Porites reticulosa* DANA, Zooph. Wilkes Expl. Exped., p. 567, pl. LVI, fig. 3.

Original description.—Dana's original description is as follows:

Incrusting, undulate, margin scarcely at all free, surface mammillate and tuberose. Corallum very porous, cells neatly angular, shallow, rather large (three-fourths of a line), plane at bottom, septa thin and often in thin ridges, like the *lichen*.

The type-specimen is fan shaped, or flabellate, greatest width 118 mm. The general aspect of *P. reticulosa* is the same as that of *P. lichen*, except *P. lichen* is based on a smaller specimen.

The calices exhibit the same tendency in places to occur in depressed rows between elevated walls, but the walls between the calices in the rows were in every case observed distinctly present. The calices of *reticulosa* are somewhat larger, 1 to 2 mm. in diameter. The walls are more solid and the septa are thicker. I could find no other differences between the type-specimens. The septal arrangement, etc., are the same for both. It should be stated that the surface of *P. reticulosa* is considerably damaged. If the original surface of the living corallum had been preserved intact, the septa might not appear so thick.

Locality.—Fiji Islands.

Type.—Cat. No. 663, U.S.N.M., United States Exploring Expedition.

Milne Edwards and Haime[a] placed *Porites reticulosa* in the synonymy of their *Goniopora? lichen* (Dana). *P. lichen* and *P. reticulosa* may belong to the same species, but I have not seen specimens that invalidate the differences above noted. The type of *P. lichen* is here redescribed in considerable detail; notes are made on that of *P. reticulosa*; and figures of each are given, so that other students of these corals may be able to dentify them.

17. PORITES (SYNARÆA) IRREGULARIS (Verrill).

1864. *Synaræa irregularis* VERRILL, Bull. Mus. Comp. Zool., I, p. 43.

Original description.—Verrill's original description is as follows:

> This species forms large masses, consisting of numerous angular, clavate, uneven, and crowded branches, often nodose at the ends, and much coalesced, giving a rough eroded appearance to the mass. Cells larger than in the following species [*S. convexa* Verrill]; pali prominent, slender; columella rudimentary, often wanting. Surface covered with slender, prominent, often toothed granulations, which are rather loosely arranged. Color deep umber brown. Sandwich Islands; A. Garret.

I have seen no specimens of this species.

18. PORITES (SYNARÆA) HAWAIIENSIS, new species.

Plate XCI, figs. 2, 2*a*.

The corallum is incrusting, upper surface undulate. The type, the only specimen of the species that I have seen, is thin and incrusts a sawed piece of a Poritid coral that I can not identify; should they be the same, the corallum form masses at least several centimeters thick.

The calices are small, superficial, and separated by thicknesses of cœnenchyma equaling, or in some instances exceeding, the diameter of the calices. Diameter of calices, 0.5 mm. The cœnenchyma may form low rounded ridges or be almost flat; its surface is densely spinulose.

The septa show the typical poritid bilaterality. The ventral directive has the inner ends of the lateral septa of its group fused to it. There are six prominent pali; a smaller, thinner one on the dorsal directive, the others are triangular in shape.

[a] Hist. Nat. Corall., III, p. 192.

Outside of the palar ring each septum bears from one to three dentations, very irregular in size. I was unable to distinguish between septal and mural trabeculæ. The interseptal loculi are extremely narrow; are almost obliterated by the thick septa. Synapticula are abundant and crowded.

The columella is terminated by a single styliform tubercle, rising above a flat floor across the bottom of the palar crown; between the pali the floor is pitted, giving it a star shape.

Locality.—Kalihi Harbor, Oahu, received from W. T. Brigham.

Type.—Cat. No. 21624, U.S.N.M.

Family FAVOSITIDÆ Dana.

Genus ALVEOPORA Quoy and Gaimard.

ALVEOPORA VERRILLIANA Dana.

Plate XCI, figs. 3, 3*a*.

1846. *Alveopora dedalea* DANA (*part*), Zooph. Wilkes Expl. Exped., pp. 512, 513, pl. XL, fig. 4.
1872. *Alveopora verrilliana* DANA, Corals and Coral Islands, 1st ed., p. 77, with fig.

The following description is based on Dana's type specimen, which is preserved in the United States National Museum:

Corallum subpyriform, attached by the small end, which is slightly expanded on the surface of attachment. Greater diameter, near upper surface, 43 mm.; lesser, about midway down the specimen, 30 mm.; height, 38 mm. The attachment is somewhat oblique, as the corallum does not rise perpendicularly above the base. The upper surface is gradually rounded, without lobations. The basal portion is invested by a complete but thin epitheca, extending far up the sides of the corallum; 33 mm. is the greatest distance across it, measured from the base, and 11 mm. the least. Its surface shows concentric, irregular wrinkles and delicate, fine, concentric striations.

Calices polygonal, usually one axis longer than the other. The variation in diameter of the more regularly polygonal is from 1.2 mm. to 2 mm. An oblong calice has a greater diameter of 2 mm. and a lesser of 1.5. They are smaller on the summit than on the sides. The septa are in two cycles; the primaries may or may not meet along the corallite axis; when they do, they can scarcely be said to form a columella, as there is too little fusion. The walls are moderately thick or rather thin, of the usual lace-work pattern.

As there is only a single specimen, it does not seem justifiable to section it in order to describe the septal spines and the mural characters in greater detail. It is hoped that, by aid of the description and the figures, the species can be identified.

Locality.—Hawaiian Islands: Wilkes Exploring Expedition.

Type.—Cat. No. 327, U.S.N.M.

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[a] I am unable to ascertain the dates on which these sections of the report were issued.

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PLATE I.

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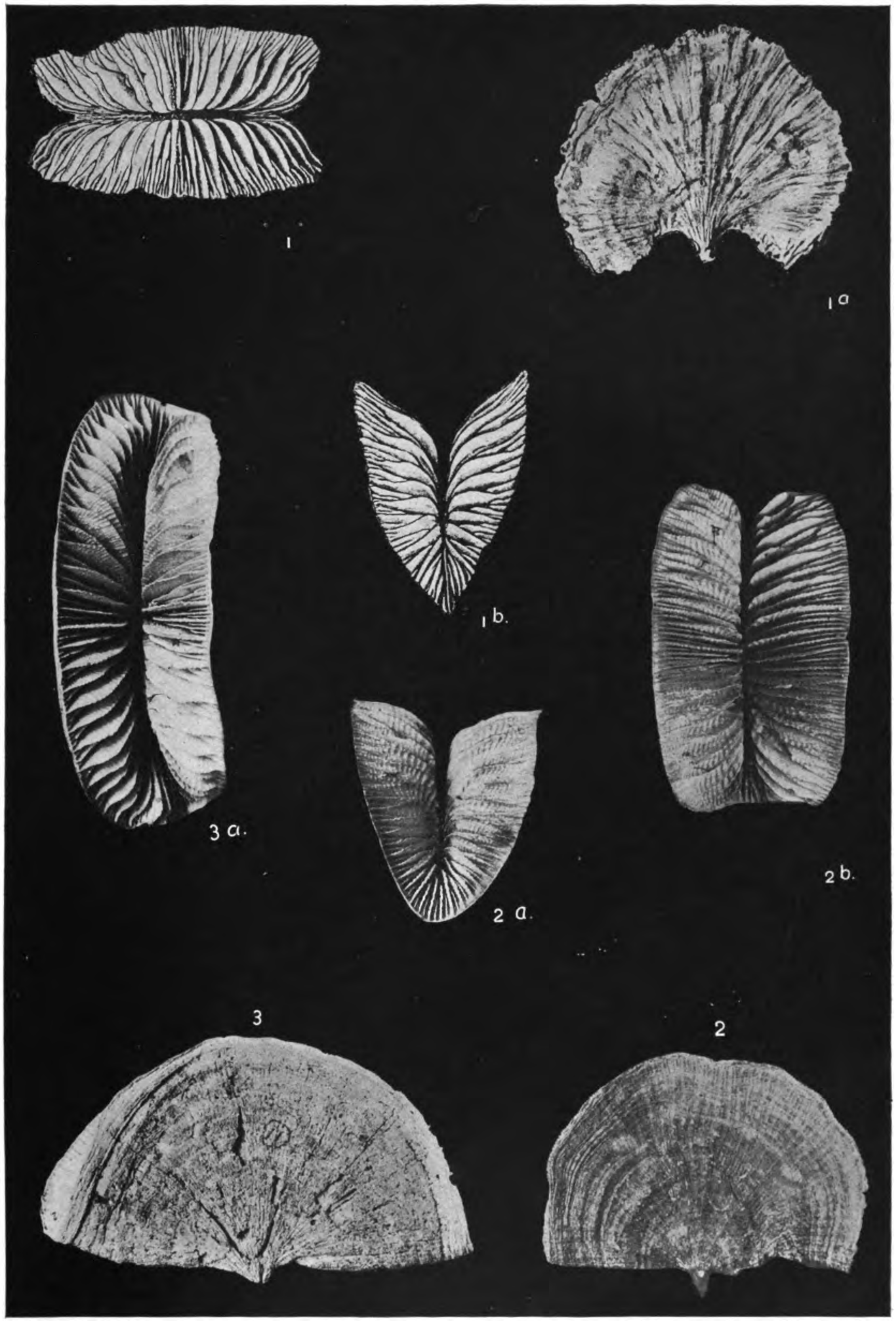
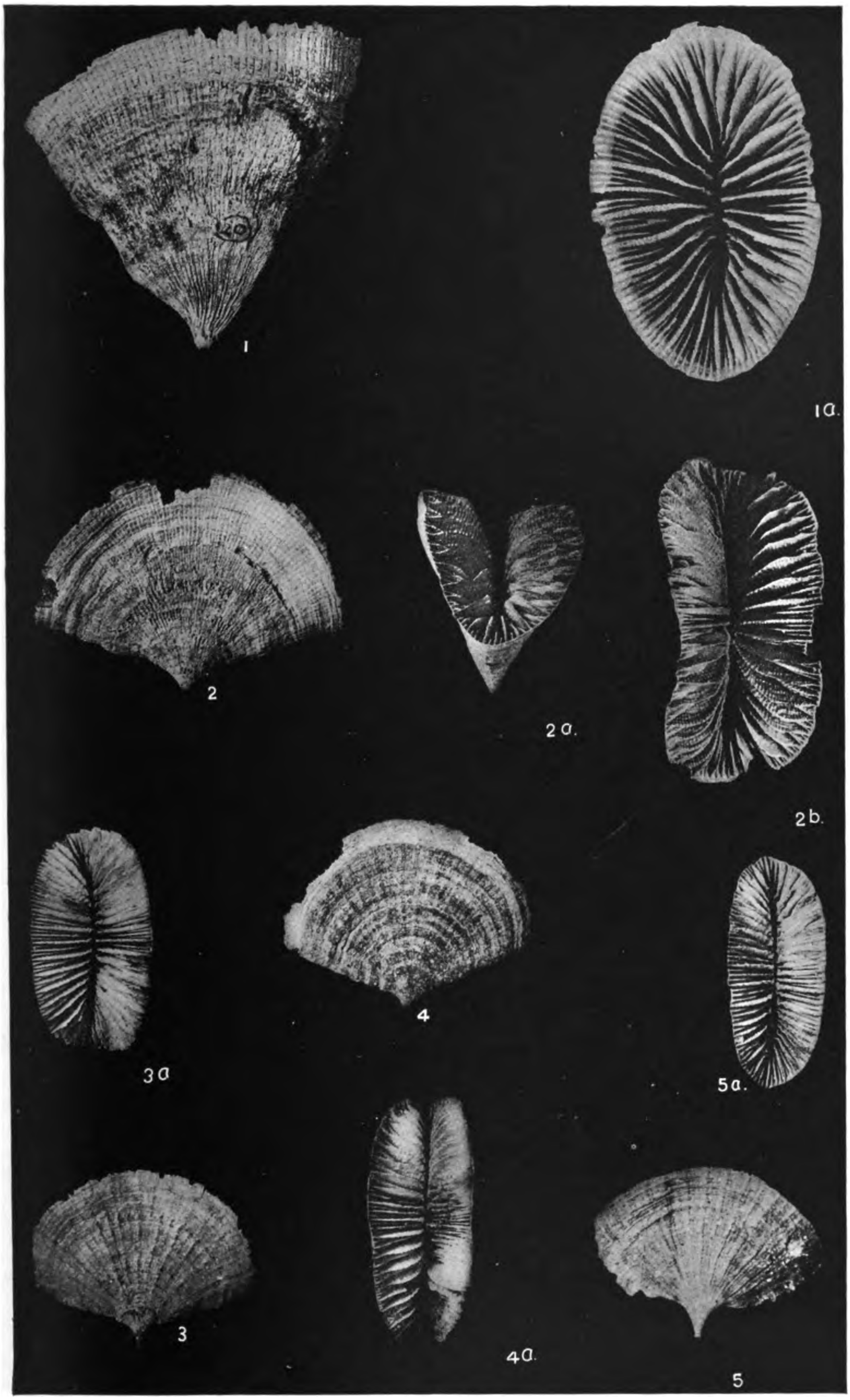


FLABELLUM.

PLATE II.

PLATE II.

All figures natural size.



FLABELLUM.

PLATE III.

PLATE III.

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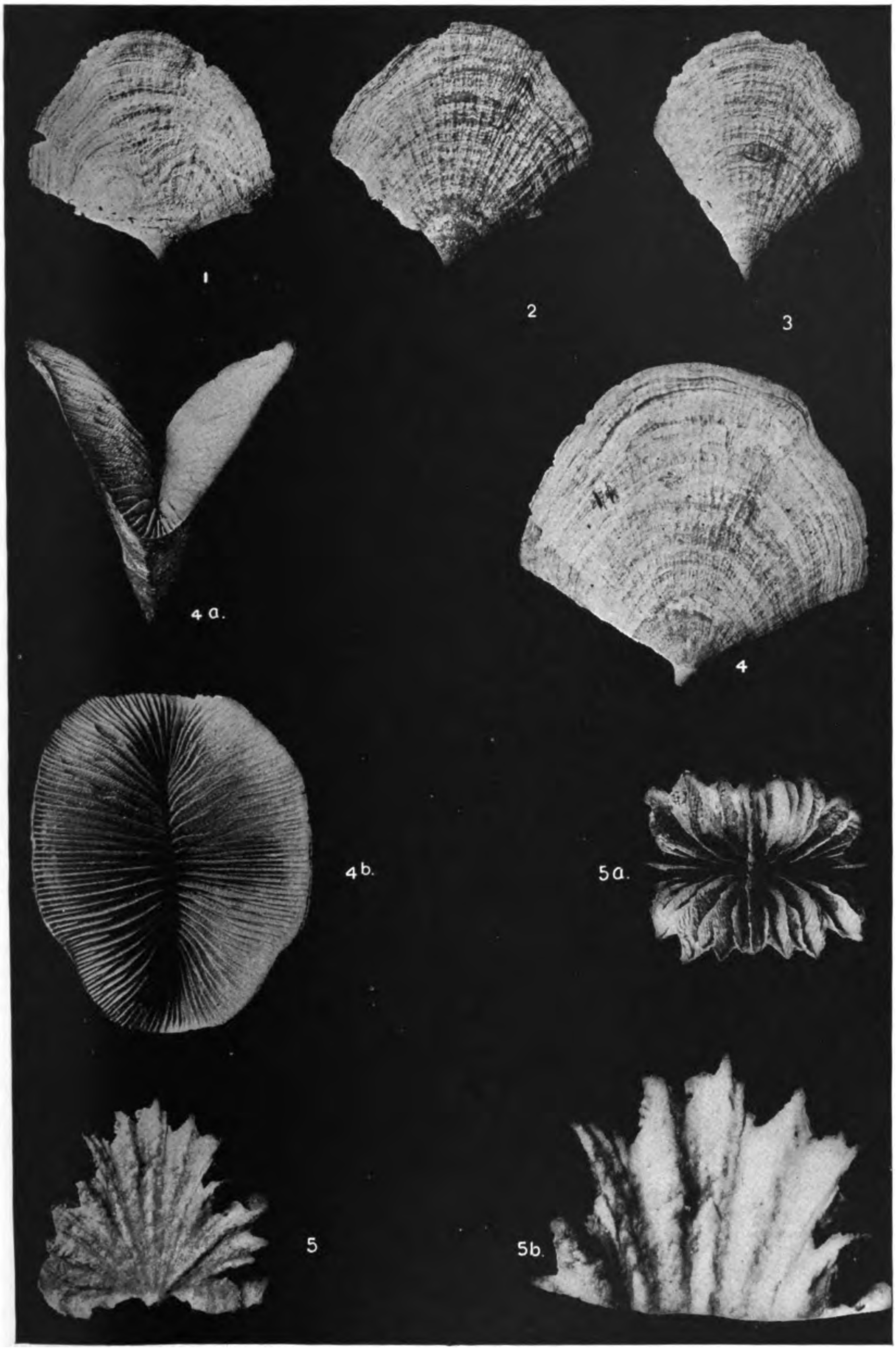

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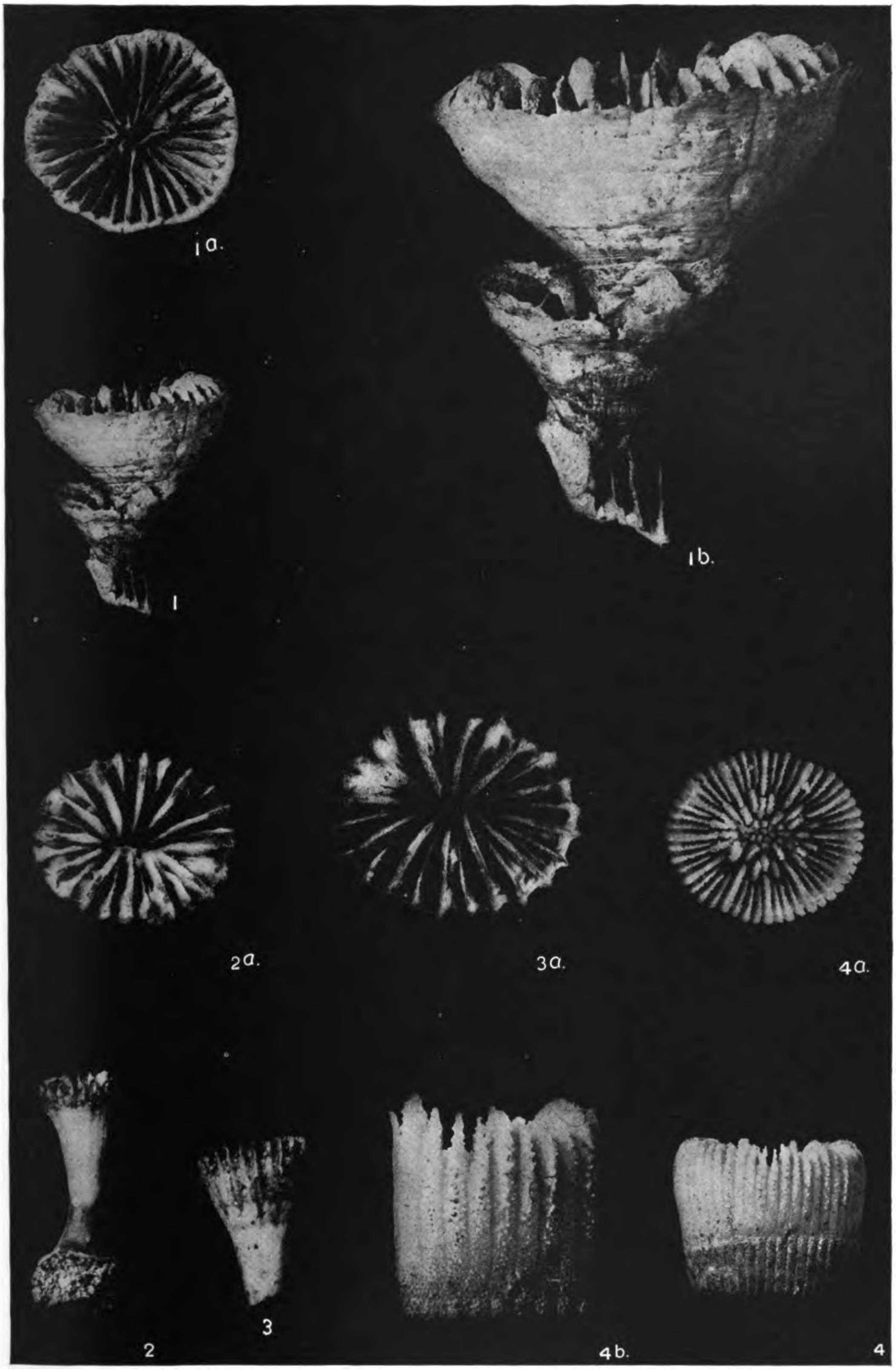

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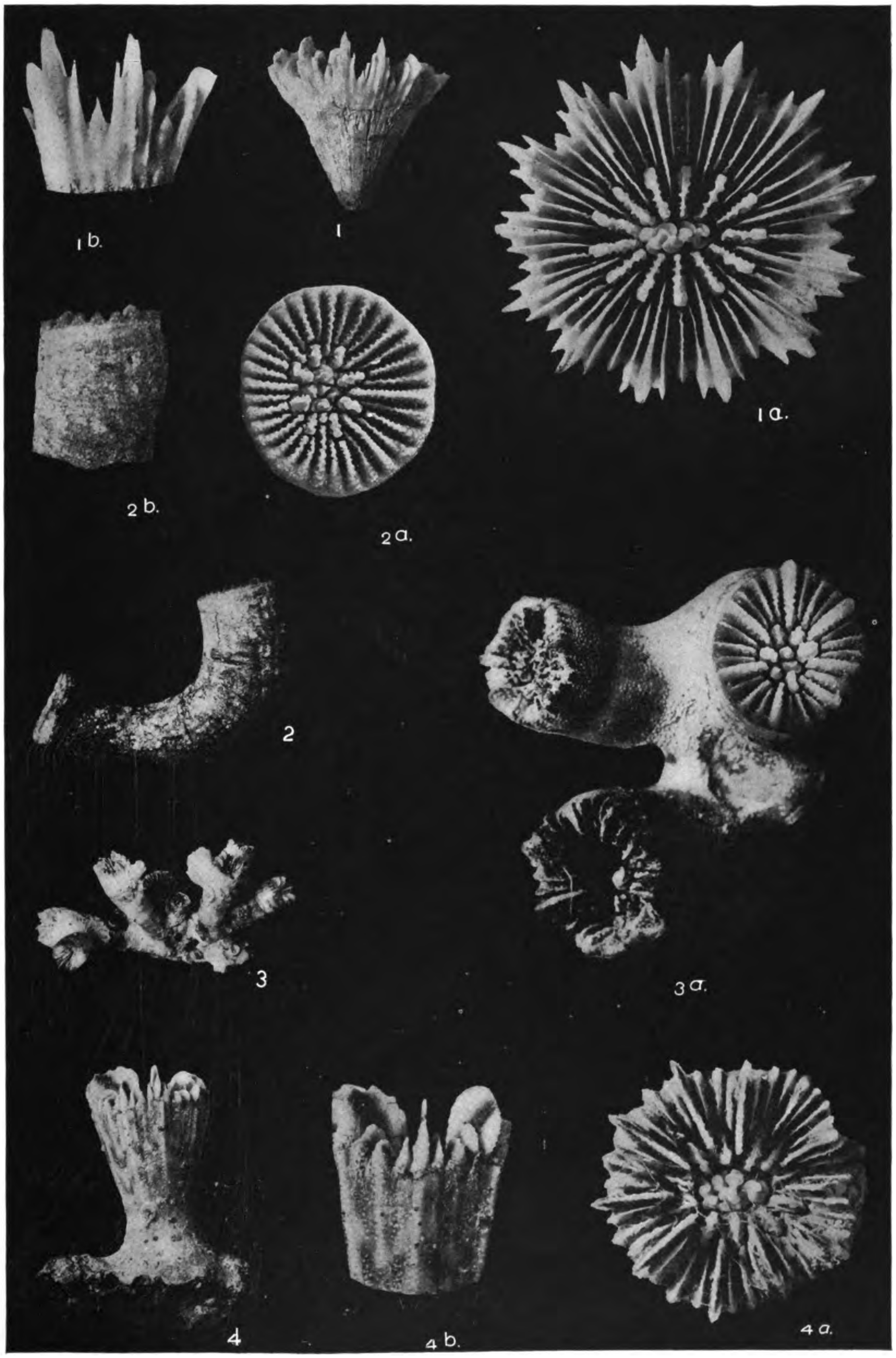

CARYOPHYLLIA.

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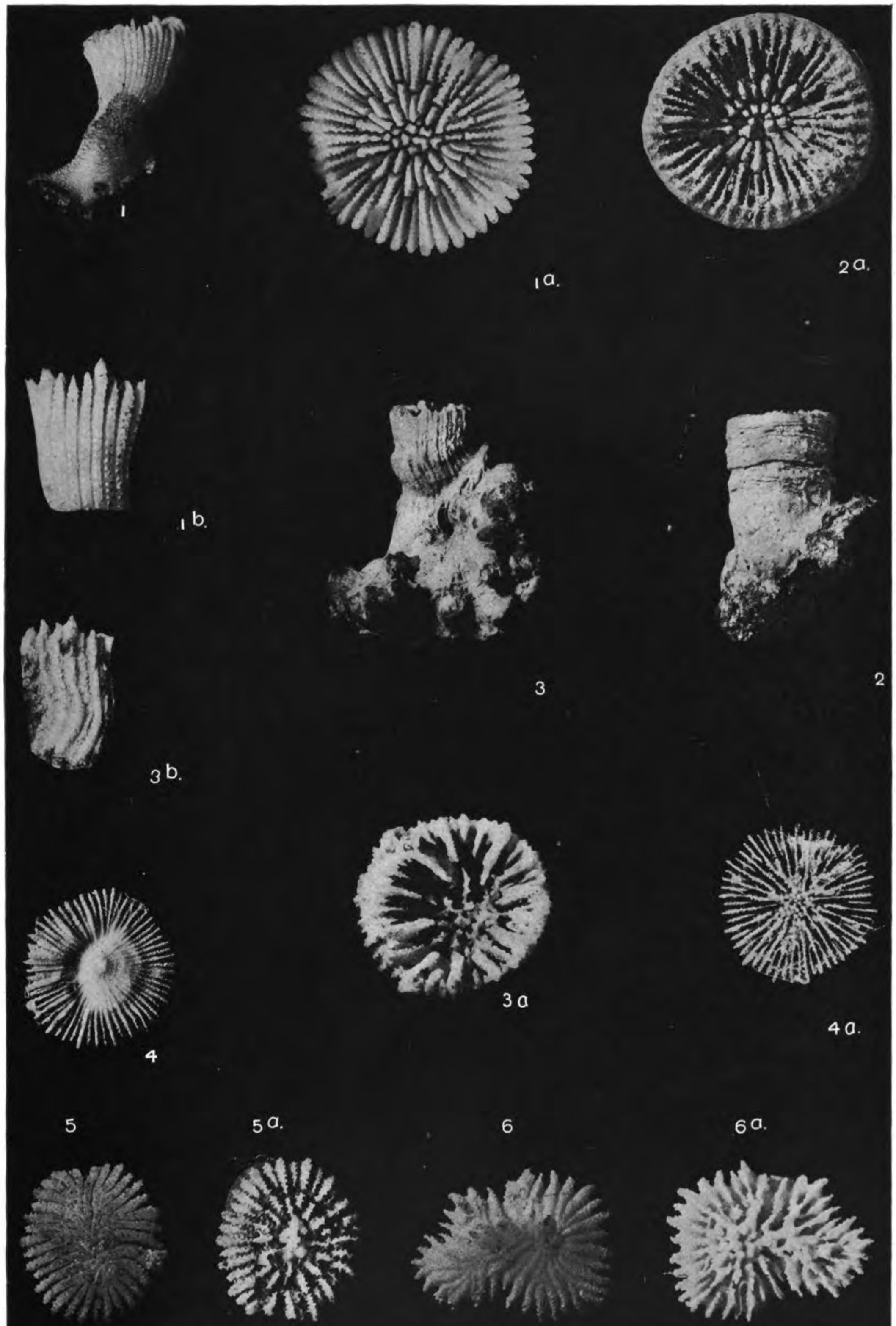
PLATE VI.



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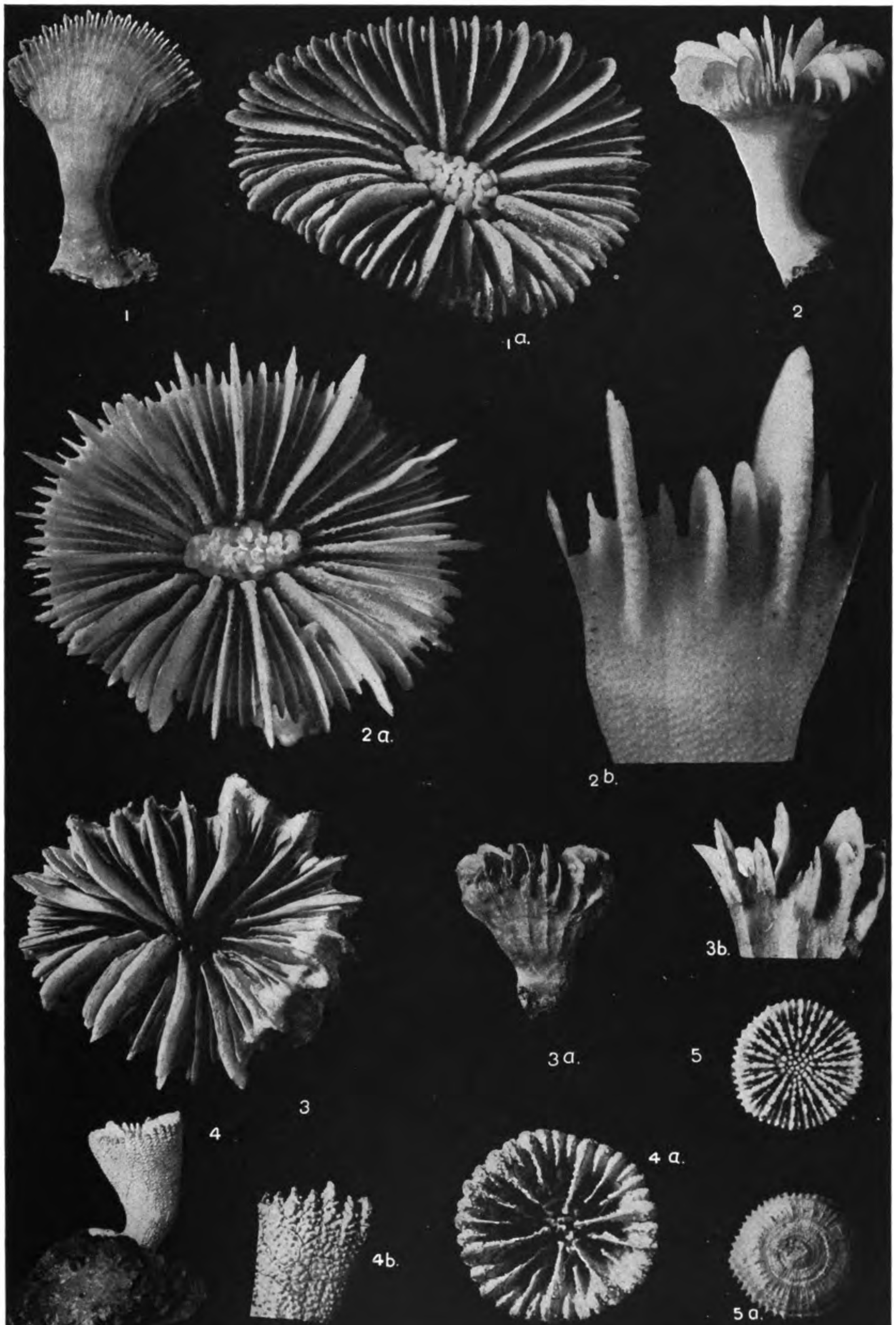
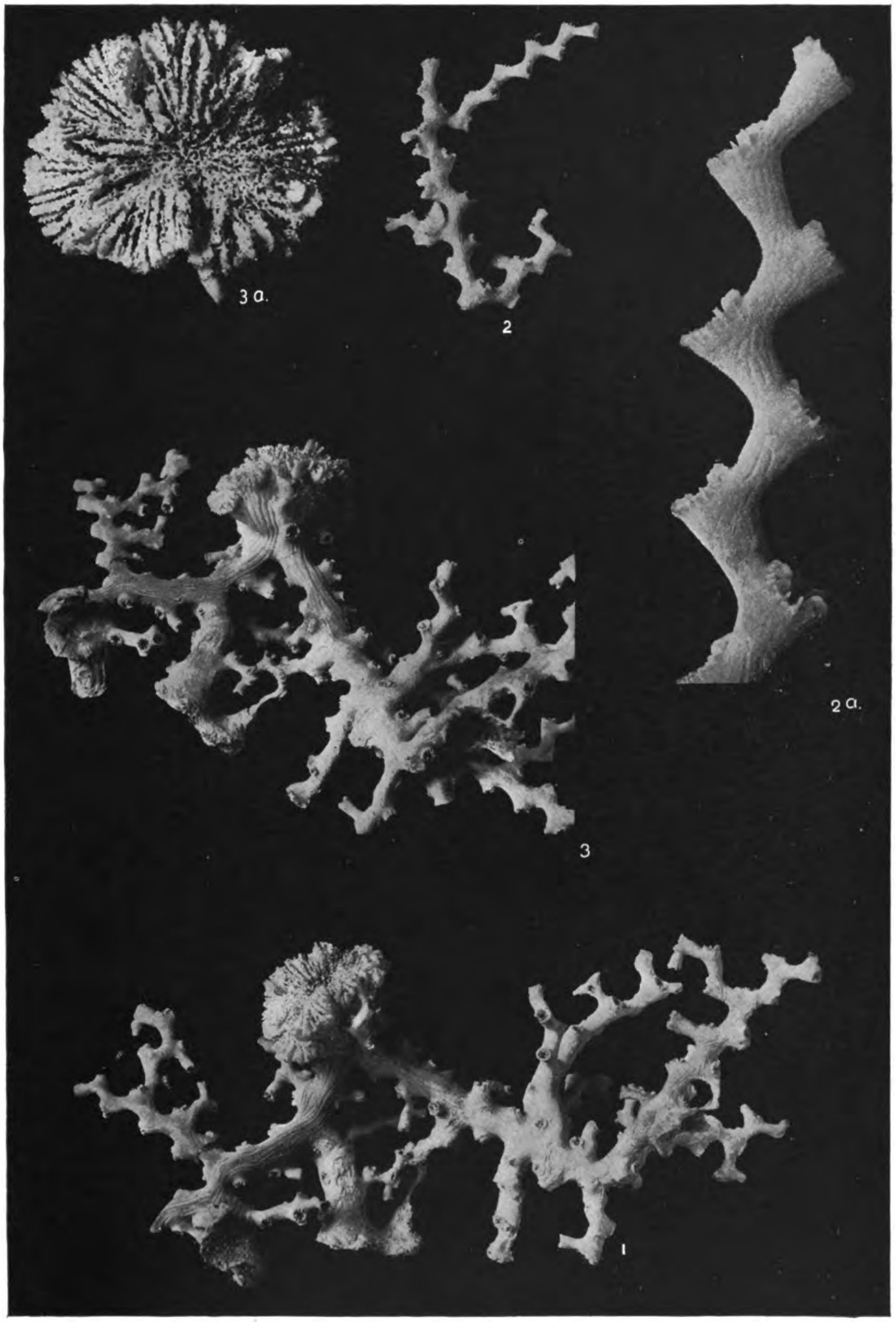


CYATHOCERAS, DESMOPHYLLUM, CERATOTROCHUS, ANTHEMIPHYLLIA.

PLATE VIII.

PLATE VIII.



MADREPORA, MUSSA (?)

PLATE IX.

PLATE IX.

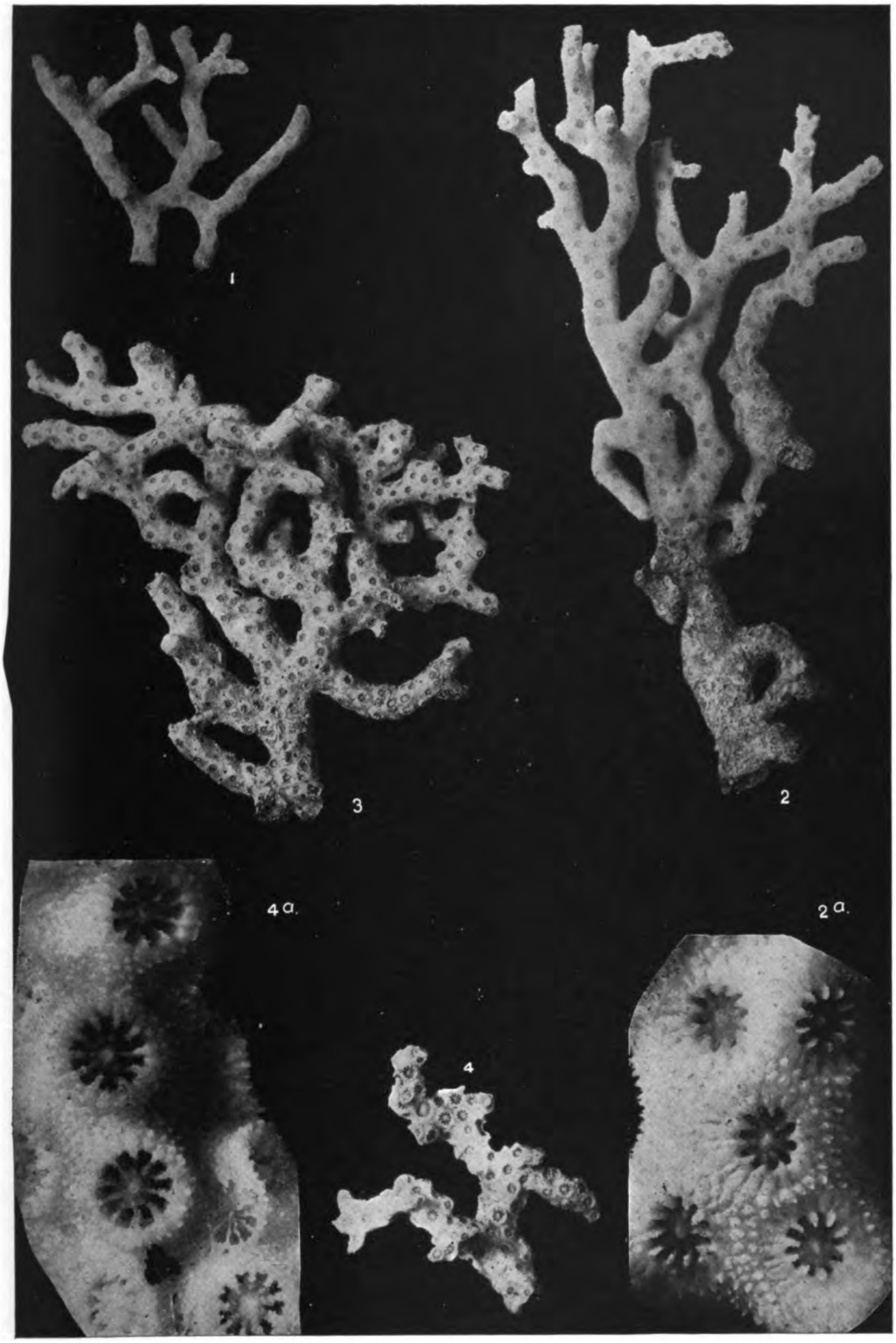


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PLATE X.

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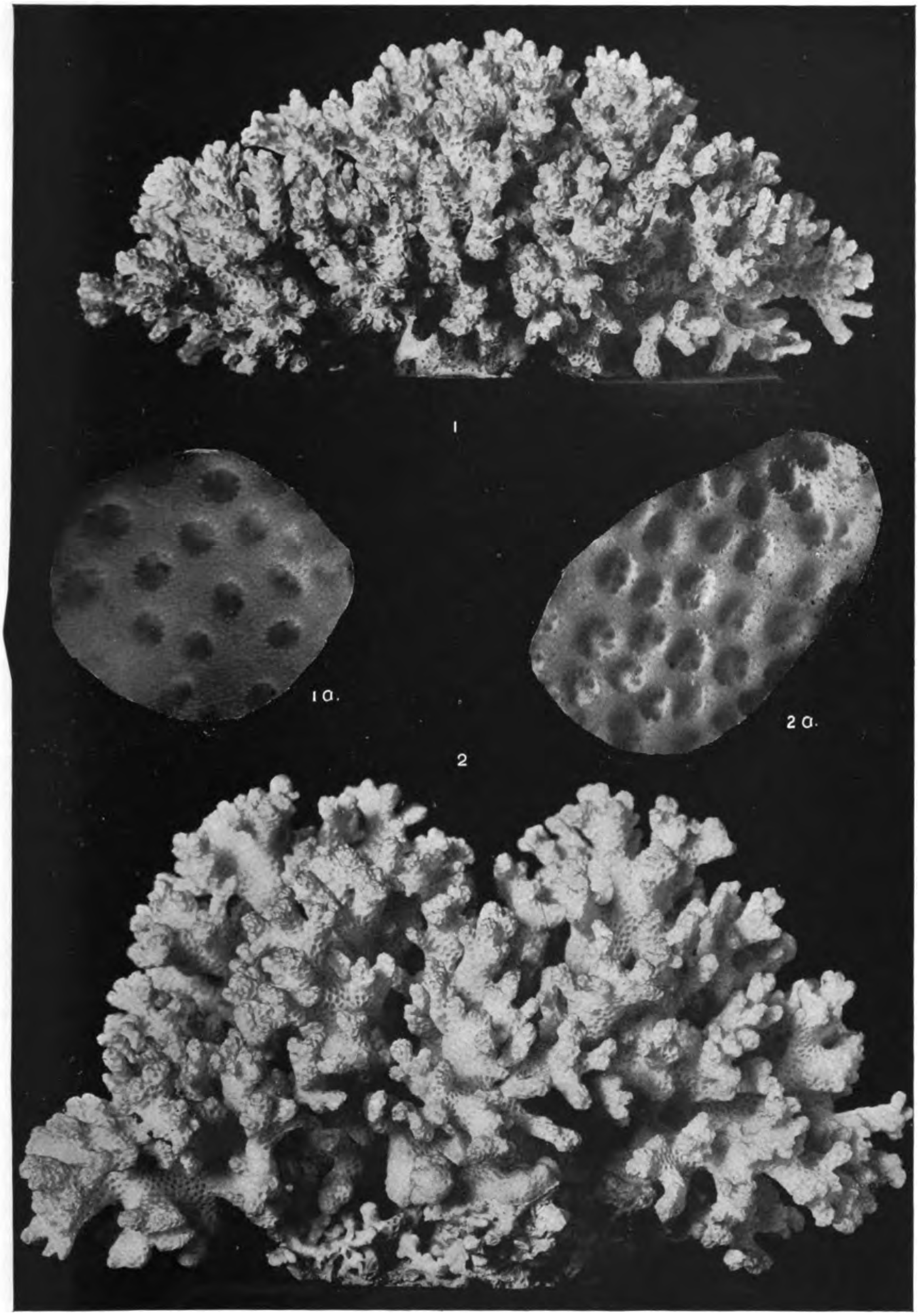

POCILLOPORA.

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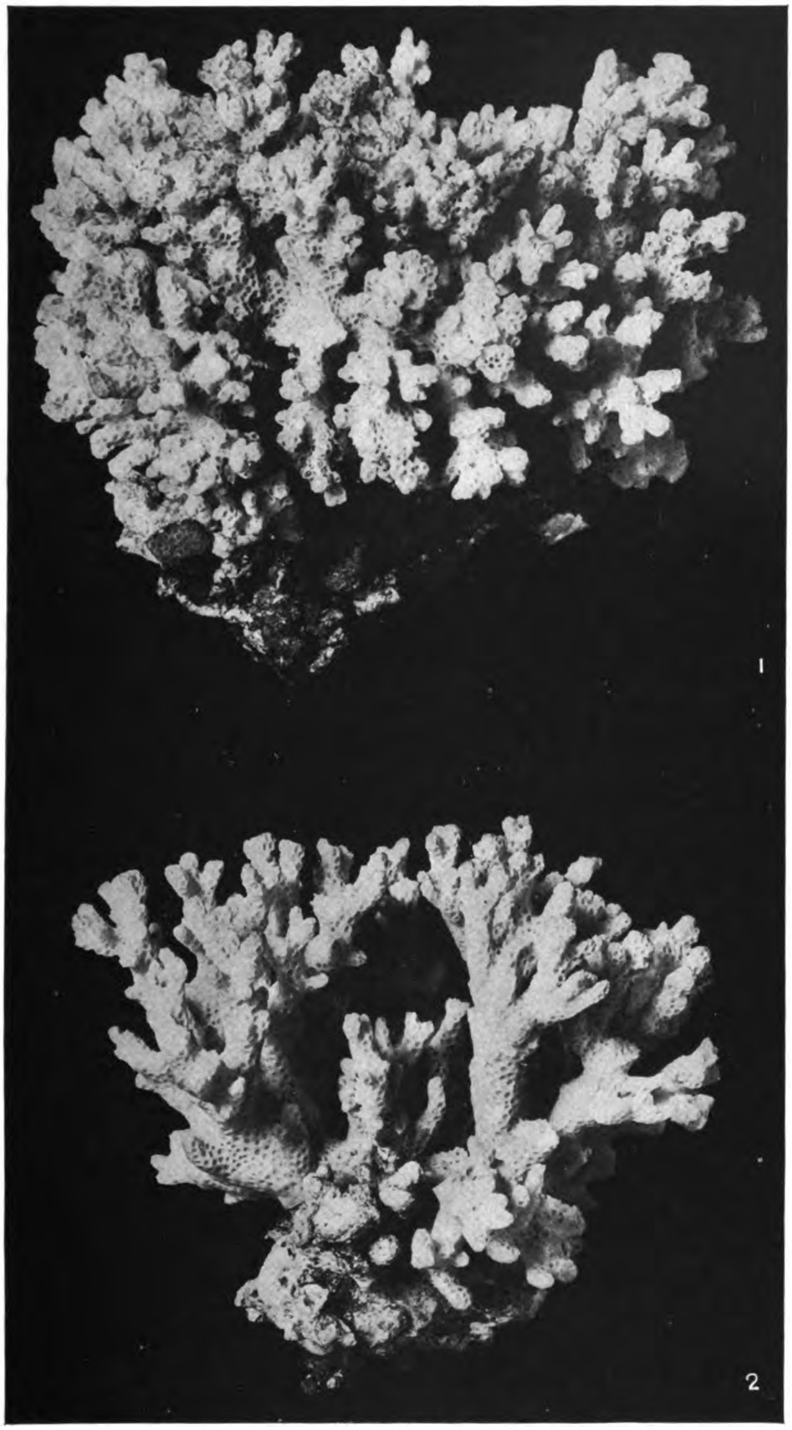
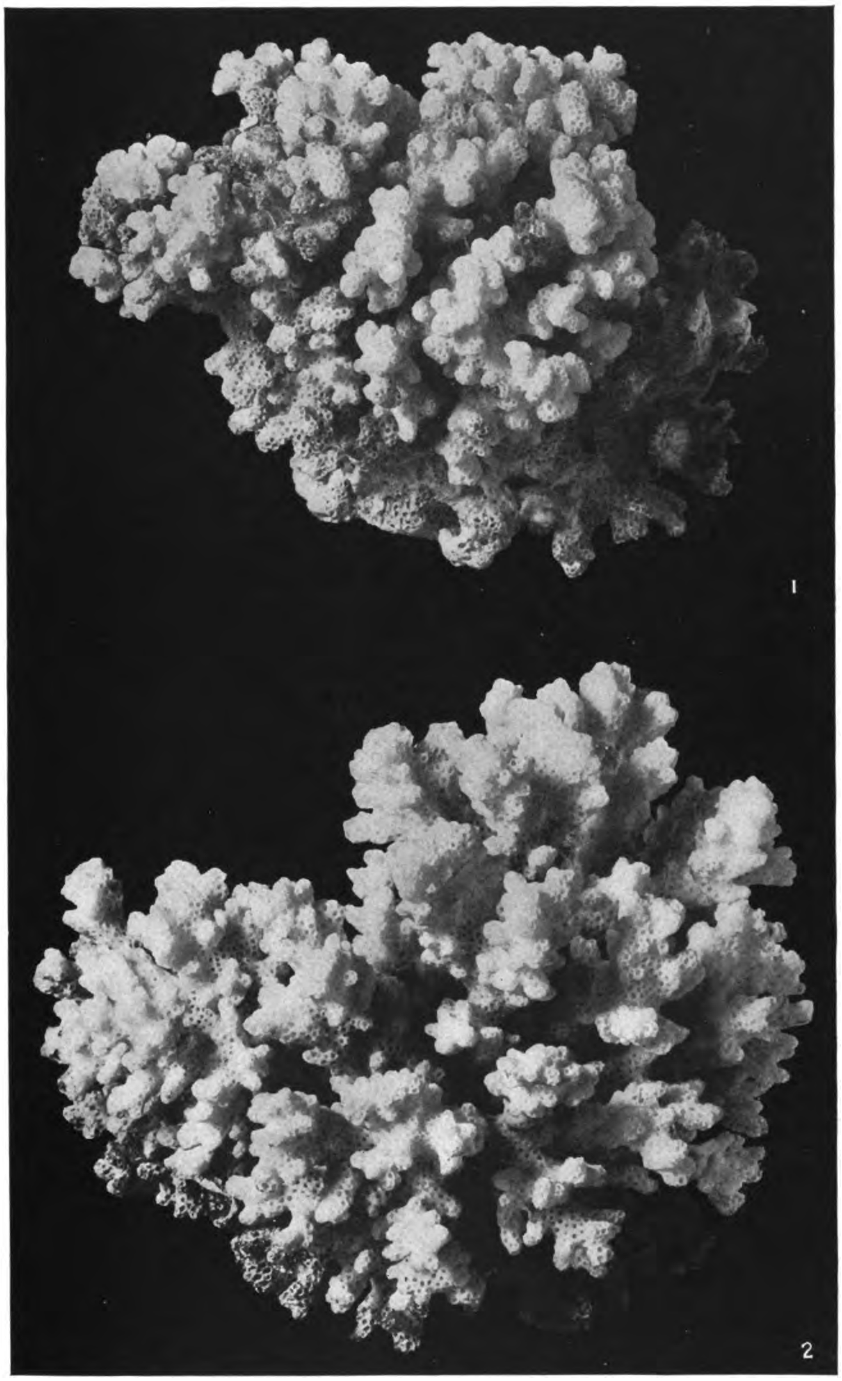


POCILLOPORA.

PLATE. XII.

PLATE XII.

Figures natural size.



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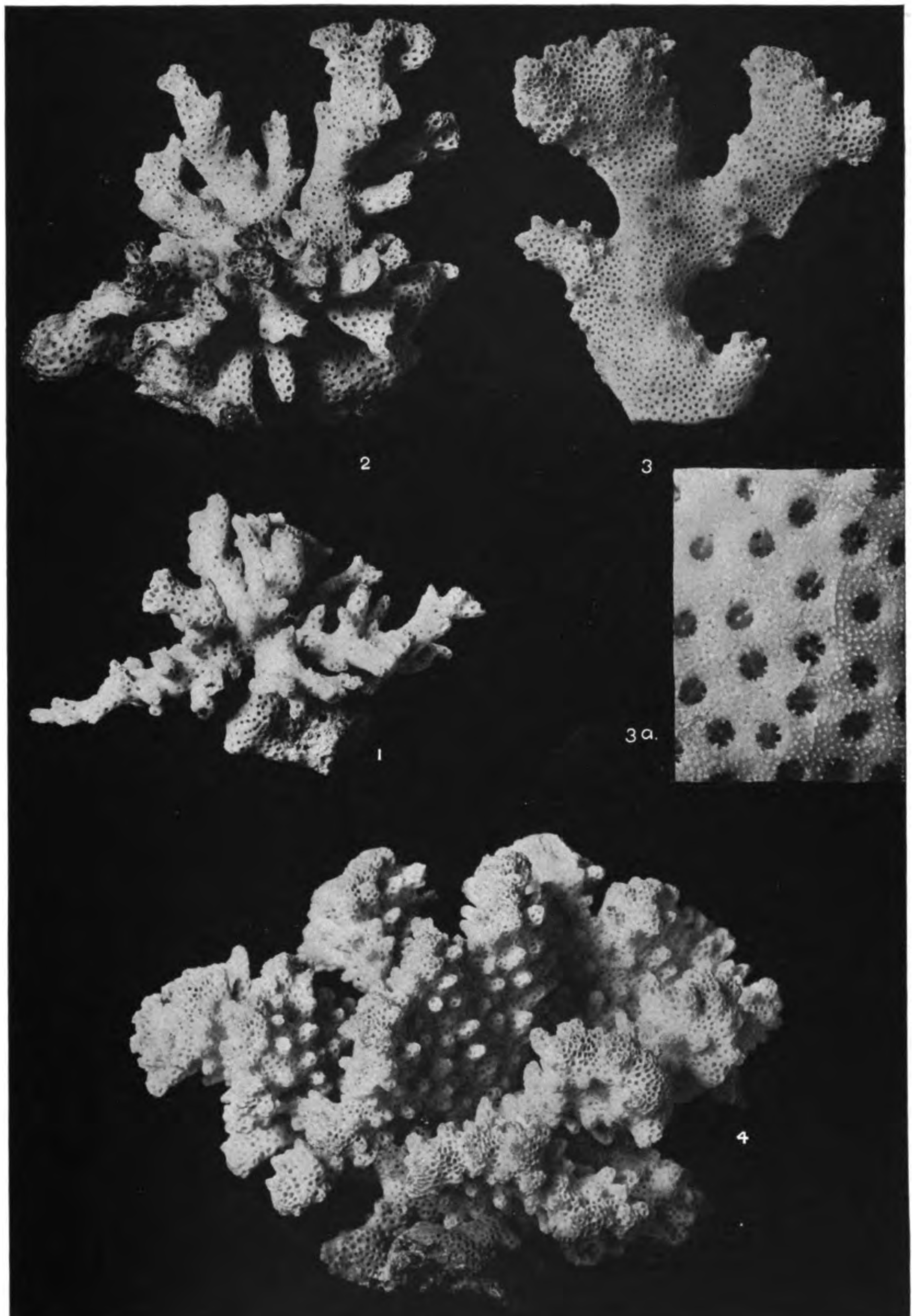

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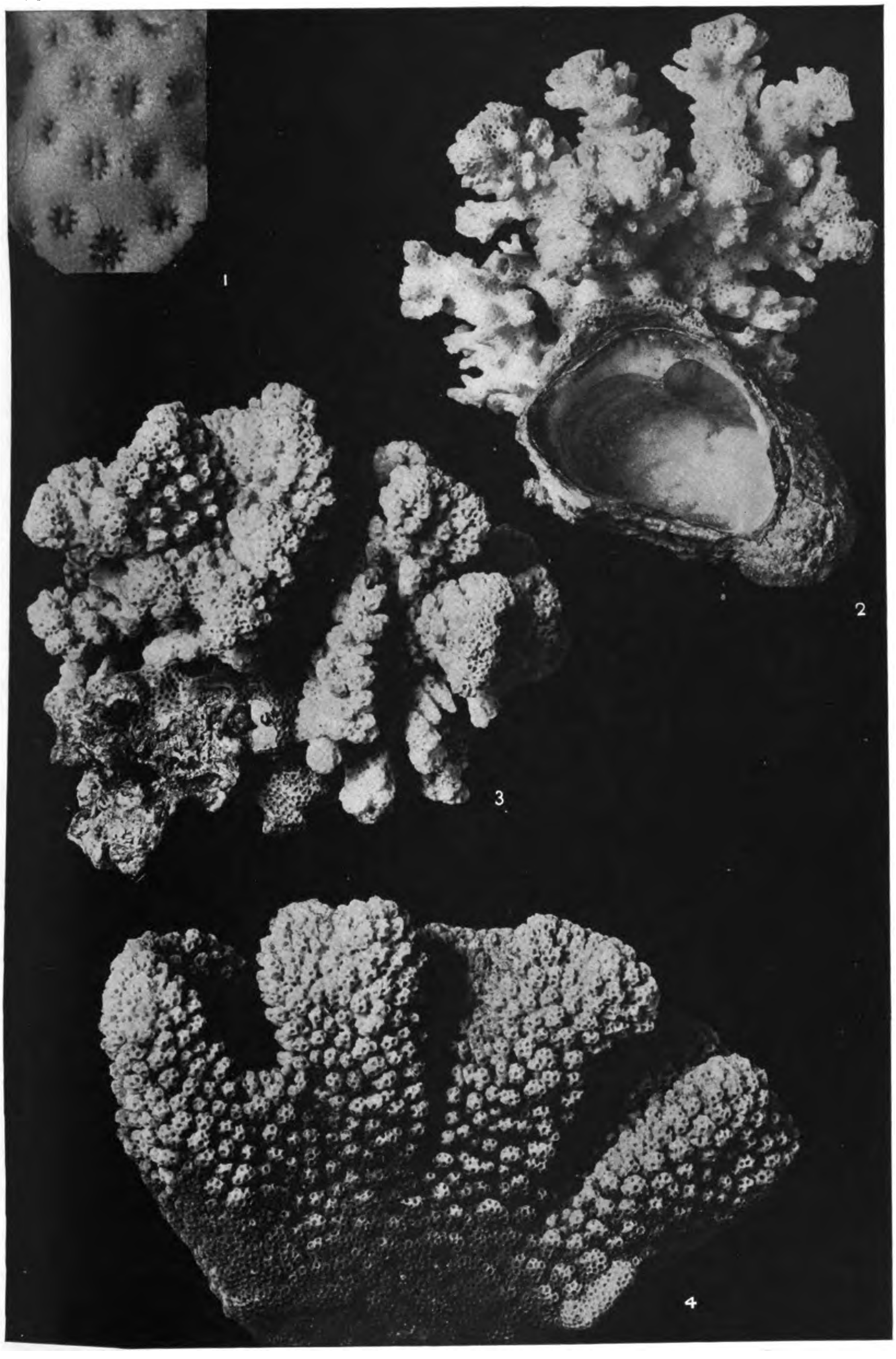
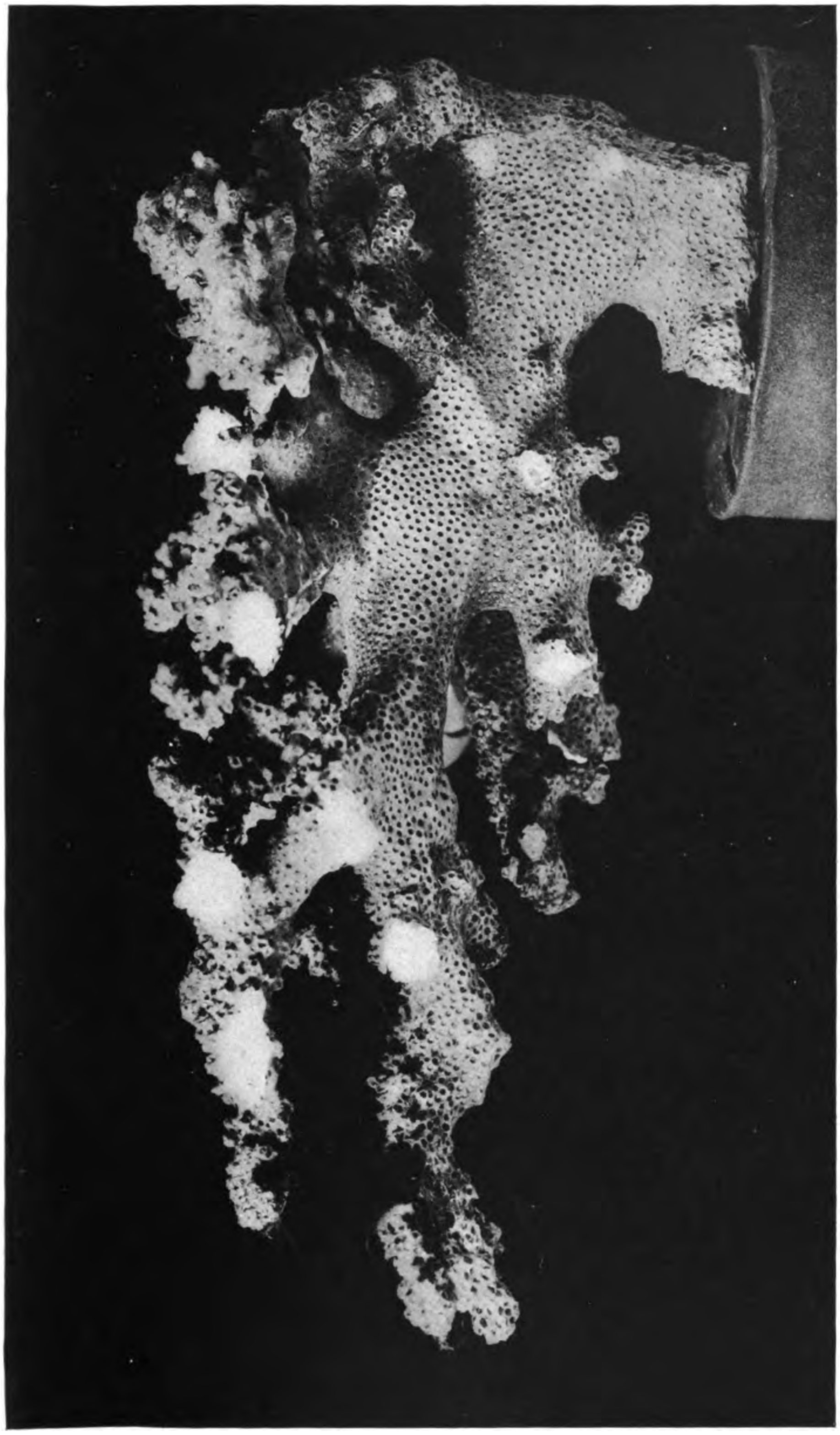


POCILLOPORA.

PLATE XV.

PLATE XV.



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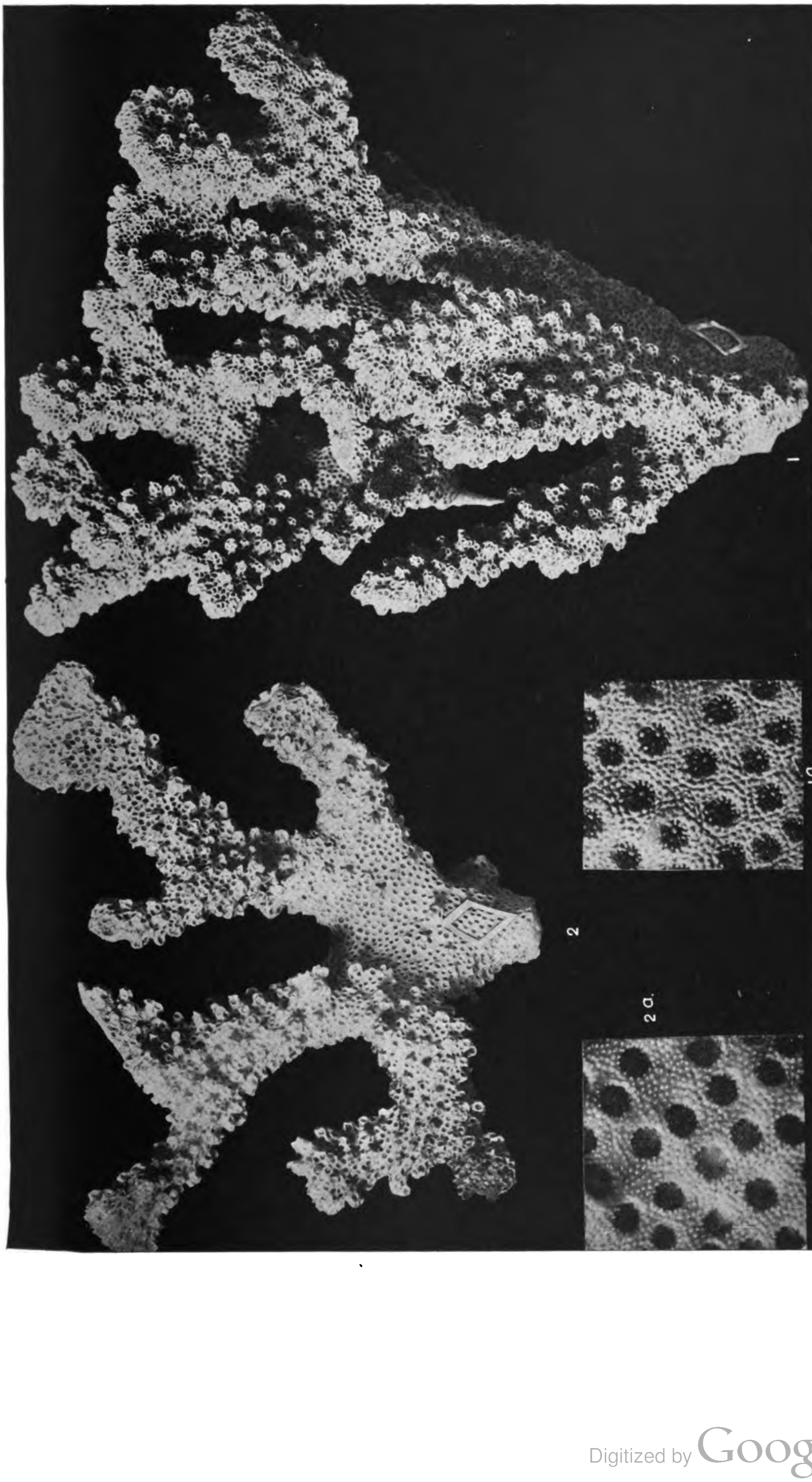

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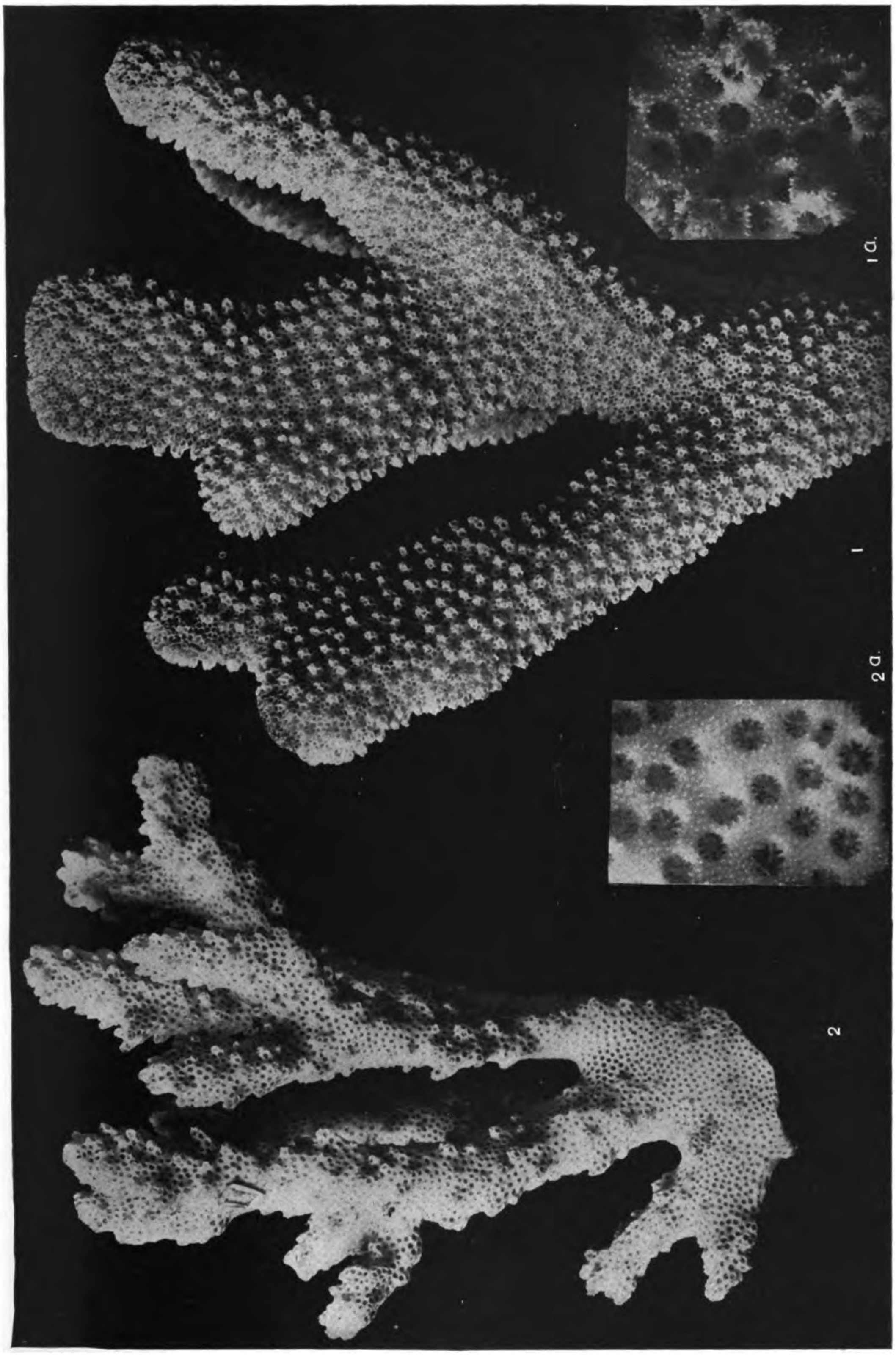

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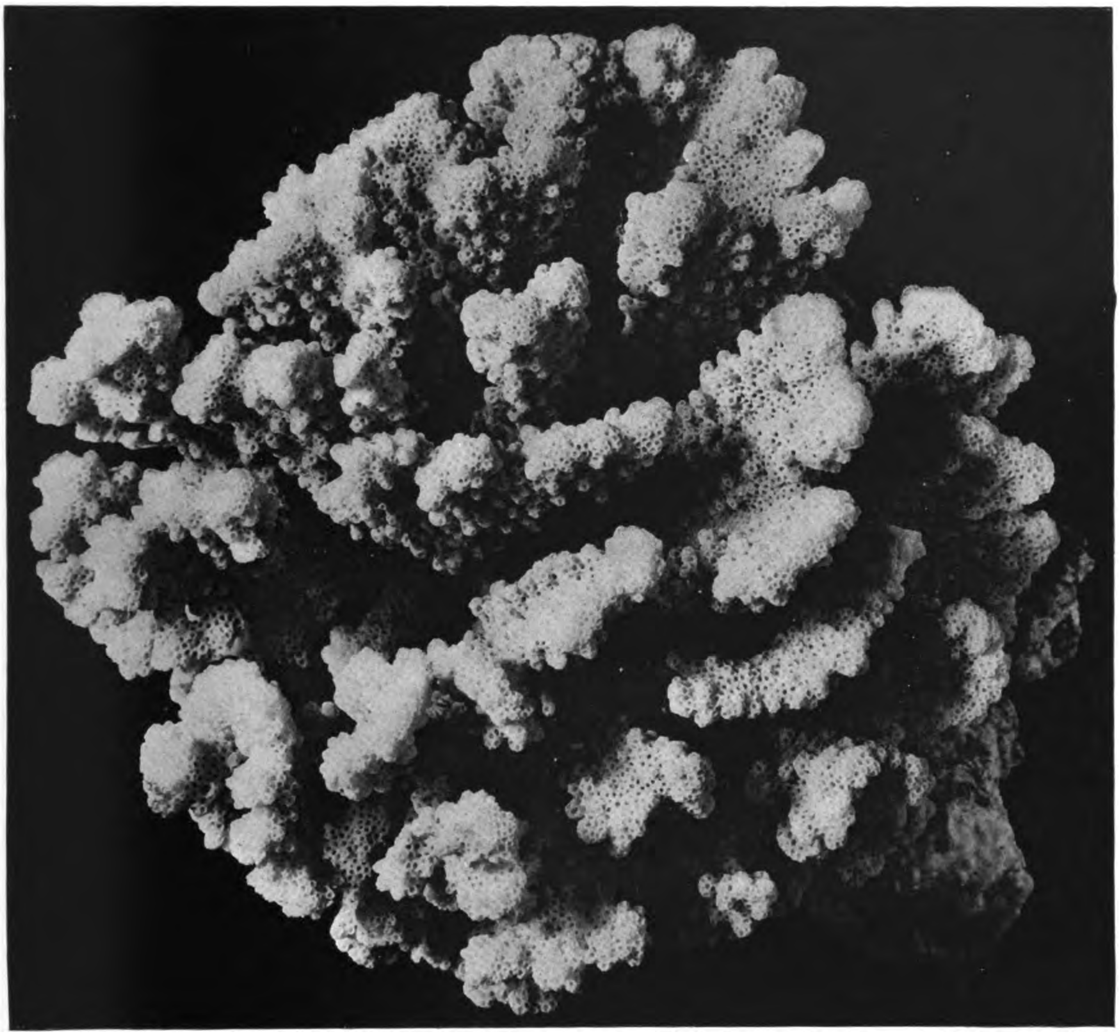

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PLATE XX.

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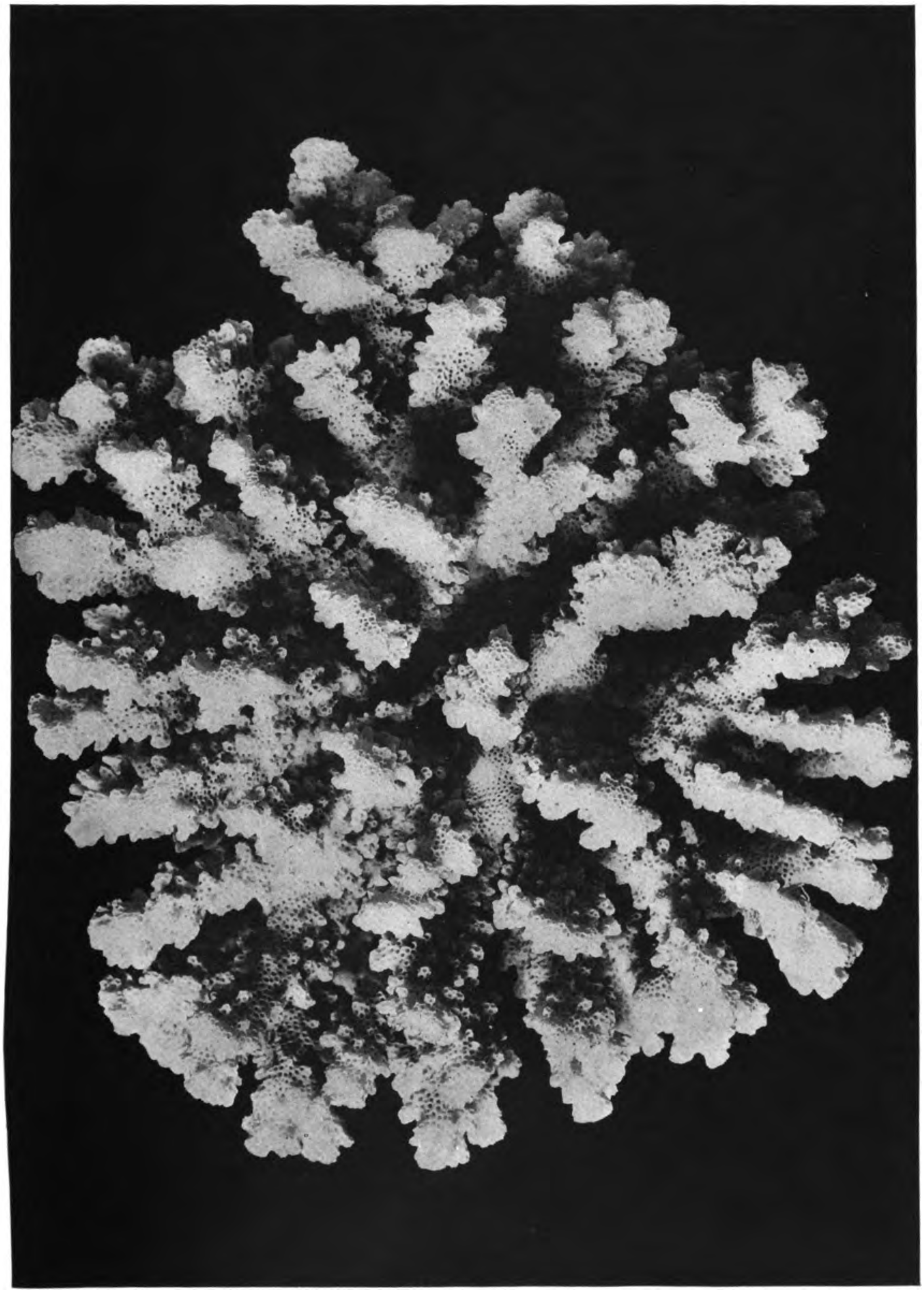
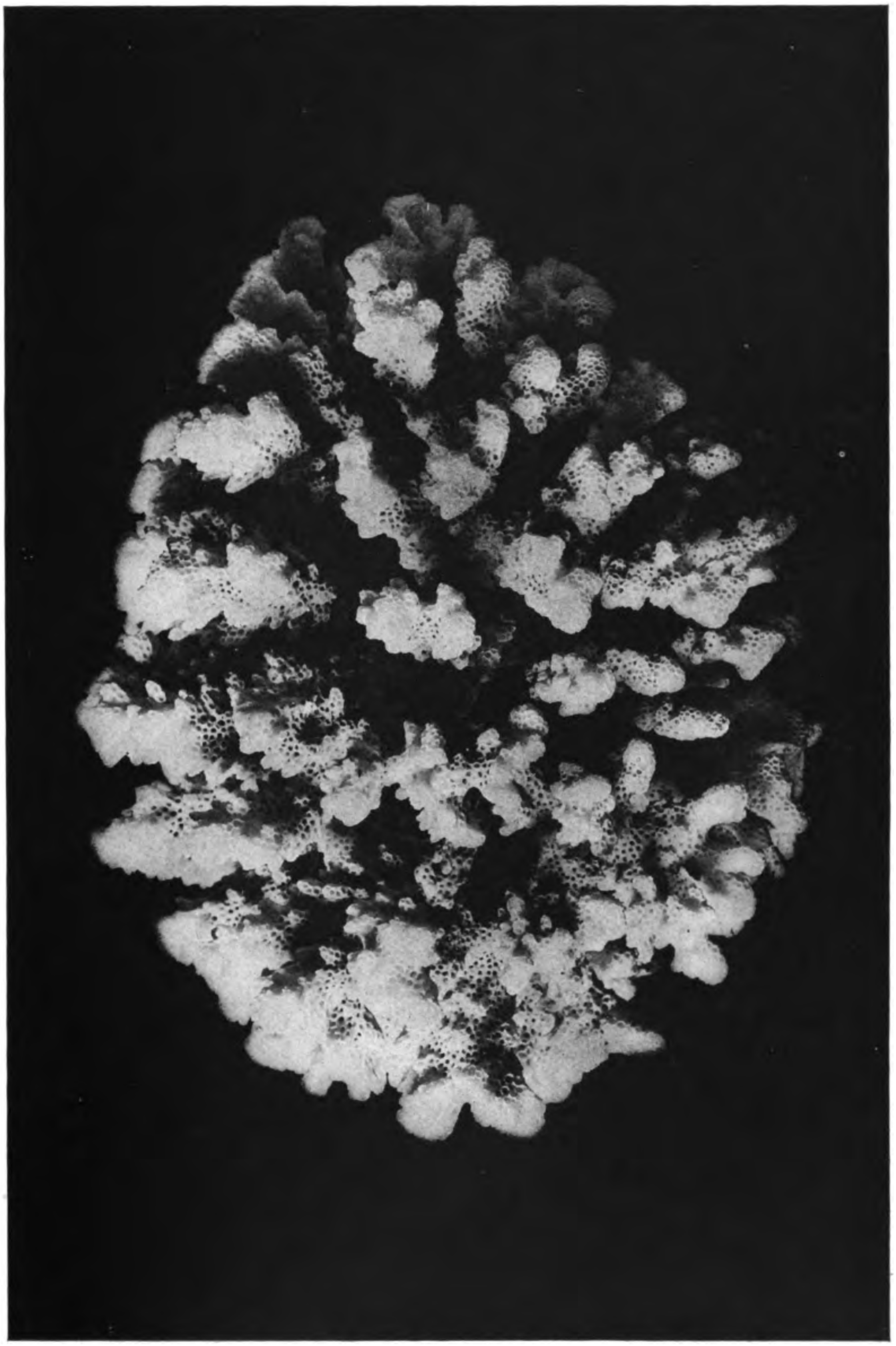


POCILLOPORA.

PLATE XXI.

PLATE XXI.

Pocillopora ligulata Dana.



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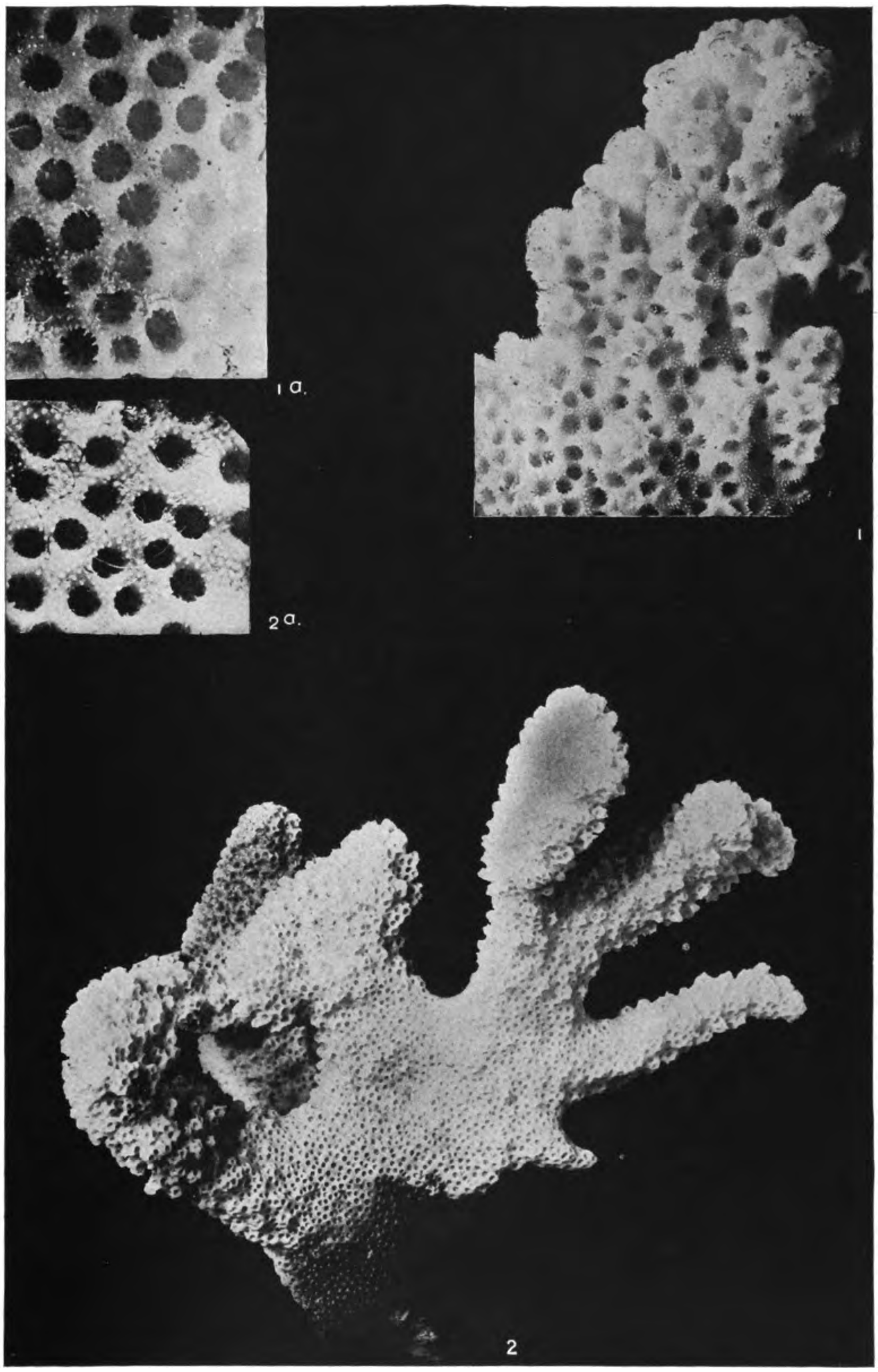
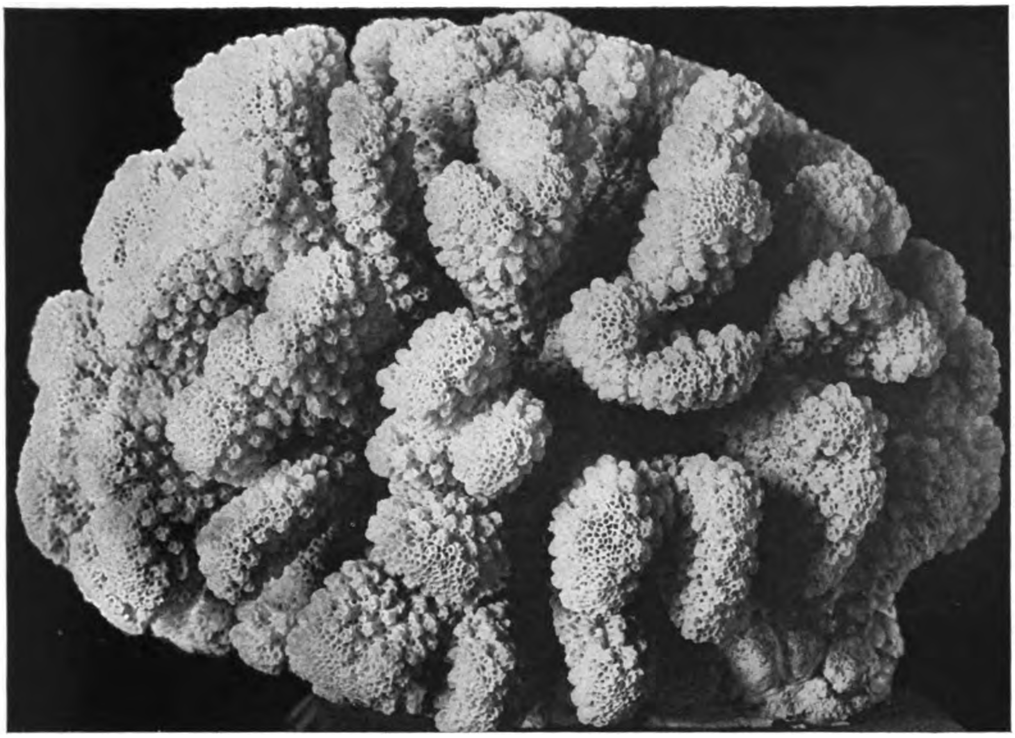


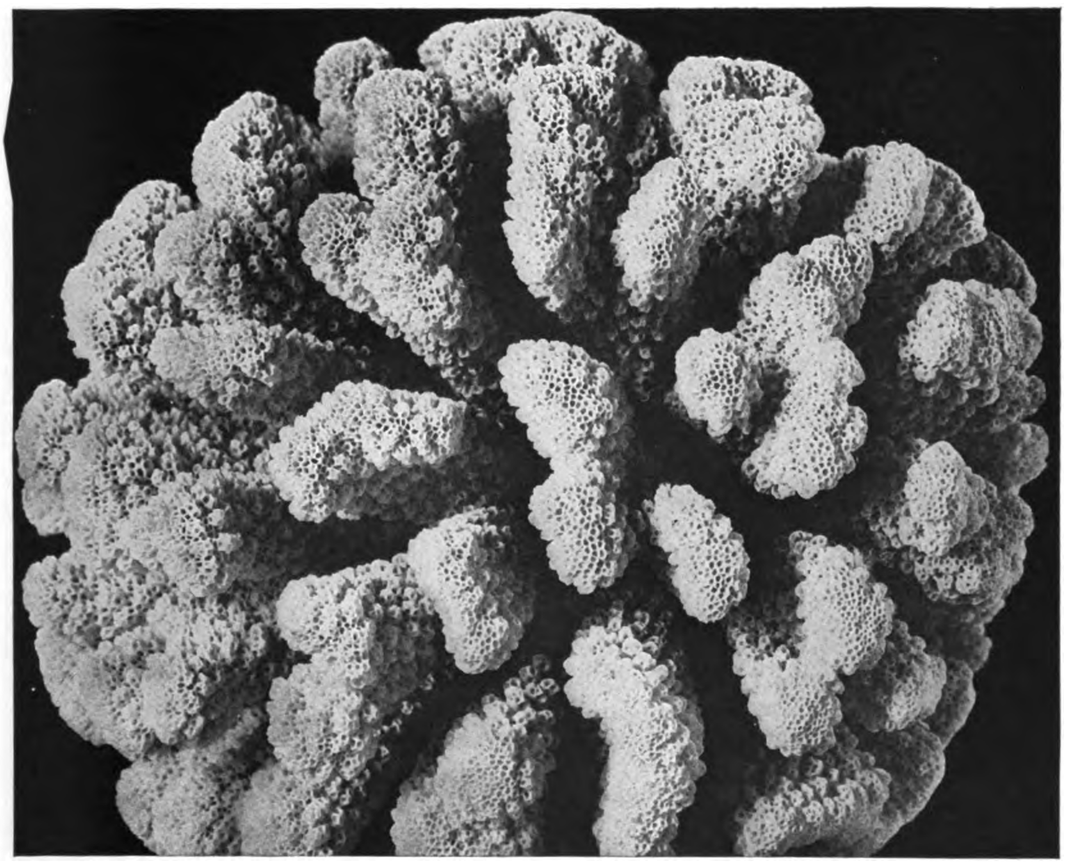
POCILLOPORA.

PLATE XXIII.

PLATE XXIII.

Pocillopora meandrina var. *nobilis* Verrill.





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POCILLOPORA.

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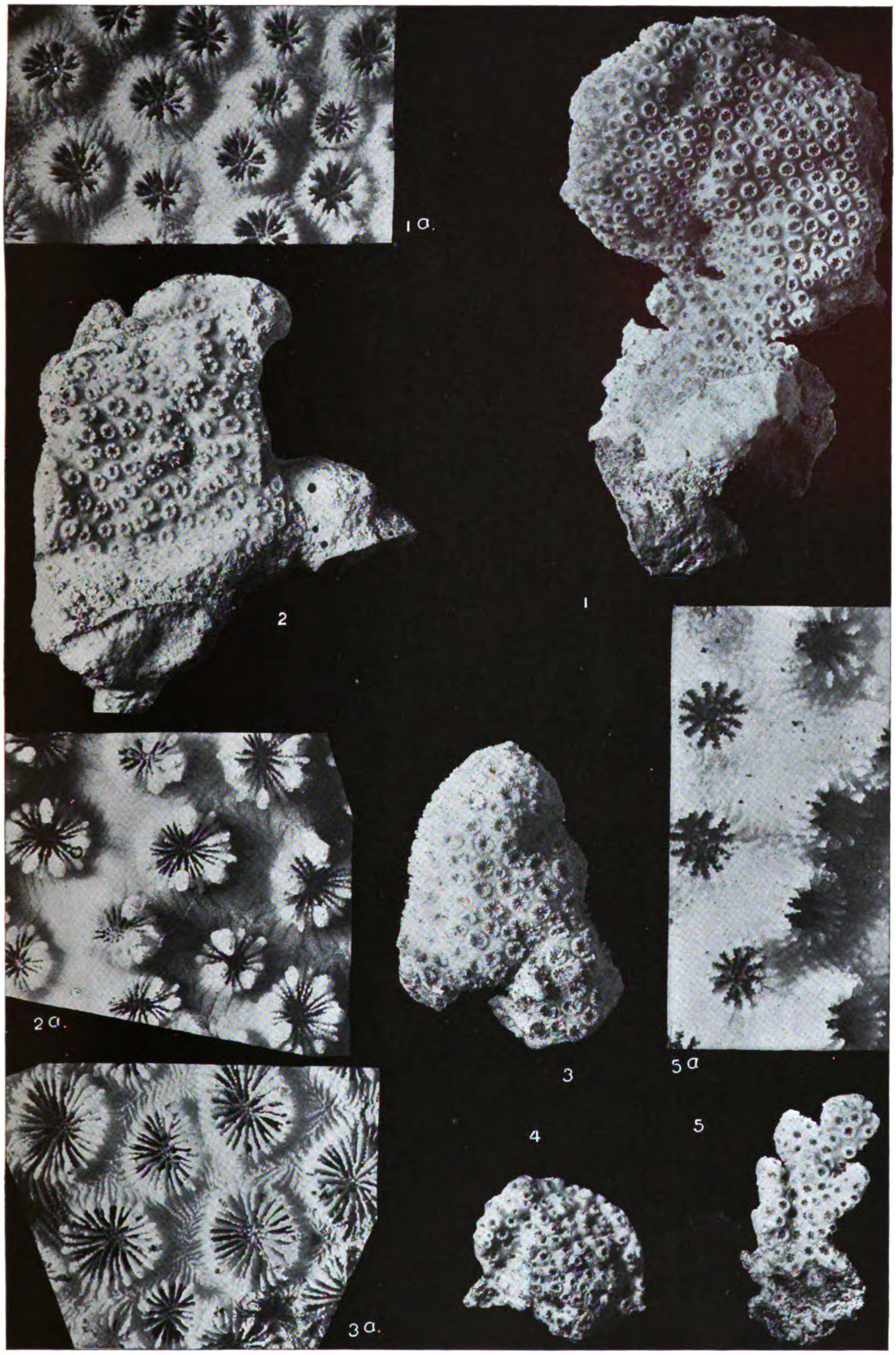

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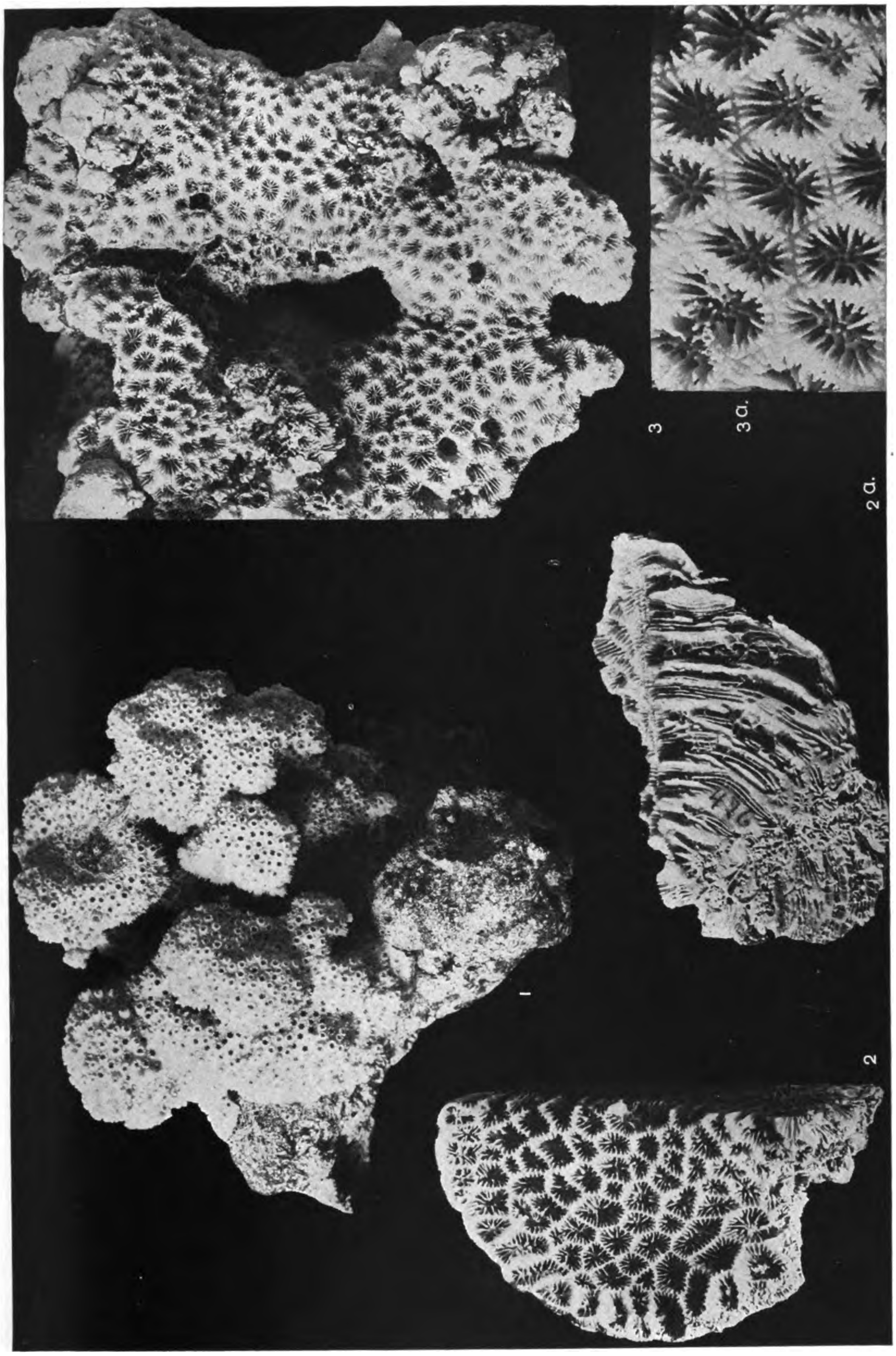

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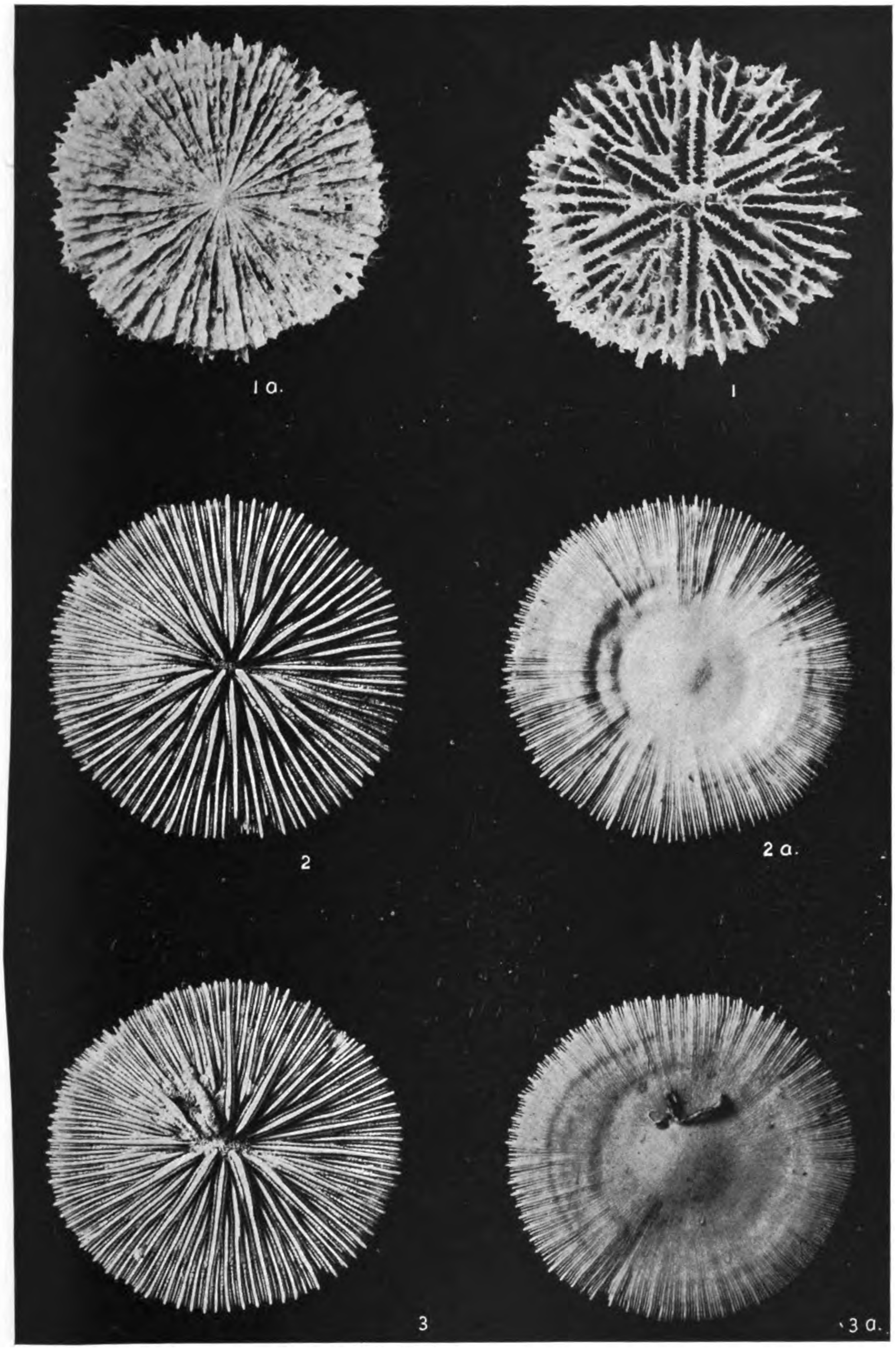

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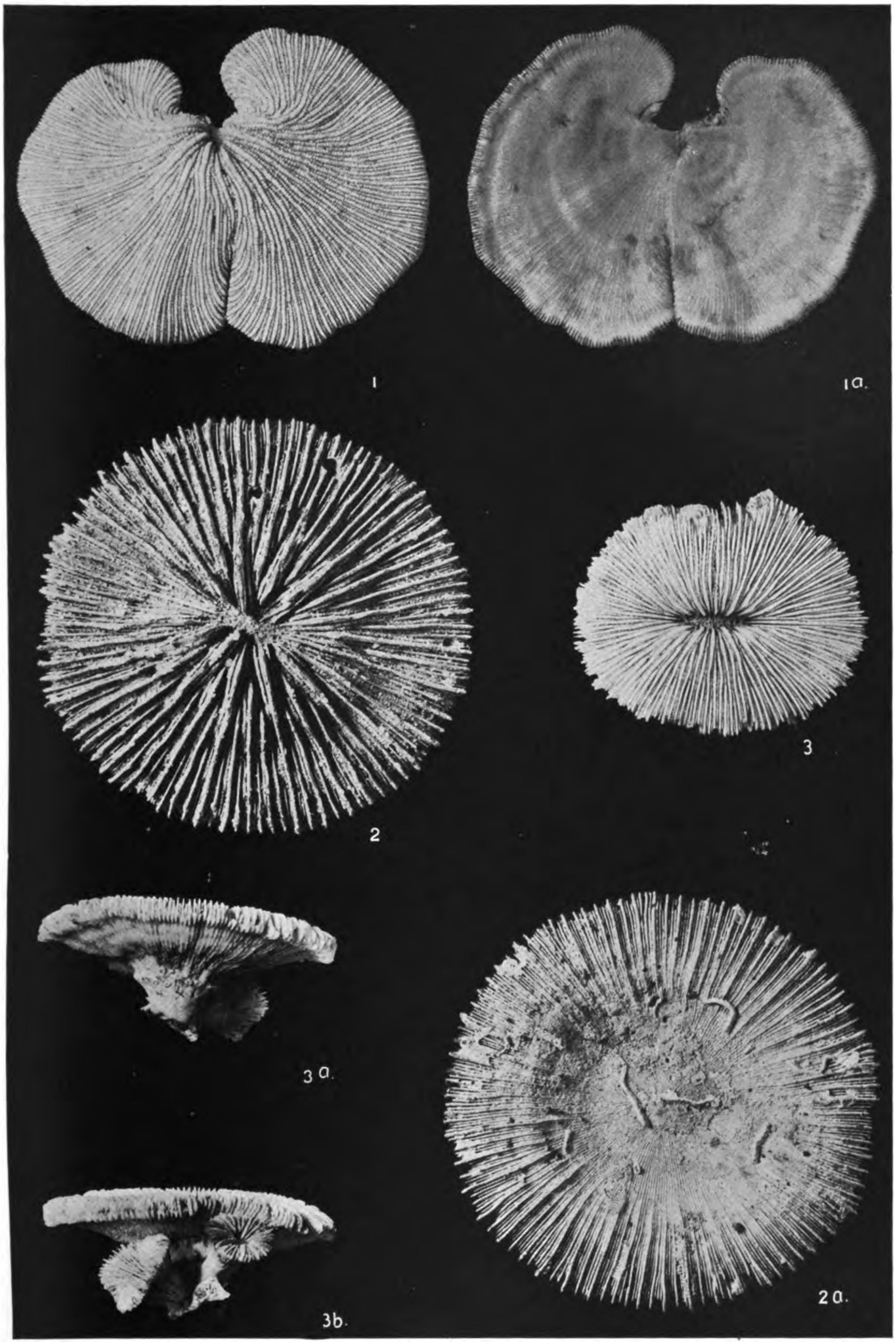

FUNGIA.

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FUNGIA.

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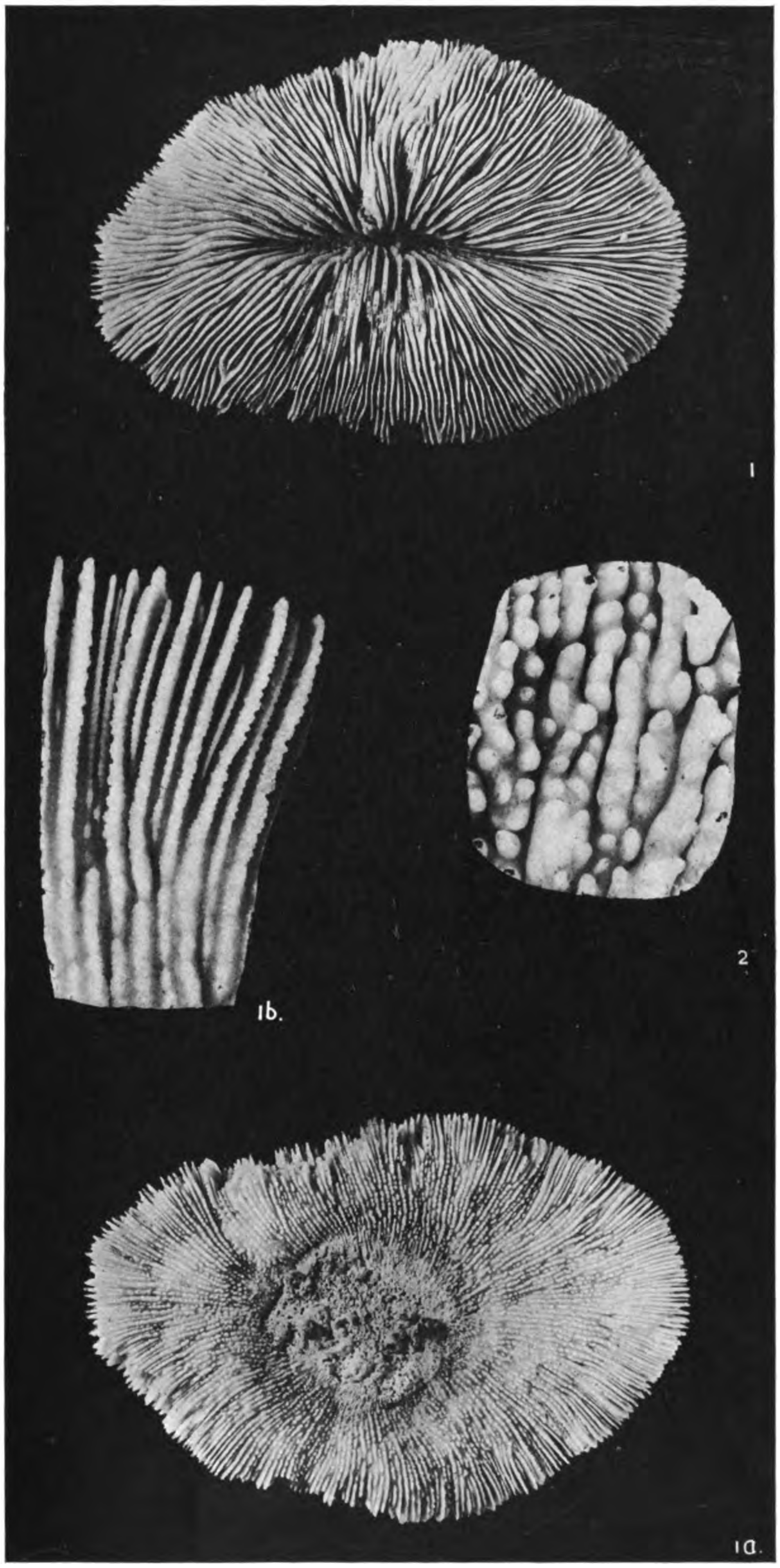
PLATE XXX.



FUNGIA.

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PLATE XXXI.

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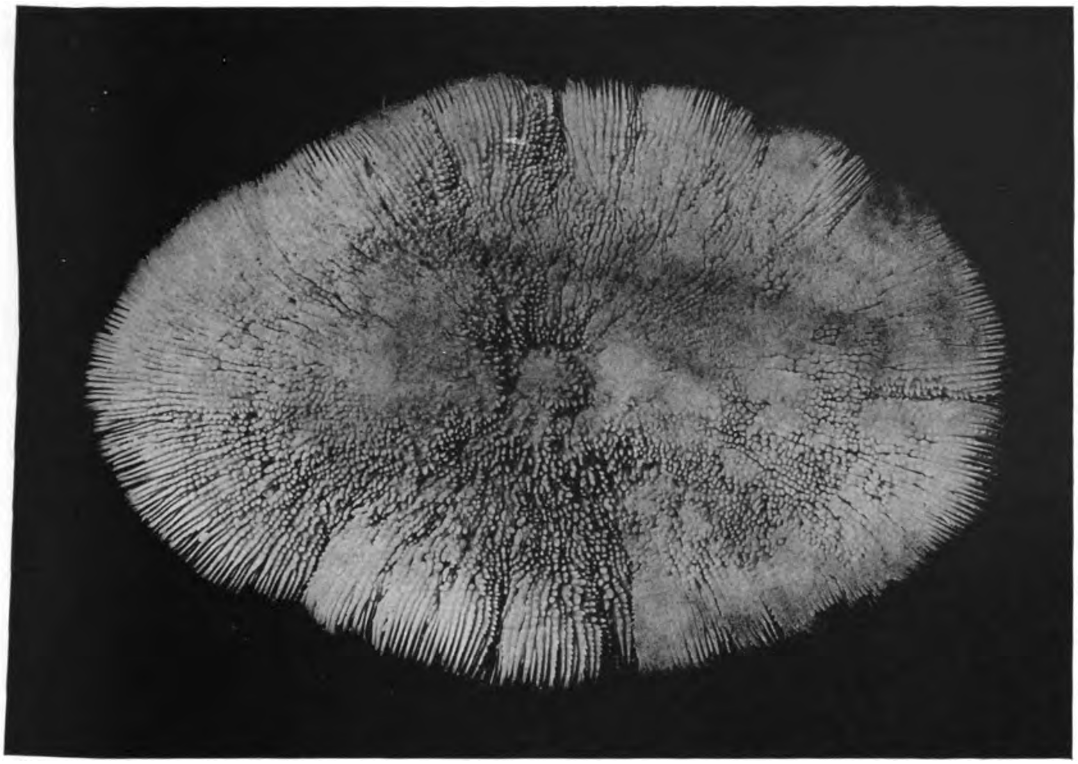

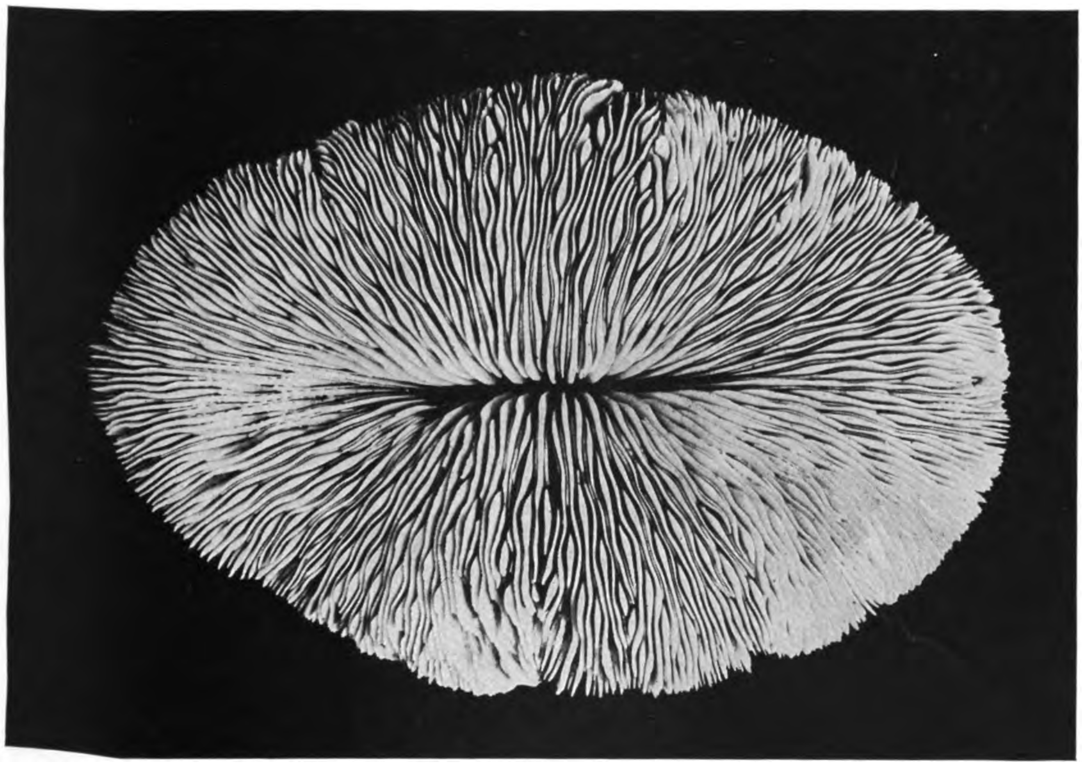

FUNGIA.

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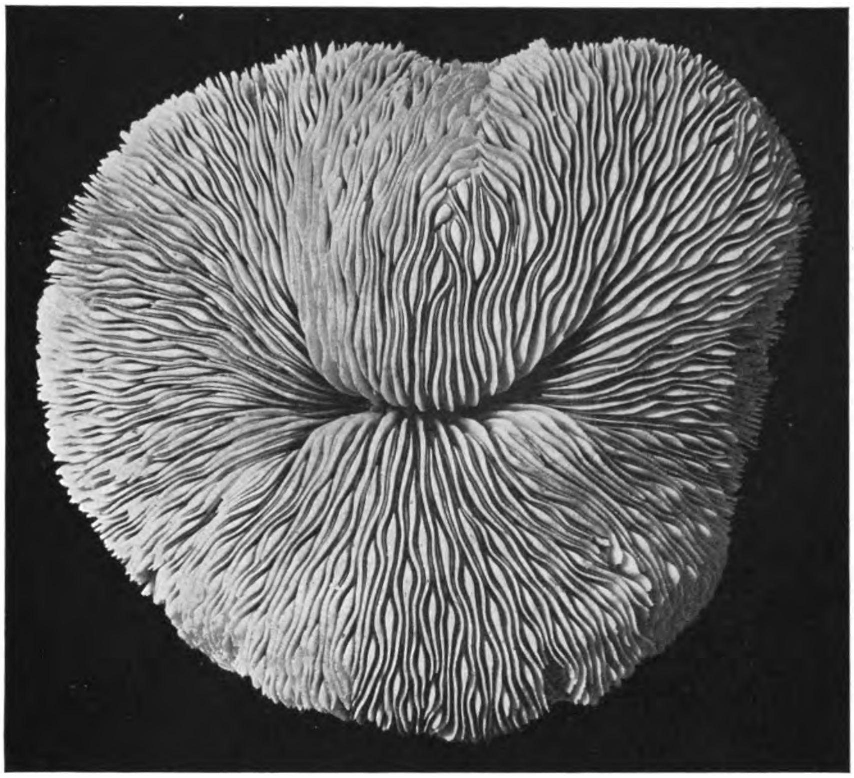

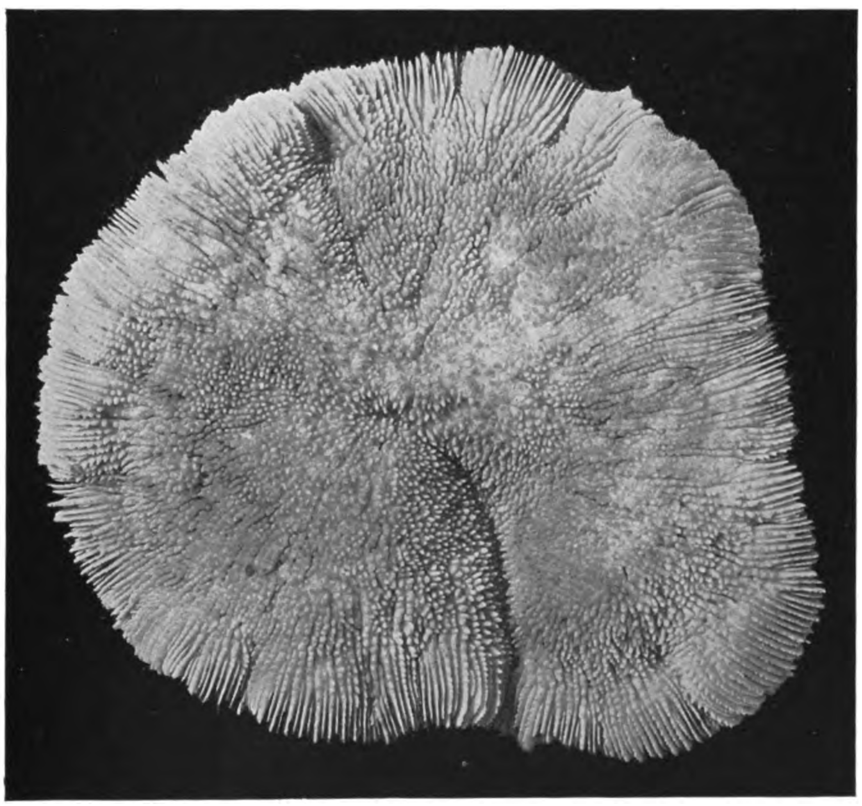

FUNGIA.

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PLATE XXXIII.

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Fungia oahensis Döderlein.

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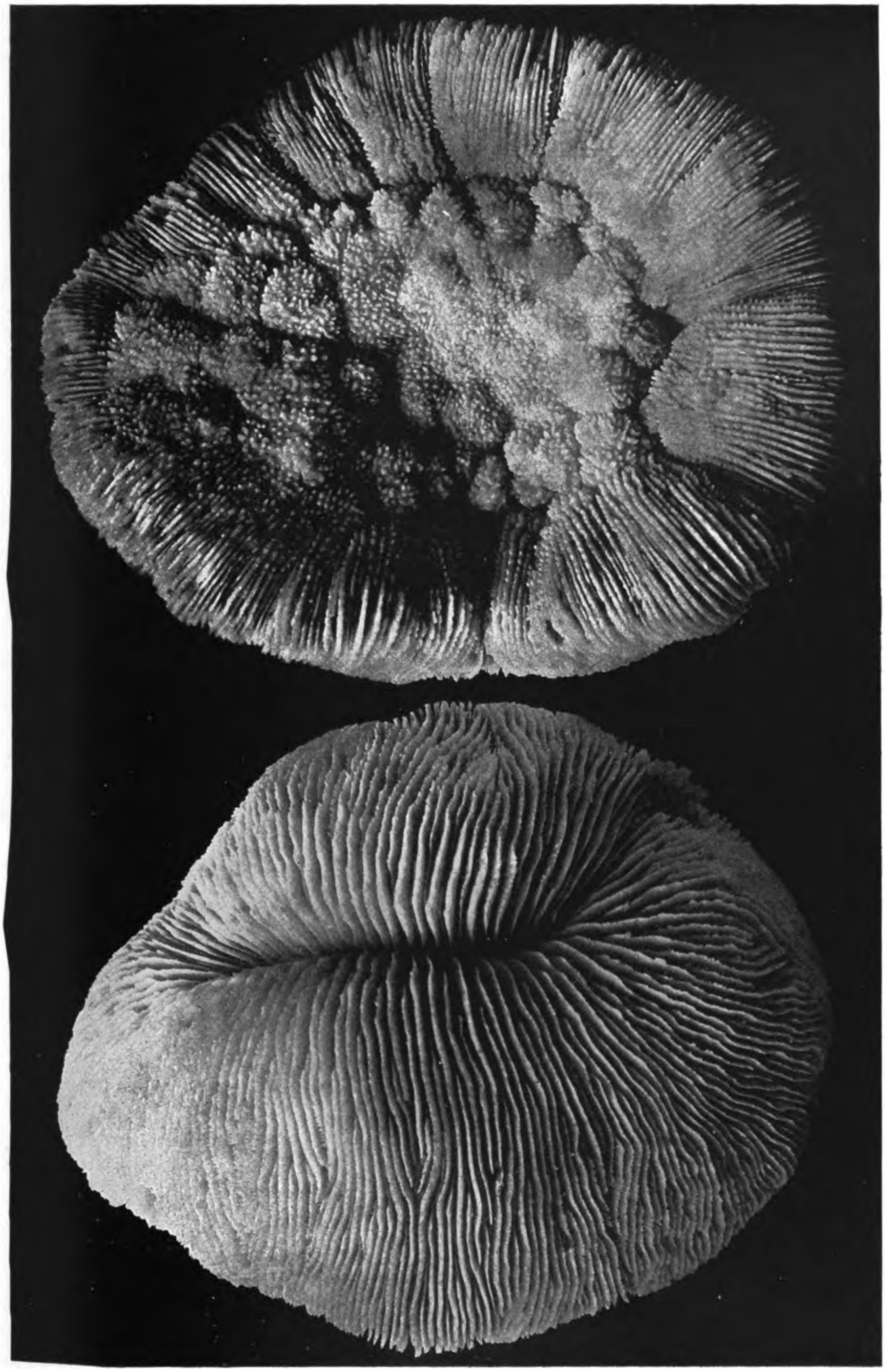

FUNGIA.

PLATE XXXV.

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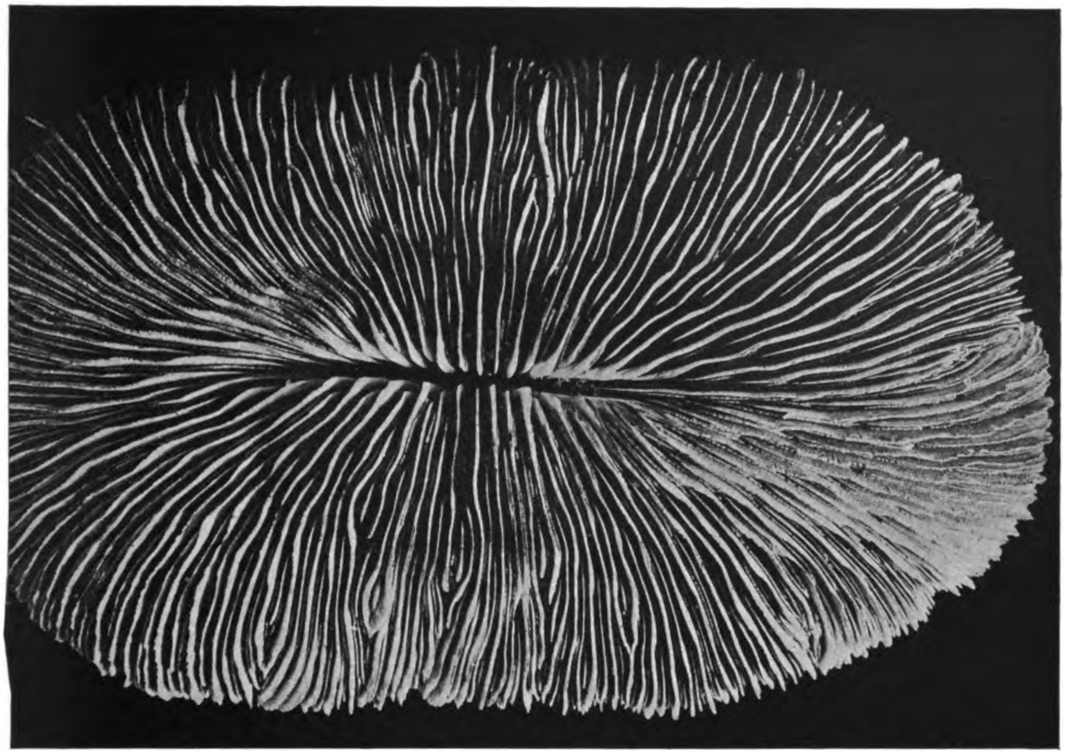

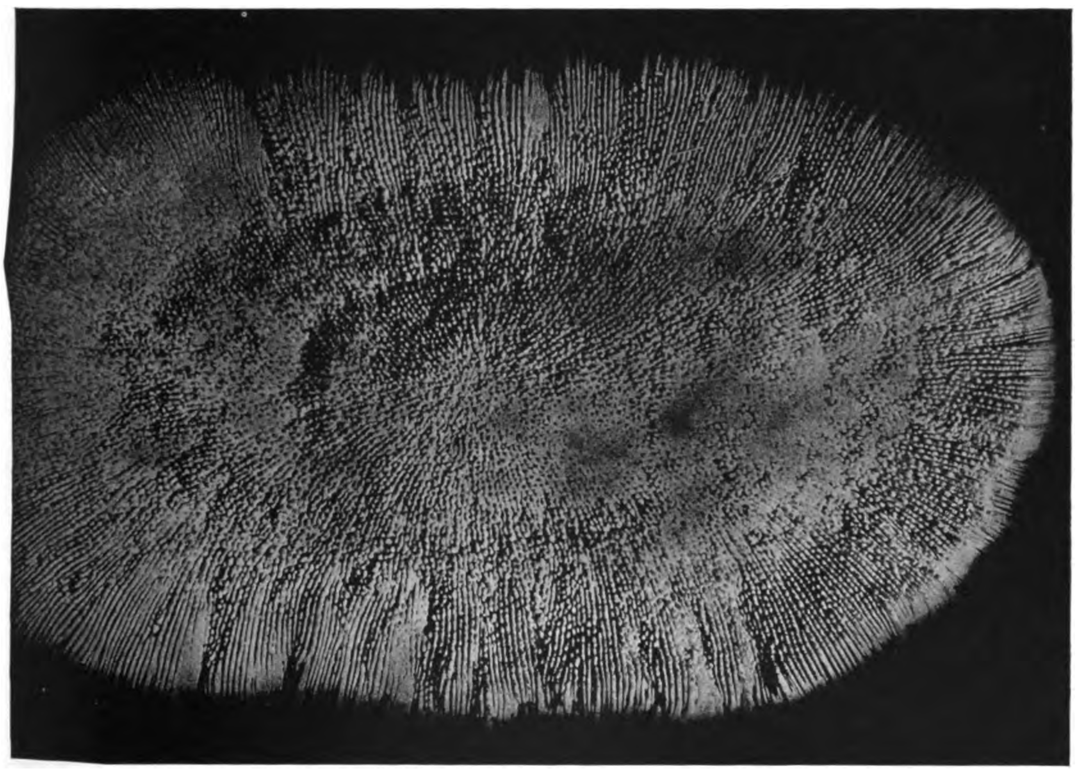

FUNGIA.

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PLATE XXXVI.

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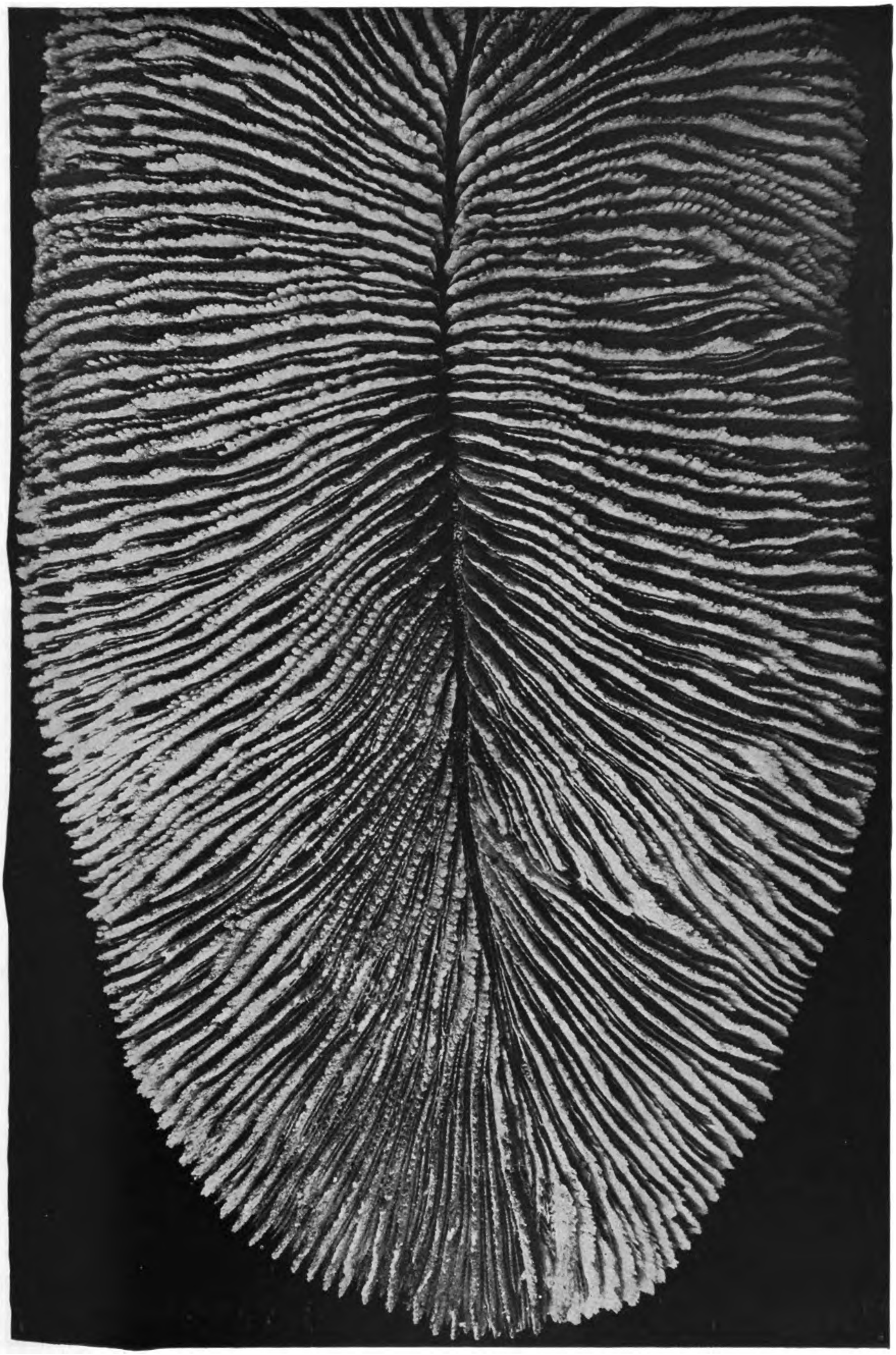

FUNGIA.

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PLATE XXXVII.

Fungia echinata (Pallas).

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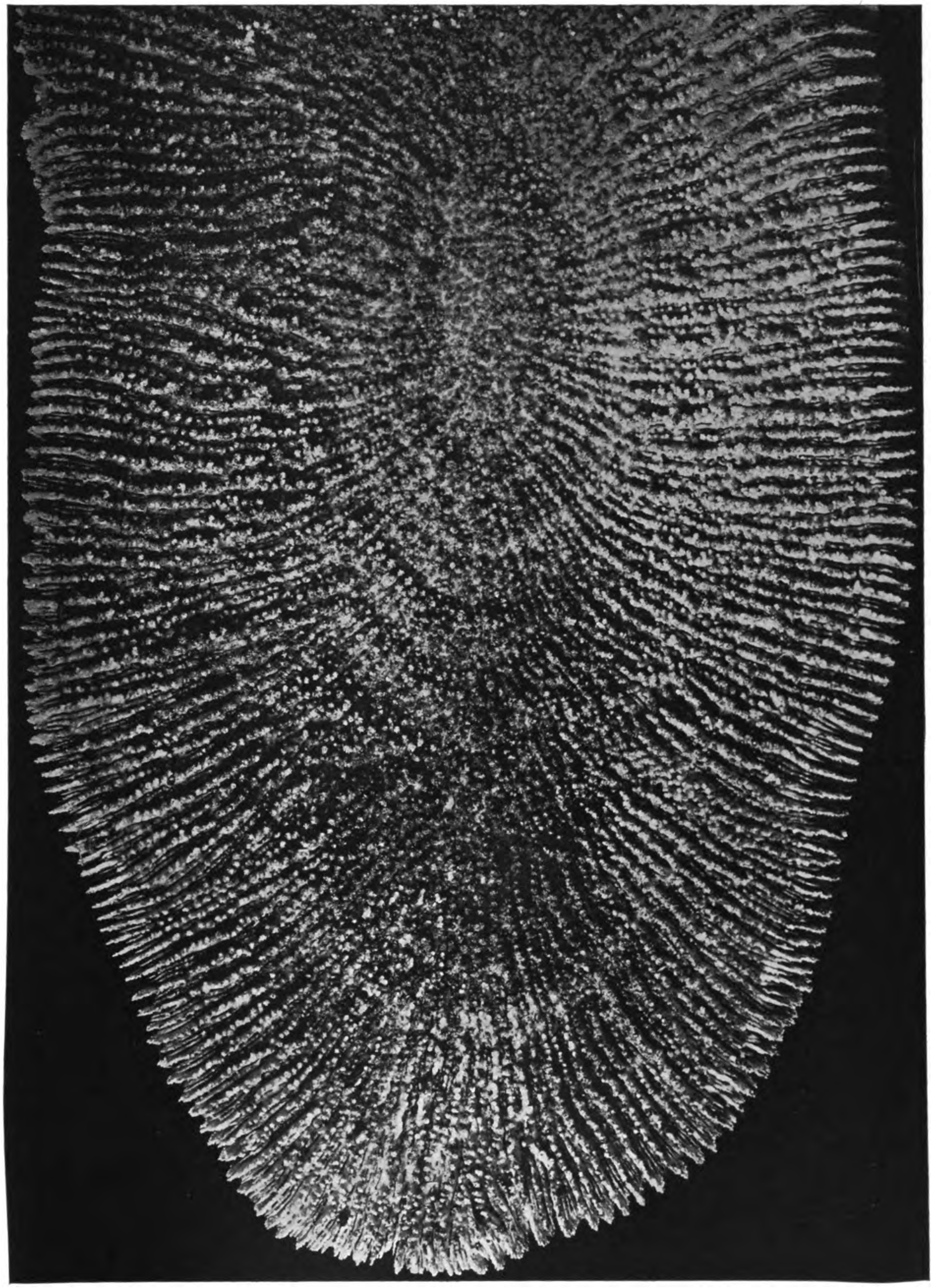

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PLATE XXXVIII.

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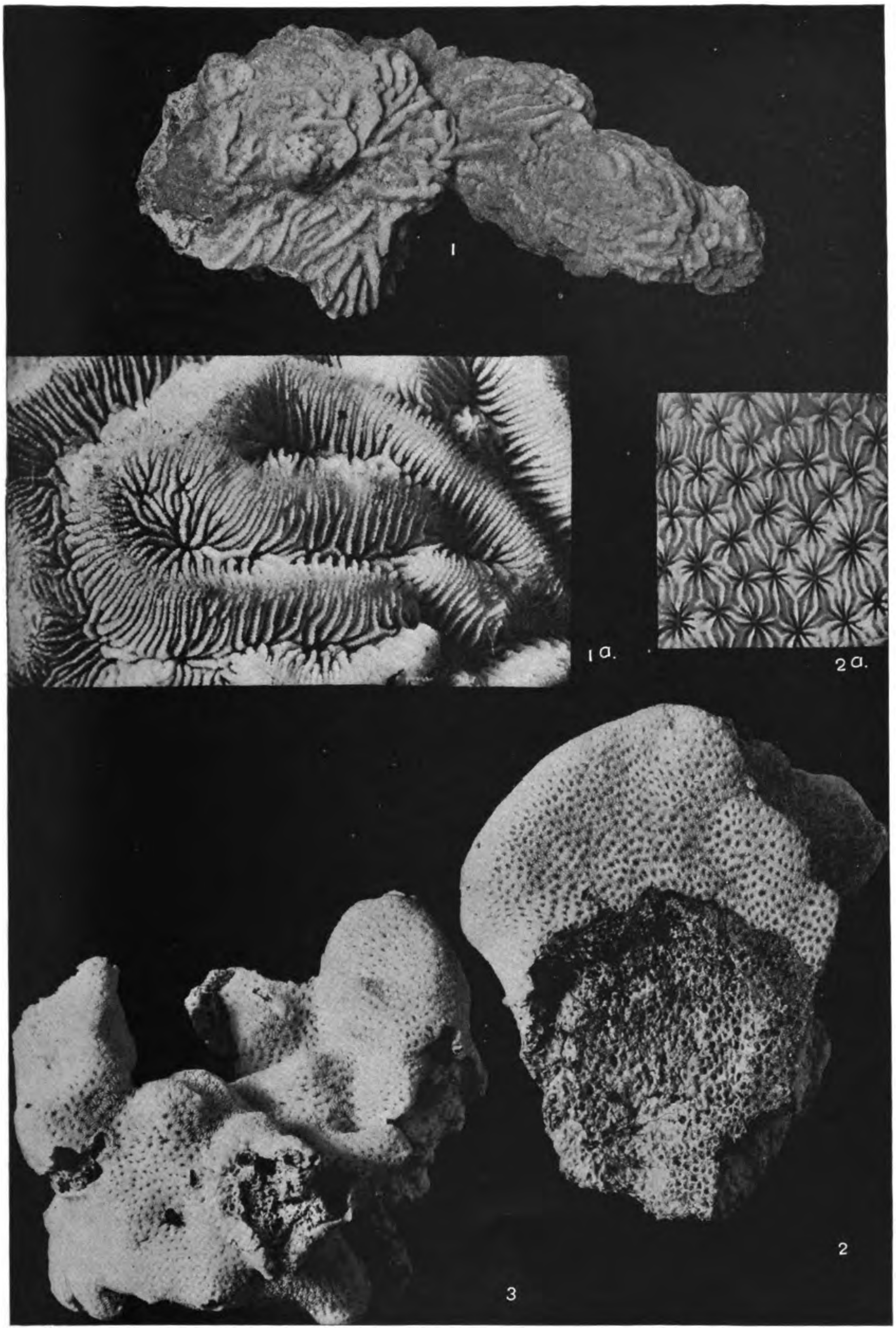

PAVONA.

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PLATE XXXIX.

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LEPTOSERIS.

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PLATE XL.

Leptoseris hawaiiensis, new species.

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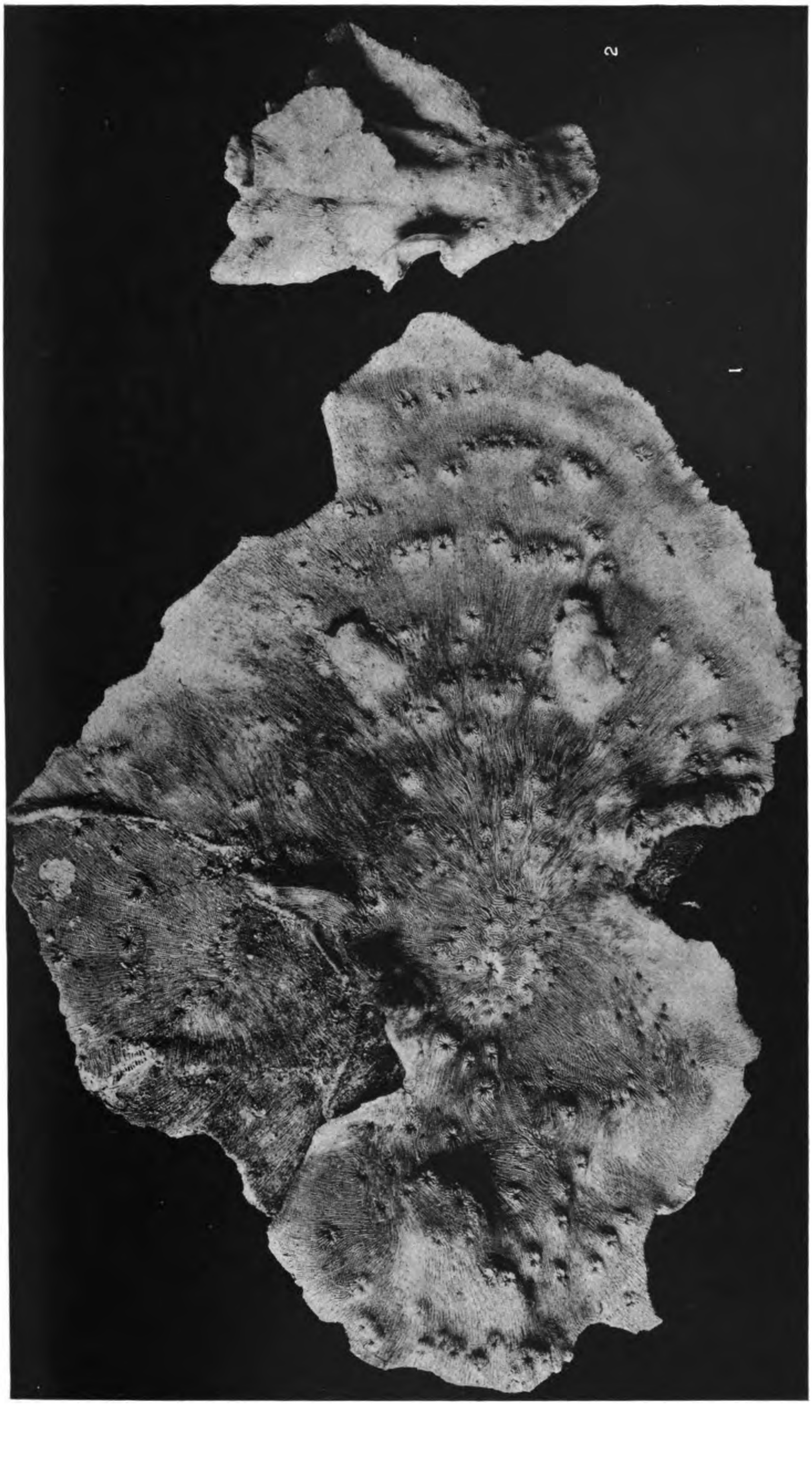

LEPTOSERIS.

PLATE XLI.

PLATE XLI.

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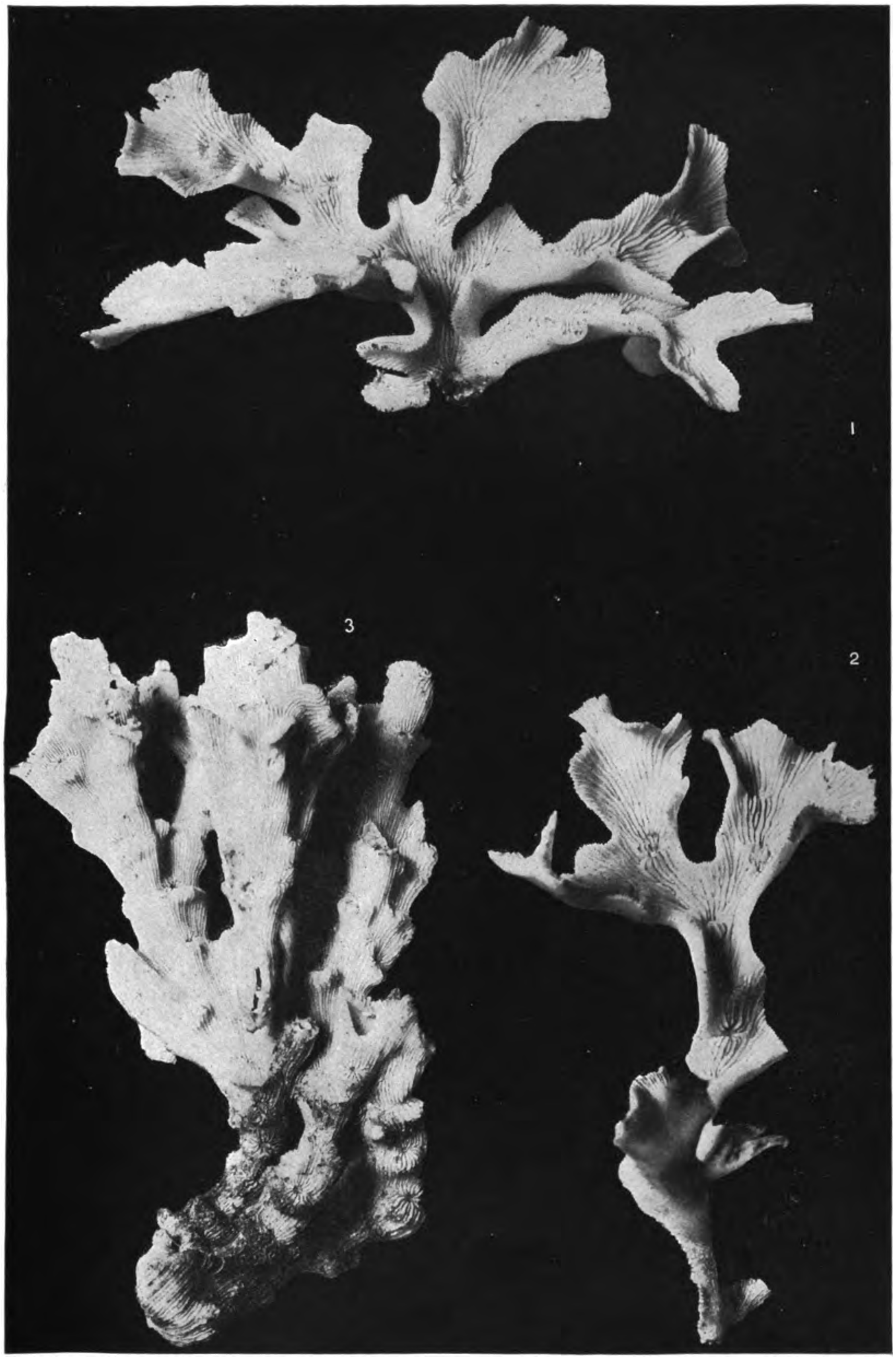

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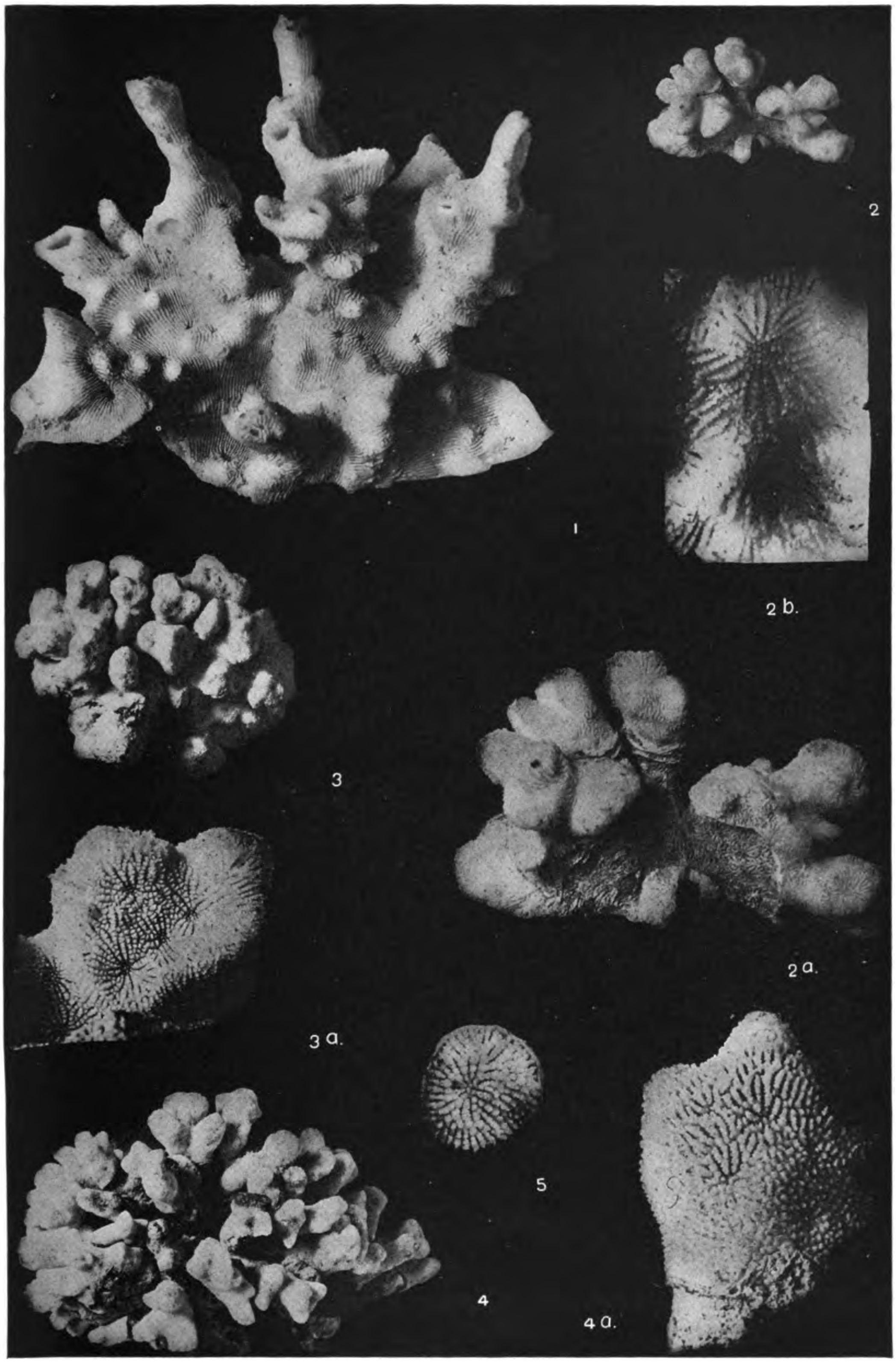

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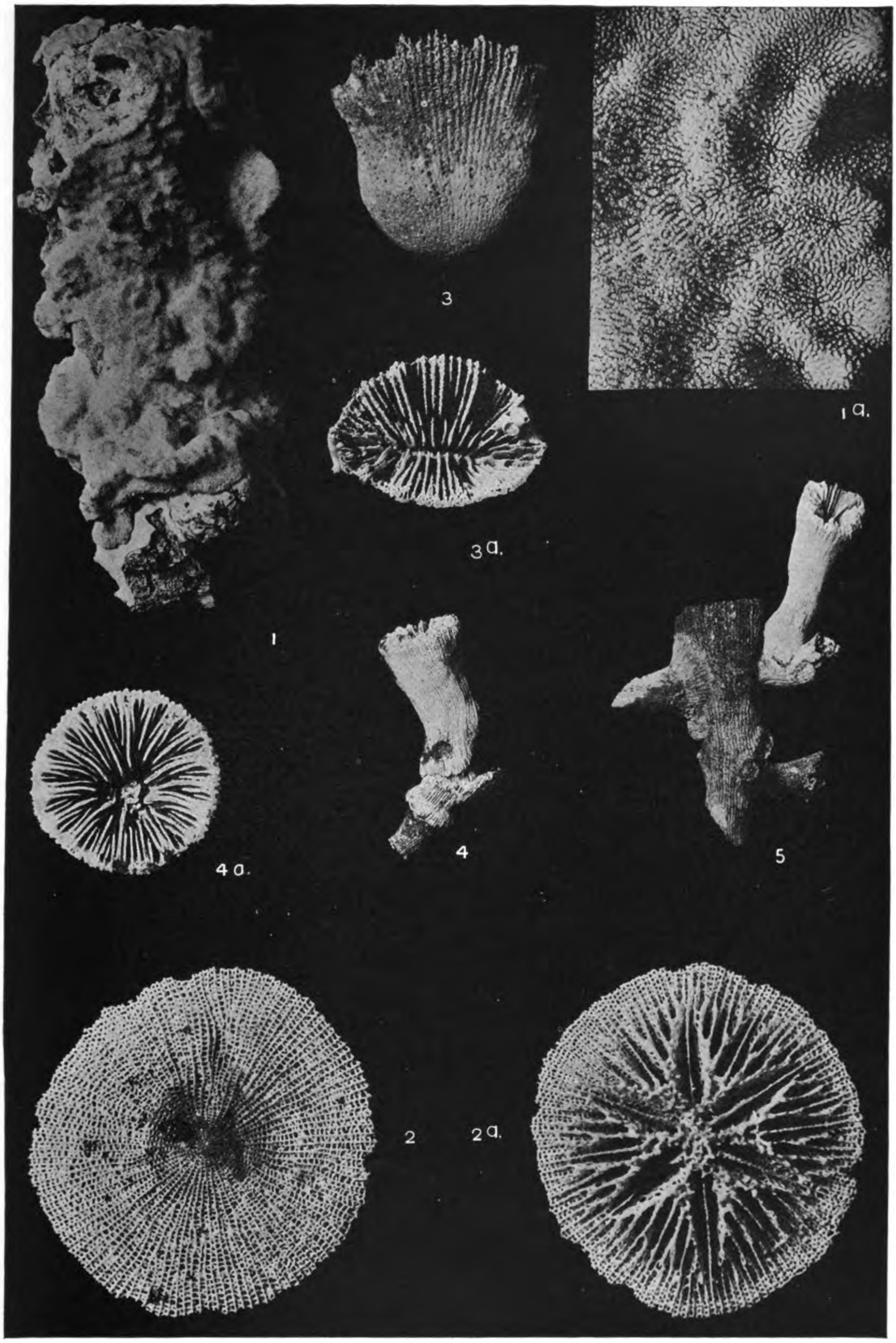

PSAMMOCORA, STEPHANOPHYLLIA, ENDOPACHYS, BALANOPHYLLIA.

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PLATE XLV.

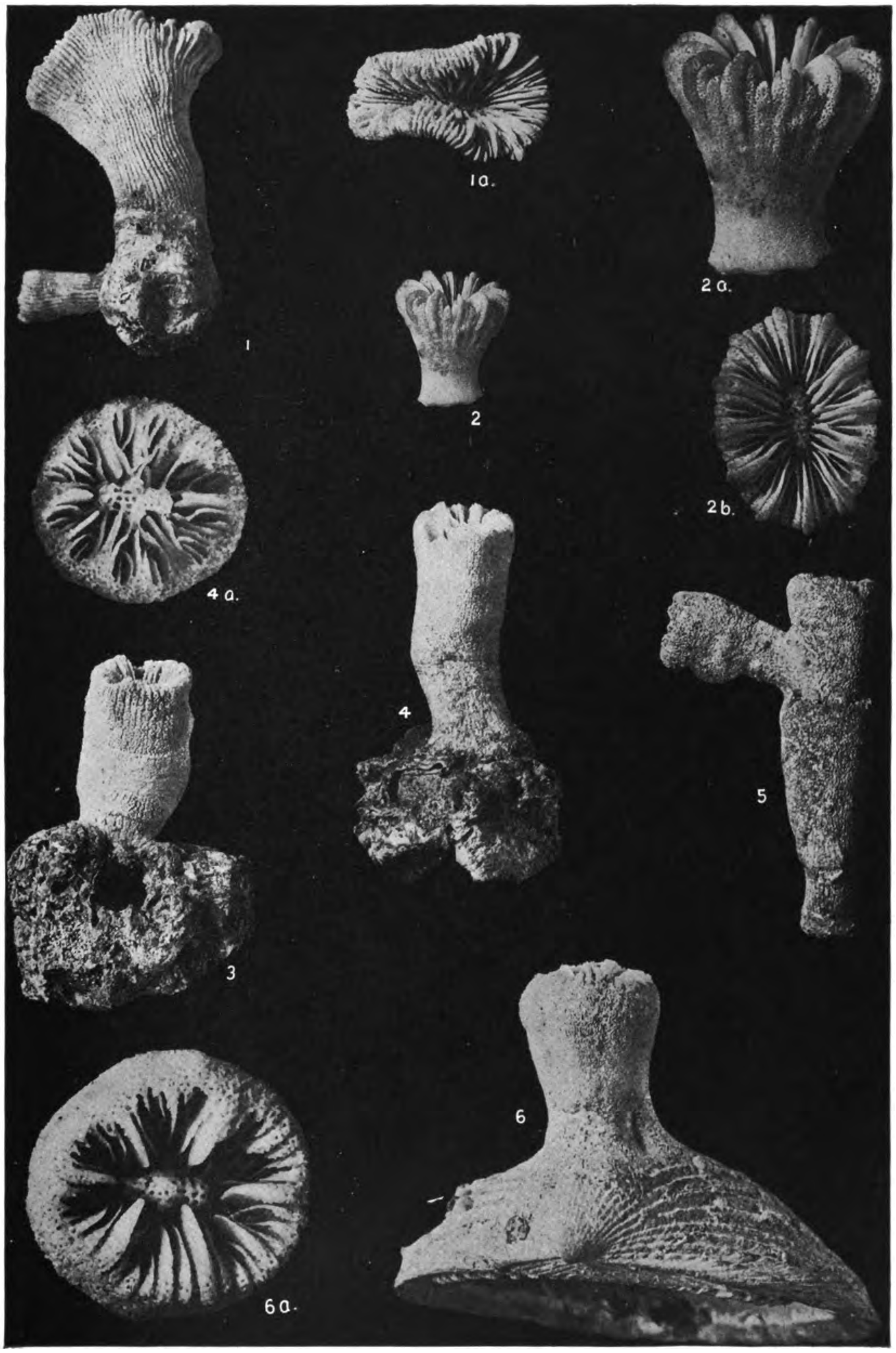

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PLATE XLVI.

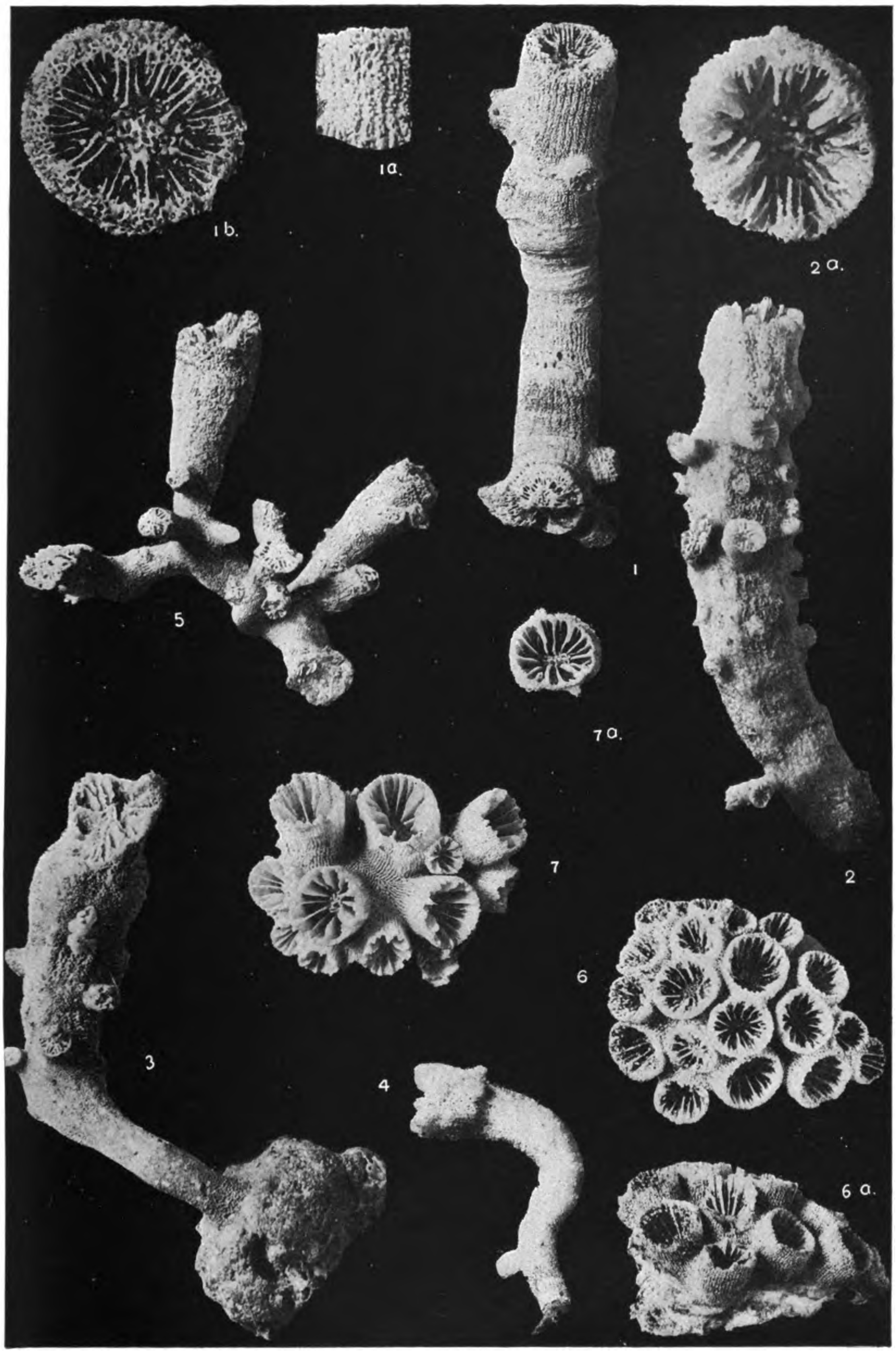

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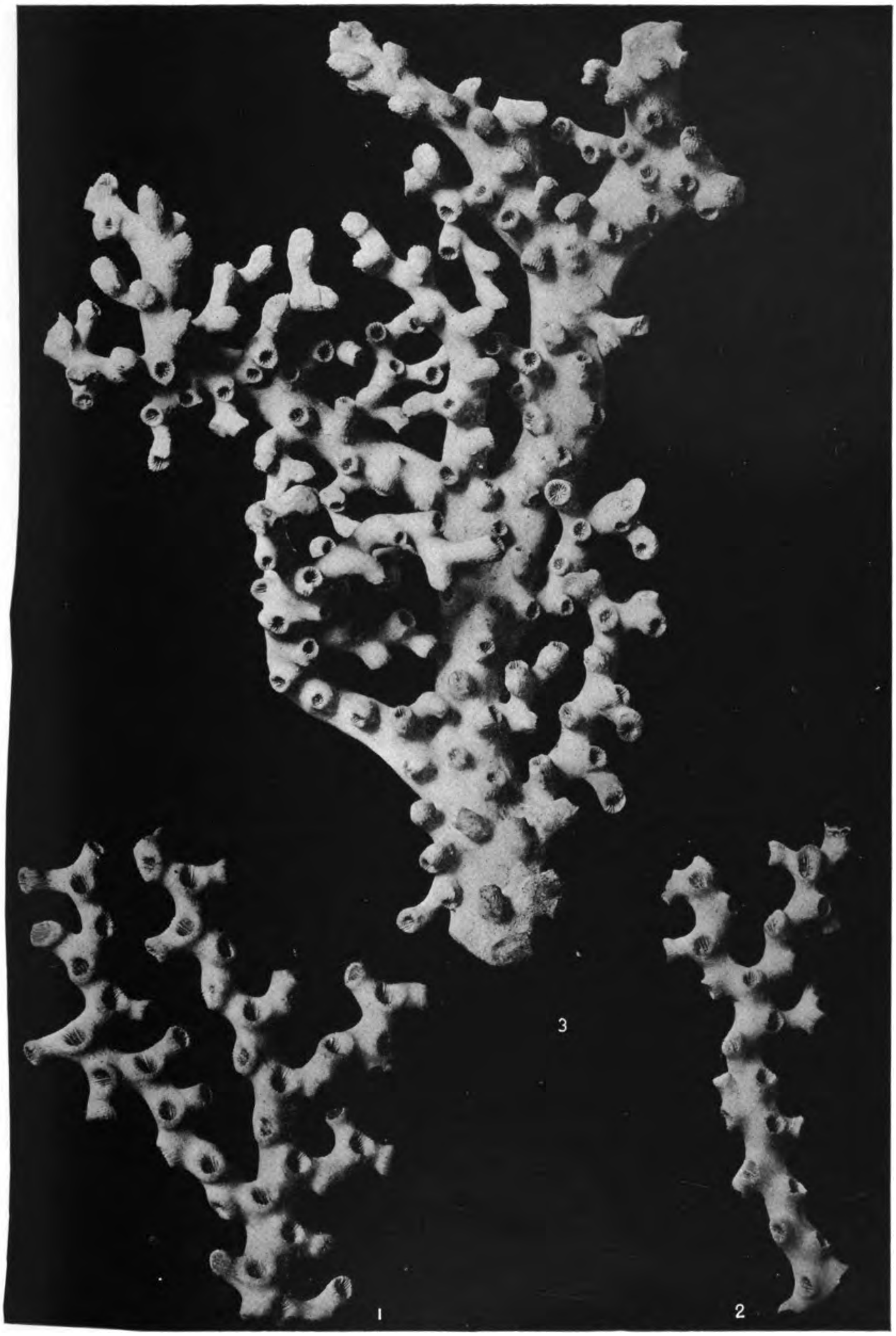
PLATE XLVII.



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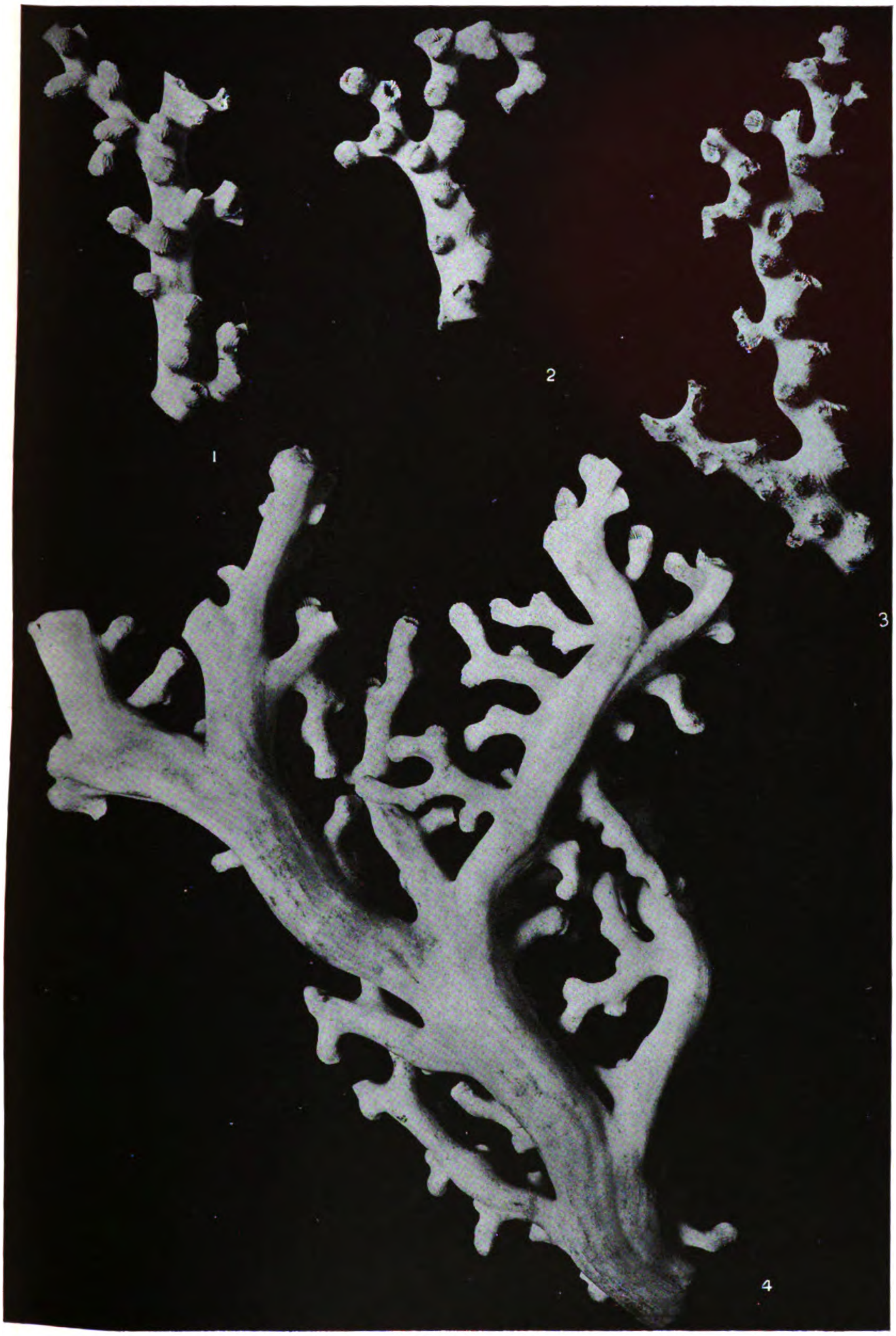

ANISOPSAMMIA.

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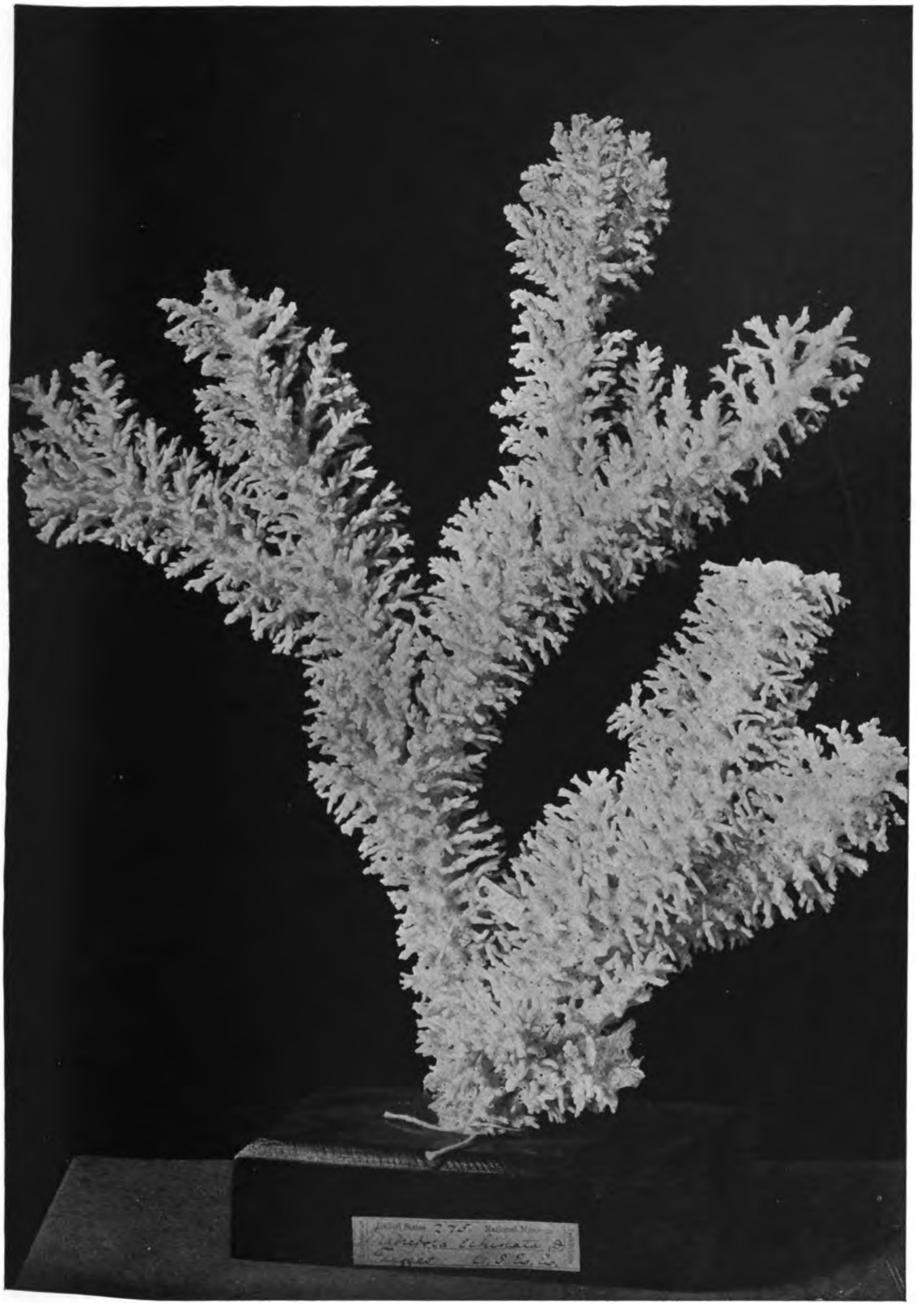
PLATE XLIX.



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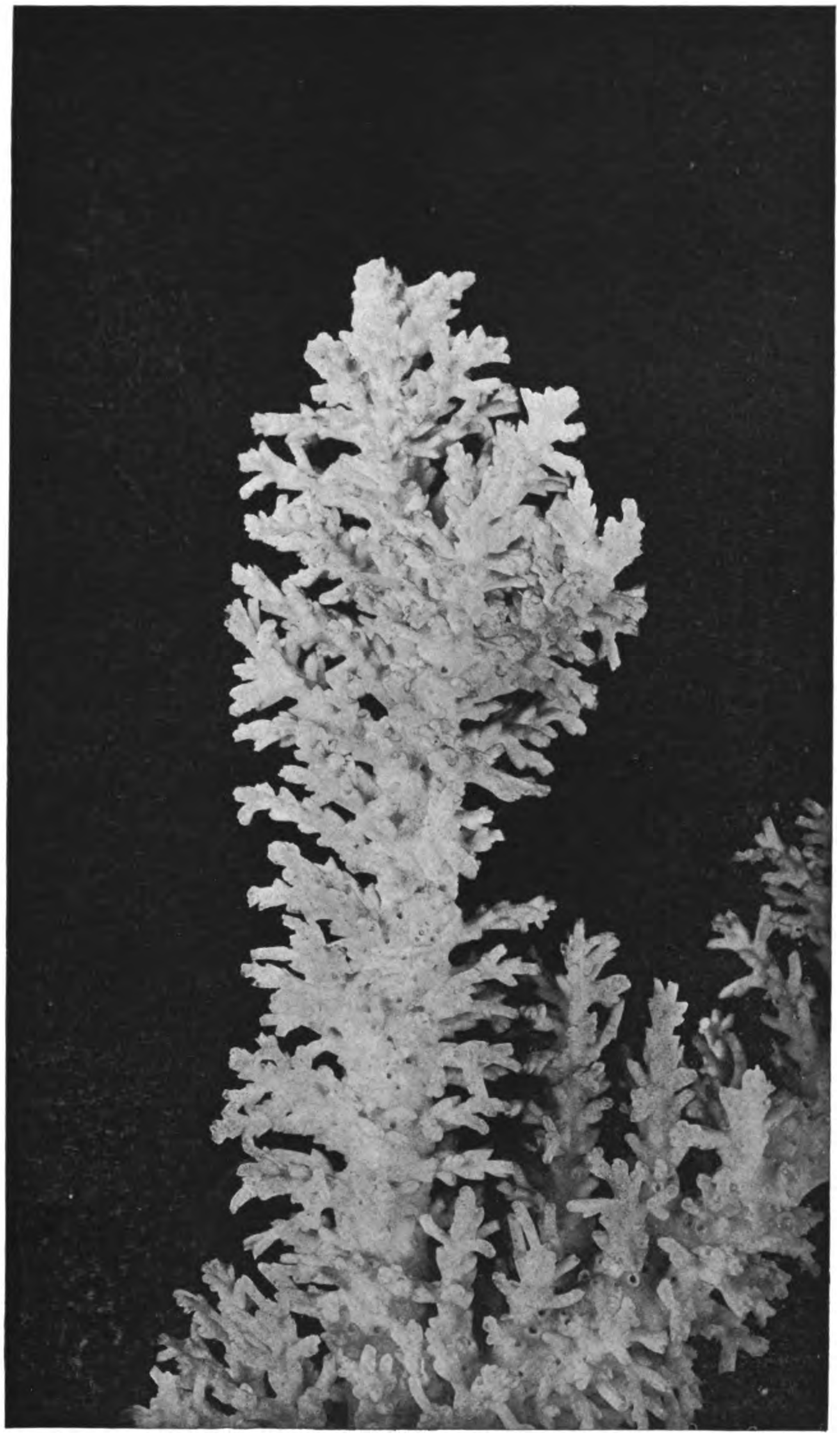

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Photographs furnished by Professor Studer.

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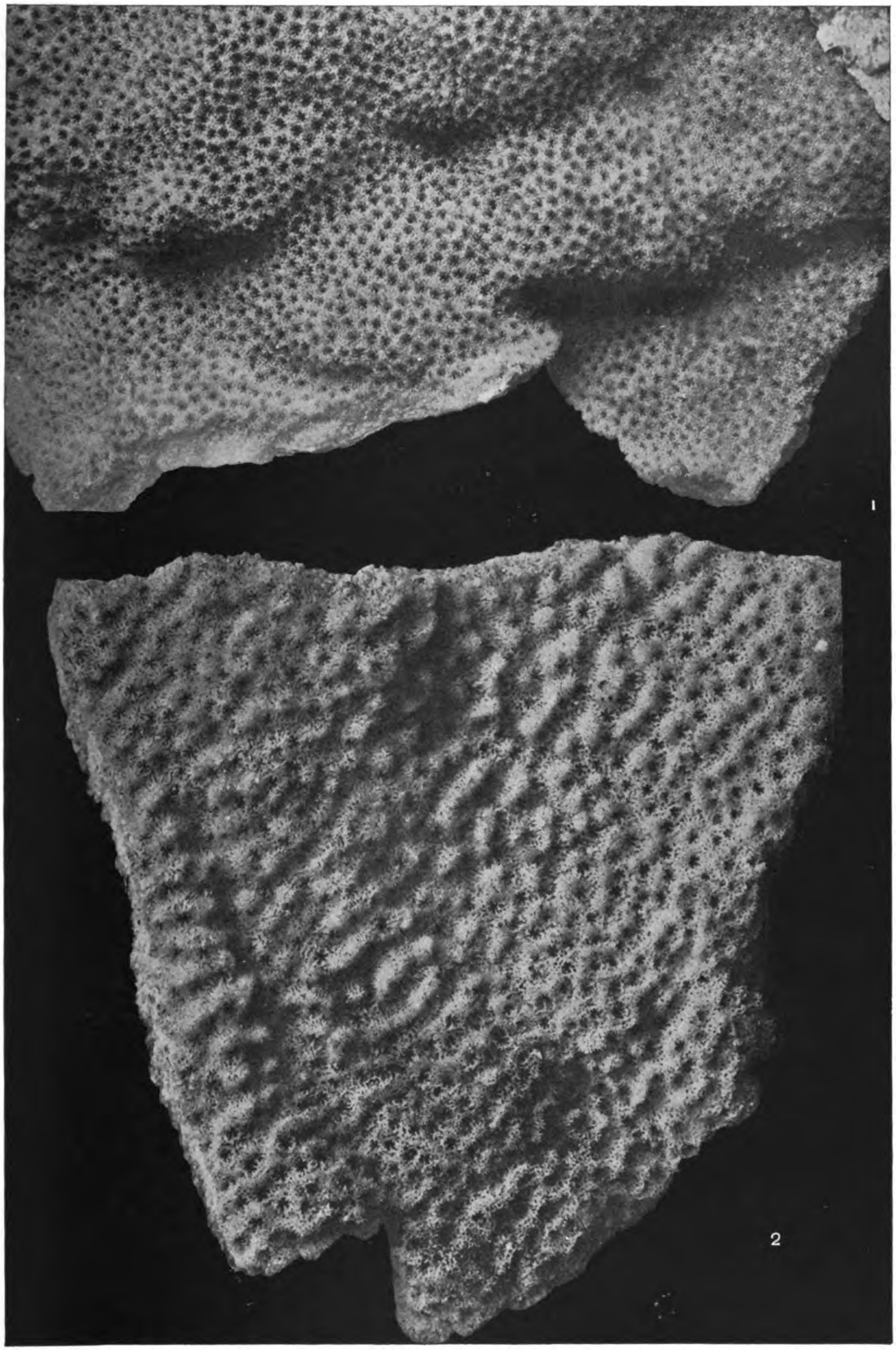
Photographs furnished by Professor Studer.



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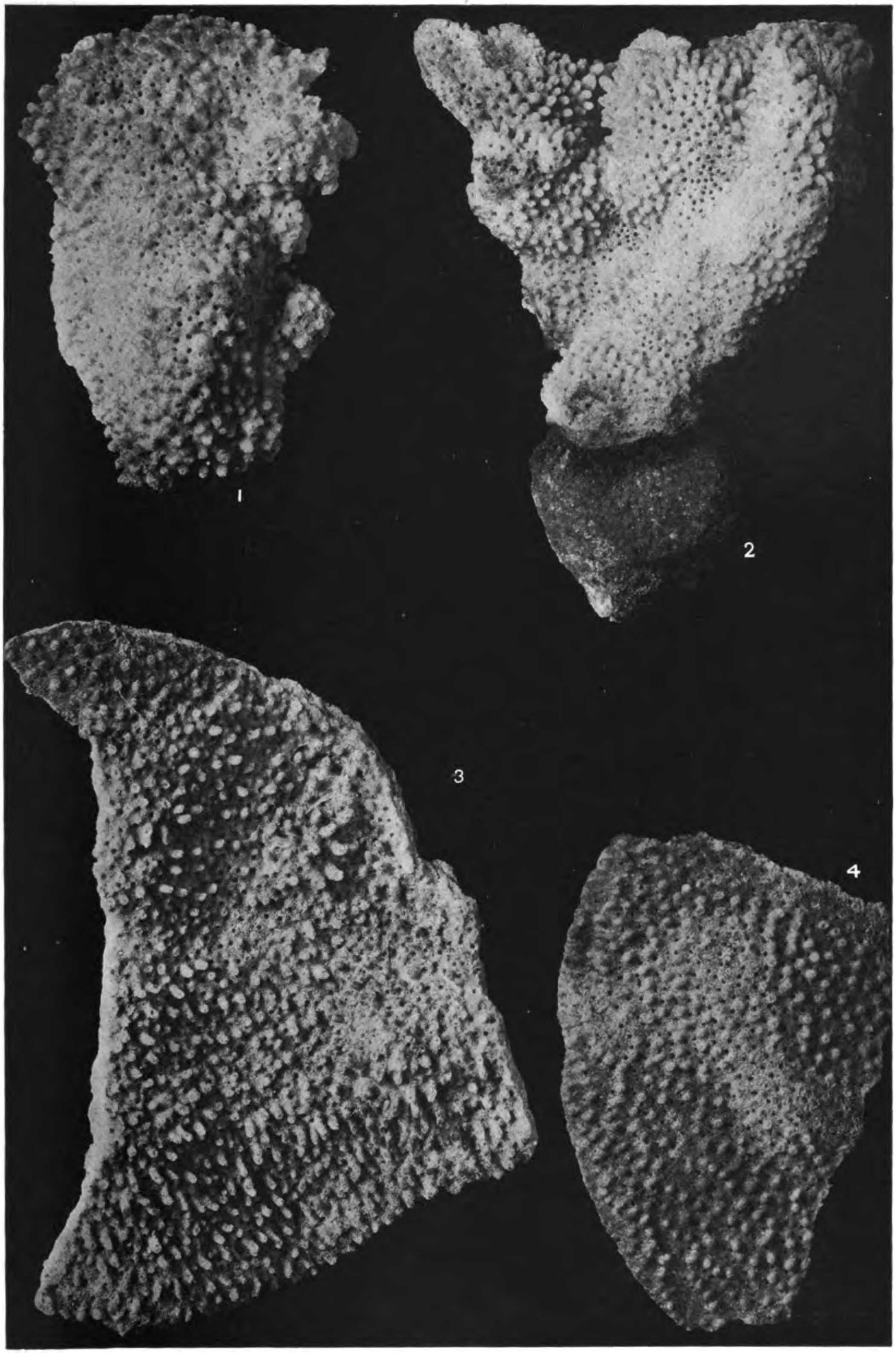

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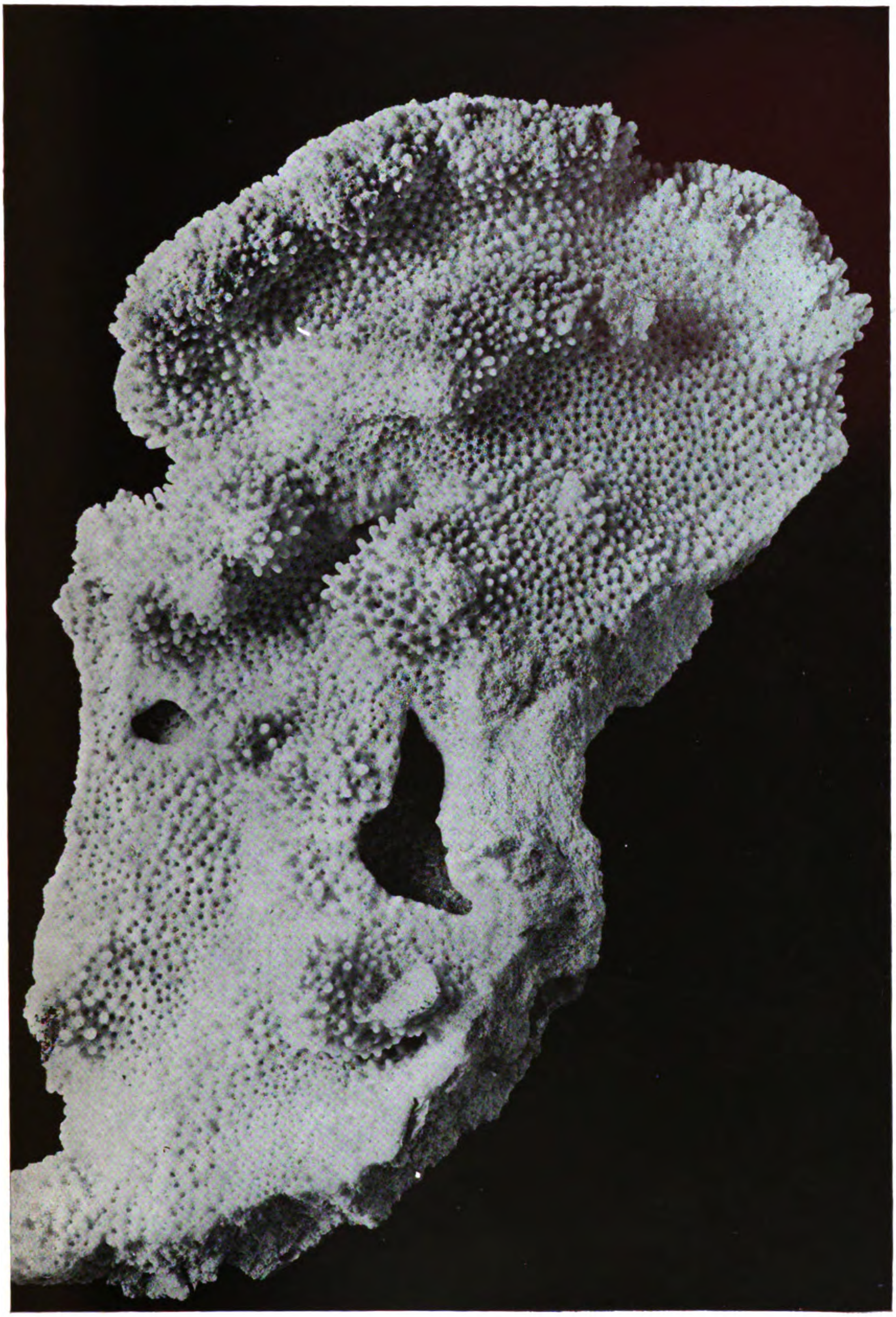

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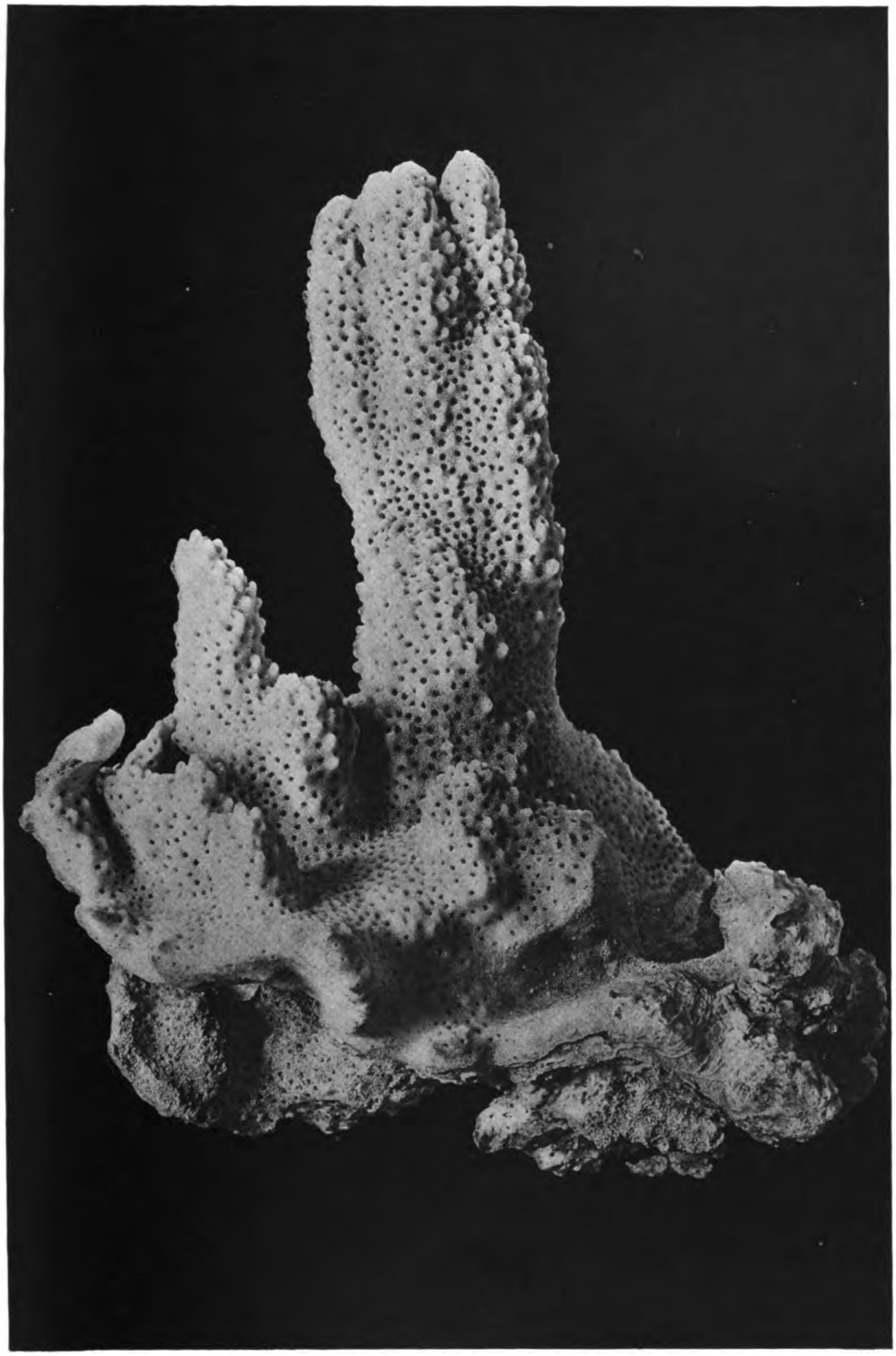
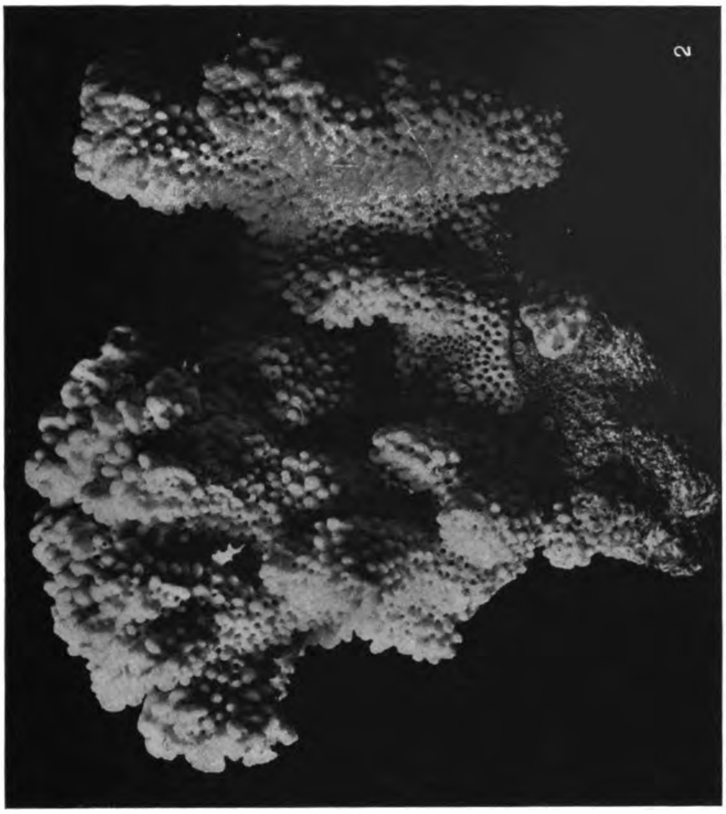


MONTIPORA.

PLATE LVII.

PLATE LVII.

Montipora verrucosa (Lamarck).



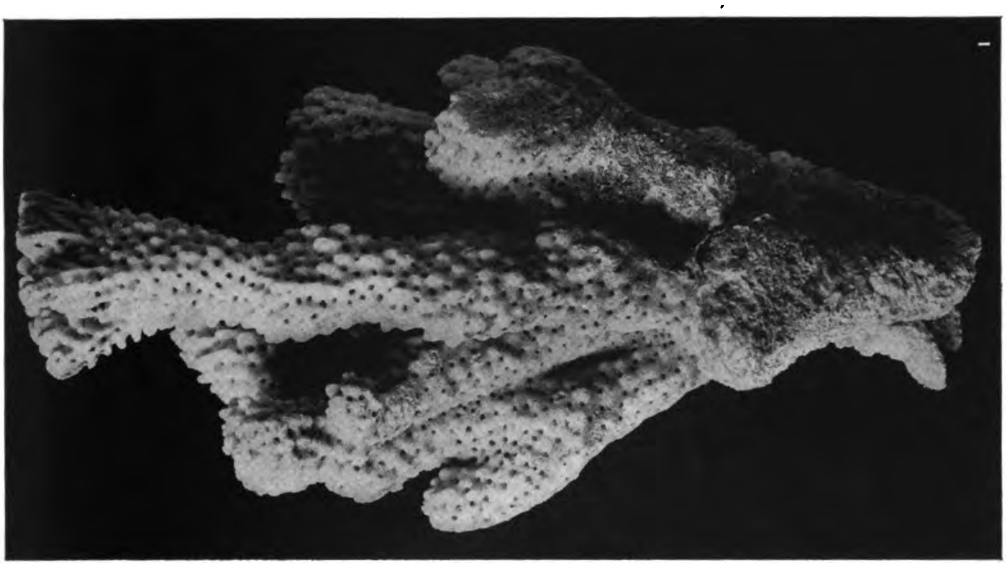


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PLATE LVIII.

Montipora verrucosa (Lamarck).

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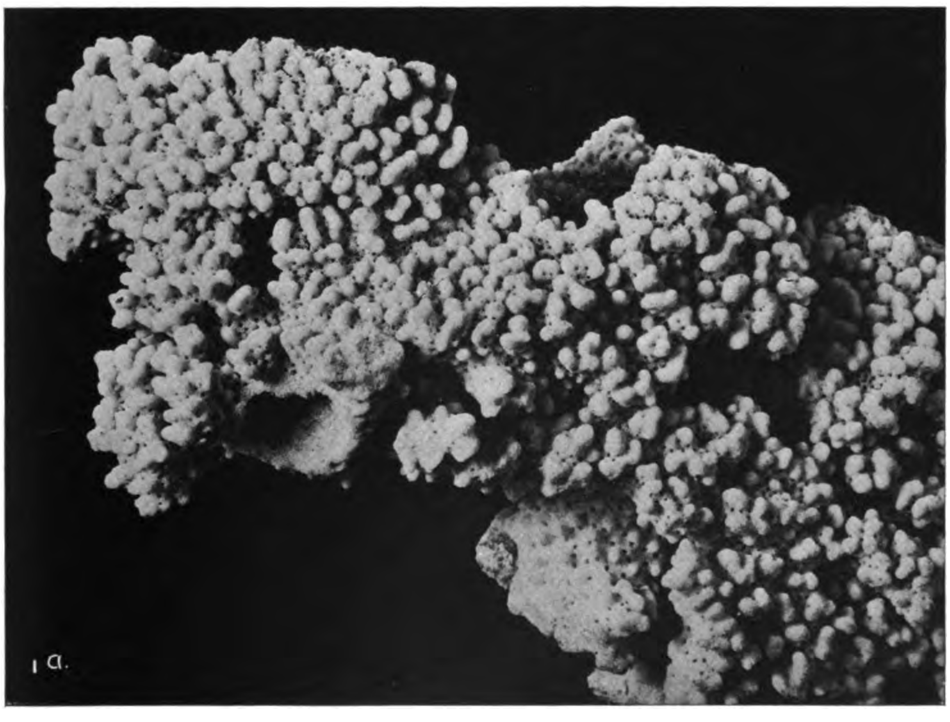

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MONTIPORA.

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Montipora verrucosa (Lamarck).

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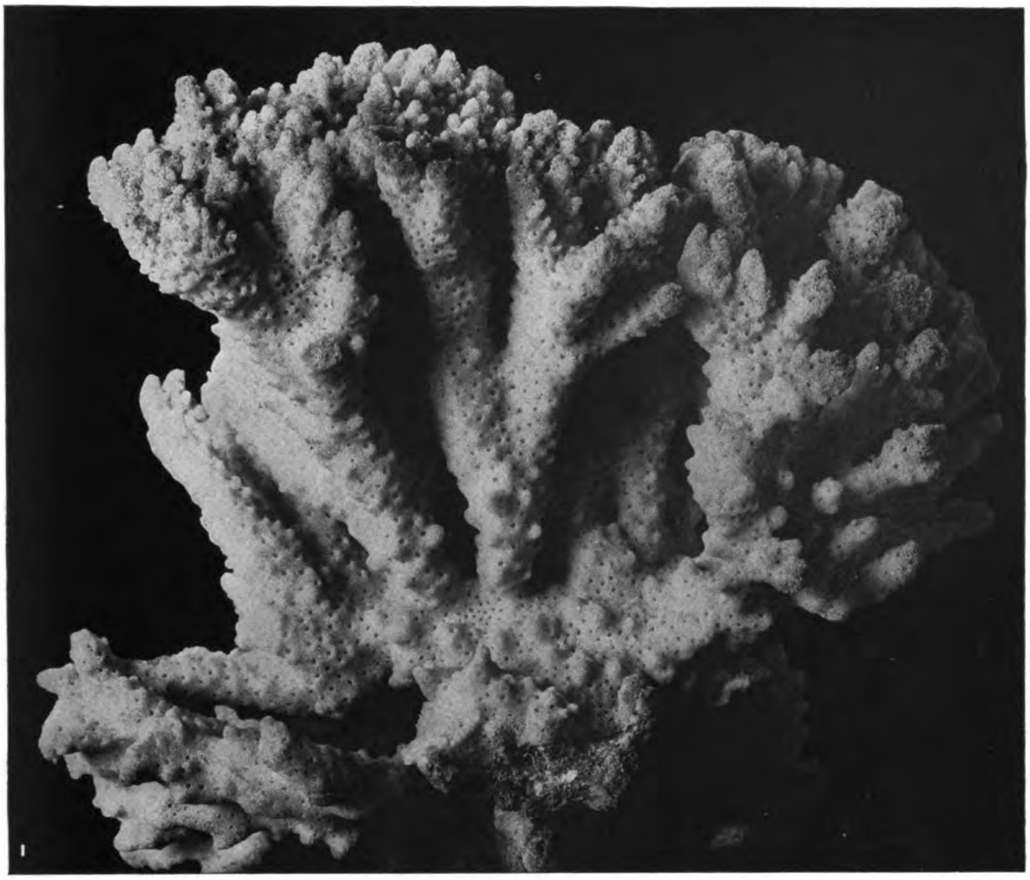

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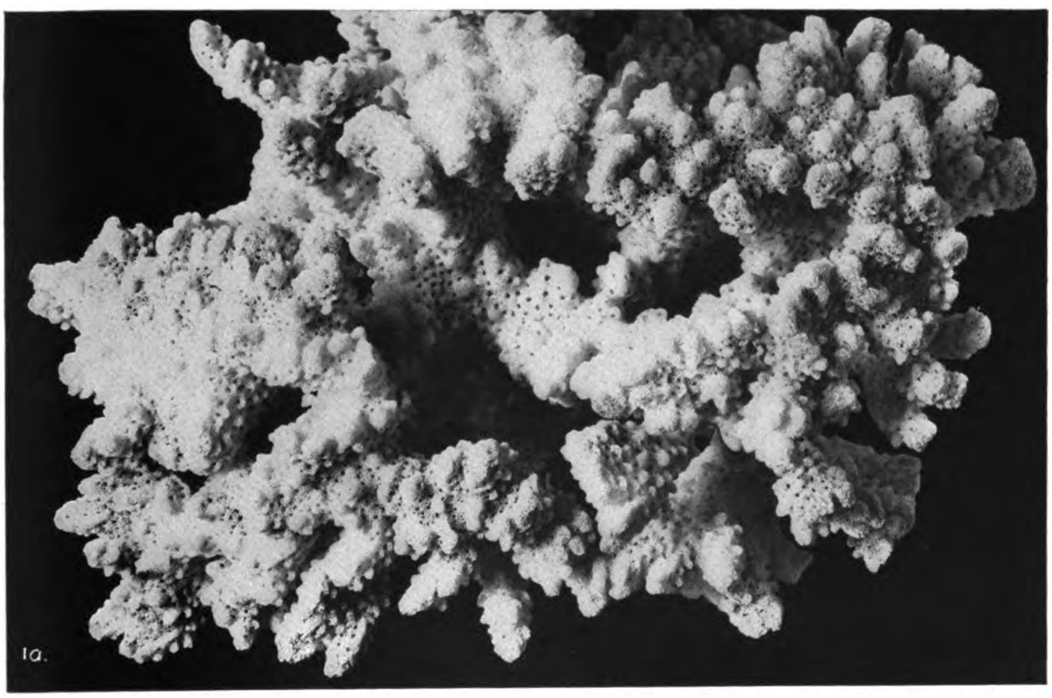

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PLATE LX.

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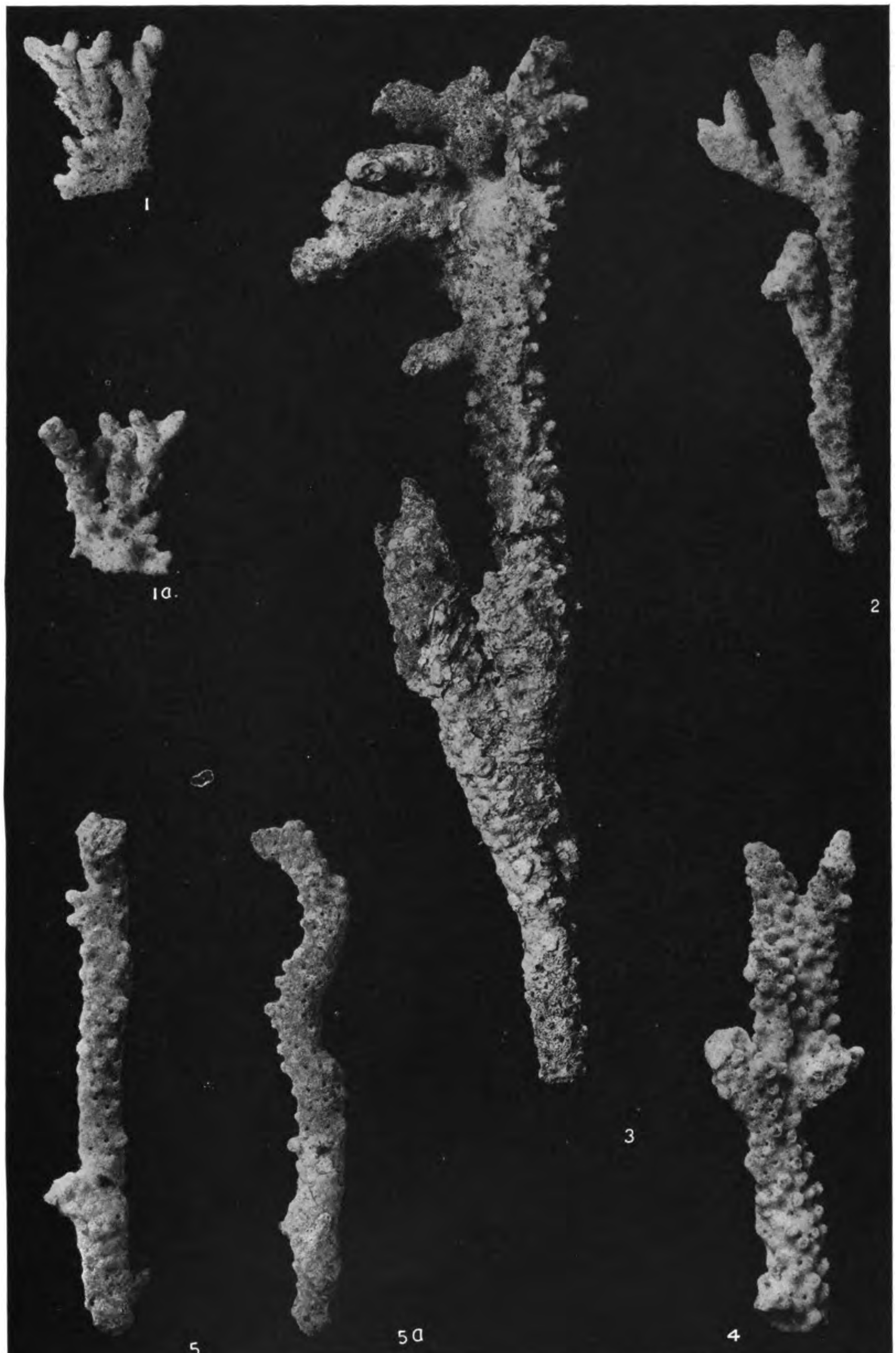

MONTIPORA.

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PLATE LXI.

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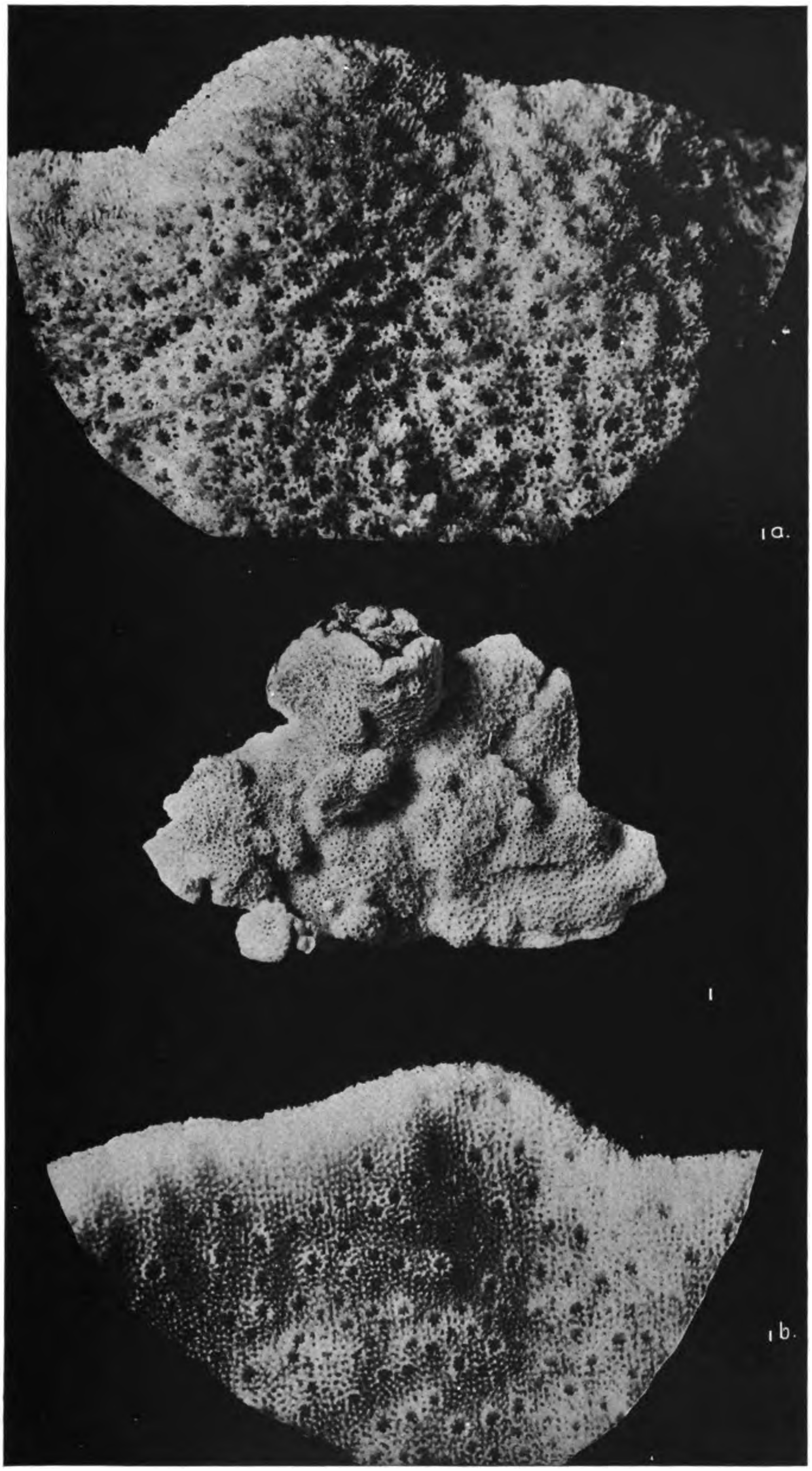

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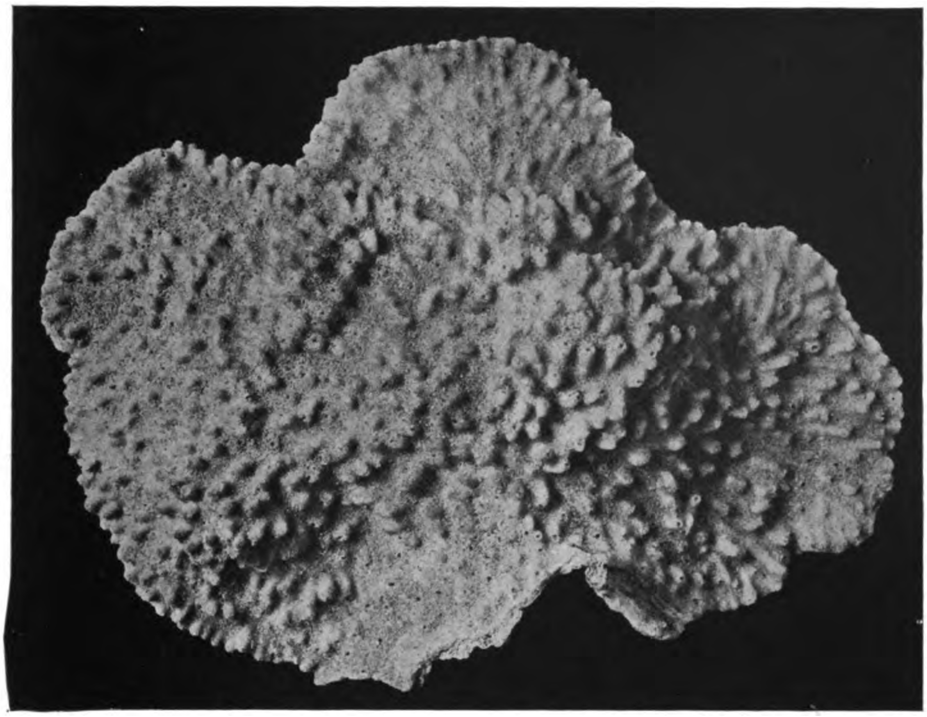

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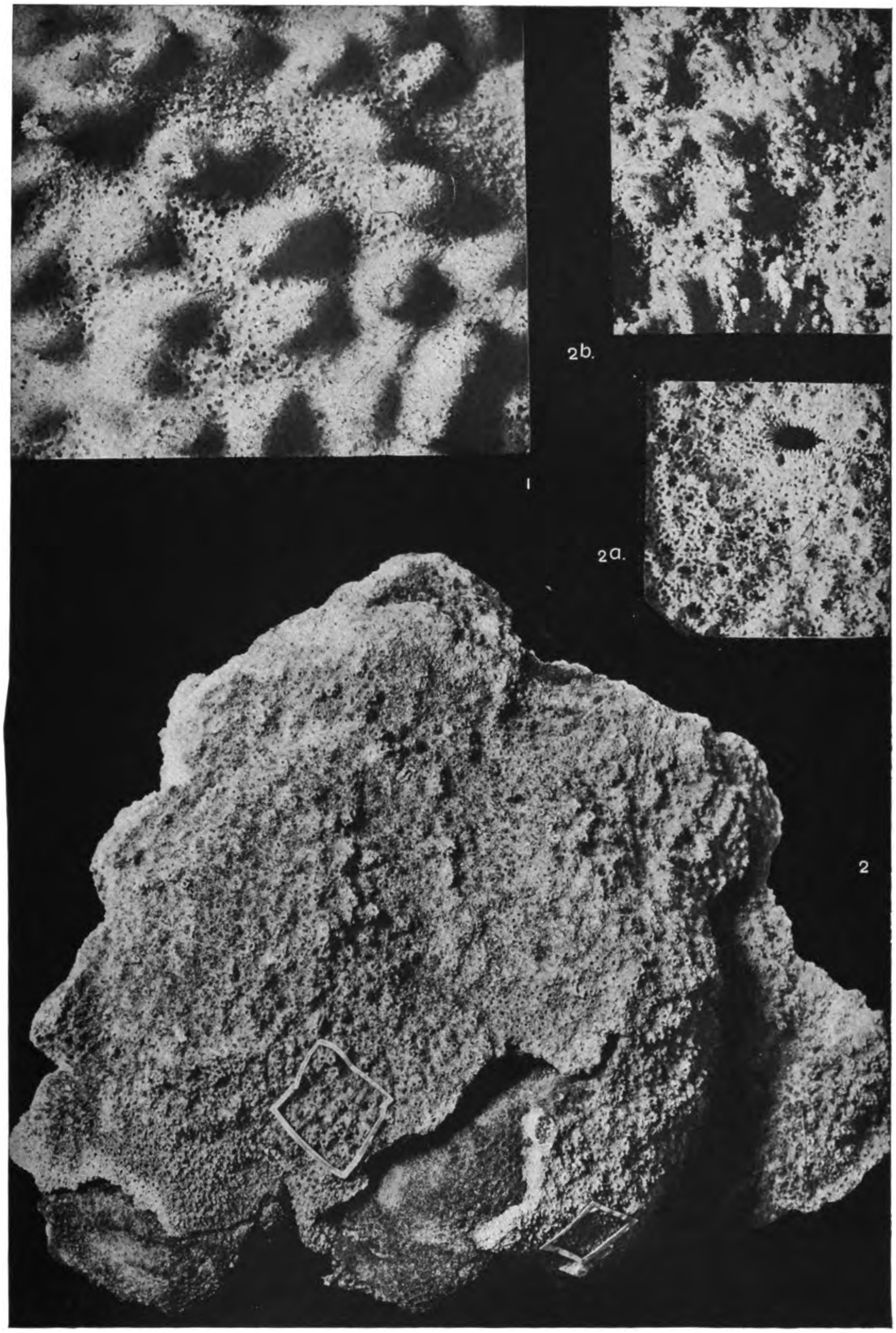

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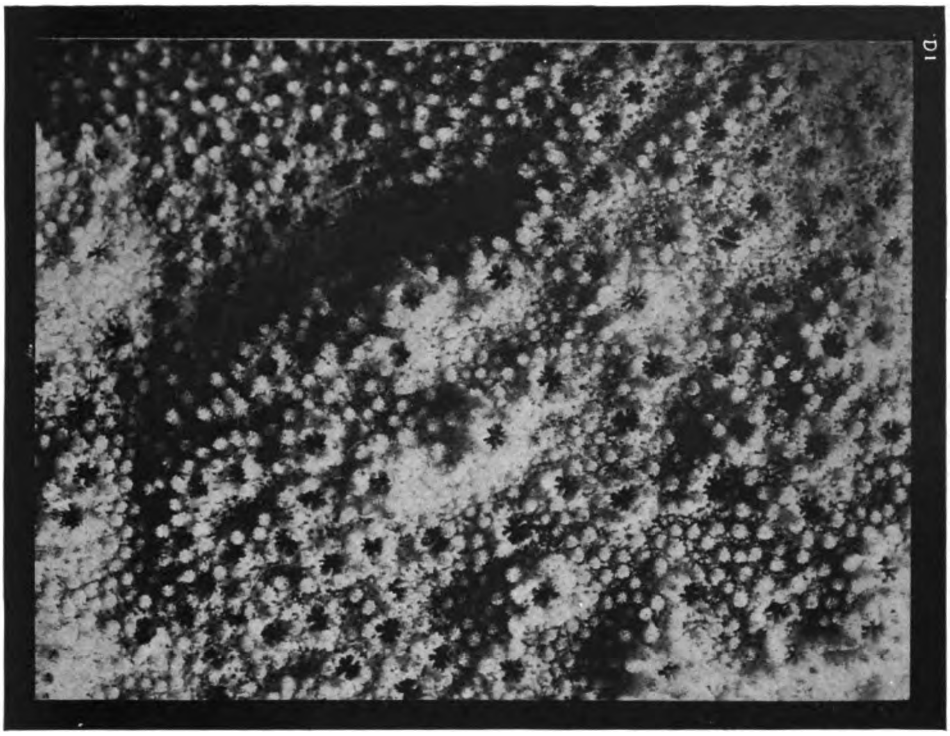

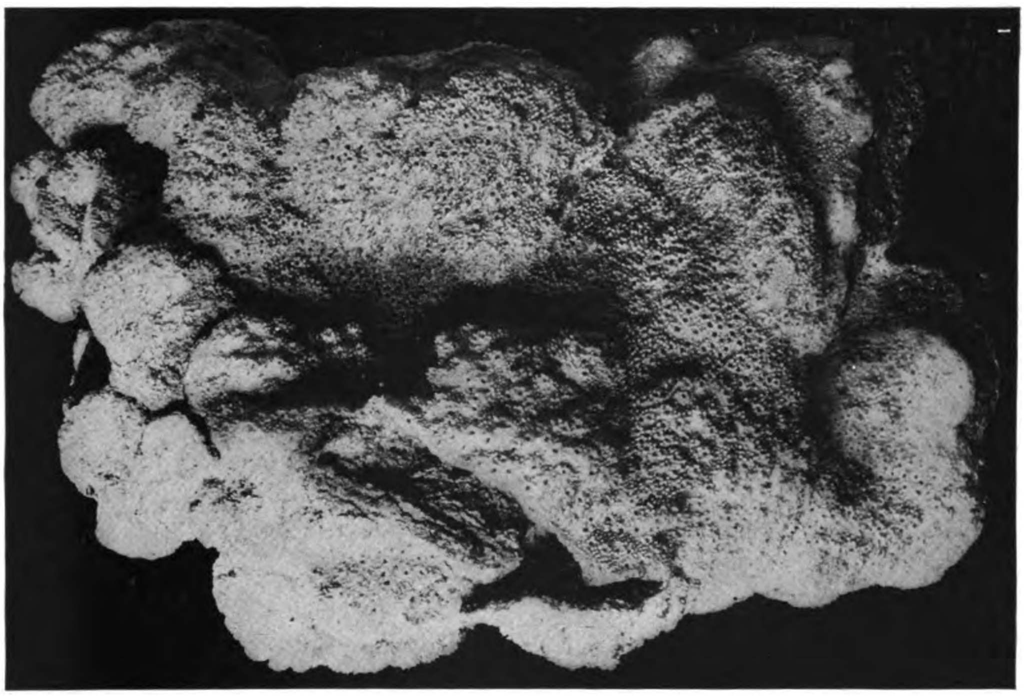

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Porites mordax Dana.

Natural size.

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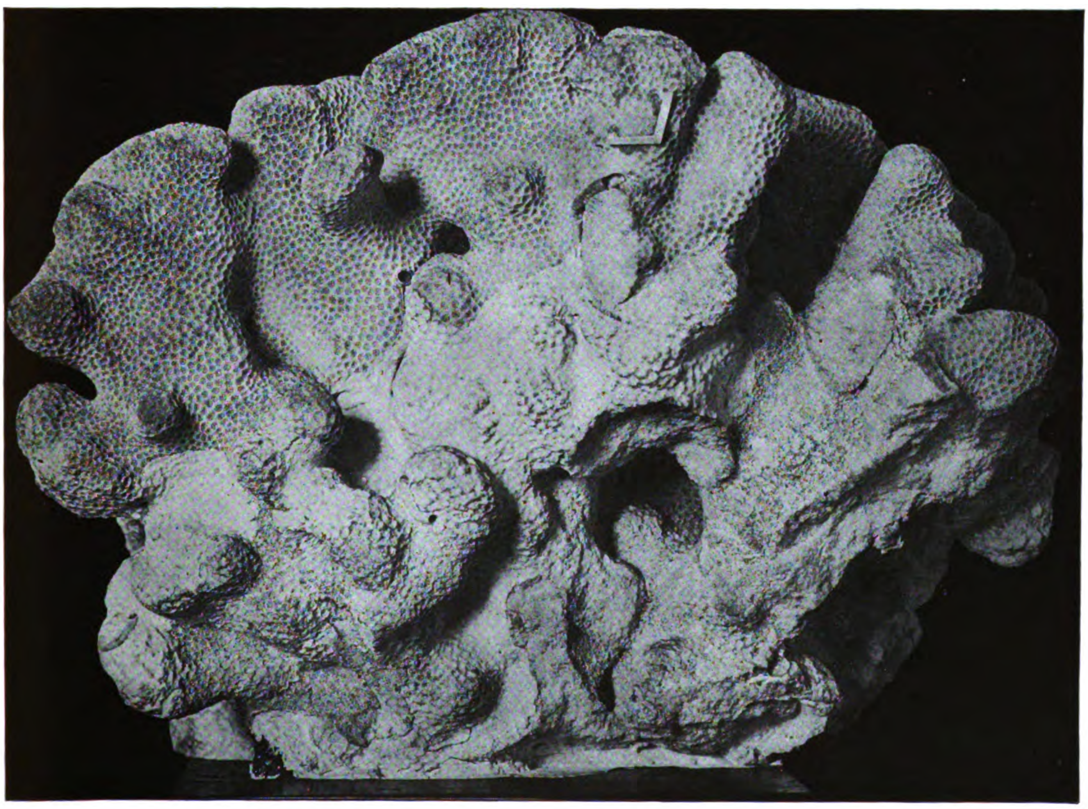
PLATE LXVII.

Porites compressa Dana.

Natural size.



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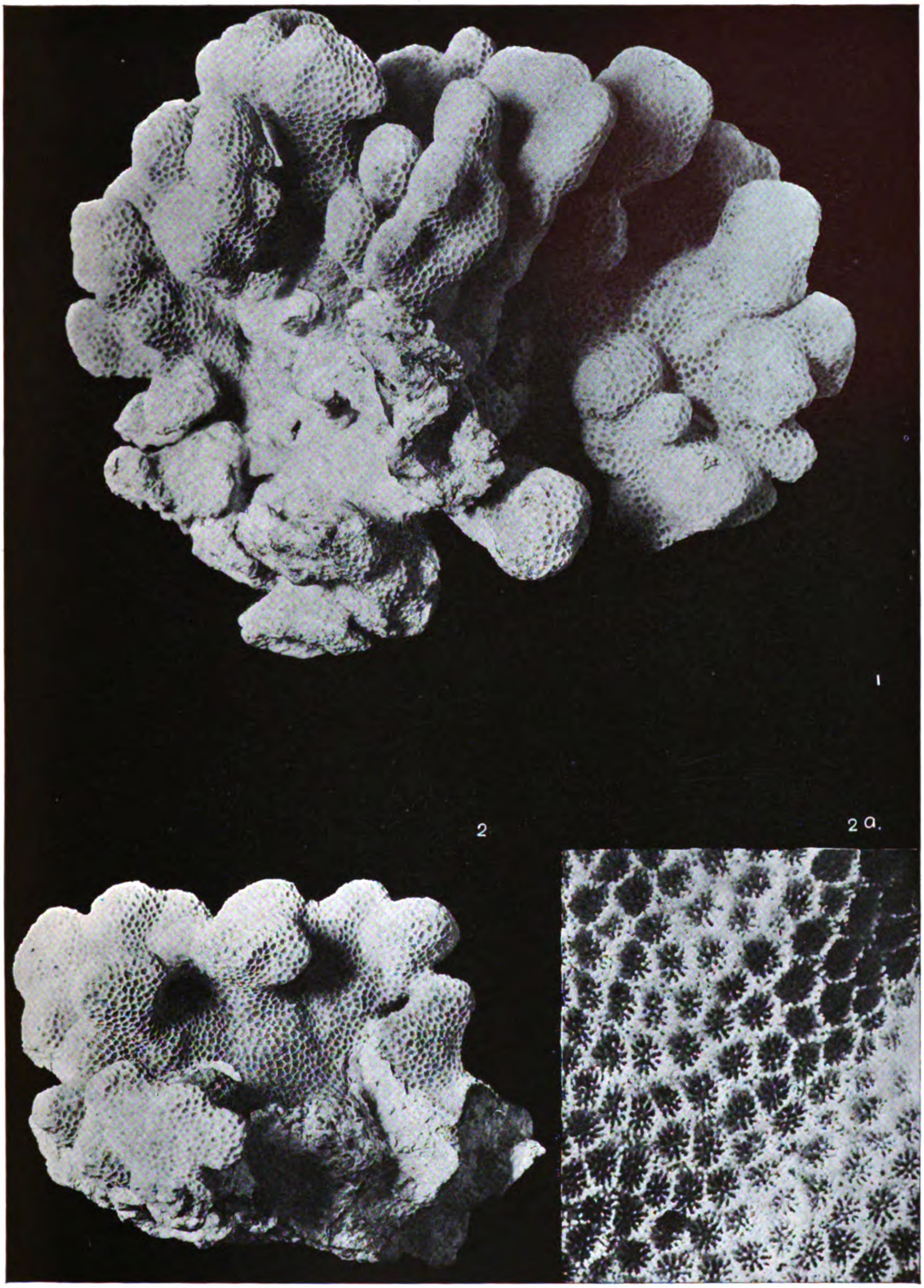

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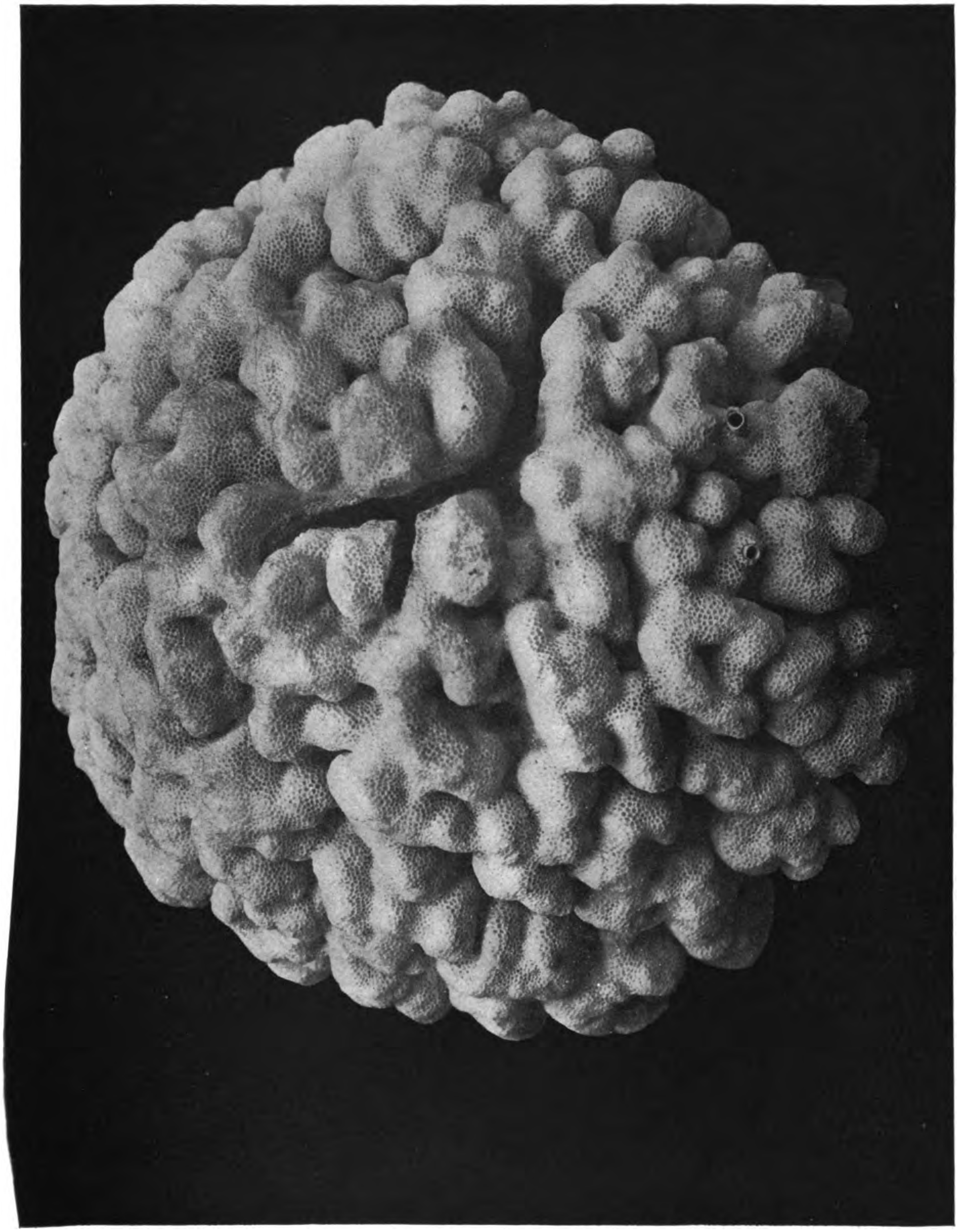

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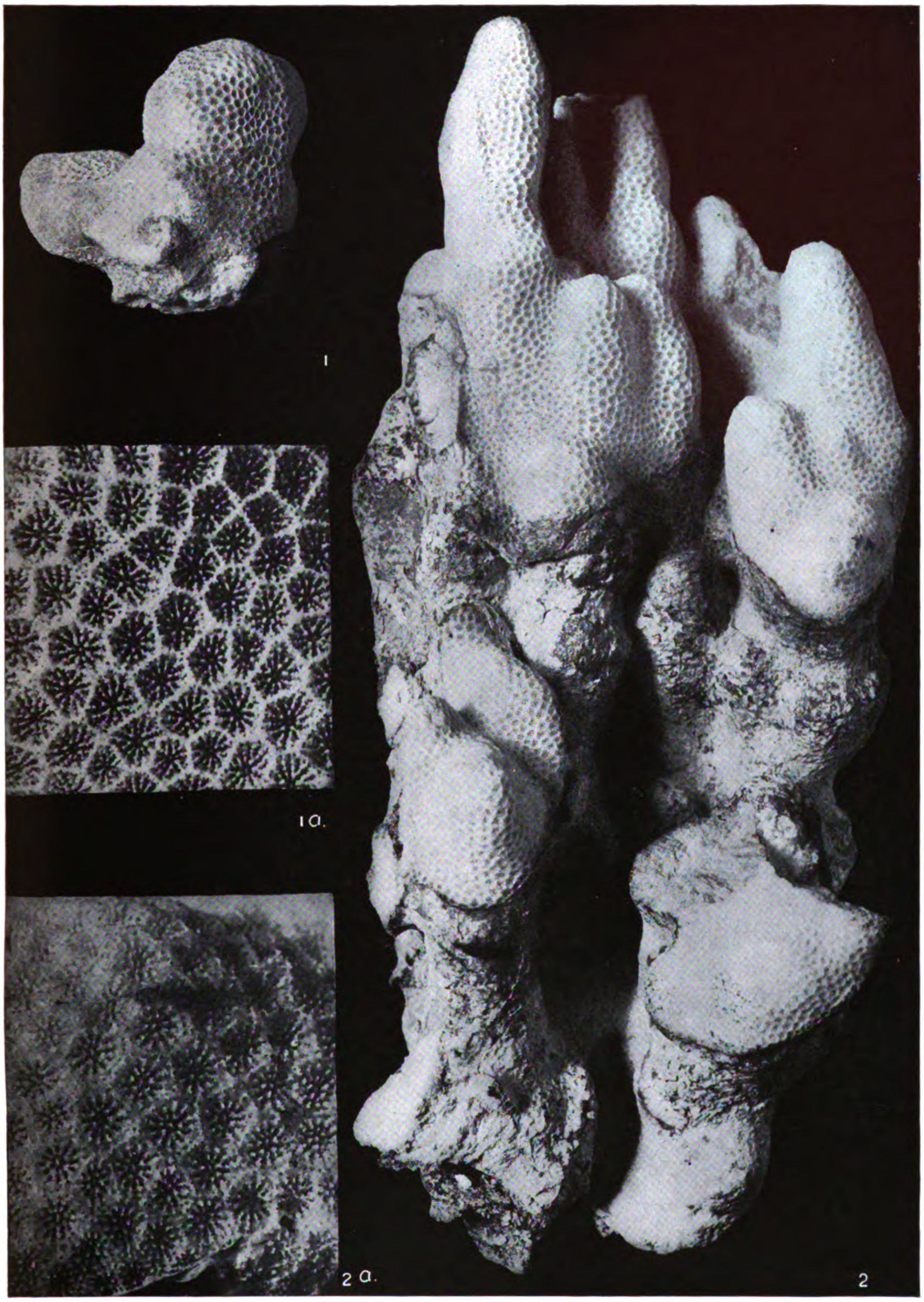

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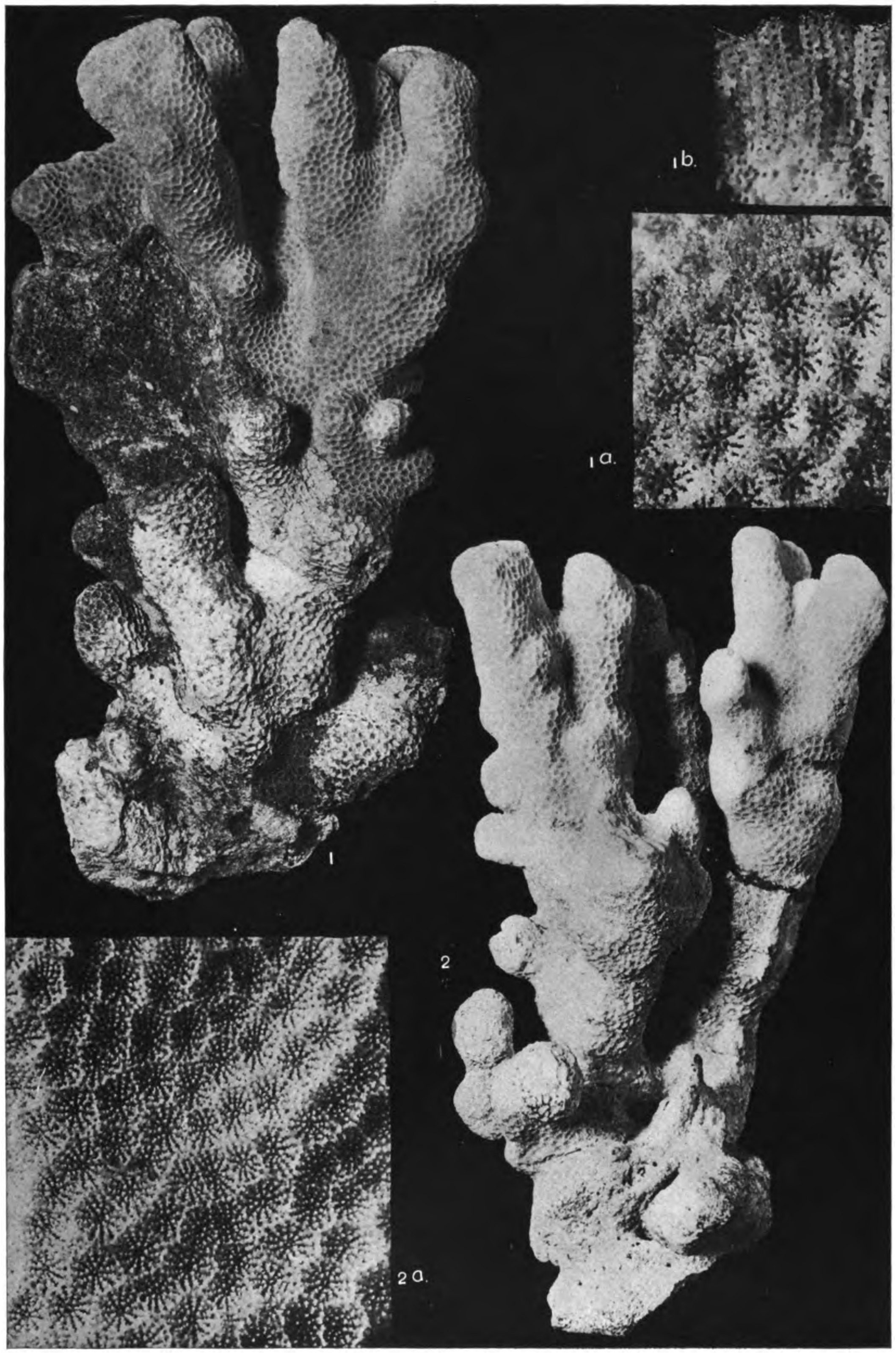

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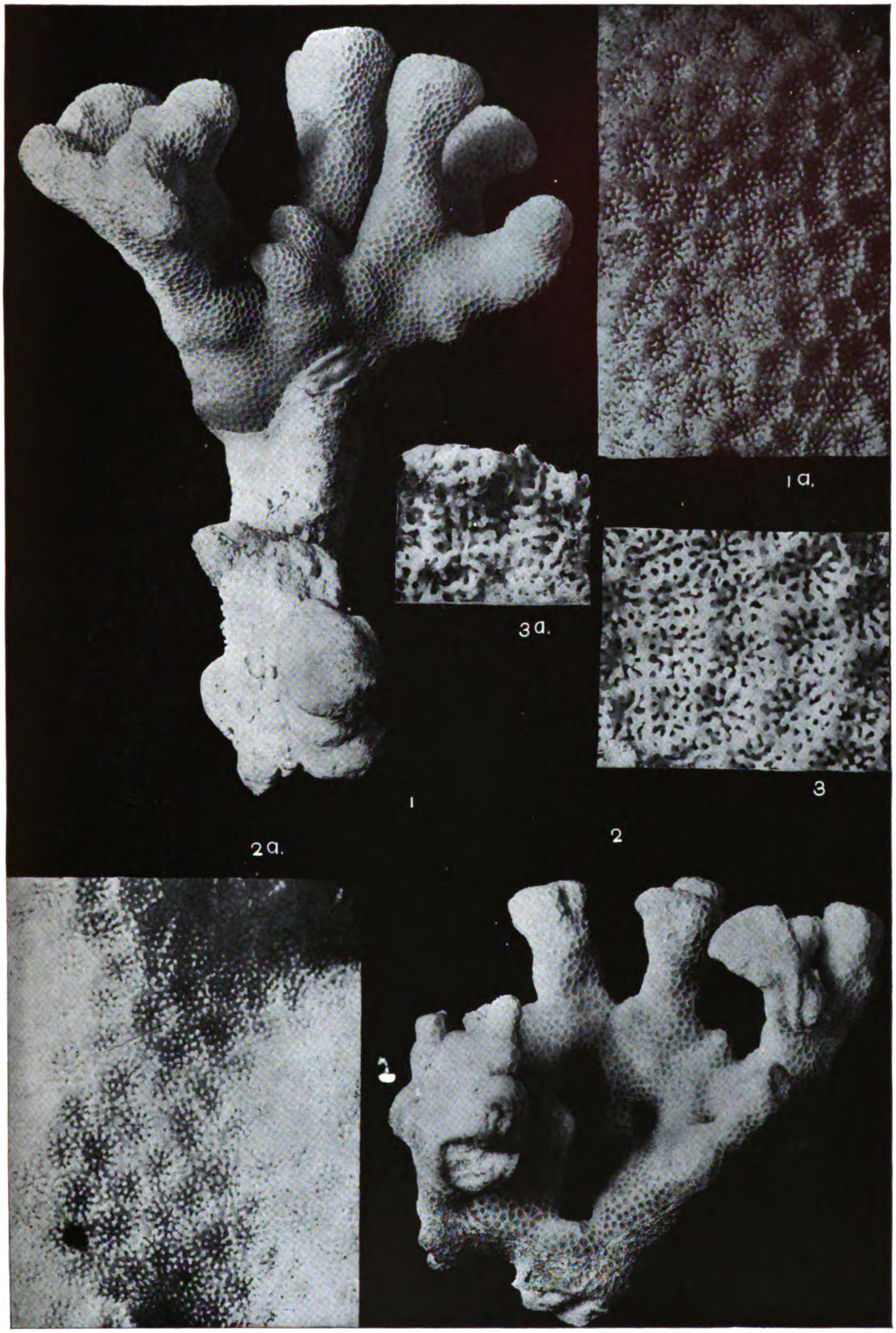

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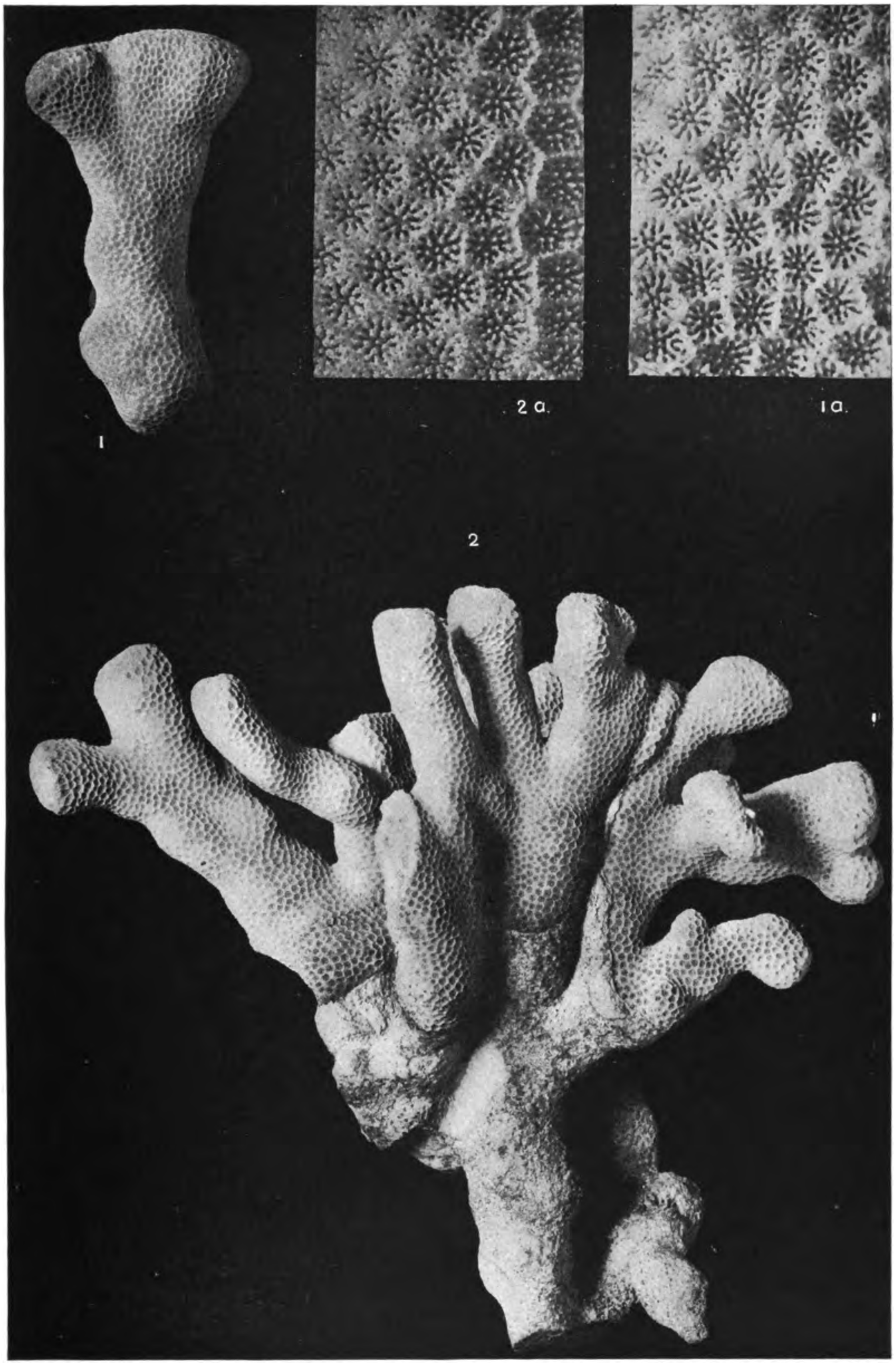

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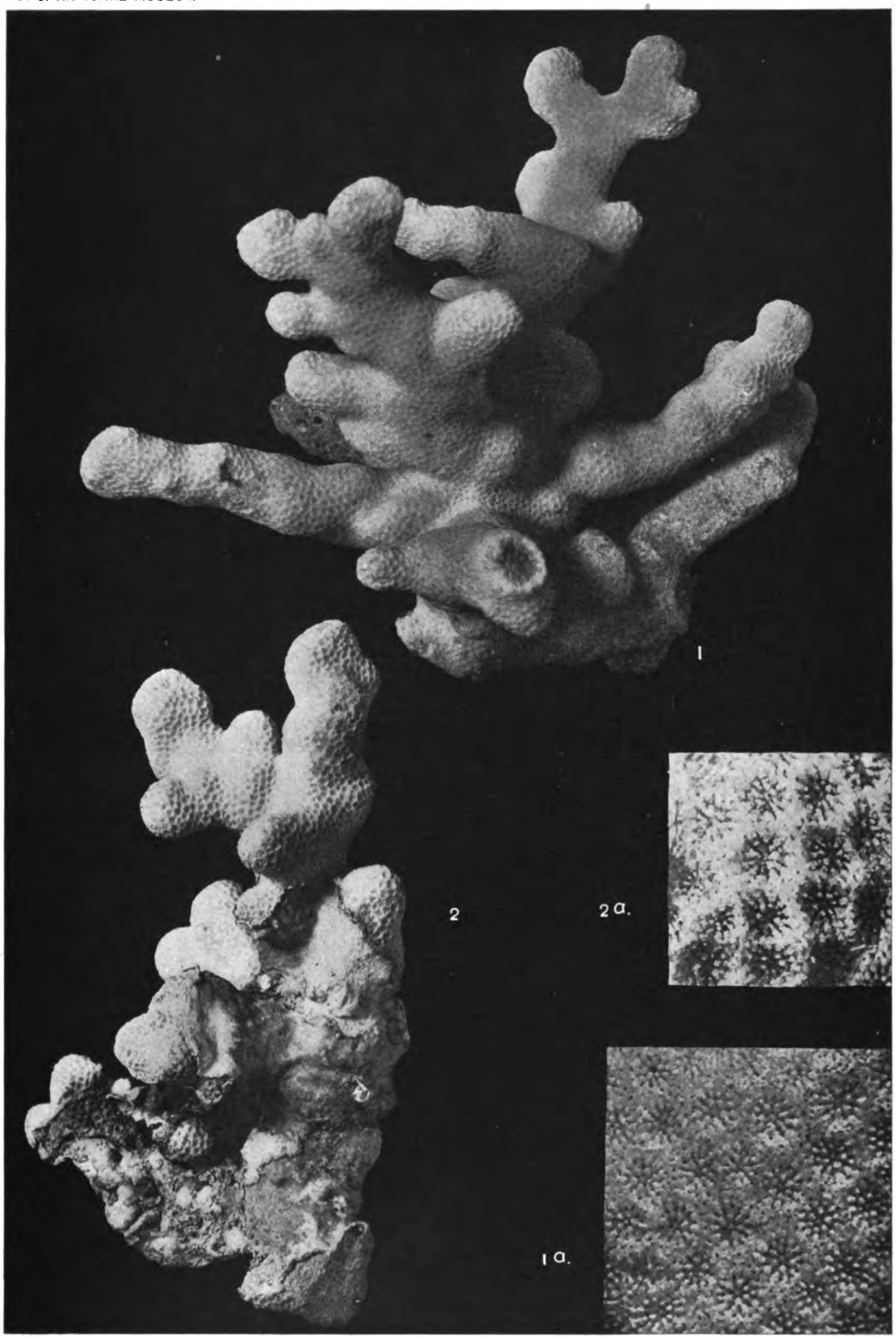

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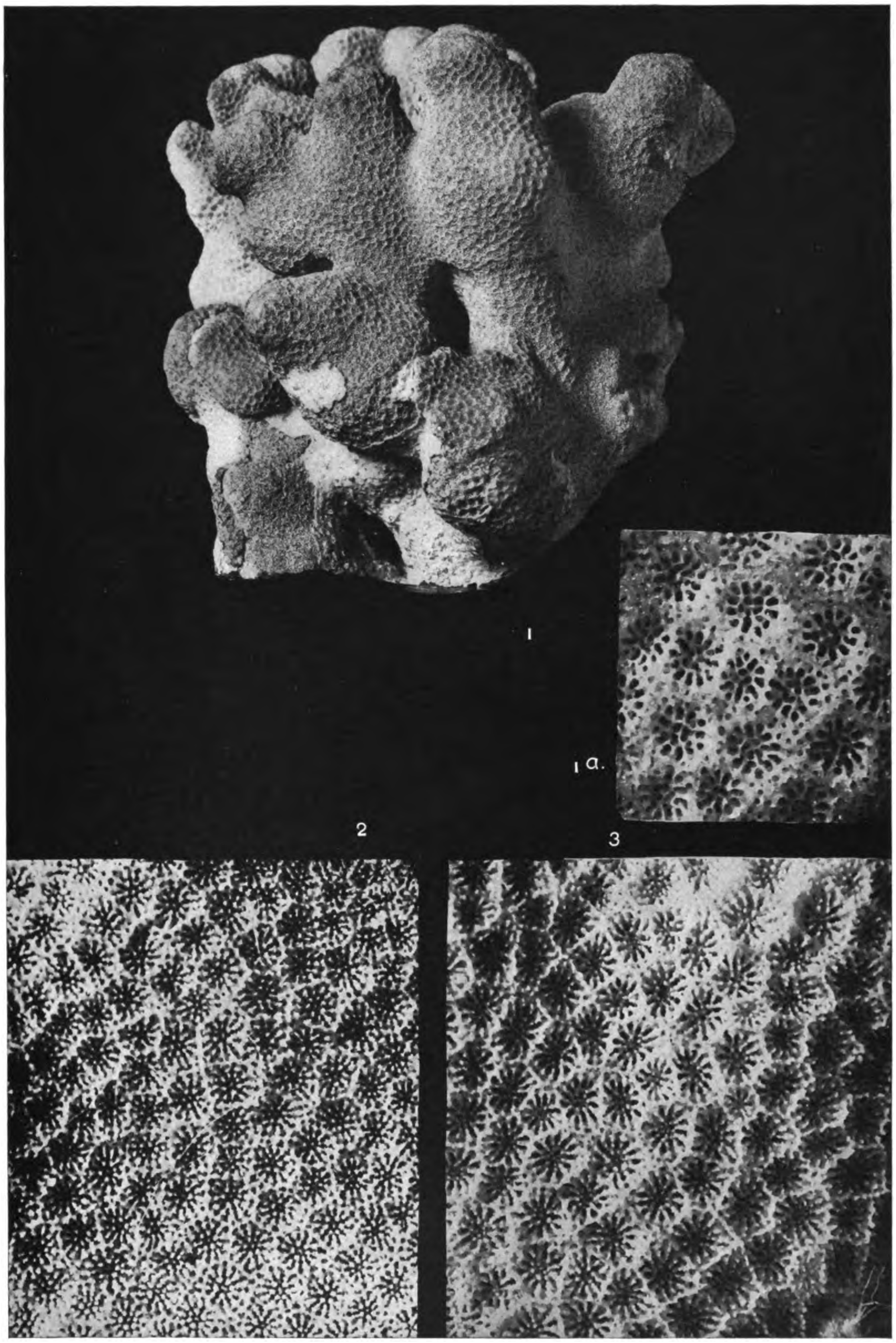

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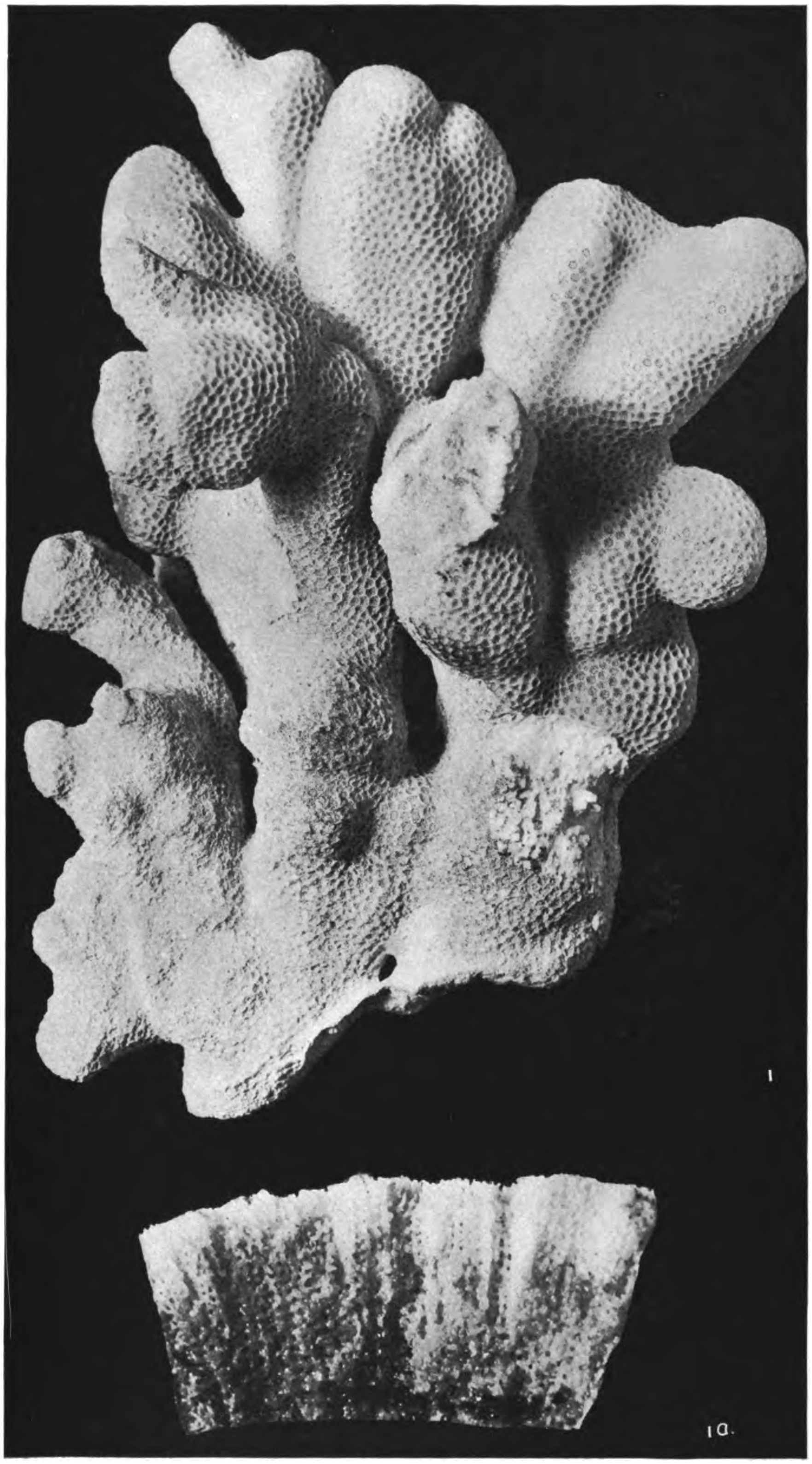

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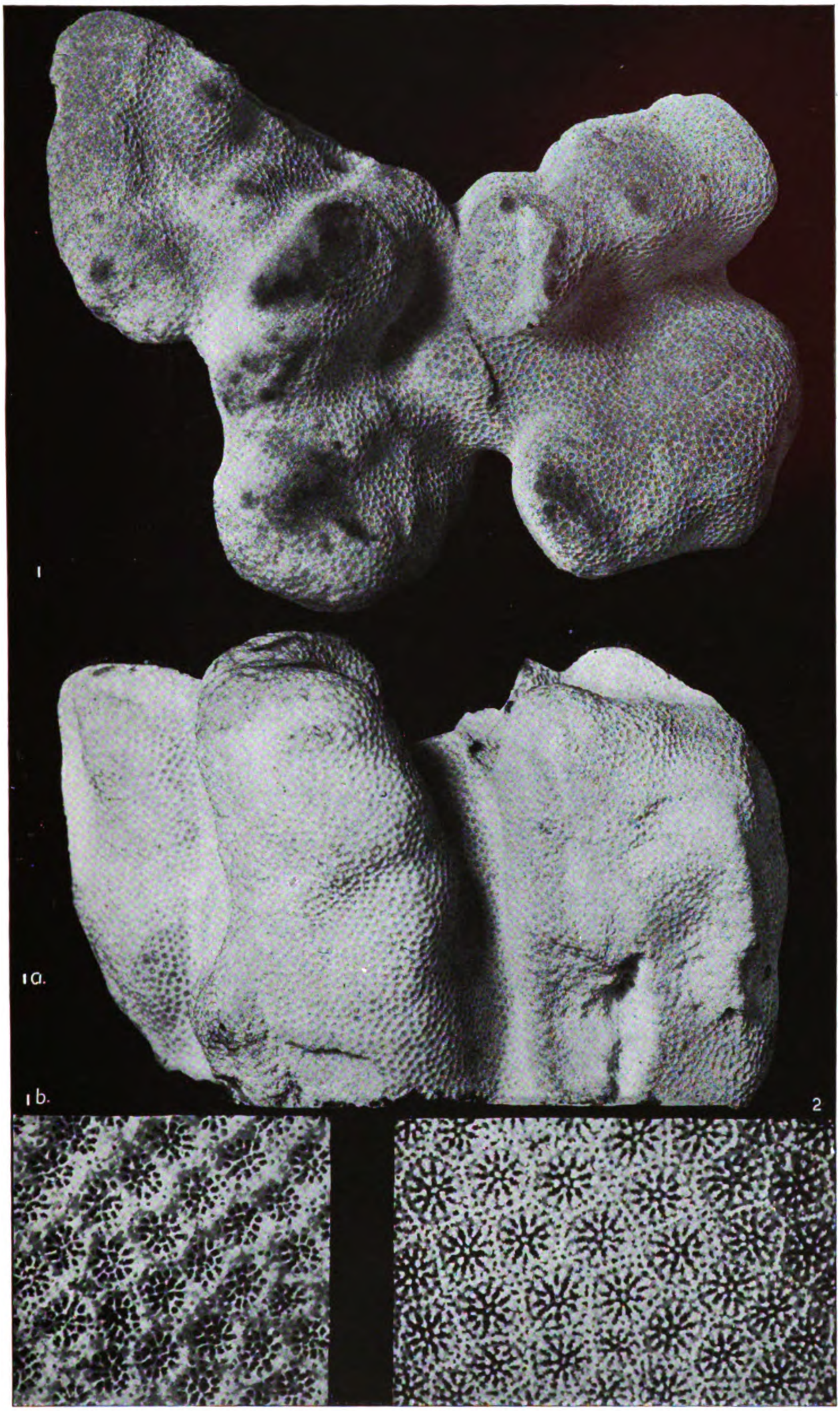

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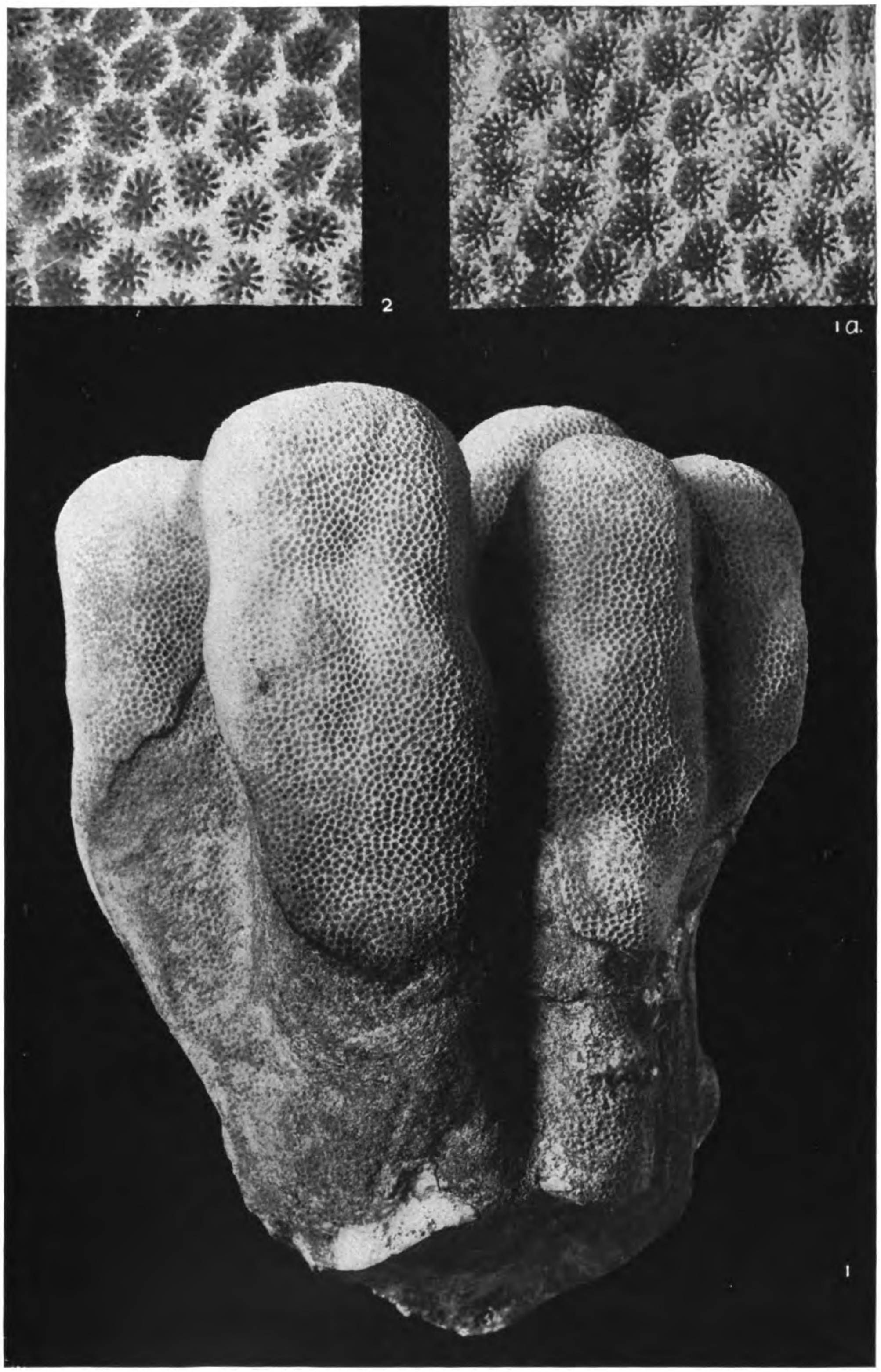

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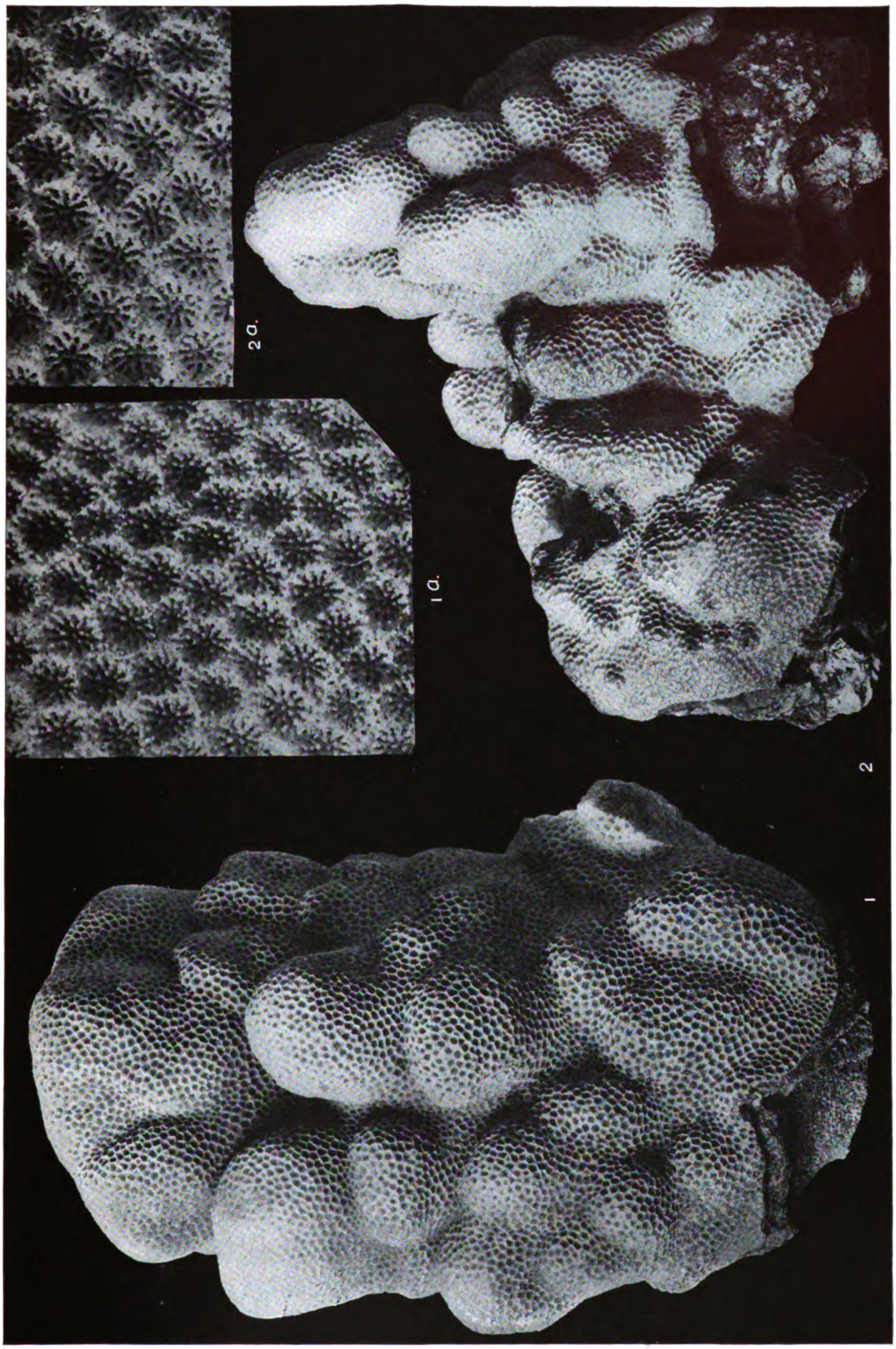

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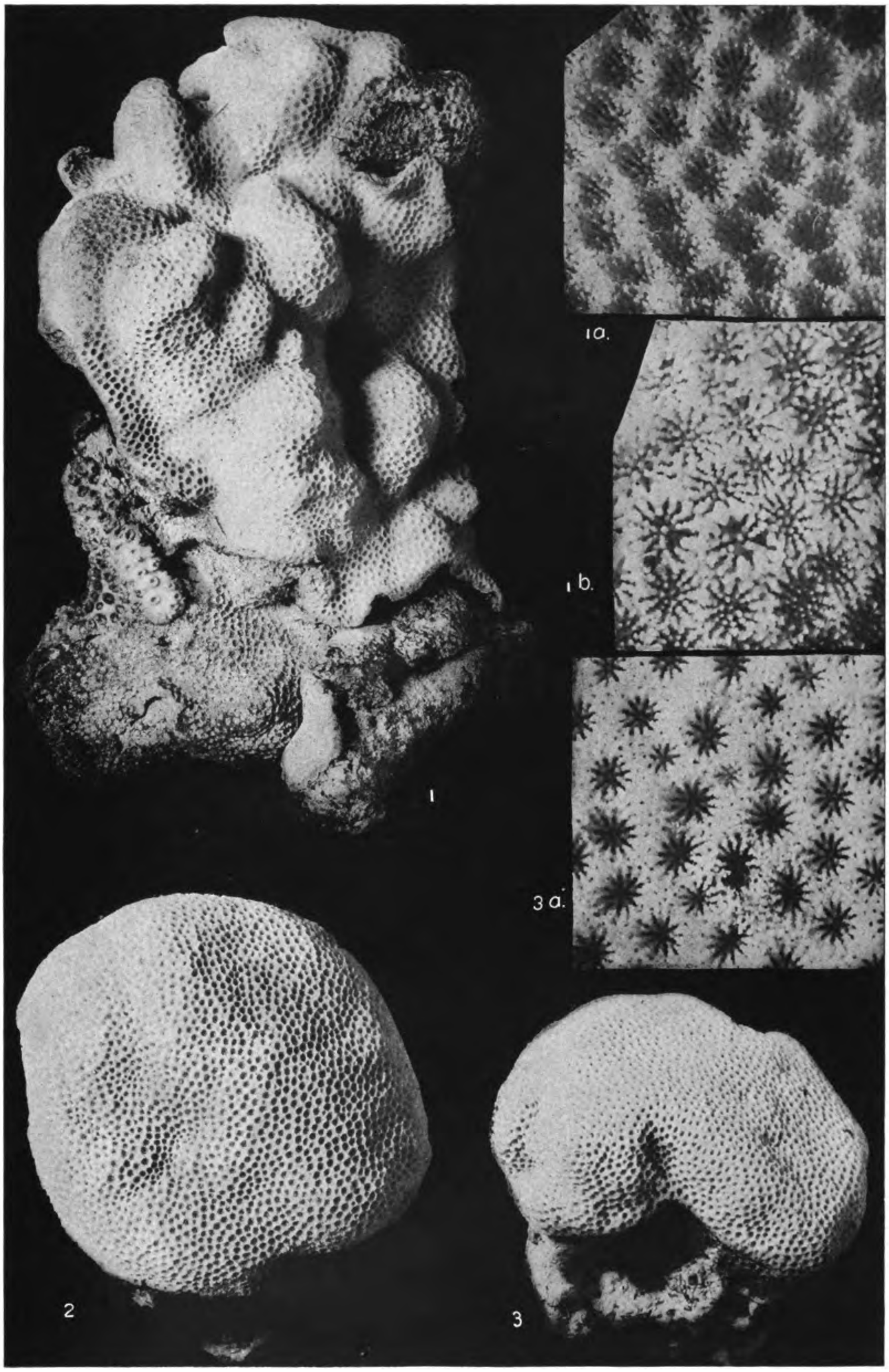

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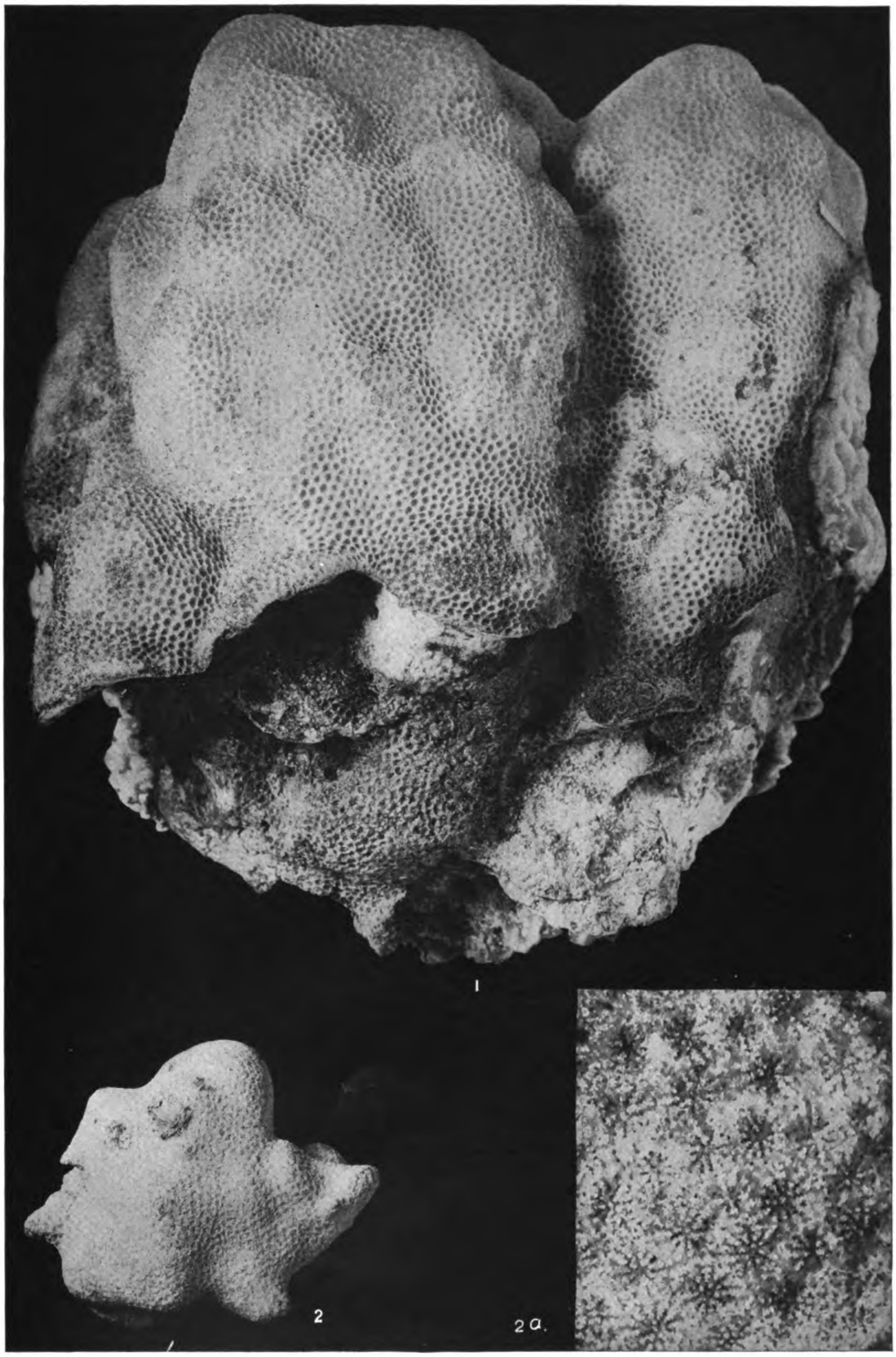

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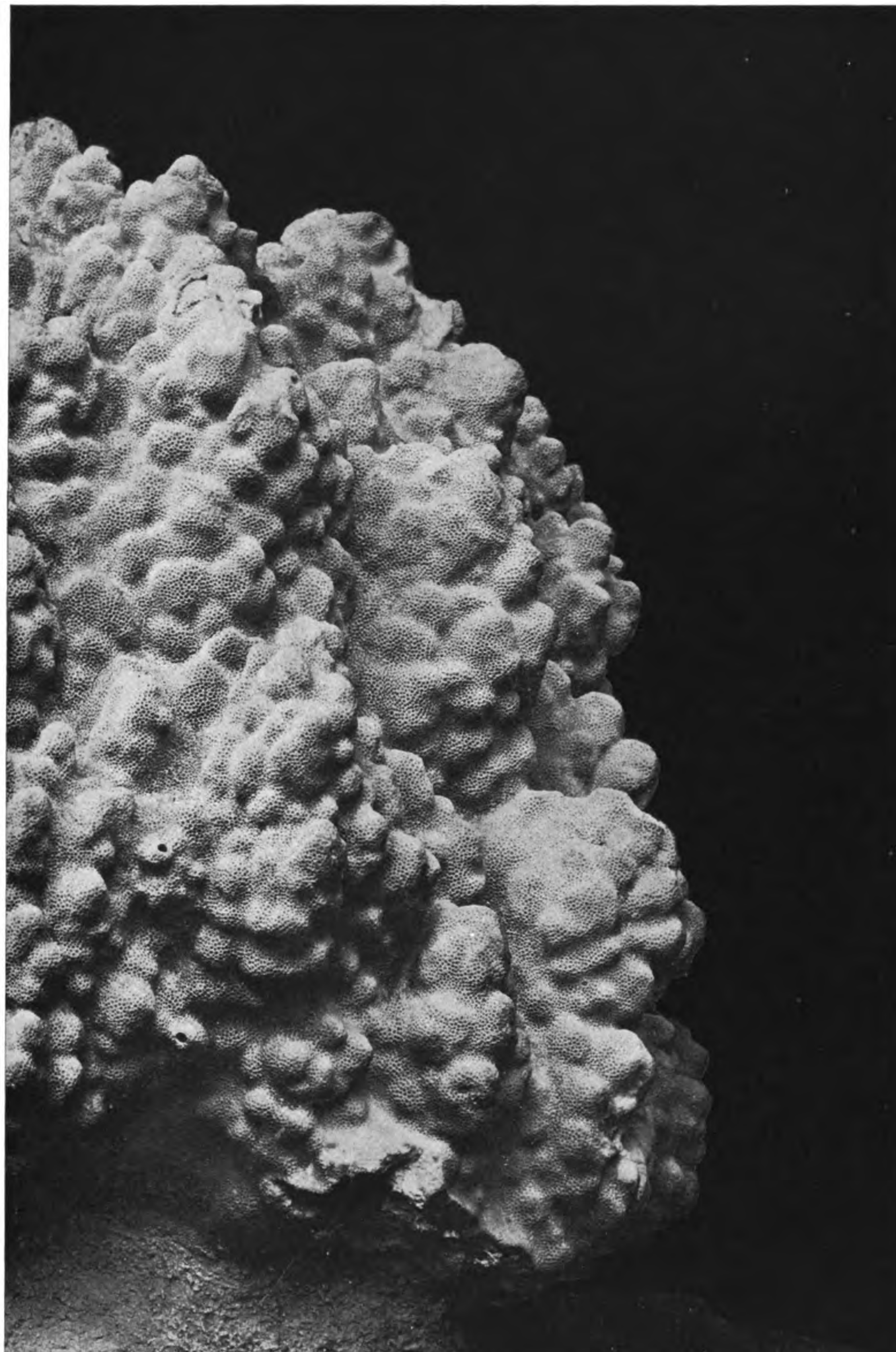

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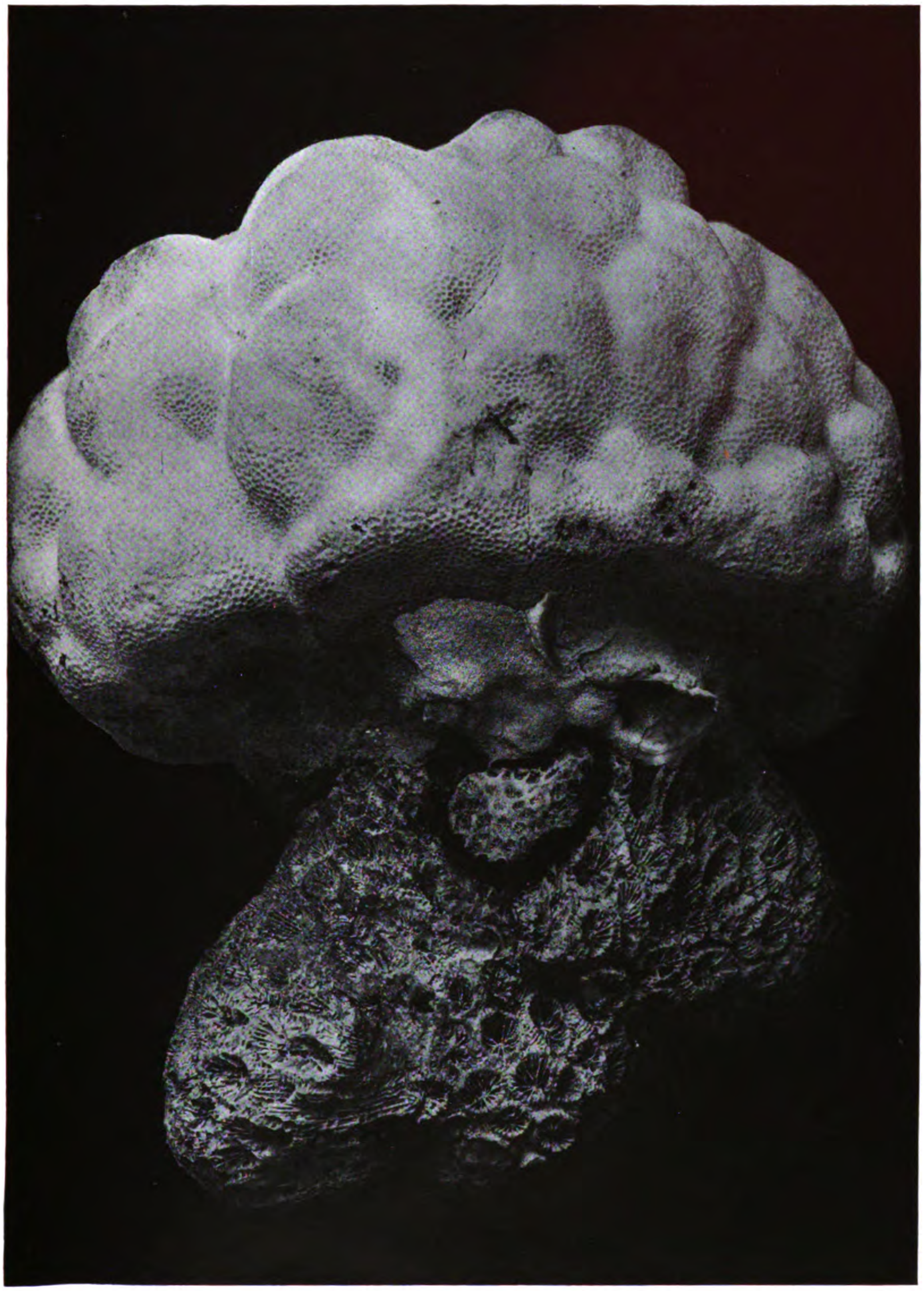

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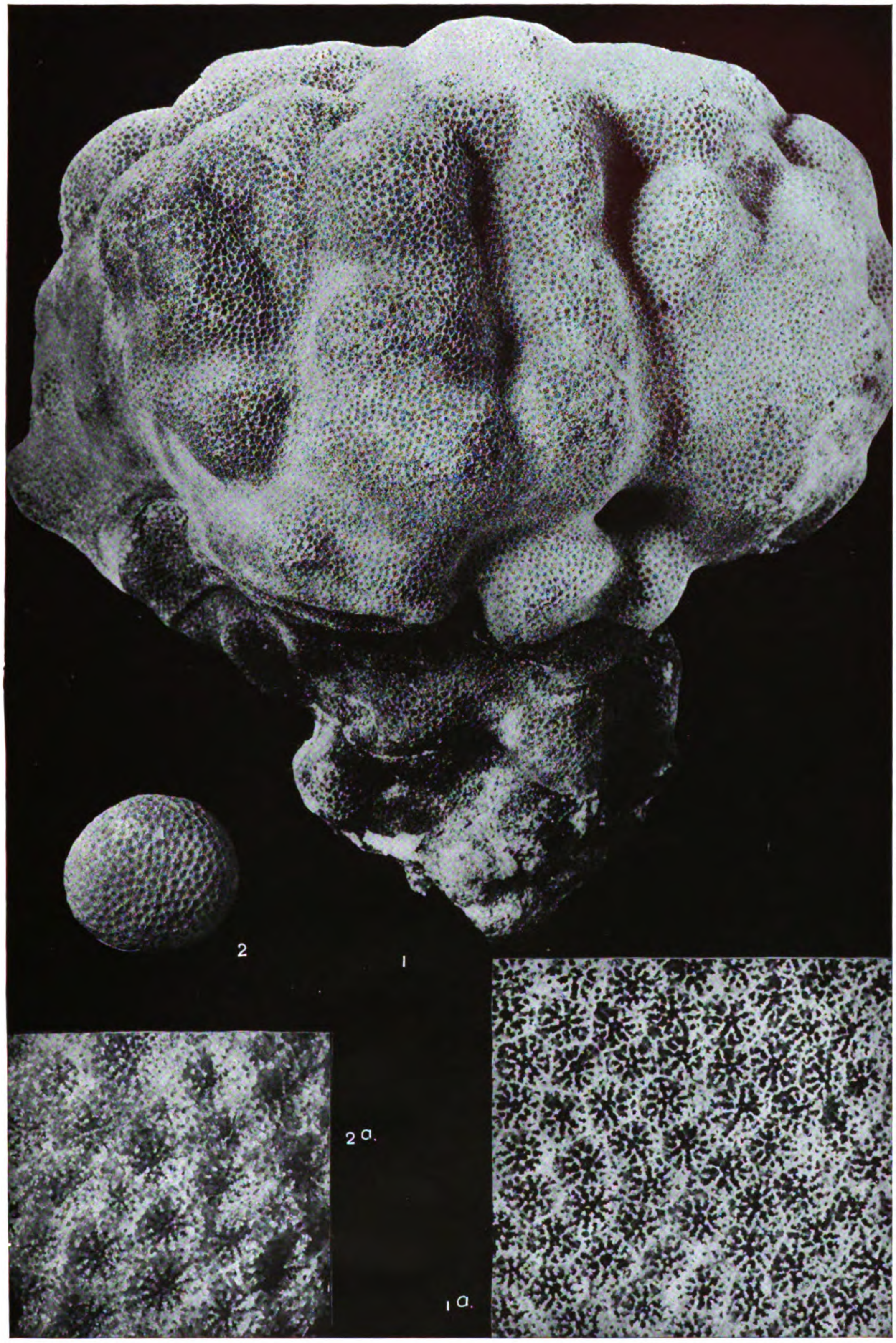

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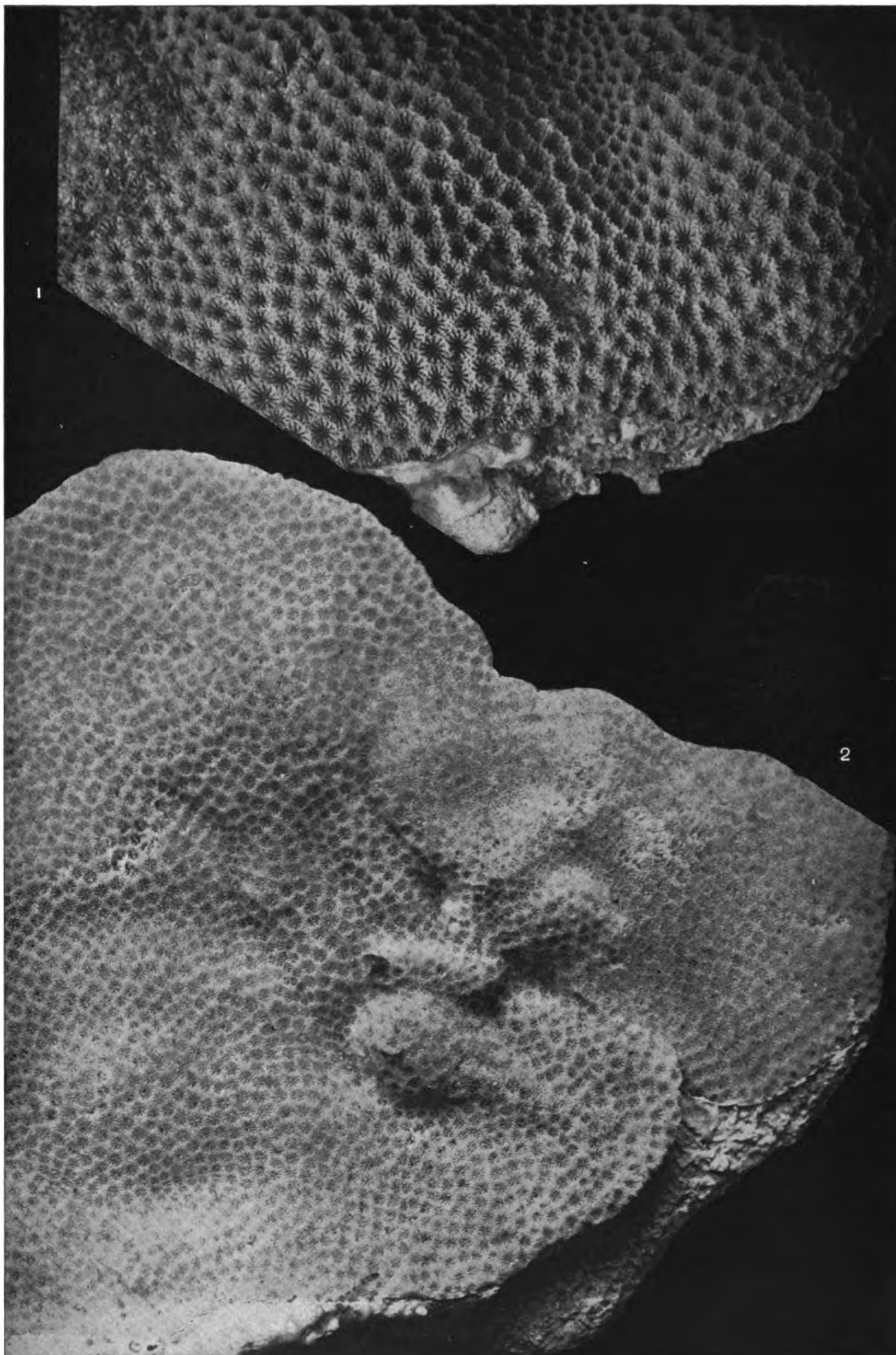

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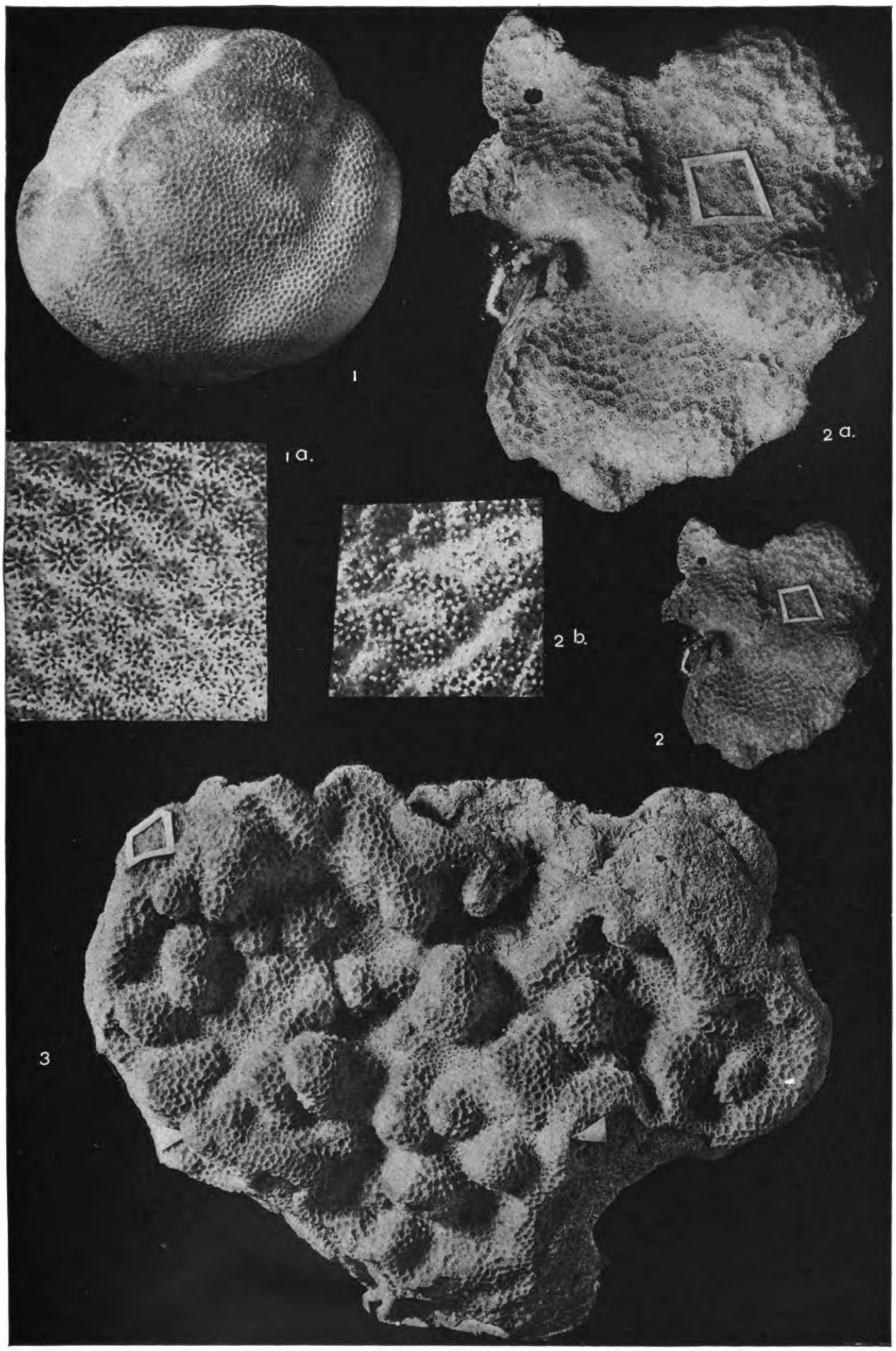
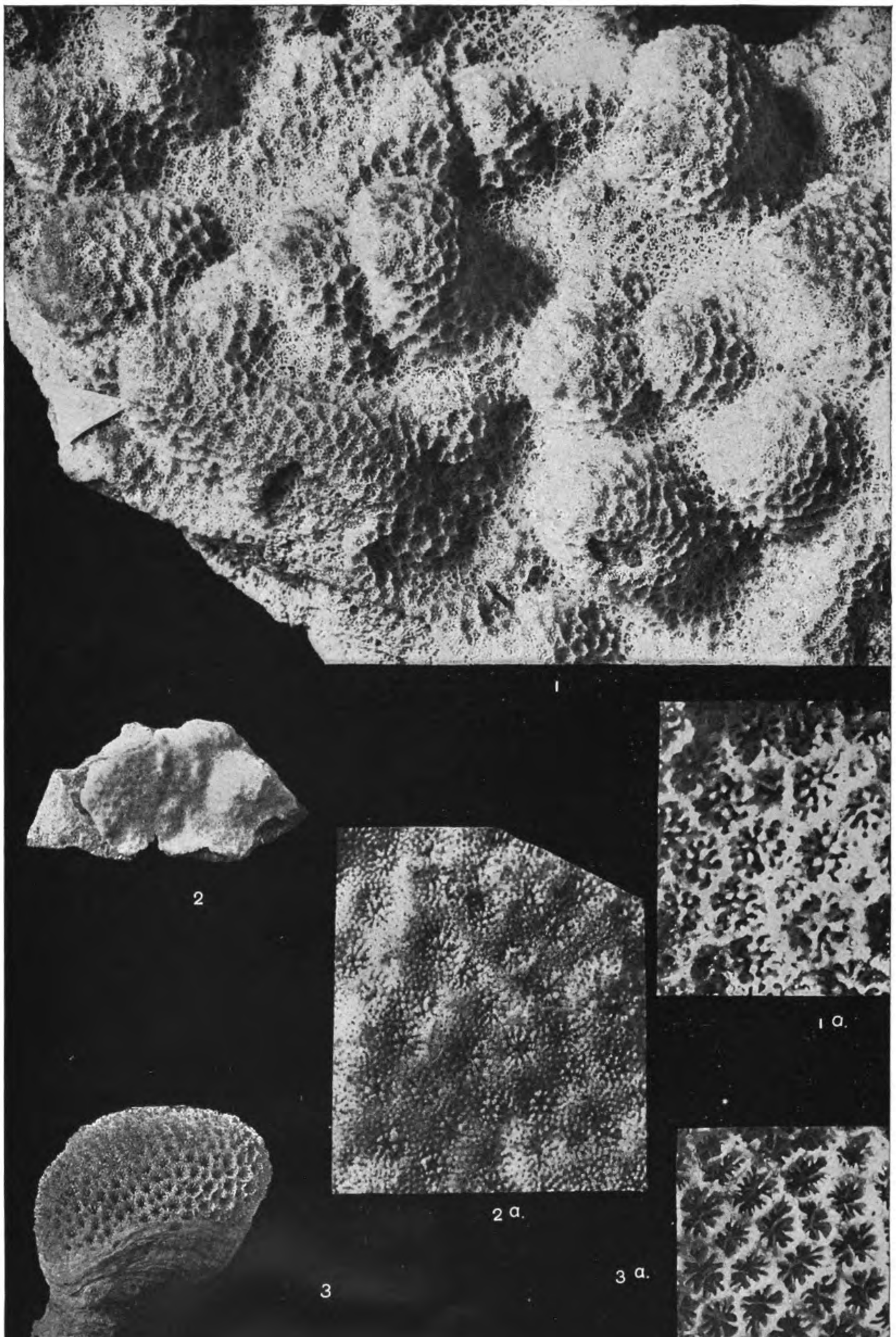
3. *Porites reticulosa* Dana. Type, upper surface, nat. size. (For calices, see Plate XCI, figs. 1, 1*a*) 215



PORITES.

PLATE XCI.

PLATE XCI.



PORITES ALVEOPORA.

PLATE XCII.

PLATE XCII.

MONTIPORA.

PLATE XCIII.

PLATE XCIII.

Porites compressa forma *angustisepta* new.

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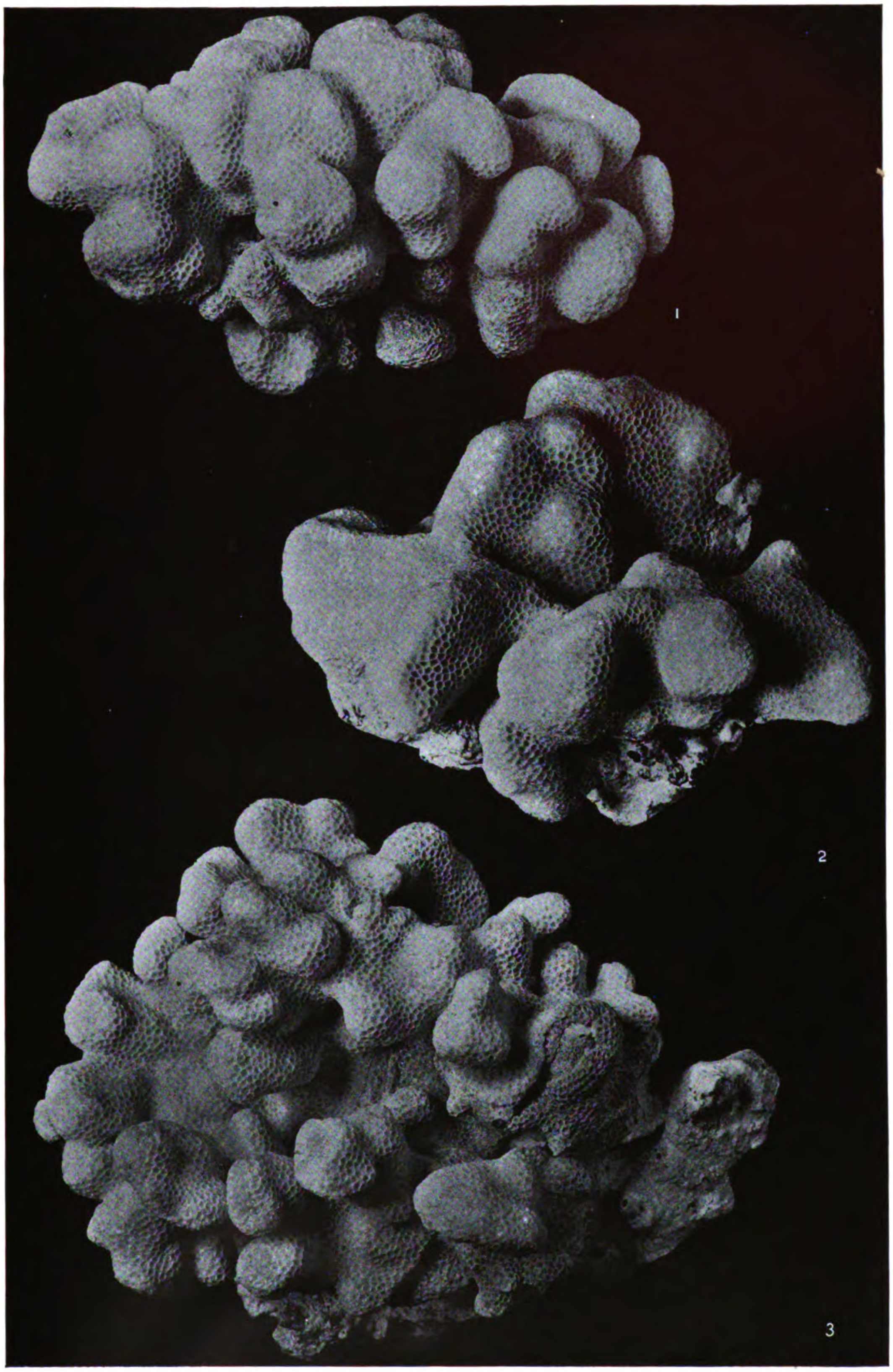
Figs. 1, 2, 3. Views of three specimens from Waikiki, Oahu, each nat. size	178



PORITES.

PLATE XCIV.

PLATE XCIV.

PORITES.

PLATE XCV.

PLATE XCV.

Porites pukoensis Vaughan. (Two views of the same specimen.)

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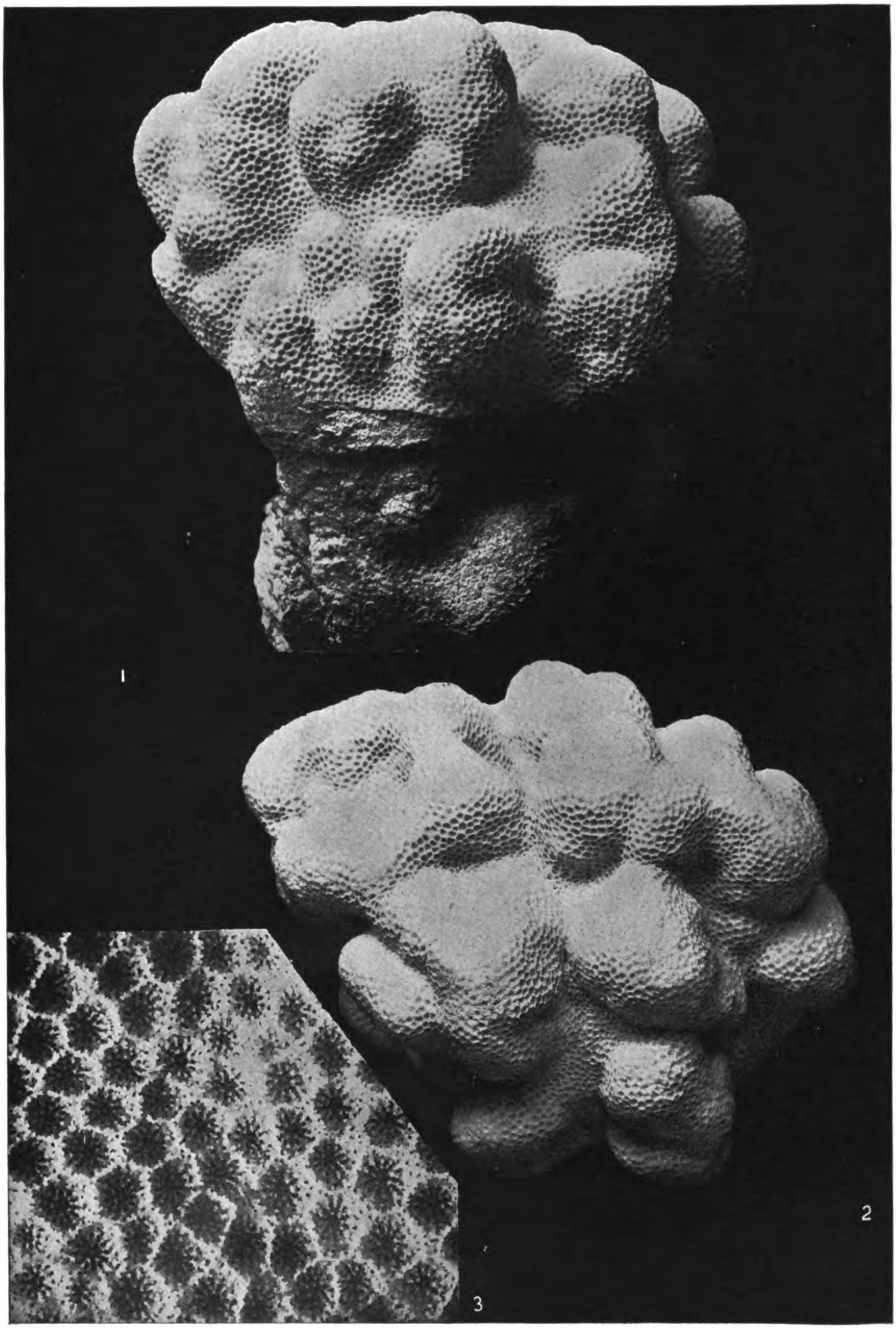
PORITES.

PLATE XCVI.

PLATE XCVI.

Porites lobata forma *centralis* subforma *epsilon* new. (Three views of the same specimen.)



PORITES.

INDEX.

The following index contains the names of the families, genera, species, varieties, formæ, and subformæ of Madreporaria, which occur in this memoir. Two kinds of type are used for the names, roman and italic; the former indicates valid names, the latter synonyms. It should be remarked that when a species name follows a genus name that is a synonym of another genus name, both the genus and species names of the combination are italicized, although the species name may be valid. When "var.," "forma," or "subforma" is inclosed by a parenthesis after a name, it indicates the value given in this memoir to the name. Two kinds of types are used in the figures referring to the pages, the heavy-faced type indicates the pages on which descriptions may be found. The numbers from 224 to 414, inclusive, refer to the explanations on the pages facing the plates.

ERRATUM.

On p. 13, insert *Madracis kauaiensis* Vaughan on the line next below *Madrepora kauaiensis* Vaughan.

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