



072 Ha

2

B.

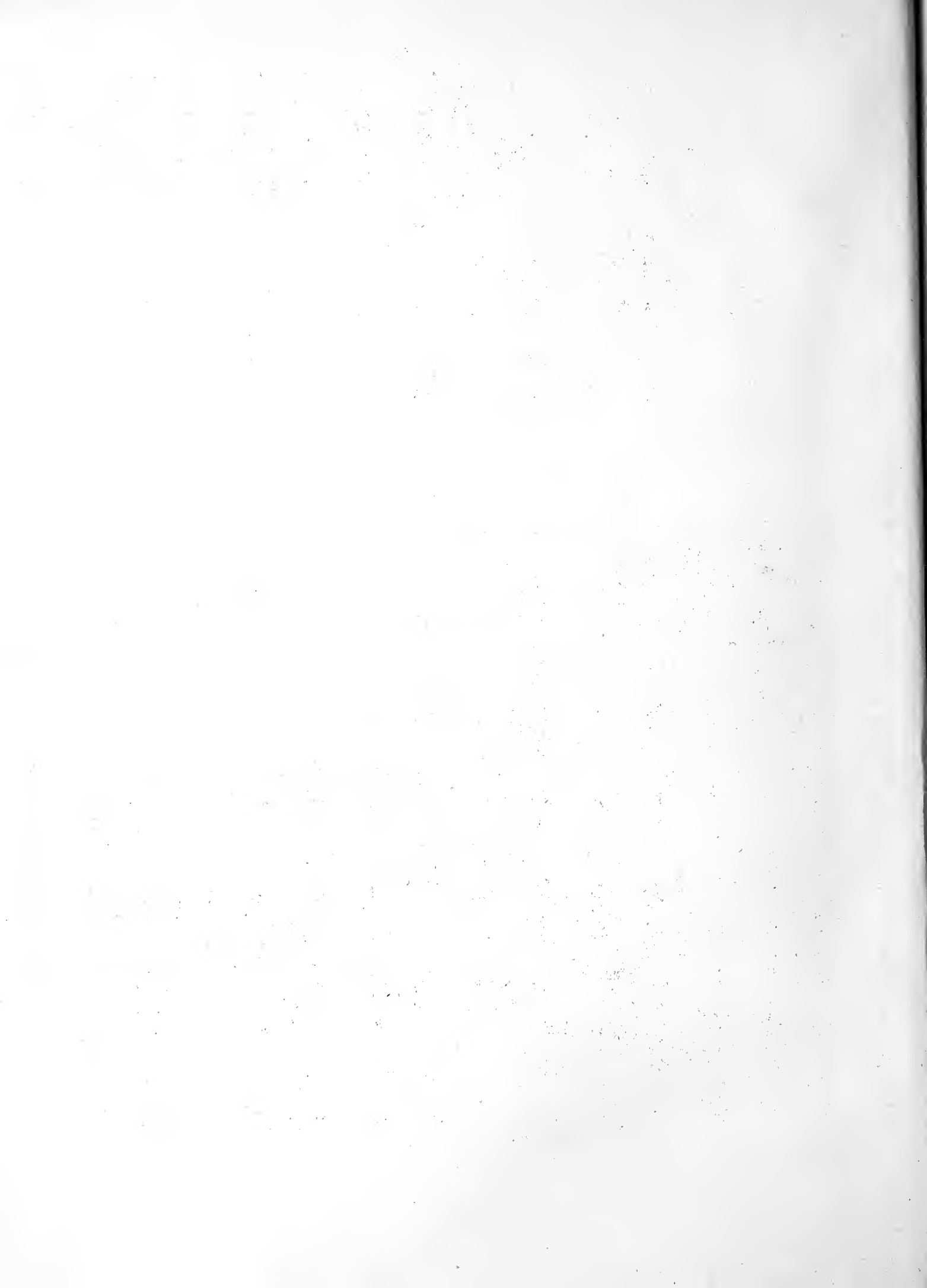
BHL

GREAT BARRIER REEF EXPEDITION

1928—29

VOLUME VI





BRITISH MUSEUM (NATURAL HISTORY)

GREAT BARRIER REEF EXPEDITION

1928—29

SCIENTIFIC REPORTS

VOLUME VI

1938—1958

TRUSTEES OF THE BRITISH MUSEUM (NATURAL HISTORY)

LONDON: 1968

PRESENTED

© Trustees of the British Museum (Natural History) 1968

Publication No. 674

CONTENTS

No.

1. THE LARVAE OF THE DECAPOD CRUSTACEA PALAEMONIDAE AND ALPHEIDAE.
By R. GURNEY. Pp. 1-60 ; 265 text-figs.
[Issued 26th February, 1938.]
2. ON *PHLYCTAENACHLAMYS LYSIOSQUILLINA* GEN. AND SP. NOV.,
A LAMELLIBRANCH COMMENSAL IN THE BURROWS OF *LYSIOSQUILLA*
MACULATA. By M. L. POPHAM. Pp. 61-84 ; 21 text-figs.
[Issued 25th March, 1939.]
3. MADREPORARIA, HYDROCORALLINAE, HELIOPORA AND TUBIPORA.
By C. CROSSLAND. Pp. 85-257 ; 56 pls., 1 text-fig.
[Issued 22nd October, 1952.]
4. HYDROMEDUSAE. By P. L. KRAMP. Pp. 259-322 ; 2 pls., 9 text-figs.
[Issued 22nd July, 1953.]
5. THE SERGESTIDAE OF THE GREAT BARRIER REEF EXPEDITION. By I. GORDON.
Pp. 323-333 ; 6 text-figs.
[Issued 31st January, 1956.]
6. FORAMINIFERA. By A. C. COLLINS. Pp. 335-437 ; 5 pls., 3 text-figs.
[Issued 16th September, 1958.]



BRITISH MUSEUM (NATURAL HISTORY)

GREAT BARRIER REEF EXPEDITION

1928-29

SCIENTIFIC REPORTS

VOLUME VI, No. 1

THE LARVAE OF THE DECAPOD
CRUSTACEA

PALAEMONIDAE AND ALPHEIDAE

BY

ROBERT GURNEY, M.A., D.Sc.

WITH TWO HUNDRED AND SIXTY-FIVE TEXT-FIGURES



LONDON:

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

SOLD BY

B. QUARITCH, LTD., 11 GRAFTON STREET, NEW BOND STREET, LONDON, W.1; DULAU & Co., LTD., 29 DOVER STREET,
LONDON, W.1; OXFORD UNIVERSITY PRESS, WARWICK SQUARE, LONDON, E.C.4
H.M. STATIONERY OFFICE, LONDON, S.W.1

AND AT

THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, LONDON, S.W.7

1938

[All rights reserved]

Price Five Shillings

[Issued 26th February, 1939]



Made and printed in Great Britain.

- 3 MAR 1938
PRESENTED



THE LARVAE OF THE DECAPOD CRUSTACEA

PALAEEMONIDAE AND ALPHEIDAE

BY

ROBERT GURNEY, M.A., D.Sc.

WITH TWO HUNDRED AND SIXTY-FIVE TEXT-FIGURES.

CONTENTS

PAGE

I. PALAEMONIDAE.

1A. PALAEMONINAE.

Leander Group.

<i>Leander pacificus</i> , Stimpson	3
<i>Leander tenuicornis</i> (Say)	4
Palaemonid B.R.I.	6

Palaemon Group.

<i>Brachycarpus biunguiculatus</i> (Lucas)	8
<i>Retrocaris</i>	9
Palaemonid D. I (<i>R. spinosa</i> , Ortm. ?)	9
Palaemonid D. II (<i>R. contraria</i> , Ortm.)	12

DISCUSSION OF THE LARVAE OF PALAEMONINAE	14
--	----

1B. PONTONINAE 15

<i>Periclimenes</i> Group	16
<i>Periclimenes grandis</i> (Stimpson)	16
<i>P. agag</i> , Kemp	16
<i>P. diversipes</i> , Kemp	17
<i>Harpilius beaupresi</i> (Audouin)	18
<i>H. gerlachei</i> , Nobili	20
<i>Coralliocaris graminea</i> (Dana)	20
Palaemonid R.S. I	21
Palaemonid B.R. II	22
Palaemonid B.R. III	23
Palaemonid D. III	24
Palaemonid D. IV	25
Palaemonid B.R. IV	26

	PAGE
DISCUSSION OF THE PERICLIMENES GROUP	27
<i>Mesocaris</i> Group	29
Palaemonid B.R. V	30
Palaemonid R.S. II	31
Palaemonid R.S. III	32
Palaemonid R.S. IV	33
Palaemonid B.R. VI	34
<i>Cryptoleander</i> Group	35
Palaemonid B.R. VII	36
Palaemonid B.R. VIII	38
Palaemonid B.R. IX	39
IC. ANCHISTIOIDINAE.	
<i>Anchistioides</i>	41
<i>Anchistioides</i> Species I	41
<i>Anchistioides</i> Species II	42
II. ALPHEIDAE.	
<i>Alpheus ventrosus</i> , M. Edw.	44
<i>A. audouini</i> , Coutière	45
<i>A. pacificus</i> , Dana ?	47
<i>Synalpheus triunguiculatus</i> (Paulson)	48
Alpheid R.S. I	51
Alpheid R.S. II	52
Alpheid B.R. I	53
<i>Athanas djiboutensis</i> , Coutière	54
Alpheid D. I	55
<i>Anebocaris ancylifer</i> , Coutière	56
Alpheid ? D. II	56
RELATION OF PALAEMONIDAE TO ALPHEIDAE	58

I. PALAEMONIDAE.

OUR present knowledge of the larvae of the Palaemonidae is very unsatisfactory. We know fully those of five species of *Leander* (*L. serratus*, *L. squilla*, *L. longirostris*, *L. fabricii*, *L. paucidens*) and of two species of *Palaemonetes*, so that the characters of these two genera are fully established. Sollaud has also described the development of a number of species of *Leander* and *Palaemon* in which the larval stages are more or less suppressed. Of the many genera and species of the Pontoniinae we know only the development of two species of *Periclimenes* of the subgenus *Ancylocaris* (*P. calmani*, *P. americanus*). In addition various larvae taken in plankton have been described under the generic names of *Retrocaris* and *Mesocaris*. Lastly I have been able to describe the early larvae of *Anchistioides antiguensis* (1936) which is regarded by Miss Gordon as a member of the Pontoniinae.

The following report is based upon a large and very varied series of larvae from the plankton of the Great Barrier Reef, and I am much indebted to Mr. F. S. Russell for the privilege of making use of it. In order to make the account as comprehensive as possible

I have brought into consideration also material from Ghardaqa on the Red Sea and also certain specimens from the "Discovery" Expedition.

From this abundant material I have selected for description 17 larval forms which can with some certainty be referred to the Palaemonidae, but cannot be definitely identified. Together they illustrate a variety of form and of structure of appendages which is surprising and raises perplexing problems of systematics.

With our present groundwork of knowledge of the two genera *Leander* and *Periclimenes* it is possible to separate these forms into the two subfamilies Palaemoninae and Pontoniinae, but even so there remains uncertainty in some cases.

The close examination of these larvae shows that the summary I have given of the characters of *Periclimenes* and *Mesocaris* (1936, p. 623) is inadequate, since there are details in the structure of the appendages which should be taken into consideration. The significance of such differences naturally only becomes apparent when the survey can be extended over a sufficiently wide field.

Another point which I have not before fully appreciated is the correct designation of the spines on the anterior part of the carapace in late stages. The homologies of these spines are not always clear. In *Leander* the anterior angle of the carapace is pointed, and this point may be taken as the pterygostomial spine, which is lost at the last moult, and does not appear at all in *Retrocaris* (*Palaemon*?). In *L. serratus* a small spine appears just above and quite close to the pterygostomial point, and is no doubt the branchiostegal spine, which usually persists in the adult and is absent in the adult of *Palaemon*. It is, however, present in the larva if *Retrocaris* is rightly referred to *Palaemon* or *Brachycarpus*. The antennal spine, which is present in the adult of both genera, does not make its appearance in the larva. In *L. paucidens* Yokoya regards a small spine which arises in Stage VI as antennal, but it has the position of the spine which I regard as branchiostegal.

Apparently the branchiostegal spine is found in all larvae of the Palaemoninae and is lost later in *Palaemon* and *Brachycarpus*, while the antennal spine is very rarely developed in larval life.

1A. PALAEMONINAE.

Leander pacificus, Stimpson. (Text-figs. 1-7.)

LOCALITY.

Common on the tidal reef-flat at Ghardaqa along the mole leading to the laboratory. One female hatched larvae on March 15th.

DESCRIPTION.

Stage I. Length 2.75-3.3 mm.

Rostrum reaching end of peduncle of antennule, serrated at end. Abdominal somite 5 without lateral spines. Telson much wider than long, the three inner pairs of spines about equal in length.

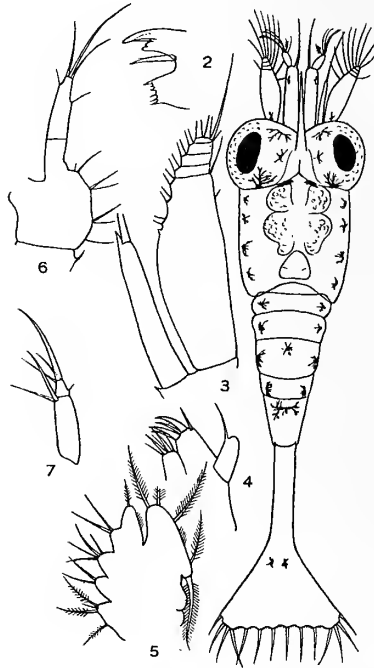
Antennal scale long and narrow, segmented at end, the proximal outer seta reduced to a minute hair. Close to the proximal inner seta is a minute tubercle, such as is found more marked in Pontoniids and some Alpheids.

Mandible with one large spine between incisor and molar parts. Maxillule, endopod small, rounded at end, with one subterminal seta; lacinia 2 with four spines. Maxilla, endopod broad, with well-marked basal lobe bearing two setae; exopod with five setae.

Maxillipede 1 with endopod faintly divided into two segments, basis not protuberant, with few small setae; exopod with six setae. Maxillipede 2, basis with three small setae; endopod of three segments; dactyl with large terminal spine and two smaller spines on either side. Maxillipede 3, dactyl with very large terminal spine; without strong spines on basis or ischium. Exopod with eight setae.

Rudiments of legs 1 and 2 biramous.

Colour: General appearance red. Thorax with a row of four dark red chromatophores with yellow branches; a double row of red chromatophores on abdominal somites 1-4. Dark olive chromatophores in base of antennae.



TEXT-FIGS. 1-7.—*Leander pacificus*, Stimpson.

- | | |
|--------------------------|---------------------------|
| FIG. 1.—Stage I, dorsal. | FIG. 5.—Stage I, maxilla. |
| FIG. 2.— „ mandible. | FIG. 6.— „ maxillipede 1. |
| FIG. 3.— „ antenna. | FIG. 7.— „ maxillipede 3. |
| FIG. 4.— „ maxillule. | |

REMARKS.

This larva is of perfectly normal *Leander* type, agreeing in all respects with that of such species as *L. longirostris* and *L. squilla*.

Leander tenuicornis (Say). (Text-figs. 8-16.)

LOCALITY.

This species is common on the *Halophila*-bed at Ghardaqa, and in floating *Sargassum*. Larvae were hatched in the laboratory on 2nd February and 9th March.

DESCRIPTION.

Stage I. Length 2.2-2.5 mm.

Carapace with small median dorsal papilla; rostrum nearly as long as antennule, with a few small denticles dorsally at end.

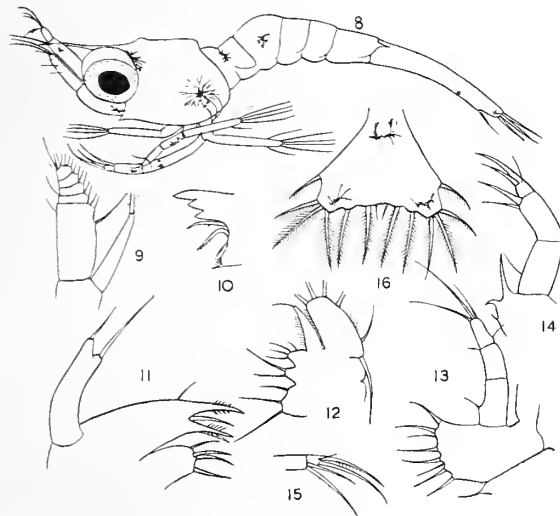
Abdominal somite 5 with lateral spines. Telson broader than long, slightly concave, the innermost pair of spines very small.

Antennule, distal segment with a feathered seta and four aesthetes, of which one is very stout and one seta-like. Antennal scale with four distal segments distinct; two outer and ten inner and apical setae; endopod with a long seta and small spine.

Mandible with three large teeth on incisor part, and three spines in the hollow between it and the molar part.

Maxillule, endopod slender, bilobed at end, and with two setae; lacinia 2 with four spines. Maxilla, endopod slender, without basal lobe or seta; exopod with five setae.

Maxillipede 1, endopod of three distinct segments: coxa very small; basis remarkably produced, axe-shaped, with six strong spines; exopod with four apical setae.



TEXT-FIGS. 8-16.—*Leander tenuicornis* (Say).

FIG. 8.—Stage I, lateral.

FIG. 9.—,, antenna.

FIG. 10.—,, mandible.

FIG. 11.—,, maxillule.

FIG. 12.—,, maxilla.

FIG. 13.—Stage I, maxillipede 1.

FIG. 14.—,, maxillipede 2.

FIG. 15.—,, maxillipede 3, dactyl.

FIG. 16.—,, telson.

Maxillipede 2, basis with two large spines; endopod of three segments, with strong spines on segments 2 and 3.

Maxillipede 3 with strong spine on basis and at position of division between ischium and merus; dactyl with two long slender apical spines. Exopods of maxillipedes 2 and 3 with six apical setae.

Rudiments of legs 1 and 2 present.

Colour: General colour of thorax pinkish yellow; abdomen nearly colourless when chromatophores are contracted. The large chromatophore behind the eye is dark red, with olive-brown branches, and, when the chromatophores are expanded, the general colour becomes red. The chromatophores in the telson and maxillipedes are olive-brown.

Stage II. Length 2.8 mm.

Carapace with large supraorbital and anterior dorsal spines. Telson with 8 + 8 spines, the middle pair unusually small.

Antennal scale segmented, with 15 setae ; endopod unchanged.

Legs 1 and 2 developed, with exopods bearing eight setae ; rudiments of legs 3 and 4 present, very small.

Additional chromatophores have appeared in thorax and abdomen.

A few specimens moulted to Stage II in the laboratory ; but neither this nor any later stages were found in the plankton.

REMARKS.

While the larva has most of the characters usual in *Leander*, the mouth-parts differ considerably. The form of the endopod in maxillule and maxilla, and of the basis in maxillipede 1 is quite unlike that of the normal type, and the presence of strong spines on the basis of maxillipede 2 is a feature unknown in *Leander*, but found again in some Pontoniids. The long slender spines on maxillipede 3 are also seen in some Pontoniids, and not in *Leander*.

Palaemonid B.R. I (*Leander* sp. ?). (Text-figs. 17-24.)

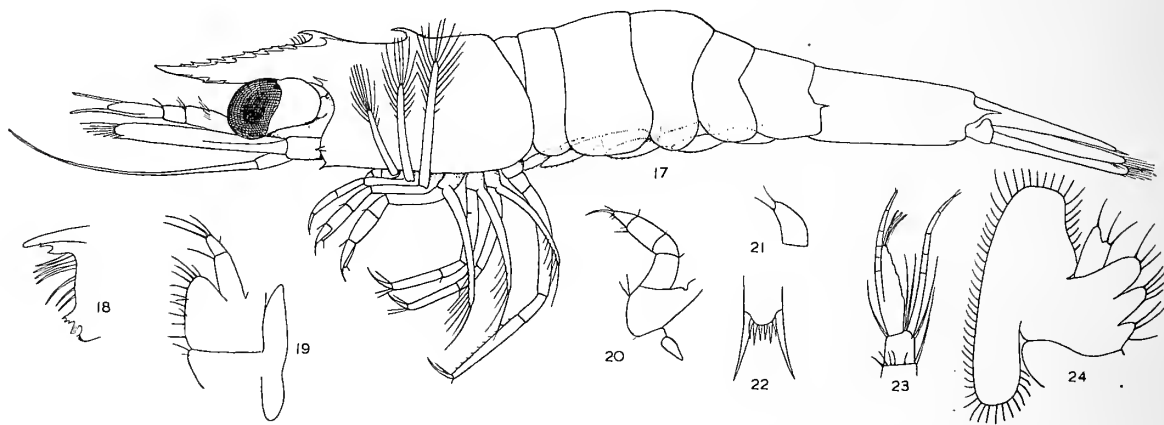
LOCALITY.

Great Barrier Reef. Stations 3, 44, 53.

DESCRIPTION.

Last stage. Length 9.85 mm.

Rostrum straight, rather deep, with large serrated spine at base and a series of very small dorsal, and one ventral teeth. Carapace with large serrated dorsal spine, small



TEXT-FIGS. 17-24.—Palaemonid B.R. I. (*Leander* sp. ?).

- | | |
|-------------------------------|---|
| FIG. 17.—Last stage, lateral. | FIG. 21.—Last stage, palp of maxillule. |
| FIG. 18.—,, mandible. | FIG. 22.—,, end of telson. |
| FIG. 19.—,, maxillipede 1. | FIG. 23.—,, end of antennule. |
| FIG. 20.—,, maxillipede 2. | FIG. 24.—,, maxilla. |

supraorbital, branchiostegal and pterygostomial spines. Abdomen straight, somite 5 with small lateral spines and rectangular pleura ; somite 6 with lateral spine. Anal spine absent. Telson five times as long as wide, without lateral spines, and with 4+4 terminal spines, the outer pair large.

Antennule, segment 1 with small ventral spine, but without outer distal spine ;

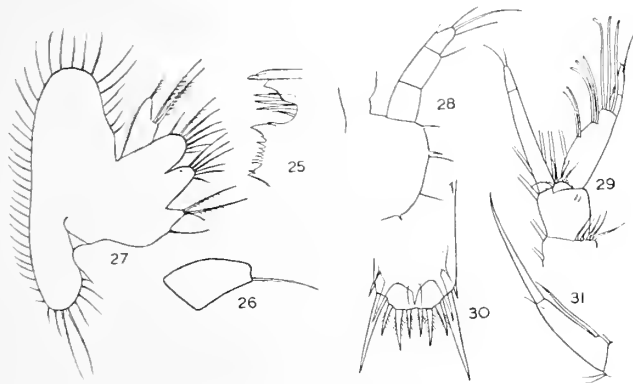
stylocerite small; otocyst cavity formed and surrounded by small setae, but not covered by extension of the stylocerite; exopod deeply cleft. Antennal scale with small distal spine; flagellum longer than scale.

Maxillule, endopod small, with two apical setae. Maxilla, exopod large, outer margin fringed with setae; endopod with basal lobe bearing two setae.

Maxillipede 1, coxa large, with large bilobed epipod; basis not protuberant, with numerous setae; endopod of two segments; exopod widened at base, with numerous setae, 6 apical setae. Maxillipede 2, coxa with small epipod; basis without spines; endopod of four segments, without strong spines. Maxillipede 3, dactyl with one strong terminal spine.

Exopods of maxillipedes with numerous setae.

Legs 1 and 2 chelate, leg 2 somewhat the larger. Legs 3 and 4 alike, leg 4 with exopod. Leg 5 not much larger than leg 4: propod with a series of small spines along inner margin, but without strong terminal spines; dactyl with basal spine.



TEXT-FIGS. 25-31.—*Leander* (last stage).

FIG. 25.—*L. serratus* mandible.

FIG. 26.— „ palp of maxillule.

FIG. 27.— „ maxilla.

FIG. 28.—*L. squilla elegans*, maxillipede 1.

FIG. 29.—*L. serratus* end of antennule.

FIG. 30.— „ end of telson.

FIG. 31.— „ leg 5, dactyl.

Pleopods large, with small points on outer side, and setae on inner side of exopods; appendix interna well developed.

REMARKS.

This larva differs so little from the corresponding stage in European species of *Leander* that I feel justified in referring it to that genus. I give some figures of the telson and appendages of the last larva of *Leander serratus* for comparison (Text-figs. 25-31), from which it will be seen that there are differences in telson and some appendages; but they are not great. It will be noted, however, that the exopod of the antennule in this form is very much farther advanced than it is in the last larval, or even the first post-larval stage of *L. serratus*. This early bifurcation of the outer flagellum will be seen also in some other larvae described below.

Some specimens which can be definitely referred to *Leander* of the *L. serratus* type were found in a sample from Barrier Reef Station 38.

Brachycarpus biunguiculatus (Lucas). (Text-figs. 32-38.)

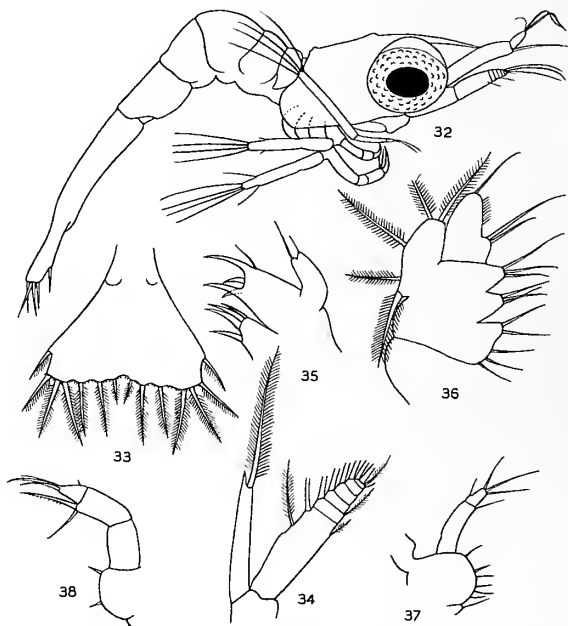
LOCALITY.

I am indebted to Dr. J. F. G. Wheeler for larvae of this species hatched out at the Bermuda Biological Station.

DESCRIPTION.

Stage I. Length 2.2 mm.

Carapace with small dorsal papilla and long slender rostrum reaching to about two-thirds length of antennular peduncle. There is a minute point representing the pterygostomial spine, but hidden by the eye in side view. Abdominal somites without dorsal



TEXT-FIGS. 32-38.—*Brachycarpus biunguiculatus* (Lucas).

FIG. 32.—Stage I, lateral.

FIG. 33.— „ telson.

FIG. 34.— „ antenna.

FIG. 35.— „ maxillule.

FIG. 36.—Stage I, maxilla.

FIG. 37.— „ maxillipede 1.

FIG. 38.— „ „ 2.

or lateral spines. Telson with nearly straight posterior margin; innermost spine very short.

Antennal scale slender, with five distal segments well marked; two outer and ten inner and terminal setae. There is a trace of the inner knob characteristic of Pontoniinae and some Alpheidae. Endopod a straight rod, with long seta and small inner apical spine.

Maxillule, endopod bilobed at end, with two small setae. Maxilla, endopod with basal lobe bearing two setae; proximal lacinia large, with five setae; exopod with five setae.

Maxillipede 1 coxa reduced; basis protuberant, with several small setae; endopod unsegmented, or faintly three segmented; exopod with five setae. Maxillipede 2, endopod

of three segments, with strong spines on segments 2 and 3; basis with two small spines. Maxillipede 3, dactyl with one strong apical spine. Exopods of maxillipedes 2 and 3 with six setae.

Rudiments of legs 1 and 2 present.

REMARKS.

Although only Stage I was obtained, it is of some interest as this is the first species of the *Palaemon* group of which the free larva has been seen. As was to be expected, the larva at this stage cannot be distinguished generically from *Leander*. We have no indication as to what the later stages may be like, but it is quite possible that they may be included in one of the forms of *Retrocaris* described below.

Retrocaris.

This larval genus was founded by Ortmann (1893) for two species, *R. contraria* and *R. spinosa*. A third, *R. antarctica*, was described by Coutière (1907). Coutière referred these larvae to the Palaemonidae, but ventured the suggestion that *R. antarcticus* might be the larva of *Campylonotus vagans*, the adult of which species was taken at the same station. While Coutière's specimen was only 5 mm. long Ortmann's *R. contraria* was 16 mm., and Coutière regarded it as one of those "giant larvae" which he believed to be due to abnormal development. I have described myself (1924, p. 123) specimens resembling *R. contraria* of sizes between 9.5 and 19 mm., and have suggested that they may be larvae of *Palaemon*.

The "Discovery" collection contains 20 specimens from six stations, evidently belonging to two species. Of one of these I have also 15 specimens from "Atlantis" Station 1121.

Palaemonid D. I (*Palaemon* sp. ?) (Text-figs. 39-52.)

Retrocaris spinosa, Ortmann ?, 1893, p. 84.

Palaemon sp. ?, Gurney, 1924, p. 123.

LOCALITY.

"Atlantis" Station 1121. 37° 53' N., 62° 45' W.

DESCRIPTION.

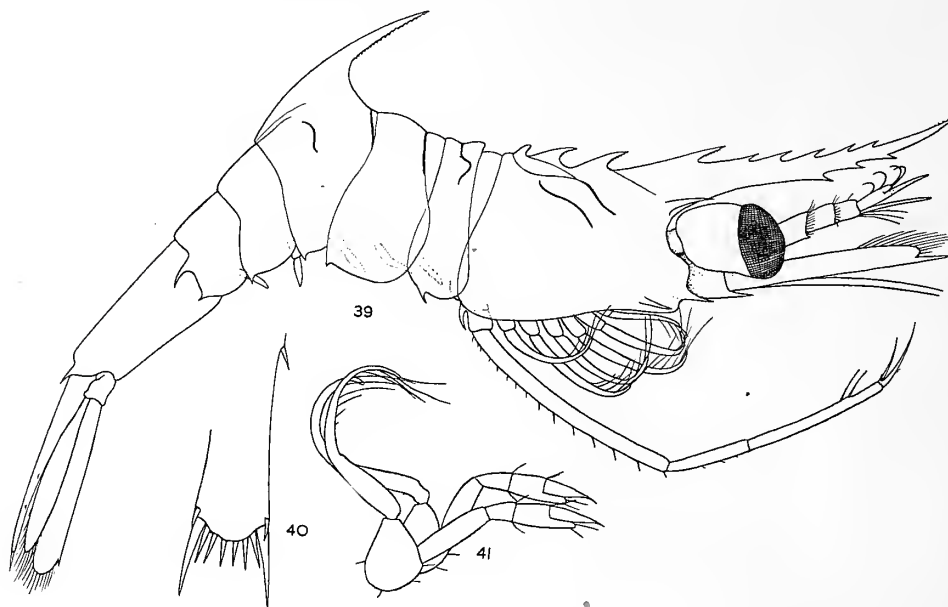
Length 18 mm. Rostrum longer than scale, with six dorsal and three ventral teeth; the basal dorsal tooth slightly larger than the rest and serrated; end of rostrum serrated dorsally. Carapace with two large serrated dorsal teeth and a posterior papilla; supra-orbital, hepatic and branchiostegal spines present, large. In one of the "Atlantis" specimens, of 17 mm., red lines are still visible on carapace and abdomen, and their position has been indicated in Text-fig. 39.

Abdominal pleura large, those of somites 1-4 with small procurved tooth; somite 3 with very large procurved dorsal process strongly serrated along anterior margin; somite 5 with large lateral spines and pleura rectangular, or with small spine at angle; somite 6 one and a half times as long as deep, with large posterior lateral spines. Anal spine absent. Telson four times as long as wide, with two pairs of lateral spines and 5 + 5 terminal, of which the second pair is the largest.

Antennule with well-developed stylocerite and strong apical outer spine on segment 1; segment 1 with ventral spine; outer flagellum deeply cleft. Antennal scale widest about

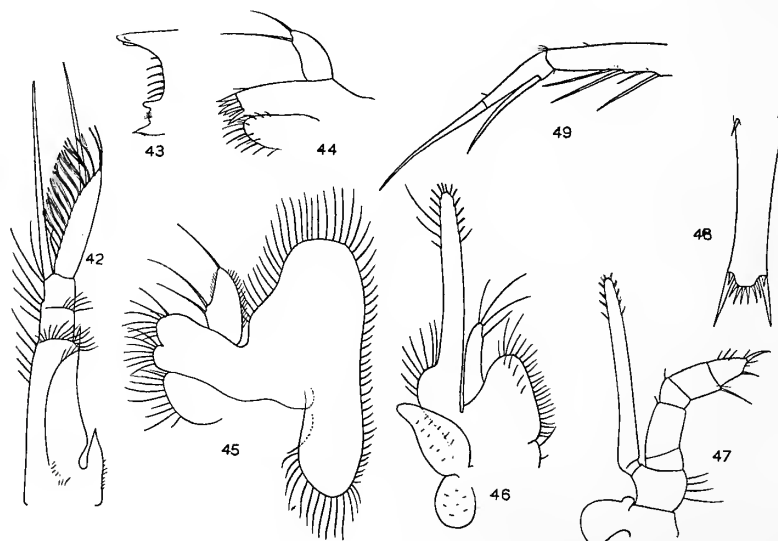
middle and more than three times as long as wide ; apical spine very large ; flagellum long, but broken. Mandible without palp, with six rather small spines between incisor and molar parts.

Maxillule, endopod unsegmented, with two setae ; lacinia 2 with five or six spines.



Maxilla, exopod very large, outer margin fringed with setae ; endopod with basal lobe bearing two setae.

Maxillipede I with large bilobed epipod ; exopod widened at base, with several setae at this point ; basis large, with straight inner margin ; endopod unsegmented. Maxilli-

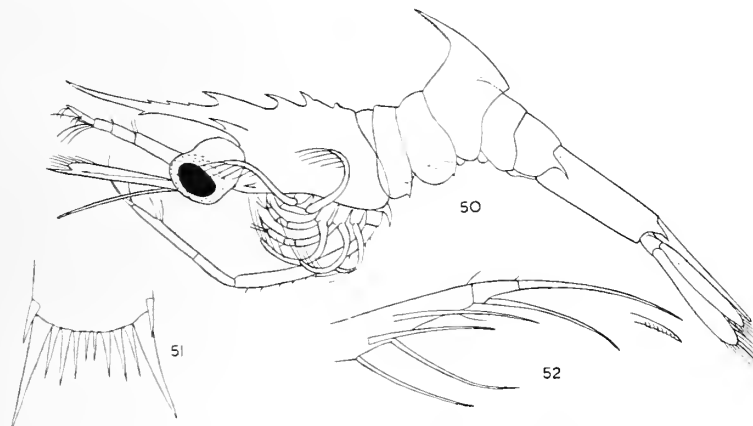


pede 2, basis with small setae ; epipod large, with small lobe representing podobranch ; endopod of five segments. Maxillipede 3 with two rudimentary gills. One of these gills is foliated and the other a simple papilla, but they are so close together that it is impossible to designate one of them as a pleurobranch ; both, by position, are arthrobranchs.

Legs 1 and 2 chelate, leg 2 slightly the larger. Legs 3 and 4 alike, with exopods, the dactyl with small terminal spine and propod without long terminal spines. Leg 5 reaching forward to end of antennal scale. Coxa with large curved spine; propod with a group of long straight spines, serrated at the end; dactyl with large spine at base and long terminal spine serrated at end.

Lengths of segments: Dactyl and spine, 1.2 mm.; propod, 2.38 mm.; carpus, 1.46 mm.; ischiomerus, 4.0 mm.

Pleopods large, with setae.



TEXT-FIGS. 39-52.—*Retrocaris (Palaemon)*.

FIG. 39.—Palaemonid D. I. 11 mm. "Discovery" Station 709. Heavy lines on carapace and abdomen indicate red markings.

FIG. 40.—,, telson.

FIG. 41.—,, legs 1 and 2.

FIG. 42.—Palaemonid D. I. 18 mm. "Atlantis" Station 1121. Antennule.

FIG. 43.—,, mandible.

FIG. 44.—,, maxillule.

FIG. 45.—,, maxilla.

FIG. 46.—,, maxillipede 1.

FIG. 47.—,, " 2.

FIG. 48.—,, telson.

FIG. 49.—,, leg 5.

FIG. 50.—Palaemonid D. I. 7.6 mm. "Discovery" Station 708.

FIG. 51.—,, part of telson.

FIG. 52.—,, part of leg 5.

REMARKS.

This description is taken from one of the largest specimens. The smallest measures 7.6 mm. and differs in having fewer and smaller teeth on the rostrum (Text-fig. 50); the basal tooth, which really belongs to the carapace series, is strikingly larger than those on the rostrum itself. The telson has an additional pair of terminal spines; legs 1 and 2 are not chelate; the pleopods are traceable only as small papillae; the flagella of the antennule are quite small, the outer one not cleft.

This is, no doubt, the same species as I have described from "Terra Nova" Stations 46 and 49, but in that case the endopod of maxillipede 1 was found to be segmented, and I must assume an error in the shape of the pleura of somite 5 shown in the figure. In these large, opaque specimens such an error is easily made.

Janeiro. It was, however, also taken on the eastern side of the ocean near the Cape Verde Islands, and so wide a distribution suggests that there may be two species included.

DISTRIBUTION OF *Retrocaris* LARVAE.

	Number of specimens.	
	D. I.	D. II.
"Discovery"		
Station 691	00° 25' S., 29° 56' W.	1
„ 701	14° 39' N., 25° 51' W.	1
„ 704	3° 37' N., 29° 14' W. 2
„ 706	3° 26' N., 32° 08' W. 6
„ 708	10° 26' S., 34° 54' W.	1
„ 709	14° 01' S., 36° 30' W.	4
„ 711	24° 40' S., 41° 30' W.	5
"Atlantis"		
Station 1121	37° 53' N., 62° 45' W.	15
"Terra Nova"		
Station 46	20° 30' S., 36° 30' W. }	6
„ 49	18° 51' S., 33° 40' W. }	

I have attached the name *Palaemon* to both the species ; but it is probable that one of them may be, or includes, *Brachycarpus unguiculatus*.

Coutière's suggestion that *Retrocaris* may be the larva of *Campylonotus* can be dismissed, since the gill formula of the oldest specimens is evidently complete, and there is no trace of epipods or arthrobranchs on any of the legs.

DISCUSSION OF THE LARVAE OF PALAEMONINAE.

Having regard to the fact that we know fully the larvae of all the European species of Palaemoninae, and that they agree in almost every detail, one would suppose that the generic characters would be as securely founded as could well be. Nevertheless Yokoya's description of *L. paucidens* (De Haan) shows that there may be important differences, since in this species leg 5 becomes very much larger than in the other species, and indeed approaches the disproportionate size seen in *Retrocaris*. In *L. tenuicornis*, while the general form in Stages I and II is exactly the same as in the European species, the structure of the maxilla and maxillipedes is very different, and approaches very closely to that found in some Pontoniinae. It is unfortunate that later larvae in which legs 4 and 5 are developed are not known, but the differences in the maxillipedes are so great that one is tempted to suggest that *L. tenuicornis* should be excluded from *Leander*. The adult has in fact certain exceptional characters, as has been pointed out by Kemp (1925, p. 302). The colouring is very unusual, and the pigmentation of the eye is such as is "not often seen in *Leander*". The cornea is marked with bands of dark pigment, and such bands "are of very frequent occurrence in *Periclimenes* and other genera of Pontoniinae". The sexual difference in length of leg 2 is also a most unusual feature according to Kemp ; and the endopod of pleopod 1 in the male has an appendix interna. So far as is known this appendix is found among Palaemonidae only in *Urocaridella gracilis*, *Palaemonetes*

hornelli and *Anchistioides antiguensis*.* In my own specimens the palp of the mandible has two segments only, as in *L. squilla*, *L. cubensis* and *L. semmelinki*.

When one considers that the genus *Palaemonetes* is generally accepted as distinct from *Leander* although it differs only in the absence of the mandible palp and of the pleurobranch on maxillipede 3 it is not unreasonable to claim that the peculiarities of the larva combined with those of the adult would justify the same separation of *L. tenuicornis*.

SUMMARY OF THE CHARACTERS OF THE LAST LARVA.

Leander. (Excluding *L. tenuicornis* (Say).)

Carapace with one or more dorsal spines; pterygostomial and branchiostegal spines present, antennal and hepatic absent. Abdominal somite 3 without dorsal spine; somite 5 with lateral spines, except in *L. paucidens*; anal spine present or absent. Telson with two pairs of very small lateral spines, or without them; apical spines usually 5 + 5, spine 2 large, but spine 1 very small and sometimes absent.

Antennule with ventral spine. Antennal scale with spine.

Maxillule, endopod bilobed at end. with one seta.

Maxilla, endopod with basal lobe; exopod with setae along outer margin.

Maxillipede 1, basis small, not protuberant, without spines. Maxillipede 2, basis not protuberant, without spines. Maxillipede 3, dactyl with one strong terminal spine.

Leg 4 with exopod (except in *L. longirostris*); developing later than leg 5; structure as leg 3.

Leg 5 larger than leg 4. but usually not much larger; dactyl with basal spine.

Retrocaris (*Palaemon* or *Brachycarpus*).

As above, but differing as follows:

Abdominal somite 3 with dorsal spine. Anal spine absent.

Telson with 5 + 5 or 6 + 6 apical spines, very slender.

Maxillipede 3 basis large, somewhat produced distally.

Leg 5 very long, twice as long as leg 4.

1B. PONTONIINAE.

The first larva of the following species was obtained by hatching in the laboratory at Ghardaqa: †

Periclimenes (*Ancylocaris*) *grandis* (Stimpson).

P. (A.) agag, Kemp.

P. (A.) diversipes, Kemp.

Harpilius beaupresi (Audouin).

H. gerlachei, Nobili.

Coralliocaris graminea (Dana).

* According to Schmitt (1935, p. 61) it is present in *Leander paulensis* (Ortmann), which is probably a synonym of *L. tenuicornis*. It is also found in the male of *Gnathophyllum fasciolatum*; in some *Atyidae* and in *Rhynchocinetes* (Gordon, 1935).

† For the identification of these and other species from the Red Sea I am much indebted to Dr. M. Ramadan.

Conchodytes biunguiculatus (Paulson) was seen, but the eggs were in quite early stages, while *Palaemonella tenuipes* (Dana) and *Periclimenes petittouarsi* (Audouin) had not begun to breed. It is unfortunate that the species of *Periclimenes* belong to the subgenus of which the larvae are already known, and that late stages of *Harpilius* and *Coralliocaris* could not be identified. Pontoniid larvae were rare in the plankton at that time, but four types are described below.

The Barrier Reef plankton contains large numbers of Pontoniid larvae in late stages, among which those of *Periclimenes* predominate. I have made no attempt to examine the whole of this material in detail; but I have selected for description those forms which show striking characters, or may be supposed to represent types rather than species. The variety in form and structure of appendages is astonishing and baffling.

GROUP I: *Periclimenes*.

Periclimenes grandis (Stimpson). (Text-figs. 54-60.)

LOCALITY.

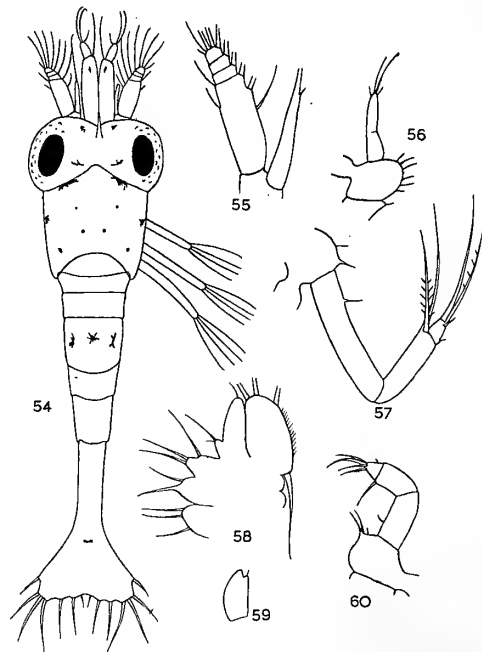
Common, together with *P. agag*, Kemp, on *Halophila* near the laboratory at Ghardaqa.

DESCRIPTION.

Stage I. Length 1.63-1.8 mm.

Rostrum very small and slender. Abdomen straight; pleura rounded. Telson with posterior margin nearly straight, spine 4 not much longer than 3, and innermost pair very small.

Antennal scale with three distinct segments; two outer and ten inner and terminal setae; proximal papilla absent; endopod with long seta and very small terminal spine.



TEXT-FIGS. 54-60.—*Periclimenes grandis* (Stimpson).

FIG. 54.—Stage I, dorsal.

FIG. 55.—,, antenna.

FIG. 56.—,, maxillipede 1.

FIG. 57.—,, maxillipede 3.

FIG. 58.—Stage I, maxilla.

FIG. 59.—,, palp of maxillule.

FIG. 60.—,, maxillipede 2.

Endopod of maxillule small, broad, bilobed at end, with one small seta. Endopod of maxilla with very small terminal seta and small basal lobe; exopod with four setae only.

Maxillipede 1, endopod not distinctly segmented; basis protuberant; exopod with four setae. Maxillipede 2, basis with two small spines; endopod of three segments. Maxillipede 3, endopod very long and slender, apparently of three segments only; dactyl with two long subequal terminal spines, as in *Leander tumicornis*. In *P. americanus* Stage I, as in *P. grandis*, there are two long apical spines only. In Stage II two small spines appear at the end of the dactyl, and in later stages the long accessory spine is replaced by a very small one, so that the dactyl then bears only one strong apical spine, with three small spines at its base.

Exopods of all maxillipedes with four setae. Rudiments of legs 1 and 2 present.

Colour: General colour olive; with some red and yellow chromatophores. No ventral chromatophores in abdomen.

REMARKS.

The first larva of *P. agag* cannot be distinguished from that of *P. grandis*, as described above. Colour differences, if any, were not noted.

Periclimenes diversipes, Kemp. (Text-figs. 61–66.)

LOCALITY.

A very small, colourless species found among living corals at Ghardaqa.

DESCRIPTION.

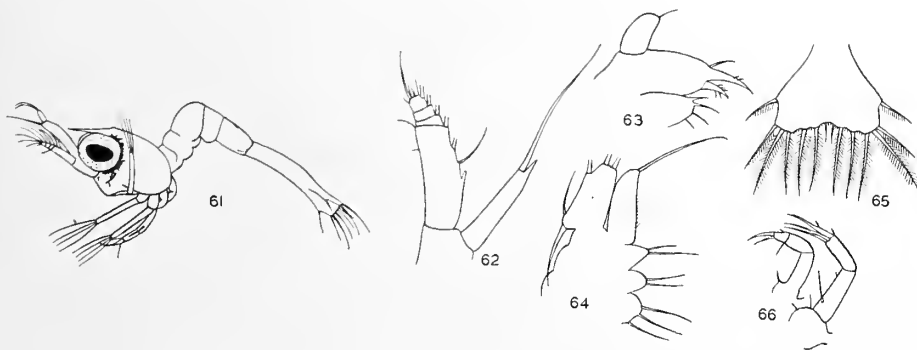
Stage I. Length 1.6 mm.

Rostrum long and slender. Abdomen very much bent at somite 3; pleura rounded. Telson as in *P. grandis*, innermost pair of spines very small.

Antenna, exopod with three distal segments; two outer setae, of which the proximal one is very small; inner papilla well marked; endopod with long seta and large spine.

Endopod of maxillule not bilobed, with one small seta. Maxilla, endopod with long apical seta and without basal lobe; exopod with five setae.

Maxillipede 1, endopod unsegmented; basis slightly protuberant, with three setae only. Maxillipede 3, dactyl with a single strong terminal spine. Rudiments of legs 1 and 2 present.



TEXT-FIGS. 61–66.—*Periclimenes diversipes*, Kemp.

FIG. 61.—Stage I, lateral.

FIG. 62.— „ antenna.

FIG. 63.— „ maxillule.

FIG. 64.—Stage I, maxilla.

FIG. 65.— „ telson.

FIG. 66.— „ maxillipedes 2 and 3.

Colour : Abdomen and posterior part of thorax colourless ; very large chromatophore behind eye with red centre but appearing yellow in reflected light.

REMARKS.

While *P. calmani*, *P. americanus* and *P. grandis* agree in almost every detail, so that it would be difficult to distinguish them, *P. diversipes* differs so much from all of them that one would suppose it should be referred to a distinct genus or subgenus. Such differences are the very well-developed antennal papilla ; form of endopod of maxillule ; presence of five setae on exopod, and absence of basal lobe on endopod of maxilla ; and terminal spines of maxillipede 3.

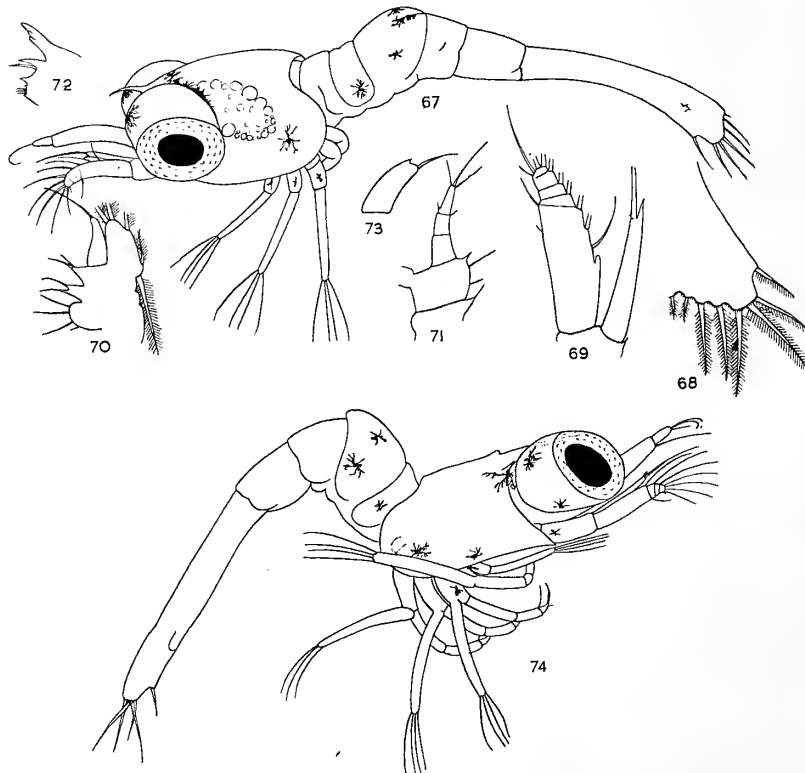
Harpilius beaupresi (Audouin). (Text-figs. 67-74.)

DESCRIPTION.

Stage I. Length 2.15 mm.

Rostrum slender, extending beyond eye. Carapace broad. Abdomen slightly bent and rather broad, somite 3 rather swollen ; pleura rounded. Telson broad, rather deeply indented, the innermost spines short, and spine 4 slightly the longest.

Antenna, exopod with four distinct segments ; two outer setae, of which the proximal is minute ; inner margin with well-developed papilla ; endopod with long apical seta and large spine. Mandible large, with large spine between molar and trifold incisor part.



TEXT-FIGS. 67-74.—*Harpilius beaupresi* (Audouin).

FIG. 67.—Stage I, lateral.

FIG. 68.—,, telson.

FIG. 69.—,, antenna.

FIG. 70.—,, maxilla.

FIG. 71.—Stage I, maxillipede 1.

FIG. 72.—,, mandible.

FIG. 73.—,, maxillule, palp.

FIG. 74.—Stage II, lateral.

Maxillule, endopod slightly bilobed at end, with one seta. Maxilla, endopod with apical seta but no basal lobe or seta; exopod with five setae.

Maxillipede 1, endopod indistinctly three-segmented: basis with spine and two setae, not protuberant. Maxillipedes 2 and 3 with similar dactyls bearing one strong terminal spine. Exopods with four setae.

Rudiments of legs 1 and 2 present.

Colour: Thorax yellowish, abdomen very faintly coloured. Chromatophores behind eye with olive and red pigment and faint yellow branches, the red largely hidden by the olive.

Stage II.

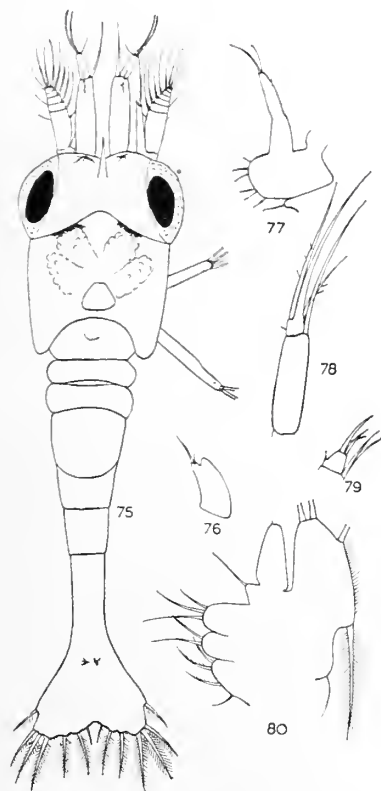
A few specimens moulted in the laboratory without increase in size.

Carapace with anterior papilla, but no dorsal spine; supra-orbital spine small; anterior angle pointed.

Abdomen sharply bent at somite 3; pleura rounded. Telson unchanged except for presence of additional small inner pair of spines.

Antenna unchanged, except for appearance of a very small seta at base of terminal spine of endopod.

Legs 1 and 2 developed, with exopods bearing four setae. Leg 3 a small rudiment.



TEXT-FIGS. 75-80.—*Harpilius gerlachei*, Nobili.

FIG. 75.—Stage I, dorsal.

FIG. 76.—,, maxillule, palp.

FIG. 77.—,, maxillipede 1.

FIG. 78.—Stage I, maxillipede 3.

FIG. 79.—,, ,, 2.

FIG. 80.—,, maxilla.

Colour : Abdomen and posterior part of thorax colourless ; very large chromatophore behind eye with red centre but appearing yellow in reflected light.

REMARKS.

While *P. calmani*, *P. americanus* and *P. grandis* agree in almost every detail, so that it would be difficult to distinguish them, *P. diversipes* differs so much from all of them that one would suppose it should be referred to a distinct genus or subgenus. Such differences are the very well-developed antennal papilla ; form of endopod of maxillule ; presence of five setae on exopod, and absence of basal lobe on endopod of maxilla ; and terminal spines of maxillipede 3.

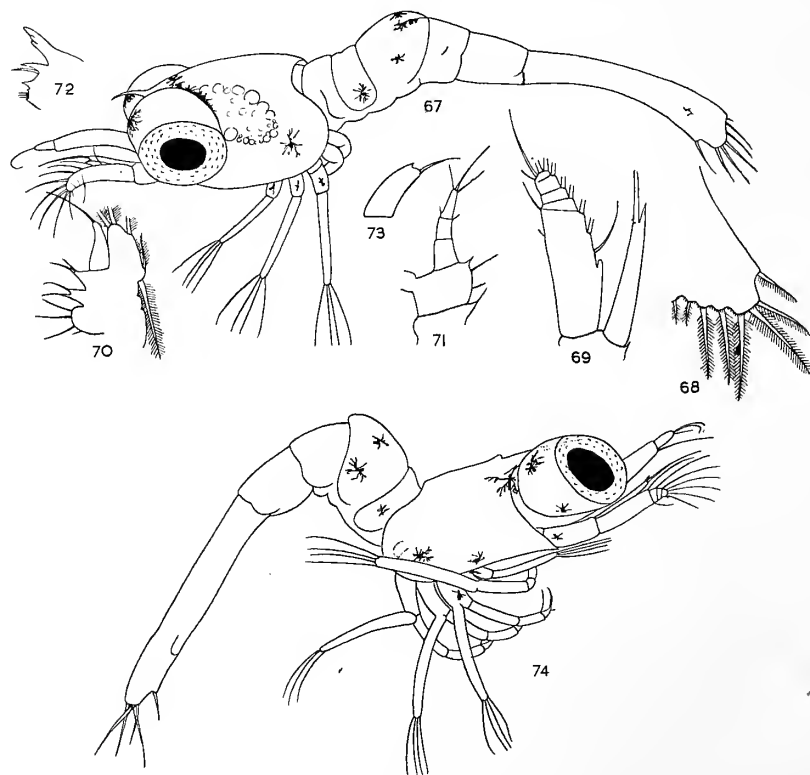
Harpilius beaupresi (Audouin). (Text-figs. 67-74.)

DESCRIPTION.

Stage I. Length 2.15 mm.

Rostrum slender, extending beyond eye. Carapace broad. Abdomen slightly bent and rather broad, somite 3 rather swollen ; pleura rounded. Telson broad, rather deeply indented, the innermost spines short, and spine 4 slightly the longest.

Antenna, exopod with four distinct segments ; two outer setae, of which the proximal is minute ; inner margin with well-developed papilla ; endopod with long apical seta and large spine. Mandible large, with large spine between molar and trifold incisor part.



TEXT-FIGS. 67-74.—*Harpilius beaupresi* (Audouin).

FIG. 67.—Stage I, lateral.

FIG. 68.— „ telson.

FIG. 69.— „ antenna.

FIG. 70.— „ maxilla.

FIG. 71.—Stage I, maxillipede 1.

FIG. 72.— „ mandible.

FIG. 73.— „ maxillule, palp.

FIG. 74.—Stage II, lateral.

Maxillule, endopod slightly bilobed at end, with one seta. Maxilla, endopod with apical seta but no basal lobe or seta; exopod with five setae.

Maxillipede 1, endopod indistinctly three-segmented; basis with spine and two setae, not protuberant. Maxillipedes 2 and 3 with similar dactyls bearing one strong terminal spine. Exopods with four setae.

Rudiments of legs 1 and 2 present.

Colour: Thorax yellowish, abdomen very faintly coloured. Chromatophores behind eye with olive and red pigment and faint yellow branches, the red largely hidden by the olive.

Stage II.

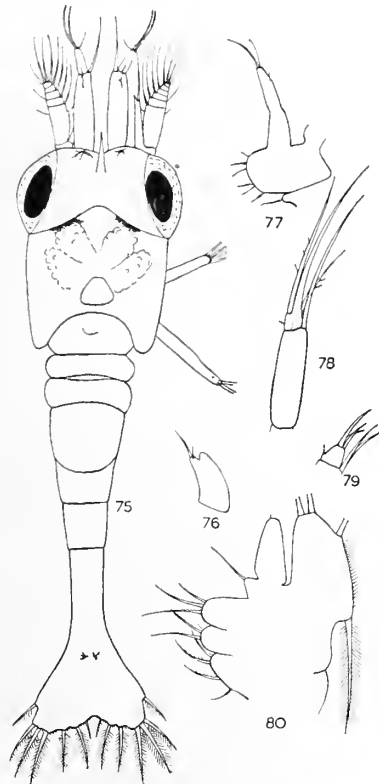
A few specimens moulted in the laboratory without increase in size.

Carapace with anterior papilla, but no dorsal spine; supra-orbital spine small; anterior angle pointed.

Abdomen sharply bent at somite 3; pleura rounded. Telson unchanged except for presence of additional small inner pair of spines.

Antenna unchanged, except for appearance of a very small seta at base of terminal spine of endopod.

Legs 1 and 2 developed, with exopods bearing four setae. Leg 3 a small rudiment.



TEXT-FIGS. 75-80.—*Harpilius gerlachei*, Nobili.

FIG. 75.—Stage I, dorsal.

FIG. 76.— „ maxillule, palp.

FIG. 77.— „ maxillipede 1.

FIG. 78.—Stage I, maxillipede 3.

FIG. 79.— „ „ 2.

FIG. 80.— „ maxilla.

Harpilius gerlachei, Nobili. (Text-figs. 75-80.)

DESCRIPTION.

Stage I. Length 2 mm.

General form as in *H. beaupresi* but differing from it in structure of appendages as follows:

Endopod of maxillule with additional small seta. Maxilla, endopod with minute apical seta and well-marked basal lobe; exopod with four setae only.

Maxillipede 1, basis very protuberant, without spines. Maxillipede 3, dactyl bearing a pair of long subequal spines.

Colour: Almost colourless. Dark red behind eye, and orange in stomach region. No chromatophores seen in abdomen, but a small pair in telson.

REMARKS.

While this species agrees with typical *Periclimenes* in form of maxilla and maxillipedes 1 and 3 so closely that it could not be separated generically, *H. beaupresi* differs in exactly the same way from *H. gerlachei* as *P. diversipes* differs from the other species of *Periclimenes*.

Coralliocaris graminea (Dana). (Text-figs. 81-89.)

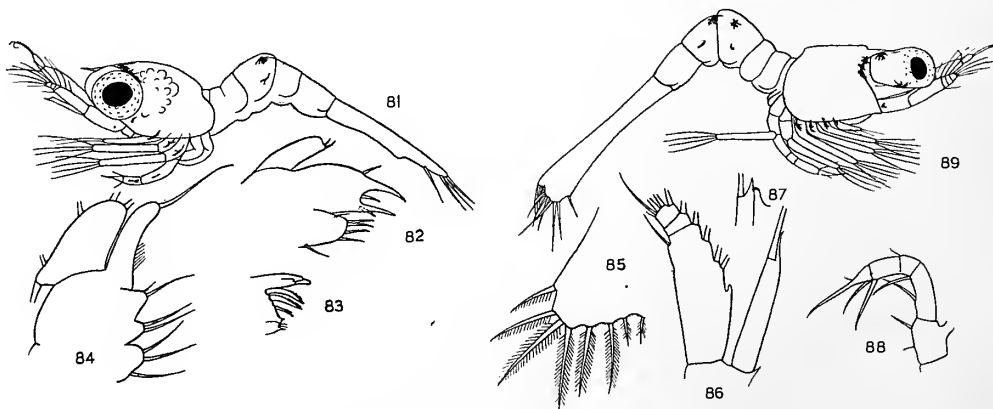
LOCALITY.

Common among the branches of *Stylophora* at Ghardaqa.

The animal snaps its large claws in exactly the same way as an Alpheid does. The eggs are borne on legs 1-3, in which the coxa is greatly elongated. Leg 1 seems to carry the most eggs, but in each leg there are only two groups of ovigerous setae, two setae at the distal and three at the proximal end of the basis.

Stage I. Length 2.2 mm.

Body slightly bent at junction of thorax and abdomen, and at abdominal segment 3. Rostrum slender, extending beyond eye. Abdominal pleura rounded. Telson broad, slightly indented, the innermost pair of spines short; spine 4 as long as spine 2.



TEXT-FIGS. 81-89.—*Coralliocaris graminea* (Dana).

FIG. 81.—Stage I, lateral.

FIG. 82.—,, maxillule.

FIG. 83.—,, mandible

FIG. 84.—,, maxilla.

FIG. 85.—,, telson

FIG. 86.—Stage I, antenna.

FIG. 87.—,, antenna, Stage II, tip of endopod.

FIG. 88.—,, maxillipede 2.

FIG. 89.—Stage II, lateral.

Antennal scale with three segments distinct; proximal outer seta reduced to a minute hair; endopod with long seta and large spine. Inner marginal papilla well developed. Maxillule, endopod with two very small setae. Maxilla, endopod slender, with long apical seta but no basal lobe or seta; exopod with five setae.

Maxillipede 1, basis not protuberant, with one spine and a seta; endopod unsegmented, or faintly three-segmented; exopod with four setae. Maxillipede 2, basis with one small spine. Maxillipede 3, dactyl with one strong terminal spine; exopod with four setae. Large rudiments of legs 1 and 2.

General colour brick-red.

Stage II.

A few specimens moulted to Stage II, but without increase in length.

Carapace without supraorbital spine. Abdomen slightly bent; pleura rounded.

Antenna unchanged, but endopod with small seta at base of terminal spine as in *Harpilius beaupresi*.

Legs 1 and 2 developed; dactyl with strong apical spine. Small rudiments of legs 3 and 4.

REMARKS.

Except in colour, and absence of supra-orbital spine in Stage II, this larva is almost identical with that of *Harpilius beaupresi*; indeed the latter resembles *C. graminea* very much more than that of *H. gerlachei*.

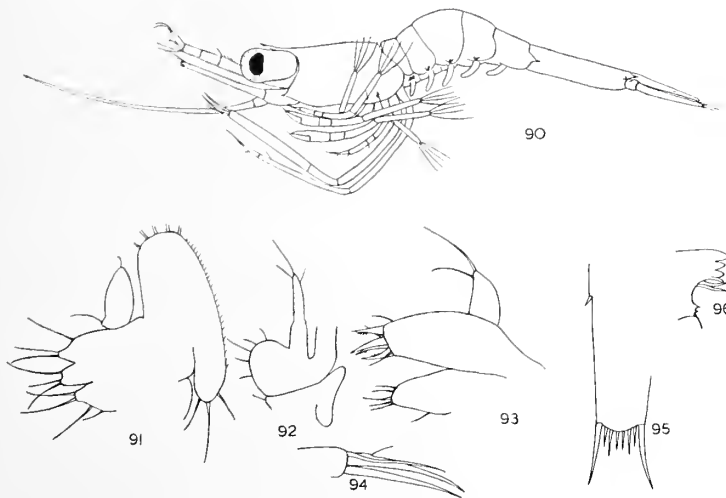
Palaemonid R.S. I (*Periclimentes*). (Text-figs. 90-96.)

LOCALITY.

Ghardaqa, plankton.

DESCRIPTION.

Stage V? Length 5.0 mm.



TEXT-FIGS. 90-96.—Palaemonid R.S. I. (*Periclimentes*.)

FIG. 90.—Stage V?, lateral.

FIG. 91.—,, maxilla.

FIG. 92.—,, maxillipede 3.

FIG. 93.—,, maxillule.

FIG. 94.—Stage V?, dactyl of leg 4.

FIG. 95.—,, telson.

FIG. 96.—,, mandible.

Rostrum shorter than eye, without teeth; carapace without supra-orbital spines but with pterygostomial angle pointed. Abdomen nearly straight, somites 5 and 6 with lateral spines. Telson with one pair of lateral spines and 4 + 4 distal, the outer pair large. Anal spine absent.

Antennule with rudiment of stylocerite, without ventral spine on segment 1; outer flagellum unsegmented and not cleft. Antenna, scale narrow, $4\frac{1}{2}$ times as long as wide; flagellum more than half length of body.

Maxillule, endopod not bilobed, with two apical setae. Maxilla, endopod with minute apical seta and small basal lobe; exopod fringed with hairs, but without setae on outer margin.

Maxillipede 1, basis protuberant, without spines; endopod not distinctly segmented. Maxillipedes 2 and 3, dactyl with one large apical spine. Exopods with four setae only.

Legs 1 and 2 chelate, nearly equal. Leg 4 longer and stouter than leg 5, without exopod; propod with long apical spines. Leg 5 long and slender, dactyl continuous with apical spine and without basal spine.

Pleopods small, without setae.

Colour: Almost colourless; end of antennal flagellum yellow.

Palaemonid B.R. II (*Periclimenes*). (Text-figs. 97-101.)

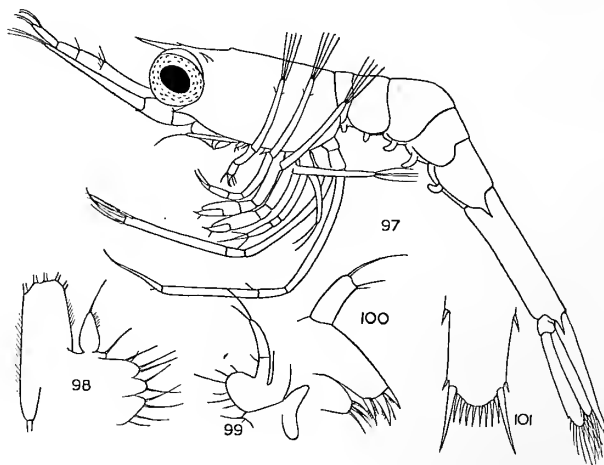
LOCALITY.

Barrier Reef Station 38.

DESCRIPTION.

Stage V? Length 4.0 mm.

Rostrum short, broadening at base, with median ridge and one small dorsal spine; carapace with supra-orbital and pterygostomial spines, but no antennal. Abdomen nearly straight, somites 5 and 6 with lateral spines. Telson four times as long as wide, with two pairs of lateral spines and 6 + 6 terminal, of which spine 2 is the largest. Anal spine absent.



TEXT-FIGS. 97-101.—Palaemonid B.R. II. (*Periclimenes*.)

FIG. 97.—Stage V?, lateral.

FIG. 98.—,, maxilla.

FIG. 99.—,, maxillipede 1.

FIG. 100.—Stage V?, maxillule.

FIG. 101.—,, part of telson.

Antennule, stylocerite small, no ventral spine on segment 1. Antennal scale four times as long as wide, with small apical spine.

Maxillule, endopod slightly bilobed, with three setae. Maxilla, palp with terminal seta and well-defined basal lobe; exopod very narrow proximally, where it bears one large seta only; outer margin without setae.

Maxillipede 1, basis protuberant, without spines; endopod two-segmented; exopod with four setae. Maxillipede 3, dactyl with one strong terminal spine; exopod with six setae, the proximal pair very small.

Legs 1 and 2 chelate, nearly equal, dactyl equal to, or shorter than, palm. Leg 4 without exopod, very elongated, and slightly longer than leg 5; propod with strong terminal spines. Leg 5 long and slender, without propodal spines, the terminal claw without a basal spine.

Pleopods small, without setae.

Palaemonid B.R. III (*Pericklimenes*?). (Text-figs. 102–106.)

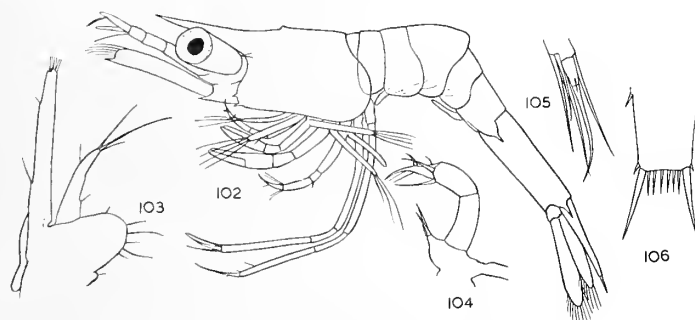
LOCALITY.

Barrier Reef Station 62.

DESCRIPTION.

Stage V? Length 5.35 mm.

Rostrum long and straight, without teeth; carapace with small supraorbital, branchiostegal and pterygostomial spines. Abdominal somite 3 rather protuberant; somites



TEXT-FIGS. 102–106.—Palaemonid B.R. III.

FIG. 102.—Stage VI?

FIG. 103.—,, maxillipede 1.

FIG. 104.—,, ,, 2.

FIG. 105.—Stage VI?, leg 4.

FIG. 106.—,, telson.

5 and 6 with lateral spines. Anal spine absent. Telson nearly four times as long as wide, with two pairs of lateral and 5 + 5 apical spines, spine 2 the largest.

Antennule with small stylocerite; exopod with very small slender extension beyond the thickened sensory basal part. Mandible with three large movable spines. Maxillule, endopod narrow, with two distal setae. Maxilla, endopod with small distal seta and basal lobe; exopod large with several setae at proximal end, but none on outer margin.

Maxillipede 1, basis very protuberant, without spines; endopod unsegmented; exopod with outer basal seta and with four apical. Maxillipede 2, basis protuberant, with two large spines; endopod of three segments; epipod absent. Maxillipede 3, dactyl with one strong apical spine.

Leg 4 as long as leg 5, without exopod; propod with long terminal spines. Leg 5 long and slender; apical claw without basal spine. Pleopods rather large, without setae.

Palaemonid D. III (*Periclimenes*?). (Text-figs. 107–112.)

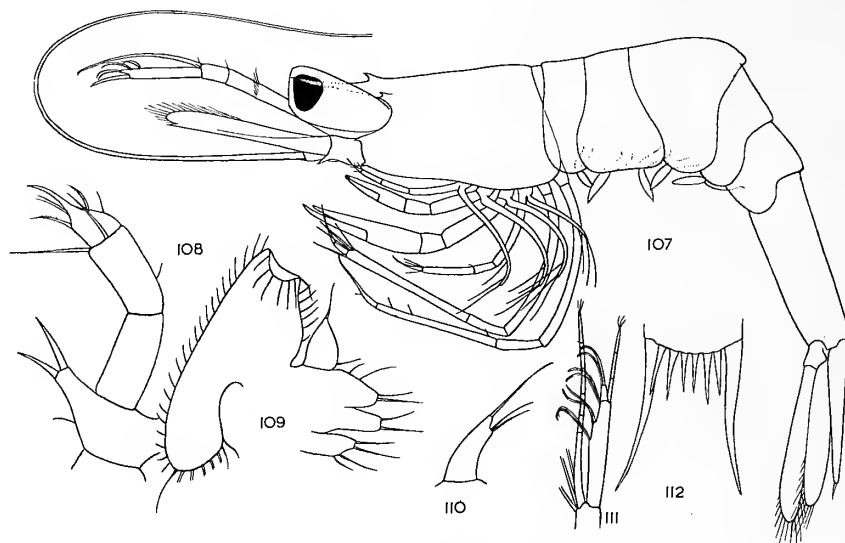
LOCALITY.

“Discovery” Station 701. 14° 39' N., 25° 51' W.

DESCRIPTION.

Length 8.2 mm.

Rostrum slender, as long as eye, with one dorsal tooth at base. Carapace with small supra-orbital, antennal and pterygostomial spines. Abdominal somite 3 rather protuberant; pleura of all somites rounded. Anal spine absent. Telson four times as



TEXT-FIGS. 107–112.—Palaemonid D. III.

FIG. 107.—Stage VI ?

FIG. 108.—,, maxillipede 2.

FIG. 109.—,, maxilla.

FIG. 110.—Stage VI ?, maxillule, palp.

FIG. 111.—,, antennule, end.

FIG. 112.—,, part of telson.

long as wide, with one pair of small lateral spines near middle, and 4 + 4 apical, the outer pair very large.

Antennule with small stylocerite but no ventral spine; exopod slightly cleft. Antennal scale with small distal spine; flagellum very long.

Maxillule, endopod with apical and two subapical setae. Maxilla, endopod small, with seta in place of basal lobe; exopod very large, with small setae on outer margin.

Maxillipede 1, endopod short and stout, of two distinct segments; basis very protuberant, without spines. Maxillipede 2, basis protuberant, with two very large spines; endopod stout, of three segments. Maxillipede 3, dactyl with single strong terminal spine.

Legs 1 and 2 chelate, leg 2 much the larger. Leg 4 slightly longer than leg 5, without exopod; propod with long terminal spines. Leg 5 slender; dactyl without basal spine.

Pleopods fairly large, without setae.

This species very closely resembles species B.R. III, in form of abdominal somite 3, maxillipede 2, etc., and no doubt belongs to the same genus.

Palaemonid D. IV (*Periclimenes* ?). (Text-figs. 113–118.)

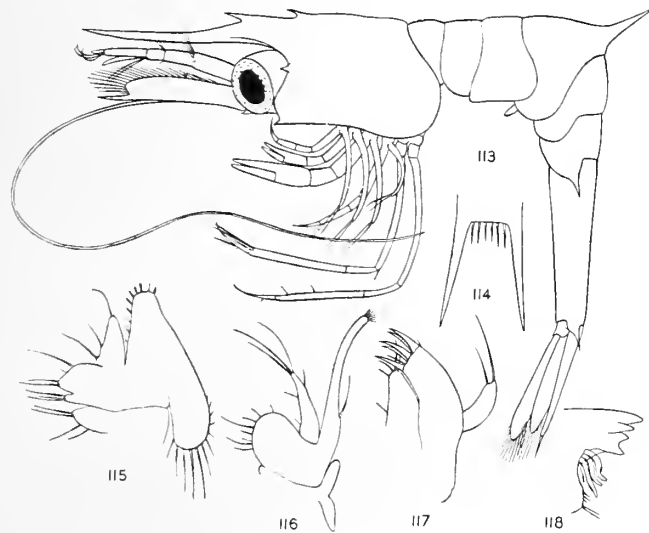
LOCALITY.

“Discovery” Station 1374. 31° 46' S., 29° 46' E.

DESCRIPTION.

Length 10.34 mm.

Rostrum longer than antennule, with one large dorsal tooth; carapace with dorsal, supra-orbital and pterygostomial spines. Abdominal somite 3 with large straight dorsal spine; somites 5 and 6 with lateral spines; anal spine absent. Telson four times as long as wide, with one pair of lateral spines and 4 + 4 distal. The outermost spines are very large and fused with the telson, forming a fork within which are six small spines.



TEXT-FIGS. 113–118.—Palaemonid D. IV.

FIG. 113.—Stage VI ?

FIG. 114.—,, telson.

FIG. 115.—,, maxilla.

FIG. 116.—Stage VI ?, maxillipede 1.

FIG. 117.—,, maxillule.

FIG. 118.—,, mandible.

Antennule with stylocerite, but no ventral spine; exopod not cleft, but with two small distal segments distinct. Antenna, basis with stout spine; scale with very large terminal spine; flagellum very long.

Mandible with four movable spines. Maxillule, endopod slender, curved, with two apical setae. Maxilla, endopod with trace of basal lobe and two setae on inner margin; exopod large, without setae on most of the outer margin.

Maxillipede 1, basis protuberant without spines; endopod unsegmented; exopod with outer basal seta and four apical. Maxillipede 2, basis with two very strong spines. Maxillipede 3, dactyl with single large apical spine.

Legs 1 and 2 chelate, leg 2 very much larger than leg 1. Leg 4 as long as leg 5, slender, without exopod; with long spines at end of propod. Leg 5 long and slender, the terminal claw without basal spine.

Pleopods small.

Palaemonid B.R. IV. (Text-figs. 119-122.)

LOCALITY.

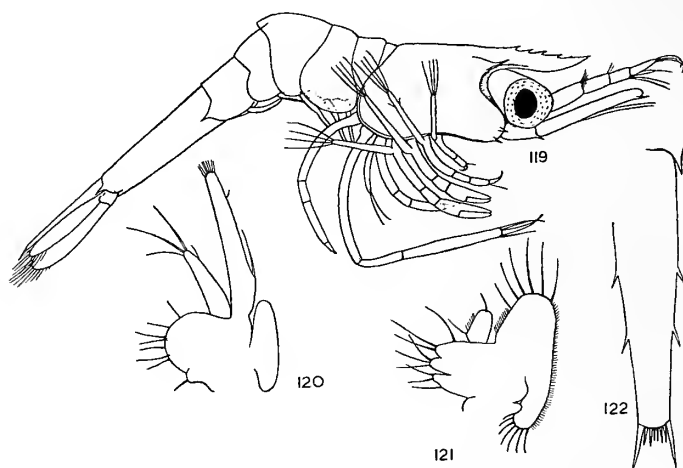
Barrier Reef Stations 16, 43, 50 and 53.

DESCRIPTION.

Length 6 mm.

Rostrum rather deep, reaching beyond eyes, with five small dorsal teeth. In a specimen about to moult to post-larval there are four above and one below under the skin. Carapace with supra-orbital, branchiostegal and pterygostomial spines. Abdominal somites 5 and 6 with lateral spines. Anal spine absent. Telson more than four times as long as wide, with two pairs of lateral spines and 4 + 4 apical, the outer pair very large.

Antennule with small stylocerite and no ventral spine. Antennal scale with large spine; flagellum much longer than scale; basis with small spine.



TEXT-FIGS. 119-122.—Palaemonid B.R. IV.

FIG. 119.—Last stage, lateral.

FIG. 121.—Last stage, maxilla.

FIG. 120.—,, maxillipede 1.

FIG. 122.—,, telson.

Maxillule, endopod slender, with two long apical setae. Maxilla, endopod small, with small apical and basal setae, basal lobe not distinct; exopod large without setae on outer margin.

Maxillipede 1, basis protuberant, without spines; endopod unsegmented; exopod with one outer basal seta; epipod not distinctly bilobed. Maxillipede 2, basis protuberant, with two spines. Maxillipede 3, dactyl with one strong apical spine.

Legs 1 and 2 chelate, leg 2 slightly the larger. Leg 4 without exopod, very much longer than 3 and 5; propod with long apical spines. Leg 5 about as long as leg 3, propod and dactyl without spines. Dactyls of legs 3-5 of post-larval stage, seen under skin, apparently simple.

Pleopods large, without setae.

REMARKS.

This form is included in the *Perichlimenes* series by reason of the great elongation of leg 4 and the general structure of the mouth-parts; but the reduction of leg 5 as compared with leg 4 is a feature hitherto unknown among the Palaemonidae.

DISCUSSION OF THE PERICLIMENES GROUP.

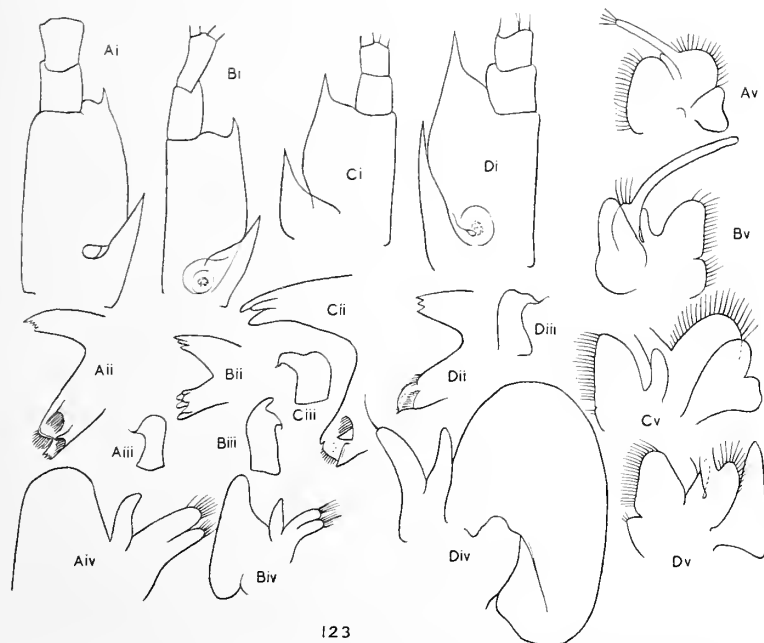
It has been pointed out above (pp. 18, 20) that the larvae of *Periclimenes diversipes* and *Harpilius gerlachei* indicate quite a different generic grouping of the adults from that which is adopted by Kemp. Comparison of the antennule and mouth-parts of such species as are available to me seem to confirm the conclusion drawn from the larvae. The three species of *Periclimenes*, *P. grandis*, *P. agag* and *P. americanus*, agree in almost every detail, the only exception being that I find a podobranch on maxillipede 2 only in *P. grandis*. On the other hand *P. diversipes* differs from all of them in almost every appendage, and in each case approaches much more nearly to *Harpilius beaupresi* or to *Coralliocaris*.

In descriptions of species, or even sometimes of genera, the mouth-parts are often neglected, and as I think some characters of importance in the systematics of the Pontoniinae are available which have not had weight given to them, I give here the facts with regard to these species.

Antennule and Mouth-Parts of P. diversipes. (Text-fig. 123A.)

Antennule: Stylocerite without the inner expansion covering the opening of the statocyst found in other *Periclimenes*. The opening is also free in *H. beaupresi* and *Coralliocaris*. It is covered in *Urocaridella gracilis*.

Mandible: The mandibles are not symmetrical, but in *P. americanus*, for example, the molar part on the one side has a series of large blunt teeth, and on the other rounded knobs or ridges with small bristles on one of them. In *P. diversipes*, as in *H. beaupresi* and *Coralliocaris* these teeth or ridges are replaced by a more or less horse-shoe-shaped



TEXT-FIG. 123.—Antennule and mouth-parts of Pontoniinae. A. *Periclimenes diversipes*. B. *P. americanus*. C. *Harpilius gerlachei*. D. *H. beaupresi*. i. Antennule. ii. Mandible. iii. Palp of maxillule. iv. Maxilla. v. Maxillipede 1.

ridge bearing a brush-like arrangement of small spines. The difference is very striking. In *Urocaridella* the mandible is similar to that of *Periclimenes*.

In *Periclimenes* and *Urocardella* the incisor part is much larger in proportion to the molar part.

Maxillule: In *Urocaridella* and *Periclimenes* the palp is bifid at the end, the outer lobe very well defined, whereas in *P. diversipes*, *H. beaupresi* and *Coralliocaris* it is absent.

Maxilla: The lacinia is deeply cleft in *P. diversipes*, as it is in other *Periclimenes*, and in this respect differs from *Harpilius*, where it is narrower and not cleft. In *Coralliocaris* it is narrow, but bilobed. On the other hand the exopod, which is narrow in front in *Urocaridella* and *Periclimenes*, is very broad in *P. diversipes*, *Harpilius* and *Coralliocaris*.

Maxillipede 1: Coxa and basis are separated by a well-marked notch in *Periclimenes* and *Urocardella*, and the basal expansion of the exopod is not very wide, whereas in *P. diversipes* there is no distinction at all between coxa and basis, and the expansion of the exopod is very wide. In both respects it resembles *Harpilius* and *Coralliocaris*.

Maxillipedes 2 and 3: There is no difference in these appendages sufficiently marked to be defined, but *P. diversipes* is exceptional in having the arthrobranch of maxillipede 3 vestigial, as it is in *Harpilius gerlachei*.

Harpilius beaupresi and *H. gerlachei*.

While these two species agree in the narrow, uncleft, form of the endopod of the maxilla they differ in the following characters in addition to those mentioned by Kemp.

Antennule: Stylocerite covers the otocyst in *H. gerlachei*.

Mandible: In *H. gerlachei* the incisor process is larger in proportion to the molar part than in *H. beaupresi* and the molar part is intermediate between that of *H. beaupresi*, in which there are no teeth and a granular grinding surface is surrounded by stiff spines, and that of *Periclimenes*, having blunt teeth together with two short rows of spinules.

Maxillipede 1: Coxa and basis very distinct in *H. gerlachei*, scarcely distinguishable in *H. beaupresi*.

Basal expansion of exopod very much less wide in *H. gerlachei*.

Maxillipede 2: Carpus without the sharp spine-like process seen in *H. beaupresi*, and with dactyl much narrower, and spines on it differently arranged.

Maxillipede 3: Arthrobranch vestigial in *H. gerlachei*.

While it seems clear that *P. diversipes* should be transferred to the same genus as *H. beaupresi*, the separation of the latter from *H. gerlachei* is not so fully justified. Borradaile distinguished, on insufficient grounds, *Harpilius* with type *H. lutescens* and including *H. gerlachei*, from *Harpiliopsis*, Borr., with type *H. beaupresi*, and Tattersall, while rejecting Borradaile's genera, suggested that it might be necessary to form a new genus for *H. gerlachei*. With this Kemp did not agree. Having only examined two of the species of *Harpilius* I am not in a position to make any definite proposition on this point, but it is my opinion that the facts strongly support Tattersall's suggestion.

In the later stages of the larva the structure of legs 4 and 5 is the most striking feature of the two species of known parentage, and exactly the same form is found in the species described here under the designations R.S. I, B.R. II, B.R. III, D. III and D. IV. All these forms also agree in the structure of the maxilla, but differ among themselves in

details which may be regarded as specific. The following summary may now be given of the characters of *Ancylocaris* (if *P. diversipes* is excluded) :

- (1) Rostrum small, slender, with few or no dorsal teeth, and without median crest.
- (2) Carapace without hepatic spine and usually without branchiostegal.
- (3) Abdomen without dorsal spines. Anal spine absent.
- (4) Antennule without ventral spine (?).
- (5) Antennal scale, in Stage I, with or without inner papilla.
- (6) Maxilla, endopod with basal lobe : exopod with 4 setae only in Stage I, outer margin bare in later stages.
- (7) Maxillipede 1, basis protuberant, without spines.
- (8) Maxillipede 3, in Stage I, with two long equal spines at end of dactyl.
- (9) Legs 4 and 5 very much longer than leg 3, subequal. Leg 4 without exopod, propod with long terminal spines. Leg 5, propod without long terminal spines : dactyl without inner basal spine.

It is, of course, impossible to say if these characters are distinctive of the subgenus *Ancylocaris* only.

The species described here as B.R. IV seems, from its general form of body and most of the appendages, to belong to *Periclimenes*, but it differs strikingly in the form of the rostrum, and particularly in the very unusual feature of having leg 5 very much smaller than leg 4. It must certainly represent a genus or subgenus distinct from *Ancylocaris*.

GROUP II : *Mesocaris*.

While there is no difficulty in accepting the larvae described above as a *Periclimenes* group closely related to each other, the remaining species are very difficult to deal with. There is here no basis of established fact, and it is impossible to determine how far the differences between the larvae are generic or specific. There is one striking feature which characterizes the larval genus *Mesocaris* (see Gurney, 1936, p. 621), namely the acute double flexure of the depressed body and abdomen, and the same flexure is seen in the three forms B.R. V, R.S. II and R.S. IV. They also agree in the general structure of legs 3-5, which are all of about the same length, and in having no basal lobe on the endopod of the maxilla ; but there is no other character common to all. None the less I include them, as a matter of convenience, in a single group.

One of these forms (R.S. IV) is remarkable in having no spine on the antennal scale and, if this is also absent in the adult, it can only be referred to *Onychocaris aualitica*, Nobili, which it also resembles in the reduction of the rostrum.

The two forms R.S. III and B.R. VI diverge greatly from the others. The former has not the flexure of the body characteristic of the group, and the enlargement of the abdominal pleura gives it a very distinct appearance. It is also unlike any other larva in having strong hooked spines on the propod of legs 3-4 instead of the usual straight slender spines. In *Coralliocaris* and other genera the dactyl is curved and provided with a hooked basal claw, but I cannot find any species described as having strong propodal claws. The peculiar modification of these legs does not afford, as one would expect it might, any clue to the genus.

The second larva, B.R. VI, has the body flexed, and the legs of the form usual in *Mesocaris*, but it is remarkable for the great length of the rostrum, of the branchiostegal spine, and of the pleural spines of abdominal somites 1 and 2. Here, again, there is not sufficient ground for identification, but it may be pointed out that there is some general similarity to the strange genus *Coutierea*, Nobili. The single species of this genus, *C. agassizi* (Coutière), was taken at Barbadoes, but there is no reason why the genus should not also occur in the Indo-Pacific. The great length of its rostrum, and antennal (or branchiostegal ?) spines, and the pointed abdominal pleura are striking features of the species. The eyes are overhung by a broadening of the rostrum which is regarded as produced by the connate supra-orbital spines. In the larva the supra-orbital spines are very small, and it may be that they are really lost in the adult and that the covering over the eye is simply an extension of the widening of the rostrum already present in the larva.

MESOCARIS, Ortmann.

Gurney, 1936, p. 621, pls. iii, iv.

Body very much flattened and flexed. Rostrum in late stages with high toothed crest. Carapace with small supra-orbital and with or without antennal and branchiostegal spines, hepatic spine absent. Telson with lateral spines; apical spines 3 + 3 (?). Anal spine absent.

Antennule with ventral spine. Antennal scale in stage I with inner papilla and with outer proximal seta reduced.

Maxilla, endopod with apical seta, without basal lobe; exopod with five setae in stage I, with setae on outer margin in late stages.

Maxillipede 1 in late stages with basis large, not protuberant, without spines; endopod stout, with three distinct segments. Maxillipede 2, basis with two spines, the distal one strong; apical spine of dactyl stout, with conspicuous feathering. Maxillipede 3 with single strong apical spine in all stages.

Leg 4 with exopod; propod with long terminal spines. Leg 5 not markedly longer than leg 4, propod with one long terminal spine; dactyl with or without basal spine.

Palaemonid B.R. V. (Text-figs. 124-133.)

LOCALITY.

Barrier Reef Station 38.

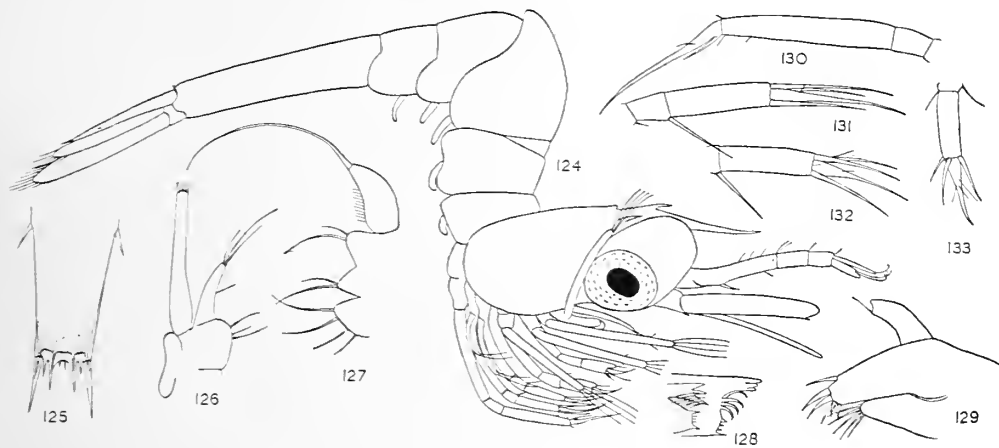
DESCRIPTION.

Stage V? Length 5.6 mm.

Body rather depressed, and sharply bent at thorax and abdominal somite 3. Rostrum as long as segment 1 of antennule, with one dorsal serrated tooth. Carapace with serrated supra-orbital spine and antennal spine. Pleura of abdominal somites 5 and 6 rounded. Anal spine absent.

Telson four times as long as wide, with one pair of lateral and 4 + 4 terminal spines; spines 1 and 3 large.

Antennule, segment 1 with incipient stylocerite and ventral spine; flagella small, unsegmented. Antennal scale narrow, with apical spine; flagellum a little longer than scale.



TEXT-FIGS. 124-133.—Palaemonid B.R. V.

- | | |
|-------------------------------|---------------------------------|
| FIG. 124.—Stage V ?, lateral. | FIG. 129.—Stage V ?, maxillule. |
| FIG. 125.— .. telson. | FIG. 130.— .. leg 5. |
| FIG. 126.— .. maxillipede 1. | FIG. 131.— .. ,, 4. |
| FIG. 127.— .. maxilla. | FIG. 132.— .. ,, 3. |
| FIG. 128.— .. mandible. | FIG. 133.— .. maxillipede 3. |

Maxillule, endopod with one small seta. Maxilla, endopod curved, with one long terminal seta, and no basal lobe or seta; exopod without setae on outer margin.

Maxillipede 1, basis without spines; endopod unsegmented. Maxillipede 2 and 3, dactyl with one strong apical spine; exopods with four setae only.

Legs 1 and 2 subchelate. Leg 4 with exopod, a little shorter than leg 5. Legs 3 and 4 with long spines at end of propod. Leg 5 not greatly elongated, propod without long spines; dactyl with basal spine.

Pleopods rather large, without setae.

Palaemonid R.S. II. (Text-figs. 134-138.)

LOCALITY.

Two specimens from plankton at Ghardaqa.

DESCRIPTION.

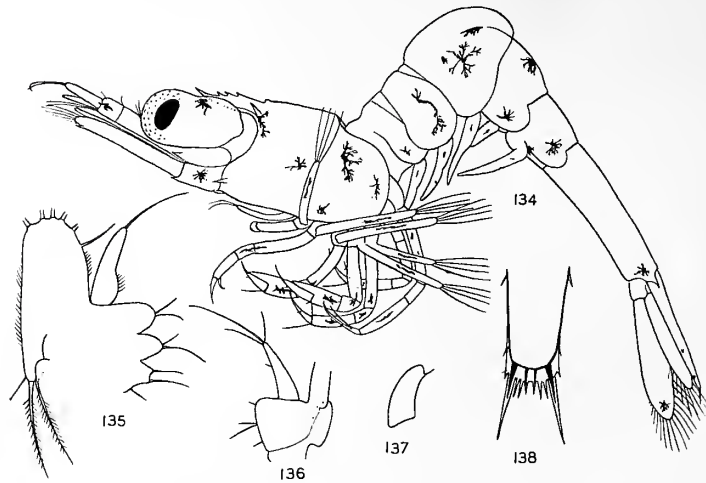
Length 4.55 mm. Last stage.

Body sharply flexed at thorax and abdominal segment 3. Rostrum shorter than eye, with three dorsal teeth. Carapace with supra-orbital and branchiostegal spines. Pleura of abdominal somite 5 rounded, somite 6 with lateral spines. Anal spine absent. Telson nearly four times as long as wide, with two pairs of lateral spines and 5 + 5 terminal, of which spine 2 is very long. One of the specimens is about to moult and shows that the two median pairs of spines of the adult arise from spines 2 and 5 of the larva (Text-fig. 133).

Antennule with small stylocerite and ventral spine; flagella small, unsegmented. Antennal scale with terminal spine; flagellum as long as scale.

Maxillule, endopod with one very small seta. Maxilla, endopod slender, with long apical seta, but no basal lobe or seta; exopod without setae on outer margin.

Maxillipede 1, basis not very protuberant, without spines; endopod unsegmented; epipod small, not bilobed. Maxillipedes 2 and 3, dactyl with one strong apical spine.



TEXT-FIGS. 134-138.—Palaemonid R.S. II.

FIG. 134.—Last stage, lateral.

FIG. 137.—Last stage, palp of maxillule.

FIG. 135.—,, maxilla.

FIG. 138.—,, telson.

FIG. 136.—,, maxillipede 1.

Legs 1 and 2 chelate, equal; exopod of leg 1 with six setae. Leg 4 a little shorter than 5, without exopod; spines on propod not very large. Leg 5 without long propodal spines; dactyl with basal spine. Pleopods large, without setae.

REMARKS.

In life this form is even more flexed than is shown in the figure, the thorax and abdomen forming an acute angle and the thorax being parallel to the last three somites of the abdomen. It swims back downwards and tail first.

Colour: General colour to eye whitish yellow, the chromatophores dark olive-brown under microscope, but light yellow in reflected light.

Palaemonid R.S. III. (Text-figs. 139-145.)

LOCALITY.

One specimen from plankton at Ghardaqa.

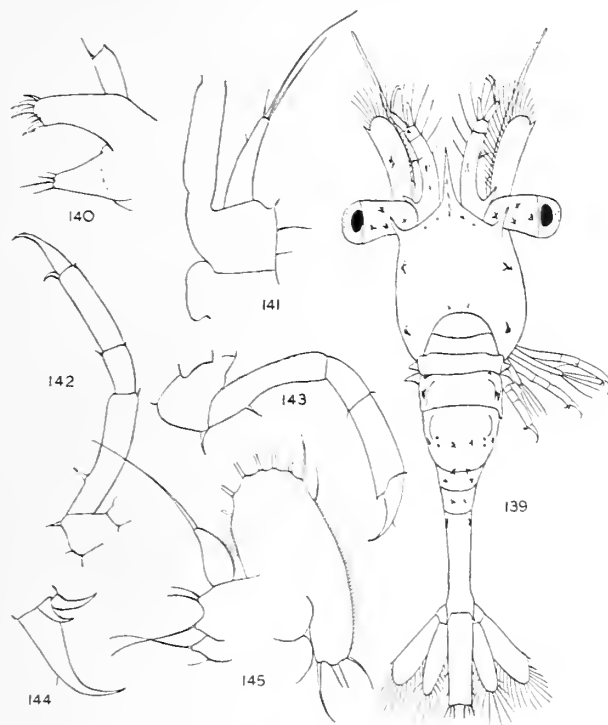
DESCRIPTION.

Stage IV? Length 4.65 mm.

Body broad and depressed, but not strikingly bent. Rostrum much shorter than peduncle of antennule, with three dorsal teeth. Carapace with supra-orbital, branchiostegal and pterygostomial spines. Abdominal somites 2 and 3 with pleura pointed and bent outwards so that they are visible from above; somite 3 not swollen dorsally; pleura of somites 4 and 5 rounded; somite 6 with lateral spines. Anal spine absent. Telson parallel-sided, with two pairs of lateral spines and 4 + 4 apical, of which the outer three pairs are subequal.

Antennule, peduncle curved, with large stylocerite and ventral spine; flagella small, unsegmented. Antennal scale broad, with small distal spine; flagellum nearly twice as long as scale.

Maxillule with laciniae widely separated; endopod with one small seta. Maxilla, endites reduced, with few setae; endopod with long apical seta and no basal lobe or seta; exopod very large, without setae on outer margin.



TEXT-FIGS. 139-145.—Palaemonid R.S. III.

- | | |
|-------------------------------|------------------------------|
| FIG. 139.—Stage IV ?, dorsal. | FIG. 143.—Stage IV ?, leg 1. |
| FIG. 140.— „ maxillule. | FIG. 144.— „ „ 4. |
| FIG. 141.— „ maxillipede 1. | FIG. 145.— „ maxilla. |
| FIG. 142.— „ leg 2. | |

Maxillipede 1, basis not protuberant, with one small spine ; endopod unsegmented ; exopod with five terminal setae. Maxillipedes 2 and 3 with one large terminal spine ; exopods of these and of legs 1-3 with six setae, the proximal pair unequal.

Leg 1 with propod slightly produced ; leg 2 without trace of chela, the propod with two stout curved spines at base of dactyl. Legs 3-5 nearly equal, but leg 5 slightly shorter than 4. Legs 3 and 4 have each two strong propodal spines, as in leg 2, while leg 5 has one. Leg 4 with exopod.

Pleopods present as small buds.

Palaemonid R.S. IV (*Onychocaris* ?). (Text-figs. 146-149.)

LOCALITY.

One specimen from plankton at Ghardaqa.

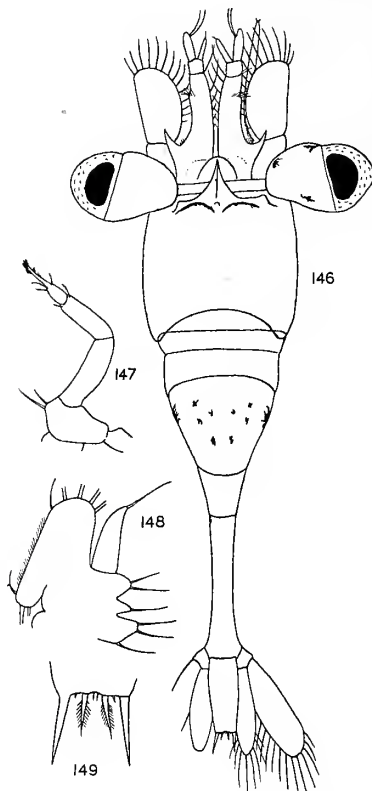
DESCRIPTION.

Stage IV ? Length 3.5 mm.

Body broad, depressed, much bent at thorax and somite 3. Rostrum very small, triangular in dorsal view, with elevated median crest, without teeth. Carapace with supra-orbital spines reduced to small blunt prominences ; branchiostegal and pterygostomial spines absent. Pleura of somites 5 and 6 rounded. Anal spine absent. Telson $2\frac{1}{2}$ times as long as wide, without lateral spines ; end straight, with 4 + 4 spines, of which the outer pair is large and spines 2 and 4 vestigial.

Antennule, peduncle broad at base, with large stylocerite and very small ventral spine. Antennal scale very broad, without spine; flagellum about $1\frac{1}{2}$ times length of scale.

Maxillule, endites rather wide apart; endopod small, without setae. Maxilla, endopod slender, without basal lobe or seta; exopod without setae on outer margin, narrow proximally. Maxillipede 1, basis slightly protuberant, without spines; endopod two-segmented, with small seta at the joint. Maxillipedes 2 and 3 with single strong terminal spine, that of maxillipede 2 straight, with conspicuous feathering (Text-fig. 147).



TEXT-FIGS. 146-149.—Palaemonid R.S. IV.

FIG. 146.—Stage IV ?, dorsal.

FIG. 148.—Stage IV ?, maxillipede 2.

FIG. 147.—,, maxilla.

FIG. 149.—,, part of telson.

Legs all equally long. Legs 1 and 2 not chelate. Leg 4 without exopod, with two rather stout spines at end of propod. Leg 5 dactyl without basal spine.

Pleopods present, small.

Colour: General colour greenish-yellow.

Palaemonid B.R. VI (*Coutièrea* ?). (Text-figs. 150-154.)

LOCALITY.

Barrier Reef Station 13.

DESCRIPTION.

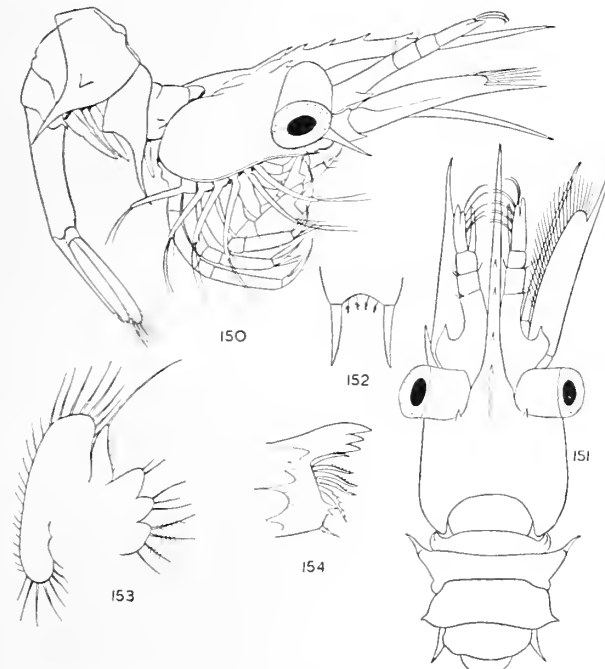
Last stage. Length: rostrum, 2.5 mm.; rest of body, 5.15 mm.

Rostrum with four dorsal teeth, distal part bare. Carapace with small supra-orbital spine and enormous branchiostegal spine. Abdominal somite 1 with papilla on either side; somites 2 and 3 produced into extremely long spines; somite 3 very broad,

depressed dorsally, with pair of small lateral spines; somites 4 and 5 with small pleural spines; somite 6 long and slender, without lateral spines. Anal spine absent. Telson four times as long as wide, without lateral spines; apex with a large outer pair of spines and four small feathered spines between.

Antennule with large stylocerite and small ventral spine; outer flagellum slightly cleft. Antennal scale narrow, with very long apical spine; flagellum about as long as scale.

Mandible with five movable spines. Maxillule, endopod small, curved, with one seta. Maxilla, endopod with long apical seta but no basal lobe or seta; exopod with outer margin fringed with short setae.



TEXT-FIGS. 150-154.—Palaemonid B.R. VI.

FIG. 150.—Last stage, lateral.

FIG. 151.—,, dorsal.

FIG. 152.—,, telson.

FIG. 153.—Last stage, maxilla.

FIG. 154.—,, mandible.

Maxillipede 1, coxa reduced; basis large, without spines; endopod with three distinct segments; exopod with two outer basal setae, four apical setae and one lateral small seta; epipod large, bilobed. Maxillipede 3, dactyl with single large spine.

Legs 1 and 2 chelate, leg 2 the larger. Leg 4 with exopod. Leg 5 a little longer than leg 4, without propodal spines; dactyl with basal spine.

Pleopods large, without setae.

GROUP III: *Cryptoleander*.

For the three forms now to be described I have coined a name which is not intended as a generic designation but simply as a convenient term for reference. There is a certain general resemblance of these larvae to those of *Leander* and *Retrocaris*, the large serrated dorsal spines and the stout upturned rostrum giving them a marked Palaemonid appearance. As in *Retrocaris* the antennular flagellum becomes cleft in the later stages, and leg 5 is

very long in comparison with leg 4. They differ from the Palaemonid group in the arrangement of propodal spines on leg 5 and in the absence of a basal lobe on the endopod of the maxilla. The branchiostegal spine is also absent.

From the *Perichimenes* group they differ in almost every respect, and they also seem to have no near relation to the *Mesocaris* group, so that they are probably not members of the Pontoniinae at all.

The resemblance to *Anchistioides* in general form is very striking; but there are fundamental differences in the mouth-parts and structure of leg 5 which make it out of the question to include them in that genus. At the same time the resemblance in form seems to point to some degree of affinity and to suggest that *Anchistioides* may be more nearly related to the Palaemoninae than to the Pontoniinae.

If these three forms cannot be included among the known genera of Palaemoninae or Pontoniinae, and do not belong to *Anchistioides*, what remains? The genus or genera to which they belong must be common on the Barrier Reef and exist also in the Red Sea, but it does not necessarily follow that the adults have yet been seen. In a coral-reef region the difficulty in collecting is very great, and there may be many new genera yet to be discovered. As an instance of such difficulty may be mentioned the fact that though *Anchistioides antiguensis* is so commonly seen swimming at night at Bermuda, its real habitat is unknown and it has never been taken there in the daytime. Similarly the larva of *Jaxea nocturna* is not very uncommon at Plymouth but the adult has only once been captured there.

On the other hand it is not impossible that the limit of the family Palaemonidae has been unduly restricted, and that it should be enlarged to include the Gnathophyllidae. The three genera of the family have some remarkable characters special to themselves, and they also have a simple mandible without incisor process. It is the latter fact which has led to the association of Gnathophyllidae, Processidae and Crangonidae into the superfamily Crangonoida, but, if any weight can be given to larval characters then *Processa* is certainly not nearly related to *Crangon*, and the character of the mandible is not decisive. There is, in fact, a tendency to a reduction of the incisor process in some Palaemonidae and Alpheidae. Borradaile (1921) in describing *Paratypton siebenrocki*, Balss, points out certain features in which it resembles *Gnathophyllum*, and concludes "I am inclined to place *Paratypton* near the point to which the Palaemonidae, Anchistioididae and Gnathophyllidae converge". His figure of the mandible seems to indicate that the part regarded as molar is really compounded of the very minute reduced incisor and molar parts, and that the long "incisor part" is, as he himself suggests, a structure *sui generis*.

Apart from the form of the mandible there seems to be less reason to associate Gnathophyllidae with Crangonidae than with Palaemonidae.

It seems not unlikely that the Gnathophyllidae will be found to have larvae of Palaemonid type, and that they may even be among those described here.

Palaemonid B.R. VII. (Text-figs. 155-162.)

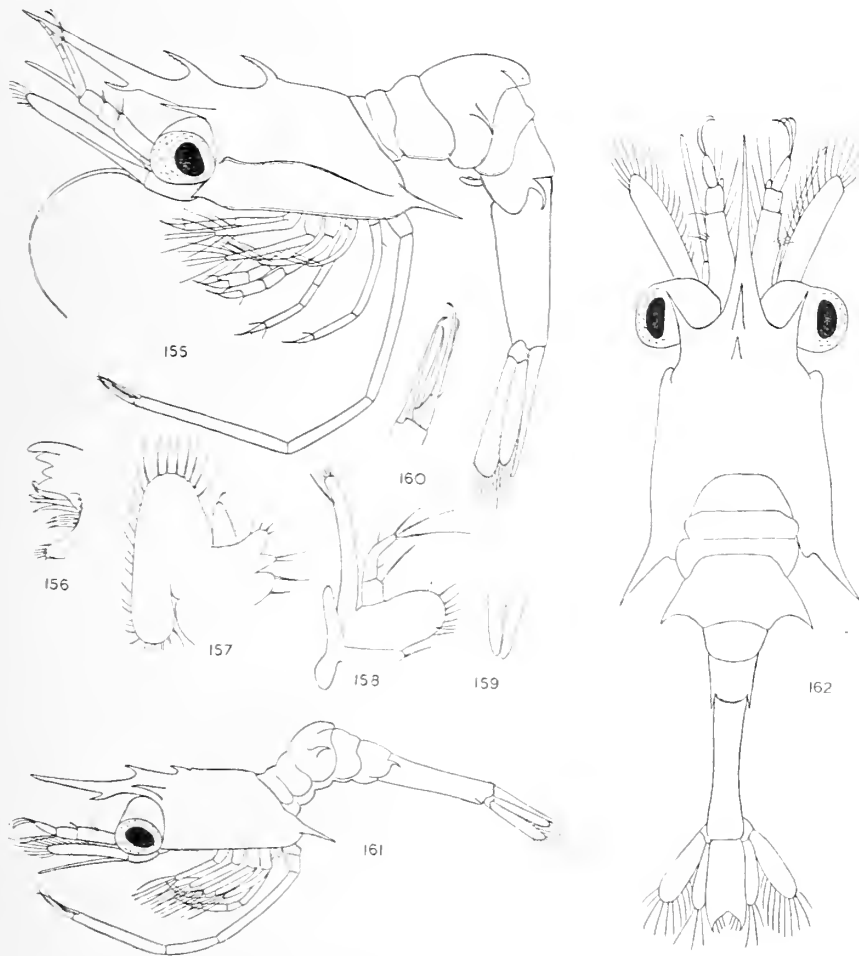
LOCALITY.

Barrier Reef Station 14; 6 specimens. Station 46; 1 specimen.

DESCRIPTION.

Stage V? Length 8.4 mm.

Rostrum longer than antennule, turned slightly upwards, with serrated spine below about middle, and another dorsal at base. Carapace with one large dorsal serrated spine; a large supra-orbital spine but no antenanal or branchiostegal; posterior angle produced into a large spine. A lateral ridge extends from the orbit nearly to the posterior angle.



TEXT-FIGS. 155-162.—Palaeomonid B.R. VII.

- | | |
|-------------------------------|---|
| FIG. 155.—Stage V ♂, lateral. | FIG. 159.—Stage V ♂, tip of telson. |
| FIG. 156.—,, mandible. | FIG. 160.—,, part of leg 5. |
| FIG. 157.—,, maxilla. | FIG. 161.—Stage IV ♂ (Ghardaqa), lateral. |
| FIG. 158.—,, maxillipede I. | FIG. 162.—,, dorsal. |

Abdominal somite 3 somewhat swollen dorsally, with a pair of large lateral spines curving downwards; somite 5 with large curved lateral spines; somite 6 without lateral spines. Anal spine absent. Telson $4\frac{1}{2}$ times as long as wide, without lateral or terminal spines, but simply bifurcated at end.

Antennule with stylocerite and small ventral spine; outer flagellum deeply cleft. Antennal scale without spine; flagellum about $1\frac{3}{4}$ times as long as scale.

Maxillule, endopod small, with two small setae. Maxilla, endopod small, with very small apical seta and no basal lobe or seta; exopod with outer margin fringed with setae.

Maxillipede I, basis very protuberant, without spines; endopod of two segments,

segment 1 with long seta ; exopod without basal setae, and five apical. Maxillipede 3, dactyl with single large apical spine ; exopod with eight setae.

Legs 1 and 2 chelate, nearly equal. Leg 4 smaller than leg 3, without exopod, and without long propodal spines. Leg 5 reaching beyond eye ; propod with two very long distal spines ; dactyl with basal spine. Lengths of segments in leg 5 : ischiomerus, 1.7 mm. ; carpus, 1.0 mm. ; propod, 1.6 mm.

Pleopods small.

REMARKS.

The Barrier Reef material contains also two other forms which, while agreeing in nearly all respects with the description given above, differ as follows :

Form B. : Stations 55, 57. 3 specimens.

Abdominal somite 3 produced dorsally into a large recurved spine.

Form C. : Stations 33, 53. 2 specimens.

Abdominal somite 3 without dorsal or lateral spines. One of these two specimens measures 10.6 mm. and is rather more advanced, having very large pleopods. The carpus of leg 5 is rather longer in proportion to the propod and ischiomerus.

Some specimens from a plankton sample taken at Ghardaqa in July, 1935 (Text-figs. 156, 157), are younger than those from the Barrier Reef, measuring about 5 mm. Legs 3 and 4 are quite rudimentary, the rudiment of leg 3 biramous, leg 5 fully developed ; there are no pleopods. The telson is parallel-sided, deeply cleft at the end, the arms of the fork narrow and blunt-ended. Within the fork are two pairs of long and a pair of very short setae. Such a form of telson is very unusual and might well develop into the simple cleft form without setae found in the older specimens from the Barrier Reef. When first seen these Red Sea specimens were thought to belong to *Anchistioides*, but dissection of the mouth-parts makes such an identification improbable (see p. 43). I regard them as belonging to the same species as that described above, or at least to one very closely allied to it.

Palaemonid B.R. VIII. (Text-figs. 163-169.)

LOCALITY.

Barrier Reef Stations 33, 38, 50, 59. 14 specimens.

DESCRIPTION.

Stage VI ? Length 6-8 mm.

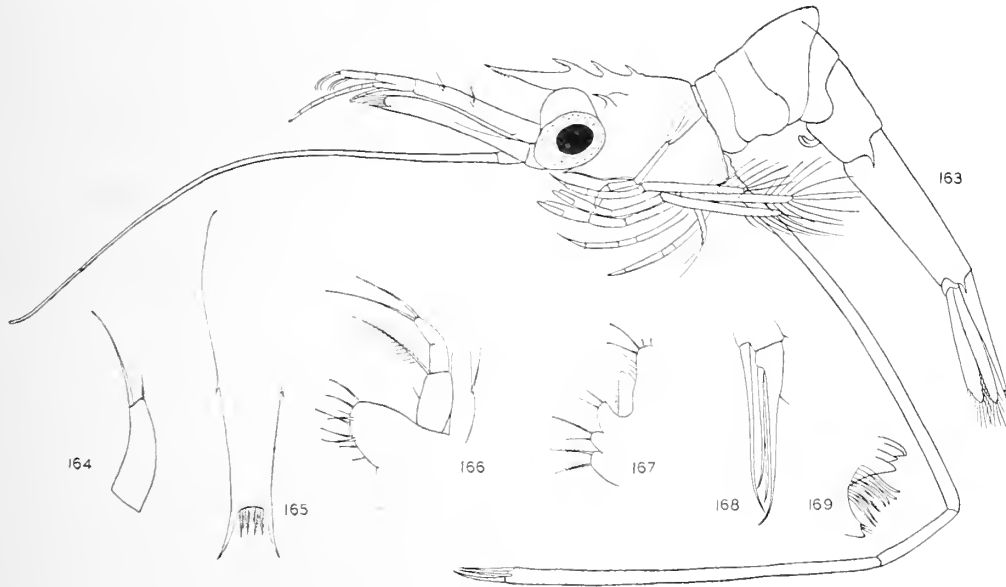
Body rather bent at thorax and somite 3. Rostrum straight, much shorter than peduncle of antennule, serrated at end, and with one dorsal serrated spine. Carapace with two dorsal spines, the anterior one serrated ; supra-orbital and pterygostomial spines present. Abdominal somite 3 projecting over somite 4 ; somites 5 and 6 with lateral spines. Anal spine absent. Telson nearly four times as long as wide, with one pair of lateral spines ; outer apical spines large, forming a fork within which are two pairs of small feathered spines.

Antennule with small stylocerite and very small ventral spine ; outer flagellum deeply cleft, shorter than inner. Antennal scale with long apical spine ; flagellum nearly four times as long as scale.

Maxillule, endopod slender, with two apical setae. Maxilla, endopod without setae or basal lobe ; exopod with outer margin fringed with setae.

Maxillipede 1, coxa without setae ; basis very protuberant, without spines ; endopod with large basal segment distinct, bearing a long seta, distal part obscurely two-segmented ; exopod with one outer basal seta. Maxillipede 2, basis rather protuberant, with two long slender spines ; epipod present, small. Maxillipede 3, dactyl with one strong apical spine.

Legs 1 and 2 chelate, leg 2 the larger. Exopods of maxillipede 3 and leg 2 with twelve setae, leg 1 with fourteen. In an older stage than that figured the chela of leg 2 is very long and slender, the dactyl twice as long as the palm. Leg 4 without exopod, slender, shorter than leg 3 and without spines on propod. Leg 5 extremely long ; coxa with anterior rounded knob ; ischiomerus and propod about equal and about four times as long as carpus ; propod with strong distal spines ; dactyl with basal spine. Pleopods small.



TEXT-FIGS. 163-169.—Palaemonid B.R. VIII.

- | | |
|--------------------------------|--------------------------------|
| FIG. 163.—Stage VI ?, lateral. | FIG. 167.—Stage VI ?, maxilla. |
| FIG. 164.—,, maxillule, palp. | FIG. 168.—,, leg 5, dactyl. |
| FIG. 165.—,, telson. | FIG. 169.—,, mandible. |
| FIG. 166.—,, maxillipede 1. | |

The youngest specimen is only 3.8 mm., but has exactly the same form and spines on rostrum and carapace as the oldest. The uropods are fully developed, but there are no pleopods. While leg 5 is as large in proportion as in later stages, legs 3 and 4 are quite rudimentary. This stage no doubt represents Stage IV, and there is probably one moult between it and the stage figured, which is therefore regarded as Stage VI. An older stage has the pleopods very large, and is no doubt the last stage, so that there seem to be seven stages in all.

Palaemonid B.R. IX. (Text-figs. 170-177.)

LOCALITY.

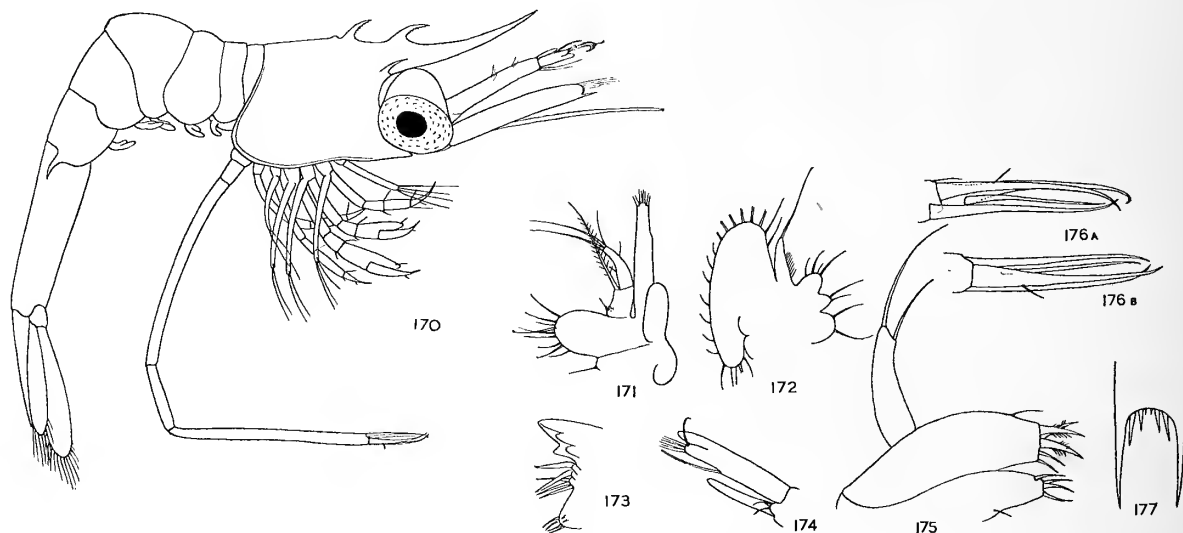
Barrier Reef Stations 2, 9, 38, 44, 53.

DESCRIPTION.

Stage V ? Length 8 mm.

Rostrum curving upwards, with one large dorsal spine at base. Carapace with large serrated dorsal spine; supraorbital and pterygostomial spines present. Abdominal somite 3 not swollen dorsally; somite 5 with lateral spines; somite 6 without spines. Anal spine absent. Telson nearly four times as long as wide, without lateral spines, the outer terminal spines very large and forming a fork within which are six small spines.

Antennule with very small stylocerite and large ventral spine; outer flagellum slightly cleft, much longer than inner. Antennal scale with strong terminal spine; flagellum about $1\frac{1}{2}$ times as long as scale.



TEXT-FIGS. 170-177.—Palaemonid B.R. IX.

- FIG. 170.—Stage V ?, lateral.
 FIG. 171.— „ maxillipede 1.
 FIG. 172.— „ maxilla.
 FIG. 173.— „ mandible.
 FIG. 174.— „ end of antennule, showing cleft in outer flagellum.
 FIG. 175.— „ maxillule.
 FIG. 176.— „ leg 5, dactyl. A. From inside. B. From outside.
 FIG. 177.— „ end of telson.

Maxillule, endopod slender, with two terminal setae. Maxilla, endopod slender, with long terminal seta but no basal lobe; outer margin of exopod fringed with setae.

Maxillipede 1, coxa with small seta; basis very protuberant; endopod of two segments, segment 1 with long seta.

Legs 1 and 2 chelate, leg 2 the larger, its dactyl longer than palm. Exopods of maxillipede 3 and legs 1 and 2 with six setae. Leg 4 about equal to leg 3, without exopod. Leg 5 very elongated; coxa without inner papilla; ischiomerus and propod equal, about three times as long as carpus. Propod with strong terminal spines; dactyl with basal spine.

Pleopods small.

A younger specimen of 4.9 mm. of same general form and with leg 5 fully developed, had leg 4 a small rudiment.

1C. ANCHISTIOIDINAE.

Anchistioides.

The larva of *Anchistioides antiguensis* (Schmitt) in Stages I and II (Gurney, 1936) has some remarkable features which make it strikingly distinct from all Palaemonid larvae hitherto described. Apart from the reduction of the mouth-parts, which also characterizes the adult, the posterior spine on the carapace, the very large branchiostegal spine, and the dorsal spine on abdominal somite 3 are features which were not known at the time when the larva was described. While the paper was going through the press I found in plankton from Ghardaqa a Palaemonid larva (described above as B.R. VII, p. 38) with large posterior spines on the carapace which I supposed was a later stage of *Anchistioides*: but examination of the mouth-parts showed that this was an error. That the later stages of *Anchistioides* are in fact much more Palaemonid in appearance than the earliest stages is confirmed by the discovery in the Barrier Reef material of late larvae which can with some confidence be referred to this genus. Two species are represented.

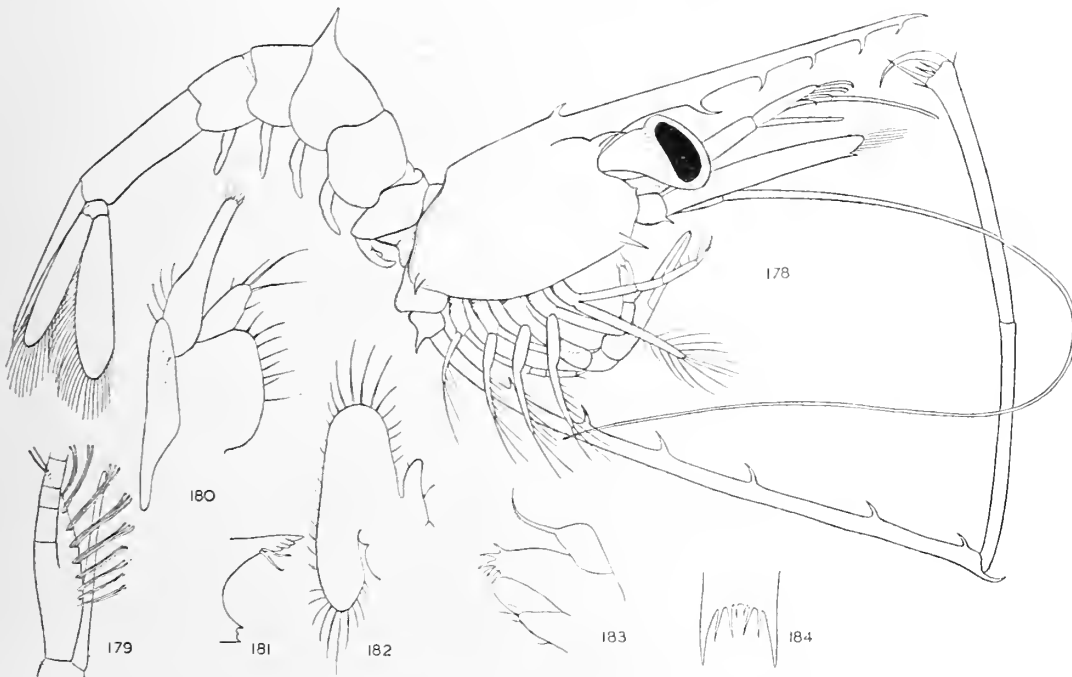
Anchistioides Species I. (Text-figs. 178-184.)

LOCALITY.

Barrier Reef Stations 15, 35, 44. 3 specimens.

DESCRIPTION.

Last stage? Length 13.5 mm. including rostrum 4 mm.



TEXT-FIGS. 178-184.—*Anchistioides* Species I.

FIG. 178.—Last stage?, lateral.

FIG. 179.—,, part of antennule.

FIG. 180.—,, maxillipede 1.

FIG. 181.—,, mandible.

FIG. 182.—Last stage?, maxilla.

FIG. 183.—,, maxillule.

FIG. 184.—,, end of telson.

Rostrum long and straight, without spines dorsally, but with five ventral spines of which the proximal one points forwards and the distal four backwards. Carapace with small dorsal spine and large supra-orbital and branchiostegal spines. A small projection seems to represent the antennal spine, and there is a small spine at the posterior angle.

Abdominal somite 3 with stout pointed dorsal process; pleura of somites 5 and 6 rounded. Anal spine absent.

Telson tapering, $4\frac{1}{2}$ times as long as its anterior width; without lateral spines; posterior margin with a pair of strong outer spines confluent with the telson and forming a fork within which are six small spines.

Antennule widened at base, with small rounded process representing stylocerite, without ventral spine; outer flagellum deeply cleft, the thin inner branch reaching end of rostrum (Text-fig. 179), thick sensory part unsegmented. Antennal scale with small distal spine; flagellum very long.

Mouth-parts reduced. Palp of maxillule small, with one curved terminal seta. Maxilla without endites, the endopod small, without terminal seta; exopod large, the outer margin fringed with small setae and hairs.

Maxillipede 1, coxa not distinct, basis not protuberant, with small setae; endopod small, unsegmented; exopod with four outer basal setae, and four terminal. Maxillipede 2 with small rudiment of epipod; endopod of three segments. Maxillipede 3, dactyl with single apical spine; exopod with 14 setae.

Legs 1 and 2 chelate, leg 2 very much larger than leg 1, the dactyl longer than palm. Leg 4 with exopod; endopod smaller than leg 3. Leg 5, basis with posterior spine; ischiomerus enormously produced, with a series of six recurved inner spines; carpus a little shorter than propod, which is slightly dilated at end; dactyl and its spine fused and forming a curved claw apposed to a stout spine on the propod to form a sort of pincer.

Lengths of segments: ischiomerus, 7 mm.; carpus, 2.25 mm.; propodus, 3.15 mm. Pleopods large, without setae.

Anchistioides Species II. (Text-figs. 185-192.)

LOCALITY.

Barrier Reef Stations 24, 26, 40, 44. 6 specimens.

DESCRIPTION.

Stage IV? Length 5.45 mm.

Rostrum straight, shorter than peduncle of antennule, with very small ventral tooth. Carapace with large supra-orbital spines, but no branchiostegal spines or spines at posterior angle. Abdomen without dorsal spine; pleura rounded. Telson $3\frac{1}{2}$ times as long as wide, without lateral spines, and with six feathered terminal spines. Anal spine absent.

Antennule, peduncle with very small ventral spine; flagella small, outer one not cleft. Antennal scale without spine, flagella about as long as body.

Mouth-parts reduced. Maxillule, proximal endite much reduced; endopod small, with one seta. Maxilla without endites; endopod reduced to a small knob; exopod large, without setae on outer margin.

Maxillipede 1, coxa not distinct; endopod with distal segment marked off.

Legs 1 and 2 not chelate. Leg 4 absent. Leg 5 exceedingly large; ischiomerus reaching beyond antennal scale, without spines on anterior margin; carpus long and

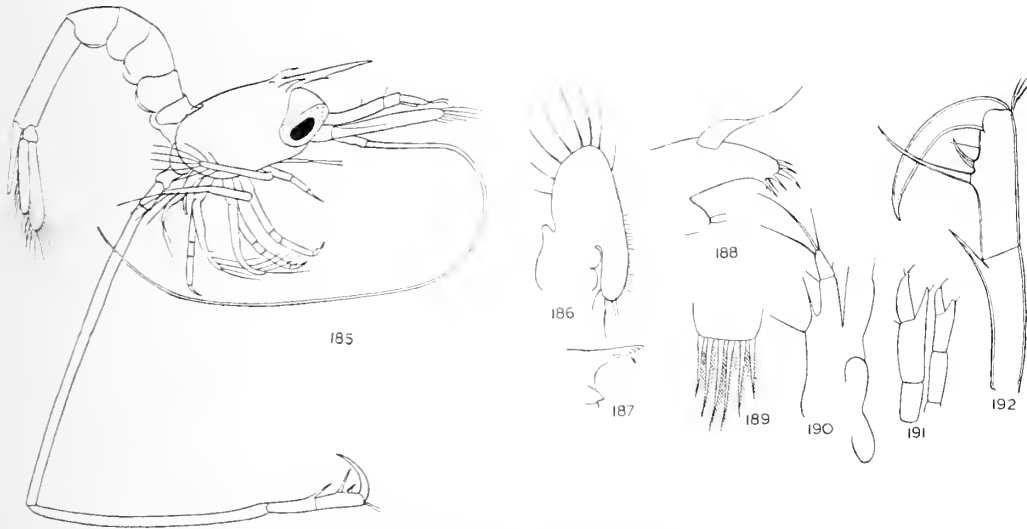
slender: propod divided into two segments with a strong spine at inner distal angle of segment 1; segment 2 not dilated, bearing, as in species 1, a large claw closing on to a strong spine on inner margin of segment.

Pleopods absent. Uropods fully developed. exopod without spine.

Last stage. Length 11 mm., including rostrum 2 mm.

General form of body exactly as in Stage IV. Rostrum with one strong ventral spine: eleven dorsal spines seen under skin, but ventral spines not sufficiently distinct to count.

Antennule, outer branch deeply cleft, with long thin distal flagellum $1\frac{1}{2}$ times as long as thick basal part, and as long as peduncle. Antennal scale without spine.



TEXT-FIGS. 185-192.—*Anchistioides* Species II.

FIG. 185.—Stage IV ?, lateral.

FIG. 186.—,, maxilla.

FIG. 187.—,, mandible.

FIG. 188.—,, maxillule.

FIG. 189.—Stage IV ?, telson, end.

FIG. 190.—,, maxillipede 1.

FIG. 191.—Stage V ?, legs 1 and 2.

FIG. 192.—Stage IV ?, end of leg 5.

Legs 1 and 2 chelate, leg 2 much larger than leg 1; dactyl shorter than palm; exopods with 18 setae. Leg 4 the same size as leg 3, without strong spines on propod, with exopod.

Leg 5, lengths of segments: ischiomerus, 6.4 mm.; carpus, 5.15 mm.; propodus, 1.65 mm.

Pleopods large.

An intermediate stage of 7.65 mm. has the pleopods present as small buds, and leg 4 a small rudiment.

REMARKS.

One of the late stages here described agrees with the earlier stages of *A. antiquensis* in having a dorsal spine on the abdomen, and it also has the same peculiar form of the mouth-parts, so that it can hardly be doubted that it belongs to the same genus, though there are great differences in the form of the carapace. In both the species described hypertrophy of leg 5 has produced an appendage of fantastic size, and terminating in a claw of remarkable construction. Such hypertrophy of leg 5 is characteristic of the

Palaemonidae, and the larva has in fact the general facies of the Palaemonidae of the *Leander* and *Cryptoleander* groups, though it differs radically in form of the mouth-parts. Apart from the fact that the mouth-parts are rather more reduced in the Pontoniinae than in the Palaemoninae there is nothing to suggest that *Anchistioides* is more nearly related to the Pontoniinae.

Miss Gordon has discussed the systematic position of the genus and concludes that it is a true Pontoniid, but I suggest that it would be more satisfactory to regard it as forming a distinct subfamily. Having regard to the great difference between the larvae of *Ancyllocaris* and those described here in the *Mesocaris* group it seems possible that, even within the Pontoniinae, some separation of genera into subgroups is required; but naturally nothing can be suggested until more of these larvae can be attached to their genera.

II. ALPHEIDAE.

The development of the Alpheidae is fairly well known through the work of Herrick, Sars, Coutière, Webb and Lebour. There is a strong tendency in the genus *Synalpheus* to abbreviation of development, and this is also seen in some species of *Alpheus*, but many, and perhaps most, of the species of *Alpheus* hatch as a perfectly normal zoea and pass through as many as nine larval stages (Lebour, 1932). The structure of the larva in such cases is remarkably uniform. Development is known in species of *Alpheus*, *Synalpheus* and *Athanas*, and examination of the eggs of other genera by Coutière indicates that the larva resembles that of *Alpheus*, and that development is not abbreviated. Such unidentified Alpheid larvae as are known (*Anebocaris*, *Diaphoropus*, Bate) do not differ to any very marked extent from those of *A. ruber*, for example, but *Anebocaris ancylifer*, Coutière, is remarkable for its size (16 mm.) and is one of those large oceanic larvae which Bouvier and Coutière suggest continued their larval phase far beyond the normal period.

This uniformity of structure is rather remarkable in view of the diversity of form within the nearly allied family of Palaemonidae, and it is desirable to add to our knowledge by description of more larvae of known parentage. The form described below as Alpheid R.S. II shows that there is some diversity, but unfortunately this larva cannot be named.

The Red Sea is extremely rich in Alpheids, as Coutière has shown, but I was not very successful at Ghardaqa in obtaining larvae. A number of species were found, but some were not breeding or had only just begun to breed, and it seems that Alpheids are peculiarly difficult to deal with in the laboratory, being very apt to throw off their eggs without hatching. Of one small species which is abundant in the coral many females were kept, some of them for many days, but not one of them produced larvae.

Alpheus ventrosus, M. Edw. (Text-figs. 193-198.)

LOCALITY.

This is a large, dark red, species found very commonly in the branches of the coral *Stylophora* at Ghardaqa, generally a male and a female together. The eggs are numerous and not large in proportion to the size of the animal. In a female of 34 mm., with early eggs, the eggs measure .87 mm. by .62 mm. For the most part the eggs were all in early stages, but those of one female hatched out in the laboratory on 23rd March.

DESCRIPTION.

Stage I. Length 2.4 mm.

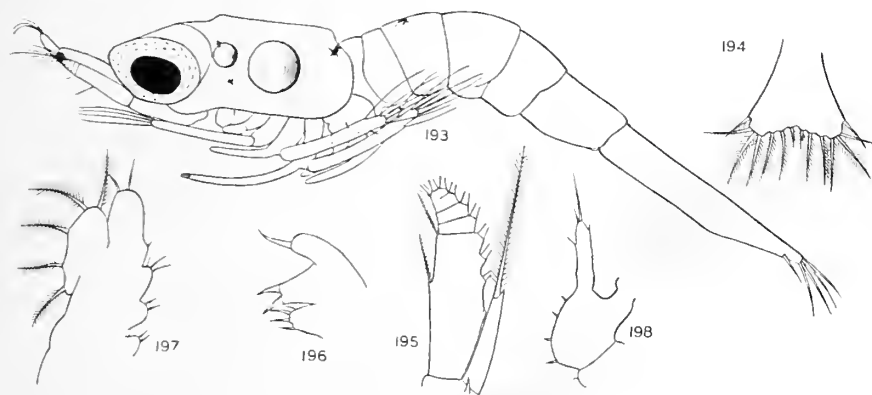
Rostrum absent. Carapace and abdomen without spines; telson triangular, not deeply indented, with 7 + 7 spines.

Eyes sessile, oval in dorsal view.

Antennule unsegmented. Antennal scale with four distal segments and ten inner and apical setae; endopod less than half length of scale, with apical seta and small spine; basis with small spine. Mandible rudimentary.

Maxillule very small, lacinia 2 with two large spines. Maxilla with endites very reduced and endopod not marked off from stem; exopod small, with five setae.

Maxillipede 1, endopod unsegmented, basis large, protuberant, with four small spines. Maxillipedes 2 and 3, endopods unsegmented, without setae. Exopods with six setae; in



TEXT-FIGS. 193-198.—*Alpheus ventrosus*.

FIG. 193.—Stage I, lateral.

FIG. 196.—Stage I, maxillule.

FIG. 194.—,, telson.

FIG. 197.—,, maxilla.

FIG. 195.—,, antenna.

FIG. 198.—,, maxillipede 1.

maxillipede 2 the proximal seta on the posterior side is reduced to a small hair. Behind the maxillipedes are two large leg rudiments, representing a biramous leg 1 and leg 5.

Colour: All the specimens were almost colourless. Only four small red chromatophores could be seen, but there was some diffuse yellow in the stomach region.

Alpheus audouini, Coutière. (Text-figs. 199-203.)

LOCALITY.

A. audouini is very common on the tidal reef-flat at Ghardaqa, where it lives under stones and in crevices in the coral rock. The snapping of its claws can be heard everywhere, but it is not easy to catch, since the rock is honey-combed with holes into which it disappears. It must also be very common in burrows in sand in deeper water since it was taken in some numbers when trawling over the *Halophila* bed at night, though never caught there by day.

DESCRIPTION.

Stage II. Length 2.75 mm.

Carapace with small pointed rostrum and pterygostomial spine. Telson triangular, posterior margin straight, with 8 + 8 spines.

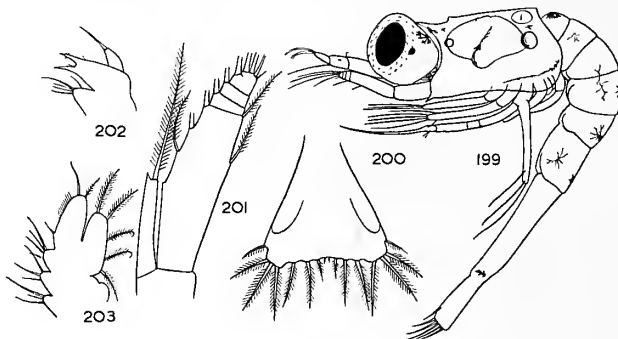
Eyes stalked. Antennule with segment 3 of peduncle distinct; exopod with one large and four slender aesthetes and a delicate hair, but no feathered seta. Antennal scale with four distal segments and 10 inner and apical setae; a small knob on inner edge between setae and base; endopod less than half length of scale, with apical seta and small spine.

Mandible small, but with teeth. Maxillule very small, with two large spines on segment 2. Maxilla with three well-marked endites bearing small setae; endopod with vestige of basal lobe; exopod small, with five setae.

Maxillipede 1, endopod very small, with apical seta. Maxillipede 2, endopod of four segments, with apical spine. Maxillipede 3, endopod very long and slender, with long apical spine; exopods with 4.6.6 setae.

Leg 1 a large biramous rudiment without setae. Leg 2 a small biramous rudiment; leg 3 a small papilla; leg 4 absent. Leg 5 a large, blunt-ended rod.

Uropods traceable within telson.



TEXT-FIGS. 199-203.—*Alpheus audouini*.

FIG. 199.—Stage II.

FIG. 202.—Stage II, maxillule.

FIG. 200.—,, telson.

FIG. 203.—,, maxilla.

FIG. 201.—,, antenna.

REMARKS.

Among large numbers of specimens from two broods nearly all are as described above. Two only were found partially moulted from a normal Stage I, having sessile eyes and telson with 7 + 7 spines.

All breeding females were examined every morning and evening, and it is clear that in this case there is a first stage which moults within a few hours into Stage II. Brooks and Herrick (1892, p. 361) noted the very short duration of Stage I in *A. minor* (= *A. bermudensis*, Bate) and it may be well that this is usual in the Alpheidae. Miss Lebour (1932) found that the first larva in *Athanas nitescens* and *Alpheus ruber* had the rostrum and stalked eyes characteristic of Stage II, and it seems likely that here also Stage I has already been passed through. There must, however, be some variation in this respect since Miss Webb (1921) found a normal Stage I of *A. nitescens* in plankton.

I have described (1927) three stages, including a normal Stage I of this species from the Suez Canal. Though the identification was then only a matter of guesswork I have no doubt now that it was correct.

Development probably proceeds as in *A. ruber* through a number of stages, but no later larvae which could be attributed to it were seen at Ghardaqa. Larvae of another species, distinguishable by the presence of a supra-orbital spine, were common in plankton from outside the reefs, but not seen in the lagoon. I attribute these with much doubt to *A. pacificus*, Dana.

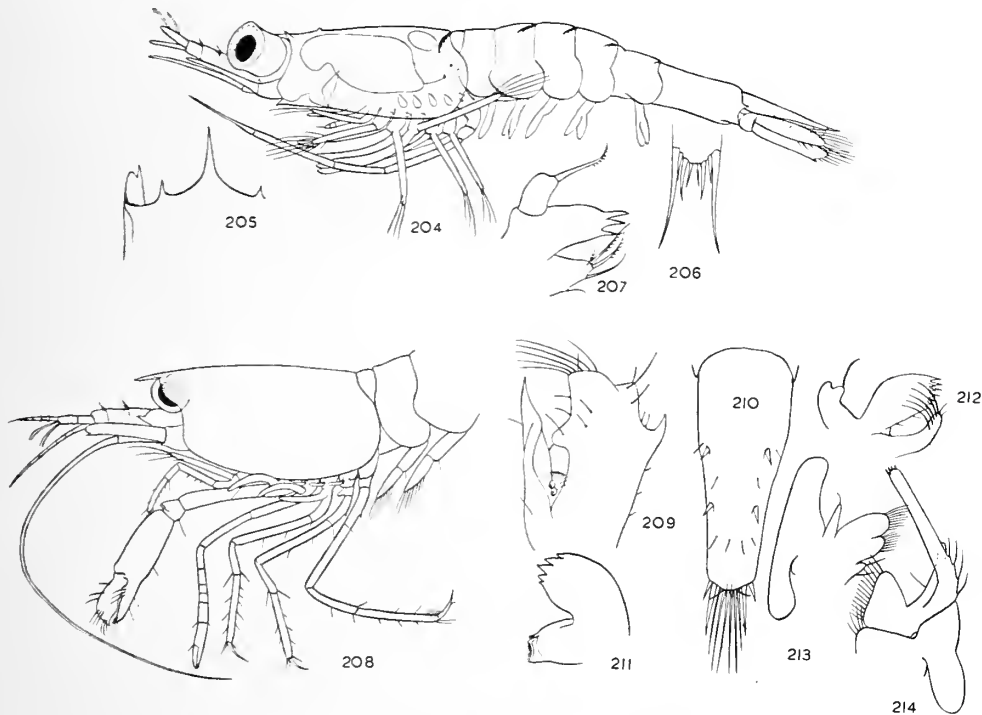
A. pacificus, Dana? (Text-figs. 204–214.)

Coutière, 1905, p. 909.

DESCRIPTION.

Larva in last stage. Length 6.3 mm.

Carapace with rostrum shorter than eyes and with supra-orbital and pterygostomial spines. Abdominal pleura rounded; somite 6 more than twice as long as deep. Telson more than three times as long as wide, without lateral spines, and with 4 + 4 apical spines, of which the outer pair are very long. Anal spine absent.

TEXT-FIGS. 204–214.—*Alpheus pacificus*?

- | | |
|-----------------------------------|----------------------------------|
| FIG. 204.—Last stage. | FIG. 210.—Post-larval I, telson. |
| FIG. 205.—,, carapace from above. | FIG. 211.—,, mandible. |
| FIG. 206.—,, end of telson. | FIG. 212.—,, maxillule. |
| FIG. 207.—,, maxillule. | FIG. 213.—,, maxilla. |
| FIG. 208.—Post-larval I. | FIG. 214.—,, maxillipede 1. |
| FIG. 209.—,, antennule. | |

Endopod of antenna longer than scale, with basal segment distinct. Mandible without palp.

Maxillule, endopod small with large apical seta; lacinia 2 with three strong spines. Maxilla, exopod with outer margin without setae; endites with several setae; endopod with basal seta.

Maxillipede 1, basis with four marginal spines.

Legs 1 and 2 indistinctly segmented, with small chelae. Leg 5 reaching with its apical spine to beyond the eyes.

Epipods present on legs 1–4.

Pleopods large, without setae. Uropods, exopod with small outer apical spine.

Colour : Bright yellow below eyes, in labrum and at bases of maxillipede 3 and leg 3. Two small red chromatophores at posterior end of carapace, and larger ones dorsally in abdominal somites 1-4.

From this stage moults were obtained to post-larval.

Post-larval Stage I. Length 6 mm.

Carapace with small rostrum, and partly, but not wholly, overhanging the eyes. Telson nearly three times as long as wide, with two pairs of dorsal spines and two pairs of terminal spines, between which there are three pairs of long feathered setae. Anal spine absent.

Antennule, segment 2 longer than segment 3 (42 : 30) ; segment 1 with large inner spine and sharp-pointed stylocerite ; otocyst widely open above (Text-fig. 209). Mandible without palp.

Mouth-parts and maxillipedes of adult form. Maxillipede 1 and 2 with epipod ; maxillipede 3 with rudiment of arthrobranch ; epipods on legs 1-4. The exopod of maxillipede 3 bears setae, and is not reduced as is so often the case in post-larval Stage I.

Leg 1 on left with very large chela, the dactyl about two-thirds length of palm and broadening near end. Right chela slender, the dactyl nearly as long as palm. Leg 2 carpus of five segments of following lengths—30, 19, 13, 12, 27.

Legs 1-3 with spine on posterior margin of ischium ; dactyl simple and slender.

Colour : Almost colourless, but with yellow in same places as in larva.

REMARKS.

It is not to be expected that the specific characters of the adult would be developed at this stage sufficiently for correct identification, especially in so difficult a genus. The form of the chela is probably more or less like that of the adult, at least in its general proportions ; but the carpus of leg 2 certainly becomes more slender and the proportional lengths of the segments may also change. Assuming, however, that these proportions may be relied upon, most of the species known from the Red Sea are excluded, since it is more usual to find segment 1 shorter than segment 2 throughout the genus. In *A. pacificus*, according to Coutière, segments 1 and 2 have the proportions 1.27 : 1, whereas they are 1.58 : 1 in my specimen. The general form of the dactyl of the large chela is the same, though the propod is very much stouter in the adult *A. pacificus*.

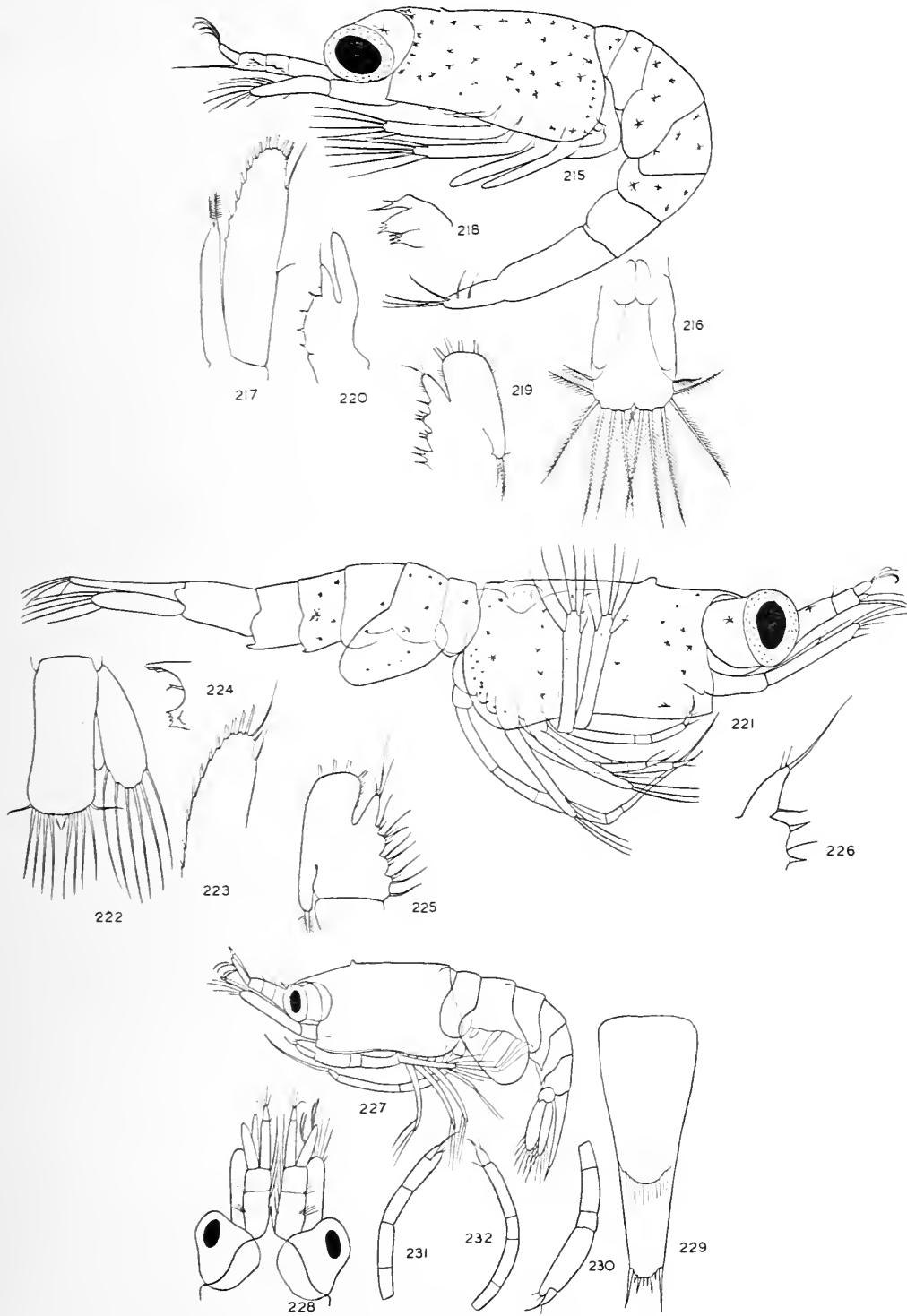
Synalpheus triunguiculatus (Paulson). (Text-figs. 215-232.)

LOCALITY.

This small, dark-red Alpheid was found in small numbers on the inner reefs at Ghardaqa in coral of the genus *Stylophora*.

One female hatched eggs on 23rd March. A number of the larvae moulted two days later to Stage II, and one specimen in Stage II and another in Stage III or IV were taken in plankton.

Coutière (1899, p. 450) regards *S. triunguiculatus* as a variety of *S. neptunus*, Dana. Both are common at Djibouti, but *S. neptunus* is found generally in sponges, and has large eggs, with a very advanced egg-larva, while he found *S. triunguiculatus* living in *Stylophora* and having smaller eggs, with a zoea larva. He noted the large size of the pleura of somite 2 (p. 455).



TEXT-FIGS. 215-232.—*Synalpheus triunguiculatus*.

- | | |
|------------------------------|-------------------------------|
| FIG. 215.—Stage I. | FIG. 224.—Stage II, mandible. |
| FIG. 216.— " telson. | FIG. 225.— " maxilla. |
| FIG. 217.— " antenna. | FIG. 226.— " maxillipede 1. |
| FIG. 218.— " maxillule. | FIG. 227.—Stage IV ? |
| FIG. 219.— " maxilla. | FIG. 228.— " head, dorsal. |
| FIG. 220.— " maxillipede 1. | FIG. 229.— " telson. |
| FIG. 221.—Stage II. | FIG. 230.— " leg 1. |
| FIG. 222.— " telson. | FIG. 231.— " " 2. |
| FIG. 223.— " antennal scale. | FIG. 232.— " " 3. |

DESCRIPTION.

Stage I. Length 2.5 mm.

Rostrum very broad, shorter than eyes, abruptly narrowed at end into a small point. Carapace without spines or marginal teeth. Abdominal somite 2 with conspicuously large pleura. Telson very narrow, nearly rectangular, setae 1 and 2 directed outwards and forwards, setae 3-5 very long; seta 2 feathered on both sides. Eyes free.

Antennule with peduncle segmented. Antennal scale unsegmented, with two outer and ten inner and terminal setae; a very small tubercle on inner margin next to proximal seta; endopod more than half as long as scale, with two short apical setae. Mandible rather rudimentary, but showing distinction of incisor and molar parts. Maxillule very small, but with spines on endites. Exopod of maxilla with four setae in front and one large proximal seta; endopod with rather large basal lobe; three endites with small spines.

Maxillipede 1 much reduced; exopod without setae; basis with four small spines. Maxillipedes 2 and 3, endopod unsegmented, without setae; exopods with 5 and 6 setae, four apical.

Legs 1 and 2 rudimentary, the exopods large, without setae. Leg 5 very long, turned forwards, without apical spine.

Stage II. Length 2.6 mm. Specimen from plankton 2.87 mm.

Rostrum broad at base, narrowed in front into an upturned spine. Abdominal somite 2, pleura very large and partly covering somites 1 and 3. Pleura of somites 4 and 5 with ventral point. Telson jointed to somite 6, parallel-sided, more than twice as long as wide, without lateral spines and with only 7 + 7 apical setae, of which the innermost is minute. Anal spine absent.

Antennule with very small endopod; base not enlarged. Antennal scale with 13 inner and apical setae and only one outer seta; endopod with two apical setae.

Mouth-parts almost unchanged; exopod of maxilla the same.

Maxillipede 1, exopod without setae. Exopods of maxillipedes 2 and 3 with six setae; endopods with setae and terminal spine. Legs 1 and 2 fully formed; legs 3 and 4 rudimentary. Leg 5 very long, with long smooth apical spine.

Uropods developed; exopod not jointed to basis, with six setae; endopod jointed, without setae.

This stage is equivalent to the normal Stage III, and this appears to be another case of the omission of the ordinary Stage II. In view of my observation of the very short duration of Stage I in *A. audouini* it seems probable that there is a similar speeding-up of metamorphosis in *S. triunguiculatus*, but my attention was not directed to this point on the spot, and I have no evidence of this supposed first moult.

Stage III (or IV?). Length 5.0 mm.

Rostrum and carapace unchanged. Abdominal somites 4 and 5 with sharply-pointed pleura. Telson very long and narrow, without lateral spines, and with 4 + 4 apical spines. Anal spine present.

Antennule, endopod longer than exopod, with small apical segment. Endopod of antenna longer than scale, with proximal and distal segments marked off; scale without apical spine. Mouth-part apparently unchanged.

Legs 1 and 2 with large chelae; legs 3 and 4 fully developed, with exopods. Leg 5 with long spine reaching beyond eyes. Pleopods present, pleopod 1 very small.

This specimen, which is rather decayed and damaged, was about to moult to post-larval. It is so much further advanced in development than Stage II that there is probably an intermediate stage which was not found. Assuming also a missing Stage I, there would then be five stages in all, as in some Palaemonidae.

Alpheid R.S. I. (Text-figs. 233–237.)

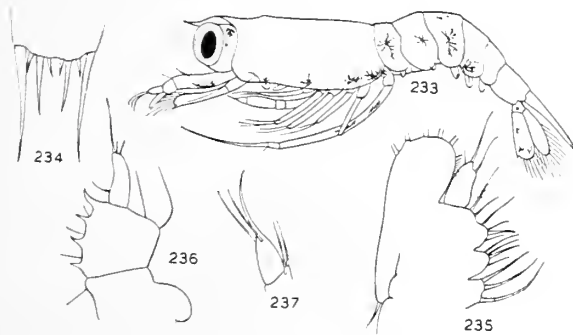
LOCALITY.

Ghardaqa plankton.

DESCRIPTION.

Length 3.7 mm.

Rostrum large and broad, longer than eyes, and overhanging them. Carapace and abdomen without spines; pleura rounded. Telson nearly three times as long as wide, without lateral spines; with 4 + 4 apical spines of which the outer pair are very long. Anal spine present.



TEXT-FIGS. 233–237.—Alpheid R.S. I.

FIG. 233.—Stage IV ?

FIG. 234.—,, telson.

FIG. 235.—,, maxilla.

FIG. 236.—Stage IV ?, maxillipede 1.

FIG. 237.—,, leg 3, dactyl.

Antennule with minute rudiment of stylocerite, but not widened at base. Antennal scale with small apical spine; endopod a little shorter than scale, without basal segment; basis without spine. Mandible small but toothed.

Maxilla with three well-developed endites; endopod without basal seta; exopod with four large setae anteriorly, outer margin smooth, narrowed behind and bearing here one small seta.

Maxillipede 1, endopod small, unsegmented; basis with four very large marginal spines; rudiment or epipod present. Maxillipedes 2 and 3 endopods normal, with four segments; exopods with six setae.

In the single specimen seen legs 1 and 2 are large and chelate on the right side, but without chelae on the left, though the propods are enlarged. Legs 3 and 4 alike, with short dactyl and apical spine (Text-fig. 237). Leg 4 with exopod without setae. Leg 5 very long and slender, reaching with its spine to end of eyes.

Pleopods present, small. Uropods well developed, exopod with 12 setae, and endopod with 10.

Colour : General colour olive-brown, but with red in the chromatophores on somite 4 and at base of leg 3.

Antennule yellow.

REMARKS.

While this is quite certainly an Alpheid larva, and very closely resembles the larva of *Synalpheus*, the absence of setae from the exopod of leg 4 is peculiar and the asymmetry of legs 1 and 2, if it is not merely abnormal, is so unusual a feature that I feel this larva may belong to another genus altogether.

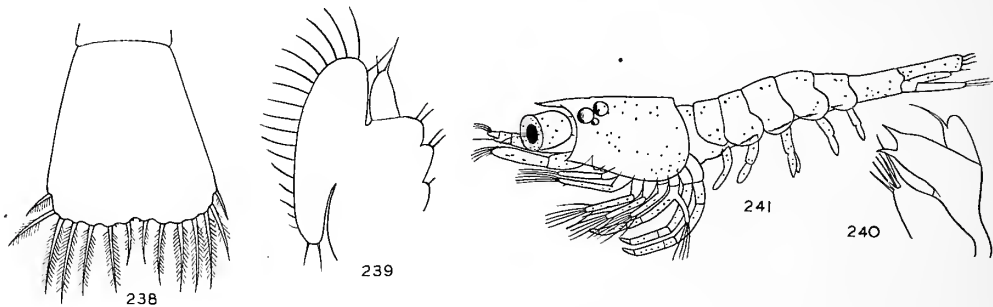
Alpheid R.S. II. (Text-figs. 238-241.)

LOCALITY.

Ghardaqa plankton.

DESCRIPTION.

Stage II ? Length 4.45 mm.-4.9 mm.



TEXT-FIGS. 238-241.—Alpheid R.S. II.

FIG. 238.—Stage II, telson.

FIG. 239.—,, maxilla.

FIG. 240.—Stage II, maxillule.

FIG. 241.—Stage III.

Carapace with small rostrum ; anterior angle pointed. Telson segmented from somite 6, about as wide as long, with 7 + 7 spines and in one case a minute median tubercle which may represent spine 8.

Eyes stalked. Antennule, peduncle of three distinct segments, endopod as long as exopod. Antennal scale unsegmented, with small spine and many setae ; endopod longer than scale, stout, with basal segment distinct, and also a small distal segment. Mandible small, but with toothed incisor part. Maxillule, segment 2 with two large spines. Maxilla with endites reduced ; endopod with two setae ; exopod fringed with setae.

Maxillipede 1, basis with four spines, epipod present. Maxillipedes 2 and 3 with very small apical claws.

Legs 1 and 2 chelate, leg 1 much larger than 2. Legs 1-3 with exopods, without setae. Leg 5 not larger than 4.

Stage III ? Length 4.5-4.8 mm.

Carapace as before. Telson widest at end, with 6 + 6 spines. No anal spine.

Mouth-parts and thoracic appendages unchanged except that chelae are larger and exopods on legs 1-3 have setae. In one specimen near moulting the right chela is very much the larger, and has a large knob on the inner edge of the dactyl.

Pleopods large, with incipient setae. Uropods present, the endopod not jointed and without setae.

Colour: General ground-colour greenish-yellow, with black dots and a few red chromatophores. Median ventral chromatophores in abdomen red.

One specimen of Stage III died in the moult to post-larval, but the new stage is not sufficiently free from the old skin to show its characters. It can, however, be seen that there is a rudimentary arthrobranch on maxillipede 3 and no epipods on the legs.

REMARKS.

The general resemblance of this larva to that of "*Alpheus sauleyi* var. *brevicarpus*" described by Herrick is very close, and this, with the absence of epipods from the legs make it practically certain that it is the larva of a species of *Synalpheus*. It differs from Herrick's species in having no exopod on leg 4, and from *S. triunguiculatus* in the same way, but also in general form and in having leg 5 not specially elongated. It is, in fact, a quite distinct type of larva, and it is unfortunate that it cannot be identified.

Only the two stages described were seen, and moults were obtained of Stage II to Stage III. If there is an earlier stage it is, no doubt, a transitory one; but, in any case development is much shortened since "Stage III" is certainly the last larval stage. There seems to be no growth between the stages, the larva probably living on yolk and not by capture of food.

Alpheid B.R. I. (Text-figs. 242-248.)

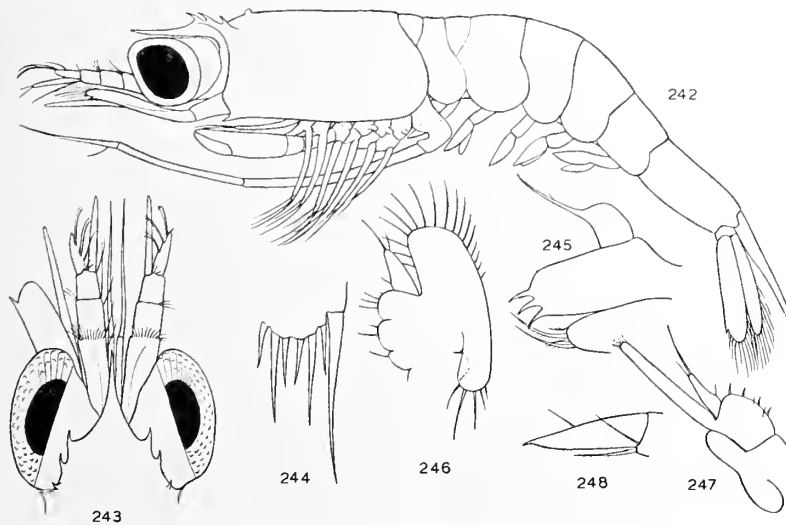
LOCALITY.

Barrier Reef Station 50.

DESCRIPTION.

Length 7.55 mm.

Rostrum as long as eyes, very broad at base where it bears three large marginal



TEXT-FIGS. 242-248.—Alpheid B.R. I.

- | | |
|-----------------------------------|--------------------------------|
| FIG. 242.—Last stage. | FIG. 246.—Last stage, maxilla. |
| FIG. 243.—,, dorsal view of head. | FIG. 247.—,, maxillipede 1 |
| FIG. 244.—,, end of telson. | FIG. 248.—,, leg 4, dactyl. |
| FIG. 245.—,, maxillule. | |

teeth on either side. Carapace with pterygostomial spine. Abdominal pleura rounded. Telson four times as long as wide, without lateral spines and with 4 + 4 terminal spines, of which the outer pair are very long. Anal spine absent.

Antennule with stylocerite, without ventral spine; endopod longer than exopod. Antenna, endopod longer than exopod with basal segment distinct. Mandible small, but with teeth. Maxillule, lacinia 2 with three large spines. Maxilla, endopod with basal seta; exopod with part of outer margin bare.

Maxillipede 1, basis with four small spines; epipod very large. Maxillipede 2, endopod of four segments, with strong apical spine; epipod small. Legs 1 and 2 with chelae. Legs 1-4 with exopods; epipods on legs 1-4. Leg 5 extending with spine beyond antennules.

Pleopods large, without setae. Uropods fully developed.

REMARKS.

One specimen of this Alpheid was found in a plankton sample from Station 50 of the Great Barrier Reef Expedition. While it is in other respects a perfectly normal larva of the *Alpheus* type it differs from all other known larvae in the strongly toothed margins of the rostral hood.

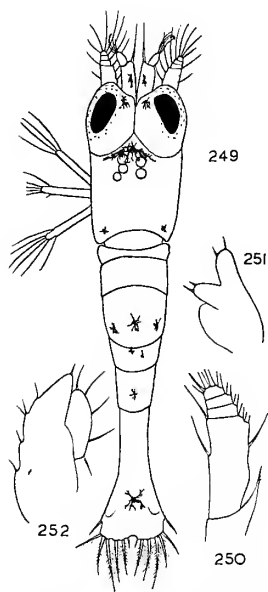
Athanas djiboutensis, Coutière. (Text-figs. 249-252.)

LOCALITY.

The adult is found commonly in pools on the reef-flat at Ghardaqa, but only one was taken with eggs. From these rather large eggs about 15 larvae were hatched on 25th March.

DESCRIPTION.

Stage I. Length 1.5 mm.



TEXT-FIGS. 249-252.—*Athanas djiboutensis*.

FIG. 249.—Stage I.

FIG. 250.—,, antenna.

FIG. 251.—Stage I, maxillule.

FIG. 252.—,, maxilla.

Rostrum absent; carapace and abdomen without spines. Telson rather narrow, slightly indented, with 7 + 7 setae, of which the fourth is the longest.

Peduncle of antennule unsegmented. Antennal scale segmented, with two outer and ten inner and terminal setae; endopod a short spine-like process. Mandible rudimentary. Maxillule and maxilla very much reduced, apparently not functional, with few setae.

Maxillipede 1, endopod minute, with one apical seta; basis without setae or spines. Maxillipede 2 and 3, endopod rather small, of three segments, with terminal curved spine. Exopods with 4.6.6 setae. Exopod of maxillipede 2 with proximal outer seta very small.

Leg 1 a large biramous rudiment. Leg 5 a large, blunt-ended rudiment. Legs 2-4 absent.

Uropods visible under skin.

Colour: Conspicuously red in eyes, somite 3 and telson, but yellow bands under reflected light. The large dorsal chromatophores have both red and olive-brown branches. No ventral chromatophores in abdomen, but a large richly-branched one at base of maxillipede 3.

REMARKS.

It will be noted that this is a quite normal Stage I larva very much like that of *A. dimorphus* (Gurney, 1927). In *A. nitescens* (Lebour, 1932) the first larva from the egg has a rostrum and stalked eyes, but the telson has 7 + 7 setae. It is suggested above that there may be, in that species, a Stage I which moults very soon after hatching into Stage II.

Alpheid D. I. (Text-figs. 253-256.)

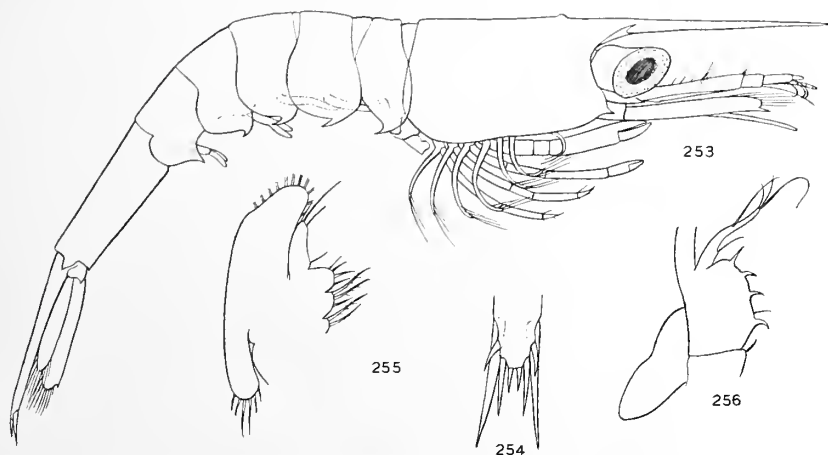
LOCALITY.

Discovery Station 1580. 8° 44' S., 41° 50' E.

DESCRIPTION.

Length: rostrum 2.85 mm.; rest of body 9.6 mm.

Rostrum longer than antennules, perfectly straight, slightly widened at base, with a marginal tooth on either side (supra-orbital spine). Carapace with median dorsal tubercle and small pterygostomial spine. Abdominal somites with large pleura, each with a



TEXT-FIGS. 253-256.—Alpheid D. I.

FIG. 253.—Last stage ?

FIG. 254.—,, part of telson.

FIG. 255.—Last stage ?, maxilla.

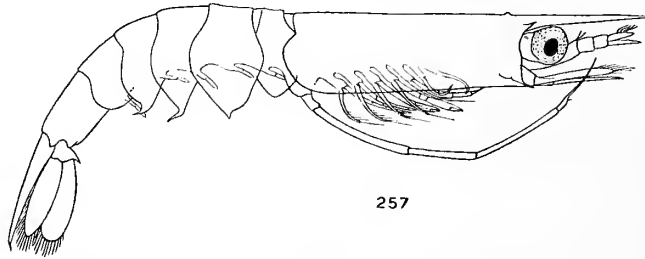
FIG. 256.—,, maxillipede I.

large tooth, recurved on somites 1-4. Somite 6 very long, with posterior lateral triangular projection over base of telson. Telson very long and narrow (2 mm. \times 0.3 mm. at base), without lateral spines, and with 4 + 4 apical spines; outermost spine very large, inserted below a median projection of the telson which bears the remaining six spines. Anal spine absent.

Antennule, peduncle segmented, with stylocerite and minute ventral tooth; endopod longer than exopod, with five segments, the two basal very long; exopod with small distal segment. Antennal scale narrow, with strong apical spine; endopod longer than scale and with basal segment distinct.

Mandible without palp, incisor process toothed. Maxillule well developed, lacinia 2 with four strong spines. Maxilla, exopod with outer margin bare; inner lobes with spines; endopod with small basal seta.

Maxillipede 1 with large bilobed epipod; basis with four strong spines; endopod slender, unsegmented, with long setae; exopod with six setae. Maxillipede 2, endopod of five segments, ischium very short; rudiment of epipod present. Maxillipede 3, endopod of four segments; exopod with 10 setae; rudiment of arthrobranch present.



TEXT-FIG. 257.—*Anebocaris ancylifer*. "Discovery" Station 704.

Legs 1-4 with exopods; leg 1 with large chela, right chela the larger. Leg 2 long and slender, with chela.

Pleopods present. Exopod of uropods with small spine. Leg 5 lost, but coxa and basis large; coxa with large posterior spine.

REMARKS.

This larva is of rather special interest since it so closely resembles *Anebocaris ancylifer*, Coutière, in its large size, long rostrum and large toothed abdominal pleura. It differs in the form of these pleura, and in the very much shorter carapace and longer abdominal somite 6. For comparison I give a figure of a specimen of Coutière's species of about the same size as the specimen here described (Text-fig. 257). No suggestion can, of course, be made as to the parentage of these remarkable forms, but they do not differ in essentials from the larvae of *Alpheus*, and they may well be found to fall within the genus.

Alpheid? D. II. (Text-figs. 258-265.)

LOCALITY.

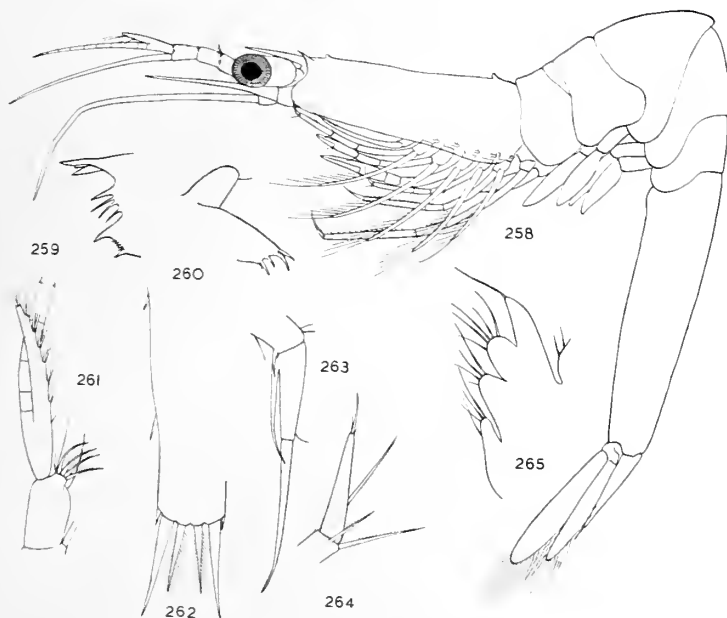
"Discovery" Station	276	: 5° 54' S., 11° 19' E.	2 specimens.
"	"	277 : 1° 44' S., 8° 38' E.	1 specimen.
"	"	703 : 7° 17' N., 28° 02' W.	3 specimens.
"	"	704 : 3° 37' N., 29° 14' W.	25 "
"	"	705 : 0° 03' N., 30° 36' W.	32 "

DESCRIPTION.

Oldest stage, length 16 mm.

Carapace narrowing forwards in side view, with anterior and posterior dorsal papillae and supra-orbital spines. Rostrum straight, without teeth. Abdomen bent at somite 3; somite 3 somewhat protuberant dorsally; somite 6 very long, very much compressed laterally and almost knife-like.

Telson deeply hollowed below, nearly four times as long as wide, with two pairs of lateral spines and 3 + 3 apical, the inner pair feathered. In a younger specimen there are 5 + 5 apical spines, of which 2 and 4 are the longest, and are the two long spines of the older stage. Anal spine present.



TEXT-FIGS. 258-265.—Alpheid? D. II.

- | | |
|--|--|
| FIG. 258.—Larva of 16 mm. "Discovery" Station 276. | FIG. 262.—Larva of 16 mm., telson (part). |
| FIG. 259.— " " mandible. | FIG. 263.— " " dactyl of leg 5. |
| FIG. 260.— " " maxillule (part). | FIG. 264.— " " " 3. |
| FIG. 261.— " " antennule (part). | FIG. 265.— " " endopod and endites of maxilla. |

Antennule with small rounded stylocerite; outer branch deeply cleft. Antenna, flagellum more than twice as long as scale, which has a very small apical spine.

Maxillule, endopod reduced to a rounded lobe bearing a minute seta. Maxilla, exopod very large, with setae on outer margin; endopod small without basal lobe or seta; three inner laciniae.

Maxillipede 1 with large epipod; basis long and straight; endopod short, broad, unsegmented, or with faintly marked division into three segments; exopod without outer basal setae. Maxillipede 2 with large flat epipod; endopod of five segments; exopod with six setae. Maxillipede 3 with epipod and rudimentary arthrobranch. There are no arthrobranches on the legs, but epipods are present on legs 1-4.

Legs 1 and 2 chelate, leg 2 the larger; exopod of leg 1 with 24 setae. Legs 1-4 with exopods.

Leg 5 much larger than leg 4, slender; dactyl with basal spine.

Pleopods large; pleopod 1, endopod very small, without appendix interna.

RELATION OF PALAEMONIDAE TO ALPHEIDAE.

Coutière (1899), whose opinion, based upon a profound comparative study of the Alpheidae, is entitled to the utmost respect, concluded that the least modified genera of the family are among the most primitive Caridea, and his comparison with other families led him to the conviction that they were most nearly related to the Hippolytidae. Borradaile (1907) included the Palaemonidae and Alpheidae in his superfamily Palaemonoidea, together with the Hippolytidae and Rhynchocinetidae, and at that time he included *Hymenocera* in the Palaemonidae, while *Gnathophyllum* fell within the Crangonoida. Balss (1927) accepted Borradaile's system with the exception that he transferred *Hymenocera* to the Gnathophyllidae, which he retained in the Crangonoida. In most published systems of Caridea there seems to be a tendency to regard the Alpheidae as more nearly related to the Hippolytidae than to the Palaemonidae.

The larva of *Rhynchocinetes* is now known, though not yet described, and has characters which completely exclude it from the Palaemonoidea, so that, in considering the position of the Alpheidae it is only necessary to bring the Palaemonidae and Hippolytidae into comparison.

Coutière does not seem to have considered the Palaemonidae as possible near relatives of the Alpheidae although in many, indeed in most, cases the characters to which he draws attention as evidence for Hippolytid affinity would have equal weight if Palaemonidae were substituted for Hippolytidae. The only characters of importance in which the Alpheidae as a whole differ from the Palaemonidae are the presence of epipods on the legs and the segmentation of the carpus of leg 2. Segmentation of the carpus is found in a number of unrelated genera of Caridea and is not of itself a feature of first-rate systematic importance. The absence of epipods from the legs of all Palaemonidae and their presence in most Alpheidae is an important difference, but it loses some of its weight when one recalls that they are also absent in *Synalpheus*, *Cheirothrix* and *Ogyrides* (which Coutière speaks of as "in many respects a true Hippolytid").

The resemblance in general form and in hypertrophy of the chelae of some Pontoniinae to the Alpheidae is very striking, and when one finds one of them (*Coralliocaris graminea*) snapping its claws like an Alpheid, it is difficult to suppose that the resemblance can be entirely a matter of convergence to a similar habitat.

On the basis of adult structure the phylogenetic grouping of the Caridea is exceedingly difficult, and if any evidence can be gathered from the larval phase it should be valuable, though it has not hitherto been taken very seriously.

Attention has already been called (Gurney, 1924, p. 131) to the close resemblance between Palaemonid and Alpheid larvae in some important characters, and a more detailed comparison may now be made in the light of the richer material available.

Apart from the genus *Lysmata* the precocious development of leg 5 and its excessive size are confined to the Alpheidae and Palaemonidae. Within these two families the propod is long and slender and the dactyl usually produced into a long spine, whereas in *Lysmata* the propod is dilated into a paddle-like organ and the dactyl is very much reduced. The great development of leg 4 seen in *Periclimenes* finds something of a parallel in a Lysmatid in which leg 4 has a paddle-like propod as well as leg 5; but the unlikeness in structure and function of these legs in the two types suggests that the disproportion in size and precocious development of leg 5 have been separately acquired. While typical

Alpheid larvae have a very uniform type of styliform leg 5, there are genera of Alpheidae, just as there are genera of Pontoninae, in which leg 5 is not larger than legs 3 and 4, and it seems likely that there may be two groups within the family of which *Alpheus* and *Synalpheus* would be typical respectively.

The general reduction of the maxillae and maxillipede 1 which characterizes all the Palaemonidae, and is carried to excess in some Alpheidae, is not found in any other families except where development is abbreviated (*e.g.* *Pasiphaea*). Invariably the endopods of the maxillule and maxilla are reduced and unsegmented, and at least the proximal lacinia of the maxilla is absent. In maxillipede 1 the coxa is reduced or scarcely traceable, and the endopod is small and often unsegmented. In the Hippolytidae this reduction does not take place. The endopod of the maxillule may be unsegmented, but it always retains evidence of the loss of segmentation in the presence of one or two setae on its inner margin. The endopod of the maxilla, though it may not be segmented, has a series of three inner lobes bearing setae. The inner laciniae are also well developed, lacinia 2 being distinct, and each bears numerous setae. Lastly the endopod of maxillipede 1 is long, and generally, if not always, shows four segments.

The antenna of Palaemonidae and Alpheidae in Stages I and II has always the exopod distinctly segmented, and there is often, in both families, a peculiar papilla on the inner margin. The endopod is a straight rod bearing a long seta and a small spine. In Hippolytidae the exopod may be unsegmented, or with slight traces of segmentation (*Hippolyte*), or it may be slender and segmented (*Caridion*, *Lysmata*), but there is no inner papilla. The endopod is not the same in the different genera, but it never has the combination of seta and spine seen in Palaemonidae and Alpheidae.

In these two families the exopods in stage I always bear four apical setae symmetrically disposed in two pairs; but in Hippolytidae one seta of the proximal pair is absent so that there are three apical setae, an arrangement which is also seen in *Processa*, *Leptochela* and some, if not all, Pandalidae.

Those who have to discuss the systematics of adult Caridea are commonly forced to rely upon characters which seem to be of very small importance, for example, form of rostrum, shape of the epipod of maxillipede 1, etc. The points of similarity and difference which I have given here are at least positive and unequivocal, and I submit that they suffice to prove that the Palaemonidae and Alpheidae are very closely related, and that they are not nearly related to the Hippolytidae.

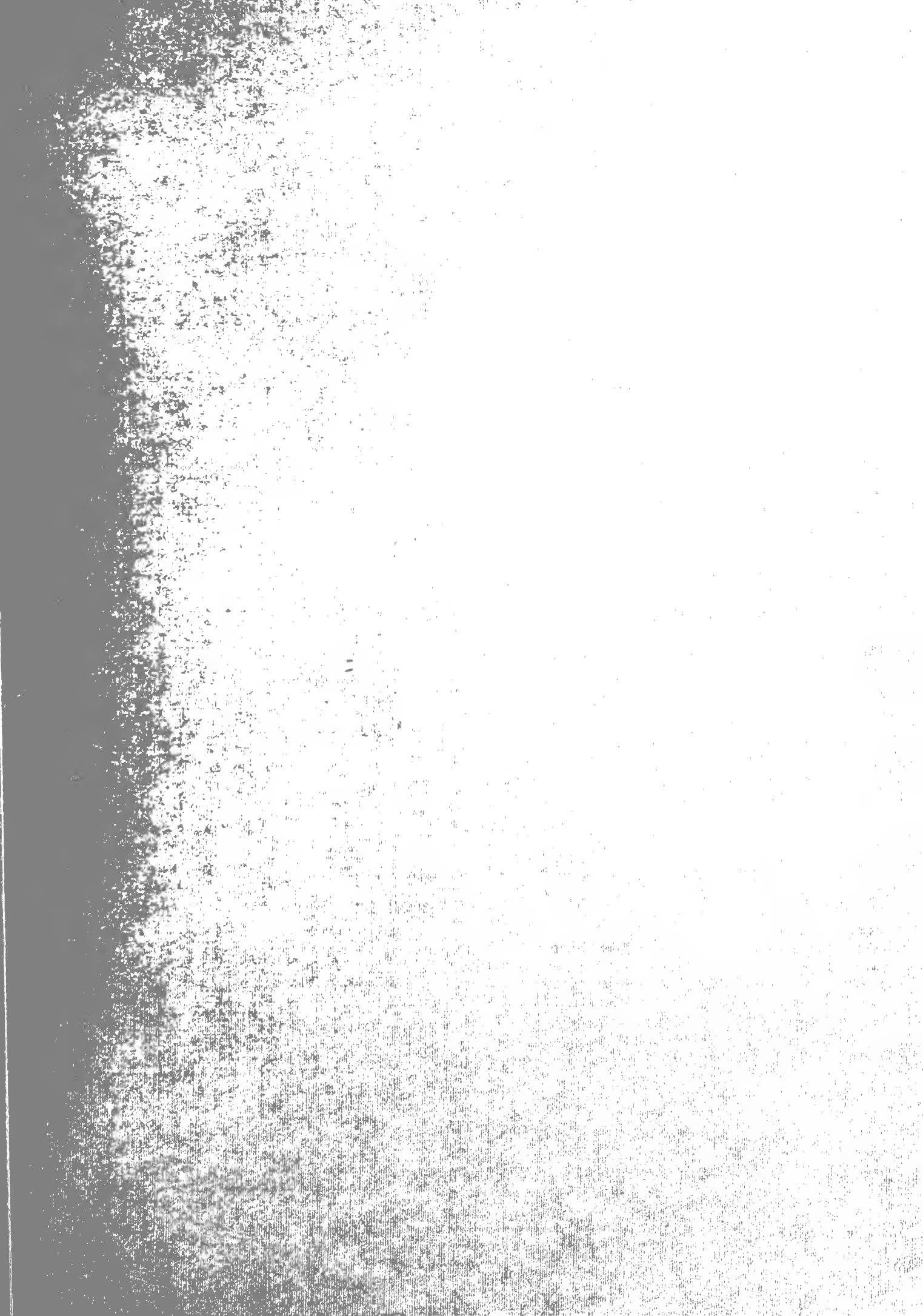
This conclusion is based upon consideration of larvae which, although not certainly identifiable, can with some confidence be assigned either to Palaemonidae or to Alpheidae, but the close relation between the two families is shown perhaps most strikingly by the larva described as Alpheid ? D. II. In this case we have a form which, while the salient characters are, on the whole, Palaemonid, has also something of the form of an Alpheid, and a series of epipods exclude it from the Palaemonidae. It is impossible to say to which of the two families it belongs, but it is quite out of the question to refer it to any other family of which the larvae are known.

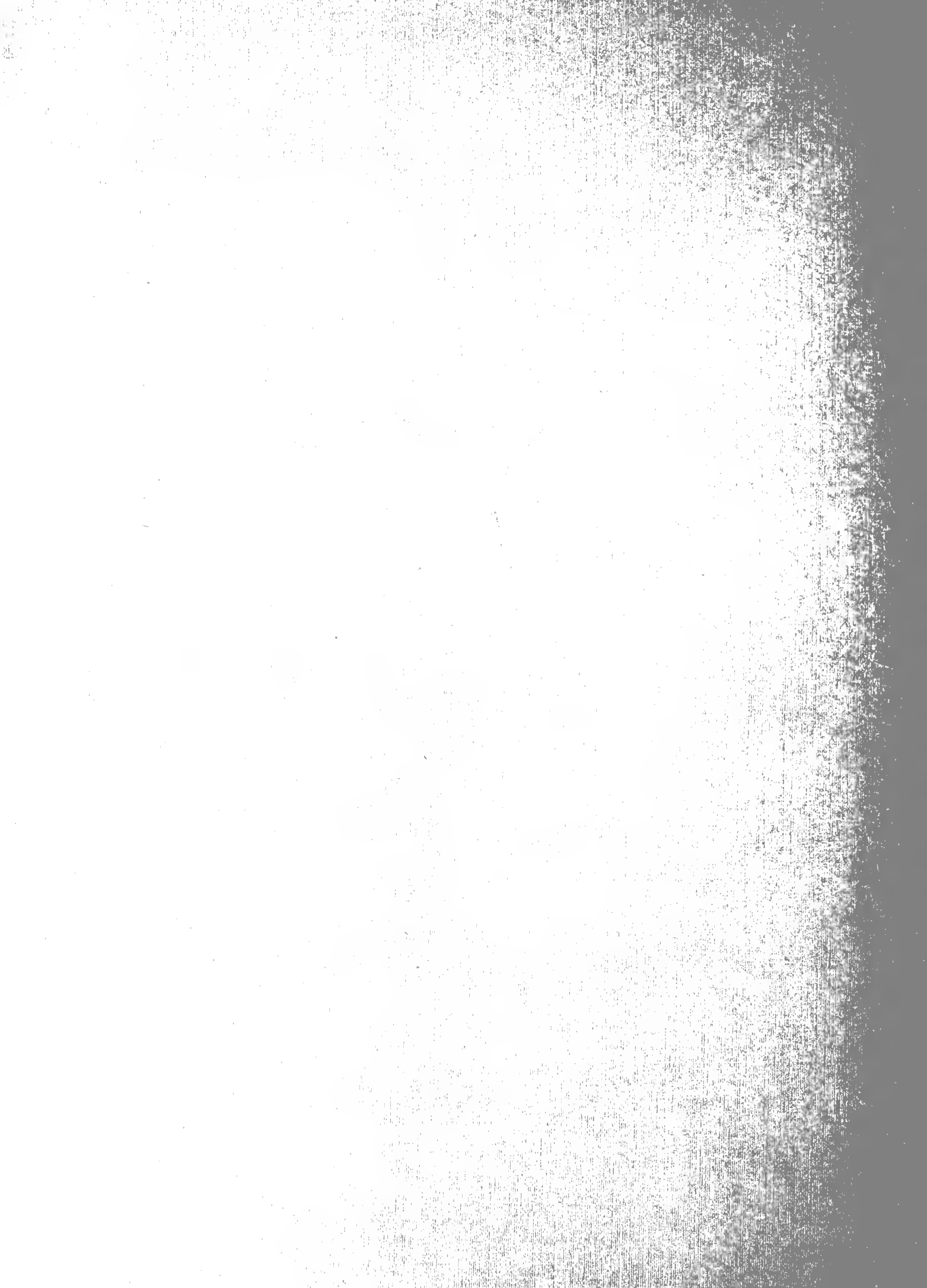
REFERENCES.

- BALSS, H. 1927. Decapoda. In Kükenthal, Handbuch der Zoologie, Bd. III.
- BORRADAILE, L. A. 1907. On the classification of the Decapod Crustacea. *Ann. Mag. Nat. Hist.* (7) XIX, pp. 457-486.
- 1917. On the Pontoniinae. *Trans. Linn. Soc.* XVII, pp. 323-396.
- 1921. On the Coral-gall Prawn *Paratypton*. *Mem. Lit. Phil. Soc. Manchester*, LXV, no. 11
- BROOKS, W. K., and HERRICK, F. H. 1891. The embryology and metamorphosis of the Macrura. *Mem. Acad. Sci. Wash.* V, pp. 321-576.
- COUTIÈRE, H. 1899. Les Alpheidae. *Ann. Sci. Nat. Zool.* (8) IX, pp. 560.
- 1905. Les Alpheidae. *Fauna and Geog. of Maldives and Laccadives*, II, pp. 852-921.
- 1907. Sur quelques formes larvaires énigmatiques d'Eucyphotes. *Bull. Mus. Oceano. Monaco*, no. 104, pp. 70.
- GORDON, I. 1935. On new or imperfectly known species of Crustacea Macrura. *J. Linn. Soc.* XXXIX, pp. 307-351.
- 1936. On the Macruran genus *Rhynchocinetes*. *Proc. Zool. Soc.* 1936, pp. 75-88.
- GURNEY, R. 1924. Decapod Larvae. *British Antarctic ("Terra Nova") Expedition, 1916, Zoology*, VIII, no. 2, pp. 37-202.
- 1927. Larvae of the Crustacea Decapoda (Cambridge Expedition to Suez Canal). *Trans. Zool. Soc.* XXII, pp. 231-286.
- 1936. Notes on some Decapod Crustacea of Bermuda. III. The larvae of the Palaemonidae. *Proc. Zool. Soc.* 1936, pp. 619-623.
- KEMP, S. W. 1922. Notes on Crustacea Decapoda in the Indian Museum. XV. Pontoniinae. *Rec. Ind. Mus.* XXIV, pp. 113-288.
- 1925. Notes on Crustacea Decapoda in the Indian Museum. XVII. On various Caridea. *Rec. Ind. Mus.* XXVII, pp. 249-343.
- LEBOUR, M. V. 1932. The larval stages of the Plymouth Caridea. IV. The Alpheidae. *Proc. Zool. Soc.* 1932, pp. 463-469.
- ORTMANN, A. 1893. Decapoden und Schizopoden. *Plankton Exp.* Bd. II.
- SCHMITT, W. L. 1935. Crustacea Macrura and Anomura of Porto Rico and the Virgin Islands. *New York Acad. Sci. Scientific Surv. P. Rico*, XV, pp. 125-227.
- WEBB, G. E. 1921. The larvae of the Decapoda Macrura and Anomura of Plymouth. *J. Mar. Biol. Ass.* XII, pp. 385-417.
- YOKOYA, YU. 1931. On the metamorphosis of two Japanese fresh-water shrimps, *Paratya compressa* and *Leander paucidens*. *J. College of Agric. Tokyo*, XI, pp. 75-150.

- 3 MAR 1938

PRINTED





BRITISH MUSEUM (NATURAL HISTORY)

GREAT BARRIER REEF EXPEDITION
1928-29

SCIENTIFIC REPORTS

19 APR 1940 VOLUME VI. No. 2

PRESENTED

ON *PHLYCTAENACHLAMYS LYSIOSQUILLINA*
GEN. AND SP. NOV., A LAMELLIBRANCH
COMMENSAL IN THE BURROWS OF
LYSIOSQUILLA MACULATA

BY

MARY LEYBORNE POPHAM, B.Sc.

Department of Zoology, University of Bristol

WITH TWENTY-ONE TEXT-FIGURES



LONDON

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

SOLD BY

B. QUARITCH, LTD., 11 GRAFTON STREET, NEW BOND STREET, LONDON, W.1; DULAU & CO., LTD., 29 DOVER STREET,

LONDON, W.1; OXFORD UNIVERSITY PRESS, WARWICK SQUARE, LONDON, E.C.4

H.M. STATIONERY OFFICE, LONDON, S.W.1

AND AT

THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, LONDON, S.W.7

1939

[All rights reserved]

Price Two Shillings and Sixpence

[Issued 25th March, 1939]



Made and printed in Great Britain.

19 APR 940

PRESENTED

ON *PHLYCTAENACHLAMYS LYSIOSQUILLINA*
GEN. AND SP. NOV., A LAMELLIBRANCH
COMMENSAL IN THE BURROWS OF
LYSIOSQUILLA MACULATA

BY

MARY LEYBORNE POPHAM, B.Sc.,

Department of Zoology, University of Bristol.

WITH TWENTY-ONE TEXT-FIGURES.

CONTENTS.

PAGE

1. INTRODUCTION	62
2. HABITAT	62
3. EXTERNAL APPEARANCE AND HABITS	62
4. MANTLE AND SHELL	65
5. CTENIDIA	71
6. LABIAL PALPS	73
7. ALIMENTARY CANAL	73
8. FOOT	77
9. CIRCULATORY SYSTEM	77
10. EXCRETORY SYSTEM	77
11. NERVOUS SYSTEM	77
12. GENITAL SYSTEM	80
13. DESCRIPTION OF GENUS AND SPECIES	80
14. GENERIC AND SPECIFIC CHARACTERS	82
15. DISCUSSION	82
16. REFERENCES	83

1. INTRODUCTION.

A NUMBER of specimens of a commensal Lamellibranch with an internal shell and inhabiting the burrows of *Lysiosquilla maculata* were collected by Prof. C. M. Yonge during the course of the Great Barrier Reef Expedition. These differ in structure and habitat from any other Lamellibranch previously described, examination revealing that a new genus of the family Galeommatidae must be constituted to include this new species.

The specimens collected were preserved, some in Bouin's fluid, and others in 70% alcohol, and were handed over to the author for examination. One specimen was stained in borax carmine, and cleared in cedar-wood oil for examination of the entire animal. Serial transverse sections were prepared of another specimen and stained in Delafield's haematoxylin and eosin. Two other specimens were dissected under a binocular microscope.

Observations were made by Prof. C. M. Yonge on the habitat and appearance in life of this animal and his notes are incorporated in this paper, which has been prepared under his direction.

2. HABITAT.

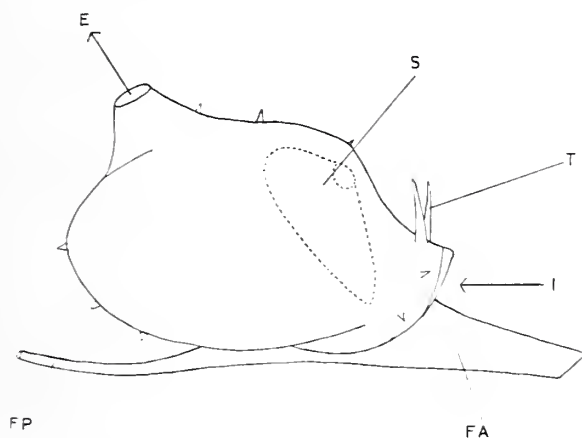
The tubes of *Lysiosquilla maculata*, one of the largest of the Stomatopoda, were common in the deep sand of the Sand Flat between the Sand Cay and the Thalamita Flat, as recorded by Stephenson, Stephenson, Tandy and Spender, in Vol. III, No. 2 of these Reports. The tubes were of great size with an internal diameter varying between 6.5 and 10 cm., and so extensive that an arm could be inserted up to the shoulder without the fingers coming in contact with the retreating occupant. The internal surface was very smooth. The external opening was much smaller, varying in diameter from 1 to 3 cm., but seldom being truly circular in outline. Fine sand from within the burrow was pushed over the edge to an extent of 4 to 5 cm., forming a ridged mound darker in colour than the surrounding surface sand. The overhanging ridge around the mouth of the burrows and the internal surface of these were very smooth, apparently owing to a viscid secretion produced by the occupant.

Within the tubes, usually near to the opening, were frequently to be found one, or occasionally two, small animals with white, fleshy bodies. Closer examination revealed that these were lamellibranchs with greatly reduced, internal shells. In some cases the animals moved about, in others they were secured by one or two fine byssus threads projecting from the posterior tip of the elongated foot.

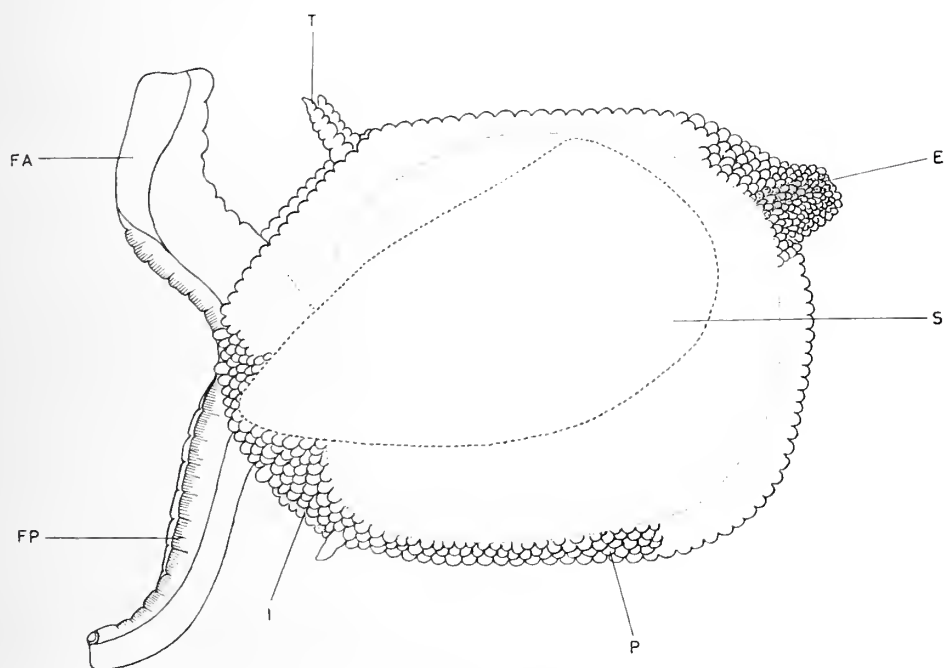
3. EXTERNAL APPEARANCE AND HABITS.

The appearance of the living animal is shown in Text-fig. 1, and the side view of a preserved specimen in Text-fig. 2. The body length of the largest specimen was, in life, 2.4 cm. The surface of the body is soft, white and partly translucent, and everywhere covered with small papillae which, when observed under a binocular microscope, have a slight brownish tinge. There are two conspicuous upward-directed tentacles (τ) at the anterior end of the dorsal surface. These are deep yellow, almost orange in colour except at the base, where they are white. A number of smaller tentacles, similar in colour, are scattered irregularly over the surface of the body, and are more numerous in larger

specimens. They appear to represent enlarged papillae. All have considerable powers of expansion and contraction, especially the large anterior pair, which give the animals, at first sight, the appearance of nudibranchs. The shell valves (s) are completely enclosed within the mantle, and are greatly reduced.



TEXT-FIG. 1.—View of the right side of the animal in life. $\times 2$. E, exhalent opening; FA, anterior portion of foot; FP, posterior portion of foot; I, inhalent opening; s, shell; T, tentacles.

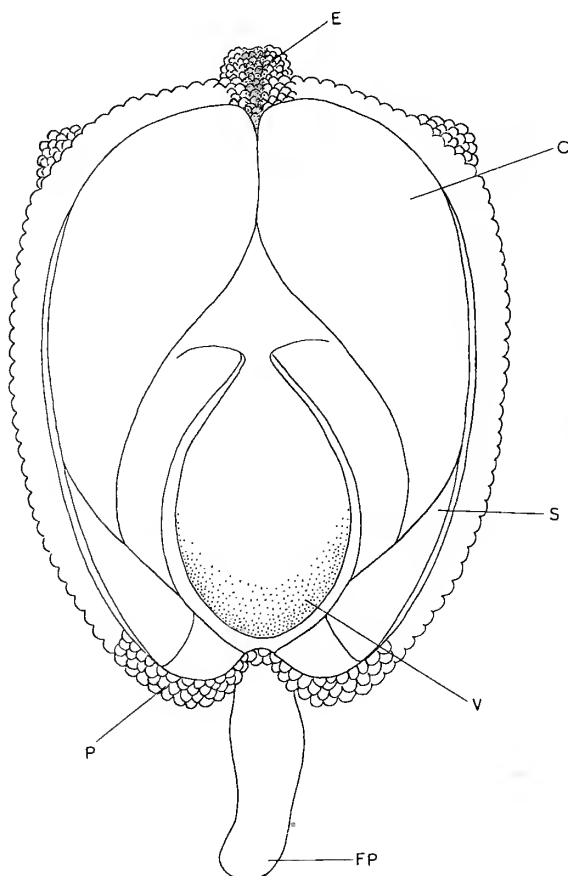


TEXT-FIG. 2.—Lateral view of the left side of a fixed specimen. $\times 12$. P, papillae. Other lettering as in Text-fig. 1.

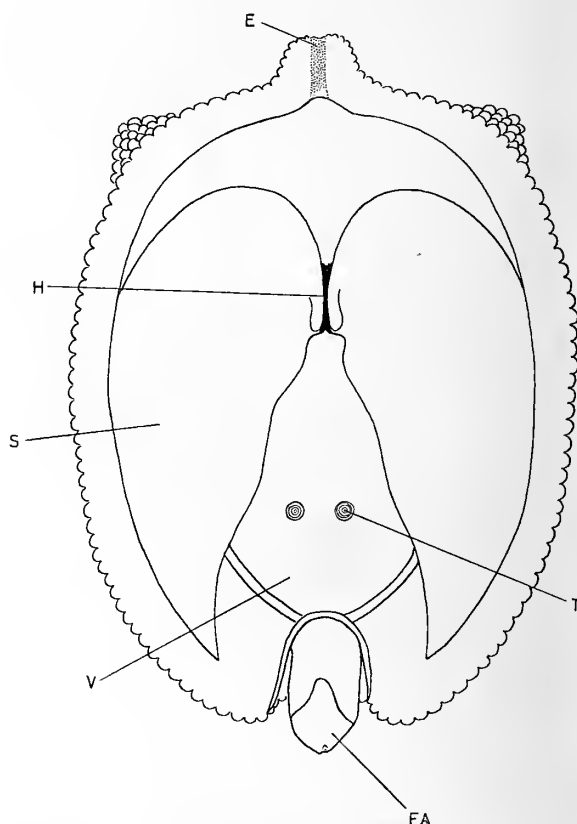
The inhalent opening (I) is anterior, and consists of that part of the antero-ventral pallial opening that is dorsal and anterior to the base of the foot. A prolongation of the mantle forms a "hood" over the anterior part of the foot, the edges of the mantle being here slightly turned back. The exhalent opening (E) is situated on the end of a conspicuous rounded protuberance in the mid-dorsal line near the posterior end. The lips of this open and draw in rhythmically when the animal is in motion, although the opening never

actually closes. The exhalent opening thus forms a more definite siphon than does the inhalent opening.

The pedal opening, which is continuous with the inhalent opening, extends from this backwards about one-third of the distance along the mid-ventral surface, the combined openings being sufficient to allow projection of the foot and the ingress of the food stream anterior and dorsal to this. The foot can be completely withdrawn, and the aperture



TEXT-FIG. 3.—Ventral view of a fixed specimen. $\times 12$. c, ctenidium; v, visceral mass. Other lettering as above.



TEXT-FIG. 4.—Dorsal view of a fixed specimen. $\times 12$. H, hinge. Other lettering as above.

closed by the apposition of the mantle edges. Posterior to the pedal opening the mantle edges are fused as far as the exhalent opening.

The foot is of considerable length when fully expanded, and consists of well-marked anterior (FA) and posterior (FP) regions. The anterior region is thicker, and is pushed out in a forward direction when the animal moves, resembling a long wedge about equal in length to the body. It possesses a creeping sole. The posterior portion is long and thin, with an opaque white area immediately short of the tip, which is sharply pointed. A byssus groove runs along the under surface and opens at the posterior end, from which byssus threads may project. Usually two of these were formed and planted between 30° and 90° apart when the animal was attached to the sides of the burrow. During movement the creeping sole advances and, at frequent intervals, the animal distends the mantle to the utmost extent and then, as a result of a convulsive movement which causes

a backward projection of water through the exhalent opening, the body is drawn forward, thereby overtaking to some extent the foot, which continues to advance slowly and without interruption. The posterior end of the foot, like a fine thread, trails behind and is capable of very great extension, up to 3 cm. in a specimen 2.4 cm. long.

In general external appearance the animal most nearly resembles *Chlamydoconcha orcutti* described by Bernard (1897). Both have a globular form, with a white, semi-transparent mantle covered with papillae, are about the same size, have a foot with a creeping sole, and the position of the inhalent and exhalent openings is similar. But *Chlamydoconcha* occurs in stony clam beds, and the shell is different.

4. MANTLE AND SHELL.

Histological examination of the mantle shows that beneath the epithelium it is composed of loose connective tissue, with very little structure (Text-figs. 12, M, and 20). It is thick, and the shell is completely embedded in it (Text-fig. 20). There are few blood-spaces, but a considerable amount of muscle.

A definite muscular layer occurs below the internal epithelium bounding the mantle cavity (Text-figs. 12–19, MS). The arrangement of the muscle-fibres is irregular, and both circular and longitudinal muscles are present. This muscle layer must be responsible for the repeated contractions of the mantle observed during movements of the living animal. The arrangement is such that contraction of the muscle would reduce the volume of the mantle cavity and force water out through the exhalent opening. Distension is presumably due to ciliary action drawing in water when the exhalent siphon is temporarily closed.

Fischer (1887) records similar convulsive movements, described as “sphincter-like contractions of the mantle”, in *Chlamydoconcha orcutti* which cause a current of water to pass over the gills.

The muscle forms a thick band towards the posterior end of the mantle cavity (Text-fig. 18, MS). There is also a well-marked muscular region round the anterior tips of the shell-valves (Text-figs. 12 and 13). The muscle layer is absent from the mantle on the dorsal side of the visceral mass in the centre of the animal (Text-figs. 14–17). Strands of muscle also occur in the outer layer of the mantle, just external to the shell (Text-fig. 12, MS), but the chief muscular region is in the inner mantle layer between the shell and the mantle cavity (Text-fig. 20, MS).

The mantle tissue between the shell and the mantle cavity is not so thick as that between the shell and the exterior. There is an irregularly-shaped cavity between the shell and the outer mantle layer (Text-figs. 13 and 20).

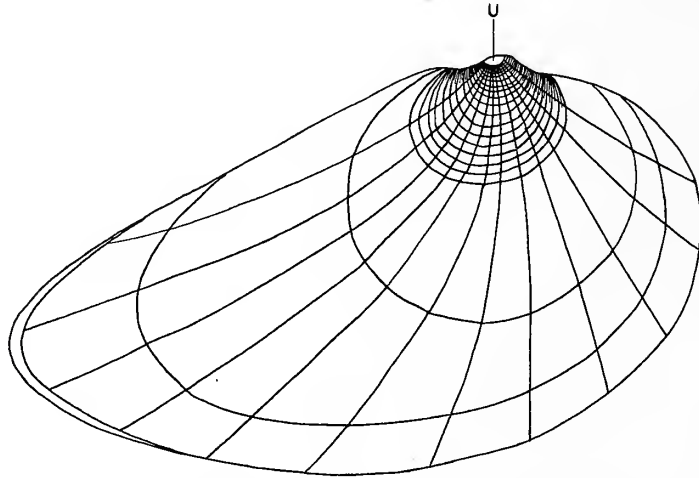
The papillae which cover the surface (Text-fig. 2, P) also contain connective tissue, together with many dark-staining goblet-cells which open externally (Text-fig. 12A, MU). These are typical mucous glands and occur in the papillae all over the body. They are particularly numerous in the “tentacles” or larger papillae. The papillae do not appear to have a sensory function; unlike the papillae in *Chlamydoconcha* (Bernard, 1897) they are not supplied by a nerve. Their function seems to be the secretion of mucus.

The “tentacles” are similar in structure to the papillae, but they are more specialized. They have longitudinal muscle strands in the centre and are capable of considerable contraction and expansion. Histologically the cells have a more granular appearance, in the contracted condition of the fixed material, than the cells of the small papillae.

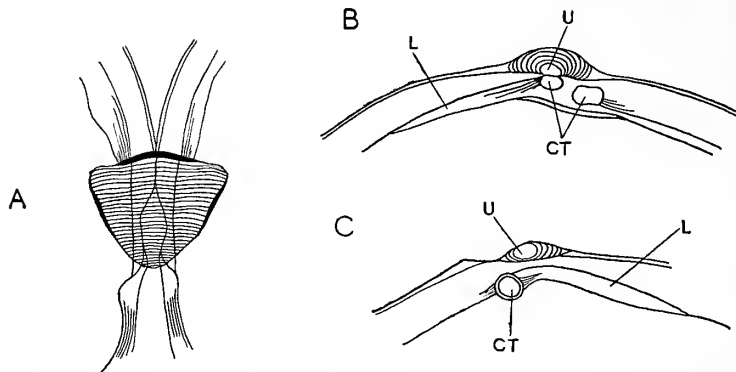
They contain more mucous glands, irregularly arranged (Text-figs. 1 and 13, τ). These small gland-cells also occur in *Chlamydoconcha* (Bernard, 1897), scattered over the surface of the mantle, but not on the papillae.

The internal surface of the mantle lining the mantle cavity is generally smooth, but there is irregular folding in parts (Text-fig. 18).

The shell measured 4.75 mm. \times 3.0 mm. in a specimen 6.0 mm. in body length. It is fragile and has little protective function, as it only covers a small part of the dorsal



TEXT-FIG. 5.—Shell. \times 12. u, umbo.



TEXT-FIG. 6.—A. Ligament. B. Right shell valve. C. Left shell valve. \times 25. ct, cardinal tooth; L, posterior lateral tooth.

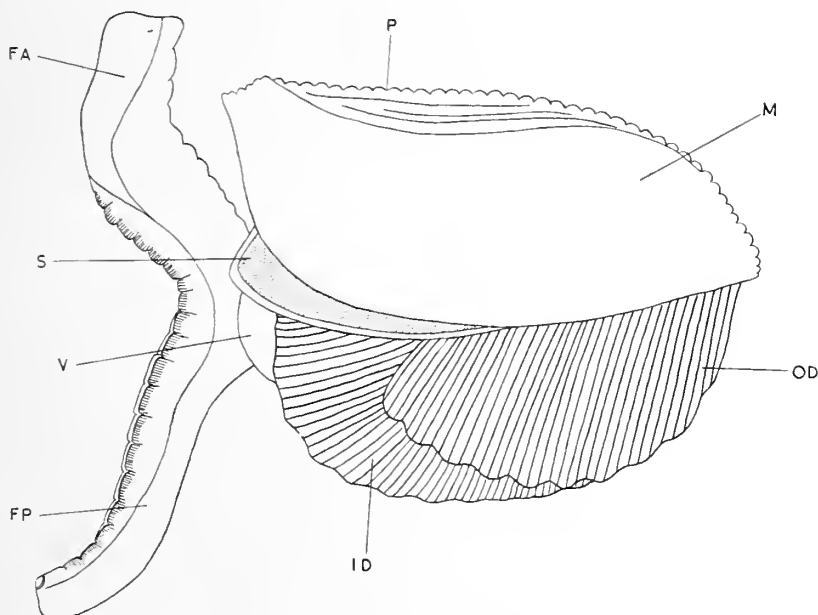
region of the visceral mass (Text-fig. 4, s). In shape it is equivalve, inequilateral, oval and flattened (Text-fig. 5). The valves are opposed only at the dorsal side in the region of the hinge. The ventral edges are always widely separated and can never be opposed, the visceral mass, ctenidia and foot, even in the contracted state, extending beyond them ventrally, anteriorly and posteriorly.

In colour the shell is pure white over most of the surface, but becomes yellowish towards the umbo. The surface is smooth, with fine lines radiating from the umbo, and also lines, presumably indicating previous growth stages, following the curve of the circumference of the shell. The edge of the shell is smooth and entire.

The umbo is situated one-third of the length from the posterior end; it is circular and convex and occupies the summit of the valve (Text-fig. 5, u). The posterior

end of the valve is short and rounded, while the anterior end is longer and more pointed, although the tip is blunt. The hinge-line is slightly curved. The hinge is situated in the region of the umbo below the summit of the valves. It is very poorly developed and the hinge teeth are small, blunt and rounded, with no means of interlocking. The hinge can, therefore, have little function.

On the left valve the cardinal tooth is represented by a round knob in the centre of the hinge, and slightly anterior to the summit of the umbo (Text-fig. 6c, ct). On the right valve the cardinal tooth is probably represented by two knobs: one immediately below the summit of the umbo is rounded and prominent, the other is anterior to the umbo and is broader and less prominent (Text-fig. 6B, ct). There are no anterior lateral teeth. The posterior lateral teeth are reduced to a ridge on the left valve, and to a socket between two ridges on the right valve (Text-fig. 6c, l).



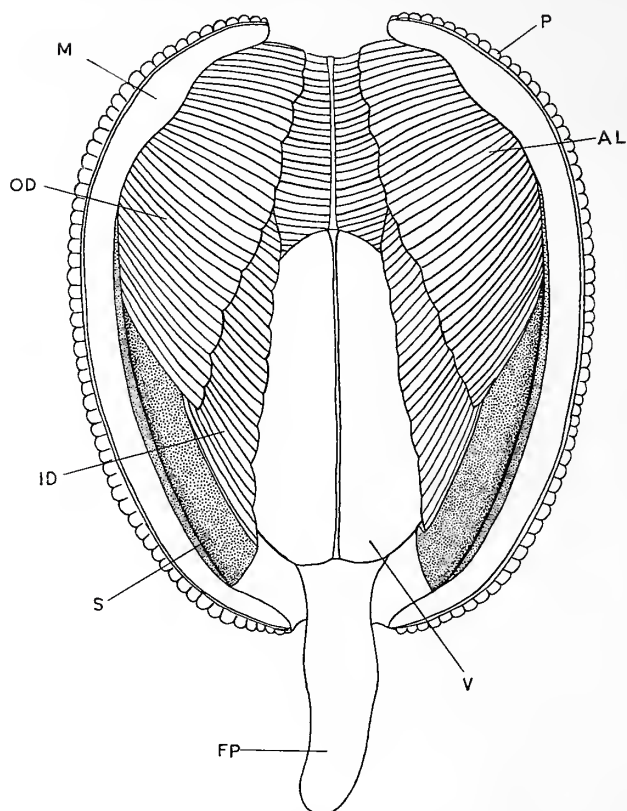
TEXT-FIG. 7.—Lateral view of the left side of a fixed specimen with the mantle turned back. $\times 12$.
ID, inner demibranch; M, mantle; OD, outer demibranch; other lettering as above.

The shell valves are held together by an internal elastic ligament, inserted below the umbo. It is thick, dark brown in colour, and triangular in shape, with the base of the triangle situated posteriorly (Text-fig. 6A).

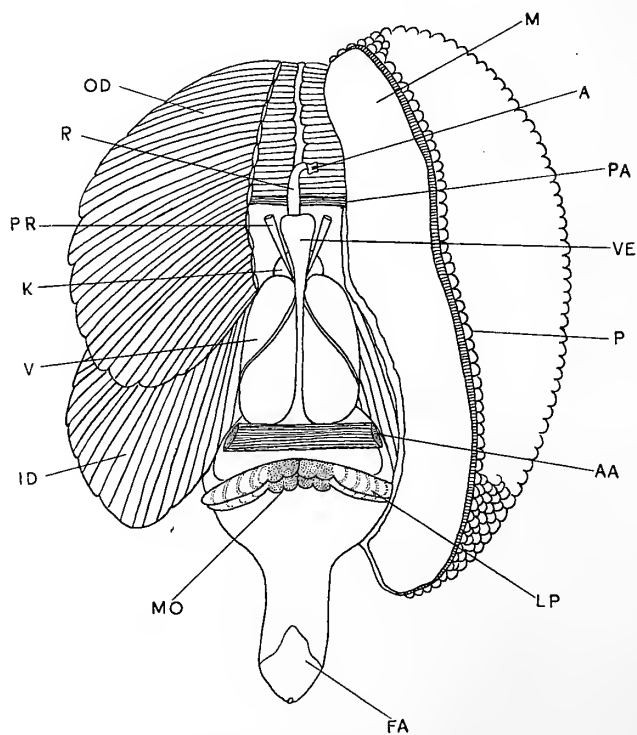
The periostracum is well marked on the outer surface of the shell, and is also visible on the inner side at the edge of the shell (Text-fig. 20, po).

The adductor muscles are poorly developed, and leave no impressions on the inner surface of the shell valves. Little movement of the shell valves occurs in life. The anterior adductor muscle is larger than the posterior, and is situated on the dorsal surface of the visceral mass over the oesophagus. It lies behind the labial palps and immediately above the cerebro-pleural ganglia (Text-fig. 9, aa). The posterior adductor muscle is small; it is situated at the posterior end of the visceral mass below the rectum and behind the heart (Text-fig. 9, pa).

The morphological relationships of the shell and mantle call for comment. In the Lamellibranchia the free margin of the mantle normally consists of three folds (Text-fig.

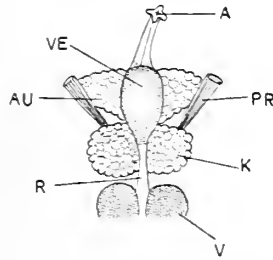


TEXT-FIG. 8.—Ventral view with the mantle removed. $\times 12$. AL, ascending lamella. Other lettering as above.

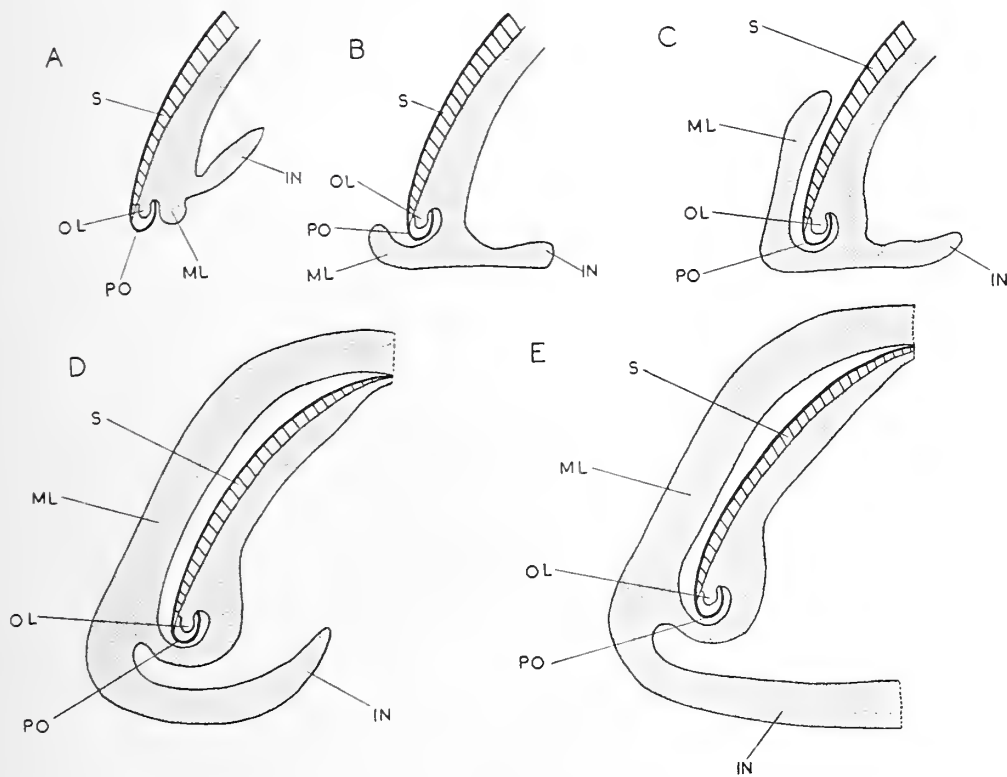


TEXT-FIG. 9.—Dorsal view with the mantle removed. $\times 12$. A, anus; AA, anterior adductor; K, kidney; LP, labial palps; MO, mouth; PA, posterior adductor; PR, pedal retractor; R, rectum; VE, ventricle. Other lettering as above.

11A). The outer fold is always secretory in function: the middle fold is usually sensory, and the inner fold forms the velum or pallial curtain where one is present (Yonge, 1936). In the animal here considered each valve is enclosed in the mantle, being completely surrounded by it. As described below, this condition has probably arisen owing to an overgrowth of the shell by the middle fold of the mantle.



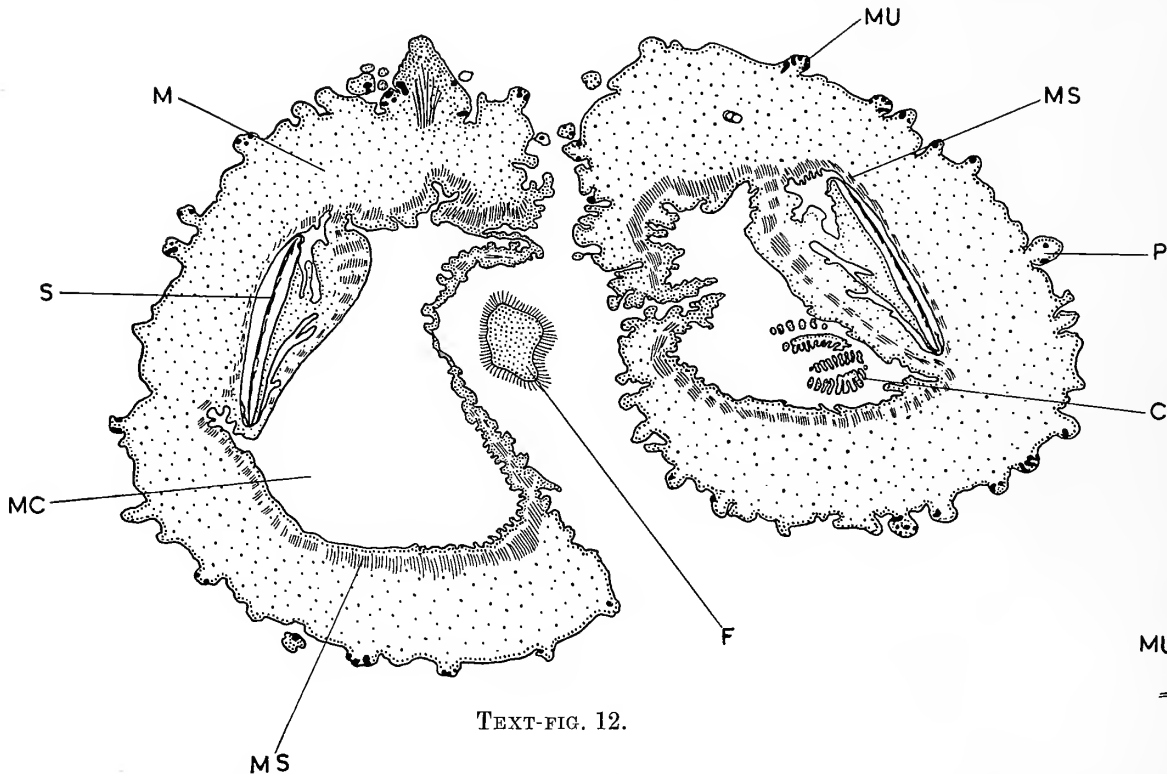
TEXT-FIG. 10.—Heart region. $\times 25$. AU, auricle. Other lettering as above.



TEXT-FIG. 11.—Relation of the mantle to the shell. A. Normal Lamellibranch. B. Hypothetical stage. C. Condition in *Scintilla*. D and E. Condition in *Phlyctacnachlamys lysiosquillina*. IN, inner mantle lobe; ML, middle mantle lobe; OL, outer mantle lobe; PO, periostracum; S, shell.

The outer fold of the mantle remains secretory in function and produces the shell. This fold remains in the normal position immediately internal to the margins of the shell (Text-fig. 11, OL). The irregular cavity between the shell and this outer mantle fold is only present in some places, and is probably an artifact due to fixation. The periostracum, as in other Lamellibranchia, is formed at the base of the groove on its inner side, and extends over the edge of the shell as shown in Text-fig. 11, PO.

Differential growth of the middle fold of the mantle has probably taken place, first in a ventral direction and then dorsally over the outer surface of the shell (Text-fig. 11, ML). A hypothetical early stage of this overgrowth is shown in Text-fig. 11B. A further stage is found in *Galeomma* in which the mantle is reflected for a short distance over the anterior, posterior and ventral borders of the shell. In *Scintilla*, as shown in Text-fig. 11C, more of the shell is covered by the mantle (Deshayes, 1855). The final stage is shown in Text-figs. 11 D and E, and represents the condition found in this specimen. The overgrowth is complete, and the middle mantle fold fuses in the mid-dorsal line with the middle fold of the opposite side. It also extends anteriorly and posteriorly. The fusion is complete posteriorly and dorsally except for the exhalent aperture. Anteriorly the



TEXT-FIG. 12.



TEXT-FIG 12a.

TEXT-FIG. 12.—Transverse section through the anterior end. $\times 33$. F, foot; MC, mantle cavity; MS, muscle layer; MU, mucous gland cell. Other lettering as above. TEXT-FIG. 12a.—Papilla enlarged. $\times 200$. CO, connective tissue; EP, epithelium.

mantle folds form the sides of the inhalent siphon. The line of fusion cannot be detected in histological examination.

The presence of a groove between the inner and middle mantle lobes on the inner side of the ventral extremity of the shell, and the irregular cavity between the shell and the mantle lying over it, support this interpretation. It also supplies an explanation for the presence of "tentacles", as the middle fold normally bears sense-organs, although the sensory function appears to be lost in this case.

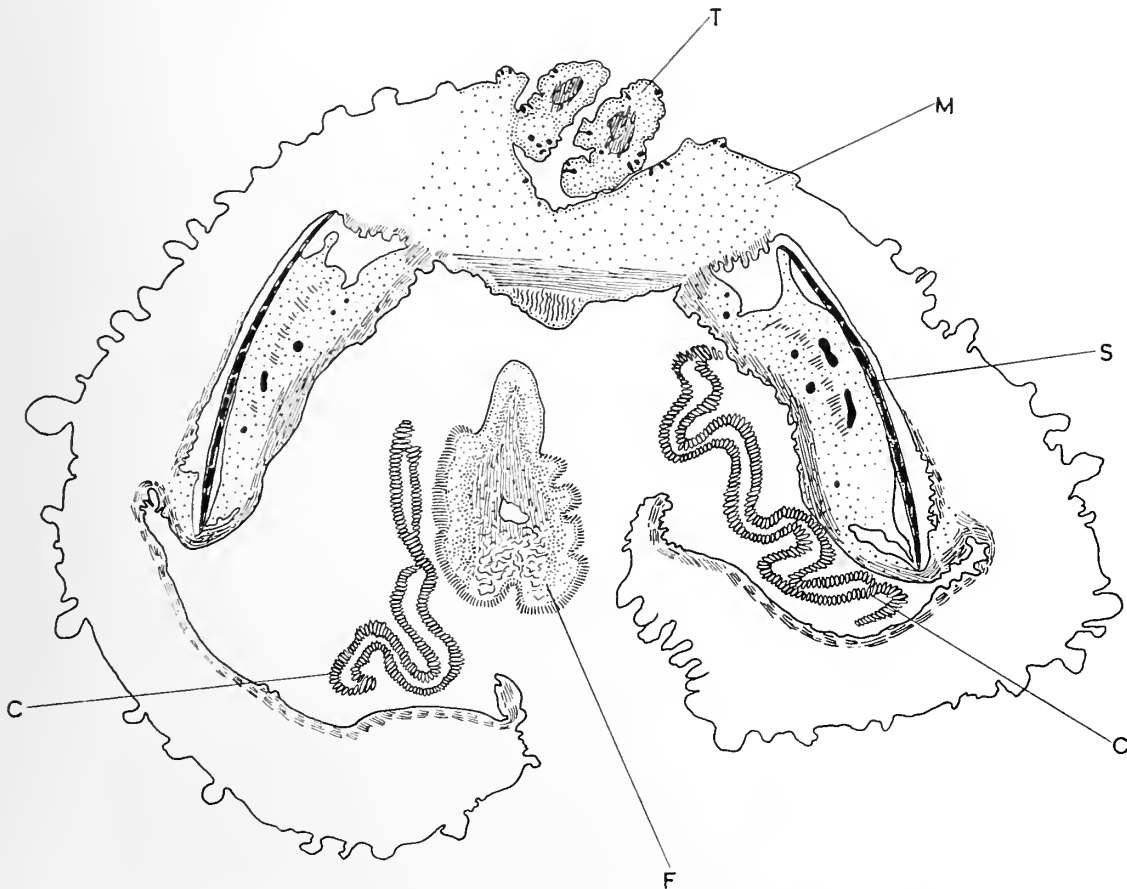
The inner mantle fold forms the velum or pallial curtain in genera such as *Pecten* or *Ostrea* where the mantle edges are not fused ventrally. This is highly muscular, and performs extensive movements primarily concerned with controlling the entrance of water into the mantle cavity, *e. g.* in *Ostrea*, but modified in connection with swimming

in *Pecten*. Where fusion of the mantle lobes takes place, it is the inner mantle folds which fuse, and in the present case it is suggested that the inner fold grows inwards and fuses with the inner fold from the opposite side in the mid-ventral line, behind the pedal opening (Text-fig. 11, IX). There is again no histological evidence of this fusion, but the chief muscular region occurs in this part of the mantle, beneath the epithelium bounding the mantle cavity (Text-fig. 12, MS), and similar fusion of the mantle is found in very many Eulamellibranchia.

5. CTENIDIA.

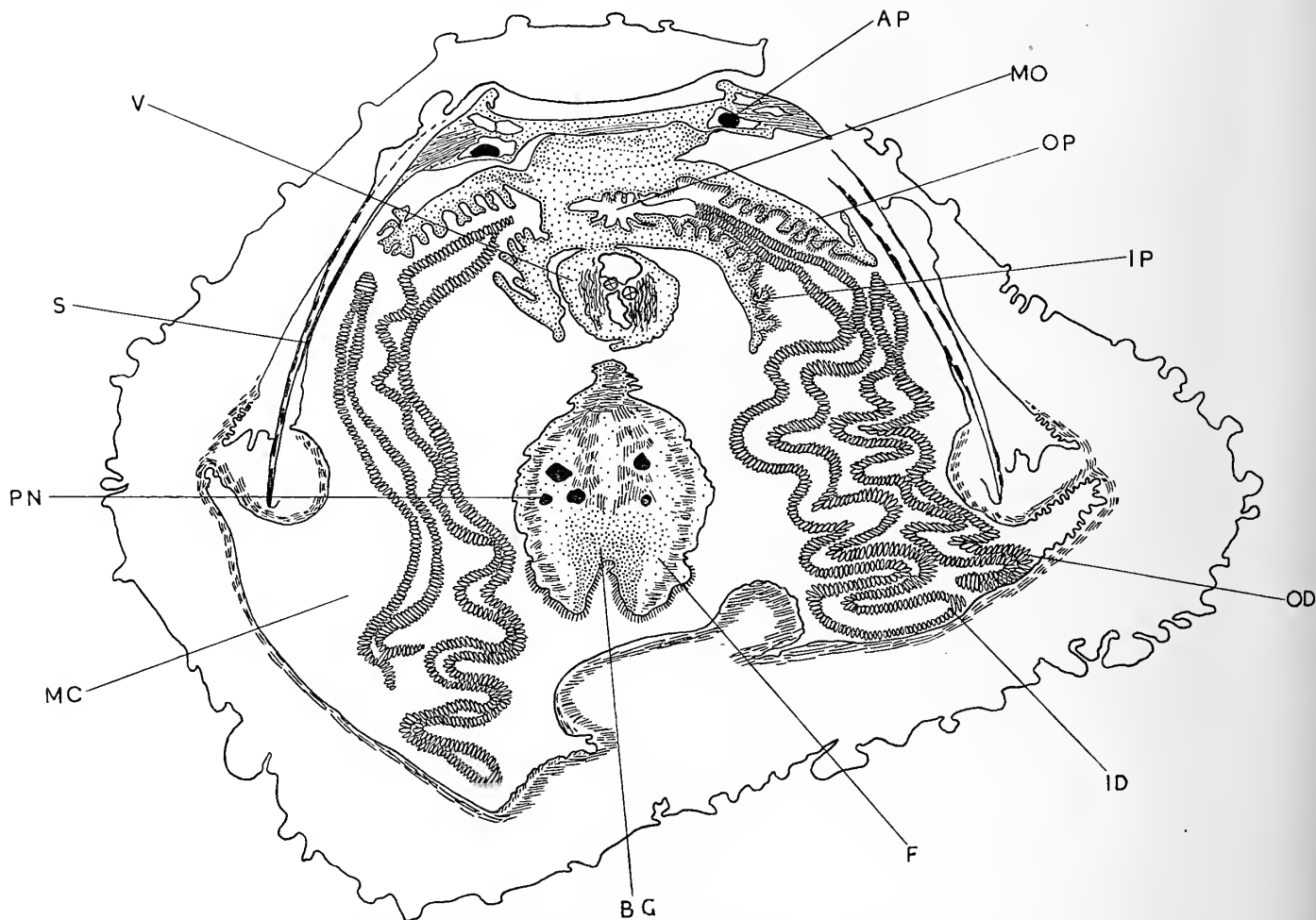
The ctenidia each consist of two demibranchs formed of a descending or direct lamella and an ascending or reflected lamella. The ctenidia are inserted dorsally behind the main part of the visceral mass. The axes are supported by the lesser reno-pericardial mass, the ascending lamellae of the outer demibranchs by the mantle, and the ascending lamellae of the inner demibranchs join in the mid-line below the reno-pericardial mass (Text-figs. 9 and 13). The inner demibranch extends farther forwards and downwards and has a more pointed anterior tip than the outer demibranch (Text-fig. 7, ID).

In fixed material the ctenidia appear to be plicated, the plicae occurring at regular intervals (Text-figs. 7-9). Histological examination shows, however, that there are no principal filaments, so the apparent plication may be due to fixation.



TEXT-FIG. 13.—Transverse section through the tip of the foot. $\times 33$. Lettering as above.

The structure of the ctenidia is very simple. The filaments are regular in arrangement with interfilamentary junctions formed by horizontal bars (Text-fig. 21, J). The lamellae of each demibranch are widely separated, with *no* interlamellar junctions. This unusual condition may be correlated with the distension and contraction of the mantle during life, and with the reduction of the shell and adductor muscles. In the fully distended condition the valves must be raised until they become almost horizontal in position, at the same time pulling out the ctenidia so that the lamellae of each demibranch are separated. This could not occur if they were connected by interlamellar junctions. When water has been



TEXT-FIG. 14.—Transverse section through the mouth. $\times 33$. AP, anterior pallial nerve; BG, byssal gland; IP, inner labial palp; OP, outer labial palp; PN, pedal nerve; v, anterior end of the visceral mass. Other lettering as above.

expelled through the exhalent siphon the volume of the mantle cavity is reduced, the valves lowered, and the ctenidia returned to their normal position with the two lamellae of each demibranch lying close together. According to Ridewood (1903), interlamellar junctions are present in all other members of the family Galeommatidae.

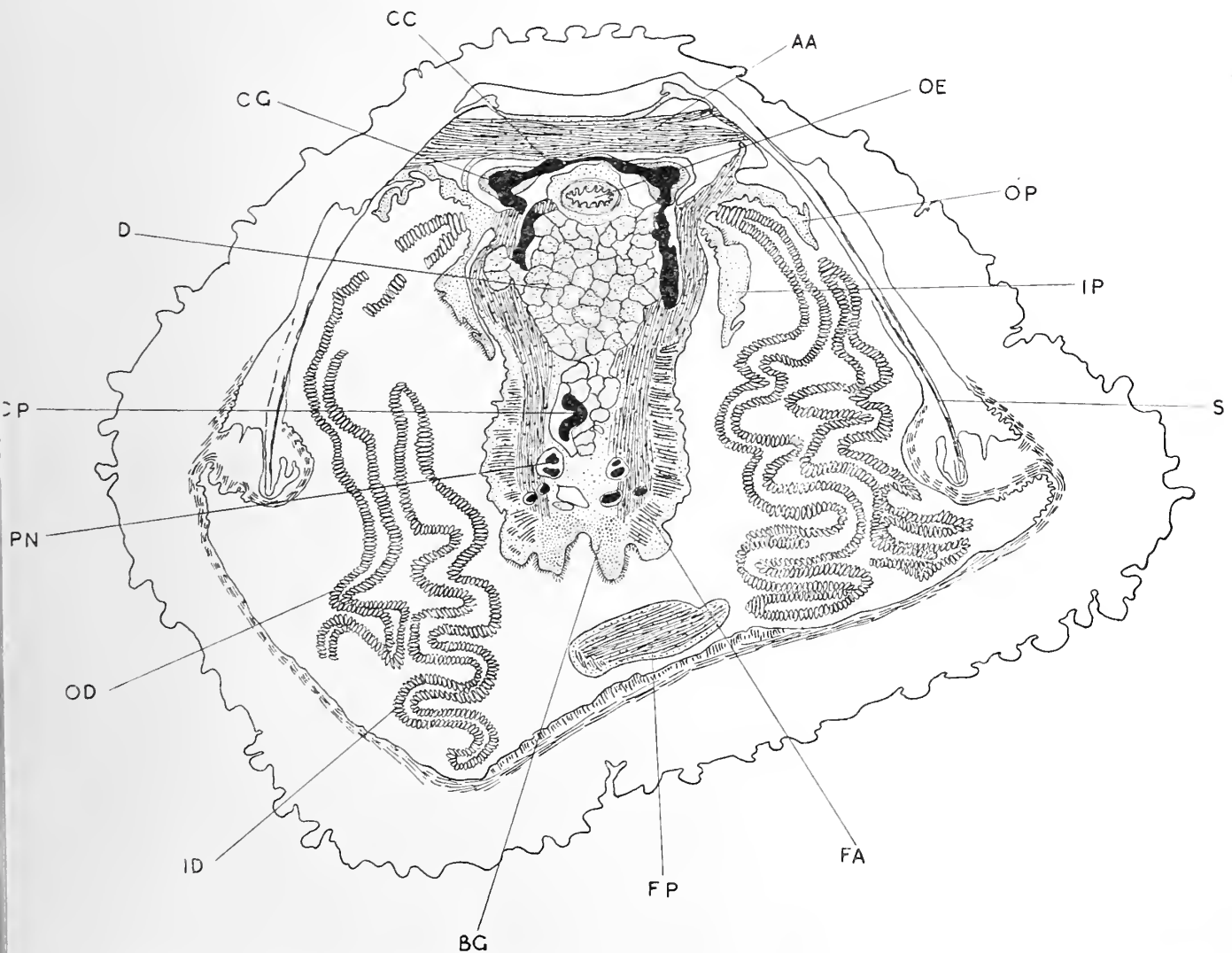
6. LABIAL PALPS.

The two pairs of labial palps have the form of smooth flat blades with rounded tips (Text-fig. 9, LP), which extend laterally on either side of the mouth and curve down slightly

into the mantle cavity on either side of the anterior tip of the inner demibranch (Text-fig. 14, IP, OP). The free portion of the upper palp extends, therefore, to a position between the termination of the two demibranchs. The anterior median portions of the palps form the lips of the mouth, fusing in the mid-line and forming a solid oval band round the mouth. The opposed surfaces of the free portions of the palps are ridged, with a ciliated epithelium and many mucous glands. Cilia were not visible in fixed material on the outer surface of both pairs of palps, but they are probably present in life.

7. ALIMENTARY CANAL.

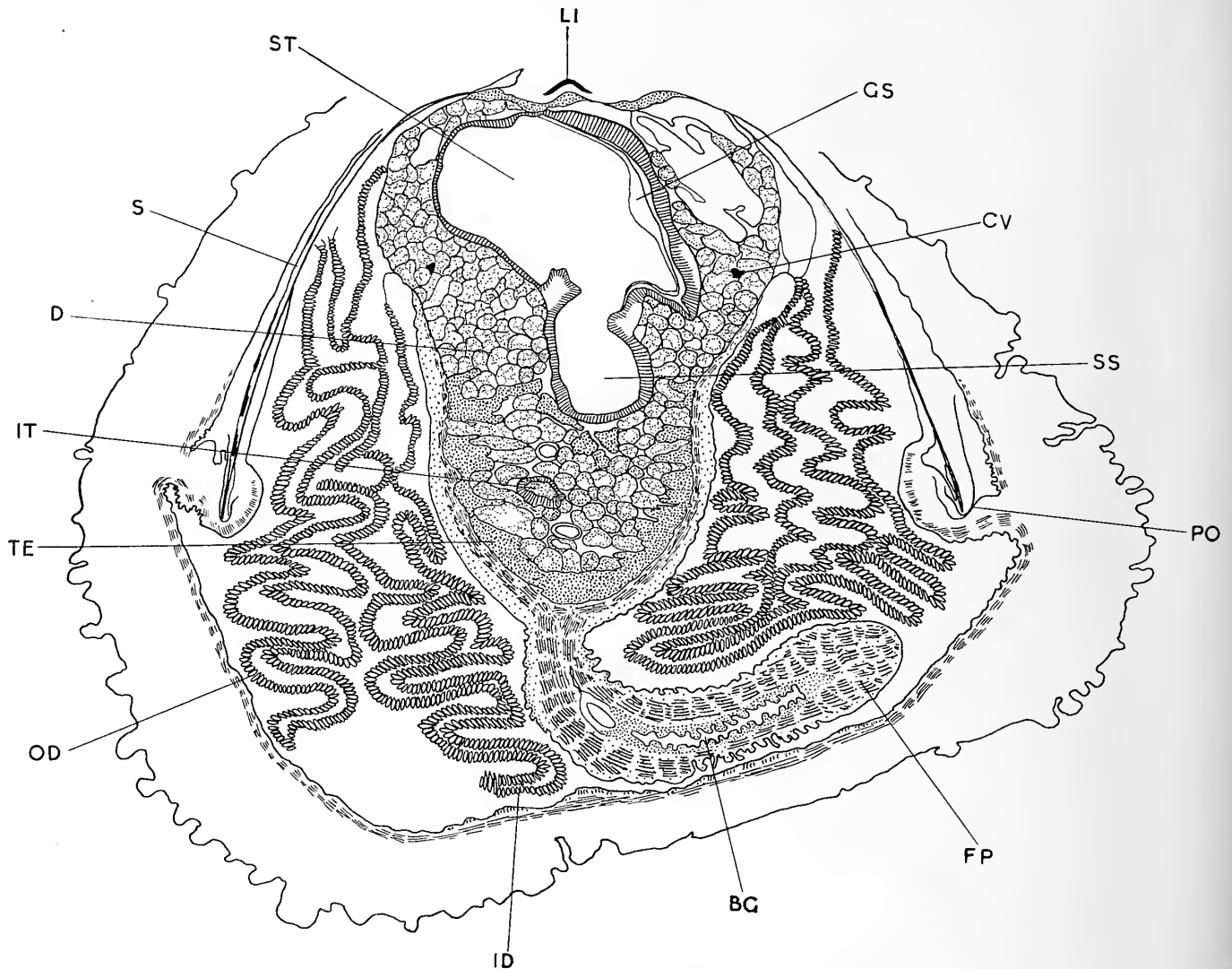
The mouth is at the anterior end of the visceral mass, opposite the inhalent opening. It opens between the two lips formed by the median portion of the labial palps, being hidden by the upper pair (Text-fig. 14). The surface of the mouth is folded and the



TEXT-FIG. 15.—Transverse section through the cerebro-pleural ganglia. $\times 33$. CC, cerebro-pleural commissure; CG, cerebro-pleural ganglia; CP, cerebro-pedal commissure; D, digestive diverticula; OE, oesophagus. Other lettering as above.

ciliated epithelium contains many mucous cells. The lower lip is fused with the visceral mass.

The mouth opens into the oesophagus, which is centrally situated below the anterior adductor muscle. It is oval in cross-section and similar in structure to the mouth, the epithelium being surrounded by a narrow band of circular muscle (Text-fig. 15, OE). It

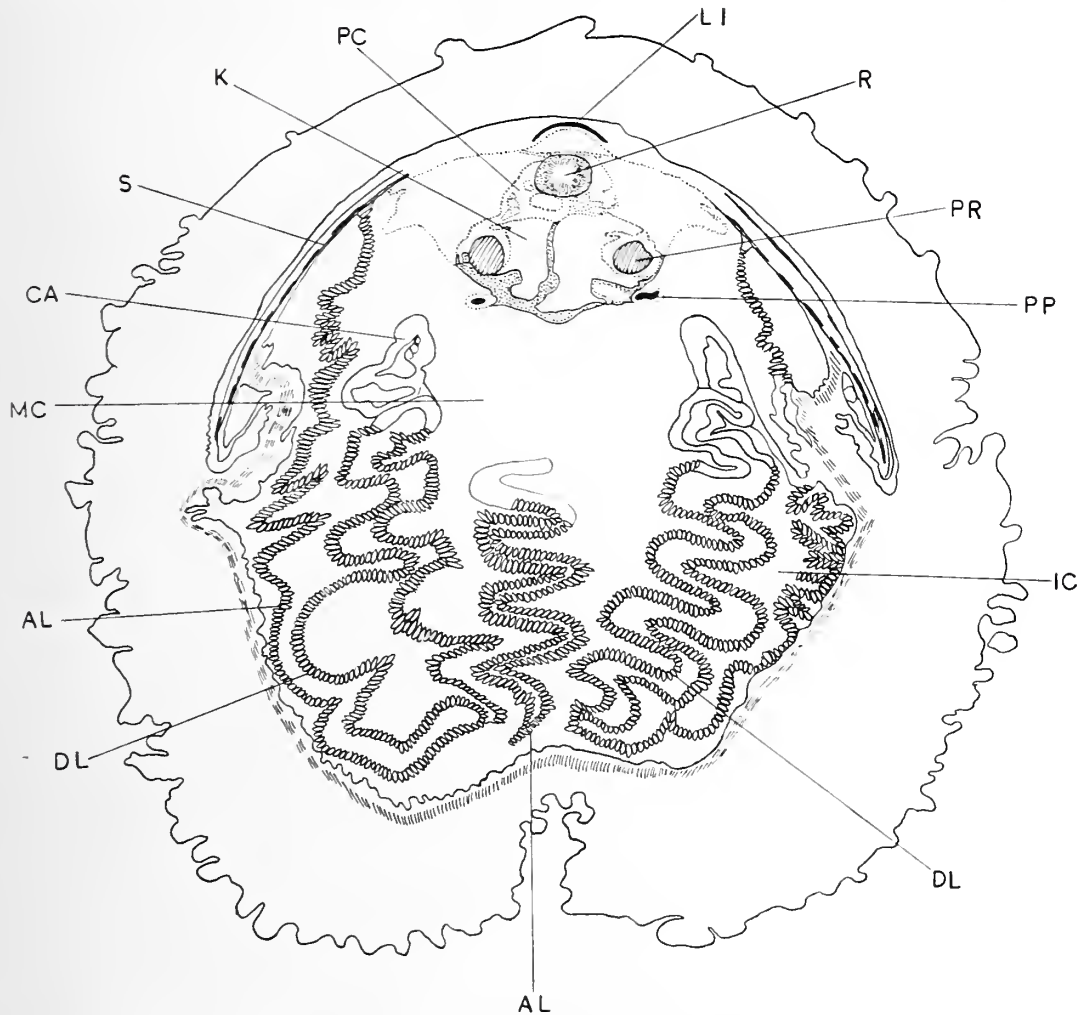


TEXT-FIG. 16.—Transverse section through the stomach. $\times 33$. cv, cerebro-visceral commissure; gs, gastric shield; it, intestine; li, ligament; ss, style-sac; st, stomach; te, testis. Other lettering as above.

passes direct to the stomach, which is slightly more ventral in position and is surrounded by the digestive diverticula. This wide, oval cavity occupies a large part of the visceral mass; it is lined with ciliated epithelium and has many mucous cells (Text-fig. 16, ST). At the posterior end the stomach loses its oval shape and becomes irregular in outline.

A large style-sac opens into the stomach to the right of the mid-ventral line. It extends ventrally into the mass of digestive diverticula (Text-fig. 16, SS), and is separate from the intestine. A smooth gastric shield covers the wall of the stomach opposite the opening of the style-sac (Text-fig. 16, GS).

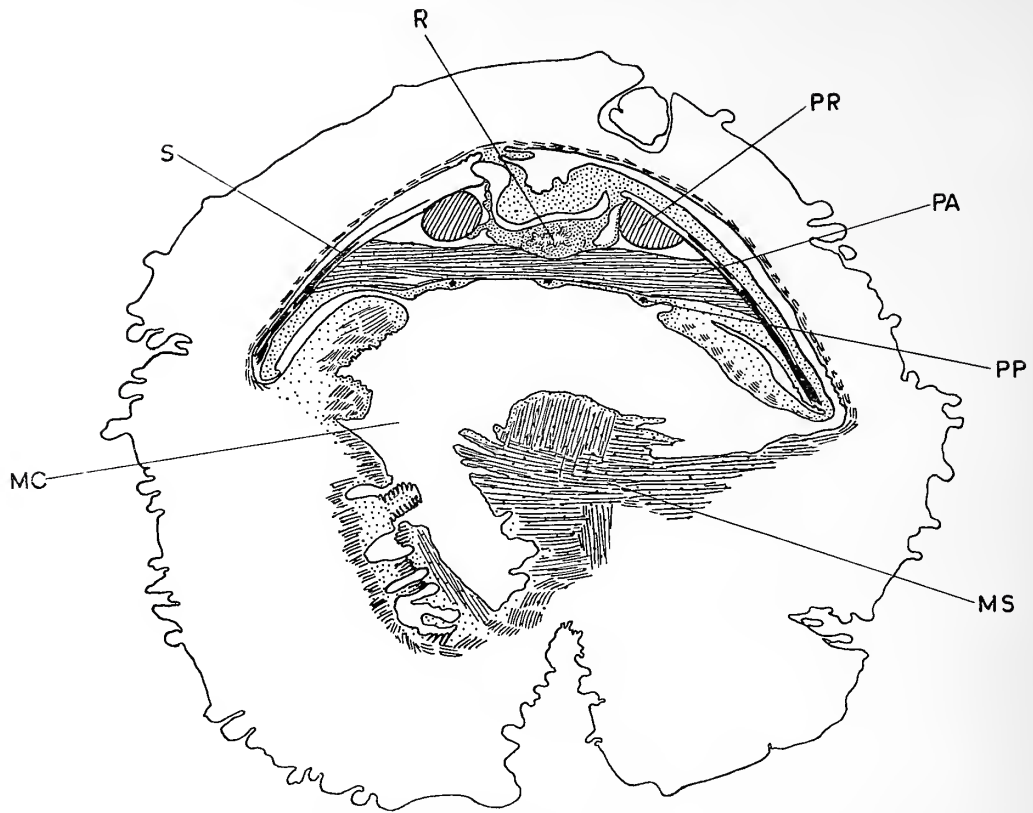
The digestive diverticula occupy most of the visceral mass, surrounding the alimentary canal from mouth to rectum (Text-fig. 15, D). In structure they consist of a mass of ramifying tubes, oval or round in cross-section, and clearly separated from each other. These tubules are lined with cubical cells containing granules, they open into ducts lined with flat ciliated epithelium, which unite and open through the ventral and lateral walls of the stomach, anterior to the style-sac. There are many separate openings, as noted by



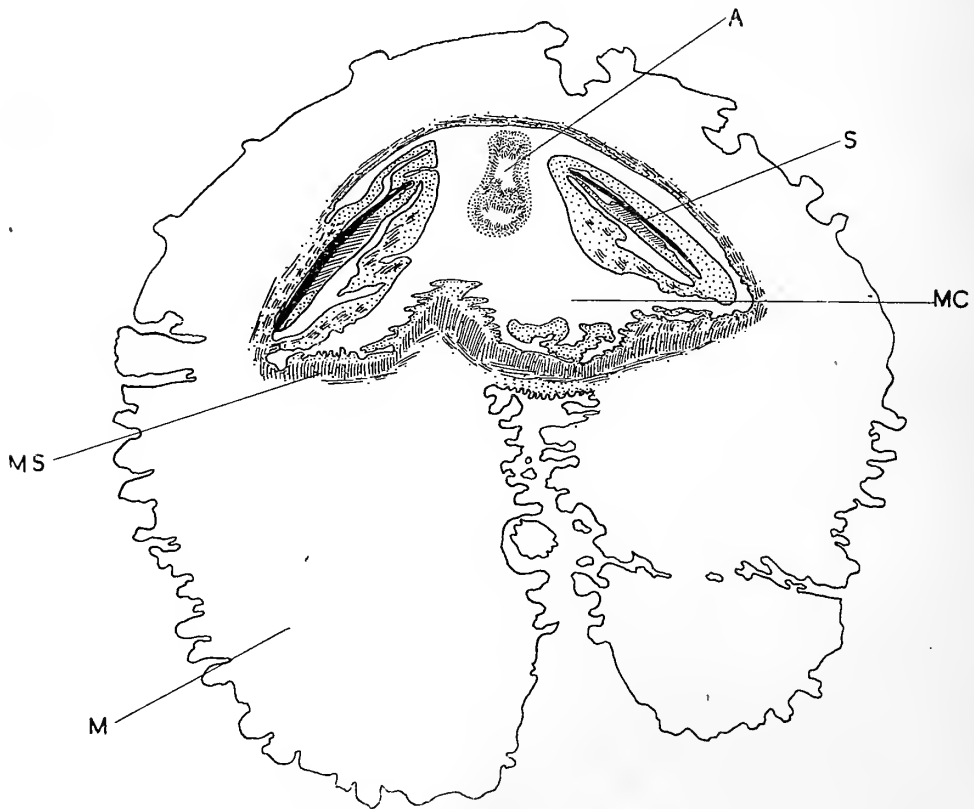
TEXT-FIG. 17.—Transverse section through the rectum and the kidney. $\times 33$. AL, ascending lamella; CA, axis of the ctenidium; DL, descending lamella; IC, interlamellar cavity; PC, pericardium; PP, posterior pallial nerve. Other lettering as above.

Bernard (1897) in *Chlamydoconcha*, but they form three main groups, one ventral, and two lateral.

The intestine leaves the stomach just anterior to the opening of the style-sac, and to the right of the mid-ventral line. It coils about through the mass of digestive diverticula, remaining ventral to the stomach throughout its course (Text-fig. 16, IT), except during the last coil, when it passes forwards and upwards to the right of the stomach. Behind the stomach the intestine passes upwards in a loop through the posterior end of the gonad, on a level with the middle of the stomach. It gradually becomes more dorsal, finally merging into the rectum. The intestine has no typhlosole.



TEXT-FIG. 18.—Transverse section through the posterior adductor. $\times 33$. Lettering as above.



TEXT-FIG. 19.—Transverse section through the anal region. $\times 33$. Lettering as above.

The rectum is a straight circular tube. It has no mucous glands; this is possibly correlated with the powerful expulsion of water through the exhalent siphon rendering the elaboration of firm faecal pellets unnecessary. The rectum passes through the ventricle of the heart, over the posterior adductor (Text-figs. 17 and 18, R), and opens by a dorsally directed anus into the mantle cavity, below the exhalent siphon (Text-fig. 19, A).

The whole of the alimentary canal, with the exception of the region bearing the gastric shield, is strongly ciliated.

8. FOOT.

Histologically the foot is a compact mass of muscle with many blood spaces in the centre. It is also well supplied with nerves (Text-figs. 12-16, FA, FP). The ventral surface of the foot, together with the sides of the byssal groove, is ciliated. These cilia are probably responsible for the slow gliding motion of the foot in life.

In the anterior portion of the foot there are typical mucous glands, the mucus produced lubricating the creeping sole of the foot. They are most numerous ventrally, but they also extend up the sides of the foot at the anterior tip; farther back they are confined to the ventral side, and eventually mingle with the byssal gland-cells.

The byssal gland consists of dark-staining cells concentrated round the inner portion of the byssal groove, but extending for a considerable depth into the pedal mass. The gland is dense in the central portion of the foot, and extends above the byssal groove throughout the posterior portion of the foot, except for the extreme posterior tip.

The paired pedal retractor muscles are inserted into the posterior portion of the shell, just anterior to the anus, and immediately above the posterior adductor muscle (Text-figs. 9 and 18, PR). They are most widely separated at the posterior end. They pass forwards on either side of the heart and kidneys (Text-fig. 17, PR), to either side of, and above the visceral ganglia. The two muscles join below the intestine, and pass into the substance of the visceral mass at its posterior end. They pass down either side of the posterior part of the gonad, and into the muscular mass of the foot.

The pair of pedal protractor muscles are slender. They pass forwards on either side of the oesophagus, remaining below the anterior adductor muscle and the cerebro-pleural commissure, and enter the anterior portion of the foot in front of the cerebro-pleural ganglia.

9. CIRCULATORY SYSTEM.

The pericardial cavity is posterior and dorsal to the visceral mass. It is situated between the two pedal retractor muscles, in the mid-line immediately behind the kidneys (Text-fig. 17, PC). It contains the heart, which consists of a ventricle and two lateral, thin-walled auricles (Text-fig. 10, AU).

The blood-vessels are not well defined, except near the heart, where anterior and posterior vessels leave the heart in the mid-line. Two lateral vessels enter the auricles close to the mid-line, they come from the visceral mass.

10. EXCRETORY SYSTEM.

The kidneys are small. They are situated just anterior to the heart and, with the pericardium, form a distinct mass separate from the main portion of the visceral mass, and posterior and dorsal to it (Text-fig. 10, K). At the anterior end there are two distinct

organs, one on either side of the rectum and separated by the anterior end of the pericardium. As the pericardium narrows posteriorly, the two kidneys enlarge towards the mid-line. They end posteriorly in a point beneath the posterior adductor muscle. Anteriorly they extend as far as the posterior end of the gonad. A ciliated duct from each kidney opens into the pericardium immediately above the pedal retractor muscle, on either side of the rectum, and below the posterior end of the gonad. The opening from the kidneys into the mantle cavity has not been observed.

The pericardial gland is situated on the lateral walls of the pericardium, and also covers the lateral walls of the anterior end of the ventricle. It extends, at the level of the axes of the ctenidia, throughout the greater part of the pericardium, and ends above the posterior face of the visceral ganglia, and opposite the auricles. It consists of a dense mass of cells which contain granules and have large nuclei.

11. NERVOUS SYSTEM.

The nervous system is normal and the ganglia are large. The cerebro-pleural ganglia are situated behind the mouth, on either side of and slightly above the oesophagus (Text-fig. 15, CG), they are joined by a large cerebral commissure, which passes over the oesophagus and under the anterior adductor muscle (Text-fig. 15, CC).

Large pallial nerves leave the anterior face of the cerebro-pleural ganglia, and pass forwards on either side of the mouth, becoming slightly more dorsal in position and farther apart (Text-fig. 14, AP). They lie in the mantle, close under the shell, and become farther apart as the anterior tips of the shell valves separate. Towards the tip of the shell the pallial nerves divide up into many small nerves, which spread out in the tissue of the mantle inside the shell. The main branch of the nerve is situated centrally beneath the shell. At the extreme anterior end the small nerves lie just below the muscle layer that borders the mantle cavity.

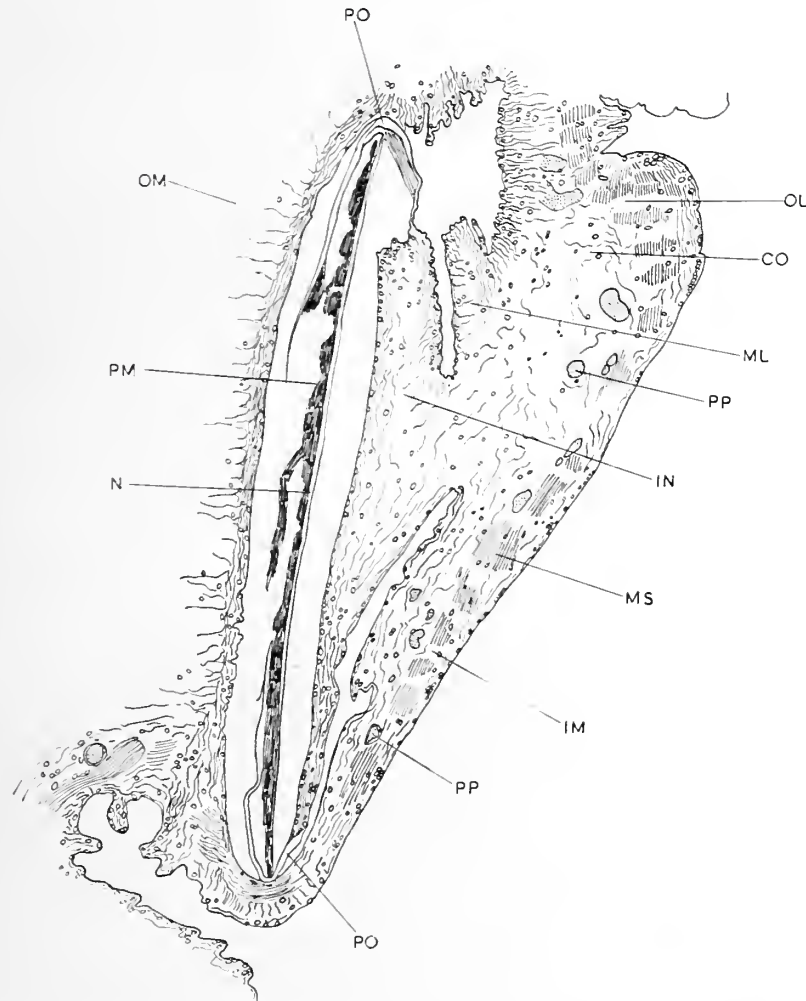
The cerebro-pedal commissures leave the posterior ventral face of the cerebro-pleural ganglia, and pass vertically downwards into the foot between the mass of digestive diverticula and the wall of muscular tissue that bounds them (Text-fig. 15, CP). Upon reaching the muscular mass of the foot the nerves pass backwards in the centre of the foot on either side of the median line and into the pedal ganglia at their anterior face.

The pedal ganglia are situated in the central portion of the foot at the approximate dividing line between the anterior and posterior portions. They lie between the byssal gland at the ventral side of the foot and the gonad. The ganglia are large and joined together in the mid-line.

Large pedal nerves pass forwards from the ganglia on either side of the mid-line into the anterior portion of the foot, and divide up into many smaller nerves. The whole of the anterior portion of the foot is richly innervated (Text-fig. 15, PN). Posterior pedal nerves leave the posterior face of the pedal ganglia. They are smaller than the anterior pedal nerves and supply the posterior portion of the foot. Like the anterior pedal nerves, they divide up into many small nerves.

The cerebro-visceral commissures leave the posterior face of the cerebro-pleural ganglia; they pass back on either side of the oesophagus, becoming farther apart and more ventral in position. They are smaller than the cerebro-pedal commissures or the anterior pallial nerves. They pass between the mass of digestive diverticula, and the muscular

wall of the visceral mass, and are at the same level as the axes of the ctenidia (Text-fig. 16, cv). They lie close to the wall of the stomach at its posterior end, approach the median line behind it and then extend beneath the dorsal portion of the gonad. They continue on either side of the heart, above and outside the pedal retractor muscles, and pass towards the mid-line beneath the posterior end of the heart. They enter the visceral ganglia at their anterior face beneath the rectum.



TEXT-FIG. 20.—Transverse section through the mantle and the shell. $\times 75$. IM, inner layer of the mantle; N, nacreous layer of the shell; OM, outer layer of the mantle; PM, prismatic layer of the shell. Other lettering as above.

The visceral ganglia are the largest of the ganglia and are situated behind the main visceral mass, beneath the pericardium and excretory organs. They lie close together, and are joined in the mid-line into one large ganglionic structure.

A large branchial nerve passes from the external lateral side of each visceral ganglion into the main axis of one of the ctenidia, continuing along this and sending branches into the descending lamellae of each demibranch. A nerve passes from the ventral face of each ganglion into the ascending lamellae and along the axes, sending branches into each lamella. A nerve also leaves the posterior face of each ganglion. These two nerves separate and pass beneath the pedal retractor muscles and the pericardium. Posteriorly

they become farther apart and pass into the tissue of the mantle inside the shell, where they divide up into many small nerves. They remain below the posterior adductor muscle. There are three main branches which lie close under it, one in the mid-line, and two laterally (Text-fig. 18, PP). The whole of the mantle inside the shell is richly innervated (Text-fig. 20, PP).

12. GENITAL SYSTEM.

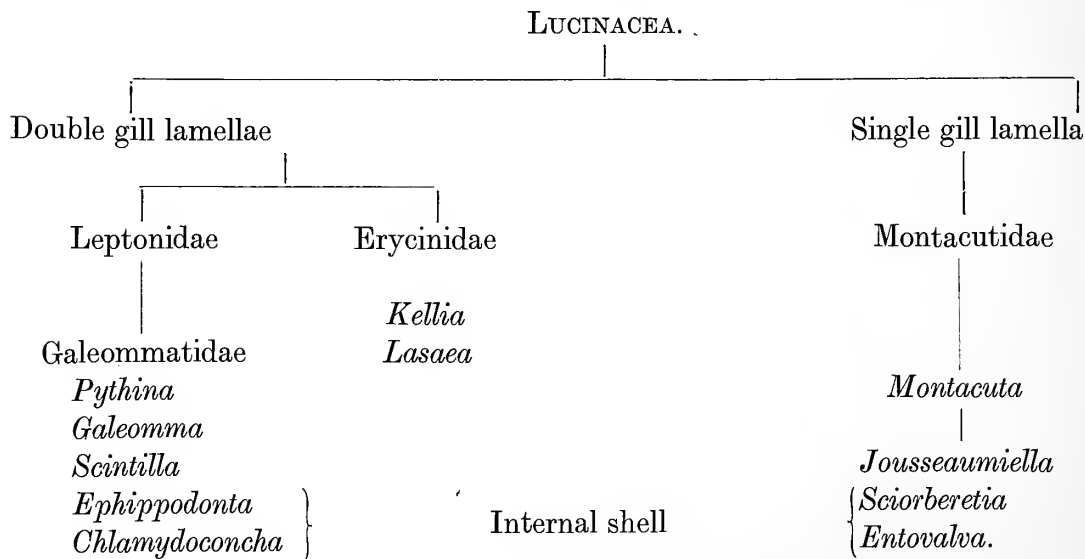
The specimen sectioned was a male, and the testis, composed of ramifying tubules, contained sperms in all stages of development.

The testis extends forwards above the foot, to the level of the pedal ganglia. At the anterior end it is confined to the ventral side of the visceral mass, and is spread out over the ventral surface of the digestive diverticula (Text-fig. 16, TE). The mass of the gonad is small compared with that of the digestive diverticula. Behind the style-sac the testis spreads out dorsally and composes most of the posterior part of the visceral mass. It surrounds the hinder, part of the intestine. At the posterior end of the visceral mass the testis becomes more dorsal in position, and forms a compact mass surrounding the rectum.

The testis opens by a short ciliated funnel into the mantle cavity on either side. The opening leads into the supra-branchial cavity in the region above the inner demibranch, immediately over the cerebro-visceral commissure, and just anterior to the opening of the excretory organ into the pericardium.

13. DESCRIPTION OF GENUS AND SPECIES.

According to Pelseneer's classification (Pelseneer, 1911), the Order Lucinacea is divided into two groups according to whether the ctenidia have one or two demibranchs:



The Erycinidae are distinguished by the presence of three pallial openings, whereas the members of the other three families have two. The Erycinidae and Montacutidae are hermaphrodite, with incubation of the embryos in the mantle cavity. In the Leptonidae and Galeommatidae the sexes are separate, and the mantle has papillae. The distinction between the two families lies in the position of the shell in relation to the mantle. In the

Leptonidae the shell is always external, but in the Galeommatidae the mantle covers the shell to a varying degree. In *Pythina* (Pelseneer, 1911) the mantle is only reflected over the extreme edge of the shell. In *Galeomma* and *Scintilla* (Fischer, 1887) the mantle is reflected for some distance over the edges of the shell valves, while in *Ephippodonta* (Tate, 1887) and *Chlamydoconcha* (Bernard, 1897) this reflection of the mantle has advanced to such an extent that the shell is completely internal. In the Erycinidae the shell is always external, but a similar development to that in the Galeommatidae has taken place in the Montacutidae. *Montacuta* has an external shell with no reflection of the mantle lobes. *Jousseaumiella* (Bourne, 1906) also has an external shell, but in *Sciorberetia* (Bernard, 1895) and *Entovalva* (Ohshima, 1930) the shell is completely enclosed in the mantle as it is in *Ephippodonta* and *Chlamydoconcha*.

Modification in the position of the shell valves has also occurred in this order, and may be related to the covering of the shell by the mantle. In *Kellia* and *Lasaea*, in which the shell is external, the foot can be withdrawn and the shell valves closed. In *Scintilla* the valves gape slightly (Deshayes, 1855), but less than in *Galeomma*, in which there is a permanent ventral gape, and in these species there is not only a gape, but the foot and part of the visceral mass extend permanently beyond the shell. In *Ephippodonta* the valves are semicircular, wide apart, and cannot be depressed to an angle of less than 70° . The animal is flat (Tate, 1887). The extreme case is found in *Libratula*, one of the Galeommatidae, in which the valves are normally perfectly horizontal and cannot be depressed to an angle of less than about 90° (Pease, 1855), but in this case the shell is external.

All members of the Lucinacea have an anterior inhalent opening and a posterior exhalent opening, and throughout the group the foot has a creeping sole.

In the species here examined for the first time there are two gill lamellae, two pallial openings, and the shell is completely enclosed in the mantle, which has papillae. There is a permanent gape between the shell valves, and the foot and part of the visceral mass extend permanently beyond the shell. The sexes are separate. It must therefore be included in the Galeommatidae and grouped with *Ephippodonta* and *Chlamydoconcha*, to which it is most closely related. In external appearance it most closely resembles *Chlamydoconcha*, but the shell is widely different (that of *Chlamydoconcha* being sword-shaped), the buccal hood is less prominent, the "anterior orifice" is absent, the papillae on the mantle are more numerous, the foot is longer and thinner, the adductor muscles are present, although reduced, and the habitat is different, the new species occurring in the burrows of *Lysiosquilla*, while *Chlamydoconcha* is found in stony clam-beds fixed to rocks or pebbles.

The animal differs from *Ephippodonta* in the form of the shell, that of *Ephippodonta* being semi-circular and covered in spines, with two bifid cardinal teeth in each valve. (These do not interlock.) The mantle lobes of *Ephippodonta* are free all round except dorsally, and the anterior margins of the mantle lobes are expanded and form a funnel. The foot is disc-shaped and very large, with a broad locomotory surface. There is also a difference in habitat. *Ephippodonta*, which was collected at Edithburg, Yorke Peninsula, South Australia (Tate, 1887), lives in the mud-formed burrows of a shrimp, sheltering beneath large stones between tide-marks.

The shell of the new species more closely resembles that of other members of the Galeommatidae, and is also similar to the shell of *Sciorberetia* (Bernard, 1895) and *Entovalva* (Anthony, 1916; Ohshima, 1930), both members of the Montacutidae.

It will be seen from the above that although this species must be included in the Galeommatidae, and is related to *Ehippodonta* and *Chlamydoconcha*, it differs to such an extent from both of these that it is reasonable to establish a new genus for its inclusion.

14. GENERIC AND SPECIFIC CHARACTERS.

Phlyctaenachlamys lysiosquillina gen. and sp. n.

HABITAT.—Occurs in the burrows of *Lysiosquilla maculata*.

Length of largest specimen in life : 2.4 cm.

Particulars of Type Specimen in the British Museum (N. H.): Length 6.0 mm. Shell, 4.75 × 3.0 mm. Mantle covered with papillae; these are not sensory, but have many mucous glands. Two large retractile tentacles at the anterior end; these are enlarged papillae. Mantle forms a hood over the anterior portion of the foot. Well-developed muscle layer in the mantle. Exhalent opening situated on a round protuberance posteriorly. Shell completely enclosed in the mantle; reduced, smooth, white and fragile, oval in shape and inequilateral. Gape between the shell valves ventrally; the mantle, foot, visceral mass and ctenidia extend permanently beyond them. Hinge teeth reduced. Internal elastic ligament. Adductor muscles reduced. Foot in two parts; anterior portion wedge-shaped; posterior portion long and thin. Foot contains many mucous glands, as well as a byssal gland. Ctenidia have no interlamellar junctions. Style-sac separate from the intestine. Intestine has no typhlosole. Rectum has no mucous glands. Sexes separate.

15. DISCUSSION.

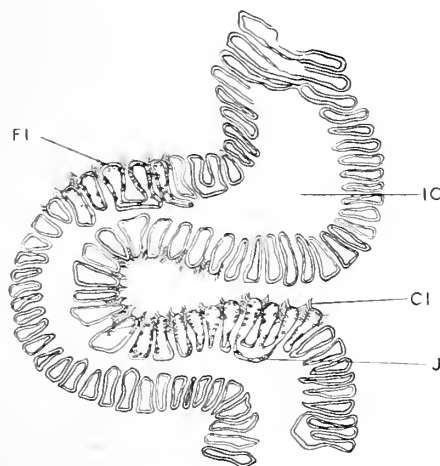
Phlyctaenachlamys lysiosquillina is a commensal from the burrows of *Lysiosquilla maculata*. The reduction of the shell, the covering of the shell by the mantle and the associated reduction of the hinge-teeth and the adductor muscles are adaptations in relation to this commensal mode of life.

In the Lucinacea an interesting series can be traced in the development of commensalism culminating in parasitism. *Kellia*, *Galeomma* and *Chlamydoconcha* are examples of the free-living members; *Ehippodonta* is commensal in the burrows of a prawn (Tate, 1887; Woodward, 1893); *Lepton squamosum* is commensal with *Upogebia stellata*; *Lepton clarkia* and *Mysella bidentata* with *Phascolosoma elongatum* (Salisbury, 1932); *Mysella bidentata* also with *Ophiocnida brachiata* (Winckworth, 1924) and *Montacuta ferruginosa* with *Echinocardium cordatum*. None of these is attached to the animal with which it is associated, and this is also the case in *Phlyctaenachlamys lysiosquillina*. *Montacuta substriata*, however, lives attached by byssus threads to the spines of *Spatangus purpureus* (Salisbury, 1932); *Entovalva semperi* lives attached to the body of a synaptid *Protankyra bidentata* (Ohshima, 1930); *Jousseáumia* in the basal chambers of the corals *Heteropsammia* and *Heterocyathus* (Bourne, 1906), while the extreme case is found in *Entovalva mirabilis*, which is an internal parasite in the gut of a holothurian (Voeltzkow, 1891).

Phlyctaenachlamys lysiosquillina produces byssus threads by which it may be attached to the sides of the burrow. The foot has a creeping sole, and movement is assisted by the unusual method of forcing water out from the mantle cavity by sudden violent contractions of the mantle. There are various modifications in relation to this form of movement, namely the development of an extensive layer of muscle in the mantle, and the

loss of the interlamellar junctions from the ctenidia. These interlamellar junctions are present in both *Chlamydoconcha* (Bernard, 1897) and *Ephippodonta* (Ridewood, 1903) and throughout the group, although Bernard records similar, although presumably less extensive, movements in *Chlamydoconcha*. This form of ctenidium will offer less resistance to the stream of water than one with a greater rigidity, and will be better able to withstand the considerable strain put upon it, due to the increase of pressure in the infrabranhial cavity when the mantle contracts.

The absence of mucous glands in the rectum is probably also associated with this movement of water through the mantle cavity. Particles of faecal matter will be shot out through the exhalent opening. There is thus no necessity for the formation of firm faecal pellets, because, owing to the violent expulsion of water, there will be less danger of the mantle cavity silting up.



TEXT-FIG. 21.—Ctenidium. $\times 150$. CI, cilia; FI, filament; IC, interlamellar cavity; J, interfilamentary junction.

The presence of a direct food current in an anterior to posterior direction, which represents the movement of the inhalent aperture from its primitive position, ventral to the exhalent aperture at the posterior end, to the anterior end, occurs only in the Order Lucinacea. It is clearly correlated with the absence of the burrowing habit in these animals, and probably with their mode of progression by means of a creeping sole. It is certainly mechanically efficient, as the ctenidia will act as "strainers" in the line of a direct current of water passing through the mantle cavity.

16. REFERENCES.

- ANTHONY, R. 1916. Contribution a l'étude de l'*Entovalva (Synapticola) perrieri*, Malard. Mollusque acéphale commensal des Synaptes. Arch. Zool. Expér. Gén. LV, pp. 375-391.
- BERNARD, F. 1895. *Sciorberetia australis* type nouveau de Lamellibranche. Bull. Sci. France Belg. XXVII, pp. 364-395.
- 1897. *Chlamydoconcha orcutti*. Ann. Sci. Nat., Zool. (8) III, pp. 220-250.
- BOURNE, G. C. 1906. On *Jousseaumia*. Cey. Pearl Oyster Fish. Rep., Roy. Soc. London, V, pp. 243-266.
- DALL, W. H. 1884. *Chlamydoconcha*. Science, IV, pp. 50-51.
- DESHAYES, G. P. 1855. Sur le genre *Scintilla*. Proc. Zool. Soc. London, 1855, p. 171.
- FISCHER, P. 1887. Sur un nouveau type de Mollusque. *Chlamydoconcha*. Man. de Conchyl. et de Palaeont. Conchyl., 1887, pp. 201-206.

- OHSHIMA, H. 1930. Preliminary Note on *Entovalva semperi* sp. nov., a Commensal Bivalve Living Attached to the Body of a Synaptid. Annot. Zool. Jap. XIII, pp. 25-26.
- PEASE, W. 1865. Descriptions of New Genera and Species of Marine Shells from the Islands of the Central Pacific. Proc. Zool. Soc. London, 1865, pp. 512-517.
- PELSENEER, P. 1911. Les Lamellibranches de l'Expédition du Siboga. Partie Anatomique. Siboga-Expédition. Mon. LIIIa.
- RIDEWOOD, W. G. 1903. On the Structure of the Gills of the Lamellibranchia. Phil. Trans. Roy. Soc., B, CXCIV, pp. 147-284.
- SALISBURY, A. E. 1932. On *Lepton squamosum* and *Montacuta ferruginosa* and some other molluscs observed at the Salcombe Estuary, Devon. Proc. Malac. Soc. London, XX, pp. 100-103.
- TATE, R. 1887. Descriptions of some New Species of Marine Mollusca from South Australia and Victoria. Trans. Proc. Rep. Roy. Soc. S. Aust. XI, pp. 62-75.
- VOELTZKOW, A. 1891. *Entovalva mirabilis* eine schmarotzende Muschel aus den Darm einer Holothurie. Zool. Jahrb. Abt. Syst. V, pp. 619-628.
- WINCKWORTH, R. 1924. Specimens of Molluscs and Other Animals associated with them Found in a Day's Digging at Salcombe. Proc. Malac. Soc. London, XVI, p. 1.
- WOODWARD, M. F. 1893. *Ephippodonta MacDougalli*. Proc. Malac. Soc. London, I, pp. 20-25.
- YONGE, C. M. (1936) The Evolution of the Swimming Habit in the Lamellibranchia. Mém. Mus. Roy. d'Hist. Nat. Belg. (2), Fasc. 3, pp. 77-100.

19 APR 1940

PRESENTED







BRITISH MUSEUM (NATURAL HISTORY)

GREAT BARRIER REEF EXPEDITION
1928-29

SCIENTIFIC REPORTS

VOLUME VI, No. 3

MADREPORARIA,
HYDROCORALLINAE,
HELIOPORA AND TUBIPORA

BY

CYRIL CROSSLAND, D.Sc.
(1878-1943)

WITH ONE TEXT-FIGURE AND FIFTY-SIX PLATES



LONDON:

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

SOLD BY

B. QUARITCH, LTD., 11 GRAFTON STREET, NEW BOND STREET, LONDON, W.1

H.M. STATIONERY OFFICE, LONDON, S.W.1

AND AT

THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, LONDON, S.W.7

1952

[All rights reserved]

Price Three Pounds, Ten Shillings

[Issued 22nd October, 1952]

PRESENTED
23 OCT 1952

DESIGNED AND
PRINTED

BY
ADLARD & SON
LIMITED



AT
BARTHOLOMEW PRESS
DORKING

MADREPORARIA, HYDROCORALLINAE, HELIOPORA AND TUBIPORA

BY

CYRIL CROSSLAND, D.Sc.
(1878-1943).

WITH ONE TEXT-FIGURE AND FIFTY-SIX PLATES.

EDITOR'S NOTE

Cyril Crossland undertook to report upon the coral collections of the Great Barrier Reef Expedition and the material was sent to him just before the outbreak of war in 1939. The task, interrupted by illness, took him three years, but he had completed it before his death early in 1943. Thanks to the kindness of the staff of the Zoological Museum of the University of Copenhagen, and especially of Dr. P. L. Kramp, his typescript and notes, and the collections were carefully preserved until communications were re-opened at the end of the war. Although the report was complete in most respects, no illustrations had been prepared. The difficult task of choosing material to illustrate to the best advantage the points made by the author and of supervising the preparation of the plates has been carried out with meticulous care by Capt. A. K. Totton, M.C. and Mr. E. White of the Zoological Department, British Museum (Natural History); they have also been responsible for the final checking of the text and seeing it through the press. It has been their aim to preserve, as far as possible, the integrity of the original text and any necessary departures from it, except the most trivial, have been indicated by notes bearing Capt. Totton's initials.

In a covering letter, found with the typescript, the author stressed the importance of good and numerous illustrations for any paper dealing with corals. He also urged that his report should be accompanied by actual photographic prints, or collotype reproductions, in order that details not mentioned in, or not clear from, the text could be made out by examination under a lens. It is hoped that the number of illustrations now presented with his report would not have disappointed him. It is also hoped that in the future no one will again be compelled to rely, as Crossland was, on illustrations alone, but that there will be freedom to consult the actual specimens or photographs prepared specifically for any particular investigation.

CONTENTS

	PAGE
1. FOREWORD: CYRIL CROSSLAND. By DR. A. F. BRUUN	86
2. INTRODUCTION	88
3. LIST OF SPECIES	89
4. DESCRIPTION OF SPECIES	101
5. REFERENCES	251
6. INDEX OF GENERA AND SPECIES	255

FOREWORD

CYRIL CROSSLAND, STUDENT OF CORALS

“The foundation of my love of science is my love of beauty.”

This is the first sentence of some autobiographical notes left by Cyril Crossland, and to which he has given the heading “How I became a Coral Reef Man.”

Crossland died in his 65th year on 7th January, 1943, in Denmark. A general outline of his life has been given elsewhere (*Vidensk. Medd. fra Dansk Naturhist. Forening*, CVI, Copenhagen 1943). Here I shall try to give a picture of Crossland as a student of corals and coral reefs.

It is based on the autobiographical notes mentioned and letters from the time when I first met him in Tahiti (or Tahaiti, as he always maintained was the correct spelling) in 1928, and not least from memories of a close friendship developed during his last years in Denmark from 1938 until his untimely death.

Crossland had a very high opinion about what ought to be the standard of scientific papers and was most self-critical. This may to some extent account for the fairly restricted number of Coral papers he produced, while he himself, modestly admitting “it has been very little,” accounts for it by the force of circumstances: “for, except when in Tahaiti, when I was greatly hindered by ill health, corals and coral-reefs have been secondary to the work for which I drew the pay, and I have conscientiously kept them secondary.” The number of coral papers published in his later years, of which the present was finished just before the final illness that led to his death, indicates that this was the real reason.

No better example of his patient study of detail can be given than his account of the Forskål Collection of Corals, so important for nomenclature. By a wonderful coincidence he had all the qualifications required for taking up that study; he had a wide knowledge of Latin and Arabic, he knew all the places where Forskål collected his specimens, and had some twenty years of personal knowledge of the coral reefs of the Red Sea. Without being a specialist on corals I venture to say that that paper will range among the classics of coral taxonomy.

But systematics was but one of the tools for Crossland in his study of the general coral reef problems which right from the start in 1900 thrilled his imagination when he first saw living corals at Prison Island, in Zanzibar harbour. “The great reef of the east coast from which the roaring surf has been heard at Dunga, in the centre of the island, 10 miles inland, about 15 from the actual reef edge, was my Mecca. I would see the great waves from Chuaka rise up white, apparently standing still like the sail of a boat, before falling in foam. Even after I had settled at Chuaka it was some time before I could get out to the reefs, in calm weather at low tide, and walk on the edge. To my great surprise I found it all quite dead.”

From his studies of the reefs of Zanzibar, Equatorial East Africa, the Red Sea, Tahiti and some other places Crossland arrived at the astonishing conclusion, suggesting that “the age of corals is past, not only in Tahiti and elsewhere, and the cliff which generally surrounds atolls, at about 50 fathoms below the surface” (*J. Linn. Soc. Lond.* XXXVI, 1928). He was fully aware that the reefs he had seen appeared to be unlike those described

by others, but he was convinced that they had to be taken into account. At the same time he always stressed the point that no coral reef area and almost no coral reef has yet been completely examined; this was not meant to underrate good work done by other scientists, but from his own experience he knew what an enormous amount of work is still left. As an example he mentioned the East African reefs, which he examined "when I was young (very young) in 1900, and, in the succeeding 39 years no one else has been there to verify, disprove, or to complete my description of those vast dead reefs, nor are they mentioned in any recent literature, though they are a really stupendous phenomenon of obvious importance to the history of coral growth."

Among the principal omissions from many accounts of reefs he found the most obvious to be the description of the outer slope, beneath and outside the breakers, as far as the bottom is visible; he was aware of the difficulty and danger of the job, though he thought the danger more apparent than real. He found the observations from the Funafuti expedition most valuable, but to have any general value they must be multiplied many times.

He would also claim that for most areas we have only incidental references to what are the dominant genera of corals, mentioning vast and wholly unexplained differences such as the dominance of *Porites* (*Synaraea*) and leafy *Pavona* in the Maldives, where the leafy species, usually so much more abundant, are absent, and the rarity of all colonial Fungiidae in the northern Red Sea, and several others. "Nature has so many tricks to play upon us, only some of which have been discovered that, as in all other investigations, no one man's work can be anything but a beginning."

He considered himself the last of the pioneers, who work alone with no elaborate equipment, "the present fashion being to go out in parties, which may degenerate into crowds, a distraction and hindrance to the leader."

"Simplicity, Scepticism, and Patience; Walking, Cycling, and Canoe Paddling, have been, for the most part, my own methods, and they have served me well."

At the same time he fully admitted that a coral reef man cannot work in isolation, the problems are too complex. The biologist, geologist, oceanographer, and meteorologist, etc., should work together and hold discussions *on the spot*. "Team work is thus even more necessary in coral reef work than in others, but it is not necessary that the team should work simultaneously in a crowd, hindering each others' movements, and leaving little privacy for that quiet thought, apparent idleness, which is so essential for anything but routine work."

For the future he wanted much more accumulation of "mere" descriptions and "mere" observations, with a programme of experiment running parallel, general theory to grow step by step as progress was made; he thought that theory has outrun observation to a large extent.

It is my hope to have given some glimpses of Crossland as the Coral Reef Man behind his printed works. To have been with him, he wearing a native loin cloth, a *pareo*, and a straw hat, in a leaking outrigger canoe on the lagoons of Tahiti, to have listened to his enthusiastic explanations of the wonderful sights in his water telescope I reckon as a very great privilege; a still greater to have known this noble and gentle character.

ANTON F. BRUUN.

INTRODUCTION.

THIS is the largest collection of corals brought from any one area, containing as it does 174 species, divided among 54 genera. Of these, 30 species are new, 2 of Bernard's have been given names, and there are several curious varieties, 3 of which have been given new names. This is evidence, not only of the richness of the fauna but of very careful collecting, since several species, which have not been seen for many years, are included. Yet it is clear that the collection does not include all the species which inhabit the Great Barrier Reef area; even assuming that Brook and others have made many synonyms, there are species described by them which have not been found again, and some of those described by T. W. Vaughan from Murray Island do not occur in this collection. This latter difference probably indicates a real difference in the faunas, the Murray Islands being about 10° S. and Low Isles 16° 20' S., but the difference in their positions with respect to the Barrier has probably an even greater influence. Dr. and Mrs. Stephenson and others remark of Yonge Reef (Vol. III, No. 2, p. 83): "The coral and alcyonarian species are unlike those with which we had become familiar, and although closer study showed that many of them represent modified growth-forms of Low Isles species, or forms which in the latter place are limited to the windward side, others were actually new, and everything looked a little different." Low Isles is distinctly muddy. The quite unexplained difference in the faunas of different reefs is frequently referred to in what follows. My experience corroborates Umbgrove's, who (1939, p. 12) writes: "We are only in the very beginning of having an idea of the true distribution of species which abound in one reef but seem absent in some other reefs." I continue this quotation under *Acrohelia horrescens*, *Montipora foliosa* and *M. ramosa*, but the fact applies to other species also.

I have noted of some species that they are absent from the Red Sea or Tahaiti, but proving a negative is, of course, always a doubtful business. For instance in my three years in Tahaiti I found only one specimen each of *Astreopora*, *Pachyseris*, and *Echinophyllia*, the latter the extraordinary specimen illustrated in Plate II (1935). In the Red Sea I specially looked for the *Cymodocea* with strong stems rising from rhizomes and bearing tufts of broad leaves, which is such an ubiquitous feature of the reefs of Zanzibar and neighbourhood, but it was some years before I found one small patch on the Sudan coast. Years later I found it abundant at Ghardaqa, in the north.

Here is a list of Murray Island species described by T. W. Vaughan, but not found by the Great Barrier Reef Expedition:—

Seriatoridae :

Seriatorpora angulata, possibly the same as *S. hystrix* :

Acroporidae :

Montipora turgescens (the only species of *Montipora* not found) ; *Acropora decipiens* ;
A. pectinata ; *A. spicifera* ; *A. sarmentosa* ; *A. plicata* ; *A. murrayensis* V.
 (possibly the same as *A. rosaria*) ; *A. squarrosa* ; *A. syringodes*.

Thamnastreidae :

Psammocora gonagra.

Fungiidae :

Fungia sp. aff. *concinna*.

Poritidae :

Porites murrayensis Vaughan ; *P. mayeri* Vaughan ; *P. viridis* Gardiner.

Faviidae :

Coeloria stricta, synonymous with *C. daedalea* ; *Leptoria gracilis*, probably the same as *L. phrygia* ; *Hydnophora exesa*, possibly the same as *H. microconos*.

Here is the list of species, with previous records, if any, from the Barrier Reef region, the recorder's name being indicated by initials, as in the list of abbreviations below. Note *Cynarina savignyi*, which has been, so far, found only in the Gulf of Suez, and turns up again now on the other side of the world. On the other hand, the fewness of the species common to the Great Barrier Reef and the Red Sea, among the Fungiidae and Perforata, is somewhat surprising. There is, for a considerable part of the fauna, a Pacific region, beginning in Malaysia and dying out beyond Fiji (the continental limit), considerably reduced in Samoa, still further in Tahaiti,* with relics only in the Marquesas.

LIST OF SPECIES COLLECTED BY MEMBERS OF THE GREAT BARRIER REEF EXPEDITION,
WITH A NOTE OF PREVIOUS RECORDS OF THEM FROM THE GREAT BARRIER REEF AND OF
THEIR WIDER DISTRIBUTION.

	Other recorders from			Page.	Plate.
	Gt. B. Reef.†		Wider distribution.		
MADREPORARIA					
[CARYOPHYLLIIDAE]					
CARYOPHYLLINAE					
<i>Trachyphyllia geoffroyi</i>	M.	.	Northern Red Sea, Indo-Pacific	101	.
<i>Heterocyathus aequicostatus</i>		.	to Philippines; Indian Ocean, including Natal and Equatorial East Africa; Persian Gulf; W. Australia; Pacific to Philippines.	102	.
[THECOCYATHINAE]					
<i>Thecocyathus minor</i>		.	Loyalty Is.	103	.
[EUSMILIINAE]					
<i>Euphyllia glabrescens</i>	M.	.	Indian Ocean, including Gulf of Aden; Pacific to Samoa.	104	II
<i>E. fimbriata</i>	M.	.	Red Sea, Indo-Pacific (western).	105	.
FLABELLIDAE					
<i>Flabellum rubrum</i>		.	Indian Ocean, including Cape; New Zealand; Pacific as far as Palau Islands.	105	.
<i>F. vacuum</i> sp. n.		.		106	I

* I adopt this spelling after Kotzebue, since one of the early travellers explained to a correspondent that the original Otaheite rhymed with "mighty." It is still the pronunciation used by old residents and natives.

† M. stands for George Matthai; T.W.V. for T. Wayland Vaughan; Död. for L. Döderlein and H.M.B. for H. M. Bernard.

	Other recorders from		Page.	Plate.
	Gt. B. Reef.	Wider distribution.		
[SERIATOPORIDAE]				
<i>Seriatopora hystrix</i>	T.W.V.	? Red Sea; Indo-Pacific to Fiji.	107	
<i>Stylophora pistillata</i>	T.W.V.	Red Sea, including Suez; Indo-Pacific to Fanning Atoll.	107	
<i>S. septata</i>		Rotuma.	108	II
<i>Pocillopora damicornis</i>		Indian Ocean, including Natal and Mauritius; Pacific, including Tahaiti and Hawaii.	110	
<i>P. danae</i>		S. Indian Ocean, including Natal and Mauritius; Fiji and Tahaiti.	110	
<i>P. verrucosa</i>		Red Sea; Indo-Pacific, including Marquesas and Tahaiti.	111	
<i>P. eydouxi</i>	T.W.V.	Indian Ocean; Pacific, including Marquesas, Tahaiti and Hawaii.	112	I
[ASTRAEIDAE: with distinct calices and cyclic septa]				
<i>Leptastrea purpurea</i>	T.W.V.	Red Sea; Indo-Pacific to Tahaiti and Hawaii.	115	I, III
<i>L. ehrenbergana</i>		Red Sea; Indo-Pacific to Tahaiti.	115	
<i>L. transversa</i>		Red Sea; Indo-Pacific to Tahaiti.	115	LIV
<i>L. bottae</i>		Red Sea to Hawaii.	116	I, II
<i>L. pruinosa</i> sp. n.			116	III
<i>Cyphastrea chalcidicum</i>		Northern Red Sea, Pacific to Philippines, ? Hawaii.	117	
<i>C. serailia</i>		Northern Red Sea to Philippines.	118	
<i>C. microphthalma</i>		Northern Red Sea to Tahaiti.	118	
<i>Echinopora lamellosa</i>		Indo-Pacific to Fiji.	119	
<i>E. horrida</i>		Malaysia to Fiji.	120	IV
[OCULINIDAE]				
<i>Madrepora kauaiensis</i>		Hawaii, Indian Ocean.	121	
<i>Galaxea fascicularis</i>		Red Sea; Indo-Pacific to Samoa.	122	
<i>G. clavus</i>	Quelch	Indo-Pacific to Samoa.	122	
<i>Acrohelix horrescens</i>	T.W.V.	Red Sea to Palao Is. and Fiji.	123	
[MONTASTREINAE]				
<i>Orbicella curta</i>	T.W.V.	Pacific to Tuamotu Atolls.	124	
<i>O. vacua</i> sp. n.			124	II, III
[ASTRAEIDAE: without cyclical septa]				
<i>Favia fava</i>		Northern Red Sea; Indo-Pacific to Samoa.	125	
<i>F. fava</i> var. <i>crassidens</i> var. n.			126	XIV
<i>F. valenciennesi</i>		Red Sea and Indian Ocean.	126	
<i>F. doreyensis</i>		Indo-Pacific to Samoa.	127	
<i>F. speciosa</i>		Northern Red Sea; Pacific to Fiji and Fanning.	127	

	Other recorders from	Wider distribution.	Page.	Plate.
	Gt. B. Reef.			
<i>F. stelligera</i>	.	Northern Red Sea; Indo-Pacific to Tahaiti.	128	.
<i>Favites halicora</i>	T.W.V.	Northern Red Sea; Indo-Pacific to Samoa.	128	.
<i>F. abdita</i>	.	Northern Red Sea; Indian Ocean, including Mauritius and Natal; Pacific to Fiji.	129	.
<i>F. virens</i>	T.W.V.	Northern Red Sea; Indo-Pacific to Samoa.	130	VI
<i>F. aspera</i>	.	Maldives, Japan, Philippines.	132	V
<i>Goniastrea retiformis</i>	T.W.V.	Northern Red Sea; Indo-Pacific to Samoa.	133	.
<i>G. pectinata</i>	T.W.V.	Northern Red Sea; Indo-Pacific to Samoa.	135	.
<i>G. benhami</i>	.	Kermadec Isl., Formosa.	136	VIII
<i>G. mantonae</i> sp. n. = <i>G.</i> K5 and K18 S. Manton	.	.	136	VII
[ASTRAEIDAE: Meandroid species]				
<i>Cynarina savignyi</i>	.	Gulf of Suez.	137	IV
<i>Lithophyllia vitiensis</i>	.	Fiji and Loyalty Is.	138	IX
<i>Caulastrea simplex</i> sp. n.	.	.	139	III
<i>C. furcata</i>	M.	G.B.R., China Sea, Tongatabu.	140	.
<i>Acanthastrea echinata</i>	T.W.V.	Northern Red Sea; Indo-Pacific to Tahaiti.	141	VIII, IX
<i>Lobophyllia corymbosa</i>	Quelch	Northern Red Sea; Indo-Pacific to Tahaiti.	142	IX
<i>L. hemprichii</i>	M.	Northern Red Sea; Indo-Pacific to Tahaiti.	143	X, XXX
<i>Symphyllia recta</i>	M.	Indo-Pacific to Samoa.	144	XI
<i>S. radians</i>	M.	Indo-Pacific to Tongatabu.	146	.
<i>Oulophyllia crista</i>	.	Indo-Pacific to Bismarck Is.	147	.
<i>Coeloria astraeiformis</i>	T.W.V.	? Red Sea, Indian Ocean, Fiji.	147	.
<i>C. daedalea</i>	M.; T.W.V.	Red Sea; Indo-Pacific to Tua- motus, but not Tahaiti.	148	XI, XII
<i>C. lamellina</i>	T.W.V.	Northern Red Sea; Indo-Pacific to Samoa.	149	.
<i>Leptoria phrygia</i>	T.W.V.	Northern Red Sea; Indo-Pacific to Samoa.	150	.
<i>Hydnophora microconos</i>	.	Northern Red Sea; Indo-Pacific to Samoa.	151	.
[MERULINIDAE]				
<i>Merulina ampliata</i>	M.	Northern Red Sea; Indo-Pacific to Samoa.	151	.
FUNGHIDAE				
<i>Fungia echinata</i>	.	Red Sea to Tahaiti.	152	.
<i>F. actiniformis</i>	.	Zanzibar, E. Indian Is. to Rotuma.	152	.
<i>F. scutaria</i>	.	Red Sea to Hawaiian Is.; Tahaiti.	152	.
<i>F. paumotensis</i>	.	Red Sea to Hawaii.	153	.
<i>F. fungites</i>	T.W.V.	Red Sea; Indo-Pacific to Marquesas.	153	.

	Other recorders from		Page.	Plate.
	Gt. B. Reef.	Wider distribution.		
<i>F. cyclolites</i>	Död.	Red Sea ; Indo-Pacific to Philippines.	153	
<i>F. patelliformis</i>		Malaysia to Samoa and Hawaii.	154	XVI
<i>Stephanophyllia formosissima</i>		Kei Is., Philippines, E. Africa, Hawaii.	154	
<i>Herpolitha limax</i>		Red Sea to Tahaiti.	154	
<i>Halomitra robusta</i>		Malaysia and Pacific to Society Is.	155	
<i>Polyphyllia talpina</i> *	T.W.V.	Malaysia, as far as Santa Cruz.	155	
<i>Podobacia crustacea</i>		Ceylon, Maldives to Philippines.	156	XII, XIII
[PECTINIIDAE]				
<i>Oxypora lacera</i>		} Doubtfully known.	158	
<i>O. aspera</i>			159	
<i>Tridacophyllia lactuca</i>		Indo-Pacific to Fiji.	160	
<i>T. paeonia</i>		Fiji and Philippines.	160	
[AGARICIIDAE]				
<i>Pavona decussata</i>		Red Sea ; Indo-Pacific to Samoa.	161	
<i>P. danai</i>		Northern Red Sea to Tahaiti.	161	
<i>P. cactus</i>		Indo-Pacific to Tahaiti.	162	
<i>P. varians</i>	T.W.V.	Northern Red Sea ; Indo-Pacific to Tahaiti and Hawaii.	162	XIII, XIV
<i>P. duerdeni</i>		Hawaii.	163	
<i>Pachyseris speciosa</i>	T.W.V.	Northern Red Sea ; Indo-Pacific to Tahaiti.	164	
<i>P. torresiana</i>	T.W.V.	G.B.R., Timor, Tahaiti.	164	
<i>Coeloseres mayeri</i>	T.W.V.	Indian Ocean (?), G.B.R., Philippines, Palao Is.	164	
[SIDERASTREIDAE]				
<i>Anomastrea irregularis</i>		Equatorial E. Africa and Natal.	165	
[THAMNASTREIDAE]				
<i>Psammocora contigua</i>		? Red Sea ; Indian Ocean to Mauritius ; Pacific to Marquesas.	165	XV, XVII
<i>P. exesa</i>		Maldives, Pacific to Fiji.	165	XVI, XVII
[AGATHIPHYLLIDAE]				
<i>Diploastrea heliopora</i> *		Gulf of Aden to Samoa.	166	
[DENDROPHYLLIIDAE]				
<i>Balanophyllia incisa</i> , sp. n.			166	XV
<i>B. yongei</i> , sp. n.			167	XIV, XV
<i>Dendrophyllia arbuscula</i>		Doubtful.	170	XIV
<i>D. micranthus</i>		Red Sea.	171	
<i>D. micranthus</i> var. <i>grandis</i> , var. n.			173	LV, LVI
<i>D. velata</i> , sp. n.			173	LV
<i>Turbinaria peltata</i>	H.M.B.	Torres Straits, W. Australia, Singapore, Fiji, Philippines.	174	XVI, XVIII, XIX
<i>T. peltata</i> var. <i>gibiari</i> , var. n.	H.M.B.	? Indian Ocean, Malaysia to Fiji.	175	XIV, XVI-XVIII, XXII
<i>T. bifrons</i>		West Australia.	176	XXI
<i>T. frondens</i>		Fiji, ? Samoa.	176	XXIII
<i>T. stephensoni</i> , sp. n.			178	LV, LVI
<i>T. mantonae</i> , sp. n.			179	XVI, XVII, XIX

* Not collected.—[A.K.T.]

	Other recorders from	Wider distribution.	Page.	Plate.
[PERFORATA]				
[ACROPORIDÆ]				
<i>Astræopora myriophthalma</i>		Northern Red Sea to Samoa and Tahaiti.	180	.
<i>Montipora granulosa</i>	H.M.B.	Macclesfield Bank.	181	XXV, XXVII
<i>M. millepora</i> , sp. n.	.	.	182	XX, XXII
<i>M. prominula</i> , sp. n.	.	.	182	XXIV, XXVII
<i>M. digitata</i>	.	Banda, Solomons, Fiji.	183	XXVI
<i>M. fruticosa</i>	H.M.B. ; T.W.V.	G.B.R. only.	184	XXIII
<i>M. ramosa</i>	T.W.V. ; H.M.B.	(as <i>M. indentata</i>) Ceylon to Fiji.	184	XXVI, XXVII
<i>M. fossae</i> , sp. n.	.	.	186	XXVI
<i>M. foveolata</i>	.	Tongatabu and Fiji.	188	.
<i>M. socialis</i>	.	Madagascar.	188	.
<i>M. venosa</i> var. <i>angulosa</i>	T.W.V.	Red Sea; Celebes, G.B.R., Samoa.	188	XXVI-XXVIII
<i>M. prolifera</i>	.	Amboina, Carolines.	190	.
<i>M. undans</i> , sp. n.	.	.	190	XXIII, XXVIII
<i>M. sulcata</i> , sp. n.	.	.	191	XXVIII, XXIX
<i>M. tertia</i> , sp. n.	.	.	192	XXV, XXVIII
<i>M. verrucosa</i>	H.M.B.	G.B.R. to Hawaii, but not Samoa or Tahaiti.	193	.
<i>M. erythraea</i>	.	Red Sea, Batavia.	193	XXIV, XXVII
<i>M. foliosa</i>	.	Indo-Pacific to Palao Is.	194	.
<i>M. informis</i>	H.M.B.	Cocos Keeling, N. Celebes, G.B.R.	195	.
<i>M. composita</i> , sp. n.	.	.	195	XXVIII, XXIX
<i>M. angularis</i> , sp. n.	.	.	197	XXV, XXVIII

The 40 species of *Acropora* are here in alphabetic, not classificatory order.

<i>Acropora abrotanoides</i>	Brook ; T.W.V.	Singapore, G.B.R., Tahaiti.	204	.
<i>A. affinis</i>	Brook	G.B.R., China Sea.	205	XXXIV
<i>A. armata</i>	.	Diego Garcia, Singapore, ? Tahaiti.	212	XXXVII
<i>A. aspera</i>	Brook	G.B.R. to Fiji.	205	XXXIII
<i>A. brooki</i> , sp. n.	.	.	228	XLI, XLVI
<i>A. bruggemanni</i>	Brook	G.B.R., Singapore.	221	.
<i>A. canalis</i>	.	Philippines.	219	.
<i>A. cancellata</i>	.	Louisiade Arch.	225	XLI
<i>A. clavigera</i>	.	G.B.R. only ?	226	XL, XLII
<i>A. corymbosa</i>	Brook	Red Sea, Indo-Pacific to Tahaiti.	211	.
<i>A. digitifera</i>	Brook ; T.W.V.	Madagascar, G.B.R.	207	XXXV
<i>A. elseyi</i>	Brook	G.B.R., Torres Straits.	223	.
<i>A. exilis</i>	Brook	G.B.R., China and Arafura Seas.	223	XXXIX
<i>A. fruticosa</i>	Brook	G.B.R., Samoa.	220	.
<i>A. gemmifera</i>	Brook	G.B.R., Fiji, Arafura Sea	220	.
<i>A. glochiados</i>	.	Indian Ocean.	213	XXXIX
<i>A. grandis</i>	Brook	G.B.R. only.	202	XXXI
<i>A. haimi</i>	T.W.V.	Red Sea; Indo-Pacific to Fiji.	207	XXXIII, XXXV

	Other recorders from		Wider distribution.	Page.	Plate.
	Gt. B. Reef.				
<i>A. hebes</i>	Brook ; T.W.V.		Malaysia, G.B.R. to Samoa.	217	
<i>A. humilis</i>	Brook		G.B.R. and Fiji.	221	
<i>A. hyacinthus</i> *	Brook		Tizard Bank, G.B.R., Fiji.	215	
<i>A. intermedia</i>			Maldives.	200	XXXII
<i>A. jeulini</i> , sp. n.				227	XLII
<i>A. laevis</i> , sp. n.				230	XLV
<i>A. latistella</i>	Brook		G.B.R. and Samoa.	216	
<i>A. lutkeni</i> , sp. n.				229	XLI, XLVI
<i>A. macrostoma</i>			Mauritius.	214	
<i>A. otteri</i> , sp. n.				229	XLIII, XLIV
<i>A. pacifica</i>			China Sea, ? Samoa.	202	XXXI, XXXII
<i>A. palifera</i>	Brook ; T.W.V.		Indo-Pacific ; G.B.R. to Samoa.	218	
<i>A. patula</i>	Brook		G.B.R. only.	215	
<i>A. proluxa</i>			"Ousima," Samoa.	226	
<i>A. pulchra</i>	Brook ; T.W.V.		Keeling Atoll, G.B.R., China Sea.	203	
<i>A. quelchi</i>			Amboina, Solomons, Samoa.	209	XXXVI
<i>A. rosaria</i>	Brook		G.B.R. to Samoa.	224	XL
<i>A. spectabilis</i>			G.B.R. only.	220	
<i>A. squamosa</i>	Brook ; T.W.V.		"E. Indies," G.B.R.	216	
<i>A. surculosa</i>	Brook		Indo-Pacific to Tahaiti.	214	XXXVIII
<i>A. tubigera</i>			Singapore, Banda, Louisiades, Palao.	208	
<i>A. variabilis</i> var. <i>pachy- clados</i>	Brook		Red Sea, Indo-Pacific.	222	XXXVIII
[PORITIDAE]					
<i>Goniopora tenuidens</i>	T.W.V.		G.B.R., Amboina, Philippines.	231	
<i>G. lobata</i>			? Red Sea, Amboina.	232	XLVII
<i>G. minor</i> , nom. nov.	H.M.B.		G.B.R. only.	233	XLVIII
<i>G. hirsuta</i> , sp. n.				233	XLVIII
<i>Porites stephensoni</i> , sp. n.				238	L
<i>P. haddoni</i>	T.W.V.		G.B.R., Pacific to Samoa.	241	
<i>P. lobata</i>			Fiji, Fanning, Samoa, Hawaii.	242	
<i>P. solida</i>			Red Sea and probably whole Indo-Pacific.	242 243	
<i>P. australiensis</i>	T.W.V.		G.B.R., Philippines.	243	
<i>P. lanuginosa</i>			Hawaii.	243	LI
<i>P. evermanni</i>			Hawaii.	243	
<i>P. densa</i>	T.W.V.		G.B.R. only.	244	
<i>P. andrewsi</i>	T.W.V.		G.B.R. and Samoa.	244	
<i>P. suppressa</i> , sp. n.				245	LI
<i>P. annae</i> , nom. nov.	H.M.B.		G.B.R. only.	246	LII
<i>P. (Synaraea) vaughani</i> sp. n.				247	LIII
<i>P. (Synaraea) hawaiiensis</i>			Macclesfield Bank, Samoa, Hawaii.	247	
<i>Alveopora irregularis</i> , sp. n.				234	XLIX, L
<i>A. mortenseni</i> , sp. n.				235	XLIX
<i>Stylaraea punctata</i>			Red Sea.	236	L

* Not collected.—[A.K.T.]

	Other recorders from				
	Gt. B. Reef.	Wider distribution.	Page.	Plate.	
HYDROCORALLINAE					
[MILLEPORINA]					
<i>Millepora tortuosa</i>	.	.	.	Not Red Sea, nor E. of Fiji.	. 249 . LIII
<i>M. foveolata</i> , sp. n. 249 . LIII
ALCYONARIA					
[COENOTHECALIA]					
<i>Heliopora coerulea</i>	.	.	.	Not Red Sea ; Indo-Pacific to Funafuti.	. 250 .
<i>Tubipora musica</i>	.	.	.	Northern Red Sea, Indo-Pacific, but neither Samoa nor Tahaiti.	. 251 .

Corals are so extraordinarily variable, not only in growth form but in what one would think were fundamental structures, such as the numbers of cycles of septa, as well as in details such as those of septal teething, that species have been found to run together, in some genera, in a wholesale fashion. I feel that it is now necessary to be on one's guard against applying results found in one genus to members of another without criticism or publication of proofs. One must be watchful for details, apparently trivial, such as in other groups are sound foundations for specific distinctions, and which, in some corals may be found constant. For example, as Vaughan shows repeatedly, septal toothing is often a vital distinction, while in other cases it is of no consequence, and may be due to mere lack of building power. (Crossland, 1931.)

In particular, growth form varies so greatly with conditions that many "species" are later found to be merely the effects of, *e.g.*, shallow water, sediment or surf. There has thus arisen a tendency to ignore form altogether as a specific distinction, action which, in many cases, may be premature. These ecologic variations have their limits for each species, and, until these limits are determined, it is not permissible to merge species on the ground that they differ in little but their growth form ; and the same applies to other variable characters. An extreme case is my new species *Montipora fossae* (p. 186), which hardly differs from *M. ramosa* except in being of decidedly different form. These forms and others may later be proved, by experiment and observation on the reef, to be only ecologic variations, but, until that is done, they must be kept apart. It is much easier for future workers if species are kept distinct until *proved* to be variations than if they are confused now and have to be sorted out later.

On the other hand I find, in this collection as elsewhere, cases of variation within one species which seem hardly believable, but which are clearly proved by the series examined.

Perhaps I may be allowed to add that I make new species with great reluctance.

In the following I have therefore given details of variation at the risk of being tedious, though using them for the creation of new names, or the resuscitation of old ones, as little as possible. My object is to give material upon which others may perhaps work, in cases where what we have is insufficient.

How far are the colours of living corals specific ? Most of the evidence is of astonishing variations without specific or even varietal differences, *e.g.*, the brilliant green discs of several *Astrean* species, the bright pink form of a species of *Pocillopora*, and local differences, such as the green-coloured species of *Stylophora* described by Gardiner, the green species of

Cyphastrea in this collection, all species being brown in the Red Sea. Among the Perforata the leafy *Montipora* of Tahaitian lagoons is usually violet or blue, but often may be pinkish or brown, while the *Acropora cytherea* nearby is distinguishable from the other stalked forms by its lilac colour. *Turbinaria* is a genus usually brightly coloured. *T. mesenterina*, in the Red Sea, is variable, but within the limits of yellow and yellow brown, while *T. peltata* of the Great Barrier Reef may be whitish or rose pink. More data are necessary, and it must not be assumed from the above that colour never has specific value, or varies without ecologic reason.

A difference between the continental reefs and those of the far oceanic islands is that in the latter, as in the Red Sea, the tide rises only about 18 inches at springs, so that corals are very rarely laid bare, and the wonderful photographs of coral beds taken by Saville Kent, Sewell and this Expedition are not to be had from these seas. More important is the fact that the barrier edge is always under the influence of the surf, whereas where there is a tide of several feet the surf's action is greatly lessened for the whole 24 hours over most of the month. Consequently the modifications in growth form induced by the surge in Tahaiti shown in the present writer's papers (1928, pls ii and iii; and 1939, pl. 12) are not found on the Great Barrier Reef to anything like the same extremes.

As species-work is the handmaid of ecology, I give reference to the ecological papers of this series whenever possible, viz., Vol. III, No. 2, by T. A. Stephenson, Anne Stephenson, Geoffrey Tandy and Michael Spender, "The Structure and Ecology of Low Isles and other Reefs," 1931; and Vol. III, No. 10, S. Manton, "Ecological Surveys of Coral Reefs," 1935. Miss Manton's scale drawings of parts of the reefs are particularly valuable; counting "heads" alone may be deceptive, e.g., Mayor, on at least one occasion, found the number of "heads" greatest where the total growth was least.

My labour has been much lightened by Prof. Matthai, not only through the simplification made by his published works, but by his having named a large number of these specimens.

I have referred to published illustrations wherever I have found those which agree well with the specimens of this collection, since in many species the name alone gives little idea of which is meant of a series of variations. The naming of species in the ecological and other reports was, naturally, somewhat provisional, and the following emendations are necessary:

Names used in earlier reports of this series.		Names used in present report.
<i>Pocillopora bulbosa</i>	synonymous with	<i>Pocillopora damicornis</i> .
<i>Galaxca musicalis</i>	" "	<i>Galaxea clavus</i> .
<i>Leptastrca agassizi</i>	" "	<i>Leptastrea purpurea</i> .
<i>Favia clouci</i>	" "	<i>Favia speciosa</i> .
<i>Favia pallida</i>	" "	<i>Favia doreyensis</i> .
<i>Favia pectinata</i>	means	<i>Goniastrea pectinata</i> .
<i>Favia acropora</i>	synonymous with	<i>Favia stelligera</i> .
<i>Favia vasta</i>	" "	<i>Favites virens</i> .
<i>Goniastrea solida</i>	for	<i>Goniastrea retiformis</i> var. <i>solida</i> .
<i>Goniastrea</i> K.5 and <i>Goniastrea</i> K.18		<i>Goniastrea mantonae</i> sp. n.
<i>Fungia danai</i>		Not found, probably <i>Fungia fungites</i> .
<i>Psammacora gonagra</i>	for	<i>Psammocora contigua</i> .
<i>Doderleinia irregularis</i>	"	<i>Halomitra robusta</i> .
<i>Dendrophyllia nigrescens</i>	"	<i>Dendrophyllia micranthus</i> var.

Names used in earlier reports of this series.		Names used in present report.
<i>Astreopora ocellata</i>	probably synonymous with	<i>Astreopora myriophthalma</i> .
<i>Montipora ramosa</i>		<i>Montipora fossae</i> sp. n.
<i>Montipora foliosa</i>		(?) <i>Several species</i> .
<i>Acropora decipiens</i>	for	<i>Acropora variabilis</i> and others.
<i>Acropora hebes</i>	includes	<i>Acropora intermedia</i> .
<i>Acropora delicatula</i>	for	<i>Acropora armata</i> and (?) others.
<i>Acropora formosa</i>		Not found in the collection.
<i>Acropora loripes</i>	for	<i>Acropora quelchi</i> .
<i>Porites haddoni</i>	„	<i>Porites stephensoni</i> sp. n.

Acropora hyacinthus and *Acropora cytherea* are probably confused.

Among differences from other coral regions, besides details noted under the species and genera, such as the absence, from the Murray Island Collection, as well as this, of the semi-encrusting species of *Dendrophyllia*, usually so abundant, it is notable that large colonies seem to be rare or absent. True, S. Manton (1935, p. 297) refers to "huge" Montiporas and Acroporas at 16 feet and below on the windward side of the Low Isles reef, but gives no idea of what "huge" means. Compared with the very small colonies S. Manton had dealt with in shallow water they may have deserved this description without being so very big. Were they over 12 feet across? In all the coral seas familiar to me, and from descriptions in the literature, corals of this size are exceptional, but those of six feet in diameter are not uncommon in most coral seas, in the genera *Porites* and *Acropora* especially, while Gardiner records quite large masses of Astreans, of species which are all quite small here, from many places in the Indo-Pacific. Eguchi (1938) records *Montipora foliosa* 3 meters across in Iwayama Bay, Palao Islands.

What is the present effect of all this growth, the balance between deposition and destruction? Paradise was the first (1925) to give any details of reef structure in this region, and described the remarkable columnar rocks found on the lee sides of many reefs, of which he gives a sketch on p. 54, which may be compared with the scale section by Stephenson and others (1931) on p. 66. Thanks to the diving helmet we now have underwater details which were invisible to Paradise, given by Stephenson and others (1931) on Plate XVII and by S. Manton (1935) on Plate XII. In both cases we see that the rock masses are smooth and bare,* and such coral as now grows thereon had no part in their formation, is adding nothing to the bulk of either reef edge or pinnacle, and does not even add anything but sand to the deposit at the base of the rock. It is clear that the lee reef edge is under erosion, and the pinnacles are remnants of once existing reefs now removed.

To windward conditions are entirely different. Paradise, Stephenson and others all agree as to the steepness of the reef edge and abundance of coral growth, S. Manton especially referring to the abundance of "huge" colonies, but unfortunately she was unable to see the character of the precipitous part of the slope, 28 feet deep out of a total of 86 feet. Such a steep sometimes indicates erosion, but, at any rate in its upper part, the reef is clearly growing

* These edges are comparable to those of the Tahaitian lagoons, but there is much more coral below the level of Low Water Spring Tides here than in Tahaiti, where live coral was confined to the upper surfaces of the overhangs, which it did not, or only exceptionally, form.

Now to take the reef as a whole we have first Paradise's (1925) diagram on p. 53, which can be well compared with the aerial photograph* of Coates Reef given by Yonge in "A Year on the Great Barrier Reef," Plate XLI, opposite p. 137. (The diagrams and figures of Stephenson and others are essentially the same, but Coates Reef is the simpler case.) Both clearly show a solid growing edge of definite outline to windward, irregular growth overbalanced by destruction on the lee side. This definiteness and solidity are due to several factors :

- (1) More rapid coral growth, which is generally found to be accompanied by decreased activity of destructive organisms.
- (2) Growth of lithothamnionae, such as are abundant only among waves.
- (3) The mechanical action of the waves, which drives fragments into all spaces between the larger corals and so consolidates the reef.

The reef is thus creeping to windward, like some of those in the Red Sea. (See Bertram, 1936, p. 1013).

Imagine such a reef in open water, and subject to winds from two directions. The photograph and diagram may then be duplicated, and fitted together like a pair of horse-shoes with the open ends together—a miniature atoll. It is also noted that the barrier edge, at least among and just outside the breakers, though cut by trenches, is smooth and has no vertical step nor outlying buttresses, in fact just like that of Tahaiti. The expedition had no opportunity of seeing the reef just outside the breakers, but this conclusion is safely drawn from the photographs of *regularly* breaking waves. The same applies to many of the Maldivan and Pacific reefs from examination of photographs by Agassiz, Gardiner and Sewell, while some of those given by Agassiz show quite a different type of edge, abruptly falling, like those of Napuka Atoll, part of the exposed shore reef of Tahaiti, and of Funafuti. Judging by Agassiz' photographs, *part* of the Funafuti reef edge is regular and smooth.

The formation of platforms in the moat, and in general beds of living coral on reef flats and the tops of the Paradise pillars, raises an interesting question which has not hitherto been considered, *viz.*, how can these living corals still exist seeing that the sea level has been nearly the same for the last few thousand years? Why did not the whole surface become a platform of dead rock many years ago? The answer evidently is that, in these areas, either the decay and removal of coral is going on as fast as its growth, or that there is an alternation of rock formation and decay in different areas, so that as fast as a platform appears in one place it is removed in another where coral growth is resumed. In short, the fate of the *whole* of the coral living on a reef flat is to be broken up into sand and mud, which is swept away into deeper water, where again, as Gardiner has shown, its fate is often further subdivision and finally solution. Permanent beds of living coral can exist only immediately along the edge of an outgrowing reef, where their foundations are being continually extended.

Here follows for cross reference an index to the corals mentioned by Dr. S. M. Manton (Mrs. J. P. Harding) in Vol. III, No. 10, of this series.

* The photograph of Coates Reef was first published by courtesy of the Royal Australian Navy as frontispiece to Prof. Richard's paper, "A geological reconnaissance in North Queensland," Trans. Roy. geol. Soc. Australasia, I, 1924.—[A.K.T.]

INDEX TO NAMES OF CORALS USED BY DR. MANTON.

SCI. REP. GT. BARRIER REEF EXPED., III No. 10, 1935, ECOLOGICAL SURVEYS OF CORAL REEFS.

(In classificatory order.)

Roman numerals refer to Plates.*

[SERIATOPORIDAE]

- Seriatopora hystrix*, 295, 298, 306, 307, VII, VIII, XVI.
Stylophora, 298, 302, 306, 307.
S. pistillata, 289, 295, IV, VII, VIII, XI, XVI.
Pocillopora, 302, XIII.
P. verrucosa, 297, 304, 305, 306, VIII, XIV, XV, XVI.
P. danae, 288, 298, 306, XII, XVI.
P. eydouxi, 288, 297, 298, 305, 307, VIII, XV.
P. bulbosa, 284, 288, 289, 292/3, 295, 298, 300, III, VII, VIII, IX, X, XVI.

ASTRAEIDAE with distinct calices and cyclic septa.†

- Leptastrea*, 284, 287, 288, 293, 294, 298, 300, 302, 305.
L. ehrenbergana, 288, 298, 305, VIII, XII, XIV, XV.
L. roissyana, 284, 287, 288, 293, 294, 300, 302, 305, III.
Cyphastrea, 284, 295, 300, 302, III, VII.
C. chalcidicum, 288, 293.
Echinopora lamellosa E. sp., 295, XI, XII.
Galaxea, 289, 295, 300, 302, XIII, XVI.
G. musicalis, 284, 288, III, VII.
G. fascicularis, 288, III, XI.
Orbicella, XI.

ASTRAEIDAE without cyclical septa.

- Favia* (including *Favites*), 284, 287, 288, 289, 294, 300, 302, 304, 305.
F. abdita, 285, 288, 294, 298, 305, 306, 307, VIII, IX, X, XII, XIV, XVI.
F. acropora, 289.
F. astraiformis, 285, 286, 288, 292-4, VIII, IX, X, XI, XIII.
F. clouei, 285, 288, 298, 302, 305, III, VIII, XII, XIV.
F. doreyensis, 285, 288, 294, 297, VIII, IX.
F. favus, 285, 286, 288, 293, 294, 298, 306, VIII, IX, XI, XII, XVI.
F. halicora, 285, 288, 294, 298, 306, 307, VIII, IX, XI, XV, XVI.
F. laxa, 305, XII, XIV.
F. vasta, 288, 298, 302, 306, 307, III, VIII, XVI.
F. wakayana, 305, XIV, XV.
Goniastrea, 293, 295, 303, 305.
G. pectinata, 284, 285, 287, 293, 294, 300, 302, III, X.

* Dr. Manton's Plates 1-VIII are diagrams of the traverses; IX-XVI, pictorial diagrams of small areas.

† It is difficult to believe that these "species" can really be recognized on the reef.

[The following information has been supplied by Dr. S. M. Manton: "Identifications of the corals encountered on the detailed surveys were not made on field observations alone. Both living and cleaned corals were examined in the laboratory, and full use was made of existing monographs. Corals which did not correspond with anything in the monographs were given provisional names. When an observer becomes sufficiently accustomed to examining the corals of a limited region it is found that many forms are clearly recognizable in the field. Those about which any doubt was felt were brought back to the laboratory for examination. It may be noteworthy that certain distinctions recorded in the field on living *Xenias* were completely invisible after preservation, but subsequent examination of the spicules by Professor J. S. Hickson confirmed that these superficially similar forms were quite distinct species. However, two corals which appeared in life to be unlike, "K.18" and "K.5", are both referred to the same species, *Goniastrea mantonae*, by Dr. Crossland."—A.K.T.]

- G. retiformis*, 285, 286, 288, 293, 294, 297, 305, 306, 307, VIII, XI, XII, XIV, XVI.
G. solida, 294.
G. K.5, 288, 294, 305, 306, VIII, XI, XII, XIV, XV, XVI.
G. K.18, 287, 293.

ASTRAEIDAE MAEANDRINAE

F. astraeiformis (see above).

Coeloria, 284, 294, 295, 303, 305, VIII, IX, XIV, XV.
C. daedalea, 288.

Platygyra phrygia, 284, 288, 295, 298, 305, VIII, IX, XI, XII, XV.

Lobophyllia, 289, 295, 298, 302, VII, VIII, XI, XII, XIII.

Symphyllia, 284, 295, 298, 302, III, VII, IX, XI, XII, XIII.

Hydnophora, 298, 305, VIII, XIV, XV.

UNCLASSIFIED

Merulina ampliata, 289, XI.

FUNGIIDAE, VII.

Fungia, 284, 290, 302, 303, 306, 307, XIII, XVI.

Herpetolitha, 303.

Halomitra, XIII.

Podobacia, XII.

Polyphyllia, 290.

[THAMNASTERIIDAE]

Psammocora, 301, 302.

Ps. exesa, 295.

Ps. gonagra, 284, 288, III, IX.

Pavona, XI.

[ACROPORIDAE]

MONTIPORA, 288, 289, 294, 298, 302, 303, 304, III, VIII, XII, XIV.

M. foliosa, 293, 294, 295, 300, VII, IX, XI.

M. erythraea, 294, VII, XI.

M. ramosa, 284, 293, 294, 300, 301, 303, III, VII, IX, X, XIII.

Astreopora, 290, 302, IV, VIII, XI, XII.

Turbinaria, 289, 290, 295, 303, XII.

ACROPORA, 289, 294, 300, 302, 303, IV, VII, IX, X.

A. abrotanoides, 298, 302, 305, VIII.

A. decipiens, 297, 298, 302, 305, 307, VIII, XIV, XV.

A. delicatula, 295, 305, XV.

A. exilis, 287, 295, 296, IV, VII, VIII, XI.

A. formosa, 287, 295, VIII.

A. gemmifera, 287, 295, 298, 303, 304, 305, 307, VIII, XI, XII, XIV, XV, XVI.

A. hebes, 284, 293, 295, 300, 305, IV, VII, VIII, XI, XIV.

A. hyacinthus, 287, 295, 298, 305, VIII, XI, XII, XIV, XV, XVI.

A. loripes, 295.

A. palifera, 305, 306, XV, XVI.

A. polymorpha, 295, 296, 298, 303, IV, VII, VIII, XI, XII.

A. pulchra, 284, 293, 295, 302, 305, VII, XIV.

A. quelchi, 284, 287, 295, IV, VII, VIII, XI, XIV, XV, XVI.

A. rosaria, 287, 295, 305, VII, XIV.

A. squamosa, 284, 295, 297, IV, VII, VIII, XI.

A. variabilis, 287, XI, XII.

[PORITIDAE]

GONIOFORA, 289, XI, XVI.

PORITES, Massive, 284, 286, 288, 289, 290, 295, 300, 302, 305, III, VII, VIII, IX, X, XI, XII, XIII, XVI.
Branched, 289, 302, VII, XI.

[DENDROPHYLLIIDAE]

DENDROPHYLLIA, XII.

TUBIPORA, 304, XIV.

HELIOPORA, 295, 298, VII, VIII.

MILLEPORA, 297, 298, 304, VIII, XI, XII, XIV, XV, XVI.

[Family CARYOPHYLLIIDAE.]

Sub-family CARYOPHYLLINAE.*

My inclusion here of the genus *Trachyphyllia* is a consequence of my examination of the solitary corals of Prof. T. A. Stephenson's South African Ecological Survey. It is based on the fact that in the genera *Polycyathus*, *Paracyathus*, and *Caryophyllia* the "pali," upon which classification is based, are parts of the septa and *not* independent structures. The three genera form a series which show this very clearly. In *Polycyathus* the septal teeth are of the same form from the top of the wall to the middle of the columella, as is particularly well seen in a section of the calyx. In the next stage, *e.g.*, in *Paracyathus*, the lower parts of the septa are differentiated from the upper. This differentiation takes various forms: in *Paracyathus* the lower part is thickened and bears large, sometimes twisted teeth, the so-called pali; in the adult *Trachyphyllia* it is entire, and broader than the slightly thinner upper and toothed part, but in young specimens its shortness suggests a palial lobe rather than a division of a septum. In this it resembles *Caryophyllia*, which has similar shortened lower portions, and in the common Mediterranean species, *C. cyathus*, this shortening has gone so far, and the notch between the two parts is so deep, as to excuse the idea of structures of independent origin. As this species was the first known, being obtained in quantity by the fishers of *Corallium rubrum*, this appearance of distinct pali was stretched to cover *Paracyathus* and *Polycyathus*, whereas morphologically the series had its starting-point in the opposite direction.

This division of the septa into two parts is found also in *Favites virens* (this report, p. 130), thus perhaps making a second connection with the *Astraeidae*.

Genus *Trachyphyllia*.*Trachyphyllia geoffroyi* Aud.1899. *Antillia sinuata* Gardiner, p. 167, pl. xx, figs. 26a, 26b.1928. *T. geoffroyi* Matthai, p. 95, pl. 22, figs. 1-11; pl. 23, figs. 1, 2, 5; pl. 26, fig. 1; pl. 60, fig. 1; pl. 62, figs. 1-3, 7, 8, 11.1936. *T. amarantum* Yabe, Sugiyama and Eguchi, p. 22, pl. xii, figs. 1-12.

* Crossland inserted in his MS. only two family and subfamily names. His descriptions of species were arranged in the same "classificatory order" as those in his "Index to Dr. Manton's Corals" (p. 99), where he had inserted six headings. These and fifteen similar new ones have been inserted in the text in square brackets. It was thought best to retain the Author's arrangement rather than to use the standard one of Vaughan and Wells (1943) published just after his death.—[A.K.T.]

Yabe, Sugiyama and Eguchi also refer to Wells' proposal to substitute *Manicina* for *Trachyphyllia*, and, quite rightly, reject it.

All the specimens were preserved in alcohol, and most remain so. Stns. 22 and 23 provided two specimens each; Stn. 19 gave 21 specimens, ranging from 15 mm. to 65 mm.; Stn. 16 one of 13 mm. All are top-shaped, and only one, of 62 mm. has a second small mouth. The deeply constricted and meandroid, large forms which occupy most plates of illustrations are not represented here, so that, of the 36 illustrations cited above, three of Matthai's (pl. 22, figs. 2-4) and the two of Gardiner's, with Savigny's, are all that illustrate this series.

Gardiner's description and figures of his *Antillia sinuata* correspond very exactly with several of these specimens, which are "widely open, trumpet-shaped," and may or may not be "somewhat bent and twisted." The epitheca is thin, as in Gardiner's, in some specimens, thick and dense in others.

In view of these facts I do not regard it as proved that there is but one species of this genus, Matthai's series being, so far as his account goes, quite incomplete. There may be even three species, *T. sinuata* (Gard.) and *T. constricta* Brüg. as well as *T. geoffroyi*, but sufficient data have not yet been published for certainty. If this turns out to be so the present species is *T. sinuata* (Gard.).

The smallest specimen figured by Matthai (1928, pl. 22, fig. 1) is 45 mm. in longer diameter, a quite regular oval without constriction. The next to it is of the same size, but shows the beginning of a constriction. Neither shows the characteristic "palial lobes," and the calices appear shallow. In all but one of the Great Barrier specimens, even in the two of 12 and 15 mm., the palial lobes are conspicuous, clearly visible even while still covered by the flesh of the polyps, and the calices are deep, though comparatively shallow in some of those of medium size. Up to 37 mm. \times 23 mm. only one specimen, of 30 mm., shows constriction, and that on only one side. The two smallest are circular, and there are none as large as Matthai's fig. 1, which has not become elongated and begun constriction. I therefore doubt whether Matthai's specimen is really the young of this species, since the present series is so complete.

The smallest known specimen is in fact a *Caryophyllia*, from which the adult form differentiates by regular steps; it is not a larval or ancestral form. In this smallest specimen 5 cycles of septa are developed regularly, of which the first two bear the palial lobes, and are thickened near the columella, which they form by sending out trabeculae. The third cycle rarely reaches it, and more rarely takes part in its formation; the fourth reaches about two-thirds of the way down the wall, and the fifth is short on one half of the calyx, rudimentary over the rest. Specimens 25 mm. in longer diameter are the same, but the third cycle regularly joins the columella. In larger specimens septa multiply, and those of the lower orders are also broadened below, at first to a smaller extent, then to equal those of the first two orders.

Distribution.—Northern Red Sea and Indian Ocean (rare in both); E. Australia and China seas, but no further east than the Philippines.

Heterocyathus aequicostatus M. E. and H.

1904(a). Gardiner, Marine Investigations in South Africa, III, 1905. (This paper published in Sept., 1904.) 1909. Harrison and Poole,* p. 898, pl. 85, figs. 1a-f.

Gardiner shows that there is only one species of this genus, the variation in which he

* See footnote, p. 103.

investigated by detailed examination of nearly 900 specimens. His plate illustrates 43 of them. Harrison considers that two species can be distinguished.

The Great Barrier specimens are only two, both young, from Linden Bank, Stn V. The larger is fairly closely represented by Gardiner's pl. iii, fig. 41, but the smaller, which has a disc measuring 6 mm. \times 4 mm., has a ridge-shaped base pointed at the closed end, apparently enclosing a very small shell completely.

Distribution.—Gardiner's specimens were all from 40 to 90 fms., apparently all off the coast of Natal; Semper's from the Philippines in from 6 to 25 fms. I have dredged it from about 10 fms. near Wasin, Equatorial East Africa, and it is recorded also from Ceylon, Burma and the Persian Gulf.* Rehberg's specimens were from West Australia and S. China.

[Sub-family THECOCYATHINAE]

Genus *Thecocyathus*.

Gardiner (1938, p. 173) places this genus in the Flabellidae, as the polyp has little or no edge-zone.

Since the value of this feature in classification needs reinvestigation, and it is not known whether all the species of *Flabellum* are without edge zone,† and in view of the close likeness of *Thecocyathus* and *Paracyathus* in their septa, palial lobes and columella, I keep the genus in its old position for the present.

Thecocyathus minor Gard.

1899. Gardiner, p. 163, pl. xix, figs. 3a-b.

I have three specimens of this species from a mass of rotten shells bound together by lithothamnionae, obviously dredged (but no data given). The B.M. number is 414.

The correspondence with Gardiner's description is very close, but I am able to add notes on variation.

The epitheca is thickly overgrown by nullipore almost to the edge of the calyx, so that no transverse or costal markings are visible. For "extremely granular sides" of the septa I should prefer to say septal sides with numerous spikes, which would become synaptacula with a little more growth. These, with the black colour of the rest of the septa, which remains after boiling in soda, give this part of the coral a resemblance to *Ulastrea crispata*. As Gardiner found, the septal series are hard to see, and in my specimens the extra thickness and prominence of the primaries can only be made out sometimes.

The "very irregular arrangement of its pali" was noted by Gardiner as a peculiarity of the species, and this deserves further examination now that three specimens are available. The two divisions of the septal edges may or may not be clear, and are sometimes non-existent. The upper parts are nearly horizontal and bear small blunt teeth, which increase in size and become flattened transversely to the septa on the nearly vertical part, and bear denticles. This enlargement amounts to great swellings in part of the circumference of one specimen, with or without a cut between them and the rest of the septum. In other

* In the typescript Crossland had entered the title of the paper as "Some corals of the Persian Gulf." The corals were collected in the Mergui Archipelago.—[A.K.T.]

† Fowler (1888); Moseley (1881), p. 164, pl. xvi, fig. 10.

parts of this same calyx the knob-like teeth pass into the columellar processes, while in other septa the teeth remain small, in marked contrast to the large knobs of the columella. In another specimen the first enlarged teeth may be high up the septum, with one or two others rather smaller below it projecting well from the septum, pali-fashion. In the third these teeth, which are not much thickened, are separated by deep vertical cuts from the upper nearly horizontal part of the septum, and so appear pillar-like. There are usually two of these teeth, but occasionally one or three, and the distance of the first vertical cut from the wall varies greatly.

Distribution.—Sandal Bay, 40 fms.; Lifu, Loyalty Is.; N.E. of New Caledonia, about 22° S.

[Sub-family EUSMILIINAE.]

Euphyllia glabrescens (Chamisso).

(Plate II, fig. 6.)

- 1899(a). *E. glabrescens* Cham. Gardiner, p. 735.
 1904(b). *E. glabrescens* Gardiner, p. 759.
 1911. *E. laxa* Gravier, p. 31, pl. 2, figs. 5-8.
 1918. *E. glabrescens* (pars) Vaughan, p. 82, text-fig. 1, pl. 26.
 1918. *E. glabrescens* Mayer, pl. 19.
 1928. *E. glabrescens* Matthai, p. 174, pl. 42, fig. 5; pl. 44, fig. 4; pl. 62, fig. 9.

One fragment, "June Reef, outer Barrier, Nigger head, No. 431," with three elongated calices and one nearly round.

All the main septa being strongly exsert, generally 2 mm., and up to 2.5 mm., gives the specimen a very abnormal appearance, the level junction of the broad main septa with the delicate wall being one of the characteristic features of the genus. Of the 10 figures in which this point can be made out published by Vaughan, Matthai, Gravier, Faustino, Yabe, Sugiyama, Eguchi and Bedot, in seven there is no exsertion, in three a slight exsertion here and there. I was therefore inclined to make this specimen a separate variety until I saw Gardiner's remarks on his Rotuman and Maldivan specimens. In 1899 (p. 736) he gives an account of variations of growth-form which disposes of Gravier's *E. laxa*. "The septa vary up to 2 mm. in exsertness" "The colour of the polyps varies from green-yellow to olive-brown, always markedly greener towards the stomodaea." "Rotuma; in pools of outer reef, very local in distribution, often forming large masses, 3-4 feet across." In 1904(b) (p. 759) he writes: "The specimens differ from the Rotuma ones in that the septa very seldom rise above the wall." The species "may generally be found in hollows towards the inner side of the reef-flat or in protected situations, where there is no sand or mud. . . . Where it occurs . . . it is exceedingly abundant, but is nowhere a reef-builder. Colour, dull green."

It may easily happen, especially in a species with so delicate a wall, that the wall does not keep pace with the upward growth of the septa, probably as a temporary growth stage. As, however, this striking and exceptional form has not been photographed I illustrate it in Plate II, fig. 6, a nearly side view to show also the rather prominent costae.

I conclude that Low Isles is too muddy for this species.

Distribution: Gulf of Aden, but not the Red Sea; Indian Ocean and Pacific as far east as Samoa only.

(?) *Euphyllia fimbriata* (Spengler).

A very small fragment from Batt Reef, B.M. 268, is all that represents this species, but its valley is only 8 mm. across. The fragment is too small to be worth further discussion.

Distribution: *E. fimbriata* has already been recorded six times from E. Australia. It occurs in the central Red Sea,* and there are numerous records from the Indo-Pacific, but it has not been found even so far east as Fiji.

Family FLABELLIDAE.

The relationship between the genera *Flabellum* and *Euphyllia* is obviously close, so much so that Dana placed two species of *Flabellum* in the genus *Euphyllia*.† In 1904 Gardiner (p. 954, pl. 93, figs. 28, 29) described an elongated *Flabellum* with several stomodaea, *F. multifore*, which, in top view, resembles *E. fimbriata* so strikingly that Matthai (1928, p. 179) puts (?) *F. multifore* in the synonymy of *E. fimbriata*. There is in the Kóbenhavn museum a specimen of a *Placotrochus* of about the same size as *F. multifore* which I hope to describe later, when this whole subject can be thoroughly discussed. Possibly *Coeloseris* Vaughan (or *Aplocoenia* M. E. and H.) may belong to this group. There has been much discussion about, and great importance attached to, the structure of the wall in this family. It is described as "epithecal," a very unsuitable term as the word means added upon the theca, whereas, as there is no edge zone in *Flabellum*,‡ the wall is deposited from the inside only, not from both sides as in most corals. It is therefore better described as a hemitheca. Two entirely distinct things have been confused under this name epitheca, apparently only because both result in dead-looking surfaces, (1) the hemitheca of the Flabellidae,§ and (2) the covering of the lower part of the skeletons in many corals, especially conspicuous in, e.g., *Trachyphyllia* (or *Antillia* as it is called in the literature of this subject.) This is a generally dull-surfaced deposit upon a theca which has been made in the usual double way, and so is a real epitheca. It is secreted by the lower border of the edge zone in its retreat as the coral grows upwards.||

Von Koch (1886) is responsible for this confusion, the lack of logic in which was exposed by Fowler (1887 p. 15.) Von Koch gave importance to "dark lines" in the skeleton, but apparently knew nothing of the living polyp. It is von Koch, however, who has gained the attention of his successors.

Genus *Flabellum*.

Flabellum rubrum (Q. and G.).

1904. Gardiner, p. 125, pl. iv, figs. 22-34.

One specimen is present, dredged from Stn. XIV, 19 fms. near Lizard Island and named

* This is the first record from the Red Sea. I especially noticed it at Dongonab, being attracted by the difference between its polyps and those of *Lobophyllia*. The living colonies resemble each other, but the polyps of the former show their tentacles by day (or at least in the early morning) when those of the latter are retracted.

† Yonge (1930, p. 20) shows that *Euphyllia* has an edge-zone.

‡ See Yonge's figure (1930, text-fig. 1) of the expanded polyp of *F. rubrum*.

§ According to Fowler (1885, p. 586) *F. patagonicum* may have a retractile edge-zone and so a complete theca. *F. pavoninum* also has a smooth porcellaneous outer surface, but nothing is known of the living polyps of either form.

|| There is evidence to suggest that both hemi- and epitheca are physiological responses to conditions e.g., sand rasp and burial, or the growth of organisms round the bases of fixed forms.

by Prof. Matthai. It resembles Gardiner's fig. 31, pl. iv, but has a third root, very short, 1 cm. up one side, and the coral is broken off at a level between the two longer roots.

Distribution: Indian Ocean, Maldives and south to Cape Colony. Of the eleven localities given by Gardiner, eight are east and north-east of Cape Agulhas, but four are not to be found on an ordinary good atlas; of the seven known localities five are off Natal, and from these 491 of the 584 specimens were obtained. Known also from the Philippines and Palao Islands in the Pacific, and as far south as New Zealand and the Bass Straits. Not recorded east of the Palao Is.

Flabellum vacuum, sp. n.

(Plate I, figs. 1, 3.)

Three specimens, dredged Stn. XVI.

	mm.	mm.	mm.
Calices	45 × 28;	24 × 16;	13 × ? (broken but nearly circular).
Heights	32	22	15

The distinctive features of the species are:

Broadly oval calyx, nearly round in the youngest, with narrow septa, leaving the cup almost empty. Columella absent in young specimens, in the largest rudimentary, formed mostly of septal teeth. Whole corallum is light and delicate. There are 24 principal septa, between each pair of which are one smaller, running down the wall to the columella, one very small reaching but a small distance down the wall, and from two to six represented only by short ridges at the top of the wall. That is to say, there are three cycles of nearly equal septa, the fourth smaller but complete, the fifth rudimentary and the sixth both rudimentary and incomplete.

In the largest specimen* the costae of the first four cycles, with traces of the fifth, run down the outside of the calyx to its base as very low but distinct ridges, but they are only visible under a lens in the two smaller.

The septa and costae project above the edge of the wall at most 1 mm., but, as always in this genus, this projection carries a portion of the wall with it, so differing from the exertion of the septa of other corals. In the smaller specimens the fifth cycle of septa is often, and the sixth is always, absent.

The species comes nearest to *F. stabile* Marenzeller, (1904, p. 273, taf. xvii, figs. 12a, 12b), but this is an Atlantic deep-water form, and, among other differences, much coarser in structure.

[Family SERIATOPORIDAE.]

Genus *Seriatopora*.

Stephenson and others (1931) refer to the genus on pp. 67, 86 and 88.

Characteristic of seaward slopes and anchorage at Low Isles, of Yonge Reef and the reef patch off Lizard Island, *i.e.*, wherever water is clear.

S. Manton refers to the genus on pp. 295, 298, 306 and 307, and on pls. vii, viii and xvi. It occurs on seaward slope of Traverse II beyond 364 feet; on the windward slope in the third 100 feet, anchorage of Yonge Reef. Pl. xvi shows some fair-sized colonies,

* Selected as Holotype.—[A.K.T.]

the largest 20 cm. in diameter, in contrast to the exceptionally small colonies brought home (7 cm. in diameter, and one colony 13 cm. long but of stunted growth).

Seriatopora hystrix Dana.

Samples 37, 281, 195, 196 and 353 have been named by Matthai. These, like No. 440, are small but of normal growth. The spirit specimens are branches of larger colonies with crab galls. B.M. 276, 13 cm. in longer diameter, is abnormally flattened in shape, with frequent dichotomies and very short end-twigs. B.M. 388, "stout pink *Seriatopora* nigger head, Undine Reef Y," is comparable to Marenzeller's pl. 29, fig. 115, which he shows to be a thickened pathologic form.

Distribution: Recorded from Murray Island by Vaughan and common through the Indo-Pacific as far as Fiji; but the genus does not extend to Samoa, Tahaiti, or Hawaii. It may be the same as *S. angulata* Klz. of the Red Sea, but the material present is not sufficient for settling the question; and, though Marenzeller has made a very full examination of this species, his figures are spoiled by being so roughly printed.

Genus *Stylophora*.

Only six small pieces of this genus have been brought home, one of which may be a nearly complete, though very small colony.

Stephenson and others (1931) refer to the genus on pp. 86 and 88 as characteristic of seaward slopes and anchorage, and of Yonge Reef and Lizard Island, in all three cases accompanied by *Seriatopora* and *Pocillopora*.

S. Manton refers to the genus and to *S. pistillata* on pp. 289, 295, 298, 302, 307, and plates iv, vii, viii, xi, xvi, on the steeper part of the seaward slope of Traverse I small colonies of 3 to 6 inches, which, like *Goniopora* and *Turbinaria*, are able to form normally shaped colonies in spite of the mud. Also on the seaward slope of Traverse II and the third 100 feet of Traverse III, but in shallower water on the windward side and accompanied by *Pocillopora* and *Seriatopora*. It appears to be one of the less abundant corals in this region, and the colonies are generally small.

The genus is distributed from the Red Sea (where it is abundant) to Murray and Fanning Islands and Fiji. It is not recorded from Samoa or Hawaii, and in Tahaiti occurs only as small thin crusts resembling Klunzinger's (1879) *S. armata* (taf. viii, fig. 12). While it seems to accompany *Pocillopora* in local distribution it is absent from the regions in which the latter especially flourishes.

Stylophora pistillata (Esper).

S. digitata Klz., Marenzeller, 1906, p. 77.

Marenzeller gives no reasons for considering this species identical with *digitata* and most of Klunzinger's species, but the chances are that he is right. Specimen No. 2 consists of nearly straight, roughly cylindrical branches, and, as is often the case in the others the columella is not stylar. No. 311 (Lizard Island, A reef) is bushy, and with more flattened branches than Nos. 3 and 1, but is clearly the same species, probably grown in rougher water. The growth forms due to varied conditions shown by Klunzinger and Marenzeller are, in short, here represented.

The best illustrations of the normal form of this species are those given by Savigny

on pl. 4 (Polypes), figs. 3 (1) to 3 (5), Klunzinger coming second, but his specimens are somewhat stunted, as he collected at Qoseir in roughish water.

Distribution : The species is abundant throughout the Red Sea, occurring even off the muddy beach at Suez, the Indian Ocean, Pacific to Fanning Island, but not to Tahaiti or Hawaii.

Stylophora septata Gardiner.

(Plate II, fig 5.)

Gardiner, 1898, p. 996, pl. lxii, fig. 1.

I refer specimen 369 to this species with some hesitation ; I have seen nothing else like it in nature or the literature.

Unfortunately the specimen is but a fragment, measuring 75 mm. across and 60 mm. high. It has the growth form usual in specimens of several species grown in rough water, as were all four on Gardiner's plate lxii. The weight of this example strikes one as unusual as soon as it is handled. To the naked eye the closeness of the calices and their large broad hoods are conspicuous. Even on the upper ends of the branches there are stout walls between the calices, perhaps more so than in Gardiner's specimen, but this crowding of calices and thinning of their walls and coenenchyma always varies greatly with conditions of growth. The obtuse broad lips projecting 1 mm. over the mouths of the calices, often so developed as to resemble a downwardly directed tube, with striae outside so continuous and prominent as to resemble costae, are remarkable features. (Plate II, fig. 5.) The coenenchyme between is covered with scattered small pointed spines. The calices of the ends of the branches are deep, and open, the primary septa being thin, secondaries rudimentary, and the columellar style low down in the calyx. The top of one branch is intermediate between these conditions and those of the calices of the sides. These, the normal calices of the colony, are remarkable for the thickness and roughness of the primary septa, usually as thick as the spaces between them are broad, often thicker ; they reach nearly to the centre of the calyx, but the columellar style is, more often than not, invisible, though it sometimes appears as a small point near the surface. Secondary septa are present and distinct, but much shorter and thinner than the primary. This specimen came from the anchorage zone of June Reef ; Gardiner's from Rotuma, outer reef.

Gardiner remarks, " This species is evidently very closely allied to *S. digitata*, having almost precisely the same mode of growth, and may perhaps be only a variety of it due to a very slow growth owing to its position on the reef, or some other cause. However, the presence of 12 distinct septa in nearly all the calices and the very obtuse lip are constant features of difference." I should add " long " to " obtuse," and observe that the growth form is common to all species grown in rough water. If this were merely a rough water form of *S. pistillata* (*S. digitata*) it would be similar to the *S. mordax* Dana described by Vaughan (1918), p. 81, pl. 25, and by him considered as probably a growth form of this species, but this is quite distinct from *S. septata*.

Genus *Pocillopora*.

I have made notes on the Family Seriatoporidae and the genus *Pocillipora* in my account of the corals of the Natal Coast (1948, pp. 179, 183). The results are briefly as follows : (1) The distinctions between the genera *Pocillopora*, *Stylophora* and *Seriatopora*,

though so clear in most cases, all have connections through species which show one or other of the characteristic features. (2) The variation in the species, especially of *Pocillopora*, is enormous (see, e.g., Vaughan, 1918, pl. 21) and the clue to it has not yet been discovered, nor can be without observation and experiment on the reef, as well as in a marine laboratory. (3) It is probable that such work would bring down the number of species in this genus to about six, but if Vaughan's work on *P. caespitosa*—*bulbosa*—*damicornis*, etc., applies to other species it might be even smaller. Gardiner wrote in 1898 (p. 942), "The complete absence of verrucae on the tops of the branches and their incrassate (*i.e.*, thickened) form in such a species as *P. grandis* [*i.e.*, *P. eydouxi*] are due to the ends of the branches having reached the low-tide level, and, being unable to grow further upwards, increasing in both thickness and breadth. Although this is by far the most common species of Madreporaria on the reef at Funafuti, I never found any of its branches with their summits dead, even though they reach almost invariably to the low-tide level." This is exactly what I found in Tahaiti, except that I should write "genus" for "species of Madreporaria." I conclude, therefore, that the presence or absence of verrucae, close crowded thin-walled calices or those of more normal type on the ends of the branches, as well as the exact shape of the branches, are not of specific value, so that I am confirmed in thinking, e.g., Hoffmeister's *P. setchelli* from Tahaiti (1929, p. 359), of which he gives three figures, of growth form only, to be only a surf-flood variety of some other species such as *P. verrucosa*. Gardiner further gives the colour of the living colonies as "usually green or pink when the polyps are expanded, but if retracted are nearly colourless." Apparently there is an extraordinary variation in colours with locality, as in some other corals. I have seen a green *Pocillopora* only once, a very dark green, in the southern Marquesas. In these islands, and Tahaiti and the Red Sea, the colour, polyps expanded or not, is, with one exception, brown; in *P. eydouxi* dark almost chocolate, ends of branches pink or white; a yellower and lighter brown, with yellowish ends of the branches in *P. verrucosa*; and a quite light yellow brown in *P. damicornis*. The exception is that *P. verrucosa* is sometimes bright red, the reason for which is unknown.

I give a table of the common Indo-Pacific species, but, as I said, we have not the data for a useful discussion of synonymy. Gardiner wrote (1897, p. 942): "In the collections there are over 50 specimens . . . and in addition I have examined a very large number in the British Museum . . . and I am doubtful whether all these so-called species should not rather be described as varieties of one species, the characters of which would be the characters of the whole genus."

TABLE OF COMMON INDO-PACIFIC SPECIES OF *Pocillopora*.

T. W. Vaughan (1907) p. 100 (1918) p. 78, writes "*P. damicornis*, *danae*, *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."

A. Septa and columella rudimentary or obsolete (except on basal expansions, and in the varieties *laysanensis* and *stylophoroides* of *P. caespitosa* (Vaughan, 1907, pp. 88, 89)).

(1) Small clumps, not exceeding 15 cm. in diameter: *caespitosa*—*bulbosa*—*damicornis*; almost certainly one species.

(2) Clumps exceed 18 cm., septa as spines, no columella, branches subterete: *P. danae*.
Branches flat: *P. verrucosa*, *P. meandrina*, *P. elegans*; all very close, if not identical.

B. Septa and columella well developed, large clumps, big flat branches (almost always); *P. eydouxi* and *P. woodjonesi*.

These two species differ in ornamentation of spicules and details of columella and septa.

I much regret that I can obtain no specimens from Ghardaqa which might help to decide whether Klunzinger's species, *favosa* and *hemprichi* are the same as *danae*—*damicornis*—*verrucosa*, as seems very likely. This would give a distribution of these species from the extremes of the Indo-Pacific, from the Red Sea to the Marquesas and Hawaii. *P. eydouxi* I have not seen in the northern Red Sea.

Pocillopora damicornis (Pallas) Dana.

The names *damicornis*, *cespitosa*, *bulbosa* and *acuta* are discussed at length by Vaughan (1918, p. 75) and by Hoffmeister (1925, p. 15).

Stephenson and others (1931) record the species *P. damicornis* from a series of habitats where coral growth is unexpected and much restricted, for example the sandy pool in the mangrove swamp, in the mangrove park, sometimes on mangrove roots and on the reef flat. It is one of the most abundant in the moat and the barren sandy flat of Batt Reef, "low massive species" being found near the edge. In Tahaiti it is common close inshore, even right at the foot of the beach at Pa'ea. It is this species which is generally found as young colonies, e.g., on floating logs (Wood Jones), chains of buoys, a wire-fence, pearl oysters, and tiles (Crossland, 1928), and a coco-nut (in the Kóbenhavn museum); other coral larvae settling much more rarely, if ever, on artificial substrata.

S. Manton distinguishes between *P. damicornis* (called *bulbosa* in her paper) and *P. danae*, probably including all the thicker-stemmed varieties of the former in the latter species if the two are really distinct. Her references bring out the fact that the thin-stemmed *P. damicornis* is "extremely resistant to exposure, and to a wide range of conditions," as we have learned from Stephenson and others. She also shows how, when conditions improve, e.g., in deeper water, or on windward or outer reefs, the change to *P. danae* or *P. verrucosa* takes place. *P. eydouxi* is less accommodating, being confined to outer regions and windward slopes, and corresponding with a more distinct specific differentiation. The following 8 of the 10 specimens have been named *damicornis* by Matthai: No. 111, "Prob. moat form"; No. 446; No. 21; "P. 51"; "P. 40," "Batt Reef, wave zone"; No. 324; No. 374; "June Reef, Int. Mad. Zone"; No. 325, "Lizard Island, A Reef"; the other two by me, viz., No. 386, "Outer Barrier June Reef, Nigger Head"; and (no number), "Low Island, ordinary moat *Pocillopora*." Of these No. 111 and (no number) are good examples of the *bulbosa* form; "P. 40" and No. 325 are thick, branched and grade into *P. danae*; Nos. 374 and 324 are small, about 6 cm. diameter, with close short branches, obviously stunted; while the Batt Reef wave zone fragments, "P. 40," show no sign of stunting. No two specimens are alike; the collection is an excellent series of the variation of this strange species, but, as all have been already illustrated, especially by T. W. Vaughan in 1907 and 1918, there is no need to publish more.

Distribution: The species is abundant from Singapore to Fanning Island in the Central Pacific, Tahaiti, and Hawaii. From the Indian Ocean Vaughan records it from Cocos-Keeling, but Prof. Stephenson's collections enable me to add Natal and Mauritius. It is not recorded from Equatorial East Africa or the Red Sea, unless Klunzinger's *P. favosa* is an extreme variation.

Pocillopora danae Verrill.

S. Manton refers to this species on pp. 288, 298, 306, and on pls. viii, xiv, xv, xvi. It is hardly possible to distinguish *P. danae* from thick specimens of *P. damicornis* on

the reef. For instance the reference on p. 288 might be read, "Thin stemmed *P. damicornis* occurs in scattered colonies (2 to 12 inches), but beyond 420 feet in the deeper water the branches thicken"; or on p. 298 on the seaward slope of Traverse III might read "as in the deeper waters of Traverse 1 on the lee side *P. damicornis* here grows with thicker branches, like those of *P. danae*."

Only one fragment, 8 cm. in diameter \times 6 cm. high, is thus labelled by Matthai. It corresponds better with Vaughan's (1918, pl. 22, fig. 2) Verrill's type of the species, than with the figures of his specimen from Murray Island. It corresponds well also with Hoffmeister's (1929, pl. 2, fig. 2) a specimen from Tahaiti.

Specimens 325 and "P. 40," both labelled *P. damicornis* by Matthai, an identification with which I agree, form an interesting series with *P. danae*. The first is a rather coarsely branched *P. damicornis* without any doubt, much like Vaughan's (1918, pl. 21, fig. 2), while "P. 40," being from the wave zone of Batt Reef, is partly the same, partly with thicker branches not distinguishable from those of *P. danae*. I therefore think it very likely that this species is, in fact, a variety of *P. damicornis*, as does Vaughan, but I cannot dogmatize without further evidence.

The species is recorded also by Thiel from Banda, but not by Umbgrove from Java or by Yabe, Sugiyama and Eguchi from Japanese seas. Faustino (1927) mentions it from the Philippines, but his figure (pl. 13, fig. 3) is the same as that already given by Vaughan (1918) in pl. 22, fig. 1a. Gardiner collected it from Funafuti and Fiji, but gives no figure. It is thus found throughout the Pacific as far east as Tahaiti. It has not hitherto been recorded from the Indian Ocean, but two of the specimens of *P. damicornis* in Prof. T. A. Stephenson's collection from Natal are much like the intermediates mentioned above. In the Universitetets zoologisk Museum, K benhavn there are 6 good-sized and complete specimens from Mauritius (labelled *P. frondosa*, n. sp. by L tken, but no description was published) which clearly belong to *P. danae*, and resemble Vaughan's figure of Verrill's type, with rather long irregular verrucae, often a little swollen at their ends. The growth forms are an interesting series, from very loose and irregular to compact. I hope to publish illustrations in the future.

Prof. T. A. Stephenson's collection from Mauritius also contains a small specimen (No. 206) clearly belonging to this species or variety.

We thus extend its distribution from the southern Indian Ocean as far as Fiji and Tahaiti. It is not recorded from the Red Sea or tropical East Africa, and figures of *P. favosa* Klz. do not resemble it.

Pocillopora verrucosa (Ell. and Sol.).

Manton, 1935, pp. 297, 304, 305, 306, pls. viii, xiv, xv, xvi.

Manton (1935) says: "On the first 100 feet of the Seaward Slope [Traverse III to windward, corals] resemble those present on the leeward side . . . with the addition of large and small massive species of *Pocillopora* (*P. verrucosa* and *P. eydouxi*) and *Acropora decipiens*. These corals do not occur elsewhere on Low Isles, and are characteristic of the exposed outer ridge and reef crest of outer barrier reefs such as Yonge Reef." This corresponds with my own experience, but pls. viii to xvi indicate that it is nowhere as abundant as in Tahaiti, though recorded as frequent on Yonge Reef.

The collection consists of one specimen and two fragments, all named by Matthai,

viz., 332 Outer Barrier, Ribbon Reef, Inner moat; 342 from the same, but the outer moat; and 74, a large branch, dividing dichotomously so that the upper surface has 24 endings. Also a small scrap, 285, with one of another species too small for identification. The specimens are typical, and call for no comment.

Distribution: Red Sea; probably Mauritius; Cocos Keeling in the Indian Ocean; throughout the Pacific to the Marquesas and Hawaii; represented in the latter by "the closely related, if not identical, *P. meandrina* Dana" (Vaughan, 1918, p. 78).

Pocillopora eydouxi M. E. and H.

(Plate I, fig. 2.)

The synonymy is given by Vaughan (1918) and Umbgrove (1939). Note Umbgrove's remarks on Thiel's new species *P. symmetrica*, an example of founding a new species on one broken scrap, which, in all corals, but especially in such a genus as this, is a proceeding which should rarely be attempted.

S. Manton refers to the species on pp. 297, 298, 305 and 307, and on pls. viii and xv.

The species is characteristic of clear water on exposed reefs.* It is, in almost all cases, recognizable at once on the reefs by its large size and flat branches, the only species with which it might be confused being *P. elegans*, *grandis* and *elongata*, three species of Dana which Gardiner gives as synonyms, and *P. woodjonesi* Vaughan, which is well distinguished by its large frosted spicules and inconspicuous columella. The colour of *P. eydouxi* is a cool brown with the ends of the branches pinkish or white.

Its broad-ended branches and comparatively cellular structure make it possible for storms to break up the colonies, but, at the same time, the coarse gravel thus produced is very resistant, so that it is a particularly important reef and beach builder. I have published (1928a, p. 582) photographs of reef islets composed entirely or largely of this species.

The present collection contains three specimens and four fragments, all but one named by Matthai (this one is quite typical). Nos. 269, 367, 268, and 274 are from June Reef, of the outer barrier series; 402 and "P. 50" from Low Isles, the former from outside the rampart; the latter, from the seaward slope, is the "tip of a long flattened branch similar to those of specimen 364." There is no note for 364.

Three very distinct forms are present:

- A. The normal form with broad-ended branches, of which there are the three fragments "P. 50," 402 and 367. They are the triangular tops of branches: the last is prolonged below into a flattened but narrow stem, 20 mm. \times 27 mm. None of them reach sufficiently near the base to show the typical calices with thick septa of Vaughan's figure.

From the literature, and from my own observations in Tahiti, this is the normal and abundant form; perhaps this is why these few scraps were considered sufficient to represent it? The other specimens, much larger, are rare varieties, and, I suppose, were specially selected.

- B. Two large parts of colonies, Nos. 268 and 274, both from June Reef, consisting of a number of nearly cylindrical branches, springing from common

* Wood Jones (1907; 1910) says, "Inhabits only the still deep water of the lagoon." This is contrary to Gardiner's, Manton's Umbgrove's and my experience, in four widely separated regions.

stems, the whole measuring 30 cm. high, by a maximum diameter of 21 cm., and 27 cm. \times 21 cm., there is also an isolated branch 16 cm. long with 4 branchlets above. This form has been recorded only by Yabe, Sugiyama and Eguchi (1936), pls. ii, iv, fig. 2, v and vii, fig. 6, from the Marshall Islands.

These three specimens differ from the others of the Barrier collections and from that of Yabe, Sugiyama and Eguchi in the irregularity of their verrucae, which in all three show a tendency to grow out into branches, the beginnings of such a curious growth as that shown by Gardiner (1897) in pl. lvii, fig. 3, under the name *P. grandis*.

C. No. 269, of which the base is unfortunately missing, consists of five broad thick roughly triangular lobes, connected by broad bases, as shown on Plate I. The largest, which is incomplete, is 13 cm. wide, and 18 cm. high. The next largest, which is complete, is 15.5 cm. wide and 10 cm. high. Thickness of the largest, across the broken edge, 6 mm. at the top, 18 mm. near the base, the common base of the whole being 32 mm. thick. All surfaces, except the upper edges, are covered with rather closely placed smallish verrucae, remarkable for their regularity of shape and distribution.

I have carefully cleaned the specimens, and examined the calicinal characters and spicules, as a result of which I endorse Matthai's identification of these three remarkably different forms with the single species *P. eydouxi*. At the same time some ecological information about them is much to be desired, since calicinal characters alone are not certainly specific in this genus. The variation of these characters has not yet been described, though referred to by Umbgrove.

The few figures given, by Milne Edwards and Haime, Vaughan, and Yabe, Sugiyama and Eguchi, all show the calices on the flat surfaces between the verrucae, and I may say at once that these are far more variable than those on the verrucae themselves, which are, however, owing to their position and delicacy, difficult to photograph. Such regular and thick septa and columella as Vaughan shows (1918, pl. 24, fig. 2a) are only found on the lower part of the branches, 15 cm. at least below the ends, higher up they become more delicate and more variable, the septa varying in both breadth and number. As this collection contains only upper ends of branches in most cases, these typical calices are present only in the two larger specimens Nos. 268 and 274, *i.e.*, those with cylindrical branches.

Thus, the two short branches of set A have, on the flat surfaces septa 0 to 6 or 8 in number, narrow and thin; near the upper edge generally only 0 or 2 or 3, or calices completely empty; columella either detached or joined to one or a pair of directive septa. In B.M. 402 [no Expedition number] columella is small and detached, often only traces of it visible. In No. 367, which is 14 cm. long, triangular end part 7 cm. long by 9.5 cm. broad, calices of the lower part of the stem like Vaughan's figure, but septa and columella are delicate, and columellae all detached. Half-way up the stem the septa appear as two series by the narrowing of half of them, and one or a pair of directives are developed, but they do not unite with the columellae. On the upper triangular part calices very degenerate and shallow, and much of the coenenchyma is smooth.

On the other hand, the calices of the verrucae almost always have 10 to 12 septa

clearly seen, and the columella is detached, or joins a single directive, except close to the top of the branch where the septa are mere lines of little spines and the columella is absent. In No. 367 there are 12 septa and detached columella everywhere, but calices very delicate near the top of the branch.

FORM B with cylindrical branches : No. 364, a single branch 16 cm. long. Irregular verrucae, as in the two larger specimens. Near base, 6 very small delicate septa and prominent columella, but septa often absent, or nearly so. Columella may broaden, and join the septum on its upper side. In the middle the same, but a complete cycle of septa is rare, and columella usually attached to one directive. On the upper part of the stem are 12 septa, columella attached to one or two directives, or these may come close to the columella without attachment. No. 268, 21 cm. long, near base 6 to 12 rather delicate septa, in middle 6 to 12 as above sometimes very distinct, sometimes almost absent; columella also absent sometimes.

In the two large specimens the basal parts, where the verrucae become low and rounded, calices exactly like Vaughan's figure, others at the same level have only one series of septa which is often incomplete, and, in places, the calices are almost empty. On the other hand, calices on the verrucae show little variation and are as in the A specimens.

FORM C : The foliose specimen is only 16 cm. high, so none of Vaughan's regular calices are present on the smooth part, and the septa are very irregular, with a distinct, even massive columella on one side of a branch, which may be absent altogether on the other. Directive septa rare; higher up many calices practically empty.

Again, calices on the verrucae with 12 delicate septa and distinct, though slender columella, which may be detached, or joined to one directive.

Distribution : Widely distributed in the Pacific; numerous records from Java to Tahaiti, the Marquesas and Hawaii (Vaughan, 1907, under the name *P. modumanensis*); but the only record from the Indian Ocean is from Cocos Keeling Atoll. I have no specimens from Mauritius, and there is no record from the Red Sea. Curiously Faustino does not mention it from the Philippines.

[Family ASTRAEIDAE : species with distinct calices and cyclic septa.]

Genus *Leptastrea*.

Stephenson and others (1931) give four references to the genus : swamp passages on roots, etc., the reef flat and mangrove park; the anchorage; Batt Reef; and dredged at Stn. 27.

S. Manton records tiny colonies of *L. roissyana* in the moat, becoming larger in the deeper part, on the descent of the seaward slope (scarce and small).

Also on Traverse II. On Traverse III larger specimens, *L. ehrenbergana* (identified from a boat). On p. 300 is a note on the wide range of conditions the species will tolerate. It occurs also on the crest of Yonge Reef in the form *ehrenbergana* (as on the barrier edge in Tahaiti), and on Batt Reef. After my experience in Tahaiti and the Red Sea I am unable to divide this genus into the species *ehrenbergana*, *roissyana* or *transversa*, since all grade into, and are all derived, by simplification, from *L. purpurea*, which is the prior name (Crossland, 1931 and 1935). However, I retain the names *purpurea*, *ehrenbergana*, *transversa* and *bottae* as a matter of convenience, and for reference to the ecological papers. Like Vaughan, I prefer the name *transversa* Klz. to *roissyana* M. E. and H., since it is far from certain what the latter is, though Vaughan shows (p. 92) that it is near to the

form *purpurea*. Klunzinger's illustration, fortunately a photographic print, shows an extreme form, but this grades into more ordinary forms not only in Tahaiti but also here, in spec. D.S.E., in which typical "transverse" calices occur here and there.

Leptastrea purpurea Dana.

(Plate I, fig. 5 : Plate III, fig. 3.)

1918. Vaughan, p. 91, pl. 30, figs. 1, 1a (showing Dana's type).

This is the form from which the others are derived. A typical example was brought from Low Isles by Mr. G. W. Otter, and two very small fragments are labelled "T.1. moat"; it is much more rare than its derivatives, and I have not seen it in Tahaiti or in the Red Sea, though there some *ehrenbergana* specimens approach it.

I include here a very curious specimen, No. B.M. 420, dredged from Stn. 27, which is unlike any other specimen or figure I have seen, though nearest to Vaughan's figure of Dana's type (1918, pl. 30, fig. 1a). The coral forms a crust, 10 mm. and more thick, on a dead *Favia*, the living area rounded-triangular, 7 cm. across the base \times 7 cm. base to apex. The surface is undulating, but remarkable in this genus for its smoothness. The calices are very shallow, being filled in, except just over and near the columella, by the thick, and for the most part, horizontal septa; their inner sides are nearly vertical. Consequently to the naked eye the coral resembles a *Siderastrea*, the characters of *Leptastrea* appearing only under a lens. All the septa have rough sides and denticulate margins; they are in 4 cycles, primaries prominent and very thick, only the last cycle thin, so that the calices are almost filled up, the loculi being exceptionally narrow. Columella solid, sometimes oval or round, sometimes compressed, bearing small but distinct tubercles, which may be in a round or oval group or in rows, often a single row, according to the shape of the columella.

Leptastrea ehrenbergana M. E. and H.

Two specimens, one a mere scrap, the other 14 cm. \times 10 cm. \times 7 cm., showing much less irregularity of shape, and even of calices, than those of the Tahaitian barrier. In the small piece from Batt Reef the roughness of the sides and the granulations of the septa vary remarkably, in some cases being very marked, in others almost smoothed out. Some septa in the larger specimen from the moat at Low Isles, are clearly "swollen in the calyx"; in the smaller they are "swollen in the theca," as Vaughan remarks of Matthai's pl. 17, fig. 6 (1914). I have a note that this distinction between "species" was not made out in my 50 Tahaitian specimens.

Leptastrea transversa Klz.

(Plate LIV, figs. 1-3.)

Specimen 227 is remarkable for its round, separated calices in which cyclical arrangement of the septa can hardly be seen, and, in short, the specimen would appear to be an *Orbicella* or *Favia*. It grows as a crust over a dead *Favia*, 0 to 25 mm. thick, and 11 cm. \times 13 cm. in area, and almost quite smooth. Multiplication by budding cannot be made out on the main area. However, the following features indicate an abnormal specimen of *Leptastrea transversa*; smooth intercalicinal grooves, over which the costae do not meet, smoothness of the upper part of the septa, and the way they run over the tops of the

columellae, and make a bilateral symmetry, as in fig. 2, on Plate LIV. The columella itself bears tubercles, quite characteristic of *Leptastrea*, and is often compressed, but how disguised are the *Leptastrea* characters is shown by the photographs on Plate LIV.

I take it that the main area of the specimen was in nature a vertical face, probably crowded by other corals, and the edge turned over the block of *Favia* is the upper horizontal surface, growing in somewhat more normal conditions. Here the smoothness of the side area is less marked, budding is frequent, the walls are thin, so calices polygonal, the intercorallite grooves mere notches in the costae, columellae often non-existent, septa thin and smooth on sides and edges, or granulated on both, with small teeth only near the columella.

Leptastrea bottae M. E. and H.

(Plate I, fig. 4; Plate II, figs. 2, 3.)

1879. *L. inaequalis* Klunzinger, Taf. v, fig. 6.

1914. *L. solida* Matthai, p. 69, pl. 18, fig. 5.

1918. *L. bottae* Vaughan, p. 94, pl. 31, figs. 3 and 4.

1936. *L. bottae* Yabe, Sugiyama and Eguchi, p. 27, pl. 30, fig. 1.

I agree with Vaughan that Matthai preferred the name *solida* to *bottae* on insufficient grounds. Yabe, Sugiyama and Eguchi are the only later authors to mention the species; they give no reference to Matthai or reasons for preferring the name *bottae*.

The present specimen, No. 407, resembles Klunzinger's (1879*a*, taf. v) fig. 6, and Matthai's (1914, pl. 18) fig. 5. In the small crowded calices of the more usual size, only the six thick primary septa reach the columella, or the secondaries may reach it deep down in the calyx, but generally they are small; tertiaries are just visible or are absent, but their costae, low and rounded like those of the other series, are generally present. Columella greatly reduced, but may bear vertical points, and septa often bear paliform lobes. As seems to be usual in this species, giant calices are present; in these, numerous septa reach the tuberculated columella, which seems to block the bottom of the theca. Comparison with the other species, and with an intermediate specimen in the K benhavn museum, indicates that these "giant" calices are, in fact, nearer to the normal form, the more numerous and smaller being the farthest from the ancestral type.

A longitudinal section of this species has not yet been figured; it is remarkable for beams* connecting the thecal walls, some solid, some hollow. I give a photograph on Plate II of a broken, *not* cut and ground section, broken sections being generally the more instructive, and, indeed, a cut and ground section might not show these curious structures. Compare Milne Edwards and Haimes' (1848) pl. 9, fig. 3*a* (for *Phymastrea valenciennesis*).

*Leptastrea pruinos*a, † sp. n.

(Plate III, fig. 1.)

The minute specimen, ‡ B.M. 414 (part), has no locality, but its being on a fragment of *Lithothamnia* suggests that it was dredged. It consists of 6 full-sized calices and 6 small, forming a crust 15 mm. × 7 mm.

* Visible also at surface.—[A.K.T.]

† Latin, *pruina*, a white frost, referring to the spinules on the septa.

‡ This holotype now bears B.M. Register No. 1934.5.14.630. It appears possible that it may have been separated from 1934.5.14.414, *Acropora squamosa*. This came from Lizard Id., A. Reef, and is marked α396.—[A.K.T.]

Calices are between round and polygonal (see Plate III) the larger 4 mm. to 5 mm. across. Lines between them quite smooth. Septa, but not walls, exert to about 0.5 mm. They are decidedly thick over the walls, thinner in the calices, where they appear much thicker than they really are through the number of square-ended spinules they bear on their sides. In some cases these meet over the top of the septum, forming a little transverse lappet, but in others the thin edge of the septum, finely toothed and bearing only minute lateral spinules, projects above the part thickened by the massive spinules. These are smaller or absent also over the walls. At the edges of the crust the septa project as costae, smooth or very lightly spinulose.

Septa in three cycles, with traces of a fourth, as thin short septa or mere platelets on the walls.

The columella is small, almost rudimentary, the tubercles of the upper surface 3 to 6 in number, spinulose like the innermost teeth of the septa; this makes another difference from other species.

I have long hesitated to describe so small a corallum of a genus in which all the species so grade into each other, but it is very clearly different from any other specimen of any species of the genus.

Genus *Cyphastrea*.

The genus is of universal distribution, but it is interesting to find that the ratio of the species is different in different regions. Here we have 10 specimens presumably taken at random, of which 8 are *C. chalcidicum* and 1 each *C. serailia* and *C. microphthalma*. Contrast the northern Red Sea where all these three species are common, but *C. microphthalma* decidedly the most abundant. Gardiner found it not abundant in the Maldives, but his collection contains 2 of *C. serailia*, 4 of *C. chalcidicum*, and only 3 of *C. microphthalma*.

It has not been recorded from the Great Barrier before, but it is evidently common, since Stephenson and others give five references, finding it on roots, etc., in passages in the mangrove swamp, scattered small colonies in the mangrove park and *Thalamita* flat, as well as on the seaward slopes and the anchorage. It is also recorded from Yonge and Batt reefs. S. Manton refers to it on six pages and in two diagrams.

There is a good deal of variation in all these specimens, but not the extremes found in Forskaal's collection. (Crossland, 1941.)

Cyphastrea chalcidicum (Forsk.).

The 8 specimens are divisible into two sets, without intermediates.

- A. Humpy, rough with projecting thecae, such as shown by Matthai (1914), pl. 13, fig. 7 (for *M. microphthalma*), or pl. 38, fig. 5 (for *C. serailia*).
- B. Smooth, thecae hardly projecting, with appearance of lines between the calices, like Matthai's pl. 14, fig. 1, for this species, or pl. 13, fig. 8 (for *C. serailia*).

Set A are numbers 285, 44, 5, and B.M. 375. The last specimen is from Batt Reef, S.W. side of S.E. corner, wave zone. This specimen is unattached, and growing on all sides, so cannot have been exposed to very heavy waves. Set B are 198, 17, and 43. The last is the largest specimen, 15 cm. × 10 cm. × 7 cm. high.

Distribution: Northern Red Sea, through the Indian Ocean to the Philippines. Not recorded from Fiji or Samoa, and does not occur in Tahaiti. *C. ocellina*, the only species in Hawaii, is very close to this, but Vaughan says it is not identical, so that records of *C. chalcidicum* from Hawaii must be received with caution.

Cyphastrea serailia (Forsk.).

A small irregular colony 7 cm. × 5 cm. × 2 cm., encrusting an irregular calcareous mass of uncertain origin.

This species and the preceding are often scarcely separable, but this specimen is clearly differentiated by its rather thick spiny septa, with costae of the first two orders not nearly so prominent as in *C. chalcidicum*, and those of the third nearly equalling them.

Inner moat, June reef, No. 415, B.M. 393.

Distribution: From the northern Red Sea, through the Indian Ocean to Murray Island and the Philippines. Not recorded from Samoa. Does not occur in Tahaiti.

Cyphastrea microphthalmia (Lamk.).

A single quite typical specimen, with thick spiny septa, etc.

Half the area is dead, the interior extremely rotten, possibly in accordance with the fact that it was dredged from Stn. XXIV.

Distribution: From the northern Red Sea to Tahaiti, where it is the only species, and shows reduced growth.

Genus *Echinopora*.

I follow Matthai, and others, in placing *Echinopora* in a division of the *Astraeidae*, near *Cyphastrea* (indeed *Echinopora* is almost a *Cyphastrea* enlarged) and leave *Echinophyllia* in the *Fungiidae*. Horst (1921, p. 29) says: "Verrill places the genus *Mycedium* in the family *Echinoporidae* and he is right in my opinion." Umbgrove (1939) follows Yabe, Sugiyama and Eguchi (1936, p. 48) in making a family *Echinoporidae* to include this genus with *Mycedium* and *Echinophyllia* (under the name *Oxyphyllia*). I do not propose to discuss this arrangement in detail, since the fact that *Echinopora* has a cyclical arrangement of the septa and the other genera have not is against any near relationship. Also, as pointed out, if the leafy *Echinopora* must join the leafy *Fungiidae*, then so must also the solid *Cyphastrea*.

Stephenson, Stephenson, Tandy and Spender refer to the genus on pp. 67, 86, 87. They found species at Low Isles, on the seaward slopes and in the anchorage, on vertical or overhanging surfaces below low water. Also on Yonge Reef and Lizard Island, in the latter among other delicate forms on and between larger coral masses (*Porites*) in some depth of water on the edge of the reef.

S. Manton (p. 295, pls. xi and xii) found *E. lamellosa* and another coarser species (? No. 420 below) infrequently in calm water on the seaward slopes of Traverse II, not far from the reef edge, and (pl. xii) on a coral head in water about 9 feet deep. The contrast with the occurrence of *E. gemmacea* at Ghardaqa in the Red Sea is marked, as this, in the encrusting form, is abundant on the surface of the harbour reefs.

Distribution: The genus does not occur in Tahaiti, nor is it recorded by Hoffmeister from Samoa, though Verrill says his *E. elegans* (*E. lamellosa*) is from Samoa.

Echinopora lamellosa (Esper).

E. elegans and *E. concinna* Verrill, 1901. Tr. Conn. Acad. Arts. Sci. vol. 11, pp. 138–39, pl. 29, figs. 3, 4.

All the 9 pieces of encrusting or free *Echinopora* have been given this name by Matthai, in spite of very great differences. To the naked eye they fall clearly into two sets: (1) Six pieces; the surfaces and calices have a soft appearance owing to the number of delicate spines borne in rows on the peritheca, costae, and exsert ends of the septa. These can hardly be shown in a photograph, certainly not in one taken vertically to the surface. (2) Three pieces, of much coarser surface, in which the peritheca bears few and stoutish spines, but is covered with low ridges, while the exsertions of the septa bear coarse teeth.

The coarser form comes near to *E. hirsutissima*, but, as noted above, these species of *Echinopora* all have members connecting with the others. After working on the genus in the Red Sea I find it impossible to decide whether all the forms there found should be placed in *E. gemmacea*, as Matthai considers, or whether, for instance, Klunzinger's *E. carduus* may not be distinct. Meanwhile I believe that the four species *gemmacea*, *lamellosa*, *hirsutissima* and *horrida* are distinct, though I am not, in every case, able to separate them with confidence. Such scraps as those before me, or the small pieces seen by other authors, are of little help, and a series of large complete colonies is necessary, examined on the reef as well as in the laboratory ashore.

Nevertheless the variations among the six more or less typical *E. lamellosa* are so curious as to deserve mention.

No. 125: Surface nearly flat, very finely "woolly" with spinules. Calices with openings 3 mm.; if projecting at all only 1 to 2 mm., usually less, and many are completely immersed; these low walls are thick and rounded; base larger than the opening. In many of them the larger part of the exsert portion of the septa, within the notch, lies inside the calyx instead of being over the edge, so these appear like huge pali; the true pali, much smaller, can often be seen within these.

No. 27 resembles 125 but is a thin plate much crinkled, and, on the ridges, calices project to 1 mm.

No. 456: Very finely "woolly." Calices much larger than in the others, viz., 5 mm. across. Septa all thin, though primaries less so than secondaries, and these than tertiaries; only slightly exsert, and extending horizontally inwards as far as the edge of the columella, to which they drop vertically 1 mm. or less, hence to the naked eye the calices look like truncated solid cylinders.

No. 38: Lamina thinner than the preceding, spinules thicker and coarser. Calices 3 mm. across, slightly more at bases. Primary septa very thick and rough, secondaries less so, tertiaries thin and nearly smooth.

No. 24: Lamina thin and deeply folded, forming in one part a flattened column which, with a little further flattening and fusion, would make a two-sided plate. Calices widely spaced, projecting about 0.5 mm., diameter generally only 2 mm., and, therefore, the tertiaries small and their cycle incomplete. Sides of septa and top of columella spinulose as usual. Primary septa thicker than secondaries.

No. 8 closely resembles No. 24.

Of the second set, No. 420 is a thick and heavy crust, the peritheca being quite solid, 20 to 25 mm. thick, with a thin free expansion at one end; the attached thicker part

bears what may be described as narrow humps or incipient branches, very like those figured by me in 1935 (pl. ii, fig. 3) which is indeed a very similar specimen in shape as well as surface. Apparently the characters of the calices were also similar, as I have a note that they considerably resemble those of *E. lamellosa*, though typical *E. lamellosa*, with the characteristic folded margins, does not occur in the Red Sea. Peritheca with low rounded ridges, spines few, low and blunt, but spinulose. Calices comparatively large, 4 mm., round or slightly oval. Thecal walls project at most 0.5 mm. but primary and secondary septa exsert 1 mm. above that. Loculi between septa distinct and deep, thus differing much from preceding set of specimens, since, in spite of the large size of the calices, the secondary septa are thin and the tertiaries rudimentary. Columella well developed, dense, one-third of the diameter of calyx, with upstanding trabecular ends. Pali small and not easily distinguished from the trabecular ends on columella.

The calices are the same on the humps as between them and on the flat expansion. Specimen 25 is a fragment of the edge of a thin plate, thinner than the expanded part of No. 420. Neither of these are at all folded. It is very like the preceding, but the primary septa are little, if at all, thicker than the secondary, and both are much less exsert.

No. 422 is a solid-walled heavy tube, like part of Dana's (1848) fig. 4, pl. 17, * at the thicker broken end 20 mm. across, the irregular cavity being 7 mm. \times 5 mm. Maximum external diameter of tube is about half-way up, 32 mm. At the top (the tube is 80 mm. long) the walls thin out to a sharp edge, enclosing a cavity roughly oval, 15 mm. \times 6 mm. Calices, septa and perithecal spines like 420, but the spinulae on the sides of the septa are very fine. There are two similar but smaller bulbous tubes with the first set of specimens, resembling them in, *e.g.*, well-marked ridges on the peritheca.

Distribution: Not in the Red Sea, but Indian and Pacific Oceans as far as the Philippines and Fiji.

Echinopora horrida Dana.

(Plate IV, fig. 3.)

Umbgrove, 1939, p. 39, pls. vii and viii.

Sample No. 26, No. B.M. 285, and a number of fragments are labelled *E. gemmacea* by Matthai. I have already recorded the difficulty of dividing the species of this genus, while still believing them to be distinct; to quote Umbgrove (1939, p. 39), "if they are it seems to me that the branched type described here is closely allied to *E. gemmacea*. It may be that it is nothing but a variety or a growth form of that species. Since I have no convincing proof for this opinion I maintain the name *E. horrida* Dana. . . . The question can be settled only by growth experiments on the living reef. I collected no specimens resembling *Echinopora fruticulosa* Ehrb. as figured by Klunzinger in his plate 6 fig. 4, and by Crossland (*Proc. Zool. Soc. London*, 1935, pl. iii), all the specimens from the Bay of Batavia having branchlets with a laciniate and alate apex." With this I agree entirely only adding that nothing comparable to this form has been seen among the many specimens of *E. fruticulosa* I have seen in the Red Sea, and that a careful, special search of the reefs of Malaysia or the Great Barrier Reef might settle the relationships of *E. horrida* to, *e.g.*, *E. lamellosa* and *E. hirsutissima* independently of growth experiments;

* Crossland had omitted the date and numbers in his typescript. This is the only figure by Dana of which I know that matches the specimen.—[A.K.T.]

but relationship to *E. gemmacea* is ruled out by the distinctiveness of the fruticulose form of that species. All the published figures of *E. horrida* show that while *E. gemmacea*, and probably the other species have quite distinct fruticulose forms, *E. horrida* has generally no such distinction, all specimens but this of the Great Barrier Reef being mixed lamellate and branched.

The specimen illustrated on Plate IV is quite clearly the same as that on Umbgrove's pl. vii, the only difference being in the absence of expansions above noted, the proportionally few lacinate branches and the great development of heavy branches with conical thecae. Of the former types most have evidently been broken off.

It seems likely that these heavy conical calices have a physiological origin, since strikingly similar forms are found on the lower branches of *Oculina* spp. from Bermuda, as shown by Verrill, (1901), pl. xxxii. Nothing similar has been seen in any specimens of *E. gemmacea*, fruticulose or otherwise.

I quote Umbgrove again: "From the facts mentioned here it is evident that there is no reason to follow Wells in his instituting a new generic name for *E. horrida*."

Distribution: Malaysia, Philippines, Fiji.

[Family OCULINIDAE.]

Genus *Madrepora*.

Vaughan, 1907, p. 80.

The use of this name for an Oculinid, for which Verrill is responsible, is a regrettable example of legalism *versus* common sense, but it is too late now to go back to the old well-established nomenclature.

Vaughan (p. 82) gives his researches into the meanings of *Amphihelia*, *Diplohelia* and so on, and ends: "However, I believe that pointing out the tremendous confusion of Duncan's work, and by attaching a name to something definite, a start may be made to unravelling the tangle of the *Amphihelie* (*Madreporidae*) *striatae*." To go back into this ancient jungle would be merely obstructive, and it is to be hoped that Vaughan's "name for something definite" will not be disturbed, but, under the present legal anarchy, anything may happen to any name.

Madrepora kauaiensis Vaughan.

Vaughan, 1907, p. 81, pl. viii, figs. 1, 2-2a and 3.

Three little fragments of thin twigs were dredged from Stn. XV. They correspond exactly with the thin branches of Vaughan's Hawaiian specimen except that the costal striations of the stems are, in places, less prominent. The species is clearly distinct from Moseley's two from the East Indian Archipelago and the Philippines.

All Moseley's and Vaughan's specimens are from deep water; this is the only record from comparatively shallow water.

Distribution: Hawaii, 5 "Mabahiss" Stations in Indian Ocean.

Genus *Galaxea*.

Stephenson and others (1931) refer to the genus on pp. 44, 67, 86, 87 and 90.

One of the corals mentioned as characteristic of the reef flat, of the seaward slopes

and anchorage; conspicuous on Yonge Reef, the fringing reefs of Lizard Island and on Batt Reef.

S. Manton refers to the genus on pp. 289, 295, 300, 302, 303, and in pls. xi, xiii, xvi. Species occur on deeper parts of the moat and are dominant on the deeper parts of seaward slopes on Traverses I and II. Here specimens attain a size of over 10 inches. Compare the Red Sea where cushions 4 to 6 in. across are not separate colonies but the tops of columns forming very large masses below. Apparently such masses do not occur in the Great Barrier region. The colonies shown on the plates are minute.

[*Galaxea fascicularis* (Linn.)].

The four specimens, only one of which [*G. musicalis*] is more than a scrap, have been labelled *G. fascicularis* (Linn.) and *G. musicalis* (Linn.) by Matthai.

[*Galaxea clavus* Dana].

On this latter name Vaughan (1918, p. 100) remarks: "Regarding the name *musicalis* which Milne Edwards and Haine applied to the species and attribute with a query to Linnaeus, it is not known, and probably never will be known, what species Linnaeus meant. Because of this uncertainty the name *clavus* proposed by Dana, concerning which there is no doubt, should be applied." My recent work on Forskaal's corals, and other species of the genus in K benhavn Museum, make me share to the full Vaughan's doubt as to the propriety of following either Linnaeus or Milne Edwards and Haine, and I therefore regard *clavus* as the first real name for this species.

In my edition of Forskaal's work I have shown how certain characters usually taken as diagnostic are only characteristic of stages of growth, and especially of dwarf specimens from the reef flat. Such are a continuous peritheca with comparatively thick-walled vesicles, the divergence of calices and their narrowing to their bases. These two last can only be found near the base of a new column, or when new buds arise, and the amount of the projection of the calices may depend on the rate of growth of the peritheca at the time. The number of septal cycles naturally varies with the size and development of the calyx; there may be five in *G. fascicularis*, but often only three, with or without an incomplete fourth. The thickening of the septa in the walls is not a constant difference, though well marked in some specimens of *G. clavus*, e.g., Matthai (1914, pl. xvi, fig. 2).

The distinctions between the species are (1) their growth forms, (2) the sizes of the calices, (3) the columellae. The growth forms are cushions in *G. fascicularis*, but, except in very shallow water, these cushions are the tops of *contiguous* columns, which therefore never bear polyps on their sides, whereas in *G. clavus* the columns are free, and bear polyps on all sides. This difference is quite real, since free columns have never been seen in the Red Sea, where I have seen many hundreds of specimens of *G. fascicularis*, both living and semi-fossil. It is in the latter, of course, that the internal arrangement of big colonies is easily seen to be an agglomeration of columns. The sizes of the calices grade into one another, as would be expected, e.g., specimen 188 T 1, labelled *G. musicalis* by Matthai, has *occasional* calices as large as the average of No. 40, *G. fascicularis*. The third distinction is given by Matthai as "columella poorly developed" and "columella distinct" for the two species. Milne Edwards and Haine say "columelle nulle" for the synonymous *G. irregularis*. Defining a columella as a structure formed by outgrowths from the inner

margins of the septa, then, *though the septa meet centrally*, there is, in *G. fascicularis*, as a rule no columella at all, at most a mere rudiment through which the septa pass, whereas in *G. clavus*, though small, it is distinct.

Vaughan (1918), p. 99, remarks: "Although large colonies [of *G. clavus*] usually form ascending columns, they do not invariably do so. There is in the U.S. National Museum a colony 15.5×18.5 cm. in diameter at the base, which has a nodulate upper surface, but there are no columns." Naturally columns will not be formed in shallow water, and it is from reef pools that so much of our material comes. Specimen 188 of this collection is incomplete, but measures 14 cm. \times 9 cm. \times 5 cm. thick, is almost quite flat, sloping down round the sides; it is from shallow water. S. Manton (p. 288), writing on Traverse I, finds *G. musicalis*, 3 to 7 inches across, which becomes large and abundant beyond 886 feet, and after 945 feet the large-polyped *G. fascicularis* is usual (see graph 29), but apparently all specimens are really extremely small.

Distribution: *G. fascicularis*, the only species in the Red Sea, so far as is yet known, extends through the Indian Ocean and Pacific as far out as Samoa. *G. clavus*, Indian Ocean and Pacific as far east as Fiji, but not in Samoa, nor Tahaiti, nor in the Red Sea.

Acrohelia horrescens (Dana).

Acrohelia horrescens Yonge, 1930, vol. i, No. 2, p. 17.

This is one of the species which are common in certain places, absent or rare in others of the same district. It is not in the collections from Low Isles or the vicinity, but both Mayor and Yonge found it in the Murray Islands, and Yonge in the Capricorns; it is common in Iwayama Bay, Palao Islands. Umbgrove (1939) also writes (p. 12): "Thus, *e.g.*, not a single specimen of *Acrohelia horrescens* was found in the Bay of Batavia although this species abounds on the Tогian reefs." On p. 14 he gives a long list of corals from Amboina (not only Bedot's collection) from which *A. horrescens* is absent.

It is close to the genus *Galaxea*, and, judging from certain specimens of a second species of the genus dredged by Dr. Mortensen off Banda, the two genera may be really identical. This view is supported by Yonge's remark, "The structure and behaviour of the polyp is identical with that of *Galaxea* and description is therefore unnecessary, particularly in view of the possibility that this genus should properly be placed in the Orbicellidae." I adhere to Matthai's division of the Astreaeidae, which includes *Orbicella*, though I do not follow him in merging the genus with *Favia*, since, as I have shown, there is the closest relationship between *Orbicella* and *Favia*. *Acrohelia* should join the Astreaeidae beside *Galaxea*.

Distribution: Malay region and as far east as Fiji.

[Sub-family MONTASTREINAE.]

Genus *Orbicella*.

I have no hesitation in following Gardiner and Vaughan, and in fact all authors but Matthai, in keeping this genus distinct from *Favia*. Not only are the round calices accompanied by intercalicinal budding sufficient grounds for doing so, but Matthai is hasty in inferring that cyclical arrangement of the septa is absent in the species which he removes to *Favia*. As Vaughan notes in 1914 and C. Crossland in 1931, cyclical arrange-

ment is often to be made out, and, in some specimens, is the rule. It is clear in some calices of Klunzinger's *O. laxa* (one of the species removed to *Favia* by Matthai), but this is only one example, and I particularly refer to my *F. ingolfi* of Tahaiti, and the wish expressed in 1931 and 1935 that its polyps, which are preserved in the British Museum, might be sectioned. Other examples are given under *O. vacua* sp. n., below.

I find the four Indo-Pacific species difficult to define, and I am uncertain whether Matthai's *F. laxa* is really the same as Klunzinger's *O. laxa* (see note on p.125). In Tahaiti the three species, *versipora*, *wakayana* (i.e., *curta*) and *solida* definitely do merge, but, as I showed in 1935 for other species, this does not necessarily apply to other regions than Tahaiti.

Gardiner (1904(b), p. 774) writes, "I must still assert my inability to find characters which clearly separate *Plesiastraea* and *Leptastraea* from this genus (*P.Z.S.* 1899, p. 751)." A case of a very striking resemblance of a specimen of *Leptastrea* to *Orbicella versipora* has been given on p. 31. Note also the strong probability that *O. mammillosa* Klz. is a form of *Echinopora gemmacea*. At the same time the facts that cyclical arrangement of septa is not universal, and that budding may be accompanied by fission, show the close relationship to *Favia*, and that the two divisions of the *Astraeidae* as tabulated by Matthai are not hard and fast.

The following are the species of this genus in the Indo-Pacific area: *O. curta*, *O. ingolfi*, and *O. vacua* n. sp.; while the following may all be synonymous with *O. curta*, viz., *O. versipora*, *O. laxa* and *O. solida*.

Orbicella curta Dana.

1899. Gardiner, *Orbicella wakayana*, p. 753, pl. 49, fig. 2.
 1914. Matthai, G., *Favia wakayana*, p. 104, pl. 25, fig. 4.
 1918. Vaughan, T. W., *Orbicella curta*, p. 86, pl. 28, figs. 2 to 5.
 1931. Crossland, C., *Favia versipora*, p. 384, pls. 15 to 19.

Matthai, examining Gardiner's collections in 1914, decides that four of his species of *Orbicella* are the same as his *Favia wakayana*. He remarks that "it is likely that the present species may have been previously recorded by Dana, but this point cannot be settled till Dana's *Astraeid* types are examined." This was done by Vaughan in 1918, who shows that this species is Dana's *O. curta* and *O. coronata*, the former name taking precedence, and publishes photographs of both types.

Specimen 401 is labelled "? *Favia wakayana*" by Matthai but I see no need for the ? mark. The scrap labelled "*Orbicella* A, Nigger Head, Undine Reef," but not numbered, is the same species.

From S. Manton's reference, p. 305, pls. xiv and xv, the species is rare on Low Isles, more common on the outer reefs.

Distribution: If distinct from *O. versipora*, Pacific Ocean only, but as far east as the Tuamotu Atolls, i.e., the limit of the Indo-Pacific area.

Orbicella vacua sp. n.

(Plate II, fig. 1, 4; Plate III, fig. 2.)

Three small specimens I am unable to place in any known species. They are sample numbers 399 (5)*; 400, "Favia 2. *Orbicella* B," from reef crest, June Reef; and 433,

* This probably means "Favia 5."—[A.K.T.]

“outer barrier, June Reef, Nigger Head.” The first two are small crusts, the third a portion of a solid cushion at least 75 mm. thick.

This species resembles *O. curta* strongly at first sight, having similar exsert septa and costae bearing the rather characteristic transverse lappets. Usually the walls project more, and the costae are more prominent, but in much of the area of No. 399 they are no more so than in most specimens of *O. curta*. All the septa are narrow, and descend vertically into a deep calyx, and there are no traces of pali—hence the specific name. The Tahaitian specimens of *O. curta* usually lack pali (Crossland, 1931, p. 384, pls. 15 to 19), only traces being found in a few calices of 8 specimens out of 60, but this is the result of degeneration, as shown by the long teeth of the lower parts of the septa and the loosely made columella. In *O. vacua* the upper parts of the septa are merely spinulose, the lower either entire or with short blunt teeth, which abruptly merge into the solidly made columella, on which only the points of the trabeculae are usually visible, the heavy beams being often fused together.

No. 433 is labelled ? *Favia laxa* (Klunzinger) by Matthai but the specimen differs from this species as much as it does from *O. curta*. In fact *Orbicella laxa* Klz. and *O. curta* are almost certainly the same. I presume that Klunzinger's and Matthai's species are the same, though Klunzinger (1879a, p. 50) says “Knospung fast immer extracalicular,” while Matthai (p. 100) says “multiplication by equal or subequal fission.” I also find several calices in Klunzinger's photograph showing distinct cycles of septa, which are not to be seen in Matthai's, but this is not even a specific difference in either *O. curta* or *O. vacua*. Klunzinger describes the calices as 8–10 mm. in diameter, but they average 6 mm. with a maximum of 8 mm. in the photograph, as in Matthai's. They may be oval in Klunzinger's species, but not as often, nor so greatly, compressed as in Matthai's. Marenzeller gave the name *O. laxa* to several large specimens from the Red Sea, but neither he nor Matthai describe them.

The contrast with *O. curta*, normal or Tahaitian, is complete.

Multiplication, in these three specimens, is by extracalicular budding alone, and all calices are round except a few in depressions in 399.

In No. 433 four cycles of septa are seen in a number of calices with almost diagrammatic clearness; in 399 they are less evident, all the larger septa are alike and all reach the columella, except occasionally one joins another. The quaternaries are very small, sometimes only their costae present, alternating with the others as in *Favia*.

Owing to these differences these three specimens *together* must be regarded as the syntypes* of the species. They must not be separated.

[Family ASTRAEIDAE : Species Without Cyclical Septa.]

Favia favius (Forsk.).

1901. *F. affinis* Marenzeller, p. 119.

1906. *F. savignyi* Marenzeller, p. 82, pl. 25.

1914. *Favia favius* Matthai, p. 79 (with synonymy), pls. 21, 22, 36.

Six specimens are definitely given this name by Matthai, *viz.*, samples 3, 134, 149,

* Crossland wrote “type.” But in accordance with the recommendations on International Rules of Nomenclature, B.M. Register No. 129, is hereby designated holotype, and Nos. 370, 396 paratypes: Crossland (1941, p. 10) remarked that such a proceeding, *i.e.*, designation of “type and cotypes” (as he called them), though scientifically absurd, had its practical use.—[A.K.T.]

160, 169, 170, and two more marked with a query. Of these latter I find No. 150 indistinguishable except that the number of septa continuous over the walls is greater than usual, and No. 410 I propose to treat as a distinct variety, var. *crassidens*.

S. Manton refers to it on pp. 285, 286, 288, 294, 298, and 306, and on plates viii, ix, xi, xii and xvi, from which I conclude that the species is one of the commonest of the Faviidae on the Great Barrier Reef as it is throughout the Red Sea. On Traverse I, were numerous small colonies, 2 to 7 inches across; in deeper parts, between 888 and 1014 feet, the commonest species occurring at the rate of 10 per square yard. In all these shallows the specimens are small, in the deeper water, according to the plates, it is rare and smaller than most other Faviidae; on the inner part of Yonge Reef one irregular colony of 27 cm. is shown. In the Red Sea I do not remember any very large specimens, and the abundance of specimens in museums I believe to be due to this habit of forming small, nicely rounded growths in shallows.

On p. 306 S. Manton writes, "Fungias and *F. favus* are more particular in habitat, and occur here and on coral heads and leeward slopes and moats of Low Isles, but are not frequent on other parts of Yonge Reef."

The specimens are matched by published figures as follows:

No. 149: Matthai, G., 1914, pl. 20, fig. 6, "Red Sea, typical form"; pl. 22, fig. 3, Forskaal's type, typical: and fig. 5, his type of *M. cavernosa*.

No. 150: As above, but there are frequent meetings of septa over walls.

No. 170: A mere scrap, like above but distorted.

No. 160: As No. 150.

No. 169 is intermediate between typical forms and that shown in Matthai, 1914, pl. 21, fig. 1.

No. 134: Marenzeller (1906), pl. 25, fig. 86.

No. 3: Matthai (1914), pl. 21, fig. 1; and Marenzeller (1906) pl. 25, fig. 84.

Distribution: Common in the Red Sea, including the northern part; recorded from all over the Indian Ocean. Pacific records are few, Tongatabu; Philippines and Samoa; and now the Great Barrier Reef, but not from Murray Island. It does not occur in Tahiti, but a specimen from the Tuamotu Atolls in the Museum at Papeete is probably of this species.

Favia favus var. *crassidens* var. n.

(Plate XIV, fig. 5.)

Specimen No. 410, though heavy for its size, is remarkable for the thickness of its septa rather than of its walls, in fact the calices are near together in comparison with Matthai's (1914) var. 2, figured on pl. 20, fig. 4, or pl. 21, fig. 3; or by Marenzeller (1906), pl. 25, fig. 88. Prominence of a few septa is common in this species, and is shown in Matthai (1914), pl. 21, fig. 3, pl. 22, fig. 1, and, in some degree in Nos. 149 and 134 of the present collection; but the state of these prominent thickened and exsert septa, as shown on pl. xiv, fig. 5, is unique. To this photograph I refer for numbers and measurements.

It is regretted that the specimen should be only a small part of a colony.

Favia valenciennesi M. E. and H.

1914. *Favia bertholleti* (Val.) Matthai, p. 94, pl. 22, fig. 7; pl. 23, figs. 4, 6; pl. 24, fig. 1.

1918. *Favia valenciennesi* Vaughan, note 2, p. 100.

1924. *F. valenciennesi* Matthai, G., p. 14, pl. 4, fig. 1; pl. 11, fig. 2.

Specimen 163 is given the name *bertholleti* by Matthai, with a ? mark on his pencilled label. The species is difficult to define, as shown by the number of photographs given above, and by the fact that Matthai (1914) shows on pl. 22, fig. 7, one of Forskaal's types of *F. favus*, “? *F. bertholleti* (Val.) . . . perhaps only a thin-walled *F. favus*.”

S. Manton does not mention the species; it is evidently rare on the Great Barrier. This specimen shows the same change from moderately deep calices on one side of the colony to very shallow ones on the other that was seen in a specimen of *F. doreyensis*, but in this case the whole colony was alive and apparently healthy when collected. This difference is common between the upper and lower parts of many corals, though not often so marked. Intercorallite grooves are not present, this being var. 1, the light form. It is very like Matthai's (1914) pl. 23, fig. 6, but the calices are usually rounder.

Distribution: Red Sea and Indian Ocean. The present record from the Great Barrier Reef is the first from the Pacific.

Favia doreyensis M. E. and H.

1914. Matthai, G., *F. doreyensis*, M. E. and H., p. 84, pls. 9, 22, 32.

1918. Vaughan, T., W. *F. pallida* Dana, p. 105, pl. 38, figs. 1-7.

1924. Matthai, G., *F. doreyensis*, p. 11.

Matthai's reason for not adopting Dana's name in 1924 is apparently that Vaughan includes *F. hululensis* Gard. in *F. pallida*, which species Matthai considers should be kept distinct. The species *hululensis* is not present here.

The species is peculiar in having round separated calices which divide very unequally and yet produce smooth colonies.

One specimen, No. 154, calls for remark; it is an oval mass, 12 cm. × 8.5 cm. × 6 cm. high, somewhat hollow underneath. About half of it is dead; along the growing inturned edge it has the characters of *F. doreyensis*, but, as we pass over the upper surface (probably the vertical surface in life) calices become more and more shallow, their edges less and less distinct, until, over the dead half of the colony, the thecae are quite superficial and widely separated, the result being almost exactly like a figure of *F. favosa* given by Matthai (1924), pl. 2, fig. 8. Doubtless the same causes, position in the colony and mud or crowding, has had the same effect on these two so different corals, and on the specimen of *F. valenciensis* referred to above.

S. Manton refers to this species on pp. 285, 288, 294 and 297, and on pls. viii, ix and xiii. It is of wide local distribution, but infrequent, and, like all the Low Isles Faviidae, very small.

Distribution: Indian Ocean, Pacific to Philippines, Fiji, and Samoa, but not from the Red Sea or Gulf of Aden.

Favia speciosa Dana.

1914. *Favia clouei* (Val.) Matthai, p. 89; pl. 10, fig. 6; pl. 23, figs. 1, 2, 5; pl. 34, fig. 1.

1918. *Favia speciosa* (Dana) Vaughan, p. 103, pl. 36, figs. 1, 2, 2a, 3, 4, 4a; pl. 37, figs. 1 to 4a.

1924. *Favia speciosa* (Dana) Matthai, p. 12, pl. 1, figs. 3, 5, 8*; pl. 11, fig. 3.

Matthai adopts Vaughan's correction of the name *clouei* to *speciosa* in 1924, but labels the four present specimens as *F. clouei*.

* As this plate is printed upside down figs. 3, 5, 8 of the 'explanation of plate' appear as figs. 7, 5, 2 on the plate itself.

To *F. clouei* S. Manton refers on pp. 285, 288, 298, 302 and 305; and on pls. iii, viii, xii and xiv. On Traverse I there was one in the moat and a few on the deeper part of the seaward slope. On Traverse III (to windward), on the third 100 feet of the slope, "the deeper water Favias of Traverse I continue or appear for the first time," *F. clouei* being one now to appear. On p. 302 Manton says, "The deeper water *F. vasta*, [i.e., *F. virens*] *F. clouei*, [i.e., *F. speciosa*] *Astreopora*† and *Lobophyllia* have larger polyps than the species found in shallow water" and withstand mud better.

This species has been thoroughly illustrated, as shown by the references above, to which many others may be added including Yabe, Sugiyama and Eguchi.

No. 159 is very like Dana's type of *Astrea pandanus* figured by Vaughan, T. W. (1918), Pls. 36 and 37, and some of its calices low down on one side resemble both fig. 4a on pl. 36 and the whole of the flat specimen dredged at Stn. XXIV. This leads on to No. 215, a distorted scrap from "Detailed survey 1. *Favia* from scanty corals, weed zone, deep water."

Nos. B.M. 419, 418 and 609 dredged at Stn. XXIV, with perfectly flat calices, marked off by thin polygonal lines, may be this species, but certainty is not possible.

Distribution: Northern Red Sea through the Indian and Pacific Oceans as far as Fiji and Fanning Islands, but not found in Samoa or Tahaiti.

Favia stelligera Dana.

F. acropora Matthai, 1914, p. 102.

One portion labelled "No. 49, *F. acropora*" by Matthai, represents this species. The names *acropora* and *lobata* have the advantage of being descriptive; in Matthai's list of 14 references the former is used six times, the latter five times, but Dana is not referred to. In 1918 Vaughan states that the earlier authors' descriptions are not identifiable, and have led to error, so that this name is not available for any coral. He therefore substitutes Dana's name *stelligera*, remarking that Klunzinger's pl. 3, fig. 9, of *F. lobata* might almost have been made from Dana's type.

S. Manton refers once, on p. 289, to the occurrence of this species on the seaward slope of Traverse I. As the species is so conspicuous in life, the columnar growths, which are thicker above, and the small calices making it one of the few *Astreans* certainly recognizable at sight, I conclude that it is rare in the Great Barrier Region. It is not recorded from Murray Island.

Distribution: From the northern Red Sea, where it may form large masses, to Tahaiti.

Favites halicora (Ehrb.).

1914. *Favia halicora* (Ehrb.) Matthai, p. 106, pl. 26, figs. 3, 5-7.
 1918. *Favites halicora* (Ehrb.) Vaughan, p. 110, pl. 41, figs. 1, 2 and 3.
 1924. *Favia halicora* (Ehrb.) Matthai, G., p. 17, pl. 1, figs. 4 and 6.*

S. Manton refers to this species on pp. 285, 288, 294, 298 and 306; and on pls. viii, ix, xv and xvi. It is generally distributed, as very small colonies, on shallows both at Low Isles and Yonge Reef. In the latter locality it grows larger, but nothing of any size is shown on the plates.

† Not true of *Astreopora*.—[C.C.]

* As this plate has been printed upside down figs. 4 and 6 of "Explanation of Plate I" are really figs. 6 and 4 on the plate.

Four small specimens and a scrap are labelled "*Favia halicora*" by Matthai. The last, 425, is too small for certain identification. 173 is thin walled, 162 and 180 are decidedly thick walled, and 229 is intermediate. Grooving between the calices is strongly marked in 162 but hardly at all in 180, though both are thick walled.

For distinction from allied species, e.g., *F. abdita*, see Vaughan (1918), pp. 101, 110.

For the relationship between thin and thick walls compare Matthai's two figures in 1924, which are taken from the same specimen, and illustrate the variation with position mentioned above in the cases of e.g., *F. doreyensis*, *F. virens* and *F. valenciennesi*.

Distribution: From the northern Red Sea through the Indian Ocean, including the Natal coast; the Pacific, including Murray Islands, Fanning and Samoa, but not Tahiti.

Favites abdita Ell. and Sol.

Of this generally common species only two small pieces are present, but S. Manton refers to it on six pages and six plates.

The great likeness of some specimens of *F. flexuosa* to some of *F. abdita* is commented upon on p. 46, and by Yabe, Sugiyama and Eguchi, while Vaughan, 1918, p. 111, remarks: "Some specimens of *F. halicora* have a most perplexing resemblance to some specimens of *F. abdita* (compare pl. 40, fig 4, with plate 41, fig. 2), as Matthai has pointed out. Usually the prominent septal dentitions just within the calices of the former are a good discriminating character."

S. Manton refers to the species on pp. 288, 294, 298, 305 and 307, and on pls. viii, ix, xii xiv and xvi.

The specimens noted are quite minute, 1 to 7 inches across, except one shown on pl. xii. This was growing on a pinnacle of dead coral which may be described as small, being 36 cm. across. It is common in shallow water on the two leeward traverses, but not to windward. On Yonge Reef it is found frequently on the inner parts and occurs also on the reef crest, where the colonies are very small. It is thus one of the species "able to exist under very variable conditions," but *not* able to grow to full size anywhere in the areas seen. Compare this observation with that of Gardiner (1899, p. 758). In Rotuma (?) "these three species" (all are *F. abdita*, *fide* Matthai) "live on the extreme breaking edge of the reef, and are exposed at spring tides for two or three hours to the sun. though constantly wetted by the spray. They form also large spreading masses as deep as can be seen outside the reef." In 1905, p. 787, of *P. fusco-viridis* Gardiner says, "Very common on lagoon shoals and outer slope, often forming immense masses both at Minikoi and in the Maldives." In the Red Sea large specimens occur off a reef edge about Lat. 21° N., but at Ghardaqa in the North it, with *F. halicora*, is one of the corals which are found as small scattered colonies on the outer part of the shore reef-flat. Large colonies have not been found there.

The two specimens are of the blunt-walled variety. Among the numerous illustrations published they are matched by Vaughan's (1918) pl. 40, fig. 3, which shows Dana's type of *A. fusco-viridis*, and fig. 5, one of the specimens from Murray Island; and by Matthai's (1914) pl. 29, figs. 3 and 4. For illustrations of the more typical growth form see Bedot (1907), pl. 30, fig. 150 (under the name *P. robusta*), and Matthai (1914), pl. 35, fig. 2. Matthai (1924, pl. iv, fig. 2) shows a curiously branched form from somewhere in the Indian Ocean, which is matched by two in the Kóbenhavn Museum from Singapore, in which hillocks become vertical branches.

Distribution : The whole Indo-Pacific, including the Red Sea, Mauritius and Natal ; but not east of the Fiji Islands.

Favites virens Dana.

(Plate VI, figs. 1, 2.)

1914. *Favia vasta* (Klz.) Matthai, G., p. 108, pl. 27, figs. 3, 5, 6.
 1918. *Favites virens* (Dana) Vaughan, p. 111, pl. 41, figs. 4, 5.
 1924. *Favia vasta* (Klz.) Matthai, p. 18, pl. 1, fig. 7* ; Pl. 11, fig. 1.
 1936. *Favites flexuosa* (Dana) Yabe, Sugiyama and Eguchi, p. 32, pl. 20, fig. 1.

S. Manton refers to this species on five pages and on three plates, using Matthai's name, *Favia vasta*.

In 1924 Matthai lists Vaughan's name *virens* as a synonym, but gives no reason against its adoption, though Vaughan's reasons appear conclusive ; they depend upon Matthai's identification of Klunzinger's *Goniastrea halicora* with his *P. vasta*, with which, after deliberation, I agree. I therefore follow Vaughan in adopting Dana's name. *Favites flexuosa* Dana is raised to a distinct species by Yabe, Sugiyama and Eguchi, though it is given as a synonym of *F. abdita* by Vaughan. While agreeing with the Japanese authors in its distinctness from *abdita*, the seven specimens before me bring *flexuosa* clearly into the range of *F. virens*. The distinctions from *F. abdita* are, however, much less than the resemblances. Yabe, Sugiyama and Eguchi give (1) broader, stouter, and more numerous septa ; (2) broader walls, rounded above ; (3) larger calices. (1) is merely a consequence of the much larger calices, and, in fact, *F. virens* is only a large form of *F. abdita*, except that in the former, when septa meet over walls generally the short meet the short, while as a rule the short meet the long in *F. abdita*. The difference between short and long septa is much more marked in *F. virens*, the former being decidedly thinner, and extending only a short way down the wall. These small differences suffice to divide the species unless intermediates are found.

Just as in *F. abdita* there are two very well marked forms (1) with thin walls and calices as almost regular pentagons ; (2) with thicker, rounded walls and calices, therefore rounded pentagons or almost oval. The latter are the *F. flexuosa* of Dana and of Yabe, Sugiyama and Eguchi.

I regard the columella as a distinctive feature, which is shared with *F. abdita*, and illustrate it on Plate VI, fig. 1. It is compact and clearly defined ; the trabeculae are delicate and expand into lappets at their ends, the edges of which are spinulose ; these have no resemblance to septal teeth, with which their connection is found only after careful examination. The septa round the columella end in a vertical drop, forming a little pit floored by the top of the columella. Klunzinger's description as "grob trabekular" is thus misleading, as apparently the coarseness refers to the little lappets, not to the columella itself. A lens shows at once that the "*Goniastrea halicora*" figured contradicts the definition of the genus in having a well-developed compact columella. I much doubt whether his var. *superficialis*, with its rudimentary columella, formed of ordinary septal teeth, can be the same species. There is nothing like it in the series before me.

Each long septum is divided into two parts, the upper narrow, with fine teeth (*i.e.*,

* As this plate has been printed upside down fig. 7 of "Explanation of Plate I" is really fig. 3 on the plate,

in proportion to the size of the calyx), the lower broader and thicker, with coarser teeth. This lower part, to the naked eye, simulates a crown of pali.

The series before me could not have been better selected to illustrate the variation from an *abdita*-like form to the very different *flexuosa*. The points in which the specimens differ are (1) size, (2) depth, (3) walls, thin and sharp or rounded, (4) presence or absence, and depth of grooves between the calices.

(1) Diameters of calices : Specimens 174 and 167 have small shallow calices, like those of *abdita*, but with some larger than are to be found in the latter, *viz.*, 15 mm. in longer diameter. The average and maximum sizes in the other specimens are 15 mm. and 20 mm., but there are only two calices of 20 mm. on one side of the colony. In No. 114 the average and maximum sizes are 20 mm. and 23 mm. In another specimen,* 20 mm. and (one) 22 mm.. In No. W.2, 20 mm. and 24 mm. (this is the typical *flexuosa*, almost exactly like Yabe, Sugiyama and Eguchi's fig. 1, pl. 20). and lastly a specimen* with all calices about 15 mm. in diameter.

(2) Depths of calices : in the first two specimens the calices are shallow, especially in the thick-walled No. 167, but in both as usual in all corals, the calices are much deeper on the summits of the dome-shaped colonies. In the third, No. 115, the calices are shallow at one end, 7 mm. deep at the other. No. 114 is similar, but has far larger calices (6 and 7 mm.). In No. 152, all calices are equally deep. In W.2 all are deep, and in 145 the calices are smaller but about 10 mm. deep.

(3) Walls thin and sharp in only the first of the series, and on the flatter part of the fourth. This specimen is particularly interesting, since fairly sharp-walled calices occupy most of the surface, thick walls round the deeper calices which are marked off by grooves. The fifth and seventh of the series have all the calices separated by grooves, in the latter quite deeply, but in the sixth, No. W.2, there are few traces of grooves, *i.e.*, it is a perfect example of *F. flexuosa*.

Illustrations of specimens matching those of this series are provided as follows :

- (1) No. 174, Klunzinger (1879a), pl. iv, fig. 2 (*Goniastrea halicora*).
- (4) No. 114, the part without grooves between the calices, Vaughan, T. W. (1918), pl. 41, fig. 5 ; Faustino (1937), pl. 28, fig. 2 ; Mayor (1918), pl. 16, fig. 28.
- (6) No. W.2 (*F. flexuosa*), Vaughan, T. W. (1918), pl. 40, fig. 2 ; Yabe, Sugiyama and Eguchi (1936), pl. 20, fig. 1.

Of the remainder of this series Nos. 114, 115 (the upper part) are illustrated on Plate VI, figs. 1 to 2.

The first is remarkable in that the calices are marked off partly by notches in the septa over the walls, in the usual way, and partly by laminae between the septa parallel to the walls.

It is to be remarked that the series would have been even more instructive had larger and more complete colonies been brought home, or, from really large masses several samples been taken with notes on their positions. At the same time I note from S. Manton's account that, although the colonies belong to a large number of species the colonies are all small—very small compared with those I know in the Red Sea, and those described by

* There are seven specimens : Nos. 114, 115, 145, 152, 167, 174, W.2. Crossland did not mention the number of this specimen in his typescript.—[A.K.T.]

Gardiner in the Indian Ocean and Pacific. There are few coral species in which the specific features are constant over any large area of a colony, and lateral crusts are generally abnormal.

Distribution : From the northern Red Sea (where it attains a considerable size) to the Pacific, but not further east than Samoa.

Favites aspera Verrill.

(Plate V, figs. 1, 2.)

1868. *Goniastrea aspera* Verrill, p. 32.
 1904(b). *Favia parvimurata* Gardiner, p. 771, pl. 62, fig. 25.
 1914. ? *Favia parvimurata* Gard., Matthai, p. 113.
 ? 1918. *Acanthastrea hemprichii* Vaughan, p. 101.
 1927. *Goniastrea aspera* Verrill, Faustino, p. 141, pl. 33, figs. 1 and 2.
 1936. *Goniastrea aspera* Yabe, Sugiyama and Eguchi, p. 35, pl. xxiv, fig. 3.
 1938. *Goniastrea aspera* Eguchi, p. 350.
 1939. *Favites aspera* (Verrill) Umbgrove, p. 30, pl. iii, fig. 3; pl. v, fig. 1.

Two specimens of widely different appearance are present, No. 155 being labelled *Favia parvimurata*, the other No. 166, ? *Favia bertholleti*, both by Matthai. This latter specimen fits no description or figure of that species, but does connect the heavier No. 155 with the lightly built *F. aspera*, from which it differs only in having smaller and simpler upwardly directed teeth on the exsert parts of the septa.

Gardiner's original description fits specimen No. 155 better than does Matthai's, which is abbreviated and omits the important fact that the walls are not only peculiarly delicate but sometimes incomplete, and dismisses the lower septal teeth, carefully described by Gardiner, mere as a conspicuous pali crown. These two points are important also in connection with the much lighter form of No. 166, which is figured with 155 on Plate V, the differences from Gardiner's specimen being all due to general lightness of build, *e.g.*, the relative inconspicuousness of the lower teeth of the septa and of the toothing of their upper parts. As might be expected, the walls in this example are quite often incomplete, though never wholly missing, and without interrupting the sequence of the septa. The columella is loose, though essentially as in No. 155. For septal numbers, measurements, etc., I refer to the photograph.

A complete description of the species can be had by combining the accounts of Gardiner, Faustino (who copies that of Verrill, with notes by Vaughan) and Umbgrove.

Vaughan (1918), p. 114, says: "I doubt *G. aspera* really being a *Goniastrea*. Besides having roughly and irregularly dentate septa, the intercorallite walls are often slit, making a combination of characters suggesting affinity with the *Coeloria* group of *Meandra*."

Distribution : Maldives, Malaysia, Japan (Yabe, Sugiyama and Eguchi), Southern Philippines and the Great Barrier Reef. Always rare.

Genus *Goniastrea*.

The genus is abundant at Low Isles and elsewhere on the Great Barrier, and apparently in many places in the Indo-Pacific it is the commonest of all the Faviidae. The smooth rounded shape and nearly white colour of the commoner species make them conspicuous.

Stephenson and others include it in *Favia*, but S. Manton gives four page references to the genus on four pages and to the several species on numerous pages and plates. At

Hope Reef Hedley and Taylor found it, with *Porites*, dominating the edge of the reef. This genus has evolved a completely meandrine form, *G. benhami* Vaughan, noted on p. 136 and figured on Plate VIII, which offers a curious ecological contrast to what we may call the meandrine form of *Favia*, i.e., *Coeloria*, in that, while the latter is a more successful species, both in number of specimens and especially in size of colonies than the original form with simple calices, the former is a rarity and always small. Similarly in *Lobophyllia* it is the simple form which is so important in the Red Sea and elsewhere, the meandrine forms being unimportant. Many species have been attributed to *Goniastrea* which are so ill described that even their generic position is uncertain. Some of these are tabulated by Matthai (1914, p. 116). It does not seem to me possible, however, to make *G. seychellensis* Klz. identical with ? *F. favus* (Forsk.). Quelch's species are not certainly identifiable, but his *G. incrustans* has been redescribed by Matthai (1924), p. 21, pl. ii, fig. 4; pl. xi, fig. 4. It is very close to *G. pectinata*. *G. lacera* Verrill is a *Favites*.*

I therefore list only the following 6 species as certainly known :

1. *G. retiformis* (*G. solida* or *G. parvistella*).
2. *G. pectinata* (*G. planulata*).
3. *G. incrustans*.
4. *G. mantonae*, n. sp.
5. *G. benhami* Vaughan.
6. *G. seychellensis*.

Of these it is barely possible that *incrustans*, *mantonae*, *benhami*, are varieties of *pectinata*.

The mode of division of calices is rarely given by authors, but, judging from the specimens before me and the numerous figures published, the "subequal division" of Vaughan's definition is the rule in all but *G. mantonae*. I tabulate the species as follows :

A. *No tendency to meander :*

- | | |
|--|---------------------------|
| (1) Multiplication by subequal fission. Calices up to
4 mm. wide | 1. <i>G. retiformis</i> . |
| (2) Multiplication by marginal fission. Calices up to
10 mm. wide | 2. <i>G. mantonae</i> . |

B. *Occasional short meanders :*

- | | |
|--|---|
| (1) Calices up to 7 mm. wide ; meanders rarely over
12 mm. Palial lobes large | } 3. <i>G. pectinata</i> .
4. <i>G. incrustans</i> . |
| (2) Calices 10 mm. wide ; meanders up to 25 mm. long.
Palial lobes poorly developed | 5. <i>G. seychellensis</i> . |

- | | |
|--|------------------------|
| c. Meanders frequent, 6 to 9 mm. wide, 30 mm. to 44 mm. long | 6. <i>G. benhami</i> . |
|--|------------------------|

Goniastrea retiformis (Lamk.).

1914. *G. retiformis* Matthai, p. 118, pl. 31 figs. 1-5; pl. 33, fig 3; pl. 38, figs 2 and 4.
 1914. *G. solida* Matthai, p. 117, pl 28, figs 3 and 4; pl. 31, fig. 1; pl. 33, fig. 4; pl. 38, fig. 3.
 1918. *G. retiformis* Vaughan, p. 114 [pl. 15, fig. 24; pl. 16, fig. 25; both of Dr. Mayer's article (1918.)]
 1918. *G. parvistella* Vaughan, p. 114, pl. 44, figs. 2, 2a.
 1925. *G. retiformis* Hoffmeister, p. 26.

* Crossland had added, "and is described as such on p. — of this report." I am unable to trace this reference.—[A.K.T.]

The typical and commonest form, with its small, sharp-walled calices, is one of the most easily recognizable of all corals, but its variation is extensive and gives puzzling cases.

The history of the species is as follows: Matthai (1914, p. 118) includes in his synonymy-list 7 references under the name *retiformis*, 3 under *solida* and 5 under other names, which means that both Milne Edwards and Haime and Gardiner are unable to distinguish these two species. On the same page, but under *G. solida*, he says that of the five specimens which Milne Edwards and Haime refer to *G. solida*, two belong to *G. retiformis*. Of the 19 "Pola" specimens at Vienna, all referred to *G. favus* by Marenzeller, he says that ten are undoubtedly *G. retiformis* and that the remaining ones may be assigned to *G. solida*. No. 15918 (*solida*), Matthai says, has corallites showing a meandering tendency. By definition above this is not *solida*, but probably *planulata*. Also I consider that Matthai's (1914) fig. 1 on pl. 30 is of *G. solida* according to the text on p. 117, but *G. retiformis* according to the text on p. 118, and the explanation of the plates on p. 139.

In 1918 Vaughan says that the name *solida* is inappropriate, and substitutes *G. parvistella* Dana since Matthai took it from Forskaal, whose *Madrepora solida* is a *Porites*, as discovered by Marenzeller. Since Forskaal says the species is the building material of considerable towns there was hardly need to wait for Marenzeller to know that it is a *Porites*! Matthai, however, distinctly writes "non *Madrepora solida* Forsk.," so the objection does not hold.

The above prepares us for Hoffmeister's finding that, in his Samoan specimens, "the main difference that I am able to make out in all these specimens is in the thickness of the walls. The Samoan specimens, however, show walls as thin as those in typical *G. retiformis* in some parts of the corallum, and, in other parts, are as thick as those of Dana's type of *G. parvistella*." "I have examined very carefully all of the specimens in the U.S. National Museum, including those in the Samoan Collection, and have compared them with Dana's type of *G. parvistella* and with Matthai's description and figures of *G. solida* and *G. retiformis*." Hoffmeister therefore concludes that the species are the same. Umbgrove (1939, p. 32) agrees, and "will describe transitional forms from Togian reefs."

Finally in 1934 Matthai labelled two specimens of the Great Barrier Reef Collection, No. 142 ? *G. solida*, and No. B.M. 183 from Batt Reef as *G. retiformis*. The two are exactly alike, except that the latter is somewhat more solid. In both, pali may or may not be divided by a deep notch from the septa, the sides and edges of which are spinulose, very much so in the "solida" specimen, the columella degenerate and often fused.

It is clear that this species is an excellent subject for ecological work on the reefs, the easier as the species is so common. For the present the species name is *retiformis*, with variety *solida*.

The other two specimens, No. 226 T. 1 moat and No. 177, are typical, and are matched by numerous figures by several authors. No. 142 B.M. 185 is best matched by Matthai's pl. 31, fig. 1; and No. B.M. 183 by Mayer's (1918) pl. 15, fig. 24. S. Manton refers to this species on pp. 285, 286, 288, 293, 294, 305 and 307, and on plates viii, xi, xii, xiv and xvi. On Traverse I it is one of the most abundant corals in the moat; at about 830 feet the rocks dip below low water, and this species appears with *F. favus*, *F. astraefiformis* and *Acropora* spp. On the seaward slope between 846 and 930 feet it is more abundant than the other Faviidae, which become more numerous as the water deepens.

On the seaward slope, as on Traverse II, are the largest specimens, as well as most numerous species, up to 16 inches across—quite a large coral for Low Isles. Pl. viii shows its extension from lowest tide level to 8 feet below, but it extends no further. On Yonge Reef it occurs both on the crest, pl. xiv showing one flat-topped colony 18 × 11 inches, and in the anchorage zone, where pl. xvi shows one 32 × 18 inches, thus showing that it is tolerant of very variable conditions. Only one specimen of the *solida* form is recorded, 3 inches in diameter on the seaward slope of Traverse II.

It is abundant, and much larger in the Maldives. Gardiner (1904*b*, p. 772) writes: "This golden-green species is common on the outer slope, occasionally occurs on the reef-flat in small heads, and is abundant in the lagoon, both at Minikoi and in the Maldives. It often forms immense masses, which on the shallow flat behind the boulder zone die in the centre but spread linearly, the blocks in growth resembling massive *Porites*." I have not seen this golden-green colour in the Red Sea, where it is very light brown or almost white.

Distribution: Vaughan says, "One of the best known Pacific and Indian Ocean corals." Common, often abundant, from the northern Red Sea to Fiji and Samoa, but not in Tahiti.

2. *Goniastrea pectinata* (Ehr.).

1892. *Coeloria australiensis* Rehberg, Abh. Naturwiss. Verein Hamburg, pp. 1-50, pls. i-iv.

1914. *Goniastrea pectinata* Matthai, p. 120, pl. 28, fig. 6; pl. 37, fig. 1.

1914. *Goniastrea planulata* Matthai, p. 121, pl. 28, fig. 5; pl. 31, figs. 7 and 8.

1918. *G. pectinata* and *planulata* Vaughan, pp. 114 and 116; pls. 42 and 43; [pl. 15 of Dr. Mayer's article (1918)].

The two species recognized by both Matthai and Vaughan differ only in the thickness of their walls. The two works quoted may be consulted for the difficulties both these highly experienced men have had in separating the species, which I will not repeat in full, but, as one example, on p. 115 Vaughan says "Dr. Mayer obtained 20 other specimens of *Gonistrea pectinata* on the Murray Island reef. The variation is simply bewildering. . . . The principal variation is in the character of the wall between adjacent corallites and in the depth of the calices." These characters vary with position on the colony in the usual way, but the means also vary from colony to colony. There is no difference in the present collection between some of the specimens labelled *pectinata* by Matthai, and those he has labelled *planulata*; all the specimens can be arranged in a continuous series.

Matthai labelled the specimens as follows:

(1) As "*G. pectinata*." No. 224 O. T.1 Moat; and the following unnumbered from Batt Reef; B.M. No. 171, Patch 1, square 4; B.M. No. 172, Patch 1, square ?; B.M. No. 175, square 3; B.M. No. 176, Patch 1, square 9. The following are marked with a query: Nos. 153, 146 and B.M. 88, locality 2. These last three specimens have very thin walls, slightly larger and deeper calices, and narrow septa, but do not differ from No. 224 preceding, which is not so queried. I do not share Prof. Matthai's hesitation. His identification of B.M. No. 88 with *Coeloria australiensis* is not queried; the ? is to *Goniastrea* sp. There is no difference between it and Nos. 153, 146 and others.

(2) As "*G. planulata*." From Batt Reef, Patch 1, square ?; B.M. No. 178, a half dead scrap; B.M. No. 179, similar; B.M. No. 180, fragment of a small but living colony;

B.M. No. 181, showing some marginal fission. The last-mentioned is a whole colony, though very small (7 cm. in diameter \times 7 cm. in height), and columnar in shape. Walls thin to very thin, calices low down the sides generally, but not always, thicker walled and shallow. It combines the characters of *G. planulata* and *G. pectinata*.

S. Manton refers to *G. pectinata* on pp. 284, 285, 287, 293, 294, 300 and 302, and on pls. iii and x. As she does not refer to *G. planulata* I presume it is included in *G. pectinata*. It is found in very small colonies, 1 to 4 inches across, in shallow parts of Traverse I, as far as 620 feet (see pl. iii, graph 22) and is one of the more abundant corals (1 to 7 inches across) in the moat, but is absent from deeper water. It occurs also on the inshore part of Traverse II, but is again absent from the seaward slope. It is found to remove sediment, both sand and mud, with relative ease, which probably accounts for its successful growth in shallow water. Pl. X shows only two little growths, $4\frac{1}{2}$ inches across, in the moat.

On this part of the Great Barrier the species is very much less common than is *G. retiformis*. Gardiner did not find it in the Pacific Islands he visited, and it is somewhat rare in the Maldives, though it is common at the Murray Islands and Samoa.

Distribution: Red Sea, Indo-Pacific to Samoa, but not to Tahaiti; and apparently absent from some islands west of Samoa.

4. *Goniastrea benhami* Vaughan.

(Plate VIII, fig. 2.)

1917. Vaughan, p. 277, pl. xviii, figs. 1, 2, 2a; pl. xix, figs. 1, 1a; pl. xx, fig. 1.

1918. Vaughan, p. 116.

One small specimen, No. 51, of this rare species is in the present collection, and another was brought to me by Mr. G. W. Otter.

Vaughan published 6 figures in the Trans. New Zealand Inst. As this publication may not be always accessible, I publish another, but do not repeat Vaughan's description except to quote "except that it has meandroid calicinal valleys it bears a considerable resemblance to some specimens of *G. pectinata*." I also remark that, in this specimen, valleys are meandroid in all parts of the colony. They are up to 30 mm. long, with 4 or 5 centres.

Distribution: Kermadec Islands, Formosa, and now the Great Barrier Reef.

Goniastrea mantonae, sp. n.

= *Goniastrea* K.5 and K.18 Manton (1935).

(Plate VII, figs. 1 and 2.)

The only three fair-sized specimens of this species are here assembled. They are labelled by Prof. Matthai only as *Goniastrea* sp., their numbers being: sample 120, B.M. 186, T.2 shallow (*Goniastrea* K.5, Manton); 128, B.M. 404, T.2 shallow; 179, B.M. 187 (*Goniastrea* K.18, Manton). They were labelled by letter and number because Dr. Manton could not identify them with any known species.

The first is apparently half a regular hemisphere, 12 cm. in diameter, 6 cm. thick. No. 128 is a whole colony, a crust 0 to 5 cm. thick, growing over some other Faviid. No. 179 is a nearly regular low dome, 12 cm. across by 5 cm. high. All were in good condition and active growth.

I am fortunate in having three good specimens on which to found a new species, but, as in most coral genera, and especially in this, a dozen would have been none too many.

Definition : As *G. pectinata*, but (1) calices are larger, the largest in K.18 being 10 mm. \times 9 mm., 11 mm. \times 7 mm., 12 mm. \times 10 mm. ; in No. 128 the largest are 10 mm. \times 7 mm., 9 mm. \times 5 mm., 11 mm. \times 7 mm. ; and in K.5. are 9 mm. \times 9 mm., 10 mm. \times 9 mm., and 12 mm. \times 7 mm. ; the depths are in proportion as in *G. pectinata*. (2) There is no trace of meanders. (3) Fission is always marginal. Palial lobes always distinct, but not thicker than the upper halves of the septa. While the latter are finely denticulate the former bear small teeth ; notch between palial lobe and upper part of septum horizontal, or extends downwards a little way. Columella deep below palial lobes, of very fine, often indistinct, trabeculae.

In No. 128 the intermediate septa are rudimentary and often absent : in K.5 small but generally present ; in K.18 longer and always present. Edges of septa strongly denticulate in all three, sides roughly granulate in K.5 and No. 128, nearly smooth in K.18. K.5 has thicker walls and septa than the other two, and, as usual, the walls are still thicker and calices shallower near the base.

The thicker-walled K.5 is shown on Plate VII, fig. 1. The general likeness to *G. pectinata* is obvious, but the marginal fission and absence of meanders are equally distinct.

Owing to differences between the specimens all three must be regarded as syntypes.* They cannot be considered apart.

S. Manton refers to this species on pp. 287, 288, 293, 294, 305 and 306, and on Plates viii, xi, xii, xiv, xv and xvi. On both Traverses I and II it is present in the moat and on the shallower part of the seaward slope, much as *G. pectinata*. On Yonge Reef both on the crest and on the inner part, where it is frequent. It thus endures a wide range of conditions, though it never extends much below low water. Manton's plates also show a wide local distribution, though it is never abundant. Pls. xv and xvi show larger specimens, up to 34 cm. across, the examination of which would have made my definition of the species much more complete and safe.

[Family ASTRAEIDAE : Meandroid species.]

Genus *Cynarina* Brüggemann.

1877. Revision of the Recent Solitary Mussaceae. *Annals and Mag. Nat. Hist.*, Ser. IV, XX, p. 305.

A genus with only one species, known only from the Gulf of Suez, where it was found by Savigny and later by MacAndrew. Now a single specimen from the Great Barrier Reef. It is distinguished from *Sclerophyllia margariticola* Klz., also from the Red Sea, by its narrow base and thin septa, among other things.

Cynarina savignyi Brügg.

(Plate IV, figs. 1, 2.)

1826. *Caryophyllia carduus* Audouin, p. 233.

1827. (*Caryophyllia carduus*) Savigny, pl. 4, fig. 2 (1-3).

1877. *Cynarina savigny* Brüggemann, p. 305.

* Crossland wrote "form the type." In accordance with the International Rules B.M. Reg. No. 187 is here designated holotype, and Nos. 186 and 404 paratypes. [See also footnote, p. 125.—A.K.T.]

The single specimen, No. B.M. 492, is the largest yet found, being $4\frac{1}{2}$ cm. over the long diameter of the calyx, and 5 cm. high, Brüggemann's largest being $3\frac{1}{2}$ cm. \times 4 cm., a little larger than Savigny's.

Savigny's figures are perfectly reliable, but Brüggemann remarks, as I have had to do, that his "figure was either mistaken" (I suppose misunderstood is meant) "or overlooked by subsequent authors." However, I refigure the larger specimen before me, as Brüggemann's is the only account between 1826 and the present day.

I agree with Brüggemann in substituting *savignyi* for Audouin's name *carduus*, since apparently that was given under the mistaken idea that the species is the young of a *Lobophyllia*, and *carduus* has been given to several species in this family, mostly badly described.

The most remarkable features of the species are the thin septa (*cf.* *Sclerophyllia margariticola* Klz. and *Mussa (Lithophyllia) lacrymalis* M. E. and H. which are probably the same) and the large columella made of closely packed thin lappets (see Plate VII, fig. 2). These features also make it impossible to be a young form of any species of *Lobophyllia*. True, in this specimen there are about 12 (many are broken) more exsert, more coarsely toothed septa, but these are not greatly thicker than the others, and almost all septa, even the thinnest and narrowest, reach and contribute to, the columella. Details can be obtained from the photograph. The toothing of the larger septa, especially their exsert parts, is very coarse—sinuous or lobed might better describe them. The smaller have more numerous, but still rounded teeth.

In contrast with Savigny's figures, and presumably Brüggemann's specimens also, only one constriction is at all deep, but three are distinct, and two more above these can be seen faintly. The theca and epitheca are so reduced in the upper part that it is full of squarish holes between the septo-costae and dissepiments: these are to be attributed to age and have no morphological significance. Endothecal dissepiments make the cup very shallow, but, as they slope inwards, it is 5 mm. deep over the columella.

Genus *Lithophyllia*.

1857. Milne Edwards and Haime, p. 290.

1877. *Scolymia* Brüggemann, p. 301.

1899. *Lithophyllia* Gardiner, p. 166.

The adoption of Haime's name *Scolymia* by Brüggemann in spite of Milne Edwards's and Haime's statement that it had not been published, is unjustified.

Lithophyllia vitiensis (Brüggemann).

(Plate IX, fig. 4.)

Scolymia vitiensis Brüggemann, *l. c.*, p. 304.

Lithophyllia vitiensis Gardiner, p. 166.

One specimen corresponding very well with Brüggemann's from Fiji, dredged at Stn. XXIV, B.M. Reg. No. 1934.5.14.410c. It has not been figured hitherto. It measures 36 mm. \times 25 mm., the type being 40 mm. in larger diameter. The substratum is an extremely rotten fragment of shell with a nullipore on it, the growth of which quite obscures the base, but the corallum appears to be 7 mm. high on one side and 3 mm. on the other. It is thus much more squat as well as more oval than the type.

Brüggeman says "no distinct epitheca." In this specimen it is distinct, but only like a thin, shrivelled-looking membrane, so thin that the low costae are clearly seen; it reaches nearly to the top of the wall. Septal granulations not visible unless suitably lighted, when they become quite distinct. The 5th cycle is incomplete, probably owing to the distortion of the specimen and its smaller size. The columella is peculiar, and as Brüggemann describes it, "very dense, with subimbricate surface, the trabeculae being enlarged to horizontal, somewhat crimped lamellae." I hope the figure on Plate IX will explain this somewhat peculiar arrangement. I add that the surfaces of the lamellae are dotted with small granules like those on the septa, and that the circular columella is quite small in comparison with the area of the quite flat theca.

Recorded Distribution: From Fiji before 1877; Loyalty Islands by Willey before 1899; the only previous records.

Genus *Caulastrea*.

For the relationships of this genus, which has special morphological interest, see Matthai (1928), pp. 11, 13, 14, 17 and 272. Briefly it is a primitive member of the *Mussa* group, the Indo-Pacific representative of the Atlantic *Protomussa*.

Caulastrea simplex sp. n.

(Plate III, figs. 4, 4a.)

A single specimen, dredged from Stn. XVI, of a small solitary coral, 12 mm. high and 8 mm. in diameter, belongs to this genus. It is not a young specimen of any compound species, since the eversion of most of the septa over the top of the calyx indicates that it is fully grown.

Its form is turbinolid, with a bent base, but this may be accidental, and due to the shape of the shell fragments to which it is attached. The upper part is nearly cylindrical, capped by the large exsertions of the septa, which exsertions add 2 mm. to the height given above. These eversions are continued to the base as distinct but narrow costae, all of nearly the same size, widely apart. They correspond to the first three cycles of septa, and bear, like them, triangular teeth, but much smaller and more rarely. The calyx opening is quite circular, and 3 mm. deep to the columella, *i.e.*, 5 mm. from the top of the larger septa. The septal series are consequently regular, the first two alike, the third narrower, especially below, where it does not reach the columella, and the fourth is rudimentary.

The septal exsertions and their teeth are more like those of *e.g.*, *Lobophyllia* than those of the other species, the teeth being broad and blunt, the largest at the outer angle of the exsertion; but the teeth of the costae are small and far apart. These are shown on Plate III, fig. 5, but those of the interior of the calyx cannot be well shown. As the calyx is deep and the septa are narrow, the greater part of their edge is nearly vertical; this part bears three or four broad blunt teeth, narrower and sharper on the 3rd order. All these teeth, like the septal edge and exsertions, are granular, the sides being smooth until examined in a carefully adjusted light. The outgrowths which form the small and rather loose columella are smooth and flattened.

The differences between this and the other species of the genus are considerable enough, and the fact that this is a solitary coral might be taken as reason for the creation

of a new genus. This is not necessary, however, since the differences are of degree rather than kind, and the solitary habit is not, of itself, a generic character.

Caulastrea simplex is also not unlike *Parasmilia centralis* M. E. and H. from the upper chalk (1850, p. 47, pl. viii, figs. 1, 1a-c). It differs mainly in the tothing of the septa, those of *Parasmilia* being entire as in other Eusmiliidae.

Caulastrea furcata Dana.

1928. Matthai, p. 273; pl. 44, fig. 5b and 6; pl. 45, fig. 3; pl. 61, fig. 3; pl. 62, figs. 6 and 12.

This species was dredged from Stn. XVIII and XXI. There is no particular difference between the sets of specimens, or between them and Matthai's complete description and figures, except that these are more loosely branched, and the edge-zone extends well down the stems.

Distribution: Already known from the Great Barrier Reef, but other records are confined to the Pacific, between the China Sea, Fiji and Tongatabu.

Genus *Acanthastrea* M. E. and H.

1914. Matthai, *Favia*, p. 77.

1918. Vaughan, *Acanthastrea*, p. 101, p. 125, pls. 50, 51.

1924. Matthai, p. 37, pl. 3, figs. 2 and 3; pl. 5, fig. 1.

1931. Crossland [*Favia hemprichii*], p. 387, pl. 21.

The genus is defined by its possession of teeth or spines on the upper parts of the septa, especially over the walls. This definition is insufficient without the distinction between, e.g., teeth which are the result of reduced growth and those due to added growth. As more pertinent examples than those I gave in 1931 of the former, I cite those on the upper edges of intertheical costae in *Favia dipsacea*, Aud. and Sav., rediscovered on the coast of Natal by Prof. T. A. Stephenson and his colleagues. Their existence, combined I suppose with distrust of Savigny's very excellent figure, has caused this species to be included in this genus. Similarly *F. parvimurata* Gard. is given as a possible synonym by Vaughan, and definitely by Thiel, though the teeth on its exsert septa are of the most ordinary sort. (See illustrations and references under *Favites aspera* on p. 132.) The spines of *Acanthastrea* are very different, and quite a special growth, with triangular bases and thinner prolongations with spinulose ends. Many of them are hollow, and all the longer ones are removed by handling before the specimens reach museums, leaving traces, when hollow, as little holes that appear in illustrations as small black dots. To show a complete specimen, with the fullest development of the spines, I had one photographed in Tahaiti, which is shown in the above quoted paper.

The relationships of the genus have been somewhat confused. Matthai in 1914 brings the two species he describes under *Favia*. Vaughan in 1918 separates Matthai's species into *Acanthastrea*, which, from the position in which he places the species he describes, he evidently regards as far removed from *Favia*. *Favia complanata*, superficially resembling an *Acanthastrea* until its spines are examined, he rightly places in *Favites*, and near to *F. abdita*.

The septa being the foundation of an *Astraeid* skeleton, from which both theca and columella are directly derived, I follow Vaughan in attaching great importance to their characters. I therefore, like Vaughan, regard this genus as quite distinct from *Favia*

and allied to *Lobophyllia* (*Mussa*) and beg the reader to refer to Vaughan (1918), pl. 50, on which figs. 1b and 2 bring out the relationship in a striking way. In 1924 Matthai, pl. 5, fig. 1, and pl. 3, figs. 2 and 3, shows a specimen of a species with huge calices, which, he names "*Acanthastrea* or *Mussa* sp.," which is certainly of this genus, differing mainly from *A. echinata* in the size of its calices, the formation of short valleys being a common occurrence in the smaller species (Matthai, 1914, p. 111; Crossland, 1931, p. 287.) My *Symphyllia simplex* from Natal is similar, but not identical, and might equally well have been placed in *Acanthastrea*.

Acanthastrea echinata Dana, 1846.

(Plate VIII, figs. 1 and 3; Plate IX, figs. 1, 2.)

- 1879a. *Prionastrea spinosa* Klunzinger. p. 39, taf. 4, fig. 7.
 1914. *Favia hemprichii* Matthai, p. 110, pl. 27, figs. 1, 2; pl. 36, fig. 3.
 1914. *Favia hirsuta* Matthai, p. 100, pl. 24, figs. 7, 8.
 1918. *Acanthastrea echinata* Vaughan, p. 125, pls. 50 and 51.
 1931. *Favia hemprichii* Crossland, p. 387, pl. 21.

The name *hemprichii* is due to Ehrenberg, whose description is *nul**; then to Milne Edwards and Haime, who describe as Ehrenberg's something which is both unidentifiable and not an *Acanthastrea*; and finally Matthai in 1914 publishes an unsatisfactory photograph of Ehrenberg's type, with which he identifies his species "with some hesitation." To me this hesitation amounts to extreme doubt, and I therefore regard *hemprichii* as a *nomen nudum* still. I regard both Matthai's names as the same, and take Dana's *Acanthastrea echinata* as the earliest name available. Fortunately, Vaughan has made this safe by his description and figures of Dana's type, without which it was confused with any Faviid having teeth on the exsertions of the septa.

I have carefully tabulated the characters given by Matthai for his two species, and find that there is no valid distinction. The two specimens before me are illustrated on Plate VIII, figs. 1, 3, and are seen to differ very greatly in appearance, but this is almost entirely due to the differing thicknesses of the walls, with which go polygonal calices in the one, and almost round in the other, but it is a commonplace that such differences are not specific. In both specimens the septa are thin; the characteristic thickening over the walls is but slight in No. 151, fairly well marked in No. 144, but in neither so strongly marked as in 1, *e.g.*, Dana's type.

The columella is generally neglected in descriptions, and I am uncertain what weight should be given to its details. Such figures of this species as show it appear to give an ordinary trabecular arrangement with simple teeth, Matthai says, "pointing upwards"; neither of these specimens is of this type. In No. 114 they are of the *F. abdita* type, figured, for *F. virens*, on Plate VI. But in No. 151 they are quite peculiar, made of greatly thickened, blunt, smooth septal teeth pointing level to the centre. As the uppermost of these highly modified teeth do not reach the centre, the columella is hollow on the top. A very few, minute, spinulose projections do occur in some calices, so that possibly the structure is not so far removed from that of No. 144 as seems at first to be the case. However I illustrate both on Plates VIII and IX.

* Dr. Crossland's meaning is not clear. At the bottom of p. 96 (Ehrenberg, 1834) appears: "9. A. Hemprichii E." At the top of p. 97 is a 6-line description. Perhaps Crossland missed the latter.—[A.K.T.]

No. 151, "*hirsuta*" is very well matched by Klunzinger's taf. 4, fig. 7, as *Prionastrea spinosa* (which Matthai makes the same as *F. hemprichii*). The columella is visible, with a lens, in two calices; it is of thick beams, probably like this Great Barrier specimen. The only other figures at all like our specimen are Matthai's (1914) pl. 27, fig. 1 (*F. hemprichii*), and Vaughan's (1918) pl. 51, fig. 2 (*A. echinata*), from Murray Island. As for No. 144, there is nothing quite like it in the literature, and I therefore illustrate it on Plate IX, fig. 2.

Distribution: From the northern Red Sea, through the Indian Ocean as far as Tahaiti. Always rare.

Genus *Lobophyllia*.

Stephenson and others mention the genus on pp. 67, 86 and 88 as one of the animals characteristic of the seaward slopes and anchorage at Low Isles, of Yonge Reef, and of the reef patch at Lizard Island.

S. Manton refers to the genus on pp. 289, 295, 298 and 302, and on pls. vii, viii, xi, xii and xiii.

On Traverse 1 the genus is met with in colonies of 2 to 12 in. occasionally in the moat, and on the seaward slope. On the windward traverse it occurs only rarely between "distances" 700 and 760 feet in water 8 to 10 feet deep. The plates of drawings show only rare and insignificant scraps. This is in very great contrast to the Red Sea, where, in both northern and central sections, numerous colonies of *L. corymbosa* make masses up to 10 feet high and 20 across; but the other two species, so far as I know, are smaller, though not at all uncommon. (Crossland, 1935, p. 502, and 1939, p. 515.) The Great Barrier conditions recall those of Tahaiti as far as this species is concerned. The only other reference to "enormous colonies" is by Umbgrove (1939, p. 37) quoting Vervey, in the Bay of Batavia.

The variation of the three species was worked out by me in Tahaiti (1931, pp. 373 to 380, and table on pl. 22), and though it is possible that variation is at a maximum in that far oceanic island, the present collection, like all the literature, shows an astounding amount of variation.

Lobophyllia corymbosa (Forsk.).

(Plate IX, fig. 3.)

For synonymy see Matthai (1928), p. 210, and pls. 25-27, 47,* 57, 58, 60, 62, 64, 68, 71.

The species is the only one of the three which is certainly definable.

The collection contains one specimen and 6 fragments. No. 110 is a regular dome 20 cm. in diameter. It resembles Matthai's (1928) pl. 68, fig. 1, "side view of Dana's type of *Mussa cactus*," the calices of which are shown on pl. 26, fig. 4, which is very near to Forskaal's type, pl. 71, figs. 5 and 6. Dana's type seems to be about the same size as No. 110, and apparently is the largest specimen to which Matthai had access, though he saw 106 specimens at the British Museum (Natural History), and 30 abroad, of which only 50 had a maximum diameter of 20 cm.

No. 447 is remarkable for the thickness and exertion of its septa, up to 6 mm., including the teeth. The upright teeth on the exert parts of the septa often number three to five,

* Pl. 47, fig. 8, is named *Lobophyllia costata* Dana. Crossland may have included it in error.—[A.K.T.]

and the upper costal teeth are unusually prominent in this, unlike any illustration I know of this species, except Crossland's (1931) pl. xii, fig. 23. It is near to Matthai's (1928) pl. xxv, fig. 6, "probably Milne Edwards' and Haime's type of *Mussa fistulosa*," or to pl. 27, fig. 1, "probably Milne Edwards' and Haime's syntype of *Mussa aspera*." It is more like the former in that the septal teeth, where broken, are seen to be hollow. The columella is very small in No. 447, as in both these type-specimens. As I wish to show the septal teeth and "eversion" of the exsert parts of the septa the illustration on Plate IX is taken a little obliquely.

Distribution: Northern Red Sea, through the Indian Ocean, including Mauritius and Rodriguez, and Pacific out as far as Tahiti.

Lobophyllia hemprichii (Ehr.).

(Plate X, figs. 1 and 2; Plate XXX, figs. 1 and 2.)

Two specimens are labelled *L. costata* by Matthai, viz., No. 255, a half dead scrap, and No. 94, a well-preserved specimen 19 cm. across and 10 cm. high. A third specimen, B.M. 380 " "*Lobophyllia*? Stn. No. 2 Low Island " is very like No. 94, but is only part of a colony; its differences will be given later. All three specimens are alike in the breadth of continuous valleys, and in the remarkable long, *tapering* teeth of the exsert parts of the septa. There are usually three of nearly equal length (5 mm. up to 8 mm.; one is vertical, the other two point inwards and outwards at an angle (Plate X, fig. 2).

The fourth specimen, No. 450, is labelled *L. hemprichii*, with which I agree. I cannot, however, agree that any of the preceding correspond with Matthai's definition of *costata*, since the wide valleys, 25 to 30 mm., are continuous. In No. 94 they are 15 to 20 mm. deep; in B.M. 380 shallower, but 13 to 17 mm. I have described the variation of the species *costata* and *hemprichii* in Tahiti (1931, p. 379, table on pl. 22), showing a difference between the species in spite of overlapping.

B.M. 380 and No. 94 differ greatly in the parts of the septa within the calices. In No. 94 there are 4 main septa per cm., of which one is generally thin, narrow, with fine teeth, and only two large teeth above the wall. The tertiary rudimentary, very finely toothed; intermediates alternate regularly, so adding 4 to the total number of septa per cm. In B.M. 380 there are 3½ large septa per cm., all alike, and the intermediates are quite rudimentary; the lower teeth of the main septa are only 1 to 3, small and triangular in this specimen, but up to 7 small sharp teeth in No. 94, but parts of No. 94 approach B.M. 380 in condition of the larger septa, and No. 255 is intermediate. The following published figures of Matthai (1928) match these two specimens: pl. 28, fig. 6. A specimen from Torres Straits; its valleys are narrower and teeth shorter. Pl. 29, fig. 4, Milne Edwards' and Haime's *Mussa echinata*, is similar, but its valleys are only 20 mm. wide, and apparently all the longest teeth are broken off. Pl. 66, fig. 2, Ehrenberg's type of *Manicina hemprichii*, valleys 25 to 30 mm., wide and teeth *occasionally* prominent. All the above are named *L. hemprichii* by Matthai.

The specimens also match Faustino's (1927, pl. 39, fig. 2, *Mussa cristata* Ehr.). Milne Edwards and Haime, in describing the species specially mention these peculiar teeth, but they are blunter than in our specimens. This specimen is called *costata* by Matthai. As these teeth are not well shown in any of these pictures, and I feel that I must offer evidence

in support of my disagreement with Matthai, I give illustrations on Plate X, figs. 1 and 2. In order to show the septal teeth the views are rather oblique.

No. 450 is entirely different in the structure of the exsert parts of the septa, and therefore differs from the first three in appearance as much as any two distinct species could. The columellae also are larger and more closely compacted, and are joined by from two to five lamellae. The tips of almost all the upper teeth are broken off,* but they seem to be only elongated triangles, not spikes, as in the preceding. They are hollow. Of these comparatively small and uniform teeth (Plate X, fig. 1) there are five on the upper edge of the septum, but as this edge forms a regular rounded arch, with no boundaries between inner, upper and costal parts, the number cannot be counted exactly. At the inner angle, or a little below it, is an extra large tooth, and below it one to three rather smaller; on septa of the second order these are sometimes followed by three or four small thin sharp teeth. Septa of the third order are very small, but bear teeth above, and below are sinuous, or bear one or two small teeth low down.

This form somewhat resembles Yabe, Sugiyama and Eguchi's (1936) pl. 32, fig. 1 (*L. hemprichii*), but the differences are considerable enough to warrant another illustration.

Distribution: Red Sea, Pacific to Tahaiti, but the only Indian Ocean record is a doubtful one by Gravier from the Gulf of Aden.

Genus *Symphyllia*.

Stephenson and others refer to the genus on pp. 67, 80, 86, 88 and 90 as one of those characteristic of the seaward slope and anchorage at Low Isles; at Three Isles it forms, with *Favia* and *Porites*, flat-topped platforms in a pool between the mangrove swamp and shingle spit; it is found also on Yonge Reef and the reef patch at Lizard Island and on Batt Reef. It is thus widely distributed, but never seems to have been conspicuous.

S. Manton refers to the genus on pp. 284, 285 and 302, and on plates iii, vii, ix, xii and xiii.

Small specimens, 3-8 inches, are found in the deeper parts of the moat, on the inner side of the seaward slope of Traverses I and II (Graphs 28 and 56 on pls. iii and vii). On p. 302 the genus is mentioned as being one of those which, having large polyps, can easily remove both mud and sand. Pl. ix shows two very small growths in the western moat, but on the other plates examples of from 23 cm. to 32 cm. in diameter are shown. The genus (or species—there is only one common) is common and widely distributed at Low Isles, but is not flourishing, which may be connected with the lightness of the specimens collected.

Distribution: Indian and Pacific Oceans, as far east as Samoa; not found in the Red Sea (unless Klunzinger's *Isophyllia erythraea* is a simple form of this genus), nor in Tahaiti.

Symphyllia recta Dana.

(Plate XI, figs. 2 and 3.)

Symphyllia sinuosa Q. and G. All authors up to Vaughan (1918).
1918. *S. nobilis* Dana; Vaughan, p. 124.

* Collectors should remember that, though stony and heavy, corals are delicate objects and need as careful handling and packing as other specimens. Most collectors should also remember that they do not know which specimens are of value and which are good for nothing but road material, but for ecological purposes all are of equal value.

1918. *S. nobilis* Mayer, pl. 17, fig. 35.

1924. *S. sinuosa* Matthai, p. 31.

1928. *S. recta* Dana. Matthai, p. 227; pl. 30, figs. 1-6; pl. 31, figs. 1, 2; pl. 48, figs. 4-6; pl. 57, figs. 1a-b.

1932 to 1936. Yabe, Sugiyama and Eguchi, alternate between *S. nobilis* and *S. recta*.

Synonymy: This species has been known as *S. sinuosa* by all authors up to 1918, and at least Milne Edwards and Haime's description and figure were adequate as far as they went. It is very unfortunate that Dana's greatly damaged and now quite worthless specimens were preserved and used as a basis for the resuscitation of his names *nobilis* and *recta*. The result is not only that a well-known name is altered, with no advantage to anyone, but certain loss, and even experts like Vaughan, Matthai and Yabe, Sugiyama and Eguchi cannot agree which name to use, but also that, instead of the identification of later specimens depending upon Dana's types it is those types which are only recognizable from later specimens and the work done upon them. Dana's samples should have been ignored.

What Ellis and Solander and Lamarck meant by their descriptions is of no interest to any practical zoologist now. It is only by assuming that our present classification cannot be upset by the ecological research which is so badly needed that Dana's names and types can have any validity.

The following specimens are labelled *S. recta* by Matthai, viz., Nos. 13, 95, 112 and 209. Three specimens, B.M. 365, B.M. 367 and B.M. 405, are not named, except "Symphyllia gonad species." All are of the "thin variety" of Matthai except No. 209, which approaches the "thick variety" in having its main septa as much as 1 mm. thick. The three "gonad species" examples have particularly thin walls and septa, which latter therefore appear much less crowded than in the others, though there are 8 to the cm. in both cases.

No. 13 is interesting as being a young specimen, 5 cm. in diameter, 4 cm. high, attached by its whole under-surface and with no radial arrangement of the valleys, and so distinct from *S. radians*. No. 95 is small and somewhat deformed. It has several monostomodaecal calices, most of the others being di- and tri-stomodaecal. Its septa are 0.75 mm. thick, in places 1 mm., and therefore appear crowded, though there are only 8 or 9 to 1 cm., as usual. The larger teeth have been broken off, but appear to have been short, giving the walls an evenly rounded appearance. There are no grooves.

The following figures match these specimens:

No. 97, Matthai (1928), pl. 30, fig. 4, "from Chagos"; Bedot (1907), pl. 21.

No. 112 and B.M. 367, Matthai (1928), pl. 30, fig. 1, of Q. and G's. type; Bedot (1907) pl. 22 (but the inner septal teeth are less prominent).

No. 209 is the only example of the thick variety, in which I place it because of its wider valleys and having three or four smaller septa between the larger, instead of the simple alternation of the other samples, and its large triangular irregular teeth, but in spite of the fact that its teeth are only 1 mm. thick instead of the 2-2.5 mm. of the definition. It is very like Matthai's (1928) pl. 30, fig. 5, but as it is part of a larger colony its valleys appear longer. This figure is labelled "thick variety," though its septa are only 1 mm. thick. Gardiner's (1899a) pl. 48, fig. 1, also affords an illustration.

Nos. B.M. 405 and B.M. 365 have thinner walls and septa than any illustration published, but they grade in with B.M. 367 and No. 112, of which figures are given by Matthai

and Bedot. Their upwardly pointed triangular teeth within the calyx are prominent, much larger than those on the walls, columellae well developed, compact, of thin rather broad lappets as in *Lobophyllia*; septa 8 or 9 to the cm., larger and smaller alternating. I give a rather oblique view on Plate XI, figs. 2, 3, to show these features.

Generally these thin forms are the less abundant. Gardiner's Maldivan and Rotuman examples are all thick, the former, of which three good illustrations are given, having the main septa 2 mm. and over in thickness. He is the only author, except those of the Great Barrier Reef Expedition Reports, who gives notes on size and habitat; as the contrast with Low Isles is marked I quote him. Writing (1899, p. 739) of Rotuma, he says: "The species in the living condition is of a green colour, brown round the peristome. The colonies form great hemispherical masses, 2-3 feet across, and are very common in the outer half of the boat-channel. The species is noticeably resistant to the action of the sun, parts of the colonies at spring tides being uncovered for 2-3 hours. Massive colonies, too, which have died in the centre and been hollowed out, are rare." Again (1904b, p. 761) he says: "The species is fairly common on the lagoon shoals and reefs of the Maldives. I have also seen it on the outer slope, and it is not improbably in places an important reef-builder . . . Colour of the Minikoi specimen . . . a large mass several feet in diameter, in central upper part of the colony, over walls transparent, peristome very light green dotted with dark green, edge of stomodoeum white, and at sides, over walls very dark green, peristome white slate, edge of stomodoeum white."

Distribution: Indo-Pacific as far east as Samoa, whence Mayer obtained one small specimen. It does not occur in the Red Sea or in Tahaiti.

Symphyllia radians M. E. and H.

One specimen, labelled "Low Isles W. moat," B.M. 366, is quite typical in having a central stalk and radial valleys, but the septa are divided by grooves over the walls, generally just visible, but in two places 2 mm. wide. Principal septa 4 to 1 cm., as in Matthai's definition, but there are generally three principal marginal teeth, often four, and the columellae are compact, made of thin broad lamellae, usually rounded.

Matthai (1928) gives 5 figures, of which pl. 54, fig. 7, from Tizard bank, resembles this specimen fairly closely. Pl. 58, the underside of Dana's *Mussa crispera*, shows a central stalk with the rest completely free, but in this specimen growths and secondary attachments hide perhaps a third of the surface. In Bedot's specimen, pl. 19, attachments seem to have covered most of the underside, and it is otherwise unlike the Gt. Barrier example.

Distribution: Indian Ocean, but not east of Rotuma and Tongatabu in the Pacific. Rather strangely there are already four records from the Great Barrier Reef.

Genus *Oulophyllia*.

The two species of this genus were placed in *Coeloria* by Gardiner in 1904, an arrangement with which I have every sympathy, the present tendency to make numbers of genera with one to three species each being very inconvenient. Of the differences from *Coeloria* given by Matthai (1928), p. 256, the first, wider and deeper valleys, and second, septa narrower and thinner, are not generic; while the third, a tendency to form palial lobes, is quite rudimentary; and the fourth, distinctness of the columellar centres, is not complete, septal trabeculae occurring frequently between centres. As Matthai remarks, description

of the polyps is needed, and it is very likely that the structure of the living and expanded polyps alone would settle the relationships of this genus to both *Coeloria* and *Tridacophyllia*.

Oulophyllia crista (Lamarck).

1904. *Coeloria cooperi* Gard., p. 762, pl. lx, fig. 9.

1928. *Oulophyllia crista* Matthai, p. 257; pl. 19, figs. 1, 2; pl. 25, fig. 2; pl. 71, figs. 1 and 3.

The first adequate figure is that by Gardiner in 1904. Rehberg's figure of his *U. maxima* is only a drawing, not very distinct. His types are photographed by Matthai (1928), pl. 71, figs. 1 and 3.

The present collection contains only one specimen, No. 52, a regular dome 12 cm. across \times 7 cm. high.

Distribution: Gulf of Aden, E. and W. of Indian Ocean, Singapore to Palau and Caroline Islands, and Bismarck Archipelago. Now Great Barrier Reef.

Genus *Coeloria*.

From S. Manton and Stephenson and others, we find that the genus is common on the Great Barrier, but inconspicuous. It appears, too, that *C. daedalea* is much more common than *C. lamellina*. Compare Gardiner's (1899a, p. 740) description of its occurrence in the South Pacific: "The genus is very abundant on the lagoon-shoals at Funafuti, where it forms large, spreading masses, which vary in colour from brown to green. It is also found sparingly on the leeward reefs at Funafuti and Rotuma, but it cannot apparently withstand the force of heavy breakers." Of *C. daedalea* he writes: "Common in the boat-channel, where it forms large spreading masses, 3-5 feet in diameter, small colonies only being found on the reef." In the Maldives, says Gardiner (1904b, p. 761) "the genus is the most abundant of all *Astraeids* on the reef-flat and outside the edge of the reef to 5 f., where the immediate force of the breakers is felt. It also occurs abundantly on the outer slope down to 15 f., and one specimen comes from 28 f. . . . Colour, generally some shade of green." It is very remarkable that the above notes refer only to *C. daedalea*, *C. lamellina* being absent. In Gardiner's collections from the central part of the Indian Ocean, Matthai (1928) records only two specimens from Chagos.

Coeloria astraeiformis (M. E. and H.).

1879a. *Coeloria esperi* Klünzinger, p. 19, pl. 2, fig. 6.

1899a. *Coeloria astraeiformis* Gardiner, p. 743, pl. 46, fig. 4.

1918. *Maeandra astraeiformis* Vaughan, p. 120.

1918. *Maeandra astraeiformis* Mayer, pl. 14, fig. 19.

1925. *Maeandra esperi* Hoffmeister, p. 29.

1928. *Favia astraeiformis* Matthai, p. 278; pl. 44, figs. 2a, 2b; pl. 45, fig. 1.

One specimen, No. 230, T1 moat, names *Favia astraeiformis* by Matthai, while Nos. 143 and 148 are given a ? mark. Whether this mark refers to the genus or the species is not indicated; probably to both, as the distinction from some specimens which Prof. Matthai has labelled *C. daedalea*, Nos. 168 and B.M. 78, are, if any, very slight.

All authors but Matthai place this species in either *Coeloria* or *Maeandra*, which means simply that the gradation with *Favia* is complete. I therefore follow the majority.

As regards *C. esperi*, Gardiner (1899a) thinks it very probably the same as *C. daedalea*,

and Matthai in 1928 was definitely of this opinion. Vaughan (1918), p. 120, says it must be the same species as *C. astraeiformis*, but Hoffmeister's (1925) Samoan specimen of *C. esperi* "agrees with Klunzinger's (1879a) description and figure (p. 19, pl. 2, fig. 6) very well," and therefore cannot be *C. astraeiformis* as Klunzinger's species is the same as *C. daedalea*.

The species is rare. S. Manton refers to it on 6 pages and 5 plates, but only once refers to *C. daedalea*. As a large number of the latter species was collected I assume that this means that the two cannot be distinguished on the reef.

Distribution: Milne Edwards and Haime record it from the Red Sea, where neither Klunzinger nor I have seen it. It has been found in widely separated places, in the Indian Ocean only by Gardiner. As far east as Fiji; it is not recorded from Samoa.

Coeloria daedalea (Ell. and Sol.).

(Plate XI, fig. 1; Plate XII, fig. 2.)

1936. *Coeloria rustica* Dana, Wells, p. 104.

The fact that Forskaal's *Madrepora daedalea* is an *Alveopora* has given the opportunity to Wells to change the well-established name *C. daedalea* to Dana's *C. rustica*. He is followed, quite uncritically, by Yabe, Sugiyama and Eguchi in 1936, and by Umbgrove in 1939.*

Matthai (1928, p. 24) gives 33 references between the years 1786 and 1927 almost all using *C. daedalea* for this well-known coral. Further references extend to 1935, making the period of unanimity 148 years. Wells' proposed change cannot be too strongly repudiated. (1) It is a defiance of the rules of nomenclature, which state that no change is to be made if greater confusion than uniformity results. Does Prof. Wells really wish to save us from confusing a species of *Coeloria* with one of *Alveopora*? (2) Such changes bring the rules into contempt. (3) It depreciates the work of men who have made real additions to our knowledge of the species in favour of two bare records of local distribution. (4) It assumes that zoological nomenclature is the affair of a few museum experts only.

I may also point out that "Madrepora," as Forskaal uses it, is not a genus but a rough division of the corals, as he himself definitely says.

Of the 12 specimens from the Great Barrier seven deserve notice, viz., the two already mentioned, Nos. 168 and B.M. 78, which are not really distinguishable from *C. astraeiformis*; three with remarkably thick walls, one with a lamellar columella, and one with remarkably shallow valleys. The remainder, Nos. 140, 147, 176, 219 and 321, fall within the normal variation of the species given by Matthai (1928, pp. 24-37).

Specimen No. 147, which is 17 cm. long and 10.5 cm. high, consists of two areas with the usual meanders and sharp walls, the longest valley 28 mm. in length, most shorter, and between them an area 8 cm. × 5 cm. on which the walls are still thinner and the calices mostly single, as in *C. astraeiformis*. Another similar but smaller area is near one end. They are but slightly depressed. They are on the side of the corallum, the top of which is dead in the centre.

* Dana's type is figured by Matthai (1928), pl. vi, figs. 7 and 8. It is a beach pebble, so worn that even such authorities as Matthai and Vaughan do not agree whether it represents the present species or *C. lamellina* (Matthai, 1928, p. 29). It is therefore absurd, whether legal or not, to make such a defective specimen the type of an important species.

The longest valley is in No. 140, and is 50 mm. long, measured in a straight line. The specimens have been named by Matthai, but No. 54 with a ? mark, which it owes to its shallow valleys, 1–2 mm. deep and 4 mm. wide, and rather broad, rather thick septa, many of which slope inwards before dropping nearly vertically to the narrow columella, features which give the colony a very distinctive appearance. The specimen is a living area of a dead hemisphere, the dead parts partly overgrown by nullipore and filamentous weed. Most of the dead area has been broken away, but in what remains along one side can be made out the higher thinner walls and narrower septa of more normal form. There is nothing like it in Matthai's 18 figures, but, as it is clearly morbid, I do not illustrate it.

No. 138 is a thin crust growing over dead *Porites* (?) illustrated on Plate XII, fig. 1. It is somewhat similar to the last but has thicker walls, but though the valleys are equally shallow, 1.75 mm. \times 4 mm. wide, they are more open at the bottom. The most interesting peculiarity is the almost plate-like columella, like the figure Matthai (1928) gives on pl. vi fig. 1, "showing variation towards the *Platygyra* facies," but there is no reference to this remarkable fact in the text, under either genus. Gardiner (1904b, p. 762) writes (under *C. sinensis*, which is most probably a synonym of *C. daedalea*): "When a valley is very shallow, owing to boring organisms underneath or other causes, the *columella* may approach in appearance the condition in *Leptoria* . . ." This specimen is free from parasites, but whatever other causes have induced growth as a crust about 8 mm. thick, a form strange to this genus, it does indicate the close relationship to *Leptoria* (*Platygyra*). Such a columella is also shown by Yabe, Sugiyama and Eguchi's (1936) pl. xxi, fig. 10, of a curious humpy growth of "*C. rustica*," but, as usual with these authors, the phenomenon receives no notice in the text. No. 321 is similar, and has been labelled "*Platygyra B*" by the collector, but the columella has nowhere the regularity of typical *Leptoria*.

The thick-walled specimens also are not figured by Matthai or other authors, nor is anything like them found in his table of variations on pp. 34 and 35, all the specimens considered having sharp-edged walls, generally perforated. The valleys are deep and open. Their peculiarities are due to morbid deposits of endotheca, which not only swell the walls but make irregular floorings among the very loose columellar trabeculae; or these may be absent, or represented only by long straight septal teeth. In the small scrap, No. 175, where walls are more normal the morbid deposition is less. It is similar to that found by me in Tahaitian specimens of *Acanthastrea echinata* (or *Favia hemprichii*) (1931, p. 387).

Distribution: Many records from the Indian Ocean and Pacific as far as Samoa. It does not occur in Tahaiti, but Agassiz collected a specimen in the Paumotu Atolls, further east (cf. *Favia favus* above). In the Red Sea it is rare; it was collected by Klunzinger (*C. esperi*) and Milne Edwards and Haime record it. The only specimen I have seen is semi-fossil, at Ghardaqa. Contrast *C. lamellina*.

Coeloria lamellina (Ell. and Sol.).

There are four specimens showing the usual great variation, numbered 61, 259, 261 and 371.

Stephenson and others only refer to the presence of the genus in the fauna; it is found everywhere, but the coralla noted by S. Manton are only 2–9 inches across, except one shown on pl. xv, the outer moat of Yonge Reef, which is 66 \times 45 cm., but is a mere flat cake growing in only a foot of water. The big conspicuous domes and cylinders of the Red Sea are nowhere noted.

No. 61 is a peculiar growth, $19 \times 13 \times 10$ cm. high, which stood out bracket fashion from a vertical face to which it was attached by a narrow stem of ? *Porites*; the top is killed by exposure at low tide. The sides, both sloping and vertical, show long, nearly straight valleys with bulging areas at the edge with the usual meanders. On the sloping or outer side are thicker rounded walls and somewhat lamellar columellae. The colour of this species in the Red Sea is a particularly bright brown.

Distribution: Abundant in the Red Sea, from which Matthai had 29 specimens, where it forms colonies up to 2 metres each way. Elsewhere it seems to be small and rare, especially in the Indian Ocean, but seems to be more common in the Pacific, where it extends to Samoa and Fanning Island.

Genus *Leptoria*.

1834. *Maeandra* (*Platygyra*, pars) Ehrenberg, non *Platygyra* Vaughan, 1901; nec *Platygyra* Brügge-mann, 1879.
 1848-1857. *Leptoria* Milne Edwards and Haime.
 1879a. *Leptoria* Klunzinger, p. 13.
 1899a. *Leptoria* Gardiner, p. 739.
 1904b. *Leptoria* Gardiner, p. 764.
 1918. *Leptoria* Vaughan, p. 117.
 1924. *Leptoria* Matthai, p. 25.
 1925. *Leptoria* Hoffmeister, p. 27.
 1927. *Leptoria* Faustino, p. 141.
 1928. *Platygyra* Matthai, p. 109.
 1936a. *Platygyra* Wells, p. 124.
 1936. *Platygyra* Yabe, Sugiyama and Eguchi, p. 38.
 1939. *Platygyra* Umbgrove, p. 33.

The genus having been known as *Leptoria* for 80 years, Matthai's unravelling of Ehrenberg's mistakes is nothing but a misfortune, a contravention of the rule that no change is to be made if greater confusion than uniformity will result. Matthai's discussion of Ehrenberg's confusion is a good example of the useless labour a rabbinical adherence to the rule of priority imposes upon men whose time is far too valuable for such rooting in old, and in this case, useless books.

I therefore return to the older name, and bring my work into line with that of the eminent workers of the past.

Matthai (1928), p. 112, writes: "*Platygyra* further differs from *Coeloria* inasmuch as the corallum usually grows to a larger size, is heavy . . ."

I find no record of the size to which *Leptoria* may grow except my own note of a specimen 2 or 3 feet across at Umm Qama'r, off Ghardaqa, which is much larger than numerous other specimens seen in that neighbourhood, on the *outer* reefs, and is trifling compared to numerous specimens of *Coeloria lamellina*. It is certainly heavy in comparison with *C. lamellina*, which, when dry, floats quite buoyantly. S. Manton's largest specimen (pl. xv) is 45×36 cm.

Leptoria phrygia (Ell. and Sol.).

Four specimens are present, all labelled as *Platygyra phrygia* by Matthai. In some specimens the distinction from *L. gracilis* is very vague, as I found was the case in the Red Sea. The specimens are numbered 10, 328 June Reef, 42 and 443.

Under the name *Platygyra* Stephenson and others give references to it on pp. 67, 86

and 88, as one of the animals characteristic of the seaward slopes and anchorage, of Yonge Reef and the reef patch at Lizard Island. S. Manton refers to it on 5 pages and 5 plates. Colonies 3–5 inches across occur in the moat, but are more frequent and larger between 860 and 960 feet on Traverse I, but it is infrequent on the seaward slope of Traverse II. It does not penetrate into deeper water on the windward side (Graph, pl. viii). It is mentioned as occurring in the moat of Yonge Reef. The plates show only rare small specimens, except the one on pl. xv mentioned above; it is evidently of no reef-building value here, or, apparently, elsewhere.

Distribution: Northern Red Sea, Indian Ocean, including Mauritius, and Pacific as far E. as Samoa.

Genus *Hydnophora*.

Hydnophora microconos (Lamk.).

One smooth little knob, No. 423, is all that represents the genus here, with a small specimen brought to me at Tahaiti by Mr. G. W. Otter, though there are a number of Australian records for *H. exesa* and *H. contignatio*. It is, however, possible that these species are not distinct.

This specimen is matched by Matthai's (1928), pl. xvii, fig. 1, for its general appearance and the monticles, but none of his enlarged figures show a similar thick and continuous columella, though fig. 7 on pl. xvi comes near. Vaughan's (1918) pl. 47, figs. 3 and 3a are similar.

Local distribution as in the preceding species, appearing also as one of the massive corals of the outer moat of Yonge Reef. S. Manton (1935, pl. xiv), shows only two tiny colonies on the crest, and pl. xv three in the moat of Yonge Reef.

Distribution: Northern Red Sea, throughout the Indian and Pacific Oceans as far E. as Samoa.

[Family MERULINIDAE.]

Genus *Merulina*.

Stephenson and others mention the genus as one which, on the seaward slopes and the anchorage, are characteristic of vertical or overhanging surfaces. It was also found on the Reef Patch at Lizard Island. S. Manton refers to it on p. 289 as occasional in the moat, and shows a fan-shaped colony, 18 cm. across, on the seaward slope of Traverse 1 on pl. xi.

Merulina ampliata (Ell. and Sol.).

Two small specimens and four scraps are labelled by Matthai, and No. 349 is well matched by Matthai (1928) on pl. xiii, figs. 1a, 1b, and B.M. No. 296 by pl. 59, fig. 4 (Dana's example of *M. ampliata*), except that the little knobby branches of the latter, which rise from the centre of the colony, are more marked in the Great Barrier Reef specimen, as are the deep radial wrinkles of the underside.

In a number of specimens in the Kóbenhavn Museum these curious knobby branches grow into large clusters, such as I have not seen illustrated, the nearest approach being Yabe, Sugiyama and Eguchi (1936), pl. 29, fig. 3. Thiel, pl. vii, figures a fairly large colony with numerous central branches, but of quite different form. I hope to discuss these Kóbenhavn specimens in a later work.

Specimen B.M. 296 is clearly Horst's *M. vaughani*, but Matthai (1928), pp. 130-131, pl. xiii, figs. 1-8, shows that the species grade into each other in respect to the sharpness or roundness of the ridges.

In such a variable genus, and in all genera in which branches rise from a basal plate, only whole, or nearly whole, coralla are really worth examination. If no basal plate is accessible, as in some large specimens of this genus, or, e.g., *Echinopora gemmacea*, the collector should note the fact. Gardiner notes huge colonies, such as no one else has seen, apparently without branches, "off the outer slope at Goidu (Maldives) this or a similar species is very abundant, forming foliaceous colonies two or three yards across and high."

Distribution: Red Sea (in the North a small scrap, probably semi-fossil), Maldives, common in Malaysia, several records from the Great Barrier Reef, and as far E. as Samoa.

[Family FUNGIIDAE.]

Fungia echinata (Pallas).

No. B.M. 280 has no Expedition label or note of locality. It is part of a large specimen, apparently the half; the piece is 15 cm. long \times 13 cm. broad; the whole would therefore be nearly as big as Döderlein's largest from Singapore.

Boschma in 1925 describes the difference between this species and *Herpetolitha simplex* Gard. In this specimen there is a tendency for the central groove to divide, it does not run out to the end of the calyx, all septa have well granulated sides, and the larger have well granulated teeth. The costal spines are conspicuously thick, of irregular length, spinulose, the costae themselves, though crowded, conspicuous from the edge to the centre, being clearly separated by deep slits, which, near the edge, make minute perforations. I find no figure exactly like this, Döderlein's taf. x, fig. 2a, being nearest, but the spines are considerably smaller than in the Great Barrier Reef specimen. There are some large specimens in the Kóbenhavn Museum from Singapore which are exactly like this of the Great Barrier Reef. Among them is one 39 cm. \times 18.5 cm., apparently the largest recorded (cf. Döderlein, p. 102).

Distribution: Red Sea to Tahaiti.

Fungia actiniformis Q. and G.

1902. Döderlein, p. 82, taf. vi, figs. 1-10.

The single specimen corresponds excellently with figs. 2 and 3 of the above plate. A photograph of an expanded specimen on the reef is given by Yonge in his book 'A Year on the Great Barrier Reef' opposite p. 63, and in (1930) pl. i, fig. 4; and by Saville Kent (1893) in pls. 93 and 94.

Distribution: As given by Döderlein only from the East Indian Islands, the Great Barrier, and as far east in the Pacific as Vanikoro (Santa Cruz Islands) and Rotuma. I distinctly remember it at Zanzibar, but it does not occur in the Red Sea or Tahaiti.

Fungia scutaria Lamarek.

Only one example of this easily recognized species was brought home, No. 275. The specimen is typical, with prominent tentacular lobes.

Distribution: From the Red Sea to the Hawaiian Islands; in Tahaiti along with the nearly related, if not identical, *F. paumotensis* (Boschma, 1929, p. 44).

Fungia paumotensis Stutchbury.

Specimen No. 258 is labelled ? *Fungia danai* by Matthai, but the equal-sized and equally spiny costae separate it from this species.

It is round, 75 mm. in diameter, thick and heavy, with the septa 25 mm. high. The under surface is flat but for depressed rings, 25, 13 and 7 mm. from the edge. The central scar projects slightly. I conclude that the specimen is abnormal, but nothing but its circular shape separates it from *F. paumotensis*. It corresponds especially well with Döderlein's (1902), Taf. vii, figs. 1 and 1a, in the arrangement of septa and their conspicuous synaptacula, and the freely projecting ends of the septa.

Distribution : Red Sea to Hawaii.

Fungia fungites (Linn.).

I place in this very variable genus 5 specimens, Nos. B.M. 386, one not numbered, and Nos. G.B.R. 86, 87, and P. 36. The first is labelled "night Fungia," the meaning of which I do not understand. They are between 75 and 145 mm. across. Of these G.B.R. 86 and 87 have been labelled "*F. repanda*" by Matthai and P. 36 *F. fungites*. Of the two former No. 86 is much like Döderlein's figure of *F. repanda* as regards the upper surface, but it is the spines of the lower which are decisive, and these are (1) pointed, (2) smooth, except sometimes minute granules on their points only, (3) not aggregated into continuous lines and clusters as in Döderlein's figures on pl. xii.

I do not attempt to arrange these specimens under Döderlein's varieties, as this has been found impossible by both Gardiner and Boschma, but remark that the smallest, B.M. 386, corresponds with Döderlein's (1902) figs. 4, 4a, pl. xx; the next, No. "0," to figs. 7, 7a; while P. 36, the only highly arched specimen, corresponds above with fig. 3, taf. xxi, but below is remarkably thickly covered with long pointed spines, not so crowded as to obscure the costae. No. 86 has the rather widely separated septa referred to above, the underside being like No. 0, but with larger spines, very like Döderlein's (1902) fig. 1a, pl. xxii. No. 87 is similar but coarser.

Distribution : I have already remarked in describing Forskaal's collection (1941, p. 40), "From numbers given by Gardiner (1908) this is much the commonest species in the Red Sea, and is distributed all over the Indo-Pacific, except the Hawaiian Islands." Boschma (1929) records it from the Marquesas, but not from Tahaiti, the only Tahaitian record being Dana's for his *F. discus*. It seems to diminish in numbers as it spreads east of the Great Barrier Reef.

Fungia cyclolites Lamarck.

1902. Döderlein, p. 77; taf. iv, figs. 7-9; taf. v, figs. 5, 5a.

1925. Boschma, p. 205, pl. v, fig. 24; pl. vi, figs. 25-48.

Stn. XIX, dredge, 26 specimens from 18 to 40 mm. \times 34 mm.; Stn. XXI, 3 specimens; Stn. XXII, 10 specimens; Stn. XXIII, 5 specimens.

The smallest are flat, the older highly arched, as usual. The prominence of the principal septa varies, the specimens from Stn. XXII being flatter, and with principal septa less prominent than those from Stns. XIX and XXIII. Costae are generally scarcely visible to the naked eye centrally, but are always clear under a lens.

Distribution : Red Sea, Indian Ocean, Gt. Barrier Reef, Philippines and China Sea, but not from Samoa and Tahaiti.

Fungia patelliformis Boschma.

(Plate XVI, fig. 1.)

1923. Boschma, p. 8, pl. ix, figs. 9, 11, 13-16a.

Stn. XVII, 5 specimens (2 in alcohol), also 3 with a label now illegible.

These correspond exactly with Boschma's description and figures. Two are broken into segments, and one has regenerated from a segment only 13 mm. wide and 27 mm. in radius; the regenerated circle being 43 mm. across, the original segment projects considerably from the regenerated part.

I give a photo of the largest specimen, 52 mm. across, by transmitted light, showing (1) the delicate yet imperforate base, (2) the junctions of the septa, (3) the columella.

Distribution: Common in Malay region. Occurs also in Samoa and Hawaii, but not recorded from Tahaiti.

Genus *Stephanophyllia*.

This genus was placed in the Eupsamiidae by Milne Edwards and Haime (1848), p. 93, and by Milne Edwards (1860) p. 109, who remark that it is the only one with discoid shape and horizontal wall. In this they have been followed by all authors except Boschma, who describes (1923, p. 16) a new species found amongst Horst's specimens of *Fungia patella*. I have never been able to see why *Stephanophyllia* should not be regarded as anything but a lightly built *Fungia*. Most species of *Fungia* have perforations, which, in *Stephanophyllia* are more numerous and wider than usual, a result of the light building of many deep water forms. These clearly defined holes, bounded by stout beams, appear to me quite another thing to the general sponginess of the perforata, and made in quite another way. Synaptacula are also conspicuous.

Stephanophyllia formosissima Moseley.

1881. Moseley, p. 201, pl. iv, fig. 11; pl. xiii, figs. 6, 7; pl. xvi, figs. 8, 9.

1907. Vaughan, p. 146, pl. xlv, figs. 2, 2a.

1939. Gardiner and Waugh, p. 234. (Occurrence only.)

One specimen from Stn. XV, dredge, B.M. 621, 25 mm. in diam. \times 5 mm. high.

It resembles Vaughan's Hawaiian examples rather than those of Moseley in that the primary and secondary septa are as high as the rest, and the overlaps of the septal junctions do not extend far from the columella. The elongated columella is peculiar, in that, while obviously formed of septal processes, much of it is fused into a solid tuberculate mass pierced with small holes.

Distribution.—Kei and Philippine Islands, E. African coast near Pemba, Hawaii, now Great Barrier Reef.

Herpolitha limax (Esper).

Only one specimen, from Lizard Island, "A" reef, No. 365.

It is one of those in which the septa alongside the central row of mouths are specially wide and prominent, their edges making a pair of flat bands along each side of the groove.

Horst (1921) gives, briefly, reasons for amalgamating the species *limax*, *foliosa*, *stricta* and *crassa*, the survivors of the eight names given in his list of 31 references. Independently I came to the same conclusion in 1931 (Horst's work not being accessible in Tahaiti), and

gave results in rather more detail (1931, p. 354). I have a note that, in the Red Sea at Ghardaqa, all specimens differ from those of Tahaiti in the solidity and the regular tothing of their septa, and in that bending towards the centres is rare.

S. Manton, p. 303, mentions it from Hedley and Taylor's work in 1907 on East Hope Isle; Stephenson and others, pp. 67 and 88, list it as found on seaward slopes and anchorage of Low Isles as well as on the Reef Patch at Lizard Island.

Distribution: Common a little below Low Water Springs from the northern Red Sea to Tahaiti.

Halomitra robusta Q.

1886. *Podobacia robusta* Quelch, p. 140, pl. vi, figs. 5-5b.
 1898. *Halomitra irregularis* Gardiner, p. 528, pl. lxiii, figs. 1, 2.
 1909. *Doderleinia irregularis* Gardiner, p. 282, pl. xxxix, figs. 25, 28.
 1921. *Doderleinia robusta, irregularis* and *sluiteri* Horst, pp. 17-19, pl. iv, figs. 1, 2.
 1925. *Halomitra robusta* Boschma, p. 242, pl. viii, figs. 99-104; pl. ix, figs. 107, 108, 112-16, 120, 122; pl. x, figs. 130-133.
 1929. *Halomitra robusta* Boschma, p. 46.
 1932. *Halomitra robusta* Thiel, p. 84 (with full synonymy), taf. xi, figs. 1, 2.
 1939. *Halomitra robusta* Umbgrove, p. 45, pl. xiv, figs. 1, 2.

Of five specimens labelled *Doderleinia irregularis* by Matthai, viz. "P. 27," and Nos. 19, 20 and 267, the fifth, No. 225, also labelled "portion of an attached funnel-shaped Fungiid" is a fragment of *Podobacia crustacea*. It has thick spinulose septal teeth and well roughened sides, a character of *Doderleinia*, which, as we have seen, is shared by several specimens of *Podobacia crustacea* which we have examined. If Matthai means by this that all the genera *Doderleinia*, *Halomitra* and *Podobacia* should be joined, there is everything in favour of his view.

The reasons for uniting all three species of *Doderleinia* under one, *Halomitra robusta*, are given by Boschma in 1925. I have also shown that the strength of tothing and spinulation of the septa is not even a specific character in *Podobacia*, and therefore cannot be a sufficient foundation for the generic separation of *Doderleinia*.

Boschma's account of variation in the genus leaves nothing to add. Of these specimens Nos. 19 and 267 are particularly rough and deformed, No. 20 is oval, somewhat flat, 23 cm. long \times 13 cm. wide, with a distinct central mouth, the subsidiaries being radial and many concentric.

Distribution.—East Indian Archipelago and Pacific, out to the Society Islands.

Polyphyllia talpina (Lamarck).

This species is not found in the collection but is recorded by S. Manton, p. 290, a large specimen 34 cm. \times 7 cm., on the muddy sea floor at the end of Traverse I. The form is so distinctive that the identification may be taken as reliable.

Distribution: Only from the East Indian Archipelago, Philippines and Murray Isl., Vanikoro, Santa Cruz Islands being the easternmost record.

Genus *Podobacia*.

The genera *Halomitra* and *Podobacia* have been united and again separated; at the present time they have been placed in distinct families, following Vaughan (1905), supported by Gardiner in 1905 and 1909.

We are on the horns of a dilemma : (1) The whole structure of species of the two sets is identical, down to small details. (2) Gardiner points out that, in spite of this, the union of the genera "implies that the budding off of *Halomitra* from a fixed stock took place absolutely independently of that of *Fungia*, and that *Podobacia* is a form which has retained the primitive fixed character." That is to say, it is impossible to separate the genera on any other character except that one lies loose while the other is attached, and impossible to unite them because of the extreme improbability of the evolution twice over of the reproduction of loose colonies from fixed stocks. The solution is that *Podobacia* is *secondarily* fixed, the descendant of a free form. The method of reproduction by successive sheddings of coralla from fixed stocks was evolved as *Fungia*, from which *Halomitra* is readily derived, especially since Boschma showed how readily *Fungia* itself may acquire accessory mouths. *Halomitra* then gave rise to species in which the calices are retained on the stock, their multiplication spreading into a plate instead of the original free form adapted to lying on sand ; this fixed plate is *Podobacia*. The two genera are thus very closely related, if not identical. Some of the other fixed Fungiidae may derive from free forms in the same way, possibly *Psammocora* from this genus.

Podobacia crustacea (Pallas).

(Plate XII, fig. 1 ; Plate XIII, fig. 3.)

Horst (1921, p. 26) gives 14 references to this species, amongst which I find only the following two reliable figures (the last, by Bedot, is, as all his photographs, specially good, but it is probably a different species, though too young for safe identification) : (1) 1883, Duncan, *Halomitra crustacea*, pl. vi. A young specimen with four rows of calices. Septo-costae arched. Underside with rounded ribs and well perforated. (2) 1905, Gardiner, p. 942, pl. 90, fig. 8. Gardiner had 20 specimens of this comparatively rare form from Goidu and Minikoi in the Maldives. It is not in the "Sealark" Collection. He gives only one figure, though stating that the variation in form, tothing of the larger septa and their granulation and spinulation, vary much. The figure shows septo-costae strongly arched between centres, which are near together. Details of tothing are missing.

Faustino's (1927, pl. 68, figs. 1 and 2) resemble this specimen, No. 36, more than do any other figures. He says that his example is like Dana's, whose description is inadequate, and who gives no figure.

Yabe, Sugiyama and Eguchi (1936, pl. 47, figs. 1-6) show excellently a specimen with thin arched septa, without teeth. Underside concentrically corrugated.

The species has only one mention in the ecological papers, viz., S. Manton (1935, pl. xii) shows one specimen, 45 cm. across, near the base of the pinnacle.

Specimen No. 36 is a portion of a saucer-shaped colony about 23 cm. across. The central calyx is not present.

The difference from all but Faustino's figure is in the flatness of the septo-costae, which begin at a low level on the distal side of each centre, rise gradually to a height of 2-3 mm., and drop suddenly to the next centre. The columella is a distinct style, rising from a flat fusion, in the well-developed centres. The underside of the plate is neglected in most descriptions ; in this case it is nearly smooth but for small spinulose projections, which sometimes fall into radial rows, but real ridges are found only within 1 cm. of the

edge. In place of perforations are small scattered round holes, not arranged in rows between ribs, and not perforating the plate, unless within 1 cm. of the edge.

As these peculiarities have not been described in other specimens I give illustrations on Plates XII-XIII. The figure of the upper surface is slightly oblique in order to show the shape of the septa and their tothing. As other photographs are taken perpendicularly to the surface they do not show details, so that Duncan's drawings remain the best illustrations, but the cup-shaped ends of the "ornamental granules of the free septal edge" have not been seen again.

Sample 225 B.M. 153 is a triangular fragment, 14 cm. measured circumferentially and 10 cm. radially, labelled "portion of an attached funnel-shaped Fungid." It is more normal than the other in that the septa are arched, project up to 5 mm. above the centres, are thick, have rough sides, and bear spinulose teeth. Columella none, or rudimentary, or bearing 1 to 3 small points.

No. 52: The smallest, lightly oval, 15 cm. in diameter, no central polyp, edges bent over downwards, as some of Gardiner's specimens. Septo-costae flat, rarely arched, no teeth, only numerous spinulations along their edges, like those of their sides. Primary septa often thickened. Columella always rudimentary, at best has no style. Underside much as in Great Barrier Reef specimen.

No. 46: 20 cm., \times 15 cm. A flat plate with two overlapping lobes. Base enwraps a dead branch of coral. Septo-costae sometimes arched, often flat, much thinner than in the Great Barrier Reef specimen. Sometimes toothed, but never so distinctly. In general much like No. 52.

No. 43: Two rather irregular plates from one base, like Faustino's figure, 39 cm. \times 27 cm. Edges folded. Much coarser with thicker septa than the other three. (This difference is therefore not due to age, as is already shown by Duncan's figure of a very young one.) Septo-costae not toothed as a rule, but if toothed teeth are low and indistinct. Columella rudimentary. Underside as above, but in places large warts bearing the usual spinulose projections.

No. 42 is a still larger specimen, folded in a complicated way. Some folds with very long septo-costae and very small centres, as in the overfolded part of 52. Septo-costae thinner than in No. 43 or G.B.R. As No. 52 or No. 46, they project little so the whole colony is smoother. Teeth thin, often indistinct. Underside with high ridges, 1 to 2 mm. high and the same distance apart, bearing large teeth with spinules. There are from one to three much smaller ridges between the high ridges. All become fainter after 5 cm. or so, but in places can be traced to the base. Usually base covered only by small, denticulate monticles as in the other specimens. In one area these are enlarged, but do not form warts.

I have also examined five specimens in the Museum of the University of K benhavn, all labelled *P. crustacea* from "Ostindien" or "Singapulra" and dated 1858 to 1872.

Specimen No. 36 is therefore a strongly marked variation, differing distinctly from the majority of those described and the specimens available to me for comparison; but it seems unlikely that it is an independent variety.

Distribution: Apparently always local; only once recorded as abundant (in the Maldives). Also Ceylon, Malaysia, Ryukyu Islands. Absent from the Red Sea and Pacific East of the Philippines.

[Family PECTINIIDAE.]

Genus *Oxypora* Kent.

1863. *Trachypora* Verrill, p. 53.
 1871. *Oxypora* Kent, p. 283.
 1879a. *Echinophyllia* Klunzinger, p. 69, pl. vi, fig. 8.
 1905. *Echinophyllia* Gardiner, p. 949, pl. 93, fig. 26.
 1935. *Echinophyllia* Crossland, p. 503, pl. 2.
 1935. *Oxyphyllia*, *Oxypora*, Yabe and Eguchi, p. 429.
 1936. *Oxypora* and *Oxyphyllia* Yabe, Sugiyama and Eguchi, pp. 50, 53.
 1936.* *Oxypora*, *Oxyphyllia* and *Echinophyllia* Vaughan and Wells. [Check list of Generic names.]
 1939. *Oxyphyllia* and *Oxypora* Umbgrove, pp. 40 and 41.

The confusion in the literature of this genus has justification in its complication in nature. For an example of the latter see the figure (1935, pl. ii) of my Tahaitian specimen, but it is also due to the fact that, although all the colonies I have seen are large, all the illustrations are from fragments of the edges, just as the Great Barrier Reef collection consists of a number of fragments, the largest 8 cm. across.

Consequently the five generic names, have been distributed among several families by Yabe, Sugiyama and Eguchi followed by Umbgrove. Vaughan and Wells, in their List of Generic Names of 15th June, 1936,* complicate the matter by recognizing both *Oxypora* Kent and *Echinophyllia* Klz. as valid, and *Oxyphyllia* as a synonym of the latter. This implies a difference between *Echinophyllia* and *Oxypora* which I am unable to find.

I propose therefore to emend Verrill's definition slightly thus: Growth form in thin free plates, never encrusting for more than a small part of the base,† Calices on one surface only; under-surface ribbed. Generally with slit-like perforations near edge and under centres, but these may be obscured by later growth. Septo-costae continuous from centre to centre, parallel between them, but at edges of centres bent towards the columella; this is especially striking where a rib passes the end of the usually transversely elongated columella, and where they together form an H-shaped structure. Theca absent or imperfect. Septa and septo-costae bear large spines with blunt ends; these are structural, not due to incision. Columella trabecular.

This definition may include other genera than those mentioned. It does *not* include *Echinopora*, which is an Astrean, whereas the septal arrangement of *Oxypora* is Fungiid. The generic distinction from such genera as *Mycedium*, *Leptoseris*, *Podobacia*, *Halomitra*, and others is largely in the spines of the septa and costae.

Oxypora lacera (Verrill).

Samples 28, 29 and 452 are all small scraps from young marginal growths. They show considerable variations, but there is no point in describing these without reference to whole colonies.

I refer to the species under Verrill's name and authorship, though the latter is an empty formality. The only real references are to Yabe, Sugiyama and Eguchi (1936), pl. xxxvii, figs. 1 and 2; and Umbgrove (1939), pl. xii, since no adequate written descrip-

* Distributed privately in advance of the "main body of the revision," which was published in 1943.—[A.K.T.]

† So far as present knowledge goes, and *pace* Ellis and Solander (1786), taf. 39. Compare *Echinopora gemmacea*, of which almost all examples are encrusting some with free edges. Exceptionally some may be free but for a small attachment. (See Crossland, 1935.)

tion of the species exists. It is unknown whether Klunzinger's *E. espera*, Gardiner's *E. espera* (*sic*) and Matthai's *Mycedium aspera* are all the same species or not, and the material for determination apparently does not exist. A step might be taken if I had access to my Ghardaqa specimens. To found anything upon such accounts as are given by Ellis, Duncan, Verrill, Schweigger and Dana is impossible, Ellis's figure is of the roughest, and his description *nil*. Verrill's description is good (with modifications) for the genus, but will include any species hereafter to be described. The first descriptions of any value are those by Klunzinger and Gardiner, but the identity of their species with those of Ellis and Verrill is apparently based on the supposition that only two species of the genus, doubtfully distinct, existed or would be discovered in the future.

Oxypora aspera (Ell. and Sol.).

1939. *Oxyphyllia aspera* Umbgrove, p. 40, pl. x, figs. 1, 2.

I have pointed out the identity of these two genera, the latter of which Vaughan and Wells identify with *Echinophyllia*. With the same proviso as in the preceding species I refer sample 84 to Umbgrove's (1939) fig. 2 on pl. x, which it exactly resembles. Information as to what the rest of the colony was like is shown in Umbgrove's fig. 1, though this is badly printed. The relationship to *Mycedium* is evident.

One end of the small Great Barrier Reef sample No. 84 is thinner and more like the usual growth of the genus, and here are calices without walls and with long septal teeth. These teeth correspond to the upper thinner free portions of the septa conspicuous in Umbgrove's fig. 2, as is shown by a single calyx of intermediate structure. Teeth on the costae are comparatively small in the sample No. 84, and in Umbgrove's and Yabe, Sugiyama and Eguchi's figures, which makes it almost certainly not the species Ellis deals with.

Genus *Tridacophyllia*.

The name *Tridacophyllia* was exchanged with *Pectinia* Oken by Vaughan in 1901, but as the former has been in constant use since 1830, the change can only cause more confusion than uniformity, and is therefore contrary to the rules of nomenclature. Matthai (1928), Yonge (1930), Thiel (1932), Yabe, Sugiyama and Eguchi (1936) and Umbgrove (1939), all retain the well-known name.

Matthai (1928) p. 262 writes: "This genus is usually placed in the family *Astraeidae*, but it seems to be related also to certain colonial *Fungiids*. Its systematic position can, therefore, be ascertained only after a comparative study of the latter group." Yonge (1930), 'Physiology of Corals,' I, p. 29, in this series, in a note says, "I am uncertain whether this genus should be considered here or under the *Mussidae*; in any case the two families have a great deal in common."

I unhesitatingly place the genus in the *Fungiidae* for two reasons: (1) The arrangement of the septo-costae and columellae of the secondary centres on the leafy expansions are certainly *Fungiid*, generally showing the characteristic H-form. Those of the main polyps are, as usual, regular, the genus differing from, *e.g.*, *Podobacia* and *Leptoseris* in that there are many, instead of only one, primary polyp. (2) The method of feeding, as described by Yonge, is surely *Fungiid*. If it were of the *Astrean* or *Mussid* type, the mouths and minute tentacles, placed deep among the leafy expansions, would get no food, but,

as things are, these expansions are themselves the food-capturing organs. The long series of specimens in the Kóbenhavn Museum shows a curious morphological fact, viz., that the "leaves" are all enormously overgrown septa, so that of the hundreds of calices in a large colony, only a few primaries have any connection with the theca. This is quite clear in young colonies (such as those figured by Matthai in 1924), and the fully grown colonies may be compared to a bowl, an enormous theca, filled and overflowing with a mass of huge leafy septa, with many mouths, both principal and secondary. It of course makes no morphological difference that, in many cases, this bowl is cut up into branching segments.

I hope later to describe this Kóbenhavn series and give full proofs later. From this I am inclined to doubt whether such species as *T. alcicornis* Kent, *T. cervicornis* Moseley and *T. primordialis* Gard. really belong to this genus, since their outgrowths are thecal. The name *T. alcicornis* Kent has been given to a Japanese species by Yabe, Sugiyama and Eguchi, but I doubt its identity.

A revision of the genus was undertaken by Thiel in 1932 (pp. 96-103), but it is rendered invalid by his taking the symphyloïd form as primitive, and, apparently, deriving the genus from the meandroid astreae through this. His speculations on the biological value of the "leaves" were written before we had Yonge's work on the feeding arrangements. The names given below are provisional.

Tridacophyllia lactuca (Ell. and Sol.).

1786. Ellis and Solander, pl. 44.

1849. Milne Edwards, in : Cuvier, 1836-49, pl. 84.

No. 417, a small distorted and partially diseased colony is probably of this species. The expansions bear secondary centres, and both these and the principals are loosely made by meetings of the widely separated septa, and neither have any columellae. All the expansions are thin.

Distribution : Indian Ocean to Fiji, reaching its greatest abundance in Malaysia.

Tridacophyllia paeonia Dana.

1927. Faustino, p. 160, pl. 42, fig. 1. (The only published figure giving details).

No. B.M. 493 from Stn. XX (Yonge gives 6 fms. off Eagle Island) is labelled *T. lactuca* (Pall.) by Matthai. *P. paeonia* is probably only a variety, but provisionally I find that this specimen corresponds exactly with Dana's and Faustino's descriptions and Faustino's figure pl. 42, fig. 1. I add that the differences from *T. lactuca* appear to be (1) the thickness of the septa and their prolongations, which are as often pillar-like as plate-shaped, e.g., measuring 13×4 mm. in section, or round and 5 mm. thick and *solid*; and (2) the well-developed columellae, of thin, closely packed trabeculae. The way in which the septa at the edges of the colony draw out the theca recalls Kent's *T. alcicornis*.

Distribution : Fiji and Southern Philippines; now G.B.R.

[Family AGARICIIDAE.]

Genus *Pavona*.

The distribution in quantity of the species of this genus is exceptionally interesting. In the Northern Red Sea it is rare, the specimens seen at Ghardaqa numbering about four,

but it may grow to a considerable size, as examples in the raised reefs show. Similarly on the Great Barrier Reef, though Stephenson and others mention the genus five times (the specimens come from five scattered localities, *viz.*, Low Isles, Three Isles, Lizard Island, and Yonge and Batt Reefs), S. Manton, in her detailed ecological surveys, met it only once (pl. xi). On the other hand, Gardiner found both solid and leafy forms common in Fiji and Rotuma, while in the Maldives only *P. varians* (*P. repens* Brüg.) and other solid forms are important builders. In Hawaii only two solid forms are present, but not in any abundance. Both forms are abundant in most places in the Pacific, perhaps reaching a climax in Tahaiti, where many lagoon reefs are practically made of leafy species of *Pavona* and *Porites* (*Synaraca*) *convexa* alone. These leafy Pavonas are good builders; they appear fragile, but in fact one can walk on most of them without doing much damage.

It is deeply regretted that Matthai's revision of the family was interrupted by the war.

Pavona decussata Dana.

One specimen, No. 260, is the only leafy *Pavona* in the collection. Hoffmeister (1925, pp. 40, 41) discusses at length the relationship of this species to *P. danai*, concluding that they are the same; Vaughan (1918, p. 137) keeps them distinct, though remarking on their relationship; his figure of *P. danai* on pl. 55 resembles *P. decussata*, and is widely different from the type of *P. danai* on pl. 56. Horst (1921, p. 22) keeps the species distinct, though considering them "nearly related." I leave the point without coming to a decision, only remarking that (1) Small scraps should all be destroyed, or at least, left out of consideration. (2) Vaughan's figures of *P. danai* are objected to by Hoffmeister as being of very young specimens. Photographs of fully adult specimens of *P. danai* are published in my description of Forskaal's collection, copies of which were sent to Vaughan and Matthai in August, 1939. The former agrees that Faustino's *P. cactus* is the same as Milne Edwards and Haime's *P. danai*, the latter that it falls within the limits of *P. cactus*. If so it seems as if Matthai were preparing to run nearly all the leafy species of *Pavona* into one. We await his evidence, which we trust will be given in full.

The present specimen is rather remarkable for the delicacy of the septa, the alternate ones being extremely thin as well as narrow, and for the prominence of the principal septa near the columellar pit, the latter feature giving the surface of the leaves a character visible to the naked eye. These are characters of *P. venusta* Dana (Vaughan, 1918, p. 136), a species never figured, until Horst (1922, pl. 31, figs. 1, 2) did so. These show the narrow curled leaves described by Dana, so different from those in *P. decussata*.

Distribution : Red Sea, Indian Ocean, Malaysia, Rotuma and Samoa.

Pavona danai M. E. and H.

A single large leaf, 8 cm. high \times 9 cm. broad, is thus labelled by Matthai. It differs from most specimens of *P. danai* in its thickness and weight, the small size and blunt edges of its marginal lobes, the few thick septa (the alternating thin ones being generally absent) and the absence of a columellar tubercle, the deeply placed columella being only an irregular fusion of septal ends. (See remarks under *P. decussata*.)

Distribution : Northern Red Sea to Tahaiti, the latter locality based on an identification by Matthai.

(?) *Pavona cactus* M. E. and H.

Two small and very thick fragments : (1) from Batt Reef Patch No. 1 (the common species labelled by Matthai ? *Pavona cactus* (Forsk.). (2) No. 223 from T2 deep (without the ? mark). I agree that this is probably the species named by Matthai, but alter the author's name to M. E. and H., since Forskaal's species is *P. danai*. It would be correct to suppress the name *cactus* altogether, but this would cause much confusion.

Distribution : Indo-Pacific.

Pavona varians Verrill, 1864.

(Plate XIII, figs. 1, 2 ; Plate XIV, fig. 4.)

Three very distinct forms of this astonishing species are present :

Form A, No. 55 : The commoner of the three, but the most striking. It is an irregular mass, apparently a thick crust over branches of a dead coral. In places it is almost smooth, in others it has sharp ridges which, on the upper parts, are 5 mm. high (at one point 15 mm.). These bear calices after the fashion of the leafy species.

I am surprised to find only one illustration comparable to this (Horst, 1922, pl. 31, fig. 3), as I found similar curious intermediates between plain crusts and leaves not uncommon in Tahaiti. Horst's figure is not very good.

In both this and Horst's specimen the leafy expansions develop at the apices of lobes, as would be expected ; the high ridges result from vigorous growth in positions where horizontal expansion is no longer possible. We find the same thing in many other corals, e.g., *Montipora*, *Merulina* and *Echinopora*, and other encrusting organisms such as Polyzoa.

Form B, No. 117 (Plate XIII, figs. 1, 2) : This is a rare form, so distinct that a special name may be desirable, in which case I suppose var. *obtusata* would be correct. Its synonymy has been confused by Quelch's imperfect illustrations.

1886. *Tichoseris obtusata* Quelch, p. 114, pl. v, figs. 3-3c.

1898. *Pavona calcifera* Gardiner, p. 532, pl. xlv, fig. 4.

1905. *Pavona repens* Gardiner, p. 946, pl. xc, figs. 9-11.

1907. *Pavona varians* Vaughan, p. 135, pl. xxxviii, figs. 1, 1a.

1918. *Pavona varians* Vaughan, p. 138, pl. 57 (7 figs.).

1936. *Polyastra obtusata* Wells, p. 551, pl. ix, figs. 1, 2.

The general appearance of this specimen is illustrated by Gardiner (1905, pl. xc, fig. 11) ; details by figures quoted below. It is uniform in structure over the whole mass, which is a rounded ridge 9 cm. high \times 9 cm. broad, and about 6 cm. thick. Its infestation by a serpulid and several cirripedes has had no effect either on form or on details of the calices.

The resuscitation by Wells of Ehrenberg's and Quelch's names, so deservedly sunk into oblivion, is nothing but a misfortune.

The invalidity of the genus *Polyastra* had already been shown by data given by Gardiner (1898), and a glance at Vaughan's (1918) pl. 56, figs. 3a, 3b, would have been sufficiently convincing. Wells's fig. 3, pl. ix of Quelch's *Tichoseris obtusata* is so exactly like Gardiner's 1898, P.Z.S., pl. xlv, fig. 4 of his *P. calcifera* as to return Quelch's name to oblivion finally. This paper is apparently unknown to Wells.

I should have been inclined to keep Gardiner's species *P. calcifera* had he not himself in 1905 incorporated his closely allied *P. intermedia* into *P. repens* (which is *P. varians*).

No. B.M. 265 (Batt Reef, Patch 1, Square 4) is similar but small, irregular and of coarser growth, and much infested by a cirripede.

Form C: Sample 251 is a thin crust of a more usual form, in which the calices are in valleys, few having separate walls.

Distribution: Northern Red Sea, Indian Ocean, Pacific to Tahiti and Hawaii.

[In the course of unpacking at the B.M. (Nat. Hist.) during January, 1950, of the Gardiner Bequest of corals from Cambridge there came to light what appears to be an important G.B.R.E. specimen "47." On one side of the label in C. Crossland's handwriting in ink appears: "*Pavona?* *varians*, see other labels. G. W. Otter, Gt. Barrier Rf. Expedn., Low Island." In the corner is pencilled "47." On the other side in G. Matthai's handwriting in pencil is: "*Pavona varians* (Verrill). This is an important specimen, as it shows the transition from the *Pavona varians* (Verrill) condition to the *Pavona ponderosa* (Gard.) condition. Note formation of corallites by intersection of radiating ridges and concentric collines. Photo—47a, nat. size. Photo—47b, nat. size. G.M."—[A.K.T.]

Pavona duerdeni Vaughan.

1907. Vaughan, p. 135, pl. 38, figs. 2, 2a and 3.
 1918. Vaughan, p. 135, table of species and footnote.
 1922. Horst, p. 420 (synonymy), pl. 31, fig. 7.

I consider that Horst is over-precipitate in combining this species with Dana's *P. clavus* and Gardiner's (1905) *Siderastrea maldivensis*. Vaughan, in his synopsis, gives a note that *clavus*, *duerdeni* and *maldivensis* are probably synonyms of *P. explanulata*, but no evidence has since been given.

Sample No. 427 is a flattish stone, heavy for its size, rather irregular in outline owing to projecting angles (probably due to cirripedes and serpulids, of which a number are visible on the surface). It lay loose on the bottom, and is completely covered with healthy calices of practically uniform structure on every side and not modified by the presence of parasites. There are a few low rounded ridges in places, recalling *P. varians*.

This specimen corresponds perfectly with Vaughan's of 1907 except in form. Septa of the third cycle, when present, are so thin as to resemble white hairs, and some of the ordinary septa have prolongations of the same kind. Particularly important is the structure of the walls; all are thick and homogeneous, but while some are solid, others are plainly made of synapticula. In no case are they loose or thin as in Horst's pl. 31, fig. 7, or Vaughan's pl. 56, fig. 3b.* The septa are never thick as in fig. 3a, nor are there projecting cushion-shaped sets of septa, or cut-off septa and costae as in Gardiner's (1905) pl. 89, figs. 2 and 3.

It is impossible to agree, in the absence of cogent evidence, that every solid *Pavona* with synapticular walls, whatever the form of those walls, of their septa, calices and costae, is of the species *P. clavus*. In fact I doubt if this species has been seen since Dana's time. If the present specimen is a synonym of anything it is yet another variety of *P. varians*.

Distribution: Hawaii and now G.B.R.

Genus *Pachyseris*.

The uniqueness of the skeleton needs no comment; and for the complete difference between the polyps and their feeding methods from those of all other corals see Yonge, vol. i, p. 42.

* Crossland's typescript said "fig. 7," but he did not specify which paper of Vaughan he was quoting. The seventh figure on pl. 56 (1918) is marked 3b, *Pavona maldivensis* (Gardiner).—[A.K.T.]

Stephenson and others give references to it on pp. 67 and 87, as one of the corals characteristic of seaward slopes and anchorages, and of the fringing reef at Lizard Island. It is evidently rare, as usual, as S. Manton does not mention it.

Pachyseris speciosa (Dana).

Sample No. 451, a deeply folded fragment, is typical of this species. No. 444, another fragment, has the same form of columella, but the ridges are vertical, thin, high and sharp-edged. They measure (in sections) 5–6 mm. high, 2 mm. thick at the base, and 1 mm. at the top, which is rounded. There are 7 ridges in 2 cm. Only at the extreme edge of the plate are the ridges low, rounded and steeper on one side than the other, in the typical way.

Two specimens from Singapore in the Kóbenhavn Museum show the variation in the height and sharpness of the ridges noticed by other authors (Horst, especially, 1921, p. 35), but the highest hardly rival those of the Great Barrier Reef specimen. In one specimen all the ridges are high and valleys narrow.

Distribution: Northern Red Sea, Indian Ocean and Pacific as far east as Tahaiti; but not Hawaii.

Pachyseris torresiana Vaughan.

1918. Vaughan, T. W., p. 132, pl. 55, figs. 1, 1a.

Specimen 16, thus labelled by Matthai, is four small fragments, which fit together. The ridges are triangular, mostly very oblique, none high. Columella plate-like, interrupted by mouth centres.

My only Tahaitian example of this genus seemed to me to combine the characters of this species with those of *P. speciosa*. The species is not recognized by Hoffmeister, while Horst thinks it may be identical with *P. rugosa*. I think the species should stand till more evidence is available.

Distribution: Great Barrier Reef, Timor, and Tahaiti.

Genus *Coeloseris* Vaughan.

Coeloseris mayeri Vaughan.

1918. Vaughan, T. W., p. 139, pl. 58, figs. 1–3b.

1924. Matthai, p. 56

1936. Yabe, Sugiyama and Eguchi, p. 63

1939. Umbgrove, p. 53

} These are records of
} occurrence only.

Only one fragment, No. 405, 6 cm. across \times 3 cm. thick, broken from a larger mass. It is evidently rare on the Great Barrier Reef, as it is not referred to in either of the ecological papers.

This piece is all of the light type, with thin walls and thin septa, like Vaughan's fig. 1a, so does not show the thickening of the inner part of the curved septa so often characteristic.

Distribution: Bay of Bengal,* Batavia, Murray Island, Southern Philippines, Palau, Riu Kiu Islands and Taiwan.

* The record of occurrence in the Bay of Bengal is due to Matthai who, in 1924, found a specimen in the Indian Museum labelled "Arracan," a place not to be found in an ordinarily good atlas. In an exceptional atlas Arakan is found, a large estuary on the Burmese coast, 20° N.—a most unlikely place for corals!

[Family SIDERASTREIDAE.]

Anomastrea irregularis Marenzeller.

1901. Marenzeller, p. 125, figs. 3, 3a.

One tiny, but typical specimen, of 6 full-sized calices and some marginal buds on a mass of lithothamnion dredged from Station XVI. It differs from the type in the regularity of the calices, and in that the septa of the first cycle and part of the second are a little thicker and slightly more prominent than the others. These are the characters of youth.

Distribution: Equatorial East Africa and Natal (collected by T. A. Stephenson). This is the third record.

[Family THAMNASTREIDAE.]

Genus *Psammocora*.*Psammocora contigua* (Esper.).

(Plate XV, figs. 4 and 5; Plate XVII, fig. 3.)

Two small pieces, both alike, numbered 11 and 18, and a third, B.M. 417 "Low Island Reef" and No. P.25. The species is fairly common in the deeper part of the moat, but not elsewhere, but even in the moat it is common only in places (S. Manton, pp. 284 and 288, pls. iii and ix; Stephenson and others, p. 49; under the name *Ps. gonagra*.)

Three pieces are named *Ps. gonagra* Klz. by Matthai, a name rarely used since Klunzinger's time. Vaughan's (1918) pl. 59, fig. 1, is difficult to reconcile with Klunzinger's taf. ix, fig. 1, with its thin septa, flat net-like coenenchyme, and much smaller calices; but examination under a lens of the upper right-hand part of Klunzinger's photograph shows a greater resemblance. In fact the type specimen is abnormally variable; having been collected at Qoseir it is almost certainly a rough-water form, probably of *Ps. contigua*; but discussion of synonymy without work on the reef is futile.

It is curious that figures of this common and oft-described species should be incomplete. Hoffmeister's figures of Samoan specimens (1925, pl. 5, figs. 1a, 1b) and Faustino's (1927, pl. 70,) are the best, but the former is abnormally branched, and the latter shows only the outside of a colony. The present specimens 17 and 18 are so exactly like the one Esper figures that I give photographs corresponding to his figs. 1 and 2 (1795, pl. lxxvi). These show the outer side of specimen 11, and the inner side a broad flat branch with its distinct rows of "stars"; also enlarged views of these latter. Those on the upper parts are similar, but rougher and looser.

Distribution: Red Sea (?); through the Indian Ocean to Mauritius (Stephenson's unpublished collection), Malaysia and the Pacific to Tahiti and the Marquesas, but not to Hawaii.

Psammocora exesa Dana.

(Plate XVI, figs. 2 and 3; Plate XVII, fig. 4.)

1846. Dana, pl. 26, fig. 1 a-c.

1905. Gardiner, J. S., p. 952, pl. xcii, fig. 22.

1936. Yabe, Sugiyama and Eguchi, pl. xlv, figs. 3 and 4.

One good specimen, No. 17, 14 cm. high and 10 cm. wide at the base, and a scrap, "P. 26. Outside rampart Low Isl." The latter is given this name with a query by VI, 3.

Matthai. It is certainly this species, but is a younger growth, with looser structure, *i.e.*, thinner septa, more spicular tothing and looser structures between the centres. Only in certain places does it resemble Gardiner's figure quoted above, but neither in this figure nor the present specimens do I find "interseptal spaces relatively large, at least of the same breadth as the septa." This specimen might be worth describing in detail were it complete. It would not, however, form a link with Quelch's "Challenger" specimen (p. 128, no figure), which I do not believe to be of this species.

Specimen 17 corresponds well with Yabe, Sugiyama and Eguchi's figures, which show part of a colony of columnar growth and calices (magnified 3 times). In the extreme coarseness of the septa, etc., it exceeds that of Gardiner's and Dana's figures. It does not, however, show the thick teeth, so closely placed as to leave only a series of narrow transverse cuts between them (pl. xvi, figs. 2, 3). The present specimen, No. 17, is nearly complete, as shown by its unattached spreading base (pl. xvii, fig. 4). It was growing over two dead columns of *Helipora*, and doubtless owes its form partly to this, but not entirely, as the three small humps on the basal expansion are quite independent.

It is remarkable that the characters of the septa remain the same over the whole colony, except on the tops of the columns, where, as expected, the whole structure is looser and lighter, as in the other specimen.

Distribution: Never abundant. Indian Ocean (Maldives); Pacific only as far east as Fiji.

[Family AGATHIPHYLLIIDAE.]

Genus *Diploastrea* Matthai, 1914, p. 72.

1816. *Diploastrea heliopora* (Lmk.), ii, p. 265.

This species is one of the few corals immediately recognizable, and which has been given this specific name by almost all authors. The numerous figures published show no striking variation: only the tothing of the septa may be more or less pronounced. This uniformity may be correlated with the fact that the species was an important member of the Oligocene coral fauna, and it has therefore had time in which to become stabilized. It occurs in great masses where it establishes itself, but elsewhere it is rare. For instance, Umbgrove (1939, p. 42) never collected it himself in the Bay of Batavia, but saw it being brought ashore for road-making! Similarly at Low Isles it is a rarity, mentioned once by Stephenson and others but not by S. Manton. The former authors (p. 88) refer to reef patches near Lizard Island, "a notable mass of coral many feet deep, square yards of which were covered by a living colony of *D. heliopora*."

Distribution: From the Gulf of Aden (Jibuti) to Samoa; but not reported from the Red Sea or Equatorial East Africa. It does not occur in Tahiti.

[Family DENDROPHYLLIIDAE.]

Balanophyllia incisa, sp. n.

(Plate XV, figs. 1 and 2.)

This species is branched, and therefore would usually be placed in the genus *Dendrophyllia*, but, as Plate XV, fig. 2, shows, its branching is an entirely different thing from that of such species as *D. micranthus*, in which a special elongated polyp forms the stem

and its lateral buds the branches and twigs; or such as *D. axifuga*, which is more or less dichotomous. I therefore retain this new species in the genus *Balanophyllia*.

Two small broken scraps are present, which, by good fortune, fit together. There is no number but B.M. 369, and no note of habitat, but the following description of the colour is given on the label: "Colony of a uniform combination of orange and carmine (nearly vermilion). Polyp carmine in its depth, modulating through light shades to white at its edges. Base of colony brownish."

I have one complete, undamaged calyx, the half of one of its buds, and a much broken second bud on which to describe the species. Fortunately it is distinctive, the compression and lateral outline of the calyx being unique. The main calyx measures 17 mm. \times 7 mm. and is 10 mm. deep if measured at the middle of one side; but at one end the wall rises only 3 mm. above the columella and even less at the other. The half of the second, much smaller calyx, the first bud, shows a similar, but less pronounced form; it is usual in most species for the younger calices to be more nearly round.

The wall is highly perforated, the part above the columella translucent. Costal ridges corresponding to the 12 principal septa are prominent. Between them is a coarse branching reticulum with a mere tendency to vertical lines. On the buds the ridging is more regular. The lower part is nearly smooth, being covered by a dense epitheca. At the same time the walls, septa and columella thicken below, and, with the epitheca, make an almost solid stem. This, like the bases of the buds, is nearly round, and is 9 mm. in diameter. The 12 septa of the first two cycles are of nearly, but not quite, equal size. Between them are the 3rd and 4th cycles, the former short and cut off by the meeting of the septa of the 4th cycle at half to one-third the distance below the top of the wall. In one loculus a septum of the 5th cycle is present, in another both 5th and 6th on one side of the 3rd. The upper ends of the 4th cycle run close alongside and fuse to those of the first two cycles, and with them form the prominent projections of the walls shown on the plate.

All septa are fairly thin and rough, with coarse tubercles, especially at their upper ends, which, like the walls, are abundantly perforated. Septa of lower cycles toothed, but these teeth appear to be perforations which have not closed up laterally.

Balanophyllia yongei, sp. n.

(Plate XIV, fig. 2; Plate XV, fig. 3.)

Seven adult and four young specimens were obtained by dredging at Stn. IX. All grew alone but one, which seems to bear a lateral bud at its base, but some sort of abnormal epithecal deposit hides the actual junction.

Two adult and three young are attached to lamellibranch shells; one has settled upon a dead example of the same species (it is quite clearly not a bud), one is on a fragment of yellow calcareous sandstone (probably consolidated coral mud), and two have their bases broken off.

Three of the specimens have been named *B. bairdiana* by Prof. Matthai. Milne Edwards and Haime's (1860) description (III, p. 103) is too brief, and has no figure. We have only the account of Moseley (1881, p. 190), who had access to the type, "which is not in good condition." The following are the differences from the present species. (Compare

Plate XV, fig. 3, with "Challenger," pl. xii, fig. 4.) Ends of longer axis much lower than those of the short.

"Calicle in the adult irregularly elliptical in outline, being angular at the ends of the long axis." The "Challenger" figure shows straight parallel sides with slightly pointed ends. The present specimens are generally regularly oval, but in three cases one end is rather blunter than the other. Principal septa slightly or considerably projecting, their costae decidedly the more prominent. They are straight, or sometimes *slightly* curved, and are twice as wide as those of the third series.

"Columella spongy, well developed, flat at the bottom of the fossa." Milne Edwards and Haime say "peu développée." It is fairly well developed and flat in these specimens, but less so than in Moseley's figure (1881, fig. 5, pl. xii), and quite without the lateral extensions shown in this figure, and the diagram of the septal arrangements on p. 191. Even in those specimens with thick and very spinulose septa, where in consequence the fusion of the septa of the 3rd and 4th cycles is at its greatest thickness, "their junctions are 'not' thickened by processes of the spongy columellar substance," such as is shown clearly in Moseley's plate.

In normal specimens with thin septa the fusion remains thin and keeled, and the septum of the 3rd cycle runs distinctly through it to the columella; on rare occasions it first joins, but does not interrupt, a 2nd cycle septum immediately above the columella.

Milne Edwards and Haime's type is about twice the size (area of calicle) of either Moseley's or of these specimens. It is also significant that Moseley's examples 'are from Bass Straits and Port Jackson, which are in a different current system to that of the tropical Pacific.

Measurements of the 7 adult calices in mm. :

- No. 1. 13 × 10 × 14. 3rd order with entire margins. Septa thin, and finely spinulate.
2. 12 × 9 × 13. 3rd order toothed. Septa thin, and finely spinulate.
3. 12 × 9 × 16. 3rd order toothed.
4. 13 × 9 (broken). Sometimes toothed. Septa thin, and finely spinulate.
5. 14 × 9 × 17. Slightly toothed.
- 6.* 15 × 9 × 20. Always toothed. Septa thick, coarsely spinulate.
7. 13 × 8 (broken). Sometimes slightly. Septa thick, coarsely spinulate.

* No. 6 is chosen as the holotype.—[A.K.T.]

The heights cannot be measured accurately owing to the widely spreading base, which often includes projections of the substratum.

These proportions agree fairly with Moseley's measurements. On p. 191 he gives ratio of axes as 100 : 200, but the measurements of his larger specimen are 14 mm. × 8 mm., say 100 : 175. Milne Edwards and Haime give 22 mm. × 12 mm., or 100 : 185. Besides this variation in measurements there is a considerable other variation in these seven adult specimens. No. 3 is remarkable for the breadth of its principal septa, which, however, remain thin. In Nos. 5, 7 and 6, in this order, they thicken, become more coarsely spinulate and perforate, and spongy near the upper edge of the walls. The

projection of the walls at the junction of the principal septa is variable, usually very slight, but in No. 6 so considerable as to deserve illustration (Plate XIV, fig. 2). In this and the thickness and spinulation of the septa it approaches *D. incisa*.

The younger specimens differ in the usual way from the adult.

(1) The largest, 8 mm. \times 7 mm., and 11 mm. high, is alone on a shell. Septa thin but with conspicuous spinules. Septa of second order joined by those of the third, and third by fourth high up the walls, the latter near the edge of the calyx. Columella well developed but loose.

(2) A second, 7 mm. \times 5 mm., growing on the side of No. 1, but probably *not* a bud. Septa thin and spinules small and inconspicuous. Septa of three cycles meet the columella, 3rd joined by 4th high up. Columella very loose.

(3) The next smaller is damaged. It is practically round.

(4) A round specimen, 4 mm. in diameter, alone on a small *Anomia* shell. Septa of second order met by the third high up on the wall. Fourth present as rudiments only in three loculi.

Genus *Dendrophyllia*.

The genus can only be defined as a colonial *Balanophyllia*, with colonies either encrusting or arborescent. Such a definition is unsatisfactory, being without morphological foundation. See J. S. Gardiner in "John Murray," 1939, p. 237, on *D. horsti*, and compare the figures of this species on pl. ii with those of *B. diffusa*, immediately above them—a comparison which illustrates perfectly the difficulty of the distinction, especially as the septal arrangements of these two species are of the same type.

It is conceivable that a distinction might be found between those species in which, in fully developed calices, the first three cycles of septa do not meet before joining the columella, and those in which some cycles meet, cutting off one or more of the lower cycles. Any two genera so founded would, of course, include both simple and compound species.

The species fall into three groups according to colour :

(1) *Orange to vermilion*, tentacles often pure yellow. Abundant as crusts and rounded masses under stones or corals in all warm seas—*e.g.*, Cape Verde Islands—under bottoms of coal lighters and under stones just below Low Water Springs. At the mouth of the harbour in masses of branched forms at Low Water Springs, the only time it has ever been seen exposed to light. Panama, under stones, abundant, never exposed to light. Also in the Red Sea, in a similar habitat ; and generally through the Indo-Pacific, including Hawaii ; but none from the Great Barrier Reef collections or from the Murray Islands. Branched orange vermilion forms are from deeper water, and of these two species are here.

(2) *Black* (the "*nigrescens*" group). In rather deeper water, not in the shade, branched. Stunted black specimens in habitat (1) are quite exceptional, if they ever occur. These species are very much more rare than those of group (1), and I have seen them only in the Northern Red Sea.

(3) *Brown*. In deep water, branched. Occasional brown specimens of group (1) are very exceptional.

These colours are protective against actinic light ; the orange is exactly the colour of the paper in which photographic plates were wrapped 30 years ago. This light protection is obviously correlated in some way with the absence of zoochlorellae.

Dendrophyllia arbuscula Horst.

1922a. Horst, p. 53, pl. viii, fig. 6.

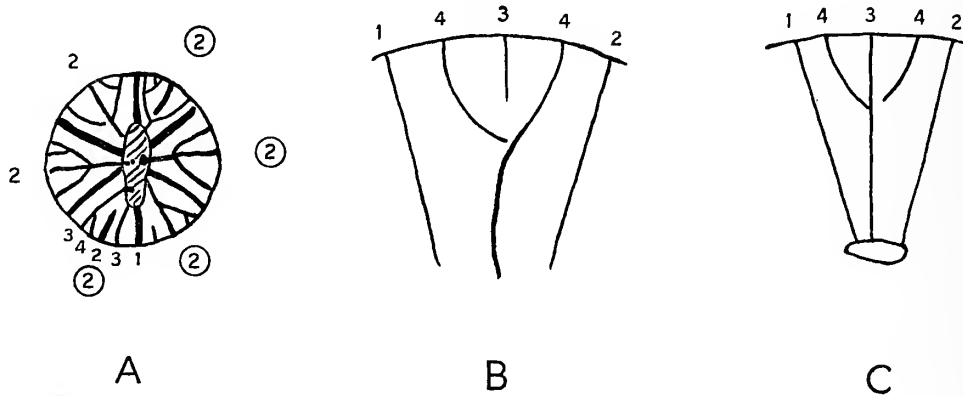
(Plate XIV, fig. 3.)

Specimen B.M. 490, Stn. 9 and a number of small broken pieces (formerly in spirit which has dried up), which cannot be fitted together to make a second colony.

I am attributing these fragments to this species in spite of differences. They agree in details of mode of growth, shape of calices, ribbing and the septal arrangement. (Compare Plate XIV, fig. 3, with Horst's fig. 6.)

They differ in being thicker in their stems, with the openings of the calices correspondingly larger, in the thinness and imperforation of the septa, on which lines of spinules are parallel to both horizontal and vertical edges. The columella may be a little smaller.

A relationship to *D. fistula* (Alcock) is apparent. (Compare Plate XIV, fig. 3, with Alcock's (1902, fig. 36, pl. v, of the type.) It may be that this species is merely a deep water—ooze habitat—form of *D. arbuscula*, differing mainly in the elongation of its calices and rarity of budding—a kind of etiolation.



TEXT-FIG. 1.—*Dendrophyllia arbuscula*. A. Diagrammatic representation of the septal arrangement in a small lateral bud 4 mm. in diameter at the base of a long calyx. Four septa of cycle 2 are cut off by those of cycle 3, or at least do not reach the columella directly; and two are complete to the columella. [From Crossland's inking over of the septa of cycle 2 in his original pencil, ink and red chalk sketch it appears that the four septa of cycle 2 that he refers to as "cut off by those of cycle 3" are those marked in this text-figure 1A by the number 2 in a circle, 2. A.K.T.] B and C. These diagrams represent adult calices whose longest diameter reaches 10 mm. In the great majority the arrangement of septa is as shown in B, but sometimes it is as shown in C, where there are no fusions of the fourth cycle.

D. fistula is described briefly by Alcock (1902, p. 42, pl. v) and by Gardiner and Waugh (1939, p. 237), and in detail by Marenzeller (1906a, pp. 8 and 16, pl. i). The three descriptions seem to differ fundamentally, as illustrated by the diagrams of Text-fig. 1, but the discrepancy is only apparent, as a study of younger calices of the Great Barrier Reef specimen shows. In these septa of cycle 3 may be found (1) running in to the columella without complication by those of the 4th cycle; (2) joined by the 4th cycle, but proceeding to join the columella; (3) apparently cut short by the 4th cycle; septa meeting below it, as in the great majority of adult calices (Text-fig. 1B). In the youngest calices the 3rd cycle septa cut off those of the 2nd, but as Text-fig. 1A shows, the 2nd cycle septa may run right through the junction to the columella. In the great majority

of adult calices the arrangement is as shown in Text-fig. 1c, in which the 4th cycle appears to cut off the 3rd completely. Parts of a 5th cycle are present in some of the oldest calices, but there is nothing like the complication. Marenzeller figures for the older calices of *D. fistula*. There is no note of the colour of these specimens.

Distribution: *D. arbuscula* has been found only once, by the "Siboga" in the Banda Sea at 45–90 metres. *D. fistula*, possibly a deep water form of this species, is found in the Red Sea, Indian Ocean, and in Malaysia.

Dendrophyllia micranthus (Ehrb.).

Not *Dendrophyllia nigrescens* Dana.

1879. *Coenopsammia micranthus* Klunzinger, p. 58, taf. vii, fig. 13; taf. x, fig. 13.

I am compelled to note typical examples of this species, such as do not occur in the collection, before it is possible to describe the var. *grandis* which represents the species on the Barrier.

Klunzinger gives the synonymy, and refers to Milne Edwards and Haime's (1857a) pl. E.2, fig. 2, of *C. viridis*, which, apart from its being "green," does not resemble this species very clearly. On p. 129 (1860) they give, under *D. nigrescens*, green, black and red species as synonyms, which I do not believe to be possible. They have only the barest mention (1848, p. 104) of Ehrenberg's *O. micranthus*, merely quoting his two and a half lines of useless Latin description.

Klunzinger writes "nec *Dendrophyllia nigrescens* Dana," in which he is right, though all subsequent writers are against him. I therefore can only refer to such later records as bear upon the distinction from Dana's species, as, in the case of others, there is no knowing which species is referred to. The species is fairly common near Ghardaqa, in the Red Sea, but not as abundant as the orange and vermilion encrusting species (whether one or more), and never found in the same habitat, the black *D. micranthus* being always exposed to the light and never exposed at Low Water Springs: the orange species grows only in the shade under coral slabs on the outer reef edge, rarely on the inner reefs. The precise localities are the wall-like outer slope of the Abu Qalawa and Abu Fanadir reefs, and on Mortensen Rock, a great mass of decaying *Porites* in the middle of the lagoon.

None of these Red Sea specimens, either Klunzinger's, my own, or the five now before me belonging to the Kóbenhavn Museum, exceeds 12 cm. in height. Klunzinger's (1879) description and figures remain the only ones available. His figure (taf. vii, fig. 13) of the corallum is small, but being an actual photograph can be examined under a lens. The figure of the calyx (Taf. x, fig. 13) is not quite satisfactory. I wish to emphasize that features of the mode of growth which might be taken as accidental to Klunzinger's specimen are, in fact, common to all that I have seen. Horst's (1922a) figures are doubtful and too poorly printed to give any information. The only photographic figures of *D. nigrescens* Dana accessible to me are those of Vaughan (1918, pl. 60) and Faustino (1927, pl. 72), which show a quite different species to that of Klunzinger. All that Horst says (1922a, p. 50) is perfectly true, but the points he discusses are not those which really separate the species. The following differences are constant, and until further proofs and figures support Horst and Vaughan I regard the species as quite distinct.

Colour : Dana (1849, pl. 27, fig. 1) gives a coloured picture of his *D. nigrescens*, differing from *D. micranthus* not only in form but also decidedly in colour. He shows a green black (*micranthus* is purple black, sometimes with a brownish tinge), tentacles of polyps white (light brown in the text), disc *bright* green; the polyps of *D. micranthus* are black uniformly.

D. micranthus (Ehr.): Bushy, few short stumpy branches. Height up to 15 cm. Branches flattened, or, if rounded basally, generally flattened at their ends. Outline of the principal polyp always more or less visible on the outside of the stem. Majority of the calices narrower at base and deep. Average breadth 7 mm.

D. nigrescens Dana: Long straggling branches, often in one plane (according to Klunzinger, but see Horst). Branches round, 7–10 mm. thick. Majority of calices short and straight, comparatively shallow, 5 mm. in diameter. The appearance of ribbing outside the calices and down the stems, and character of the coenenchyme by which the stems are thickened, are variable in both species. The appearance of specially long calices in both may mean the beginning of a new branch. A group of them at end of a branch seems to indicate cessation of growth in length.

As regards slenderness of branches and bushy shape, my Red Sea specimens were all from sheltered water, and though some have more slender branches than have the specimens before me, *none* approach Vaughan's figure, and are all built recognizably on the same plan as that of Klunzinger's specimen—*viz.*, a main polyp forming a continuous tube from the base to the summit of the colony, which buds laterally, the larger buds originating side branches. As these buds often come off from opposite sides the branches become flattened, particularly at their ends, when growth in length slows down, so that nearly all colonies show the peculiar flattening of the ends of branches shown in Klunzinger's fig. on pl. vii. Coenenchyme of a loose texture is added to the original calyx, so that the lower parts of branches are considerably thickened. As this addition tends to be more developed at the sides of the branches, particularly in the axils of buds and lateral branches, the round, main, original polyp-tube is more or less conspicuous in the flattened branches. This coenenchymal deposit may be ribbed longitudinally or be irregular (both conditions to the eye so different), often on adjacent areas of the same stem, and in some colonies the longitudinally ribbed form may cover the whole, from the youngest twigs to the base.

The septal arrangements are, as described by Klunzinger, and by him alone, the simplest possible, *viz.*, 6 septa of the 1st cycle rather broader than the 6 secondaries, and 12 (generally rudimentary) of the 3rd. The two 1st cycles reach a rudimentary columella of septal trabeculae, or sometimes only those of the 1st reach it, but in most calices, when fully grown, all the 12 septa of the first two cycles are equal in thickness and breadth and all reach the columella: sometimes even one or two of the thin 3rd cycle may also join the columella. There is no fusion of septa above the columella, but sometimes a septum of the 3rd cycle bends towards its neighbour of the second. In young calices the septa are thin and finely granulated on sides and edges, in older they are thick and coarsely granulated. In both they form a short triangular thickening at the wall: in the older they usually thicken decidedly just above the columella. These exceptions are to be recorded, but in the great majority of calices 12 septa reach the columella and 12 rudimentary septa alternate with them.

Dendrophyllia micranthus var. *grandis* var. nov.

(Plate LV, fig. 1; Plate LVI, fig. 1.)

This variety is represented by a single branch broken from a large colony. It is much regretted that more specimens, and at least one complete colony, were not brought home.

The branch measures 15 cm. high, and side branches make the specimen 14 cm. wide. The broken stem is oval in section, 25 mm. \times 17 mm. As shown on Plate LV the branches are nearly in one plane. The finer are, of course, the thickness of a single calyx, *i.e.*, 7 mm., but the main stem retains its thickness nearly to the top.

Details of the calices are as in the type species, but the columella is generally larger, and is of loose structure. In a few calices there are irregular traces of a 4th cycle, and pairs of the 3rd cycle may actually join the 2nd between them.

The most striking difference between this variety and the type, after the size of the colony, is the rough "woolly" surface of the stems, from a little below the terminal twigs to the base, though in most places a tendency to longitudinal ribbing can be made out.

There is no note of the colour of the living polyps nor of the origin of the specimen, which is numbered 75, B.M. 500.

Dendrophyllia velata, sp. n.*

(Plate LV, fig. 3.)

A single branch of this minute form (habitat unknown) numbered only B.M. 390, but with a note on colouration: "Colony orange, verging into brown towards its base. Polyps reddish brown."

In growth form it resembles Horst's *D. minuscula* (which does not agree very well with Bourne's species,† especially as the latter has remarkably thick septa, and therefore cannot be young, as Horst says), but the columella and septa differ from both descriptions. There are also the curious hoods over the calices, recalling *Stylophora*, which are unique in this genus.

The specimen is a fairly straight branch, 25 mm. long, of circular section, 4 mm. in diameter at the broken end, and that of the terminal calyx being 3 mm. This axillary polyp bears 8 buds, 6 of which are in pairs, but the pairs are none of them in the same plane, nor at right angles.

Young calices are nearly sessile; the youngest bud is near the lip of the terminal calyx, but the lowest on the stem are not the largest, and do not have the appearance of being the oldest. All are round, or very nearly so. The calyx walls are thin and perforated, costal ribbing and perforations of the stem coarse for so small a species, and flaky.

The characteristic hoods vary in their development, being absent from the terminal polyp and younger buds. In the uppermost pair one wall is higher than the other, rising gradually on one side, then dropping suddenly to the original level; this makes the wall look as if broken, but examination shows that this is not the case. The lowest theca shows

* Great caution should be observed in accepting this as a new species. Only one "hood" can be seen, and that appears to be a morbid growth, or perhaps the beginning of a new calicle.—[A.K.T.]

† Crossland is evidently referring to *D. minuscula* Bourne, 1905, "Report on the solitary corals collected by Professor Herdman, at Ceylon, 1902." R. Soc. Rep. on Pearl Oyster Fisheries, IV, p. 213.—[A.K.T.]

a similar development, but here the peak is at the side, not above the calyx when the branch is upright. The case of that of the longest calyx, one of the middle pair, is extraordinary, the hood being above and to one side, but also bending downwards so that much of the opening is hidden, and there is also a kind of crest above it. These curious arrangements can only be explained by figures.

The septa are moderately thick, with fine spinules; one to three of the primaries are especially prominent, secondary septa cut off from the columella by fusion of the tertiaries, this fusion often high above the columella, but sometimes near it, and sometimes not visible; no traces of a 4th cycle, even in the cross-section of the main calyx tube given by the broken end of the branch. Here the septa are thickened so much as to be, in most cases, thicker than the spaces between them, but the addition to the outside of the wall is slight.

The columella is remarkable for the height it rises above its junctions with the septa. It is relatively small, but well made of broad twisted ribbons with lightly scalloped edges.

Genus *Turbinaria*.

T. W. Vaughan (1918, p. 147) remarks: "The species of *Turbinaria* reported from Australia by Bernard are listed on the following page. How many of the 27 reputed species should be recognized as valid can only be determined by a critical revision of Bernard's original specimens." Of these 27 species, 21 are from the Great Barrier Reef and Torres Straits, 4 are from West Australia only, and 6 are common to E. and W.

The genus is mentioned by Stephenson and others (p. 67) as characteristic of the seaward slope and anchorage, on vertical or overhanging surfaces below the level of low water, and both massive and foliose species on the reef patch at Lizard Island. S. Manton refers to it four times, and figures a single specimen at the base of the pinnacle of pl. xii. As her diagrammatic sign is a cup with a *thick* border the species is almost certainly *T. peltata*. It is among the first corals to appear on the seaward slope of Traverse I, and minute specimens are among the corals which survive the mud at the foot of the slope and on the sea floor. It appears again, but rarely, near Traverse II. Apparently the genus was found to be more common by Hedley and Taylor on the lee side of East Hope Island.

Distribution: The genus is not recorded from Samoa,* Tahaiti, or Hawaii, though common from the Red Sea to the Western Pacific. Gardiner (1898, p. 262) notes: "There is a marked absence of this genus both at Funafuti and Rotuma, only one colony having been found, while in Fiji three species were obtained."

Turbinaria peltata Esper.

(Plate XVI, fig. 5; Plate XVIII, fig. 2; Plate XIX, fig. 2.)

1896. Bernard, p. 38, pls. vi, vii, viii and xxxi, fig. 15.

Sample 435 (major diameter 18 cm., height 8 cm.) is a stage between those figured by Bernard on pls. vi and vii, in which the edge of the cup is folded (one fold fused to a two-sided plate) and there is one upgrowth from near the centre. Having a second variety with which this is to be compared it is necessary to fill in some details of Bernard's description.

* Except one doubtful record, *T. frondens*, by Bernard (1896, p. 46); see note on p. 93.

The aperture is circular except when the calices are crowded. The majority are 4 to 5 mm. across, or 6 mm. by 4 mm. if oval, the thin walls adding 1 mm. (as in the three examples figured by Bernard and the one by Faustino). Milne Edwards and Haime's 10 mm. must refer to a giant calyx, such as is not present in this or in Bernard's collection.

According to Bernard the septa are 12 primary and 12 secondary. In this specimen I distinguish 6 primary, 6 secondary, and 12 tertiary, the total number of 24 being constant. At first sight all seem to be of the same width, as in most species, but more careful examination shows that the 6 primaries are a little broader than the secondaries, and these than the tertiaries; minute points and ridges indicate a rudimentary and incomplete 4th cycle. The septa are often toothed on their upper quarters, and are slightly granular on their sides. The septa being narrow, the columella is large, and, even in round calices, generally oval, the septa at each end slightly narrowed. It is composed of broad twisted leaves, thin and well separated, on the whole extending upwards to form an irregular honeycomb, but in many cases a central leaf forms a ridge along the top of the columella, which may become conspicuous and to which the lateral leaves may be joined pinnately. As published figures show this structure imperfectly or not at all, I illustrate it on Plate XVIII, fig. 2.

The coenenchyme is spongy, composed of broad, thin, twisted plates, more or less horizontal, bearing a few small, blunt upward points; in rare places these run into irregular sinuous lines, on which the teeth are more numerous, with grooves between—"a well marked gyrating system of ridges and furrows," as Bernard describes it. On the underside this arrangement is the rule, the ridges running radially, and the upright processes are more marked, though still low and blunt. There are numerous round or oval holes, resembling worm-holes.

Saville Kent (1893, p. 188) describes the colour of the living colony as whity-brown, whitish polyps with greenish centres; tentacles numerous and simply subulate; both occasionally a delicate rose pink. Dana (1849, pl. xxx, fig. 4a) shows the colours as brown, yellow or greenish brown with bluish discs. The colours of other Turbinarians, though often brilliant, are variable within limits (see Waugh on *T. mesenterina*, 1936, p. 913).

Distribution: Bernard (1896, p. 38) says: "This species is the most striking in the genus *Turbinaria*, and also the commonest." This latter is due to the diligent collecting by Saville Kent. Nearly all Bernard's localities are from the Great Barrier Reef and Torres Straits, but some are also from W. Australia and Singapore. Most other records are from Malaysia, but Dana, Milne Edwards and Haime and Faustino took it as far east as Fiji and the Philippines. The only Indian Ocean record is Mauritius, probably as unfounded as that from the Red Sea referred to in a note by Bernard. To the evidence for its absence from that sea I add Gravier's, Waugh's and my own. I have here from Mauritius a very different species, *T. plicata*, collected by Stephenson.

Turbinaria peltata var. *gibiari* n. var.

(Plate XIV, fig. 1; Plate XVI, fig. 4; Plate XVII, fig. 1; Plate XVIII, fig. 1;
Plate XXII, fig. 2).

Sample 193 is a sector from the edge of an explanate or cup-shaped colony measuring 11 cm. along the base and 6 cm. radially. The broken base is 17 mm. thick in the middle, 7 mm. close to, and 4 mm. at the extreme edge; it is gently folded.

The differences from the normal are :

(1) Calices projecting obliquely, those near the base 10 mm. on proximal side, near edge 5 mm. ; the distal sides 3 mm. and 1 mm. (2) Columella as in preceding, but the directive ridge may rise high above the rest.

The coenenchyme is covered with thin plate-like ridges bearing numerous minute but distinct pointed teeth, which, under the binocular, are seen to be set transversely to the plate. The underside is grooved, the grooves long or short, more or less sinuous. On their walls are similar plates, but thicker, shorter, and with less distinct teeth, often two rows of plates on each wall. Near the edge the round holes are deep and numerous, centrally rare and shallow.

Specimens with obliquely projecting calices are not mentioned in the literature, but there are three large examples in the København Museum, labelled *T. lactuca* n. sp. by Lütken. They differ from the above in that the columella never has a directive ridge, the 1st and 2nd cycles of septa are hardly distinguishable and in the coenenchyme. I hope to describe these and other specimens of the København Museum later. Possibly Lütken's unpublished name will stand, if only as a variety.

Turbinaria bifrons Brügg.

(Plate XXI, figs. 1, 2.)

1896. Bernard, p. 69, pl. xxi, pl. xxxiii, fig. 1.

Specimen B.M. 272 is whole, 13 × 20 cm. and 16 cm. high, and is evidently one of those referred to by Stephenson and others as growing on a vertical surface. Specimen B.M. 413 (Stn. XXIII dredge) is a single "leaf" 10 × 10 cm., with two fragments.

The species is easily recognized by the complete fusion of its folds, its spiny septa and fused ("glassy," Bernard) columella. The obliquely placed thecae are also a constant feature.

Specimen 272, in its complicated folding, shown on pl. xxi, resembles the "two minute stalked specimens" of Bernard's pl. xxi, rather than the larger one of the same plate. A curious feature is the occasional formation of small round branches, which superficially resemble an *Acropora* by the oblique calices. The doubling of the plates is not all due to folding, as fig. 1 shows the outside of the colony is also overgrown by calyx-covered leaves, though not always completely.

In this complete specimen the spinulation of the sides of the septa is usually less marked than in Bernard's pl. xxxi, fig. 1 ; but in the dredged fragments the septa are both thicker and more spinulate. The columella is not always prominent, and often appears folded or granular on the top.

Distribution : West Australia (young examples, Bernard). Also, if synonymous with *T. conspicua*, already recorded from the Great Barrier Reef.

Turbinaria frondens (Dana).

(Plate XXIII, fig. 1.)

1846. *Gemmipora frondens* Dana, p. 412 ; 1849, pl. 27, fig. 10.

1860. *Turbinaria frindescens* Milne Edwards and Haime, p. 167.

1896. *Turbinaria frondens* Bernard, p. 46 (no figure).

Possibly *T. brassica* (Dana) and *T. danae* Bernard are the same species, but the latter seems to be distinguishable by its broad septa, the former by its shallow calices and smooth coenenchyme: a series of specimens might possibly bring them together. The two pieces here, Nos. 326 and 333, both from Lizard Island, Reef A, agree completely in these respects, and differ from a specimen in the K benhavn Museum, which constantly agrees with *T. danae*.

Dana's description being altogether too brief, and his figures often inaccessible, I redescribe the species.*

The specimens before me are two plates, both folded and one deeply wrinkled at one side, measuring 12 and 17 cm. radially and 16 and 10 cm. across. I take the obliquity of the calices to indicate that they grew more or less vertically. One of them has a small branch 15 mm. high, growing from the surface of the plate after the style of Bernard's *T. aurantiaca*; its seven calices are all on the distal, or upward, side. Another projection surrounds what looks like a mollusc burrow.

The obliquity of the calices is shown in figure on Plate XXIII; even the immersed calices of the proximal part are also oblique at their openings. Near the edge the thinness of the plates allows the lower parts of the calicinal tubes to form ridges, which are also visible on the outer side of the plate (which is thus wrinkled). Lower down the coenenchyme is rather thicker, and the calices, cylindrical above, become elongated cones: close to the base they are, as usual, immersed. They are slightly oval, 2 mm. in larger diameter; the walls are thin.

The septa are always narrow, though a little broader in the proximal calices, at first sloping steeply, then dropping vertically, leaving a wide open fossa, of some depth. They are practically all alike, 20 to 24 in number (most often 22), thin and smooth.

The columella is broad and oval, only slightly arched above. It is formed of comparatively large foliae, twisted in the usual manner, which do not make a directive ridge.

The coenenchyme is covered with short ridges, bearing granules, or blunt and indistinct teeth, often set transversely. The ridges are thicker than those shown in Dana's fig. 10*e*, but have squarish knots in them such as he shows. They are thinner and more regular on the back of the plate, which, to the naked eye, appears smooth. There are no holes.

Distribution: Dana's specimens were from Fiji. Bernard records one from Samoa (presented by Rev. S. J. Whitmee), but no Turbinarian was found there by Mayor, and missionary records must be received with caution as, in past days, they carried on a trade in corals as curios.

Turbinaria sp.

Specimen No. 7 is a small flattish cup, 9 cm. in diameter, with a very eccentric stem; this eccentricity, together with the appearance of the calices towards the edge of the higher rim, suggests that it is the young form of such a growth as *T. frondens*. It is not of this species however.

I consider it rash to name so young an example. Matthai suggests (with a ? mark) *T. aurantiaca*, but it differs from this species thus:

* I owe my copy of Dana's work to the Librarian of the Zoological Museum of the University of K benhavn, who obtained the loan from the Royal Academy of Science, Stockholm. I am deeply gratified by this example of international co-operation.

T. aurantiaca (Bernard, p. 33).

This specimen.

Calices 1.5 mm. or less . . .	Regularly 2.0 mm.
Not typically projecting . . .	Most project 1 mm., but openings are not oblique.
Septa 18-20	Septa 20-24, usually 20. Distinctly spinulose sides.
Columella spongy, compact . . .	Columella formed of thick, close-fitting, granular leaves, usually transverse to oval. No directive ridge.

The septa are not like those of *T. pocilliformis*. In calicinal characters it comes nearest to *T. auricularis*, and there is no reason why this should not be the start of a large growth like those of this species.

I am confirmed in my refusal to name the specimen by comparison with one of the same size in the Kóbenhavn Museum, and almost identical to the naked eye, but the calicinal characters of which are completely different.

Glomerate Turbinarians.

Although I cannot follow Bernard in his emphasis upon growth form in this genus these solid glomerate forms are probably separated by a real morphological difference in the continued growth of their polyps into long tubes. Bernard himself writes (p. 166), "I was at first disposed to look upon these as merely massive varieties of other types," but in the only species of which the growth variations have been specially studied, *T. mesenterina* (Waugh, *l.c.*), such elongation of the polyps does not occur. Pending further investigation on the reefs, I therefore regard this as a distinct division of the genus, and the species about to be described as characterized by, among other things, their mode of growth. To describe two new species from single specimens is most uncongenial, but I have no choice.

Turbinaria stephensoni, sp. n.

(Plate LV, fig. 2; Plate LVI, figs. 2, 3.)

This might be a variety of *T. stellulata* Bernard,* but there are constant characters of the septa and columellae not mentioned by Bernard, and which are unique in the genus.

Specimen 449 is a rounded hump, 75 mm. in diameter \times 50 mm. in height, growing on a piece of rotten coral, probably a solid *Montipora*. By prising this away I find that the hump, though concave beneath, and spreading downwards into an encrusting sheet, is, in reality, 30 mm. thick. There is also a thinner extension on one side of the base about 3 cm. wide and 10 mm. thick (near the edge about 5 mm.).

The calices project slightly and are conical, conspicuously so on the top of the hump, where they may project 3 mm. and be 3 mm. across on the top, though the openings are only 2 mm. On the lower expansions they project little though remaining conical, and the opening is generally 1.5 mm. across. It is slightly oval. The calyx wall is well defined.

The coenenchyme bears little plates and ridges, with sharp-pointed processes in little groups, a distinct contrast to the blunt granules of the next species.

The number of septa averages 25 on the hump, 20 on the lower expansions. They are thin, very finely toothed along their edges, their sides very finely spinulate, thicker

* Bernard, p. 65, refers the species to Blainville and Lamarck, but on very slender grounds. The only way to define the species is by using Bernard's name.

and more spinulose on the spreading bases. They are very narrow above, and slope down to the columella either without forming an angle, or forming at most a low and rounded one. The septa share with those of *T. stellulata* a peculiarity in this genus, that they are not all the same length: short and long do not regularly alternate, the short being much the fewer. A further peculiarity, not mentioned by Bernard, is that septa adjacent to a short one are often bent towards it, and sometimes (generally once in each theca) fuse between the end of the short septum and the columella. In distinction from *T. stellulata* most of the long septa very clearly join the columella, and sometimes bear a knob just before they join.

The columella is also very distinctive. At its best development it is small, oval, not arched above, elongated in the same direction as the calyx, solid and tuberculated above. A line of the small but high tubercles forms a crest along the top, which often develops into a high plate. In many cases the lower part is inconspicuous, often invisible, the plate then remaining the chief, or even the sole, representative of the columella. Ordinarily this is quite distinct as a row of tubercles, but, towards the edge of the colony it may become irregular and fused; in a few calices it degenerates to a tubercle or two, or may be absent, the septa then meeting in the centre.

Where the columella is less developed the lower teeth of the septa are more prominent, as would be expected.

Turbinaria mantonae, sp. n.

(Plate XVI, fig. 6; Plate XVII, fig. 2; Plate XIX, fig. 1.)

Specimens 323 and 316, both labelled "A" reef, Lizard Island.

To the naked eye the specimens are distinguished from the preceding by the slightly projecting cylindrical thin-walled calices, sometimes level with the surface; they are 2.5 mm. across the openings, with many smaller, down to 1.5 mm.* and even 1.0 mm. (fully developed) on the sides low down; on the hump are also numerous small calices, but these are young. They are distinctly deep.

One hump of No. 323 is broken through and shows thecal tubes 5 cm. long. The specific gravity is high, perhaps more so than in *T. stephensoni*.

The coenenchyme is a fine but loose network on the summit, but in places gives place to more regular, wavy lines bearing low blunt granules.

Fully developed calices are completely regular, oval or round, of a type common in the genus. The septa are all alike, sloping gradually at first then dropping vertically to the columella. They are thin and smooth, and in full-sized calices their number averages from 24 up to 27.

The columellae are large, oval, of closely packed trabeculae, lying deep in the fossa, flat on the top and bearing numerous upright tubercles. In many calices the lower parts of the septa are toothed and bend suddenly towards the centre, passing into the columella, on the top of which they form low ridges. In younger calices the septa remain distinct almost to the centre of the columella. Thus we have here two cases in which the columellae are seen to be made from the septa, a fact which seems to be not usually visible in this genus.

* Corresponds in these respects with *T. parvistella* Kent, which cannot be identified from the description given. The name therefore lapses.

[PERFORATA.]

[Family ACROPORIDAE.]

Genus *Astraeopora*.

As an example of the difference between pure museum work and observations on the reef compare Bernard's division of this genus into explanate, pulvinate and glomerate forms with Waugh's demonstration that all these forms frequently occur in one colony. His glomerate division is particularly artificial. Such detached forms occur in almost any sort of coral, and is purely environmental. This is especially well shown by the numerous potato-like loose growths of *Leptastrea*, *Cyphastrea* and *Porites*, which abound in a certain habitat near Ghardaqa—viz., the wide, weedy flat on the west side of Abu Qalawa Reef.

Bernard's Australian species are listed by Vaughan (1918, p. 145), who accepts four of them, describing *A. myriophthalma* (Lmk.) and *A. ocellata* Bernard, while *A. profunda* Verrill is redescribed, after examination of the type, by Hoffmeister. When in Tahiti I tabulated these species for comparison with the single good-sized specimen I found there. There may or may not be a columella (the distinguishing mark of *A. profunda* according to Hoffmeister) and the primary septa may or may not meet, and, in short, this specimen seems to combine the characteristics of all these three species. Indeed, of Bernard's 14 species it seems unlikely that more than three or four are real.

The genus is listed by Stephenson and others on pp. 67 and 86 as characteristic of the seaward slope and anchorage at Low Isles and of Yonge Reef. By S. Manton it was found on the muddy sea floor (two quite fair-sized colonies 16–20 inches across) and on the slope where the influence of the mud begins.

Astraeopora myriophthalma (Lmk.).

1930. *Astraeopora ocellata* Yonge, p. 46.

1936. *Astraeopora myriophthalma* Waugh, p. 927.

Specimens 41 and 329, the latter from Ribbon Reef, are typical of massive growths of this species. No. B.M. 392 and No. 428 are of different appearance, but, in view of what I have written above I consider them the same. No final revision of the species is possible without long investigations on the reef, and an extension of Miss Waugh's work to other seas.

Both Yonge and Waugh give figures of the living polyp which differ widely. It seems more likely that Yonge's specimens were not fully expanded than that the species *A. ocellata* can be distinguished by having short stumpy tentacles. At the same time the naked eye anatomy of polyps may very well be of use in the discrimination of species. Preliminary observations at Ghardaqa showed that this is possible for some Faviidae.

Distribution: Though not common in collections the species has been recorded from the whole Indo-Pacific, from the Red Sea to Samoa and Tahiti.

Genus *Montipora*.

The usual division of this genus, introduced by Bernard, into smooth (glabrous), foveolate, papillate and tuberculate is generally useful, and the only one possible; but the 19 species here described include some which are both smooth and foveolate—e.g., *M. ramosa*; and tuberculate and papillate—e.g., *M. prolifera*. In foveolate species the

ramparts may occasionally break up into papillae, and Bernard's class "*Papillae irregular*" includes such forms as *M. venosa*, which are often more foveolate than papillate. It is just possible that papillae formed from ramparts are not homologous with those formed independently, but this is hardly a practical distinction.

I have not attempted to trace out all possible synonyms, contenting myself with the few which are well grounded and illustrated by the present collection. Doubtful and possible synonyms are not helpful, witness the wild confusion caused by baseless guesses at the identities of Forskaal's *Madrepora monasteriata* and *M. rus*.—the trouble by no means ended by Marenzeller's showing what these species really are.

As in the case of *Acropora* and the other perforates most of the species are confined to the Malay-Fiji area, in contrast to the imperforates, many of which are found over the whole Indo-Pacific, from the Red Sea to the Tuamotus, dying out in the Marquesas.

Smooth, explanate *Montiporae*.

Montipora granulosa Bernard.

(Plate XXV, figs. 1, 4; Plate XXVII, fig. 4.)

1897. Bernard, p. 21; pl. i, fig. 2; pl. xxxi, fig. 3.

Bernard described 14 glabrous, explanate species: other authors very few. The present specimens do not completely correspond with any of them, but come so near to *M. granulosa* that I give them this name and detail the differences from Bernard's single specimen from 44 fms. on Macclesfield Bank. These, No. G.B.R. 113, dredged from Stn. XXV,* consist of 4 small irregular thin plates, the larger 8 cm. across its base, 9 cm. radially; they may or may not have formed one corallum originally. Unlike Bernard's specimen they grew freely, no point of attachment is present, the only approach to one being portions of older lamellae of the same species.

The epitheca is well developed, generally right up to the edge, which, in some places, bends back and forms a thin, living layer over the epitheca for from 5 to 10 mm. The epitheca is strongly marked with fine and coarse concentric wrinkles, besides deep wrinkles in the corallum itself. These were caused by periods of cessation of growth, as shown by small portions of the free edges projecting from the epitheca at some of these folds.

The surface is raised into low rounded hillocks, often elongated radially or circumferentially, and easily distinguished from those resulting from adhering Balanids and Serpulids. They do not bear calices, all of which are level with the more or less flat surfaces between these hillocks, nor is there any relation suggesting modified foveolae.

Calices correspond with Bernard's description, except that none "appear to open irregularly on slight mounds of coarse reticulum." Some are irregularly compressed. The "granulations" of the surface extend onto the proximal parts of the septa. These "granular ends of reticular threads" deserve more description than Bernard gives; as he says, they "give a soft velvety sheen to the whole surface," which is characteristic of these specimens, and of no others in the collection. With few exceptions—*e.g.*, close to the growing edge—they cover the whole surface thickly; they are in the form of minute plates bearing a row of 2 to 5 vertical slender spinules, or else a little clump of the same; between them can be seen the rounded pores of the reticulum.

* Comparatively shallow water near the Low Isles may be ecologically equivalent to much greater depths in the open sea—*e.g.*, at Macclesfield Bank.

The section shows a thin glassy solid layer, not distinguishable from the epitheca (a narrow reticular layer), above which most of the section is occupied by thin irregular vertical rods joined by horizontal nodes. Bernard describes them as short. This is, of course, the case where the lamina is thin; near the growing edge the reticulate layer occupies most of the section.

Distribution: One specimen from Macclesfield Bank in 1888. Now Great Barrier Reef.

Montipora millepora, sp. n.

(Plate XX, figs. 1 and 2; Plate XXII, figs. 1, 3, 4, 5.)

Specimen B.M. 410 (dredged from Stn. XXIV) bears an extraordinary resemblance to a crust of *Millepora*, not only in its green-brown colour and the character of its surface, but also through the small, widely separated pore-like calices; only under a lens do the septa come into view. The section of the corallum is unlike that of any other *Montipora* yet described.

The single specimen, fortunately broken across, forms a crust of an average thickness of 6 mm., near one edge 3 mm., growing on dead and rotten coral, possibly a *Cyphastrea*. The edges are blunt, usually bent downwards over the edge of the substratum, but at one corner upwards, following the substratum. The surface is smooth, with fine granules, closely placed, and not continuous with any structure seen in the section.

The calices are of different sizes and stages of development. The larger are 0.5 mm. across, and have roughened well-developed septa, some fairly regular, others not, without prominent directives; a few septa of the 2nd cycle present; they nearly meet, but there is no columella. The calices are raised on conical or roughly cylindrical mounds. Many of those on the surface are oblique, one side slightly raised, in which case the three lower septa are much broader than the upper, the middle one the broadest. The wholly immersed calices are only about 0.25 mm. across, some of them of irregular outline, with indistinct and irregular septa; or perhaps with only two or three septa, which are, however, indistinct.

The section shows a series of hard, glassy, horizontal strata, separated by thin, vertical rods; at the base these fuse into a solid layer several mm. thick. In only two places, one below this and one above, are there patches of the usual reticulum. It is evident that at a different stage of growth the appearance of the surface would be very different, as the thin rods would stand up above the granulations. This can be seen at a point in the section where a portion of one of the hard layers is exposed. Possibly, as in *Cyphastrea* and *Orbicella* (in which a somewhat similar mode of growth occurs), the whole surface would not be at the same stage at the same time.

The species resembles Bernard's species *tenuissima* and *reticulata*, which have conical protuberances bearing the larger calices; certainty is not possible until Bernard's specimens are re-examined, but it is unlikely that Bernard would not have emphasized the peculiarities of this new species if it had been in his hands.

Smooth, Branched *Montiporae*.

Montipora prominula, sp. n.

(Plate XXIV, fig. 1; Plate XXVII, fig. 6.)

No. 327 rises from an irregularly-shaped stem 20 mm. \times 17 mm., and expands into

two irregular lobes, apparently formed of fused branchlets (best described by the figure on Plate XXIV). The section shows two layers of coenenchyme, vaguely divided and both spongy. The surface is covered with minute white points, between which it is reticular. There is no trace of foveolation. The principal characters are the large (1.0 mm.) calices with projecting coenenchymal walls, both of which characters are conspicuous to the naked eye: and the septa, which, represented only by points at the orifice, are seen lower down to be thick, in two cycles and swollen at their inner ends, where the primaries generally meet to form a thick columella. The septa of the 2nd cycle are generally narrower; but where the columella is exceptionally broad they may join it. The walls are thin, perforate, and end in a row of upright spinules and costal ridges along their rims. These walls are not developed on the tips of the branchlets, though appearing immediately on their sides. Nor are they developed round some calices in the grooves between the the main lobes, or they may be reduced to low rings. But over all the sides of the branchlets and ridges they are conspicuous, and usually higher on the proximal sides, thus directing the opening upwards.

In growth form this species resembles *M. divaricata* Brügg. (Bernard, 1897, p. 39, pl. iii, fig. 4), but in that species the calices (0.75 mm.) open flush with the surface and the septa, though stout, are very short. *M. compressa* Esper. from the Philippines (Bernard, 1897, p. 42, pl. iii, fig. 5) is "a loose bush-like cluster of long and very irregular branches" but flattens in a somewhat similar way: the coenenchyme is divided sharply into two layers, the outer of which is nearly solid and the calices, 0.75 mm. across, are "lined by a membranous layer of coenenchyme, which rises slightly above the surface as a thin white ring." In spite of the difference of form, work on the reef might possibly connect these last two species, though it seems unlikely.

Montipora digitata (Dana).

(Plate XXVI, fig. 1).

1846. *Manopora digitata* Dana, p. 508; 1849, pl. 48, figs. 1, 1a-c.
 1886. *Montipora levis* Quelch, pl. 8, figs. 2-2a.
 1897. *M. digitata* (D) Bernard, p. 47.
 1897. *M. levis* Quelch, Bernard, p. 41, pl. xxxi, fig. 19.
 1918. *M. levis* Vaughan, p. 150, pl. 61, figs. 1, 1a (no description).

The single specimen of this species, B.M. 281 (without Expedition number or locality) is the first of any size to be described, and to this is due the fact that it combines the characters of the two species named, the modes of growth of which seem so different. Both Quelch's and Vaughan's specimens are mere scraps, the former with crowded stunted branches, and broken remains of long, slender branches in the background; Vaughan's specimen only one branch from a more normal specimen. This specimen from the Great Barrier Reef combines both the cockscombs of *M. levis* and the long slender branches of *M. digitata*. The outwardly bent tips of branches which give Dana's specimen its peculiar appearance are not conspicuous, but two broken branches show them perfectly. The closeness and parallelism of the main vertical branches are also shown in this specimen.

Bernard, 1897 (p. 44, under *M. fruticosa*), says: "I have no hesitation in separating this from the *M. digitata* of Dana, in which the apertures are irregular breaks in a surface reticulum (*cf.* Zooph., pl. xlvi, fig. 1c)." Dana gives a rough figure which shows an irregular

but distinct wall. In this specimen the wall is more often quite circular. The septa are irregular in breadth, as in Dana's figure.

Distribution : Banda, Solomons, Fiji. Now G.B.R.

Smooth-foveolate, Branched Montiporae.

Montipora fruticosa Bernard.

(Plate XXIII, fig. 2.)

1897. *M. fruticosa* Bernard, p. 44; pl. iv, fig. 2; pl. xxxii, fig. 2.

1918. *M. ramosa* (part) Vaughan, p. 151, pl. 62, fig. 2.

This species is near to *M. ramosa*, with which it is considered synonymous by Vaughan, but the differences seem constant.

The collection contains four specimens, B.M. 193, 277, 287 and 300. The first is G.B.R. No. 8, but no locality is given. It is labelled *M. fruticosa*, *M. divaricata*, *M. compressa* by Matthai, who thereby recognizes its distinctness from *M. ramosa*, but follows Vaughan with regard to the other two species (reasons against which are given under *M. ramosa* on p. 186).

The differences from *M. ramosa* are :

(1) The "fruticose," loosely branching growth-form. There are flattenings and fusions, but no large, long fusions of parallel branches. These specimens, like Bernard's and Vaughan's (Plate 62, fig. 2 labelled *ramosa*), are all small, the largest 11 cm. high.

(2) The small size of the calices, which are, however, conspicuous through their depth and openness, "as if punctured in the almost solid corallum" (Bernard). In these specimens the calices measure generally 0.5 mm. or even 0.75 mm., not many so little as the 0.35 mm. of Bernard's specimens.

(3) The solidity of the coenenchyme surface, and its spinulation. These specimens show the "almost solid cortical layer" only near the base, but the threads of the reticulum are all thick.

The figure on Plate XXIII shows a specimen in which fusion is at a maximum.

Distribution : Recorded only by Bernard and Vaughan. From the Great Barrier Reef only.

Montipora ramosa Bernard.

(Plate XXVI, figs. 3, 4; Plate XXVII, fig. 3.)

1897. Bernard, p. 49, pl. v; pl. xxxii, fig. 3.

1918. Vaughan, p. 150, pl. 62, figs. 1 and 3 (not fig. 2, which is *M. fruticosa*).

1932. Thiel, p. 114, pl. xvii, figs. 2 and 3.

1938. Eguchi, p. 375.

Umbgrove and others on distribution on reefs.*

This widely distributed species is known for the variation in its forms of growth. The Great Barrier Reef specimens, though without an Expedition number or note of locality, have evidently been carefully selected, and show a wider variation in form than anything hitherto described, but, paradoxical though it appears, show also that the mode of branching is a specific character. They also show wide variation in structure, com-

* Perhaps Crossland was referring to Umbgrove's (1939, p. 5) work on "facies-types."—[A.K.T.]

binning completely smooth with markedly foveolate forms. This is one of those species of great importance on some reefs, but absent, for some quite unknown reason, from others. Umbgrove (1939, p. 12) remarks on its abundance in the Bay of Batavia (in the moats, as at Low Isles), but that it is absent from the Togian Reefs, though carefully searched for.

Apparently the specimens were not regarded as of this species by the members of the Expedition, as there is no reference to thin-branched examples in the ecological reports, all mentions of this name referring to *M. fossae* n. sp.

The specimens are B.M. 271, 273, 275, 279A, 279B and 300A. I have added the letters A and B since the two pieces of 279 and 300 do not fit together and those of 300 are of different species.

No. B.M. 300A is almost exactly like Bernard's pl. v, fig. 3. Others are more like the very slender form of his fig. 2, which shows the distinct foveolation of the upper ends of the branches characteristic of most of the Great Barrier Reef specimens.

No. 273 is of much looser build, long branches with only occasional fusions and comparatively inconsiderable broadenings of their ends; it leads on to 279A, in which the fusion of parallel plates is so marked, and 279B, with its palmate branches. This short series illustrates the essential unity of plan in these so different growth forms, *viz.*, the fusion of adjacent branches resulting in plate formation, not merely of isolated branches but of the coralla as wholes, and the broadenings by branchings remaining fused, leading to the palmate ends of 279B.

The variation in minute structure is even more interesting. No. 300 is smooth to the naked eye, like Bernard's figs. 1 and 3, the other specimens showing quite distinct foveolation in places, as in the upper parts of Bernard's fig. 2, while No. 275 is deeply foveolate all over. Under a lens a slight foveolation can be made out in 300A, the ridges being low and rounded, but here and there thin, with sharp, fringed edges. In one place there is a low mound (Plate XXVII, fig. 4) in perfect continuity with the rest of the branch, and showing no trace of a parasite or other cause of abnormality, in which the foveolae are deep, funnel-shaped and frequently sharp-edged and fringed with spicules. The characters of the calices and coenenchyme differ greatly between the upper, middle and lower parts of the branches. In the upper 1 or 2 cm. the coenenchyme is loose, walls of calices absent or indistinct, septa thin and reaching only to half the radius, as in Bedot's (1907) fig. 255 on pl. 46 (under the name *palmata*) and Vaughan's (1918) pl. 62, fig. 1a. Lower down, the walls are well made and slightly projecting, septa thicker and broader, and slightly exsert, directives nearly meeting, coenenchyma solid, with low blunt spicules. The difference is greater than that shown in Thiel's (1932) two figures (pl. xvii, figs. 2 and 3). In the low mound referred to above, the thickening of the walls reaches a maximum, so that there is a space between the calyx-opening and the surrounding ramparts: probably the reason for the sharpness of their edges.

This character is frequent in the more deeply foveolate parts of the other specimens; it is the chief characteristic of *M. palmata* Bernard (*not* Dana), which is thus a synonym of *ramosa*, separated from it by Bernard (p. 66) because it is foveolate, whilst *ramosa* is glabro-foveolate; but this series shows that this division cannot, in this species, be maintained.

The foveolations in the upper parts of 273 and 279 have an upwardly directed appearance to the naked eye, due to the greater development of the ramparts and calyx-walls on their lower sides. They are often broken, so that three calices may lie in a valley,

or a portion of a rampart may be isolated like a pyramidal papilla. This might seem to lead on to the papillae of *M. palmata* (Dana), but they never resemble those shown in his figure (1849, pl. 44, 2c), in which they are shown as quite isolated and with round tops. Otherwise Dana's species is remarkably like this. No. 279A is almost completely foveolate, only the main stem near its base being smooth on one side; the other side is foveolate all over, deeply over the upper half, moderately in the middle area, and not very clearly at the bottom. All the other specimens are smooth at the base and have one side more deeply foveolate than the other.

No. 271 is a crust over other corals, probably partly of the same species, very irregular and covered with aborted branchlets from 0.5 to 2 cm. high; the character of their tops, with fully developed calices, indicates retardation of growth. There are also growing branches at each end of the corallum up to 5 cm. high, and a few between up to 2 cm. Foveolation visible under a lens on the branches, with ramparts rounded or sharp, but it is ill developed elsewhere, *i.e.*, over most of the corallum. No. 295 is encrusting a branched coral probably *M. fossae*; the crust is thin but knobby, with only rudiments of branches. It is not possible to be certain which of the two species the crust belongs. No. 275 is a collection of branches which I am unable to fit together. Some are much thicker than the preceding, the largest piece being 10 mm. thick and up to 22 mm. wide; others, on the same piece, are only the usual 5 to 8 mm. thick, and nearly round. The large expansion 22 mm. wide, is not made of fused branches.

Synonymy.—It has already been shown that *M. palmata* Bernard is synonymous with this species. Vaughan (1918, p. 151) gives *fruticosa*, *compressa* and *divaricata* as synonyms, and is followed by Thiel, though, as Thiel says that all his specimens are like the very slender form of Bernard's fig. 2, they can hardly afford any evidence. For *M. fruticosa* see under that species; *divaricata* is a lobed, smooth form, showing nothing of the characteristic flat fusions of *ramosa*, and its septa are in two cycles. *M. compressa* is slender and with palmate ends to the branches, and therefore like *ramosa* in shape, but the projecting thecal walls make prominent rings such as I have not found in any of these specimens, and there is no trace of foveolation. Bernard's figure on pl. 3, fortunately a collotype, shows these walls clearly under a lens, even on the upper ends of the branches where walls are but slightly developed, if at all, in *ramosa*. "As a rule the septa, very irregular and feeble at the margin, become more prominent deep down," whereas in *ramosa* they are always level with the wall, and, where better developed, slightly exsert. Esper's figure of his *M. compressa* (tab. x, fig. 1) is like B.M. 279B of this series, while his fig. 2 is probably *M. fruticosa*; and fig. 3, but for the prominent rings, might also be of *M. fruticosa*.

Another synonym is the foveolate *M. indentata* Bernard (1897, p. 65, pl. v, fig. 5; pl. xxxii, fig. 5).

Distribution: Throughout the Malay region to Fiji and Palao. Not recorded from Samoa, Tahaiti or the Red Sea. In the Indian Ocean, Ramesvaram and Cocos Keeling I. Always recorded as abundant on the shoreward side of coral areas.

Montipora fossae, sp. n.

(Plate XXVI, fig. 2.)

This is the species named *M. ramosa* in the ecological reports, and which forms so important a constituent of the moat fauna (hence the specific name). It differs from

Bernard's *M. ramosa* (three forms are illustrated on his pl. v) so greatly in its growth form that, in the absence of intermediates, they cannot be united.

The species is figured, in its natural surroundings, by Stephenson and others in five photos on pls. ix, x and xvi, all of which agree in showing the same thick, blunt vertical branches with trifling variation, quite evidently the same as Samples 6 and B.M. Nos. 286 and 282. The uniformity of the species shown in these photographs strongly supports my considering the species as distinct. True, the habitat is a special one, but we have no evidence that this has caused so remarkable a variation from an allied species, especially when we find that other corals of the moat are not particularly affected.

The species belongs to the glabro-foveolate group, No. 6 being distinctly foveolate all over, No. 7 has smooth areas, while B.M. 286 and 282 are smooth but for small areas of weak foveolation. These areas in No. 286 are discoverable under a lens, but in 282 are, here and there, visible to the naked eye, as in the other specimens.

These two specimens correspond with the photographs above mentioned by Stephenson and S. Manton, No. 286, with pl. ix, fig. 1 on the left, consisting of two upright branches, fused together through the lower halves, and ending in smaller branches, partly fused with the typical blunt conical ends. The fused base is about 34 mm. × 20 mm.; exact measurements are impossible owing to irregularity and rounded or conical swellings. The free branches are rather flattened, 25 mm. × 20 mm., and 20 mm. × 17 mm.

No. B.M. 282 has a thinner stem, 13 mm. thick at the base, where it is dead, broadening and flattening where it is overgrown by living corallum from above, and still more so higher up. It is too irregular for measurement. This main branch appears to have grown at an angle of 45°, and bears 5 vertical branches about 20 mm. thick, ending in blunt cones; in both specimens these seem to be more slender than those shown in Stephenson's and S. Manton's photographs.

Calices small, near the base 0.5 mm. across, distally a little more. The thecal wall is moderately distinct, septa $\frac{1}{2}$ to $\frac{3}{4}$ of the radius, but irregular in breadth and often also in thickness; a pair of directives often more prominent. Six primaries and one or two rudimentary secondaries are present, but one or two primaries may also be narrow. They are continuous plates and may be slightly exsert.

Besides being distinctly foveolate the calices of Nos. 6 and 7 are different, 0.75 mm. across, primary septa broader and more regular; they do not meet centrally but join a columellar mass lying below their inner ends. Directives generally distinguishable, often broad, but not meeting.

These specimens might be a variety of *M. ramosa*, and Nos. 6 and 7 have been so labelled by Matthai, but proof is lacking. Compare Bernard's pl. v, fig. 1, in which the lower stems are as thick as those of the present specimens, but note that in *M. fossae* it is the lower parts of the stems that are the thinner. In Bernard's the upper parts are a cluster of thin branches, which are not conical at their ends. Compare the note on growth form in the Introduction.

Eguchi (1938, p. 376) mentions *M. palmata* (Dana). As he gives *M. palmata* Bernard as a synonym this may be *M. ramosa*, but he goes on to say: "It is easily distinguishable from the typical *M. ramosa* by having much stout[er] branches, which is usually irregularly united with the neighbouring branches and sometimes forms more or less massive corallum." This is almost certainly *M. fossae*. How many other records, e.g., Baker's* and Umbgrove's are really this species there is no direct evidence.

* This appears to be a reference to Proc. Zool. Soc. London, 1925, pp. 1007-19.—[A.K.T.]

Foveolate Montiporae.

Montipora foveolata (Dana).

1897. Bernard, p. 54, pl. vi, fig. 1; pl. xxxii, fig. 12.

Specimen 303 (outer moat, June Reef) corresponds exactly with Bernard's description and the left-hand figure on pl. vi; but fig. 12 on pl. xxxii does not show the interior of the calyx, which is deep, the 12 septa (nearly of the same size) running down to the bottom, and thinning below. When there are one or two thicker primaries they are not opposite: *i.e.*, they are not directives.

Bernard does not mention the columellar mass, which is generally present, very irregular in shape and size. (The calices of this specimen often contain sand grains, but the real columella can often be made out clearly.) Sometimes it is represented by thickenings of the inner ends of the septa.

Distribution: Tongatabu and Fiji; now G.B.R.

Montipora socialis Bernard.

1897. Bernard, p. 56, pl. v, fig. 4.

Specimen 318 is, like the preceding, from the outer moat of June Reef. I am doubtful whether this species is really distinct from the preceding, but two small and incomplete specimens afford no evidence for uniting them. According to Bernard the species differ as follows:

<i>M. foveolata.</i>	<i>M. socialis.</i>
Calices large, to 1.5 mm.	Calices less than 1 mm.
Calices each surrounded by ridges.	Several calices in one valley.
Young calices on meeting points of the ridges.	Calices as "swallow nests" on sides of ridges.

These two specimens differ distinctly in these respects, but in *foveolata* there are occasionally two calices surrounded by one ridge, and the difference between young calices on the meeting points of the ridges and on their sides is not always definite. The structure of septa and columella is identical. The fact that Bernard had seven specimens of *foveolata* and three of *socialis* is against their identity.

Distribution: Great Barrier Reef and the Gloriosa Islands. These are off the north-west end of Madagascar.

Foveolate-Papillate ("Irregular papillae") Montiporae.

Montipora venosa (Ehr.) var. *angulosa* Klz.

(Plate XXVI, fig. 5; Plate XXVII, fig. 5; Plate XXVIII, fig. 7.)

1879. *M. verrucosa*, Klunzinger, p. 35, pl. vi, fig. 10; pl. v, figs. 14, 15; pl. x, fig. 7a.
 1897. *M. venosa* (part) Bernard, p. 69, pl. xxxii, fig. 15.
 1906. ? *M. venosa* Marenzeller, p. 63, pl. 21, figs. 66-68; pl. 23, figs. 66a-68a.
 1907. *not M. venosa* Bedot, p. 274, pl. 46, figs. 260-262; pl. 47, figs. 263-266.
 1918. *M. venosa* Vaughan, p. 153, pl. 63, fig. 3.
 1918. *M. venosa* Mayer, pl. xix, fig. 46.
 1925. *M. venosa* Hoffmeister, p. 50, pl. vi, figs. 2a, 2b.

The two specimens of this species are remarkably uniform, in contrast to those described above. They correspond well with Klunzinger's figures mentioned above.

Bernard (p. 35) includes Klunzinger's species with *tuberculosa*. But the latter is quite distinct, and, as Marenzeller points out (p. 61), is *M. monasteriata* F. Bernard's only figure, a drawing, does not elucidate either species. Bedot's *M. venosa* is totally different, notably in the looseness of the reticular surface, absence of calicinal walls, and irregularity of the septa. Marenzeller's description and figures are unconvincing, especially in the abundance of thick rounded ridges. Vaughan and Umbgrove accept Bedot's identification; Vaughan and Hoffmeister that of Bernard without question: and none of them refer to Klunzinger.

The most interesting feature of the present specimens is the absence of free papillae. Either the calices are level with the surface on smooth areas, or they are surrounded by coenenchymal ramparts which make shallow funnels. The correspondence with Klunzinger's figures, pl. v, fig. 15 and pl. vi, fig. 10 (left hand), is exact, except that in the former the rampart round one calyx is divided into 5 papillae, and, in the latter, more or less free papillae can be seen here and there. A point mentioned only by Vaughan is that the secondary septa often bend towards or meet and fuse in a straight "V" with an adjacent primary, and there is often a columellar mass.

No. B.M. 394 is completely foveolate, except in depressions, where it is smooth. The surface is knobby, and on these knobs and on lower elevations the foveolation is perfect, the ridges being sharp-edged and enclosing a shallow, funnel-shaped depression, at the bottom of which is the calyx. This specimen was growing on a mangrove-root in Pool 3, Low Island. The root had decayed away except for some of the bark, and the corallum forms a hollow cylinder with edges turned outwards below, very little free, as the main lamella shown on Plate XXVI follows a branch root; but at the top the lamella turns over the top of the cylinder and downwards inside it for 1 or 2 cm.

A fragment tied to this specimen, but not part of it, is from a basal expansion. Its characters are the same as the corresponding parts in B.M. 394. No. G.B.R. 424 is a small crust growing over unidentifiable coral; its calices are smaller and more numerous, the ramparts form ridges in places, and are, here and there, broken into single papillae, not in a group round a calyx. Otherwise it is like the other fragment.

The calices and their variation deserve fuller description. All are 1.0 mm. across, or a little over. Those on the smooth areas are immersed, with up to 12 narrow but very distinct septa, the primaries broader, but a deep open fossa is often left. The directives may be distinguished by being thicker; or they may be broader also, when one may bear a columellar thickening, or both may join one, or (where the columella is broad) all the primaries may join it. Calices have well-marked walls, which may project as a low ring. Round the calices which are surrounded by the funnel-shaped ramparts the wall is naturally less conspicuous, but it is clearly present. The septa are as above. Even on the upper surface of the cylindrical corallum, where the coenenchyme is loosely reticular, walls, though thin, are distinct, and the septa (also thinner) are straight and well developed. On the foveolate basal expansions some of the fossae are deep and open, and at the edges calices tend to run in rows and the ramparts to form ridges.

The coenenchyme is spicular and densely reticular: on the "back" of the cylinder nearly solid. It throws up very delicate, branched spicules round the funnel edges, which often broaden into plates; these, of course, are not comparable to tubercles.

G.B.R. 14, a fragment of a crust, is probably of this species. The hummocks of the surface are low, separated by smooth valleys in which are well separated calices about

0.75 mm. across. These have 6 primary and a few secondary septa, with columellar plugs. Most of the hillocks bear low, pyramidal, separated papillae, but in places they fuse together to form ridges and the usual funnel-like walls round the calices.

This specimen is also very close to *M. elschneri* Vaughan from Fanning Atoll (1918, p. 154, pl. 64, figs. 1, 1a).

Distribution: Red Sea, Northern Celebes, Murray Islands, Samoa; now G.B.R. Bernard's record from Fiji is doubtful, though it must occur there.

Foveolate-Papillate Montiporae (papillae fusing to ridges).

Montipora prolifera Bernard.

1897. Bernard, p. 93, pl. xviii.

I identify sample No. 10 with this species, with the proviso that I think it possible that a considerable series of whole coralla might prove its identity with *M. foliosa*. According to Bernard's classification the species are widely separated, *foliosa* being a tuberculate form and *prolifera* papillate; but this distinction is not absolute. Of *prolifera* Bernard says that in young fronds the papillae may be quite small, and indistinguishable from tubercles. In this specimen the surface has overgrown two older growths, the whole being a plate in three layers, so that it is probably young. The tubercles are much more abundant than the papillae, which are so "proliferous," and so overgrown by tubercles and plates as to be hardly recognizable as such. The ridges in this specimen are conspicuous only 1 cm. or so from the edge, and on the tops of the larger processes. They are very thin, and less than 1 mm. high.

The great majority of the calices are immersed, with only one or two tubercles standing near their walls. Some, on the processes, may be surrounded by tubercles, but the ring is very rarely complete, or regular.

Bernard says that there are 12 septa: I find this rare; 6 plus 3 or 4 is more usual, the secondaries being small, while the primaries may exceed half the radius in breadth. There is often a minute columella-like body.

Distribution: Ponape (Caroline Islands) and Amboina (Netherlands E. Indies). Now G.B.R.

Montipora undans sp. n.

(Plate XXIII, fig. 3; Plate XXVIII, fig. 2.)

The name indicates a likeness to *M. undata* Bernard (1897, p. 98, pl. xxi, fig. 2 and pl. xxxiii, fig. 9). This latter figure, a drawing of enlarged calyx and ridges, contradicts the text, as do others of these drawings.

Specimens 13 and 187 agree closely; they are small, nearly complete and partly encrusting coralla of irregular outline, saucer-shaped, but with the edges turned downwards; major diameters 65 and 45 mm. There is no information as to localities of either.

The thick continuous ridges rise into crests and meet occasionally as shown in Plate XXIII. The valleys between are much narrower than in *M. undata*, Bernard's figure of which, it must be remembered, is reduced to half size. The central area is covered with short plates and round papillae. In the valleys are no small papillae or tubercles, but occasional short plates and thick rounded papillae.

The calices are 0.5 mm. across, with clearly circumscribed margins; septa 6 plus

2 to 4, rather thick, broad, symmetrical, not meeting. The walls and septa may project a little. Many calices are borne up on smooth processes resembling the papillae to various heights not exceeding 2 mm.; these are always more or less oblique, even in the central areas, though those only slightly projecting are level, even in the marginal areas, where the tubular ones are procumbent.

The coenenchyme is divided sharply into three layers; the middle a delicate open reticulum bounded above and below by very thin layers; the upper of very short, close-packed trabeculae; the lower stony and not distinct from the epitheca. The ends of the trabeculae cover the upper surface of valleys densely, and are like minute upright plates, usually set at right angles to the ridges or radially to papillae. The surfaces of the ridges and papillae are closely granular. There is no reticulum on the surface such as characterizes *M. undata*, nor is any of the surface spicular as shown in Bernard's fig. 9, pl. xxxiii.

It is tempting to consider these as possibly only young coralla of *M. undata*. The valleys might broaden out as growth extended, and even the papillae and plates of the central area become continuous serpentine ridges; but the differences in the calices and their supports, the presence of an epitheca, and the character of the coenenchyme are among the features not likely to change with age.

Montipora sulcata sp. n.

(Plate XXVIII, fig. 6; Plate XXIX, figs. 2, 5.)

Specimen 16 is a curved segment of a circle, measuring 15 cm. radially (the actual centre is unfortunately missing) \times 18 cm. across the chord. The right-hand edge looks as if it were broken, but the appearance is due to a sharp downward bend of the straight edge of the plate on this side.

The name refers to the long, comparatively regular ridges which cover the upper surface from close to the centre to the edge.

The characters in which the species differs from other species with somewhat similar ridges are:

- (1) Absence of epitheca.
- (2) Height, thinness and continuity of the ridges.
- (3) Small and very small papillae (tubercles?) between the main ridges.
- (4) Small, inconspicuous, immersed calices, very few in number; those on the underside very small.
- (5) Septa in one cycle, sometimes one or two of the second cycle present.

The plate is thin, from 4 to 5 mm. thick centrally, 1.5 mm. at the edge. The ridges are equally well formed, though not so high near the centre of the plate, but here are serrate, showing their origin by fusion of flat papillae. But over most of the corallum they are only slightly sinuous. The ridges are from 2 to 3 mm. high, but only from 0.5 to 0.75 mm. thick below (the upper edge much less), almost quite smooth above under a lens, but their sides are finely spinulose. For details of their junctions and endings see Plate XXVIII. Between them (never upon their sides) lie the calices and small, nearly cylindrical papillae, much smaller than those which, by their fusion, give rise to the ridges; many are quite minute. These papillae are scattered, but often one stands

immediately proximal to a calyx. The surface of the coenenchyme is rougher than that of the ridges and papillae.

All calices are completely immersed, there being no projection of the wall, which is not visible as a distinct structure. They are small, measuring 0.5 mm. and less across, rather far apart, and so inconspicuous that they have to be searched for with a lens. Septa well defined and broad, but second cycle at most represented by two narrow septa.

The surface of the underside is smooth (a lens reveals minute blunt spinules) but raised into numerous warts, on one side near the base developing into short root-like processes. Some of the warts bear calices at their points like those of the upper surface, and others may be found on the flat surface. Over most of the corallum, however, the calices are almost obliterated by thickenings of the septa: over the proximal half they can hardly be made out at all. The coenenchyme is excavated by linear, bent pits, the remains of the original reticulation.

In section the coenenchyme shows two layers only, a thin solid layer beneath, above which is an irregular network rising into the papillae.

The species resembles *M. pulcherrima* Bernard (1897, p. 91; pl. xvii, fig. 2; pl. xxxiii, fig. 7) but *M. sulcata* has (1) no epitheca, (2) continuous ridges, (3) calices all immersed, (4) small papillae, or tubercles, between the ridges, besides other differences.

Montipora tertia sp. n.

(Plate XXV, fig. 2; Plate XXVIII, fig. 4.)

Specimen No. 11 (no locality) is thus named as it is the third species known in which both the directive septa are highly exsert; the other two are *M. exserta* Quelch, the peculiarity of which is shown in his pl. viii, fig. 5*b* (Bernard in pl. xxxi, fig. 13 does not attempt to do so) and *M. saxea* Bernard (p. 180 in the appendix) from Gardiner's Funafuti Collection. *M. exserta* is glabrous, in *M. saxea* the septa are only half the width of the radius and irregular in shape, the papillae "small pimples without any definite association with the calices." This specimen No. 11 is a half column, evidently grown vertically, formed of an incrustation loosely overgrowing a cavernous mass of the same species, some parts of which are continuous with the living layer; the hollows and spaces of this mass are due to the mode of growth.

The living side of this specimen is made up of irregular vertical branches fused together and bearing numerous abortive branchlets as shown on Plate XXV. The papillae are low and rounded, often directed upwards and elongated in this direction, sometimes forming low rounded ridges. The branches seem to begin as fusions of papillae and ridges.

Except on smooth, depressed areas near the base the calices are hardly visible to the naked eye, being only 0.5 mm. across. Seen under a lens directly from above, the 6 primary septa with two broader and thicker directives are conspicuous; these latter nearly meet at the centre, and are nearly joined by the lateral primaries, but fusion is not visible. Seen slightly obliquely the exsertion of the directives is striking, and sometimes some of the others are exsert to a less extent. Some very thin short secondaries are often seen. There is a not very distinct "petaloid" wall.

Most calices are immersed, the adjacent coenenchyme smooth with minute spicules. Other calices lie at the base of a papilla which forms a hood over it; or they may open

on the side or summit of a papilla, or on a ridge. They are well developed on the spongy upper surfaces of the corallum.

A small portion of the under surface is visible; it is smoothly reticular with small spicules, calices, all immersed, some with thick slightly projecting walls. In another part small, aborted, spicular papillae occur.

The vertical, trabecular layer takes up most of the section; the middle layer is narrow and spongy, in places absent; the lowest layer may be of short thick vertical trabeculae, or, where the under surface is not living, a thin solid plate. An epitheca is not visible.

Foveolate-Papillate Montiporae (papillae regularly nipple-shaped).

Montipora verrucosa (Lamk.).

Two specimens; No. 9 identified by Matthai, and No. 12, neither with locality. Both are typical, lamellate in form, with none of the remarkable variation figured by Vaughan (1907, pls. 53 to 59.) Vaughan's specimens came from Hawaii, a marginal belt island where possibly variation is extreme. Even Bernard's series was more uniform.

Distribution: Great Barrier Reef to Hawaii, including Fanning and Fumafuti Atolls; but not recorded from Samoa or Tahiti. There is a form very like it in the Red Sea (not *verrucosa* Klz.), but Bernard thinks this is distinct.

Tuberculate Montiporae.

Montipora erythraea Marenz.

(Plate XXIV, figs. 2, 3, 4; Pl. XXVII, figs. 1, 2.)

1906. Marenzeller, p. 58, pl. 22, figs. 73, 74; pl. 23, figs. 73a, 74a.

1935. Manton, p. 294, pls. vii, xi.

1939. Umbgrove, p. 55.

Marenzeller says, "Diese *Montipora* steht der *M. foliosa* (Pallas) Bernard's nahe, und ist vielleicht nur eine lokale Form derselben." The species, after much consideration, seem to me quite distinct, and its discovery in the Bay of Batavia and on the Great Barrier Reef corroborates this. The two specimens are widely different. No. 319, from June Reef "Int. Mad. Zone," is heavy, humpy and rough, and its surface recalls that of *M. prolifera*. No. 30 is a thin plate covered with ridges over the whole 10 cm. which it measures radially. No. 319 is heavily wrinkled. In the proximal part it is as much as 18 mm. thick, but at the edge thins down to only 1.5 mm.; it measures 12 cm. radially and 9 cm. across. It is deeply concave below, the hollow 3.5 cm. deep, and correspondingly raised into humps and ridges on the upper side as shown in Plate XXIV, fig. 4. The literature later than Marenzeller's work supports his contention that this irregularity and flatness of the leaves is a distinction from *M. foliosa*; but no part of Marenzeller's specimens was so old and heavy as this, nor so completely covered with ridges as is No. 30. Neither bears upright branches; but the presence or absence of these is certainly not a specific character in other foliose species.

The main distinction from *M. foliosa* and other species is the way in which many calices are completely surrounded by tubercles. As they increase in length the tubercles carry up the calyx with them, forming tall pillars. These are described by Marenzeller, who duly emphasizes the fact that their ends remain free, fusion taking place only low

down. All stages in this remarkable growth are shown in this specimen, No. 319. It is quite different from the formation of a calyx on a papilla, or from the compound arrangement in *M. composita*, n. sp. described on p. 111, or from the fused collars, or imperfect rings of *M. foliosa* referred to in my note on that species on p. 112. On the distal ridged part of the corallum the pillars are less conspicuous, and generally oblique.

As I have remarked before, it is a real misfortune that Marenzeller's photographs are so coarsely printed, thus making necessary the fresh illustrations on Plates XXIV and XXVII.

Calyx walls everywhere distinct; septa well developed, 6 plus 6 or 4, breadth about half the radius, secondaries narrower, directives not prominent.

In this heavy specimen (No. 319) the lowest layer of the coenenchyme is quite solid and measures 1.5 mm. in thickness at the middle of the radius, but 2 mm. nearer the centre. Specimen 303 consists of two fragments, (1) from the edge and (2) from near the edge of a leaf. The pillars are therefore short.

Specimen 30 is included here because I can make out no clear difference between it and the distal edge of *M. erythraea*. but, in his specimen, these conditions hold for the whole 10 cm. which it measures radially. The calices are surrounded by similar tubercles in the same way, but are little, if at all, elevated. The underside is covered to 25 mm. of the edge by lithothamniae and brown weed, more thinly than in No 319, the whole plate being evidently much younger. It is deeply wrinkled, maximum thickness 8 mm., but mostly much thinner, 4 mm. on the average, 2 mm. near the edge. Structure of section as in the preceding. Free part of the underside smooth, without tubercles or papillae; here and there a rudimentary calyx can doubtfully be made out. It is possible that several large and complete colonies would complete the connection between these specimens and those of Marenzeller, or, on the other hand, show them to be distinct species. In the absence of such material I content myself with a figure which will be useful in the future.

Specimen 136 from Traverse II, Deep, is an irregular column, 13 cm. high, 8 cm. wide; the base encloses a mass of *Porites*, and there is little doubt that this gives the shape to an incrustation which is not likely to be anywhere thicker than the section exposed at the base, viz., 4 to 8 mm.

As there are no free edges there are no long ridges, but neither are there short ones elsewhere. In No. 136, as in 319, the tubercles are much reduced in the hollows and near the base, where they become small groups of mere spicules. Sometimes in such areas the calyx wall may stand up as a glassy tube independently of the surrounding reduced tubercles. Bare spaces showing a reticular coenenchyme are found here and there.

The calices on the sides stand out horizontally, and are not inclined upwards. There is one giant theca, with 12 nearly equal septa, all of which reach a broad flat columellar mass. The hard layer of the coenenchyme is somewhat thinner than in 319 but, as in that specimen, the middle layer is very narrow where it is present at all, and the trabeculae of the upper layer thick and glassy.

Distribution: Red Sea, Bay of Batavia and now G.B.R. only.

Montipora foliosa (Pallas) Bernard.

This species is recorded by Bernard from several localities between Mauritius and the New Hebrides; by Vaughan from Cocos Keeling; by Faustino from the Philippines;

by Umbgrove from the Bay of Batavia;* and by Eguchi from Palao where it may reach 3 m. across. It may thus be expected to be common on the Great Barrier Reef, but it has not been recorded from this region except for a doubtful mention by Saville Kent; and it is not present in this collection. Nevertheless I think S. Manton was probably right in giving the name to many of the foliose forms she met with, though many species are hardly distinguishable until closely examined. I attribute the absence of the species from the collection to the quite unavoidable but regrettable limitation of the packing and transport facilities available in such a place as Low Isles, and to the size of the launches used for expeditions. Most of the older records probably refer to several foliose forms, but we have the following reliable descriptions and figures.

Bernard (1897, pp. 156 to 162) describes specimens marked "a" to "w," and figures "f" on pl. xxx. Pl. xxxiv, fig. 13 (a drawing of a single calyx) contradicts the text which says (p. 158): "they are mostly protuberant, that is, surrounded by rings of tubercles within which they rise." One tubercle per calyx can be seen in some cases in Vaughan's (1918) pl. 65, fig. 2a. (Vaughan gives no description.) Bedot's (1907) pl. 50, fig. 276 is similar: the rings are neither complete nor do they form pillars. Faustino's figures on pl. 82 show thin tubular calices without distinct tubercles.

This shows how distinct is *M. foliosa* from *M. erythraea* apart from the marked differences in the arrangement of the ridges, etc.

Montipora informis Bernard.

1897. Bernard, p. 133, pl. 27, fig. 3; pl. 34, fig. 3.†

1918. Vaughan, pp. 156, 158; pl. 64, figs. 3, 4, a-c; pl. 65, figs. 1, 1a.

Sample 181 from "Traverse I outside" is a portion of a plate measuring 12 cm. radially and 19 cm. across the chord. It is slightly wrinkled, and bears two small vertical branches, the longer 24 mm. high. It is like the specimens described by Vaughan: rather more like his *M. aff. informis* than the typical form. In brief the main character of the species is that the tubercles are confined to small groups of 3 to 5, generally proximal to certain of the calices, in very few cases forming a ring round them. Most of the surface is covered with spicules rising from the delicate reticulum of the coenenchyme.

This specimen differs from both Bernard's and Vaughan's in that the epitheca is confined to a thin line along the edge where it is growing over a dead part of the plate; the whole under-surface bears very numerous, smaller thecae, 0.5 mm. to 0.75 mm. across, corresponding exactly to Vaughan's description and figures. There are small scattered protuberances carrying a small proportion of these calices. Those of the upper surface are very nearly 1.0 mm. across, as in Vaughan's variety.

Distribution: Cocos Keeling; N. Celebes; Murray Islands; and now the G.B.R.

Montipora composita sp. n.

(Plate XXVIII, figs. 1, 5; Plate XXIX, figs. 1, 3, 4.)

Two specimens (Nos. 23 and 186) are given this name, in spite of their widely different appearance; it refers to the arrangement of the tubercles into fused groups, as seen in

* But, like *M. ramosa*, not from the Togian Islands, though carefully searched for there.

† This figure shows a ring of widely-spaced tubercles. In this specimen 181, as in Vaughan's, they are close together; though not fused. I have ceased to expect accuracy in Bernard's drawings of calices.

section, which form warts on the upper surface, whence their free ends project. Between these warts single tubercles cover the surface.

No. 23 is a young leaf, thin and delicate, 3 mm. thick near the edge (average 4 mm.). Longest radius 13 cm., chord 18 cm. No. 186 is much larger and stouter, 6 mm. thick (peripherally 4 mm., at the edge 3 mm.), measuring radially 21 cm., chord 25 cm. It grows over an older sheet which is 10 mm. thick centrally.

In the young piece the warts are low and crowded, the tubercles short, and there is no great difference between those on the warts and those standing alone, so that the surface has a remarkably uniform, smooth appearance. The large specimen, No. 186, is on the other hand rough, the plate itself being wrinkled and hummocky, warts and tubercles higher and less regular; and the general aspect recalling *M. prolifera* and *M. erythraea*. It resembles the latter in having calices raised on "pillars." These are completely surrounded by tubercles, the ends of which are free. The tubercles are remarkable for being compound, *i.e.*, composed of other tubercles around and below those immediately surrounding the calices. There is also no formation of plates centrally, or of ridges peripherally, except for a small area near the edge of the big specimen, where they are extremely thin, perforate and jagged: their origin from tubercles is obvious. The warts may be arranged in irregularly circumferential lines in the small specimen, in the larger in no particular direction. No. 186 is infested with numerous small balanids, which have no share in the formation of warts. Though they seem to prefer to settle on warts their effect is to shorten and flatten them; and uninfested warts are in a great majority. The young leaf, in which the warts are small, is free of all parasites.

The tubercles are long and slender, round with rounded tops; and though covered with fine spicules the general effect is smoothness. A few are larger and flattened—I presume what Bernard calls "flame-shaped." Those between the warts are shorter, but like the others so closely placed that little (or, in the smaller specimen, practically nothing) can be seen of the coenenchyme. What can be seen of the surface appears solid in the small specimen: in the larger reticular, with small rounded meshes.

Calices numerous; many not supported, but immersed between the warts, some of which have no relation to tubercles. Many of the calices are oblique (to be seen only by tilting the plate), and may point in any direction over the central area, but in the peripheral part generally towards the edge. They are 1.0 mm. across, with 6 broad primary septa and several narrower secondaries. The primaries may nearly meet, and apparently do meet low down, or there may be a columellar nodule. In some places directives clearly marked; in others all primaries about the same size.

The underside is smooth, solid, with very fine spicules. There are numerous small calices with degenerate septa borne on conical protuberances. In the old specimen the peripheral calices become elongated, in one part up to 5 mm. long, and adpressed to the plate.

The young specimen, No. 23, shows no epitheca. In No. 186 it extends to 7 cm. from the edge, with some small patches further out. It is much overgrown, part of it by irregular layers of coral, differing from the rest in its immersed calices. These are crowded, have reticular coenenchyme between, and slightly projecting walls with well developed septa. In spite of all these marked differences there is no doubt that these layers belong to this corallum, as in one place a patch is continuous with the rest of the surface.

M. composita may be compared with Bernard's description of *M. aequituberculata*

(p. 130, no figure): "Single calices or small groups are raised up by the tubercles so as to form small excrescences on the surface." But this seems hardly equivalent to the wart-formation of my species; nor can the tubercles, with their rounded tops, be compared to "erect cylindrical flames."

*Montipora angularis** sp. n.

(Plate XXV, fig. 3; Plate XXVIII, fig. 3.).

Specimen 137 is from the anchorage, presumably at Low Isles: No. 5 has no locality but one concludes from its number that it was collected long before the other, making it unlikely that they are parts of the same corallum. Both consist of a thin crust, growing over dead plates and branches of the same species. This soon gives rise to lobes, plates and thin branches, which fuse again into plates in all kinds of irregular ways. The top of the corallum is composed of free slender pointed branches, 5 to 8 mm. thick. On them are long ridges separating areas of tubercles which give them an angular shape. The ridges are always bent and some are broadened and flattened near their ends.

The tubercles, apart from the ridges which show their origin from fusion of longer tubercles quite clearly, are generally cylindrical, of various lengths and thicknesses, with frequent flattenings and fusions into plates. Many of the shorter tubercles form incomplete rings proximal to the calices; on the branches these are longer and turn the calyx upwards. Even these tubercles are often broadened, and the direction of the flattening may be either radial or tangential to the calyx.

Calices mostly lie in the flat, and generally smooth, valley-bottoms, where tubercles are low or absent, and areas of finely spicular and solid or reticular coenenchyme are left bare. None are to be found within 1 cm. or so of the tips of the branches. They are 0.75 mm. across, with 12 septa; the primaries reach nearly to the centre and the directives meet, but without fusion; there is no columella, nor do the septa swell at their inner borders. Secondary septa often turn to join the adjacent primary ones, or they may form a straight "V." The lower part of the corallum (where it forms a thin crust over dead branches) is quite smooth, has no tubercles, is solid looking, and has closely placed spicules. The calices are smaller, placed often at the tops of conical protuberances, their septa irregular and narrower. In passing higher up the corallum one can see these cones gradually changing into groups of tubercles.

Sections of branches show a reticular central strand, but the outer layer is very solidly made. In branches low down on the corallum the reticular part becomes small; in one place in the crust the section is nearly solid throughout, though the fusions of the vertical trabeculae can be made out. The glassy under-layer is thin, and an epitheca is visible in one place.

A group of species described by Bernard shows resemblances to *M. angularis* which differs from *efflorescens* (p. 150, pl. xxviii, fig. 1) in having pointed, not rounded terminal stems, though the figure shows pointed and looser branchlets lower down the corallum. *M. angularis* differs in the regularity of its uniform tubercles, which leave no bare areas, and primary septa reach only to half the radius. *M. ellisi* (p. 151) has shorter rounder

* My Latin Dictionary (published 1711): "angularis, crooked, having corners." Both attributes apply to this species. There is no risk of confusion with *M. angulata* (Lamarck), which is a "very markedly foveolate" form (Bernard, p. 63).

tubercles which form the whole surface, and the calices have columellae. *M. striata* (p. 154) seems closer; in this the branches rise from a saucer-like plate, but this, in some other species at least, is not always of specific value. One cannot be sure what Bernard means by "striated." The drawing of pl. xxxiv, fig. 12 shows longitudinal bars of the reticulum, and pl. xxviii, fig. 3 is too coarsely printed to help in detail. The branches are pointed, but straight, and do not fuse except basally; they are like those of *M. angularis* in having no calices on the uppermost 4 or 5 mm. Septa differ in being thin, slightly swollen at their inner margins; the fossa is clear and deep.

Genus *Acropora*.

This is the largest genus of the corals, and the most abundant reef-former. In my experience, as in that of the Great Barrier Reef Expedition, it is the most abundant and varied in clear water along the reef edge, where its species often crowd out nearly all other genera. Vaughan mentions Bernard's 74 species from this region, but adds that about half of the names are probably synonyms. Mayer's Murray Island Collection contains only 18 species, of which five, including one new, are not recorded by Bernard.

Forty species are described here, of which five are new (a number attributable to the richness of the area and the skill of the collectors) but it is clear that, however much Bernard's number of 74 species may be reduced by further research, this collection does not contain even all the known species from this area. The fewness of the species common to the Great Barrier Reef and the Red Sea and Indian Ocean is remarkable.

In working out these species I have acquired a great respect for Bernard's work. Before 1893 the great variability of corals with their surroundings was hardly known, or only hinted at. What was known was the fact that among plants every slight ecologic change has a distinct species to fit it, and it was only natural that the same should have been supposed to apply to the corals. Gardiner was the first to emphasize the difference and some of his successors seem to me to have possibly carried the merging of species beyond what is, at present at any rate, capable of proof.

Bernard's work is open to criticism mainly on account of the number of species which are not illustrated, and the absence of enlarged photographs, but it must be remembered that he had to take his own photographs, and seems to have been unable to obtain them from foreign museums. The day when all coral illustrations published will be actual photographs, like Klunzinger's, is still in the future. The fact that the species are, in my text (not in the index list), arranged in the order Bernard uses, does not imply complete acceptance of his classification. Many species fall into related groups, which do not always correspond with the usual subgenera, but attempts by earlier authors to classify *all* the species have not succeeded. Compare, *e.g.*, *A. cancellata*, *A. clavigera* on p. 225.

Some species show remarkable adaptations for resistance to surf by flattening out into plates, with the shortening or disappearance of the stem of corymbose forms. As an illustration of this Crossland (1928, p. 723) describes the extreme forms due to the almost complete absence of tide in Tahaiti; but even here the species are always recognizable as derived from the normal forms growing in the lagoon. This is one indication that the extreme variability of many species under changed conditions has its limits, which could be worked out by observations on the reefs.

Brook (1893, p. 8) gives a long description of the septa in his introduction, yet, like

other authors, often omits them from his descriptions of species. In many species they afford little help, but in others the differences are constant and afford clear distinctions, not likely to be affected by external conditions. For instance directives may or may not be broader than the other septa in the axial calices. It is perhaps worth mentioning that the septa, in these and other corals with more or less translucent walls, cannot be properly seen unless the theca is shaded, by the finger or a fragment of opaque material.

Brook was the first to discuss the priority of the name *Madrepora*, concluding that its use was justified in practice, like that of, e.g., *Holothuria*. The later change to *Acropora* has no practical justification whatsoever, but, as it has been adopted by later authors, there is now even less advantage in changing back again.

Umbgrove (1940, p. 303) gives a list of the species from Batavia provided by Dr. Verwey, in which several of the names used here are regarded as synonyms. As the list is provisional, and, after full consideration, I find that the names I use are, pending Dr. Verwey's expected monograph of the genus, the correct ones, I treat the synonymy here instead of taking each case separately. The names I use are marked with an asterisk in the list.

1. *A. virgata* (Dana) = **A. pulchra* (Brook), 3 specimens in the Batavia Collection. Brook p. 40. Figure by Dana, pl. 39, figs. 1, 1a.

Brook places the two species under separate divisions, thus :

C, p. 38. *Prominent radial corallites, ascending, tubular.*

D, p. 41. *Short, erect tubulars unless near apex of a branch.*

A. virgata shows the ascending tubulars very markedly in Dana's figure. Brook says "none are immersed."

In *A. pulchra* they are equally conspicuous and erect; and there are sub-immersed and fully immersed corallites among them.

Brook had 11 specimens: this collection has 13, with wide variation, but *A. virgata* is not found among them.

2. **A. aspera* (Dana) = **A. hebes*, and two other of Dana's species. 4 specimens.

For *A. hebes* see Brook (p. 128); Dana (pl. 35, fig. 5); Vaughan (pls. 73 and 74); and Hoffmeister (p. 57, pl. 9).

The two species are kept distinct by Brook, Dana, Quelch and Gardiner. I agree that they are not easy to separate, but the following characters of *A. aspera* constantly differentiate it from *A. hebes*.

(1) Irregularity in sizes of radials, giving a rough appearance.

(2) "Funnel-shaped" cavities of axials; septa deep down.

(3) Thin, as well as perforated walls; and pointed shape of radials.

(4) Thin, wavy or bent septa of axials.

This collection contains 5 specimens of *A. hebes*, and 6 of *A. aspera*. Vaughan had several specimens, and figures Dana's type. Hoffmeister had "a very large and excellent suite." Both consider their variation.

3. *A. millepora* (Ehr.) = **A. squamosa* (Brook) and four other species. 2 specimens only.

Brook, p. 116, says that *Heteropora millepora* Ehr. is not *M. millepora* Dana: he had seen Ehrenberg's type in Berlin. There is no figure of this species in existence. On p. 117 Brook repeats this, says that Dana's type is lost, but takes his species as synonymous

with his own *M. squamosa*. There is thus complete uncertainty about the name *A. millepora* and Brook is justified in substituting a new name, *squamosa*.

The species falls into Brook's class "A" (*Radials gutter-shaped, thin walled*), which includes *M. convexa* Dana, *M. prostrata* Dana, *M. subulata* Dana and *M. selago* Studer, all of which Verwey regards as synonyms. Brook himself says the first three hardly differ. Dr. Verwey's discussion and figures of the types will be interesting, but the name *squamosa* stands, for the reason given above. The description of these other species, if their names are synonymous, has not been found sufficiently complete for use by subsequent workers.

4. *A. hyacinthus* (Dana) = **A. patulata* and 4 others, including *A. bifaria* (Brook), *A. kenti* (Brook) and *A. capillaris* (Klz.)

The difficulty here is to know exactly what Dana's *M. hyacinthus* is. I am not convinced by Hoffmeister's identification, in spite of his photograph of Dana's type; or, perhaps, because of it.

A. bifaria almost certainly owes its peculiarity to having been overturned without being killed, and so having become two-faced, like examples I have seen in Tahiti. But *A. kenti* shows a difference on its two sides similar to those of normal growths, and the number and size of the branches of the underside, as well as the characters of the radials of the upper, distinguish it at once from both *patula* and *hyacinthus*. I remark that Verwey had only two specimens in place of the long series collected by Mayor. As for *A. capillaris* (Klz.) of the Red Sea I can see little resemblance.

A. hyacinthus, which was so conspicuous in Tahiti, I have not seen in the Red Sea.

5. *A. acervata* (Dana) = **A. gemmifera* = **A. spectabilis*. There are 9 specimens.

Vaughan describes variation in *A. gemmifera* and compares it with the closely related *A. scherzeriana*, but does not mention *A. spectabilis* as a possible synonym. Verwey had 9 specimens, Vaughan "a fair suite" and the Great Barrier Reef Collection 6.

The differences given by Brook seem to be constant. As for *M. acervata* Dana the figure suggests *A. brüggemanni*, but certainty is not possible. It is caespitose, and "acervate" at its apices. *A. gemmifera* and *A. spectabilis* are, I believe, always massive and corymbose, as described by Brooks but Vaughan figures specimens which appear to be caespitose, though one is certainly morbid, partly overgrown by lithothamnia.

Acropora intermedia (Brook).

(Plate XXXII, fig. 1.)

1893. Brook, p. 31, pl. 1, fig. c.

Specimens 312, 89, 366σ, 309, 78, 71, 377σ and P3σ differ greatly in appearance and mode of growth. Some of them show the lax branching of several species which grow into areas of tangled stems, in which the lax branches from several main stems form a hardly extricable tangle—a tangle in which the lower parts are dead. As is expected, a free-growing corallum exposed to water movements on every side has a more closely branched and bushy form, and the characters of the corallites typical of the upper ends of branches extend further down, or even to the bases of their branches.

There are no fusions of branches in any of these 9 specimens.

As this is the best represented of this group of species in the collection, and the one with the strongest branches (2 cm. thick), it is probably this and not *A. hebes*, which is the main constituent of the "platforms" found near the exits from the moats at Low Isles and near the ends of the outer barrier reefs where they dip a little under the surface, as in pl. viii, fig. 3, and pl. xxvi, fig. 4 of Stephenson and others. The former shows bushy growths in the lower left-hand corner on the edge of the main mass, quite probably the same species as the crowded masses behind.

These are extremes of growth-form. The intermediates are 377 σ , apparently a complete corallum; and 71, a single branch 23 cm. long, alive for 18 cm., and 2 cm. thick at the base and for most of its length. It divides into two main branches 13 cm. long, each of which bears a number of smaller branches. No. 377 σ resembles a main branch of No. 78, (Plate XXXII, fig. 1), but is twice as long and has better developed branching.

As regards structure all agree with Brook's description, but his single figure is of a rather deformed, laxly-branched stem, in which the corallites typical of the upper parts of the stems extend but a little downwards, as in No. 366 σ of this series. The length Brook gives for the radials, 3 mm., holds for these specimens, but in the great majority in No. 366, some branches of 377 and the fragment P3 and in 89 they are confined to the summits of the long branches. The forms of the radials vary, though keeping to the same type.

No. 309: Radials very prominent, erect and thin-walled; openings oblique; septa narrow, but 6 + 4 or 6 + 6 in number. Buds on bases are frequent.

No. 312 similar, but walls thicker; openings circular and very little oblique. Septa as above, but usually broader. These tubulars extend practically to the bases of the two branches (16 cm. long), becoming a little shorter, and the septa thicker and meeting. Nos. 71, 78, and 377 are similar. In all these the upper directive is the longer.

Nos. 366 and 89, with shorter but thin-walled tubulars, have their openings a little compressed. Septa 6 + 0 in number, but distinct. Upper directive usually the broader but the two may be equal. They may or may not meet.

No. P3 σ is a fragment, a single branch 13 cm. long and 2 cm. thick, prolonged by a side branch for 5 cm. The main branch ends bluntly, and its terminal calyx cannot be distinguished. On the smaller branches, which are not so blunt, the terminal calyx is scarcely exsert. Septa 6 + 6 in number, primaries nearly meeting. There are no tubulars so long as 3 mm. anywhere; and over the whole of the main stem they are only 1 mm. in length and adpressed, the inner wall visible but fused to the stem, the opening facing upwards. Calices of this type cover the stem thickly and evenly. Immersed ones are rare and inconspicuous. In all the radials the septa are conspicuous, 6 + 6 in number, primaries nearly meeting. The walls are thick and spongy, except a small portion next to the stem, the surface peculiarly "woolly." This specimen is so unlike the others as perhaps to deserve a varietal name.

Two specimens are marked by Matthai "c. f. *pharaonis* and *grandis*." They are separated at once from *A. grandis*, the radials of which are "practically without septa," and while odd pieces of *A. pharaonis* strongly resemble *A. intermedia*, if the coralla, and the series of coralla, are considered as wholes the resemblance disappears. I may remark that I shall continue to regard Marenzeller's account of *A. pharaonis* with distrust until it has been worked out again *on the reef*.

Distribution: Recorded only from the Maldives, now Great Barrier Reef.

Acropora pacifica (Brook).

(Plate XXXI, fig. 2 ; Plate XXXII, fig. 2.)

1893. Brook, p. 39, pl. xxx, fig. B.

There are four fragments of this interesting species : No. 270 (Outer Barrier, June Reef, outer ridge π 2), a large horizontal branch, 25 cm. long, 35 mm. thick at the base, with seven branches curving upwards and three terminal branches nearly horizontal ; No. 345 (Ribbon Reef, outer moat, also marked π 2) essentially similar, 10 cm. long, 33 mm. thick at the base ; No. B.M. 60 (marked P.5, Batt Reef, surf zone, S.W. side of S.E. corner) ; and No. 333 (other indications illegible,* marked δ 2.).

The first corresponds best with Brook's description and the growth form is similar, viz., "subarborescent, stout and spreading." All the details of the calices, etc., are the same, but I should add that there is an irregularity in the direction of the openings of the calices, which is visible in Brook's photograph. The next two specimens show fusions between horizontal branches, amounting to a flat plate in part of No. 345 (Pl. XXXI, fig. 2.) The upright branches are more slender, but retain their characteristic proportions. Only in this specimen No. 345 are the axial calices exsert (2 mm.) as in Brook's specimen : in the other two they are 1 mm. and less in length.

No. 333 is a small scrap, consisting of a group of five little branches rising from an encrusting base. Its well exsert axials and more regular radials give it a somewhat different appearance, but the peculiar characters of its details are the same.

From these specimens with fused branches it is evident that the long branches are broken from a massive plate. Some whole colonies, which have never been collected, would be very interesting. It is probable that the two specimens drawn diagrammatically by S. Manton on her pl. xv, and provisionally named *A. decipiens*, really show the growth form of this species, which, so far as I know, is unique.

Distribution : According to Brook, China Sea and Samoa. The latter locality may be doubtful, as missionaries used to trade in corals as curios, and it is not mentioned by Hoffmeister. This is the first record from the Great Barrier Reef region.

Acropora grandis (Brook).

(Plate XXXI, figs. 1, 3, 4).

1893. Brook, p. 42, pl. 1, figs. A and B.

Samples 266 from June Reef and 457 (locality not given) correspond well with Brook's description and fig. A, but the cluster of branches shown in fig. B is not here represented. These two specimens differ considerably, chiefly in the longer radials and more tapering branches of No. 457. The result is that No. 266 is on the whole smooth, whilst No. 457 is rough. The June Reef specimen No. 266 is 41 cm. long, though the base and the ends of the branches are lost. The two main branches are slightly oval in section, at the bottom measuring 30 mm. \times 27 mm., and decrease very gradually to the tops. They are slightly bent.

The species is rare, and the distinction from others, e.g., *A. robusta*, needs emphasis. I therefore add to Brook's description.

* Appear to read, "Hefty outer moat."—[A.K.T.]

The main characters are : (1) Size and thickness of the stems, with which is correlated ; (2) a solidity which is complete at the base, and remarkable even in the breaks a few centimetres from the ends of the branches ; (3) a surface reticulation so coarse as to be visible to the naked eye ; (4) the curious grouping of the radials ; (5) radial calices are short, cylindrical or slightly compressed, and very thin walled, of irregular lengths and opening in various directions ; (6) the blunt ends of the branches, on which the apicals are small and hardly distinguishable from the radials (in No. 266) ; (7) almost complete absence of septa from the radials.

The larger specimen, No. 266, probably lay near the ground, since the longer branches all rise in one direction, though some stumps rise near the base on the supposed lower side, and the calices on this side are shorter and less crowded than on the other. On both sides they become much shorter basally than distally, as in all species, but here they project only about 0.5 mm. for the lower two-thirds of the main stems. In the four stumpy branches of the base, and in one 24 cm. above and pointing upwards, the axial calyx cannot be distinguished ; probably these branches ceased growth some time ago. In the remaining few ends it is just distinguishable.

For the curious irregularities of the radials I refer to the figures. A few near the ends of the branches attain a length of from 2.5 to 3 mm. and give some appearance of regularity ; but even here there are shorter and immersed calices, irregular in size and direction. These downward or sideways projecting tubulars are not mentioned by Brook, but can be made out in his figure. Similarly another peculiarity, the placing of the calices in groups or lines of three to six, in which their walls actually fuse, can be seen under a lens in Brook's figure. This grouping leaves small areas of coenenchyme free, exposing its characteristic coarse reticulation. The costal ridges are thin, but broad and continuous, not spinulate, extending on to the lip of the theca. They broaden as they pass downwards, so that the corallite appears slightly conical, but do not spread out on to the coenenchyme. Such spinules on the coenenchyme as there are, are broad and blunt : there are none on the costae.

The smaller specimen, No. 457, is only 19 cm. long. The apicals of 7 branchlets are present, those of the three main branches being lost ; though no larger than the adjacent radials they are distinct. These young branches are more slender and more pointed than those of the large specimen, though still blunt. In addition there are more pointed branchlets and longer tubulars, aborted branchlets, along one side of each main branch. These, and the irregular lengths of the same elsewhere give the corallum a very rough appearance, compared with which No. 266 is smooth. Otherwise the structures of both are the same.

Distribution : Great Barrier Reef only. Saville Kent collected five specimens ; not seen again till now.

Acropora pulchra (Brook).

1893. Brook, p. 44, pl. 28, figs. A, B, C.

1918. Vaughan, p. 162, pl. 66, figs. 1, 2, 3, 3a.

The collection contains 13 specimens, of which no two are even approximately alike. Evidently they have been carefully selected to illustrate the variation. Eight specimens have been labelled by Matthai, one each as variations *alveolata* and *stricta*, and four others with a ? mark. One is not named. The usual colour is given by Stephenson and others

as brown, with pale blue tips; but No. 217: "0. outside Low Isles. yellow tipped." This is an extreme variety, but colour may or may not be a specific distinction, as noted in the introduction, each case should be considered separately.

Only one specimen (No. 370, Lizard Island, A. Reef) corresponds exactly with Brook's description and his and Vaughan's figures (though Brook's is a mere fragment and he gives no enlarged photographs.) It is a curved stem, 23 cm. long showing numerous round, open and nearly immersed calices, especially in the lower half. Here also, in some cases, septa are fairly developed, whereas in the upper parts one directive alone, the upper, is usually conspicuous, the other septa rudimentary, as in the type. The calices are ridged outside, the ridges passing into a reticular coenenchyme, broken up on the surface into "dot and dash" granules. At the base of the stem this granulation becomes more regular, but never fine and even, as in the form described later.

Acropora pulchra var. *alveolata* Brook.

No. 91, thus labelled by Matthai, is like the type in having branches that ascend at about 30°, but differs in its "nariform or half tubular" radial calices; these are much less like those of the type in Vaughan's figure than of this specimen. Brook also says that the inner directive is often broader than the outer, which is very rarely the case here. In short, the characters upon which Brook founds his variety are variable.

Acropora pulchra, var. *stricta* (Brook).

(Plate XXXIV, fig. 2.)

No. 92 is thus named by Matthai and with it I consider No. 280, from the reef crest, at the north end of June Reef. They differ from all the other specimens in being more frequently branched, the branches thinner and set at a wide angle with the main stems. They are "more slender and tapering" but the larger calices are not more distant: in fact in No. 92 they are rather crowded. "The septa are better developed in the radial corallites" in some cases; in others no better developed than in the type. The larger radials in No. 280 often run in rows. They are nariform, as in var. *alveolata*, but a few on the backs of the branches are tubular.

The differences between the variety and the type are probably ecological (see Mayor's experiments given by Hoffmeister, and here quoted under *A. hebes*).

Acropora abrotanoides (Lamk.)

1893. Brook, p. 56 (no figure).

1918. Vaughan, p. 166, pl. 68, figs. 1, 1a, 2.

Specimen No. 286 corresponds with Brook's description and Vaughan's figures, the only ones existing. I add that the axial septa, though broad, are thin, and that the secondaries tend to bend and fuse to primaries; of these septa, the directives and sometimes two others meet. Radial directives may meet deep down, with a thickening at the junction. Immersed calices with a low, ring-shaped wall; septa represented by directives (which may meet) and rudiments of others, or all may be rudimentary. Axials with small buds near apex; long tubulars with small buds, or forming short branchlets.

Specimen B.M. 293 (no G.B.R. locality) consists of two thick stems, one now lost rising from a broad incrustation, 4.5 × 5 cm. on one side, and about 4 × 3 cm. on the

other. The remaining branch is 25 mm. thick—the lost one 22 mm.—and 60 mm. high. Half-way up it gives off three branches and some small stumps. The specimen is evidently a surf-swept dwarf.

The interesting part is the incrustation: this bears 3 stumps, 1 cm. high and thick, but elsewhere is closely covered with thick-walled, short, tubular calices, generally 2 mm. thick, but varying to small and nearly immersed. Here and there can be made out indistinctly little rosettes, in which an axial is surrounded by, or bears, a few irregularly placed radials. All these calices, even the asymmetrical ones, but not the very small immersed ones, in which the septa are very narrow, have well developed septa meeting a columellar mass. Septa in the calices of the branches may meet, but there is no columellar mass. The species is near to *A. danai* and *A. decipiens*; but Vaughan finds it distinct, as did Brook.

Distribution: Singapore; Great Barrier Reef; Tahaiti.

Acropora affinis (Brook).

(Plate XXXIV, fig. 1.)

1893. Brook, p. 60, pl. xxviii, fig. F.

This species, though very distinct and conspicuous, is recorded only by Brook. This is true also of his allied species *A. gravida*, which is doubtfully the same as *A. brachyclados* (Ortman). The collection contains two remarkable specimens, of special interest, since all Brook's nine specimens are either very young or only terminal branches.

The Great Barrier Reef Expedition's specimens are massive branches; No. 356 (without locality) 50 cm. long, 6 to 8 cm. thick; No. 384 (from June Reef) 43 cm. long 8 cm. thick near the base, about 6 cm. over most of the rest. These branches are irregular both in direction and thickness; in No 384 the lower 6 cm. is decayed, and only 3.5 cm. thick at the bottom. It seems likely that these are branches from large growths which must have been very conspicuous. A peculiar feature of both, most marked in No. 384, is that forks of the main branches grow parallel and close together without fusing before diverging, so that the fork is divided by a deep and narrow slit.

Probably because these are fully grown specimens there are some divergences from Brook's description. In No. 356, but not in No. 384, the branchlets of the main stem, but not those near the apices, are often in groups of 3 to 5; or the branchlet thickens, and bears branchlets of nearly equal size at its base.

Secondly, both in axials and radials of both specimens, the septa on the twigs on the main stems and those near the apices are quite well developed, though narrow, as in *A. gravida*. In all other respects, however, both correspond exactly with *A. affinis*, as described by Brook.

Distribution: Great Barrier Reef and Macclesfield Bank only.

Acropora aspera (Dana).

(Plate XXXIII, figs. 2 and 3.)

1848. Dana, p. 468, pl. 38, fig. 1.

1893. Brook, p. 62.

1886. Quelch, p. 156.

The six specimens, Nos. G.B.R. 285, 66, 304 and B.M. 299, and two unlabelled, are

low bushy growths, probably from shallow water (localities are not given). No. 304 is a remarkable contrast, consisting of long branches, more gently tapering, evidently grown under more free conditions. This is from the outer barrier of June Reef, presumably from the "madrepore field" where the end of the reef dips into deeper water. It affords an exact parallel to the experiment Mayor made in Samoa with *A. hebes*.

Dana's is the only figure, but he was interested only in the expanded polyyps: the branchlet showing the skeleton was merely sketched in. It is therefore advisable to expand the description, particularly of the septa.

The blunt-ended branches are given as characteristic, but, as noted, this is not invariable. Besides in No. 304 there are some tapering branches in Nos. 0, 1* and 285, in which most are typically blunt-ended. The thin-walled, generally fragile (Dana's term), short, rounded, labellate radials are characteristic. They are never tubular, or even partly so, the upper wall being at most a mere ridge, though in No. 304 they are longer, and some have the upper wall distinct. Many are small and sub-immersed, on the lower parts completely so. A peculiarity of these smaller radials, not hitherto noted is that they are often placed in close relation to the bases of the larger calices, and in many cases a little way up their walls, but usually one only is so related to, or budded from, a larger radial. The axials are described by Brook (in Quelch's specimen) as "often with a large deep funnel-shaped cup." I find that though a few are almost without septa they generally have six primaries and a variable number of secondaries. No. 66 *e.g.*, has axial septa as follows; they are all very thin, and often bent.

Axial calices.	Septa.
5	6 primaries, meeting.
2	6 primaries, meeting; also some rudimentaries.
1	6 quite regular primaries, meeting; and 6 smaller.
2	6 primaries and 10 others, all very narrow.
2	Too irregular to count.
2	7 irregular.

In No. 304 the arrangement of septa is:—

Calices.	Septa.
3	Quite irregular.
1	8 long and 6 short, the former with irregular fusions.
1	6 plus 6, all short.
1	6 plus 0, all short.
1	4 short and 2 directives.

In No. 285 the septa are irregular and very thin, often so deep down as to be hard to see. In a few calices they number 6 plus 6, with primaries meeting; but generally none meet.

Dana says (apparently of the radial calices), "star very short rayed, the directive septa prominent." In No. 285 most radials appear empty, or with narrow directives, but low down the larger calices can be seen irregular, not countable septa. Sometimes

* An unlabelled fragment. [A.K.T.]

there are very narrow ridges at the tops of the cups. The immersed calices of the lower parts of the specimen generally show very narrow septa; but they are irregular in size and number. In other respects, *e.g.*, character of the coenenchyme, the specimens agree with Dana's and Brook's descriptions.

Distribution: (as given by Brook): Philippines; New Hanover; Great Barrier Reef; Fiji; Rotuma.

Acropora digitifera (Dana).

(Plate XXXV, fig. 2.)

1846. Dana *Madrepora digitifera*, p. 454.

1893. Brook *M. digitifera*, p. 75.

1902a. Verrill *Acropora digitifera*, p. 228; pl. 36, fig. 12; pl. 36b, fig. 3.

1918. Vaughan *Acropora (Tylopora) digitifera* (Dana), p. 175, pl. 76, figs. 1, 1a, 2.

1918. Mayer, pl. 13, fig. 7.

This species has been thoroughly described by the above authors. Neither Dana nor Brook give figures, but Verrill photographs portions of the type, correcting Dana as to the thickness of the axials. Vaughan and Mayor figure Murray Island specimens. Vaughan's fig. 1 shows a more straggling bush, with rather more tapering branches than the specimen here, which is more like Mayer's figure.

The present specimen, No. 308 ("Lizard Island, 3.6.29. A. Reef. Mad. L.") is a compact bush, with stout upright branches, 15 mm. thick and 7 to 8 cm. long, corresponding exactly to descriptions except that the immersed calices among the ordinary radials are few, and generally not completely immersed. It is labelled by Matthai "*Acropora gemmifera* (Brook). This is really *A. digitifera* (Dana)" In spite of the close resemblance of the upper parts of the branches above the characteristic lateral branchlets to those of *A. gemmifera*, the different form of growth alone is a real specific distinction from that species. This view is supported by Stephenson and others' photograph on pl. 24, showing numerous specimens of *A. spectabilis* (or *gemmifera*?) growing in sheltered water behind the edge of Yonge Reef, none of which show a bushy growth. By contrast S. Manton's pls. xiv and xv show both corymbose and bushy specimens of "*A. gemmifera*" scattered over exactly the same habitat, proving that the different forms are not due to any influence of the habitat. The bushy forms are in fact, a distinct species, *vis.*, *A. canalis*.

Distribution: Great Barrier Reef (Murray to Capricorn Islands), Madagascar; not recorded east of the Great Barrier Reef.

Acropora haimeii M. E. and H.

(Plate XXXIII, fig. 1; Plate XXXV, fig. 1.)

1860. Milne Edwards and Haime, p. 151.

1879. Klunzinger, p. 21, pl. i, fig. 9; pl. v, fig. 4; pl. ix, fig. 16.

1893. Brook, p. 77.

1906. Marenzeller, p. 51, pl. xvi, figs. 45-48.

1918. Vaughan, p. 164, pl. 66, figs. 4, 5.

Klunzinger regards his identification of the Red Sea specimens with Milne Edwards and Haime's three-line description as safe. Brook mentions the type, but says nothing of the "orifice ovalaire ou même presque linéaire": he only says that in some specimens it is circular on the edge of the colony. None of the three, nor Marenzeller, say anything

about the septa. Klunzinger's figure shows a surf-swept dwarf, though he says, "Die Kolonie hat verschiedenen Habitus; bald ist sie (das häufigste) rasen oder rosetten-formig und meist viel sprossig. . . ." That the turf-like forms are the most common is what would be expected at Koseir: they are not common at other places where there is shelter. more bushy growths are illustrated by Marenzeller, who, as usual, gives no reason for his inclusion of these widely differing forms in one species. (His fig. 46 shows a dwarf form again, but it is recorded from Sherm Sheikh, Sinai, which is completely landlocked. Probably it is really from outside the Sherm.) In Vaughan's specimens, both of the species and of its variety, the radials are "very slightly or not at all compressed." He mentions the presence of two complete cycles of septa in the radials, which I find a somewhat striking feature of the Great Barrier Reef specimens.

These two specimens, named by Matthai, Nos. 296 and 234, are, to the naked eye, as different as two species could well be, both in growth form and in the regularity versus irregularity of calices and branches. No. 234, labelled "T2 shallow Bush," is a single stem 18 cm. long and 10 mm. thick throughout its length, with branches at angles of 15° to 30°. It is most like Vaughan's pl. 66, fig. 4, while No. 296 rather resembles pl. xvi, fig. 48 of Marenzeller. As the differences are so very striking and resemblances to published figures not complete I give a figure on Plate XXXV, and remark that I cannot feel satisfied with these determinations without having the evidence which Marenzeller withholds, and that to be gained by further work on the reefs.

Distribution: Apparently common in the Red Sea; but, in spite of its wide distribution, rare elsewhere. It is not recorded from Samoa, Malaysia or the Philippines, nor from the Great Barrier Reef until 1918.

A. tubigera (Horn).

1902a. Verrill, p. 239, pls. 36, 36A and 36F.

1893. Brook, p. 79.

Specimen 65 is complete, spreading horizontally from a base on one side, and is 17 cm. long, 18 cm. wide, and 9 cm. high.

This specimen is not translucent, as were Verrill's Singapore specimens, but the coenenchyme is hard and strong, though broken branches show circles of spaces radiating from the distinct, imperforate wall of the axial calyx. "The main branches . . . branch dichotomously." As there is no figure of the whole corallum I do not feel sure that "dichotomous" is here used in its strict sense; if it were the corallum would be I think, unique in the genus. That "the distal calices are about as large as the axial, or even larger," is another apparently abnormal state of things, but the figures show nothing unexpected. Otherwise the description is thorough and good.

I am doubtful whether the distinction Verrill makes between his specimens and Brook's is valid. This one seems to be intermediate in the solidity of the coenenchyme, and there is little difference between a short, adpressed, tubular radial and a round, nariform one. The inconspicuousness (not absence) of the second cycle of septa in the radials is, in this species, a minor detail, since, though most radials show them distinctly, in some others all the septa are much reduced.

Distribution: (including Brook's specimens): Singapore to Louisiade Archipelago, (just east of Papua). Now Great Barrier Reef.

Acropora quelchi (Brook).

(Plate XXXVI, figs. 1-3.)

1893. Brook, p. 90, pl. 32, figs. D, E.

1907. Bedot, p. 256, pl. 41, figs. 225 to 234.

1932. Thiel, p. 119, pl. 14, fig. 3.

Quelch (under the name *M. effusa*), Hoffmeister and Faustino also record the species, but without description or figures.

The species is not very easily distinguished from *A. loripes* except by growth-form though Brook places them in different sub-genera (*Polystachys* and *Conocyathus*); but these are separated only by details of the axial calices, which are often variable, as in, e.g., *A. rosaria*.

A. quelchi is "half vasiform from a lateral stalk." Only one of this series of 9 specimens, No. 272, is complete, and this is more bushy than vasiform, (Plate XXXVI, fig. 3), but it evidently grew on the side of a vertical support, its branches bending upwards at an apparent angle of 80° with the horizontal. At the other extreme are specimens which are clearly portions of flattened horizontal growths in which long and comparatively simple branches are connected by flattened fusions, the ends of which turn up at an angle of 30° or so. No. 305 is intermediate between these extremes, but is much nearer to the bushy form, No. 272.

I divide the series into four forms; they may, in fact, be distinct species, but only evidence from the reef can decide. Almost all are like var. *paradoxa* Brook (which Brook thought might be a separate species) in having "swollen hemicotyloid" instead of wart-like theca among the adpressed tubulars of the lower parts. But I find no axial rods formed by fusion of primary septa in immersed calices in any specimen; in fact none are perfectly immersed, all having more or less projecting rims.

Form A.—A more or less prostrate bush, with numerous long, upwardly bending branches, bearing few lateral branches, and those very short. Long, spreading radials, in distinct rows, over most of the upright parts. In specimen 272 the branches are from 5 to 7 cm. long, tapering, and with fairly prominent axials projecting from 2 to 2.5 mm., 2.5 mm. thick externally, with cavity 1 mm. deep.

No. 305 is distinctly of the corymbose form, very like Thiel's figure; branches shorter from 4 to 5 cm., and reaching to the same level above; underside with numerous short branches, the ends of which are more or less horizontal (more so than in 272). Axials exert only 1.5 mm., i.e., "scarcely prominent" as Brook says for his var. *paradoxa*, 3 mm. thick, cavities 1 mm. deep.

The axials differ from those in *A. quelchi* as described by Brook, both specimens having only 6 primary septa, as in Thiel's specimen, rarely with from 1 to 3 rudimentary septa of the second cycle; but the primaries do not meet, and are "subequal and not very prominent." The septa of the radial calices usually consists of directives, and narrow, almost rudimentary laterals formed of rows of spines; sometimes some of the second cycle also present

Coenenchyme finely echinulate, everywhere in rows.

Form B.—Specimen 279; growth form resembling No. 305, but branches longer in proportion, and the development of branchlets on the lower side much less marked. The whole specimen is very light and fragile; horizontal branches 12 mm. thick, those bending

towards the vertical only from 7 to 8 mm. at base and 5 mm. at a point 2 cm. below their finely tapering ends.

Axials 2.5 mm. exsert, 2.5 mm. in external diameter; owing to the long tapering branches they appear much more prominent than in any other specimen. Their septa number 6 plus 6, are thin and often bent, and may or may not meet, and directives are distinguishable.

Radials thin-walled, much compressed and lips not rounded; their openings long and narrow, but tubulars with short openings are also common. Septa well developed, the second cycle well represented. Radials stand well out from the stems and are in distinct rows.

There are a few incompletely adressed tubulars with round openings at the bases of the stems, but no hemicotyloids, and the rims of the subimmersed calices project well.

No. Z3 comes nearest to this specimen in delicacy of build. Like all the others, except No. 272, it is unfortunately only a fragment. The underside is distinguishable by a few short horizontal branchlets. The main stems are short and give rise to from 1 to 4 terminal branches, which are straight or only very slightly curved, so that the form is not markedly corymbose. Branches taper, from 8 to 10 mm. thick at base, from 3 to 5 mm. above.

Axials 2.5 mm. thick, only 1 mm. exsert, and so not at all prominent; cavities 1 mm. deep. Their septa generally number 6 plus 4, occasionally 6 plus 1 to 3, none meeting; directives not distinguishable. Radials long, spreading and in distinct rows, and mostly distinctly tubular with short oblique openings. Their septa well developed, though laterals may be rows of spines, usually 6 plus 0, but there may be from one to three secondaries; the outer directives are the larger. In the lower calices the arrangement is the same, but directives not prominent in the subimmersed calices, some of which appear almost empty. I have found only one "swollen hemicotyloid" in this piece, and, even on bases of branches, the shorter tubulars are not completely adressed and the free tubulars are to be found almost to the bottom of the colony.

These two specimens, though differing so much, seem to agree on the whole. I keep them as a form of *A. quelchi* out of deference to Matthai's labelling, being myself inclined to regard them as distinct species. Only work on the reef can decide.

No. P.4 may come here, but there is not enough of it to show the mode of growth. It has completely immersed thecae basally, and for some way up the branches which are practically straight.

Form C.—includes Nos. 34, 35, 80, and 284*x*. They are all distinguished by their thick horizontal branches, crowded with adressed or partly free tubular thecae, which, in No. 284*x* are mostly "swollen hemicotyloids." This specimen is from June Reef anchorage, and is much larger than the others, which have no locality record and so may be presumed to be from Low Isles: They have none of the broader, basal stems. In none of the four are any of the branches nearly vertical, the main stems being bare almost to their ends. The undersides of 35 and 284*x* bear blunt, abortive, horizontal and flattened branchlets with fusions, thus approaching the completely corymbose form much more closely than do the preceding forms. The same structures are less marked in Nos. 34 and 80, but they may have been equally well formed in other parts of the coralla. On the uppersides near their ends the horizontal branches bear a few slightly raised branches, only a little thinner than themselves, and somewhat blunt.

The axials of the first three are 2.5 mm. in outside diameter, and exert from 1 to 2 mm., but No. 284 has axials 3 mm. in diameter, exert only 1 mm., the internal diameter of all calices measures 1 mm. as usual. Their septa number 6 plus 6, secondaries being very thin. The radials are thick-walled (especially the lower lip) ascending, tubular, and not clearly in rows. Mouths on upper radials compressed oblique, well enclosed by the swollen lip; round or oval in the lower radials; some half-free tubulars occur among the compressed mouths low down the stems in No. 35 (the smallest fragment, only 55 mm. long, so that the real basal stems are missing) but hemicotyloids occur in all. The septa number 6 plus 0, sometimes with two of the second cycle. Laterals all narrow, formed of rows of spines. Coenenchyme well spiculated, usually in lines, and thecae striate throughout their lengths.

Owing to the great variation in growth-forms according to habitat, there has arisen a tendency to regard growth form, *in all cases*, as of little specific meaning. This tendency may have been exaggerated, and I am inclined to regard it here, along with other details, as quite possibly sufficient grounds for specific distinction.

Form D.—Three specimens, Nos. 70, 81 and 101, are fragments distinguished by their thick blunt branches and short and greatly thickened radials, though the axials are of the usual proportions. This general thickening involves the septa, which are thicker and longer than usual, the primaries of the axials and the directives of the radials almost meeting.

In the absence of ecologic or other information I do not feel any certainty that these fragments are really of this species; two of them are labelled *A. quelchi* by Matthai.

Distribution: Amboina, Banda, Solomon, Philippine and Samoan Islands. Now Great Barrier Reef.

Acropora corymbosa (Lmk.).

Specimen No. 375 (June Reef, Patch No. 1, square 12) corresponds well with Klunzinger's description, but the axials and the tubulars of the underside are longer, 4 to 8 mm. and 8 to 10 mm. respectively. It is most like his fig. 2b, Taf. ii, but this specimen is of regular shape, and the ends of the branches on the upper surface all of the same length. It does not correspond well with any of Marenzeller's figures, or those of Hoffmeister, Vaughan or Thiel. The large number of twigs and tubular axials on the sides of the branches near their summits seem to indicate that it is a young specimen which would have grown into a corymbose shape.

The septa are described only by Brook; this specimen corresponds. The shapes of the radials are as the outlines of Klunzinger's Taf. ix, fig. 19, except that the curious form "c" has the narrow end distal, not proximal as in Klunzinger's sketch. Otherwise they are so similar and so striking that the difference is evidently due to a slip on Klunzinger's part.

Marenzeller gives few details of his specimens, and, as in some others of his determinations, I consider that his work needs confirmation—work best done on the reefs.

Distribution: One of the few species found throughout the whole Indo-Pacific, including its extremes, the Red Sea and the Tuamotu Atolls.

Acropora armata (Brook).

(Plate XXXVII, figs. 1 and 3.)

1893. Brook, p. 100, pl. 10, figs. A, B.

Two specimens are both labelled *A. delicatula* by Matthai, and I have difficulty in distinguishing these species by following Brook's descriptions, the main difference being the form of growth. *A. delicatula* is bushy, without a stem, and with long curving branches of irregular length. Should further research bring these species together (and, from what is said on development under *A. hyacinthus*, this is not very likely) the name *armata* would have the priority as it was the first described species.

Only specimen No. 238 is complete with the stem. To it the plate-like portion is eccentric and oblique, corresponding with Brook's figure and description. I may add that the tubular axial calices thereon are up to 4 mm. thick, those of the underside of the oblique branches at most 2.5 mm., while those of the upperside measure only 2 mm. Their openings measure 2 mm., 1.5 mm., and less than 1 mm. respectively.

The stem of No. 76 is unfortunately missing, but it seems to have been oblique. I regard specimen No. 76 as belonging to the same species as No. 238, though it differs markedly in several ways :

(1) In general appearance of the upperside the axials long, slender and exsert in No. 238 are not prominent in No. 76, but it is to be noted that these axials are not so much exsert as they appear, as all bear minute buds 1 mm. or less from their apices. In a few cases those of No. 76 are exactly similar.

(2) A much more important difference is in the upright branches, which, in No. 238 are often 1 cm. thick at the base, thickening still further higher up (Plate XXXVII, fig. 3), where they divide into from two to five very slender tapering branchlets. The appearance of these thick bases suggests fusion of a group of long slender branches such as those of No. 76.

(3) The thicker, downwardly directed, tubular axials and abortive branchlets of the underside are much longer in No. 76, being from 7 to 10 mm in length.

The septa of the axials are not mentioned by Brook for either species ; in No. 238 there are two cycles nearly complete, but in No. 76 only the primaries ; in both, primaries are about half the radius wide, and one directive is broader.

In other details, such as the very distinct straight costulae, correspondence with Brook's description is complete. The inturred lips of the upper radials are characteristic. Seen from the side they give the radials a claw-like outline. Brook had eight specimens, apparently all in good agreement.

Distribution : Singapore, Diego Garcia (Indian Ocean), ? Tahaiti. Now Great Barrier Reef.

Acropora armata Brook var.

(Plate XXXVII, fig. 2.)

Certain small bushy specimens are referred to by Stephenson and others on p. 83, under the name *A. delicatula* as follows : " Apart from these more or less solid forms of *Acropora* on the outer ridge of Yonge Reef a totally different species occurring particularly on the sides of clefts, makes small rounded bushes of branches so slender and brittle

that an entire specimen can with difficulty be obtained—yet this form can withstand the breakers.”

Three of the four specimens are from June Reef, Nos. 335 and 359 from the outer moat, and 326 from the outer ridge; but there is no doubt that these are the same as those referred to. They are all labelled *A. delicatula* by Matthai, and it is certainly likely that they are stunted specimens, modified by the environment. At the same time there are differences not likely to be due to conditions, and it is quite possible that more than one species would be modified in the same way, and so converge by simplification.

Besides the fact that the branches rise more or less vertically from an encrusting base, with no trace of a stem or main horizontal branches (though there are long tubular calices and abortive branchlets round the edge of No. 326), the axial calices are thick-walled and costulate, costulae forming only fine lines in the ordinary way. The openings of all calices measure 1 mm. in diameter; but externally calices are 3 mm., 2.52 mm. and 2.3 mm. thick in Nos. 326, 359 and 335 respectively, the thicker axials corresponding to rather thicker branches. The septa differ in No. 326 numbering in the axials 6 plus 1 to 3; in Nos. 359 and 335 there are often 6 secondaries. In all, the directives meet low down and are nearly joined by the lateral primaries. The radial calices are fairly thick-walled, lamellate or nariform above, *elongated*, adpressed, tubular below; immersed calices found only quite at the bases of the branches. They contain 6 septa, all narrow, and in No. 359 some secondaries. These details seem to indicate that we are dealing with another species, but it is not possible to be certain on the evidence. I can only point out that in other corymbose forms the disappearance of the stem from exposure to the rush of spent waves (not to the breaking waves, under which, in Tahaiti, *Acropora* does not live) does not result in a bushy growth, but in the fusion of horizontal branches and reduction of the length of the upright branchlets.

Acropora glochiados (Brook).

(Plate XXXIX, figs. 1–2.)

1893. Brook, p. 104. (No figure.)

This species, represented by one specimen, No. 64, differs from *A. aculeus* Dana in its larger branches and much larger radial corallites, and in that the “surface and walls are striate and echinulate,” the echinules being fine and pointed. Whether these characters are specific cannot be said without further evidence. The fact that this specimen, in the sizes of the radials, comes nearer to *A. aculeus* is not sufficient alone. The radial calices are 2 mm. in diameter and 3 mm., rarely 4 mm. long; walls moderately thick except near the stem, apertures nearly round; with 12 septa so well developed as to be visible to the naked eye: directives meet deep down, the other primaries nearly meet. Axials hardly 1 mm. exsert, their outside diameter 2 mm., inside 1 mm.; walls spongy, costulate, 2 cycles of septa well developed.

As this species has never been figured, and *A. aculeus* not since Dana's time, I give two photographs on Plate XXXIX.

The branchlets below the main branches are much longer than in Dana's figure of *A. aculeus*, and so, presumably than in his specimen of *A. glochiados*, I should emphasize the striation of the thecal walls, with their fine-pointed echinulae, both of which become coarser on the coenenchyme of the main branches. The thecae “shorter and subimmersed

below" according to Brook, on the main branches are completely immersed but for a low rim proximally.

Distribution: Brook had only one specimen, from the Indian Ocean. If *A. aculeus* is synonymous with *A. glochicladus*, add Philippines, (?) Fiji, (?) and China Sea. Now Great Barrier Reef.

Acropora surculosa (Dana).

(Plate XXXVIII, figs. 2-5.)

1848. *Madrepora surculosa* Dana, p. 445, pl. 32, figs. 4 and 5.

1893. *M. surculosa* Brook, p. 104.

1893. *M. recumbens* Brook, p. 106, pl. xxvii, fig. F.

The three specimens of this species, Nos. 287, 288 and 339 (all with the additional mark W.2), form a very interesting series showing the variation in solidity of the base of corymbose species and the structure and delicacy of the branches and calices induced by exposure to the surf. This series begins with a netted plate; then one with slits remaining between the branches; and finally a solid mass, 28 mm. thick at a distance of 5 cm. from the edge, with 3 slits 3 cm. long near the margin. (cf. Crossland, 1928, p. 723, pl. ii.) These effects are sufficiently shown on Plate XXXVIII, but those of the detailed structures of calices, etc., need verbal description. The figures show, however, the great variation in the thicknesses of the branchlets.

I have no direct information of the conditions under which these specimens grew. No. 287, the most open form, is from a "Nigger Head" off June Reef, while Nos. 288 and 339 are from the outer moats of June and Ribbon Reefs, all parts of the outer barrier. These more massive forms have the more delicate thecal walls; in 288 they are very delicate and perforate, in 339 less so, in 287, though still delicate and porous, the lower ones are distinctly thicker. Similarly the development of the septa: in all the axials there are six rather narrow septa, of which the directives are broader; with, sometimes, representatives of the second cycle, best developed in No. 287, where the directives may meet. In the radials twelve narrow septa are well developed, the lower directives not much broader. In No. 339, the most solid, most radials are quite empty, or with a narrow lower directive, though a few show rudiments of the others. In No. 282 very few radial calices show any traces of septa.

Matthai has labelled Nos. 287 and 288 as *A. arcuata*, apparently regarding this as a synonym of *A. surculosa*. Brook's description of this species is overmuch occupied with its horizontal growth form, but there are differences in the shapes of the radials, etc., which separate the species, at least until a more complete comparison is possible. No. 339 Matthai labels *A. baeodactyla*, a caespitose form differing also in similar details. This specimens corresponds well with *A. recumbens*.

Distribution: From Mergui (Indian Ocean) to Tahaiti.

Acropora macrostoma (Brook).

1893. Brook, p. 105, pl. xix, fig. B.

Specimens No. 240 "i W moat" and 99 are too young for certain identification, and the group of species to which this belongs needs revision. We know little about the possible changes which occur during later growth. Both these studies can only be properly done on the reef.

The correspondence with Brook's description is, however, exact, except that only the youngest corallites have walls very thin, though all are spongy, and the growth form of these young examples is purely caespitose, the base being nearly as broad as the area covered by the branches.

Distribution: Recorded only from Mauritius, but probably already brought from The Great Barrier Reef of Australia under some other name.

Note on *Acropora hyacinthus* Dana and *A. cytherea* Dana.

1849. Dana, pl. 32, fig. 2.

1925. Hoffmeister, pl. 13, fig. 3, and pl. 14.

1924. Mayor, pls. 2, 3, 5, 12, 19 and 20.

Neither species is present in the collection, though Stephenson and others mention the former on p. 83, and on pl. 24 show very large corals given this name; and S. Manton has a number of references. Dana's species differs from the above figures not only (1) in the branchlets of the lower surface but (2) in having thicker and shorter branchlets above, also (3) in the radial calices which are "not fragile, lip not at all flattened," and (4) in the axials being short.

Stephenson's (1931) beautiful photograph (pl. 24) of the top of a Paradyce pillar to leeward of Yonge Reef is very suggestive of *A. cytherea*, apparently showing the branchlets in the little clusters characteristic of that species. In Tahaiti both *A. cytherea* and the species figured by Hoffmeister and Mayor are common. *A. cytherea* alone grows to sizes similar to those in Stephenson's photograph, *i.e.*, usually 1 to 2 metres and more across, the species figured by Hoffmeister and Mayor to a foot or two at most. Hoffmeister describes the young colonies of his species as bushy, but Mayor's figures as well as his own show that the future formation of an excentric stem is indicated at a very early stage: there is nothing like the small bushy or caespitose forms tentatively included under *A. armata* here. One of the distinctions of *A. cytherea* is that the corallum begins as a stout pillar, in which fusion of branches is merely indicated by grooves. (My specimen of this stage from Tahaiti is at Cambridge.) The species differ also constantly in colour, *A. cytherea* being uniformly lilac pink, *A. hyacinthus* "brown purple with pink tips" (Mayor).

Hoffmeister's species is very near to *A. armata*, but differs (1) in having much more fusion of the branches, and especially (2) in that the tubulars of the underside are adpressed, and (3) the projecting branches of the stems, with their specially developed tubulars, are not found.

Acropora patula (Brook).

1893. Brook, p. 111; pl. ix, fig. e.

Sample No. 62, without exact locality, corresponds in every way to Brook's description except that the septa in the radials are more prominent. In the lower radials, where they are well developed both here and in Brook's specimen, it is the *upper* directive which is the broader.

The species is very near *A. latistella*, but differs distinctly in the nariform radials which "remain more or less slightly prominent quite to the bases of the branches" (Brook). On the main stems immersed corallites, 1 mm. and less across, are rather far apart, on the underside still more widely scattered. Tubulars bearing small buds are conspicuous

on the underside, or on part thereof, and may be 9 mm. long, against 4 mm. in Brook's specimen, but this specimen, No. 62, is only from the edge of a specimen. I do not find the distinction Brook makes in "the condition of the surface." Both are strongly striate and somewhat porous. The Great Barrier Reef specimen of *A. latistella* perhaps is more echinulate, but there is no real distinction. A long series might lead to the merging of the species, but on present evidence they are distinct.

No. 63 may be this species. Branches much more slender; stouter, more adpressed radials; in this more like Brook's figure. Radials of equal size, meeting. No tubulars on underside.

Distribution: Like *A. latistella*, *A. patula* is known only from the Great Barrier Reef.

Acropora latistella (Brook).

1893. Brook, p. 112, pl. ix, fig. B.
 1898. J. S. Gardiner, p. 261.
 1925. Hoffmeister, p. 65, pl. 15, figs. 1a, 1b.

No. G.B.R. 85 is easily recognized by the naked eye from the characters and distribution of the radial calices alone. Further examination shows complete agreement with Brook's description, especially since the strongly developed septa are in two cycles in the radials—a rather rare character; suitably lighted the septa are often visible to the naked eye.

Brook says, "Radial walls of moderate length, but becoming reduced to a crescentic rim near the base of the branchlets." In most cases the crescent is a complete circle, the inner wall generally well formed, as is quite well shown in Brook's figure. The projecting labellate radials are found only near the tops of the branches. As their walls are thin the subimmersed calices are very open and conspicuous.

Distribution: Great Barrier Reef of Australia, Funafuti and Samoa.

Acropora squamosa (Brook).

1893. Brook, p. 120, pl. xx, fig. B.
 1918. Vaughan, p. 173, pl. 72, figs. 1-3.

Seven fragments broken from the edges of corymbose plates, and showing underneath the short irregular horizontal branchlets the fusion of which forms the plate; and one larger fragment, possibly the fourth part of the colony. The numbers are P.12, 90, 105, 336, 236 and 285, the larger specimen being No. 107. No. 396 is from A. Reef, Lizard Island. No. 109 is complete though small, 13 cm. across.

For relationship to *A. sarmentosa* see Vaughan, p. 174, and to *A. hebes* under that species on p. 133.

In No. 285 the branches are thinner than usual, and there are no plate-forming branchlets beneath; but the stems are procumbent, and all calices on the underside are immersed. Higher up branches fuse twice; they are not in actual contact, but the narrow space between them is bridged by outgrowths. The specimen is thus more like Brook's than Vaughan's, and so less like *A. sarmentosa*.

No. 107, the larger piece, and No. 396 correspond well with Brook's figure. Brook says: "Axial corallites cylindrical, 2.5 to 3.5 mm. in diameter, wall thick, star very well marked, the directive septa rarely more prominent than the others." In specimen No. 107, in which none of the more central branches are present, the axial corallites are

fairly regularly 3 mm. in external diameter, the mean of Brook's measurements, but the thick walls reduce the thecae to 1 mm. internal diameter. The axial septa are distinct but narrow; usually the primaries alone are present, and even this cycle is sometimes incomplete; but, on the other hand, rudiments of the second cycle are sometimes visible. I have seen broader directives only once in No. 107, but they are usual in No. 396.

The septa of the radials are always narrow, sometimes quite rudimentary, and the lower directives not always prominent: so in this specimen the conditions that Brook found only on the central branches are here present on the outer ones.

Certain branches on the central side are remarkable in having the axial calyx filled up with coenenchyme. They are not otherwise deformed or stunted in any way. The same thing is found in some specimens of, *e.g.*, *A. variabilis*.

Distribution: "East Indies" (Dana), Great Barrier Reef of Australia.

Acropora hebes (Dana).

1848. *Madrepora hebes* Dana, p. 468, pl. 35, fig. 5.

1893. *Madrepora hebes* Brook, p. 128 (no figures).

1918. *Acropora hebes* Vaughan, p. 174, pls. 73 and 74.

1925. *Acropora hebes* Hoffmeister, p. 57, pl. 9, figs. 3a, 3b.

Five small specimens correspond to the above descriptions and figures, *viz.*, Z.7, Low Isles moat; B.M. 278; B.M. 294; B.M. 288 (the last three have no G.B.R. number or locality) and G.B.R. 294 (B.M. 35) with long lax branches.

No. Z.7 (B.M. 50) is especially interesting, as it corresponds very closely with Dana's figure, and to Vaughan's photograph of Dana's type. The fact that it has been labelled *A. squamosa* by Matthai shows that these two species differ only in (1) mode of growth, (2) the greater regularity of the arrangement of the radial calices, and (3) the absence of immersed calices among the usual exsert ones in *A. squamosa*. The present specimen appears to be complete: four main stems (one now lost) rise from a common base and the whole is 8 cm. high, being thus, as well as in detail, very like Dana's type. But his type has more regularly arranged radials and fewer immersed calices among them, thus being more like *A. squamosa* than is this G.B.R. specimen Z.7.

In larger specimens the form of growth is a decisive specific difference. Such a colony as Z.7 might be imagined to grow up into a corymbose form; but this is no reason for merging branching and corymbose species until evidence *for each case* has been produced, since it is the rule throughout nature that almost identical young forms differentiate as they grow older.

Sample 294 (B.M. 35) differs remarkably from the above in its long lax branches, resembling Vaughan's pl. 74, fig. 2 of a specimen from Murray Island. Both Vaughan's figures and Hoffmeister's account of Mayor's experiments show that the ends of the branches may be blunt or tapering according to conditions of growth.

Vaughan's photograph of an apical calyx shows only twelve short septa, the description stating that the primaries meet deep down. I find that, though all six may meet, usually only four do, and they occasionally meet quite near the surface. For example, in specimen B.M. 294 there may be the twelve narrow septa shown by Vaughan; or the septa may be much broader at the top; from three to five primaries may meet quite a short distance down.

Distribution: Malacca, Murray Islands, Great Barrier Reef, Fiji, Samoa.

Acropora palifera (Lamarck).

1893. *Madrepora palifera* Brook, p. 131 (no figure).
 1893. *M. hispida* Brook, p. 133, pl. ix, fig. c.
 1907. *Isopora hispida* Bedot, p. 262, pl. 42, figs. 235-239.
 1918. *Acropora palifera* Vaughan, p. 178, pls. 78 and 79 (all figs.).
 1925. *A. palifera* Hoffmeister, p. 69 (no figs.).

The identity of *A. palifera* with Brook's *A. hispida* is shown by Vaughan who discusses other possible synonyms which might be proved by further collecting, but he had a good series of this species and, so far, finds it distinct.

Stephenson and others (p. 83, 85 and 88) refer to this species. Dr. and Mrs. Stephenson found it as encrusting sheets yards in extent on the outer ridge of Yonge Reef, in the anchorage coral zone; and common "under several growth-forms" (some of which may be separate species) on most parts of the reef. It is a massive encrusting or lobed form unlike the other species of the genus. "Also on a reef near Lizard Island." S. Manton (p. 305) found it also in the moat of Yonge Reef and anchorage zone, her plates xv and xvi showing growths 27 cm. and 54 cm. across.

In comparison with these the samples brought home are very small, the larger 12 cm. and 14 cm. high. They are all from parts of the Outer Barrier, and all of the same species, though one (No. 322) is labelled *A. plicata* by Matthai. This is a solid plate with narrower plates at right angles. It resembles *plicata* in bearing low ridges, along some of which run lines of tubular calices resembling apicals; but they are in contact with one another, have nothing resembling rosettes around them, and all the other calices have decidedly reduced upper walls and thick lower lips, the typical *palifera* type. There is little doubt that a larger collection would have contained *plicata*, which both Brook and Vaughan record from the Great Barrier Reef.

No. 317 is a cushion-shaped incrustation, 42 mm. thick (and therefore not a young corallum), very closely covered with short tubular thecae. It is labelled by Matthai " ? *Acropora ocellata* (Kl.) " but there are ecological as well as morphological reasons for regarding it as a form of *A. palifera*. It is unlike any of the numerous figures published. *A. ocellata* is a stumpy bushy form, and this specimen No. 317 *might* be a very highly modified surf form. If such forms occur in the Red Sea, Qoseir, where Klunzinger collected, would be an excellent locality for it, but apparently Klunzinger did not find it; nor have I seen it, or anything resembling *palifera* at either Ghardaqa or Dongonab. Again, were such a reduction of branches possible under the influence of surf it would surely be found on the Tahaitian barrier edge, *where this influence is at its maximum*; but from what I have seen there the utmost reduction would be to a form like *plicata*, with terminal calices and rosettes round them well traceable, as shown by me (1928) in pls. ii and iii. (Neither *A. palifera* itself nor any of its related species occur in Tahaiti, though *palifera* is recorded from Samoa.) I can only conclude that this specimen, No. 317, in spite of its numerous thecae with completely circular walls, among which those with incomplete walls on one side are less conspicuous, is a part of those encrusting bases referred to by Hoffmeister and the Stephensons. In this connection note Hoffmeister's remark on the variation in the septa; in this specimen all the calices are practically empty, only small teeth at the margins perhaps indicating 12 septa.

Distribution: Diego Garcia (Indian Ocean) to the Philippines, Rotuma and Samoa. Murray Island and now Great Barrier Reef.

Acropora canalis Quelch.

1886. *Madrepora canalis* Quelch, p. 150, pl. ix, figs. 2, 2a, 2b.
 1893. *M. canalis* Brook, p. 136.
 1927. *A. canalis* Faustino, p. 275 (who only quotes Brook and copies Quelch's figures).

The species is characterized by a rather loosely arborescent growth, the main branches procumbent bearing upwardly curving branches. These are blunt, with thick-walled axials, 3 to 3.5 mm. in diameter, 1.5 mm. internally, hardly at all exsert. The radials are peculiar, in typical examples the lower lip projects beyond the narrower part containing the septa, is thickened and porous as drawn by Quelch, and this outer part is usually wider than the inner. The septa are well developed, two cycles even in the radials, though the second is usually incomplete.

The present collection of eight specimens varies in an interesting way. No. 100, the largest, 17 cm. across, is quite typical. Near it is No. 253, in which the radials have rather thinner lips and septa that often meet an irregular nodule representing a columella. No. 341 is also procumbent, as shown by the more immersed calices of one side; but above has numerous short branches, only 15 to 20 mm. long, and thinner than in the type: the radials are smaller with thinner walls; radial septa 6 plus in number and not meeting; there is no rudiment of a columella. This specimen No. 100 is from the Outer Barrier, Ribbon Reef, inner moat (the preceding presumably from Low Isles), and probably owes its bushy form to rougher water.

No. 106 seems to have grown in an upright position. The branches are of normal thickness but more elongated and pointed. A few of the axials appear exsert, but they have radial buds close to the tops. The septa of the radials nearly reached the edge of the lower lip and are 6 plus in number; but the *upper* directive is often prominent, and sometimes, deep down, a columella rudiment may be seen. No. 293 ("June Reef, outer Madrepore field, *Madrepore* E") has four long (5 to 7 cm.) branches with prominent axials, which, under a lens, are seen to bear minute buds. The lower lips of the radials are generally thin, but still a little thicker than the rest of the wall; the septa are degenerate, but the *upper* directive is the largest. No. 455 (E. Moat, Low Isles) is normal, except that the crowded radials and their short lips give the branches a peculiar appearance, almost like a honeycomb.

No. 282 (Outer Barrier, Ribbon Reef E. Anchorage) is peculiar in the thinness of its upright branches, and smaller calices. The axials are well exsert, but as in the preceding bear small buds, and their walls are rather thinner than usual. Radial septa well developed, 6 plus in number, upper directives sometimes conspicuous. Lower lip of radials as in preceding specimen.

No. 72 is abnormal, consisting of a branch which, having been broken off, continued growth and fused to the broken pieces upon which it fell. This fact may account for some irregularity in the sizes of the radials over a part of the specimen, their regularity elsewhere being a feature of the species. Its main branch is only 15 mm. thick (against 20 mm. in the type), apical branchlets 4 to 5 mm. (against 7 mm.), radials 2 mm. wide and long (not 3 mm.), axials 3.5 mm. and internal diameter 1.5 mm. as typical. Small radial buds appear immediately below the top of the axial calyx.

The thin branches of these two last specimens give them a resemblance to *A. aspera*, but the septa, among other details, show a constant difference.

Distribution: Philippines; and now Great Barrier Reef.

Acropora fruticosa (Brook).

1893. Brook, p. 138, pl. xviii, fig. A.

Specimen No. 387 is thus determined by Matthai. It corresponds with the above description exactly, except that the axial calices are narrower, usually 3 mm. instead of from 4 to 5 mm. across, but, as we have seen in the case of *A. pacifica*, this feature is sometimes variable.

Brook says "Radial calices . . . a little compressed." This refers to their external shape, but the thickening of their walls makes their openings quite elongated and narrow, as may often be seen in his figure, though perhaps they are more so in this specimen.

Distribution : Recorded only from the Great Barrier Reef and Samoa.

Acropora spectabilis (Brook).

1893. Brook, p. 141, pl. xviii, fig. B.

The five specimens of this species fall into three sets. Three specimens labelled by Matthai are more like the type than the others in having thicker lower and side-walls of the radials : Nos. P.14 and 98 have the walls of the usual thickness, while those of No. 104, in which some of the branches are dead at the top, are only 1 cm. thick, and the radial septa are generally so narrow as to be difficult to see. In the other two the radial septa are much better developed, and a second cycle is visible. In No. 98 the primaries generally meet and the secondaries, though narrow, are complete ; in P.14 the colony seems to have grown in a crack, and is deformed into a vertical plate, and the two cycles are complete, but narrow. Two other specimens, Nos. 204 and 372, have slightly thinner walls to the radials ; and the septa of the radials, except the directives, are narrow, though quite distinct. They are small colonies, and less regular and flat on the upper surface, which may be an effect of youth, but the type specimen probably owes its short and regular branches to a surf-swept habitat. Compare pl. xxiv, fig. 2 of Stephenson and others, which most probably shows this species (not *A. gemmifera*), but with far longer branches than any brought home, the habitat shown being sheltered from the surf.

Distribution ; "The habitat of the type-specimen is unknown" (Brook). Now Great Barrier Reef.

Acropora gemmifera (Brook).

1893. Brook, p. 142, pl. xxi.

Specimen No. 337 (labelled by Matthai " ? *A. gemmifera* (Brook) may be *A. spectabilis*") comes from Outer Barrier, Ribbon Reef, outer moat, L.2. It is a fragment with a very solid base, evidently surf-swept.

The differences between this species and the preceding are small, but apparently constant. The axials are much narrower, and their twelve septa narrower and irregular, directives often meeting. Outsides of axials and radials striated. In this specimen the septa of radials are fairly distinct, but are usually made of rows of spines. For "radial corallites stouter and more proliferous" I should write "more irregular in length and thickness."

Distribution : Brook gives six records from the Great Barrier Reef. Also Fiji and Arafura Sea ; not recorded further east.

Acropora humilis (Dana.)

1848. Dana, p. 483.

1849. Dana, pl. 31, fig. 4; pl. 41, fig. 4.

1893. Brook, p. 145.

1925. *A. samoensis* Hoffmeister, p. 60, pl. 11, fig. 4.

This species has a great resemblance to *A. digitifera*, in its growth form: thickness, length, and bluntness of branches, and proportions of the axials, so that it is very easy to confuse them. They differ in the form of the radials, absence of immersed calices except right at the bottoms of the branches, and especially in the well developed septa, which in *A. humilis*, are so well formed, so as to be visible even to the naked eye. Dana's drawing of them shows the complete bilateral symmetry of the oval apertures due to the nearly equal directives coming close together centrally: but it is peculiar in showing 8 primaries, a mistake which is probably due to the fact that, in some cases, one of the secondaries may be enlarged, though usually they are narrow, and the cycle incomplete. Dana also states "star scarcely distinct," which is at variance with his drawing; but perhaps he means that the *radial symmetry* is quite lost.

The axials have 12 septa, of which 6 almost meet, and the secondaries too are broader than usual. They are thin and somewhat irregular, may be turned at a sharp angle at their inner edges, and sometimes bear an appendage that stands, as noted by Brook, at an angle with the plate. Directives are distinguishable, but not usually prominent.

The two specimens of this collection are larger than Dana's type, which is obviously young, and have branches up to 8 cm. long, and rather more tapering. No. 73 (no locality, presumably Low Isles) is complete but for one lost branch. No. P.10 is a forked branch with three short branchlets, and differs from both the type and No. 73 in having shorter and thicker radials, and more regular septa in the axials. Both show occasional arrangement of the radials in rows, as in Hoffmeister's photograph.

Distribution: Fiji, ? Samoa (Hoffm.), Great Barrier Reef.

Acropora brüggemannii (Brook).

1893. Brook, p. 145, pl. xxiv (with synonymy).

Three small coralla, of which the largest (No. 256) is 11 cm. high, and therefore very much smaller than Brook's figured example, and seems to be the whole of a young colony. Nos. 247 and 257 are about the same height, but consist of only a few branches each. They are all labelled by Matthai.

This is an easily recognized form, and is mentioned by Stephenson and others but not by S. Manton. It is therefore rare or absent from Low Isles, and Dr. and Mrs. Stephenson write of Three Isles: "Only one common coral species was noted as a form not familiar to us at Low Isles. This was an important form ecologically—a species of *Acropora* (*A. brüggemannii*) occurring in quantity on part of the flat adjacent to the anchorage, and making platforms like those of *A. hebes* at Low Isles (the latter species was also present)." This, like the occurrence here of three alcyonarians, is another of those unexplained differences between reef faunas already noted. Three Isles is a long way north of Low Isles, but it is similar in structure and similarly situated on the Barrier platform.

All these specimens belong to the typical blunt-ended form, but No. 256 has springing from its base, three short branches (the longest 3 cm.) which are tapering and pointed.

Brook does not mention the irregular broadenings of many branches; the species clearly leads on to the *Isopora* group, and a branch in this specimen 35 mm. broad and 38 cm. high carries on the resemblance, especially as this is one of those branches in which an apical theca is not distinguishable.

The septa differ from Brook's description in that (1) the primaries are often narrow, and so do not differ greatly from the secondaries, and (2) the directives may be broader in both axials and radials. Their edges are curiously wrinkled.

Distribution: Not recorded since Brook wrote, and only from Singapore besides a number of localities on or about the Great Barrier Reef.

Acropora variabilis var. *pachyclados* Klz.

(Plate XXXVIII, figs. 1, 6.)

1879. Klunzinger, p. 17, pl. ii, figs. 1 and 5; pl. v, figs. 1a, 1b, 3; pl. ix, fig. 14.
 1893. Brook, p. 161.
 1906. Marenzeller, p. 49, pl. 15, figs. 40 to 44.
 1918. Vaughan, p. 181, pl. 80.

Three specimens, Nos. 343, 344 and 348, correspond closely with Klunzinger's description of his thick-stemmed variety; of his figures pl. ii, fig. 5, pl. v, fig. 1b, and pl. ix, fig. 14 afford good illustrations, the last giving the shapes of the calices. Of Marenzeller's figures pl. 15, figs. 41a and 43 are nearest to these specimens. Vaughan's figures are of a thin-stemmed form.

The significance of the name *variabilis* is shown in these samples by the existence, among the thick stems, of some much thinner. In No. 344 the stems are mostly from 2 to 2.5 cm. thick, but counting only those *springing from the base*, there are two averaging only 1.5 cm. In No. 348 the thicker stems are only about 1.5 cm. thick, and four are only 1.0 cm. In this specimen there is a tendency for the larger radials to fall into rows, as in Marenzeller's figure 43a. This is a peculiarity, which reaches an extreme in No. 343, where, not only are the rows quite definite, but there is a fusion of the bases of the radials, (sometimes almost their whole lengths are involved), so that they form almost plate-like structures, bearing also small buds and half immersed calices. This arrangement is curious and unique, deserving illustration, and perhaps even a varietal name, but unfortunately only three detached branches are present.

In Nos. 344 and 348, especially in the latter, some of the tubular radials taper towards their tops; in the latter many of the adpressed tubulars low down on the stems are almost bulb-shaped.

The axials are up to 6 mm. thick, with rounded, smooth, finely-granulated walls, and their internal diameter 1.0 mm. and less. In No. 348 all but two of the main axials are filled in with coenenchymal matter, leaving only a trace of the cavity, or none at all. In No. 344 the cavities are usually 0.75 mm. across, or may be oval, 1.0 mm. \times 0.75 mm.

The septa have not been described. In the axials two cycles are complete, directives broader, nearly, but not actually, meeting; laterals well developed, in the two axial calices available in No. 348 the septa are broad but thin, and rather irregular; in No. 344 some calices have narrow septa.

In the tubular radials again there are two cycles of septa, the second not always complete. In No. 343 the lateral septa are well developed, but in the others this is rare, laterals being usually narrow or even rudimentary. The immersed calices have also

two cycles of septa, all very narrow (no directives) so that they look like open holes: these are very conspicuous in No. 343, but less so in the other two, in which they are surrounded by a low, ring-like wall. The characteristic buds on the larger radials figured by Klunzinger are not always present in No. 348.

Distribution: Red Sea: Philippines, to Tongatabu, but not further east. Vaughan gives Samoa, but Hoffmeister does not record it.

Acropora exilis (Brook).

(Plate XXXIX, figs. 3, 4.)

1893. Brook, p. 172, pl. x, figs. c, d.

The species is quite abundant at Low Isles since S. Manton referred to it on pp. 287, 295 and 296, and on pls. iv, vii and viii, and shows numerous examples on pl. xi. It is common at the seaward ends of all three traverses; on Traverse I "The most abundant species as measured by the number of separate colonies. It forms bush-like growths 3 to 12 inches across." On Traverse II "particularly abundant at the seaward edge of the reef." This local abundance is striking, considering that the species has not been recorded anywhere else since Saville Kent's time, and is a good instance of the way in which coral faunas vary from one area to another.

Of four specimens labelled by Matthai, Nos. 69, 83 and 199 ("T1 outside") are typical, Nos. 69 and 83 corresponding to Brook's figures of bushy and long-stemmed ("virgate") forms, while No. 199 is intermediate. These two long-stemmed forms show that this is one of the species which, like *A. elseyi* and others, may grow up from some depth, dying below as they extend upwards in a crowded mass of branches. It would be interesting to know whether the lower dead parts differ in any way from the living bushes above. The bushy specimen has made a fresh start, though growing on a broken and dead fragment of its own species.

The fourth specimen, No. 45, bears little resemblance to the others. The branchlets consist of stout, tubular axials bearing a few small short buds, but are naked for the distal 3 or 4 millimetres. On the main branches the radials are mostly long tubules pressed to the stem except near the ends of the branches, where their upper ends are free. (Plate XXXIX, fig. 3.) The septa are fewer, 6 in number plus 1 to 4 or 5 secondaries. Nevertheless the identity is clarified by the basal and some inner branches of the bushy specimen, the only one with basal branches in which similar conditions are found, though not including the long adpressed radials. However, as intermediates to these radials occur on normal branches we may consider this curiously abnormal form as belonging to this species. It is unfortunate, however, that the whole colony was not brought home.

Distribution: Brook records it from the Great Barrier Reef, the China and Arafura seas. Though a very beautiful and easily recognized species, it has not been recorded again until now.

Acropora elseyi (Brook).

1893. Brook, p. 172, pl. xi, figs. e and f.

No. G.B.R. 307 (June Reef Anchorage, coral zone, μ) is one branch with three divisions. No. B.M. 33 is a small but complete colony growing upon broken pieces, probably of the

same stock. As Brook's fig. F also suggests, this is one of those species of which specimens die off below as growth proceeds upwards.

These specimens are about half the size of those figured by Brook, and No. 33 seems to be young, as the upper radials nearly all have clean-cut edges; but in No. 307 they are nearly all thick and rounded. Below the radial calices thicken and finally become "verruciform," or rather conical, with very small apertures which sometimes disappear altogether. In these peculiar basal corallites, as in the septa and the densely echinulate coenenchyme, the species differs from *A. polymorpha*, to which species there is a strong naked-eye resemblance. A few other basal corallites are immersed, wide open (1 mm.), with *slightly* projecting walls.

There are six well-developed axial septa.

Distribution: N. Australia and Torres Straits. Saville Kent collected it from Rocky Island, the position of which I am unable to find.

Acropora rosaria (Dana).

(Plate XL, figs. 1, 3 to 4.)

The species, usually rare, is referred to by S. Manton on pp. 287, 295, 305, and plates vii and xiv: the last figure shows a single small specimen on the crest of Yonge Reef. On Traverses I and II it is one of the rarer species in the deeper parts.

The series of 7 specimens:—No. 310, Ribbon Reef; 334, June Reef anchorage; 368, Ribbon Reef; 108 and 77 no locality; 207 and 216, "T1 outside"; and 276, June Reef "Inner moat, 0 2"; (the first three and the fifth and sixth also bear the sign θ). All but Nos. 206 and 334 have been labelled *rosaria* by Matthai, but No. 108 is labelled "*A. spicifera* (Dana) may be *A. rosaria* (Dana)," yet seems quite clearly to belong to the latter species.

These 7 specimens fall into three well-marked forms. That the species is variable is noted by Brook, who describes three forms, the first divided into two varieties, only the last of which, forma *dumosa*, he illustrates: it is not found in this collection. I therefore cannot identify them here, but Nos. 368 and 108 may be his forma *rosaria* var. *diffusa*; and Nos. 206, 216 and 276 may be his forma *pygmaea*, of which S. Kent brought four specimens from Low Woody Island. None here are exactly like Dana's type, a photograph of which is given by Vaughan, in pl. 82, fig. 2.

I therefore describe the series afresh. *Form I.*—(Plate XL, fig. 3.) Nos. 310 and 334 are alike; both are from the outer barrier, Ribbon and June Reefs. They have the typical growth form with the ends of twigs standing out nearly at right angles to the main stems. Axial septa 6 plus 6, primaries nearly meeting, secondaries comparatively broad; directives generally distinguishable. Radial septa also 6 plus 6, all narrow, directives the broader, the upper one usually best developed. Septa of immersed calices have both series of septa, also narrow; but being thicker, they are more distinct. These immersed calices are frequent more than half-way up the branches on the fronts of the specimens, nearly to the tops on their backs.

In these characters the specimens are typical, but they have some additional characters the most striking difference being that the axial calices are extraordinarily broad—4 to 5 mm. (generally the latter) in No. 310, 3.5 mm. in No. 334. As in other specimens (the exceptions are noted below) the cavities of the axial calices are only 1.5 mm. wide.

The walls of the radials are also thick; many are short tubules, 2 mm. long, pressed to the stem. Coenenchyme porous, with echinulae in rows. thecae finely striate, but scarcely costulate. In both specimens the backs have thinner, shorter branches with narrower axials, and little but immersed calices on the main stems.

Form II:—Nos. 108, 368 and 77 (Plate XL, fig. 1.) are complete colonies, bushy growths 10 and 17 cm. high, with encrusting bases overgrowing dead coral—in the case of No. 108 probably of the same species. In spite of their irregular bushy forms one side is flatter than the other, with thinner branches and axials; in No. 108 and on the back of 77 these are quite long and slender, some of the branchlets being long, tubular axials bearing only a few small buds; but none are quite naked as in Brook's forma *dumosa*. In these specimens the normal axials are 3 mm. thick, with cavity 1.25 mm. across. Radials are also thinner-walled than in the preceding, and many are short, adpressed tubules. Immersed radials are numerous at a point more than half-way up on both sides of the colonies.

Axial septa not always 6 plus 6. In twelve main axials examined there are four with this formula, one with 6 plus 5, two with 6 plus 3 and one with 6 plus 2, the remaining one having 10 septa rather irregularly arranged. The radial septa are arranged as before. Thecal walls porous, but thecae not striate; coenenchyme with echinulations in lines, but compact.

Form III:—Specimen No. 216 (Plate XL, fig. 4) and especially the fragments No. 276 and 207 differ in that most of the radials are 4 mm. long, and pressed to the stems. Axials narrow, 3 mm. externally, and only 1.0 mm. internally, as are the radials. In No. 216 the lower branchlets have, especially on some dead branches at the base, small radials and elongated axials which have an appearance quite unlike those of this species. Many of the adpressed tubular radials have broad septa like the axials, as though the distinction between axials and radials were not developed. In No. 207 the septa of the second cycle are few, often absent in the radials, in which the directives are often prominent.

These three specimens have faintly striate thecal walls, prominent echinulae on ridges over the coenenchyme, which is sometimes dense, sometimes reticulate. *A. murrayensis* Vaughan is only distinguished from this species by a denser coenenchyme, involving thecal walls without costulae, and, in view of the above, this seems hardly enough for a specific distinction.

Distribution: Fiji and Great Barrier Reef.

Acropora cancellata (Brook).

(Plate XLI, figs. 3 and 4.)

1893. Brook, p. 166, pl. xxxii, fig. c.

A fine specimen of this species was dredged from Stn. XXVII. It is a contrast to the small piece figured by Brook, the only known specimen, which was dredged over 90 years ago from 15 fms.

The correspondence with Brook's description is exact, except that, being fully grown, the branches at the base are much thicker; but I give figures of the complete specimen, and details. The density of the corallum is noticeable as soon as it is taken in the hand. This applies to the walls of the tubular corallites, as in *A. clavigera*. The coral, though

growing from an encrusting base, differs on its two sides as does Brook's specimen, and therefore may be supposed to have grown out horizontally, or nearly so.

Distribution : Louisiade Archipelago, and now Great Barrier Reef.

Acropora clavigera (Brook).

(Plate XL, fig. 2 ; Plate XLII, fig. 3.)

1893. Brook, p. 183, pl. ix, figs. A, A'.

A fragment dredged at Stn. XXV differs somewhat in growth form from Brook's specimen. No branch is quite so like a rhizome of *Caulerpa racemosa* as is Brook's fig. A', and the base does not form a network though the branches are flattened. Different parts of the colony naturally differ in these respects. The Expedition piece is from the edge of a growing corallum. The correspondence with Brook's figure is otherwise complete ; but I should emphasize the inconspicuousness of the buds on the sides of the tubular calices due to their being small and "hemitoyloid," and the thickness and solidity of the walls of the tubulars even close to their ends—a very rare thing in the genus. There is a ring of about 16 costal ridges surrounding the apical orifices ; the 6 primary septa are thin, but not narrow ; of the directives one or both maybe conspicuous sometimes neither. The secondaries are short and distinct, and may be two only is complete.

As this is only the second fragment to be collected, and Brook's figures are obscure, I illustrate it again on Plates XL, XLII. The locality of the original specimen is not known.

These last two species are described by Brook, the one under the subgenus *Conocyathus* the other under *Rhabdocyathus*. As a matter of fact the species are strikingly similar, the main difference being the greater prominence of the smaller radials and number of immersed calices in *A. cancellata*. Indeed the separation of the two species is probably only provisional until more specimens can be compared.

Acropora proluxa (Verrill).

1868. *Madrepora proluxa* Verrill, p. 22.

1902a. *Acropora proluxa* Verrill, p. 237, pl. 36, figs. 3, 3a ; pl. 36 A, figs. 3, 3a ; pl. 36 F, fig. 14.

1925. *Acropora proluxa* Hoffmeister, p. 65, pl. 16, figs. 1a-c (with synonymy).

Hoffmeister's is the only figure of a complete colony, and should be supplemented by Verrill's of small branches. The single branch dredged from Station XXVII is more loosely growing, and, as one side bears fewer and less developed branchlets it may have been more or less procumbent. It is 11 cm. long, and 8 mm. × 12 mm. at the base (which is irregularly elliptical, as the break passes through the thick bases of a pair of branchlets).

A marked peculiarity of this specimen is that its echinulations and the ridging of most of the main stem (there are no ridges on the thecae) are more conspicuous than on any other species I have seen—far more so than Verrill and Hoffmeister describe. In places the large, closely-placed granules are seen to be thicker at the top than below ; the striations are well separated by deep groves. The explanation is found in the section of a branch ; the main stem is nearly solid, but that of a smaller branch is built of several solid rings surrounding the imperforate walls of the axial calyx, the rings connected by stout bars ; and outside all are the echinulate plates. Evidently the stalked granules and deeply separated plates are only a stage in the growth of the coenenchyme.

The septa are as described by Hoffmeister, but the whole of the second cycle is not

often present. In some cases the upper directive is much the larger than the other. I agree with Hoffmeister that this species is distinct from *M. echinata* Dana and the other species listed by him. It is near to *M. procumbens* Brook, and just possibly identical.

Distribution: Samoa, Sulu Sea, now Great Barrier Reef. (Verrill's "Ousima" cannot be found in the largest atlases.)

Aeropora jeulini sp. n.

(Plate XLII, figs. 1-2, 4-5.)

Specimen No. 330 (no locality) is a horizontal growth, of three main branches, 2, 2.5 and 3 cm. thick, joined by a base 5 × 3 cm. in section. The ends of two branches are dead and overgrown, but they widen to 3.5 and 3 cm. where stumpy side branches are given off. The underside bears stumpy branches, more or less horizontal, as shown on Plate XLII, covered with somewhat conical calices, distally tubular, proximally mere warts without openings; a few calices are immersed with projecting ring, generally thicker and higher on one side. The axial calices of the proximal branches are hardly distinguishable.

The upper surface bears short conical branchlets, two of which are 2 cm. long and wide, and others range from a mere central tubular calyx with a rosette of radials round it to branchlets 1 cm. long × 1 cm. thick.

Axials thick-walled, walls very rounded, spongy without costulae, 3.75 mm. thick; cup 1 mm. across, very little exsert, and bearing small buds near their margins. Septa 12, of which the primaries join an irregular columella-like body. In one case the cup is 1.6 mm. wide, but this is a giant calyx, having 16 septa all of the same size, joining a rough columella.

The radials of the branchlets are all tubular; inner walls thick, the outer very thick and rounded; apertures round, facing upwards, and therefore oblique. Septa in two cycles, the two lower laterals nearly as broad as the directive between them, the upper directives and upper laterals being much shorter. Walls spongy, only the lower third finely striated.

The flattened surface of the main branches is crowded with similar calices, many facing in all directions, but more often distally: in any case they face so far outwards that the openings are conspicuous in a view from above (Plate XLII, fig. 5). Some of the larger, though not cylindrical calices, bear small buds. Among these are completely immersed calices, in which the 12 septa are all equally narrow.

Some of the calices become closed up, partly by thickening of the septa, but also by ingrowth of the walls. This is particularly frequent on the lower surface where, proximally, many become mere warts with no trace of an opening. The coenenchyme is reticulate in places, but generally striate and echinulate, with holes in between the striate. The echinulae are flat-topped and bear minute spines, visible under a lens but best seen by binocular. On the proximal part of the main branches these are very numerous, so that their flat tops fit together into a mosaic.

This species resembles *A. decipiens* (the specimen shown by Vaughan (1918) on pl. 67*) *A. smithi* (Brook) and *A. plicata*, but is at once distinguished by its thick-walled

* Crossland in his typescript did not indicate what figure of Vaughan's he had in mind.—[A.K.T.]

and never gutter-shaped radials, besides other structures. It might be a surf-flood modification of some form like *A. secaloides* Verrill or *A. abrotanoides* (Brook), but this is not likely. The effect of the surf-flood in the *Astreans* certainly, and in *Acropora*, etc., so far as my observations go, is not to thicken or shorten the calices (rather the reverse), but to shorten branches and solidify the basal plate only. (Crossland, 1928, p. 723, pl. ii. For *Astreans* see Crossland, 1931, *e.g.*, pl. v, fig. 9,† and its explanation.) I have named the species after M. Jeulin, who worked as an amateur of corals at Ghardaqa and in the Gulf of Suez.

Acropora brooki sp. n.

(Plate XLI, fig. 2; Plate XLV, fig. 3; Plate XLVI, fig. 1.)

Specimen No. 290 (? June Reef, outer moat) is a fragment of a corymbose plate, measuring 13 cm. radially and 10 cm. across. Viewed from the underside the branches are flattened and fused, leaving small holes proximally, elongated slits distally, as shown on Plate XLI. The surface is largely smooth, but for scattered warts and immersed calices, but distally completely adpressed tubulars abound. The sides of the branches, however, bear long tubulars 2 mm. thick, which proximally form triangular branchlets, often fusing to the adjacent branches. The upper side bears branchlets 2.5 to 3 cm. long and about 0.5 cm. thick, the proximal nearly vertical, the distal curved upwards. These are placed further apart than usual, their apices 1.5 to 3 cm. distant; probably in correspondence with this the immersed calices of the plate are very numerous, and nariform radials continue on to the plate in lines from the bases of the outer branchlets.

The axials are long, 4 mm. × 2 mm., but lower down the branchlets are others 8 mm. long bearing a few small buds, or becoming aborted twigs. They are 2 mm. thick, cavity 1 mm., wall strongly striate and porous. Axials with 6 narrow septa, and small representatives of the second cycle, sometimes complete. Directives sometimes smaller.

Radials nariform or compressed, tubular, quickly attaining their full size; projecting at an angle of 45° to the stem; walls thin. As they are 4 mm. long they are conspicuous; width 0.75 mm., shape of opening like a Canadian canoe, and with thin lips; the opening does not reach the stem, but sometimes is close to it; in the larger and lower radials it is separated by a variable distance increasing to nearly the length of the calyx in the tubulars, in which the opening is oval. Walls, like those of the axials, very distinctly striate, the striae continuing over the lips.

About half-way down the branches the radials become nariform, with much wider oval openings, and finally become round, subimmersed and immersed.

Septa of the radials reduced to the outer directive, which is, at its best, a thin line along the bottom of the "canoe"; and even this is often difficult to distinguish. Tubulars with buds have small laterals as well as narrow directives.

The large, immersed calices of the plates have slightly raised walls; some, near the bases of branches derived from the short nariforms of the lower parts of the branches, are only subimmersed. They are quite open, without septa or with the slightest rudiments.

Coenenchyme reticular, echinulate, the prominent striae of the thecae not extending beyond their bases.

† Crossland had written "pl. ix," which shows *Lobophyllia*. It seems likely that he meant "figure 9," which shows a *Leptastrea* of the barrier edge series.—[A.K.T.]

Acropora lutkeni sp. n.

(Plate XLI, fig. 1; Plate XLVI, fig. 2.)

Specimen No. 271, from the Outer Barrier, June Reef, Nigger Head, is a complete colony, consisting of a solid conical base 11 cm. high, 6 cm. wide at the bottom, with a more or less flat top about 20 cm. across. This bears a number of simple upright branches about 3 cm. thick, regularly tapering, bearing on their lower halves numerous branchlets, up to 1 cm. long and thick, but mostly much smaller. At one side of the base are branches 4 cm. long, 1 to 1.5 cm. thick, obviously homologous with the branchlets of the main stems. Where the branches come near together they are flattened, so that sections are oblong or triangular. The striking character of the species is the extreme compression of the more prominent radials, 3 to 4 mm. long, the cavities of which are usually deep slits, opening outwards distally and not quite reaching the stems proximally. In other words the radials have greatly thickened side-walls, but their ends are not, as in many species, specially thick. These openings, and the upper surfaces of the calices, are nearly at right angles to the stems, but the lower walls slope upwards slightly. Among these are shorter calices with oval openings, and immersed with ring-like walls. The longer radials bear small buds, and, about 3 cm. down the stems, these buds enlarge to form rosettes, the beginnings of the branchlets of the lower parts of the stems; but though these radials have now become axials they retain the slit-like shape of their cups. Even the axials of the main branches are oval. The immersed calices with ring-walls are found up to 1 cm. from the tips of the branches; but lower down they become numerous, occupying most of the space between the branchlets. As their 12 septa are all very narrow their calices are open and conspicuous. They are accompanied by adpressed tubular radials, with thick outer walls and small (0.5 mm.) openings, upwardly directed and close to the stem.

The axials of the main stems are 3.5 mm. thick, their cavities 1 mm. longer in diameter; they have 12 septa, all short, but in most cases accident or abnormal growth make them difficult to see. In the radials only the directives are conspicuous, the lower as a long ridge in the bottom of the trough, the upper as a wedge-shaped tooth on the proximal wall; laterals are present, but rudimentary.

The walls of the thecae and the coenenchyme are finely and closely echinulate, not striate, echinules long and pointed.

I name this striking species after the late Professor Lütken, in recognition of his labours in collecting and arranging the corals of the University Museum of Kóbenhavn. Prof. Lütken did not publish his results, but I hope to give some account of his work later.

Acropora otteri sp. n.

(Plate XLIII, figs. 1-2; Plate XLIV, figs. 1-2.)

The three specimens Nos. 306 ♀2, 338 ♀2, and 60 (the two former from the outer barrier, Ribbon Reef, inner moat; and June Reef, outer moat respectively) differ greatly in appearance and largely in structure, but undoubtedly belong to the same species.

The growth form is corymbose, with arching upright branches. But while No. 60 is decidedly lax, with no fusions of branches beneath, and only a trace of flattening, the upper branches somewhat irregular, up to 11 cm. long, Nos. 306 and 338 have flattenings

and fusions beneath, the former with regular branches 7 cm. long, of which the radials are all approximately the same length, the latter with stout branches, made irregular by numerous long tubulars bearing buds and aborted twigs—an effect which is even more marked in No. 60. These differences are so curious that all three specimens are photographed. These three specimens are the syntypes of the species.*

All are alike in having thick, axial calices, walls spongy above, inconspicuous striae on the sides, and moderately wide cavities. External diameters are 3 mm. in No. 60, 3.5 mm. in the others; internal diameter 1 mm. in all. Septa number 6 plus 6, thin but straight, narrow above except the directives, but broad below. Axials exert about 2 mm., but may have minute buds within this distance of the apex.

The projecting radials are of two kinds, (1) shorter, nariform with oval or nearly round openings, inner wall always distinct, though short, and (2) tubular, with straight or nearly straight-cut ends, the longer of which bear buds. These larger radials tend to fall into rows, straight or somewhat spiral. Lower down the nariforms become adpressed the outer lip thickening and the opening becoming round, the whole becoming like short adpressed tubulars. Among these are numerous immersed and subimmersed calices, some of which are to be found 1 or 2 cm. from the tips of the branches.

In the upper radials only a narrow, lower directive is visible, but, lower down the other septa appear and are often well developed, some of the second cycle being present.

The long, tubular radials, with others which are shorter and bear small buds, are a characteristic of several species, e.g., *A. abrotanoides*; but the combination of these with the adpressed tubulars and sub- and fully-immersed calices of the lower parts of the stems are a special feature of this species (Plate XLIII, fig. 2). In No. 306 tubulars occur, but are not prominent, and rarely bear buds; and the lateral twigs are short and stumpy. Exactly the reverse is true of No. 60, in which long tubulars bearing buds are conspicuous, and the lateral twigs are long and thin, often hardly thicker than the axial calyx itself. In No. 338 they are often prominent, but lateral twigs are short.

The coenenchyme is finely striate and echinulate, but more coarsely than the thecal walls.

The species is near to *A. abrotanoides*, but its corymbose form is not the only difference. It is not proved that caespitose and corymbose forms occur in the same species when adult: the form of branching of the specimens of *A. abrotanoides* in this collection and Vaughan's figures (1918, pl. 68, figs 1, 1a and 2) make it especially unlikely in this case.

Acropora laevis sp. n.

(Plate XLV, figs. 1-2.)

Nine specimens, though widely differing in detail among themselves and all differing from *A. pulchra*, agree in a general smoothness to the naked eye, which is due to (1) the smoothly rounded and thickened edges of the calices, (2) the fine and uniform granulation of the coenenchyme, (3) having well developed stars of septa in the radials, and (4) the conical shape of the half-immersed radials of the lower halves and backs of the branches. Branching is lax, side branches at angles of 30° to 45° to the main stems, and varying

* Crossland wrote: "All three constitute the type." But in accordance with the recommendations on International Rules of Nomenclature, No. 338 is hereby designated holotype, and Nos. 306 and 60 paratypes.—[A.K.T.]

in thickness from 12 mm. to 8 mm. basally. Radials well separated (No. 79) or crowded (No. 93), usually tubular, and sometimes at right angles to the stem, or inclined (compare figs 1 and 2 on Plate XLV). There are also conical and immersed calices high up the stems, but the latter reach their characteristic form 5 cm. or so from the tops, and are the only kind for the lower halves of the stems (Plate XLV, fig. 1). The walls of the longer calices are ridged, if at all, only near their bases, and the upper parts are slightly thicker and finely granular. The lower directive is usually the largest septum, but is not so prominent as to prevent the septa making a star.

For other characters I refer to the plates, but Nos. 33, 212 and 217 deserve special mention for their large, thick-walled calices, of which the largest are remarkable for their narrow bases: some might be called club-shaped.

Holotype: B.M. Reg. No. 1934. 5. 14. 349. G.B.R.E. Sample No. 79.

[Family PORITIDAE.]

Genus *Goniopora*.

S. Manton mentions (p. 289 and graph xi) that species of the genus occur in minute colonies on the muddy rocks of the seaward slope of Traverse I. On pl. xvi she shows a single, small specimen on the inner part of Yonge Reef. Stephenson and others give four references (pp. 67, 86, 89 and 90) listing it as characteristic of seaward slopes and the anchorage at Low Isles, of Yonge Reef, the reef patch at Lizard Island and Batt Reef.

In many cases I cannot make out the mode of growth by layer over layer which Bernard so elaborately describes as characteristic of the genus (indeed he implies that it is invariable). Such layer-over-layer formations are found in any genus when a colony is successful in resisting periodical partial burials in mud or sand; and it is particularly common in this genus, which, as noted also by S. Manton, often inhabits muddy areas. Gardiner (1939, p. 242) also finds that Brook's "description is inapt; for the central part, perhaps inches thick, has no epithelial plates one over another, but is a mass of trabeculae, as described above." He is speaking here of *G. stokesi*, but the same thing is true of three of the species about to be described, and in *G. columna*, which is common at Ghardaqa, the tall columns, say two feet long, are continuous from top to bottom. Gardiner continues, "Clearly there is no true 'epitheca,' based on a 'primitive epithelial cup' as Bernard expressed it (p. 18), but a later secondary formation," a protective adaptation to the special surroundings in which many of the species live.

The genus occurs from the Red Sea to the Pacific. It is recorded as far east as Samoa by Brook, but the record is doubtful; and Hoffmeister does not describe any species from Mayer's collection. J. J. Lister, however, found three species in Tongatabu.

As my identifications of these specimens with Brook's 12 numbers from the Great Barrier Reef are all marked "probably" I omit them.

Goniopora tenuidens Q.

1918. Vaughan, p. 186, pl. 84, figs. 1, 2.

No. 254 is the greater part of a fair-sized colony, 12 cm. across \times 9 cm. high, smooth and originally hemispherical. The mode of growth is not layer over layer, but it is a thick (max. 4 cm.) sheet folded to a horseshoe section. A delicate epitheca covers part

of the base. The specimen corresponds well with Vaughan's variety 2 on p. 187 over most of the surface, but there is rather a sudden change near the base, illustrating Brook's quaint remark that all *Gonioporas* are *Rhodaraeas* near their bases: the calices change from being more lightly built than Vaughan's fig. 1 to the shallow, thick-walled, solidly built calices with huge pali of his fig. 2.

Distribution: Great Barrier Reef; Amboina; Philippines.

Goniopora lobata M. E. and H., Bedot.

(Plate XLVII, figs. 1-3.)

1907. Bedot, p. 267, pls. 43 and 44, 3 figs.

Specimen P.37 is part of a hemispherical colony 6.5 cm. across; No. 57 is a fragment of a large colony; and the third, dredged from Stn. XVI, is complete, but only a flat crust measuring 4×2.5 cm.

These three specimens differ greatly in structure. No. P.37 is the most like Bedot's typical examples, which he says are absolutely like those of Milne Edwards and Haime. Bedot's description is excellent, but the looser structure of the columella in the present specimen enables me to describe an interesting point in its morphology (Plate XLVII, fig. 2). It is large, occupying most of the bottom of the calyx but for holes round the edge representing the loculi, and is flat except a small area in the middle, forming a floor. It has two origins, the central part being made of trabeculae from the edges of the septa in the usual way, this part being about one-third of the diameter of the calyx, and bearing the characteristic upright spinules. Outside this and below the edges of the septa, the columella is formed of distinct synaptacula, standing more or less at right angles to the septa. Being at a slightly lower level they appear only occasionally in the published photographs, and also are often obscured by greater development of the upright columellar teeth.

The specimen dredged from Stn. XVI is very different, having shallow, flat calices divided by flat-topped walls 1-2 mm. thick. The columellar teeth become, in some cases, indistinguishable from pali, plate like or double: the columella is narrower, but its parts distinct. This specimen shows the typical fusions of the septa described by Bernard (1903, p. 21) in which tridents alternate with simple primaries, with unusual distinctness.

Sample No. 57 I identify with some doubt, as it is only a fragment of a large colony. It has exceedingly delicate walls, which have been much rubbed, and the large, flat columella is obscured by fusions, but the columellar septal teeth are essentially the same.

On the broken edges of these specimens I can see delicate tabulae in P.37 similar to those in Bedot's figure, but not everywhere in the section. In No. 57 I can see none at all, and of the dredged specimen no section is available.

The synonymy of this genus is in a hopeless condition. Bernard's obsession with growth forms naturally led him to abandon attempts at synonymy, and spoils his descriptions. Consequently we have sound descriptions, such as those by Bedot and Vaughan, for very few species. Bedot says the Paris specimens of *G. lobata* and *G. savignyi* are not distinguishable, but Savigny's drawing and I find in such cases as I know that his drawings are very accurate) represents another (species, so that it seems as if there had been some confusion of labels. Klunzinger's *G. planulata* is, apparently, a stunted specimen of Dana's *G. columna*, such as one would expect to get at Qoseir. In sheltered water at Ghardaqa this species is found in large convex masses, made up of closely fitting columns. This is quite

different to the present species, and is not at all like Bernard's pl. xiii, fig. 12, which he calls (p. 100) Red Sea (6) 1,—*G. lobata*. In *G. columna* there is no "expanding column consisting of a thick sheaf of lamellae"—there are no lamellae.

Distribution: Red Sea (?) and Amboina. If the synonymy were worked out I should probably include the Philippines, but no place further east as yet.

Goniopora minor nom. n. for *G.* "Great Barrier Reef (12) 5."

(Plate XLVIII, figs. 1, 3.)

1903. Bernard, p. 52, Great Barrier Reef (12) 5, pl. ii, fig. 6.

Bernard's specimen was "only a chip" but corresponds well with No. 56, which is a smooth oval dome, with two little domes attached. The main mass is 8.5 cm. long and 4.5 cm. high, not in layers. The thecal tubes are continuous from top to bottom.

The salient features are small calices, usually 2 mm. across, often 1.5 mm., deep for their size and open; the 12 thick but narrow septa descending vertically, rudiments of third cycle sometimes visible, occasional junctions of septa before reaching the columella. Columella occupies most of the bottom of the calyx, and is much fused, but 4 to 6 septa run on to it and bear small spinulose pali. On the surface on the main dome these septa are thin and the pali very irregular, but on the small domes and at the edges of the large ones, they are always six in number, vertical and symmetrical, often joined by synapticula and making a low cylinder above the columella. These pali are borne by 6 thicker primary septa. The walls are thin, but appear thicker by being crossed *at right angles* by the septal edges. This is one distinction from Bernard's G.B.R. (12) 8.

Distribution: Known only from the Barrier Reef, at least until the synonymy can be worked out.

Goniopora hirsuta sp. n.

(Plate XLVIII, figs. 2, 4.)

A minute colony which I should decline to describe were it not strikingly different from any other species in having the septal edges covered with fine compound spinules, giving them a hairy appearance.

This was found on a mass of shells, *Chama* sp.?, heavily overgrown with lithothamnia,* dredged from Stn. XVI. It is a crust 3 mm. thick, yet in several layers, triangular in shape, 20 mm. along the side. It is probably one of those corals which never reach a much larger size, like *Stylaraea punctata* and *Stylophora armata*. Unfortunately only one-third of the area was alive when collected, the rest apparently overgrown by a crust of lithothamnia, which is, however, so thin as to let the structures be seen.

All calices are shallow, living calices 2.5 mm. across, the older ones, in the dead part, 3 mm. Walls of the former generally very thin, loosely made, and confused by compound spinules similar to those of the septa; where walls are thicker septa cross them at right angles, and, in the older calices, this is always clear.

Septa 12, equal; sometimes from one to three fusions before the centre is reached; and there are occasional rudiments of a third cycle. They are rather thick, and with their

* I follow Stephenson, J. Linn. Soc. Zool. '1939' p. 500. "In this paper the word 'lithothamnia' (not italicised and without a capital) is used to indicate the encrusting Corallineae belonging to *Lithothamnion* and related genera." "Lithothamniaceae" is more correct, but is cumbersome, and implies the presence of more than one genus.

spinulose processes, tend to fill up the theca. The columella is visible only as one or two spinulose points. There are no pali.

In the older calices pali are distinct, generally as six conspicuous points, but they may be double, and such pairs may be connected to form a plate. The columella is rudimentary or an irregular fusion, bearing one or two upright spinulose points. In these older calices the septa are conspicuously thickened in and near the walls.

Genus *Alveopora*.

The long controversy over the relationships of this genus is given by Bernard (1903), pp. 4-9, and at length in J. Linn. Soc. Zool. XXVI, 1898, and XXVII, 1899. In those days morphology was occupying our minds rather to the exclusion of ecology, etc., and the attempt to make the epitheca and other coral parts into strictly defined morphological entities tended sometimes to unnecessary obscurity. In simple fact *Alveopora* is scarcely distinguishable from *Goniopora*, from which it is directly derived by reduction of building power, in walls and septa. Compare, e.g., Bernard's (1903) division "b" of *Goniopora* (p. 179), calices with high thin walls, and note at foot of page, "at the sides of all these colonies the calices revert to the primitive type with thicker walls; but for this they would be indistinguishable from true *Alveopora*," and other species have spinous septa also. (See, e.g., Bernard, 1903, pl. ix, figs. 1 and 2.)

Yet in the Catalogue (p. 8) he maintains the position he took up in his earlier papers, in which, while agreeing that *Goniopora* is much like an enlarged *Porites*, these two genera making the family Poritinae. *Alveopora* has no relationship, and belongs to another family. This arises from his obsession with the epitheca, which, when looked at simply, is seen to be merely an ecological adaptation, certainly not of the overwhelming morphological importance Bernard attributes to it. With this Gardiner and Waugh (1939, p. 242) under "*Goniopora*" in the John Murray Expedition corals, agree.

Alveopora irregularis, sp. n.

(Plate XLIX, fig. 2; Plate L, fig. 1.)

A single specimen, No. B.M. 607, dredged at Stn. XIV.

Growth form columnar, with expanded top, the lower, constricted part tightly bound by a firm mass of *Halimeda* combined with sponge. This and the base of the expansion also wrapped in a stout wrinkled epitheca. A vertical section, to one side of the centre, shows no epitheca within the corallum, and the horizontal layers shown on Plate XLIX do not indicate pauses in growth, or increase by layer-over-layer formation, such as Bernard postulates in similar coralla of *Goniopora*.

The species is very like *A. allingi* Hoffmeister from Samoa (1925, p. 81, pl. 23, figs. 2a, b and 2c) in the sizes of the calices, their walls and columellae; but the septa, as seen in his fig. 2c, are distinctly different. Hoffmeister's species has 12 nearly equal, distinct though narrow septa, not spines, of considerable breadth at the bottom, where they all join the columella. In *A. irregularis* they are 20-24 in number (in the larger calices) but most of them are low, toothed ridges or rows of very short, close-set spines, but, here and there, from one to three of them may broaden out into long spines. Such broader septa often meet in groups of two or three before joining the columella. The irregular network forming the columella is like that of *A. allingi*, but even broader, practically forming a

bottom to the cup in the larger calices. In the smaller it is of more normal size, and irregular in shape. Very few of the septa reach the top of the theca, though all approach it.

It is possible that this species is merely *A. allingi*, which has suffered a degeneration parallel to that I have described (1931) in *Leptastrea* of Tahiti.

Alveopora mortenseni sp. n.

(Plate XLIX, figs. 1, 3-4.)

A single specimen was dredged from Stn. XXIII, but by the kind permission of Dr. Mortensen I am enabled to enlarge the description of the species by comparison with six dredged by him off Mauritius (Stns. 44 and 45, 15 and 16 Oct., 1929, the former from 25 fms.) Some of these are exactly like that from the Great Barrier Reef; others show variation in the direction of what Bernard (p. 101) calls "that mysterious coral" *Porites clavasia*, Aud. et Sav. of the Red Sea. While at Ghardaqa, Dr. Mortensen trawled a large number of corals of exactly this peculiar growth form, and it seems likely that an examination of the series would connect this species with that of Savigny. These were from 30 fms. near Ashrafi lighthouse, at the entrance to the Gulf of Suez, and were accompanied by a number of species of gorgonians.

As Plate XLIX, figs. 3-4 show, the growth of "epitheca" characteristic of the genus here reaches its greatest development. The branches lie loose on the muddy bottom, liable to burial, so that only their tips are alive, and even the dead stems would probably decay very rapidly if unprotected.

Calices round, variable in size up to 3 mm. There is a slight tendency for some on the sides of branches to be drawn out in the direction of the branch, which is more marked in some of the Mauritian examples. As the figure shows, buds are very numerous, wherever there is any space between calices there a bud develops. Rarely can a place be found where the walls are double, but they do occur, for parts of the circumference of a calyx. Otherwise the walls are extremely thin and highly perforate.

The septal spines are, in this Barrier Reef specimen, so thin and irregular that no cyclic arrangement can be made out from them, but the number of short processes on the lip of the wall is twelve, indicating two cycles, and there are indications of a third; within the calyx the upper parts of the walls bear a few short spines, scattered or more or less in vertical rows, lower down they become long, bending and fusing so that the original rows are quite confused (Plate XLIX, fig. 3). Generally they are very thin, almost hair-like, but thicker in calices low down in the colony. Deep down they meet and cross in the centre, and may form a tangle vaguely resembling a columella; only in a few cases does this become a definite structure.

Dr. Mortensen's specimens might possibly be considered a variety, but having only one specimen from the Barrier Reef it is impossible to say whether the small differences observed are constant. While some calices are not distinguishable from those of the Barrier Reef specimen, the septal spines are usually thicker and more generally fall into rows; sometimes a primary cycle can be made out, in rare cases it is very distinct and alone forms a definite columella. A tertiary cycle exists only as small spines alongside those of the secondary cycle. As for columellae, one specimen and two scraps have none, another and a scrap none or rudiments; in a third thick primaries and some secondaries quite often make a distinct columella.

The single small specimen from Mauritius (Stn. XLIV, 25 fms.) is even more delicate than the others; the fine long spines rise from the walls at a higher level, making the theca appear shallower, though most are extremely irregular, some are in definite rows.

Distribution: Besides the Great Barrier Reef only from Mauritius, and possibly, the Red Sea.

Genus *Stylaraea* M. E. and H.

For a discussion of the rightness of separating this genus from *Porites* see Bernard (1905), p. 11. I resuscitate it against the opinions of both Milne Edwards and Haime and Bernard; though agreeing that it is a modified *Porites* its peculiarities warrant the distinction. I do not agree that the specimens before me, any more than those of Klunzinger, show imperfection due to youth, and I believe that their small size is normal for the species, as it is in *Stylophora armata* (?), of which I saw many specimens, all very small, in Tahiti. It is always small, like Klunzinger's specimens, in the Red Sea also.

Stylaraea punctata Klz.

(Plate L, fig. 2.)

1879. Klunzinger, p. 44, pl. v, fig. 27.

The species is generally attributed to Linnaeus and Esper, but to go behind Klunzinger is to land in the quagmire described by Bernard which I do not propose to enter (Bernard, 1905, p. 11, and under *Porites Red Sea* 9 and *P. molluccas* 1, pp. 161 and 243). To alter the attribution to Klunzinger is the only way to find footing without adding to the confusion by giving a new name.

Eleven specimens were preserved, all labelled "Mangroves, Passage 62, Low Island, Miniature Favia." The largest, and one of the smallest, are on a fragment of a heavy shell, completely riddled by sponge, etc.; the other six are on a living *Melina** shell; and three on an *Arca* shell, accompanied by a small colony of *Porites stephensoni* sp. n. (p. 241). They are accompanied by minute colonies of *Leptastrea* and *Cyphastrea*.

The colonies of *Stylaraea* form cushion-shaped crusts, with a thin line of "epitheca" appearing round their bases. The largest is 15 mm. across and about 7 high; most are not much smaller, but the smallest is only 7 mm. across and has 12 calices and some buds.

As in Klunzinger's example, calices are of uniform size, just under 1 mm. across. There are some details of importance to add to Klunzinger's description, "Die Septa sind sehr schmal, springen sehr wenig vor, sind leistenartig oder trabeculär," but, as seen in Klunzinger's photograph when examined under a lens, in many calices one, more rarely two or three, reach the columella at a high level in the calyx. Rarely all six of the first cycle may be seen to join the columella low down, but generally such regularity, if existing, is obscured. Two cycles of septa can usually be distinguished among the 12 little ridges or beams at the top of the wall. Costal ridges frequently cross the walls. The columella is not always a single style; it is often double, or, more rarely, ends in three small points; in the former case it may be a flattened plate. It is to be noted that in very young buds the styler columella is already prominent.

* Dr. Bruun informs me that the shell is correctly named, but that *Pedalion* (Solander) is more generally used.

The resemblance to *Stylophora* mentioned by Klunzinger is very superficial. All the above variations can be made out by careful examination of Klunzinger's photograph, but, as it is very small, and in my copy fading, I give another. This shows details such as wall-structure; and the minute spinules of the septa and tops of columellae, which may never have been visible in Klunzinger's. These spinules are always present, but conspicuous only in the largest specimen. Walls are more loose and irregular in smaller examples, but the septa and their costal ridges always rise above it. Whether they reach across it to the next calyx or not in the largest specimen they are always thickened over the wall, very much as in Klunzinger's photograph.

Distribution: Only known hitherto from the Red Sea. Earlier records, if any, are without locality.

Genus *Porites*.

Stephenson and others (1931) refer fourteen times to the genus, well illustrating its adaptation to all habitats, from pools and passages into the mangrove swamp, in the "Mangrove Park," reef flat, the moat, seaward slope and anchorage.* S. Manton's traverses of the moat, shown at the tops of her pls. i to iii, illustrate an extraordinary disproportion between *Porites* and *Montipora ramosa*, the latter being vastly predominant. In only one part of the moat is *Porites* noted by Stephenson and others as predominant. There is also a "Porites pond" at Three Isles, and an abundance of small colonies on Yonge and Batt Reefs. The only place where colonies of a normally large size are recorded is the reef at Lizard Island, where much of the reef and its outer slope are made of colonies two yards across. This, it should be remembered, is a lagoon reef.

Dr. Umbgrove (1939, p. 10) notes how this preponderance of *Montipora* (both *foliosa* and *ramosa*) in the moat of Leiden Island, in the Bay of Batavia, resembles conditions at Low Isles, but here, in deeper water, "the largest corals are doubtless enormous *Porites* colonies (according to Verwey, 1931, p. 206, *Porites lobata*)," and there are other interesting differences. Umbgrove and I agree that "we are only at the very beginning of having an idea of the true distribution of species, which abound on one reef but seem absent in other reefs." I have given large scale examples under *Pavona* and *Coeloria*, but of the reasons for this and other phenomena of coral-growth we have no idea whatever.

All this distribution of *Porites* is quite unlike the reef-areas I know in Equatorial East Africa, the Red Sea, or Tahaiti, and even the Marquesas, where colonies 6 feet \times 6 feet and larger are striking objects everywhere.†

S. Manton gives details. She also found the genus ubiquitous, but never saw or drew a colony of any size, her largest being 30 inches across, found in deeper water (see her graphs on pls. iii, vii and viii).

Her criticism of Wood Jones on the formation of flat-topped cylinders is borne out by everyone who has ever seen a coral reef, and Wood Jones should not be quoted in future. She also quotes Marshall and Orr on removal of sediment, which, they say, is always done more effectively by large polyps. Yet here we have a genus in which the polyps are of the smallest, yet which is peculiarly resistant to muddy water. The explanation is, as S.

* It is here marked with an asterisk as characteristic of vertical or overhanging surfaces, surely a printer's error; cf. S. Manton.

† A colony of ordinary size is shown on pl. i of the writer's "Forskaal's Collection of Corals," Univ. Mus. Zool., København, 1941. Mr. Otter's photograph in P.Z.S., 1935, p. 504, shows an extensive growth of *Synaraca convexa* in a Tahaitian lagoon, but the large colony is by no means one of the largest.

Manton says, that *Porites* removes mud easily, while unable to deal with coarser sediment. Another is that laboratory experiments do not last long enough to be comparable with nature; at Ghardaqa the death of corals damaged by sediment was spread over several years.

Whether this ubiquity of the genus applies to any of its species we have not enough evidence to decide.

In this genus the usual difference between lighter calices on the upper, and stouter built on the lower sides of colonies is particularly striking. The phenomenon is usually explained by saying that the former are growing the more rapidly, but this could only be true if the resulting mass is to be columnar; it cannot be true in the case of a regular dome. The fact is that the vast majority of museum specimens of *Porites*, as of other corals, were collected from reefs drying at the level of low water spring tides, where upward growth has ceased, or is about to cease. I call to mind innumerable colonies of *Pocillopora*, in which this difference reaches its extreme, the upper parts of the branches resembling empty honeycomb, wherever the branches have reached as high as they can, and are deformed by this fact. We find no thinning of the walls in the apical thecae of *Acropora*, where upward growth is at its greatest. Dredged specimens of massive *Porites* are rare; we have one in this collection, and in this the difference between upper and lower calices is much less than usual.

I suggest that what we need for the proper determination of species in *Porites* are series of examples of (1) young colonies, such as that of *P. stephensoni* of this collection, only more of them and from various habitats, (2) larger colonies, such as those described by Gravier and Vaughan, and (3) the full-sized colonies, however large. The last would, of course, be examined by means of small samples, say 10 cm. across, of which a large number would be needed, 6 to 9 from each mass, *viz.*, one or two from the top surface, and six or eight from the sides, from near the top and low down, the latter collected in many cases by means of a diving hood. Drawings would be made showing the relations of the colonies to the reef and other surroundings, to currents, waves and light, and the samples numbered to correspond with the positions on these drawings. This would mean handling a mass of material difficult to bring home to European or American museums, and to store on arrival. There would therefore be a preliminary examination on the spot, and a careful selection made of the samples to be brought home. In some species it might be found that there is little variation in response to conditions; in others results seem likely to be quite surprising, and likely to lead to general conclusions. Experiments would, of course, go on concurrently. This task would be a heavy one, quite outside the programme of such an expedition as the present one, which was occupied fully in more useful ways; I suggest it for such a biological station as that of Ghardaqa in the Red Sea, where the semi-fossil corals of the raised reef would of course be included.

Solid Forms.

Porites stephensoni sp. n.

(Plate L, figs. 3-4.)

1918. *Porites haddoni* Vaughan, p. 197, pl. 87, figs. 1-1b.

1931. *Porites haddoni* Stephenson, p. 129, pl. 1, figs. 1, 3-4; pl. iv, fig. 1; pl. v, figs. 1-3, 5-9, 11.

1933. *Porites haddoni* Marshall and Stephenson, p. 236.

The species is most readily distinguished from *P. haddoni* by the absence of the

columellar tubercle, which is never present unless as a mere rudiment, and by the proportions of "the triplet."

Six of the specimens were some of those used by Stephenson and Marshall in experimental breeding. Having this very special importance I describe these specimens first, and then five others of the same species. These six are Nos. B.M. 232, 262, 305, 373, 377 and 381. They are all very small, columnar in shape, but narrower at their bases and tops; the largest 85 mm. high \times 70 mm. in greater diameter; the smallest 30 mm. high \times 55 mm. in diameter. The narrower tops are bluntly pointed in four specimens; No. 373, though narrower, is flat on the top. No. 262 has grown abnormally: the surface has small monticles, indicating that the fused columns of the colony are smaller than usual. There is much variation, No. 377 being covered with small, upwardly directed mounds, while No. 381, the other extreme of this series, has them much lower, broader, and therefore fewer. These growth forms are similar to those in Bernard's (1905) pl. xii. fig. 4, or to those in Quelch's (1886) pl. xi, fig. 8, which are very like Nos. 232 and 381, but No. 377 is unique, and is therefore illustrated on Plate L.

The surface appears smooth to the naked eye but for a polygonal reticulation due to the thin walls being raised a little above the level of the contents of the calices, which appear shallow through being filled up by the septa and pali; they are, in fact, when seen under the binocular, distinctly deep except, of course, those near the bases of the colonies.

Taking No. 381 as an example, the walls are very thin, much perforate, and bear large granules, generally one above each septum, and flattened usually in the plane of the wall. The septa originate well below the edge of the wall, and bear a granule near it; here may be an incomplete synapticular ring. The septa may run nearly horizontally to the pali, the free part of which is then comparatively short, or, more typically, the septa dip, leaving the pali as long, free, slender pillars. Sides and edges of septa, and especially the tops of the pali, finely spicular. Septa thin, much thinner than the loculi. The central fossa is comparatively wide and open, the septa being narrow, and there being no columellar tubercle, or, in some calices, only a microscopic rudiment. The top of the columella therefore forms a flat floor to the fossa, only sometimes the synapticular ring rises a little above its margin. It is generally solid, or nearly so.

This clear, deep fossa without columellar tubercle is very characteristic. Gravier's description of his *P. somaliensis* (p. 81) is very like this species: "C'est cette taille relativement très grande des palis qui constitue l'une des caractéristiques les plus frappantes de ce *Porites*. Dans la plupart des calices la saillie columaire est indiscernable." His figures, however, show a tubercle fairly frequently, and in Vaughan's (1918) specimen it is generally present, though small. Gravier's statement, taken alone, would apply equally well to *P. lutea*, as described by Klunzinger (1879, p. 40) and myself (1941, p. 24), but the pali of this latter are remarkably thick, and they hide the columella by being close together instead of leaving a wide fossa. The septa of "the triplet" in *P. stephensoni* are narrower than the others, the laterals often half their width; they may be mere ridges, and joined, if at all, only deep down, immediately above the columella, where they meet the synapticular ring; generally they are quite free. Pali on the paired septa are always tall, those on the single septum smaller; on the "triplet" there may be one large one, three small ones, two small ones or none at all. In No. 377 the arrangement is the same as described above, but a small tubercle is sometimes present, and often the columella is looser, its radiating parts joining the synapticular ring like the spokes of a wheel.

No. 373 is a colony with a flat upper surface: here the pali are particularly well separated from the septa, and on some of the pairs they are "V"-shaped. A considerable area low down one side has shallow calices, thick septa, and inconspicuous pali. Some septa join over walls. Columella is solid, and there are no more traces of the columellar tubercle than in No. 381.

No. 262, an abnormally shaped colony, may have grown on a vertical surface. Septa and walls often thicker than normal; near the base much more so than in any other specimen. Columella solid.

No. 232 is lightly built, so some wheel columellae are present. Laterals of "triplet" very narrow, but joined low down oftener than usual. No trace of a columellar tubercle. This specimen is labelled by Matthai (but not in his hand) "*Porites* (? *P. haddoni*)."

No. 305 has deep calices; thin, narrow, smooth septa; very slender pali, spinulae at tops; triplets mere ridges, and usually only four pali. Yet the walls are rather thick.

Stephenson, p. 130, remarks: "It is not impossible that more than one species provided us with planulae. The identification of *Porites* down to species is probably impossible in the field, and in any case there is no certainty as to what characteristics constitute specific limits in the genus, the matter being still within the realm of personal opinion." I have described this series in detail since, so far as only six samples go, it shows that only one species was dealt with, and that a particularly well-defined one.

It is of interest to compare the parents with the very young colonies bred by Stephenson, and illustrated on his pl. v. There is hardly any resemblance, except in the case of fig. 12 (a "colony of *Porites* from a larva, or larvae, which settled on clean materials fixed in a box in *Porites* pond"), which shows the conspicuous pali, single septal granule, and spinulation of this species. The chances are, therefore, that it belongs to this species, and that the differences from the other figures are due to age.

It is interesting to note that the ease with which young colonies of *Pocillopora* and *Porites*, and of these genera only, are obtained artificially is paralleled by the fact that corals found on artificial objects, e.g., buoys and their chains, are nearly always species of *Pocillopora* (*bulbosa* or *damicornis*), or more rarely *Porites*. In particular I may mention tiles and clean pearl-oysters put down for the purpose of obtaining young colonies in a bed of a great variety of corals at Dongonab; in the course of a year or more only these two genera appeared. Pearl-shells with attached corals are common in museums and curioshops, but I found in Dongonab that, of the hundreds of thousands of pearl-shells cultivated a proportion of which spent four or five years among growing coral, very few indeed had young coral colonies on them. It is a mystery, as it is difficult to believe that the substrata were unsuitable, for the other conditions were those in which many species of corals flourished.

Besides the breeding series we have the following:

No. B.M. 233 is a minute scrap from Batt Reef, Patch No. 1, labelled *P. somaliensis* by Matthai. It is a little coarser than those of the series, but has no better development of the columella, and the fossa is quite open. The "triplet" is, perhaps, better formed, and fusion more frequent. These conditions can be matched on many areas of the series. The absence of a columellar tubercle, and the usually free ends of the "triplet," divide it distinctly from *P. somaliensis*.

In sample 122, a small scrap, the "triplet" is usually free, sometimes fused to a (synapticular) membrane. In places small columellar tubercles are frequent.

Sample No. 4 is similar to No. 122 in calicular characters, but the "triplet" is more often fused to a part of the synapticular ring. The corallum is a wholly detached nodule, covered everywhere with living calices, somewhat flattened, 45 mm. long, 37 mm. broad, about 27 mm. thick, with a somewhat undulating surface. It would be expected that movement of the corallum would bring every part into the same relationship to its surroundings, but the differences characteristic of the tops and bases of fixed colonies are found here, *viz.*, at one end and on one side are found deeper, thinner-walled calices and long, slender pali and thin septa; at the other end and other side distinctly shallower calices, stouter septa and shorter pali.

No. 62, B.M. 368, along with small colonies of *Stylaraea punctata* is encrusting an *Arca* shell from a mangrove passage. It has the usual thin perforated walls (they thicken below) besides the thick synapticular ring. This, and the large flat-topped columella-complex, close up the theca so that the loculi below its level appear as a ring of nearly round holes. The septa are fairly thick and coarsely granular on their sides, and the pali less conspicuous than usual; these are features of the shallower calices. Over the umbo of the shell the crust is thicker, the calices are deeper, etc., but the great, flat columella is found over the whole colony, though it is not always quite solid.

Sample 248 is one of the larger specimens, a nearly smooth column, attached by a narrow base, and narrowing again at the top; 8 cm. high, about 6.5 cm. at the thickest. The calices, etc., are typical. One side of the colony has delicate calices with very narrow triplet-septa; on the other side both are stouter. There are some few columellar tubercles near the base, but they are rudimentary.

Eleven specimens with such constant characters justify my creation of a new species, though I do so with reluctance. Examination of a larger series, including older colonies from varied habitats, might prove the deep, open fossa to be a phenomenon of youth.

It is conceivable that there was a columellar style or plate which has been reabsorbed during the breeding stage* to make room for the planula when the polyp is retracted, and the "triplet" may have been affected also, but it is all very unlikely.

Porites haddoni Vaughan.

1918. Vaughan, p. 197, pl. 87, figs. 1, 1a and 1b (with synonymy).

1925. *Porites lutea* Hoffmeister, p. 73, pl. 21, fig. 3.

1905. *Porites Solomon Islands*, 6. Bernard, p. 86, pl. viii, figs. 5-6; pl. xi, fig. 6.†

1938. *Porites lutea haddoni* Eguchi, p. 385.

Two larger specimens and a small nodule, Nos. B.M. 399, 406 and 231, belong to this species. The latter was named by Matthai, but it is less typical than the other larger ones, which are from Low Isles, 231 being from Batt Reef. The growth-form is markedly different in the two larger specimens. No. 399 is a piece broken from the edge of the top of a large solid mass, two fused and flat-topped columns being included, having a total width of 11 cm. The surface of both is undulating. No. 406 is a low summit from the top of a larger mass, the surface consisting of a number of mammillae; it is perfectly shown by Bernard's pl. xi, fig. 6 of his "Solomon Islands 6," which differs little, if at all, from this species.

* Bernard (1905), p. 21.

† The reference to pl. xi, fig. 6, is not given in Bernard's text, but in the explanation of the plates.

The walls are particularly delicate, and, in places, tall, their granules usually flattened in the same plane, projecting but little, and so delicately frosted as to be almost smooth. To the naked eye they form a delicate network over the surface of the corallum as in *P. stephensoni*.

The great difference between upper and lower calices of the sides of the corallum illustrated by Bernard, pl. viii, figs. 5 and 6, is even more striking than usual, and the shallow calices are not confined to the actual base; this may be a specific character.

The correspondence with Vaughan's description is good, except that, like Hoffmeister, I should describe the columella as a "compressed granulated plate, but it is often styliform." Also "as a rule the pali are distributed according to Bernard's illustration 3 B" (*i.e.*, in the diagram on p. 19), "although they may be arranged as in 3 C."

I cannot agree that *P. haddoni* is a synonym of *P. lutea* until the stabilization of this species, demanded in my account of Forskaal's Collection, is carried out. Hoffmeister's fig. 3 corresponds to *part* of the Red Sea specimen attributed to Forskaal, but, for the present, the majority of calices must show the big, thick pali, etc., of my own and Klunzinger's figures before the name *P. lutea* can be applied.

Distribution: Great Barrier, including Murray Island; Samoa, Palao and Solomon Islands. Probably also Fiji and Ellice Islands.

Porites lobata Dana.

1907. Vaughan, p. 196.

A small chip from the surface of a larger colony (Batt Reef, Patch 1, B.M. 236) is thus labelled by Matthai.

It would seem to be nearest to Vaughan's form *parvicalyx*, the portion he described in the middle paragraph of p. 201. The larger calices are 1 mm. across. This specimen is peculiar in that the tall, but imperfect synapticular ring above the edge of the columella is generally joined by the septa before they meet each other, so that the characteristic Poritid fusions cannot be made out, and, as the pali are very slightly developed, the bilateral pairs cannot be distinguished by their presence. In fact, in most calices, the septa resemble the spokes of a wheel joined to a thick hub. There is the further complication that, instead of a columellar style or plate, the synapticular ring is crossed irregularly by several delicate beams in any direction, nearly level with the tops of the small pali. Only rarely is a style or plate distinguished among them.

It is particularly unfortunate that this scrap is all we have of this interesting corallum.

Distribution: Hawaii, Fanning, Fiji and Samoa Islands. Now Great Barrier Reef.

Porites solida (Forsk.).

1918. Vaughan, p. 191, pl. 84, figs. 3, 3a.

1941. Crossland, p. 21, pls. i to iv.

There are only four samples of this species, usually so abundant, *viz.*, a small flat nodule, and a small piece of a crust tied together as sample 404, while Nos. 46 and 50 are pieces of the top edge of larger colonies.

Distribution: Red Sea (the Arabian towns of both sides of the sea are built of it); Cocos Keeling, where Wood Jones says it is very abundant. It will probably be found abundant throughout the Indo-Pacific when the synonymy, and confusion with *P. lutea*, are cleared up.

Porites australiensis Vaughan.

1918. Vaughan, p. 194, pl. 85, figs. 4, 4a, 5, 6 and 6a. (This gives also Bernard's reference numbers.)

A small nodule (Batt Reef, Patch 1, No. B.M. 234) is thus labelled by Matthai. It corresponds well with Vaughan's description and figures.

Distribution: Great Barrier Reef and Murray Island; Philippines.

Porites sp. indet.

Sample 47 is a lamina, 7 cm. across the base, proximally 7 mm. thick. The calices recall those of *P. haddoni*, but I do not attempt identification of such a fragment, since I noted in Tahaiti (though not elsewhere) that both *Synaraea* species and solid species of *Porites* often form basally lamellar outgrowths, the calices of which vary greatly from those of the main masses.

Porites lanuginosa Studer.

(Plate LI, fig. 1.)

1901. Studer, p. 423, pl. xxix, fig. 9.

1907. Vaughan, p. 209; pl. lxxxvii; pl. lxxxviii, figs. 1-1a.

The specimen dredged at Stu. XXV is rather larger than Studer's, being 17 cm. \times 11 cm. above, and 19 cm. high; 7 cm. was living, the rest being a narrower dead stalk, as in Studer's specimen, but larger. The broken attachment is only 3 cm. wide and 11 cm. long; the dead part is rotted by the usual organisms, and its original surface removed: it is partly covered by lithothamnia, *Gypsina*, and a thin crust of *Montipora*.

Studer does not give the sizes of the calices, and from Vaughan's figures they seem to be 1.6 mm. across; but this refers to a specimen supplied by Verrill. I therefore hesitated to identify this Barrier Reef specimen, in which the calices are only 1 mm. across, and many, even on the humps, rather less. But Studer's figure, being a colotype, is clearer than Vaughan's half-tone, and agrees with this example quite clearly, showing too that many of the walls are not so thin as in Vaughan's fig. 1a. Studer gives no illustration of calices, which I therefore supply, attempting to show the characteristic high, spinulate wall and septal granules which give the coral its "woolly," or better, velvety surface. The triplets are usually fused, and the laterals bend to the median, which bears one palus; but they are often free and bear three pali, which may sometimes fuse side by side to a plate. Pali tall, palial synapticular ring not visible.

Distribution: Hawaii (Laysan); and now Great Barrier Reef.

Porites evermanni Vaughan.

1907. Vaughan, p. 194; pl. 80; pl. 81, fig. 2.

Sample No. 1 is, apparently, the half of a solid, conical mass, the vertical section being 13 cm. wide and 10 cm. high, with undulating surface—the whole very like the figure of *P. solida* on Plate I of my description of Forskaal's collection: the low projections are the tops of fused columns. It is quite different from the specimen figured by Vaughan on pl. 80 (but see the last paragraph of his description, in which he describes a series of growth forms parallel to Forskaal's of *P. solida*).

This specimen is remarkable for the lightness of its walls and septa over most of the surface, in spite of the weight and solidity of the colony as a whole. The synapticular

ring inside the wall is conspicuous, but often incomplete. The differences from Vaughan's description are : (1) that the palus on the dorsal directive, always small, is often suppressed altogether so that there are generally 5 pali, not 6. (2) I cannot make out the forking of the septa against the wall, nor is it visible in Vaughan's figure. (3) In the very delicate calices of the upper parts the pali are often radially flattened.

The two ends of the specimen differ markedly in the strength of the walls and septa—another case where some ecological details are called for.

Distribution : Hawaii and now Great Barrier Reef.

Porites densa Vaughan.

1918. Vaughan, p. 201, pl. 89, figs. 2, 2a and 2b.

Sample Nos. 414 and 408 correspond exactly with the above description, except that, in some calices, there are definite pali.

No. 408 is a small, low mass 5 cm. in longer diameter and about 3 cm. in greatest height. No. 414 is broken from a solid mass, the broken surface 7 cm. thick and 9 cm. wide, not made of fused columns. Only an oval area, measuring 4 cm. \times 7 or 8 cm., was living, the rest being covered with lithothamnia. In both cases the top is smooth, as in the type.

Distribution : Great Barrier Reef and Murray Island only.

Branched Species

Sidnie Manton (1935) refers to them on p. 289 and in pls. vii and xi. Specimens are small and rare.

Porites andrewsi Vaughan.

1918. Vaughan, p. 203, pl. 91, figs. 1, 1a, 2 and 2a.

1925. *Porites andrewsi* Hoffmeister, p. 77, pl. 22, figs. 2a-2c.

Bernard's "Queensland 12", "Fiji 1," "Tonga 8 and 9," and "Solomon Isles 9." Vaughan gives Bernard's "Fiji 1" and "Tonga 8 and 9" as "almost certainly" this species; I omit the "almost" and add "Solomon Islands 9," which was overlooked by Vaughan, probably owing to an error in Bernard's reference to the plates. In the text (p. 89) he refers to pl. xii, fig. 1, in the Explanation of the Plates to pl. xi, fig. 7. The former corresponds to the description of "Caroline Islands 3" (p. 94), the latter to the description given of "Solomon Islands 9," and is typical of this species.

There are three small fragments: samples 412-416; and a single branch dredged from Station XXVII that was tied to the lamina I have named *Porites (Synaraea) vaughani*, but not related to it: I take their being tied together to mean only that they are from the same station.

Sample 412 is a small piece consisting of a fork, each branch with three small branchlets; it corresponds with both Bernard's and Vaughan's descriptions, but the growth form is more like Bernard's figure.

As Vaughan found, the peculiar arrangement of the "triplet," shown in Bernard's diagram "H" on p. 19, is only occasional.

Sample 416 is a broad fusion of two flattened branches, of equal size at the base, one of which aborts while the other grows on and branches. This branch bears low mounds

on one side (possibly the beginnings of branches) and two short branches on its other side, which demonstrate their readiness for fusion (characteristic of the species) by attaching themselves to a piece of dead, lithothamnia-covered coral.

The dredged specimen is interesting in comparison with the one Mayer placed in "deep water" (about 5 fms.) where there was no appreciable current (Hoffmeister, 1925 p. 77, pl. 22, fig. 2c; Mayor, Memorial Volume, 1924, p. 55, and table 8, p. 71, pl. 19, fig. 24D). This branch is similar, *i.e.*, thin and round, but the calices are normal, almost quite level with the surface. A considerable part of one side is morbid, covered with broad flakes, among which calices are barely distinguishable. Clearly the habitat was unsuitable.

Distribution : Great Barrier Reef ; Tonga, Fiji, Solomon and Samoa Islands.

Porites suppressa sp. n.

(Plate LI, figs. 2 and 3.)

No. B.M. 371 ("Nigger Head, Undine Reef. Branched massive *Porites*") is illustrated on Plate LI. The flat, much divided branch to the right is in marked contrast to the simpler, rounded, and more upright ones to the left; and, in view of the importance attached to growth-form by some authors, a further selection of branches would have been interesting. I take it that the word "massive" on the label, usually meaning "solid," here means that the colony was large.

The specific name refers to the fact that of the very short, thick septa several may be partly or wholly suppressed.

The walls have thin edges, covering the surface with a reticulation, as in several other species; the calices are filled up by pali and columella; but, except near the base, they cannot be called superficial. The walls are thickened below by broad synapticular rings, which bear thick, spinulose septal granules close to the wall much larger than those of the wall, which are upright, thin, and often circumferentially flattened.

Below these large granules the thick septa lie rather deep in the calyx, and are very short, joining a thick columellar ring, so that it is often impossible to make out the usual fusions. That several septa are suppressed is obvious. With care one can determine that these may be one of a lateral pair, one or both of the laterals of the "triplet," or the dorsal directive, the suppression may be partial or complete. It appears as though some lateral pairs were fused throughout their lengths. The sides of the septa are rough.

There are usually five tall pali, with rather swollen, roughened (not spinulate) ends, symmetrically surrounding a lower, but thick, prominent, and round columellar tubercle—thicker than in most species. A sixth small palus may be present on the dorsal directive, set back from the ring of the larger. Loculi appear rather as holes than slits, an outer circle between the synapticular rings, and about four minute holes between the inner ring and the columella. This describes the more open calices of the upper parts of the branches. Basally the walls and all granules thicken, the calyx becomes much shallower, and the loculi are obliterated, often so completely that the septa are invisible, except perhaps a low ridge or two. This thickening and shallowing extends over much larger areas on one side of the specimen than on the other. This species resembles Bernard's "*Tonga 10*" (p. 41, pl. ii, fig. 8; pl. xi, fig. 1) and, as Bernard himself remarks, "*Singapore 7*" (p. 187, pl. xxviii, fig. 7; pl. xxix, fig. 1). Bernard separates these species on account of the difference

in growth forms, which seems to me quite insufficient. They differ from *P. suppressa* in having (1) smaller septal granules near walls; (2) often 3 pali on the triplet, as shown in the figure; (3) small columellar tubercle; (4) more distinct septa; (5) "the transverse section shows immense development of the horizontal elements." Sections of the new species show nothing of this.

Porites annae nom. nov.

(Plate LII, figs. 1 to 3.)

1905. *Porites* "Great Barrier Reef 26." Bernard, p. 129, pl. xvi, figs. 8 and 9; pl. xx, fig. 1.

I am placing four specimens in this species, though only one corresponds closely with Bernard's "Great Barrier Reef 26." They are "Batt Reef, Patch 1, Square 11" (the specimen just referred to) and Samples 213, 4, and 15.

Bernard's illustration, pl. xx, fig. 1, is of a far better grown example than any of these, which are, in comparison, stunted. They show the same fundamental structure, though it results, in two cases, in striking variations of form.

I therefore amplify Bernard's description. The base of the colony is an incrustation, not free at the edges, or only rarely and to a trifling extent free, which sends up small, columnar branches usually with rather thicker ends. (Measurements may be taken from Plate LII.) These may fuse basally or higher up, in the latter case enclosing cavities. In the Batt Reef specimen and in No. 213 these branches are hardly more than knobs, whilst in No. 4 some attain a length of up to 35 mm., though the longest *free* branch is only 15 mm. In No. 15 some are regular columns 40 mm. high, but of these four, with some smaller, are completely fused by their sides to form a nearly straight-topped plate. In the Batt Reef specimen there is a fusion at one end into a solid mass, the columns composing which are visible on the surface only to the same extent as in normally solid growths. The difference between the calices of the tops and those of the sides of the branches is not always so marked as in Bernard's description; fairly deep and thin-walled calices may extend down the sides, though those on the basal crusts are always superficial. I do not find eight pali constantly: this number is only made up when there are three on the "triplet" and one on the dorsal directive, besides the usual four on the lateral pairs; and, in all the cases I have seen, the "triplet" bears three pali only occasionally (it may bear only one in the very next calyx) and the dorsal palus may be rudimentary or absent. The walls "here and there surge up into a loose filamentous reticulum; it is this which causes the colony to rise into branches." In my view the appearance of this reticulum is the first stage in budding—which may be the same thing. "The septa are thin and irregular in shape and position" (this is not apparent in Bernard's fig. 8); the pali, on the other hand, form a conspicuous ring of eight small, frosted points or plates." In these specimens these exceptionally lightly made calices are not found on the tips of all the branches; they are present, but rather exceptional, and are clearly a stage of growth; in many cases the septa are regular, fairly thick, and with well-formed *rounded* pali even on the tops of branches. On their sides they are always like this, with pali conspicuous throughout, and, on the shallow calices of the basal crusts, remarkably thick and spinulose.

Distribution: Great Barrier Reef of Australia only.

Subgenus *Synaraea*.*Porites (Synaraea) vaughani* sp. n.

(Plate LIII, figs. 4-5.)

From Stn. XXVII (dredge) a free, squarish lamina. 5 cm. across, about 5 mm. thick at one side, which is dead, very thin on the others, covered underneath with epitheca concentrically ridged, partly overgrown with sponge, polyzoa, etc. The main peculiarity of the species is that the broad coenenchymal ridges also bear calices, though more widely separated than those in the valleys. For details I refer to the plate. This shows that the calices in the valleys do not fall into rows, and are generally a little under 1 mm. across, while those on the mounds are a little wider. Those in the valleys are the more distinct because their loculi are more open and deep as well as nearer together. The coenenchyme forms rounded ridges, about 1 mm. high, finely spongy, bearing numerous, small, upright, spinulate processes. Septa very thick in all cases, spinulose on sides as well as edges, thus closing up the loculi still further. There are two granules on each septum between wall and palus, but they are often confused in the general spinulation. In spite of this the typical arrangement of the septa is easily seen: the "triplet" is free, and bears one to three small pali, or none; the triplet septa are shorter than the others. All pali low, but thick; spinulose, generally distinct, but often no more than an emphasis of the general spinulation. The central fossa is open, and there is no columellar tubercle.

I am taking this to be the expanded base of a branched corallum. It is close to Bernard's "Great Barrier 9," "North West Australia 4" and "China Sea 10" which, when more material is available, may turn out to be all the same, in spite of wide difference in growth form of one of them. The distance between Macclesfield Bank in the China Sea and Low Isles is now known to be not at all too great for them to be the homes of the same species, as was thought possible in Bernard's time.

I am naming this species after Dr. T. Wayland Vaughan, as a slight recognition of the immense and fruitful work he has accomplished, especially in this genus, of which he is, in fact, the pioneer investigator.

Porites (Synaraea) hawaiiensis Vaughan.1905. *Porites* "China Sea (19) 3," Bernard, p. 167, pl. xxv, fig. 9.1907. *Porites hawaiiensis* Vaughan, p. 216, pl. xci, figs. 2, 2a.1925. *Porites (Synaraea) horizontalata* Hoffmeister, p. 80, pl. 23, figs. 3a-3b.

Two very small, but complete, colonies were dredged from Station XXIV. They form thin crusts completely attached to substrata not now recognizable owing to decay. Their outlines are irregular, 40 mm. and 14 mm. across. The surface of the larger specimen is smoothly undulated; whether this is due to irregularity of the substratum cannot be said. The scattered calices would be inconspicuous but that the thick walls and coenenchyme rise a very little between them: it does not rise up into ridges.

The calices are about 1 mm. in diameter, with about the same between their walls; they are almost completely filled up by the thick septa, even the central fossa being only a minute hole—too small to allow any columella to be seen. The septa fuse in the usual ways, the lateral pairs and the central of the "triplet" bearing the five conspicuous pali. The triplet is fused, but occasionally one of the laterals may not reach the fusion of the

other two. The pali are often not more conspicuous than the septal and mural "granules," which are upstanding pillars of much the same shape, and, like them, well spinulate.

Details of wall structure cannot be made out; the space between loculi of adjacent calices is a spongy mass, in which thick, horizontal elements bear upright processes, spinulate like those on the walls and septa. This seems to be a distinctive character, dividing the species from some described by Bernard. In some places these processes are smoothed away, not by abrasion, but by some morbid process by which the reticulum is thickened almost to solidity—far beyond what is shown in a normal section, where the horizontal elements are seen to be very thick and solid.

The minute second specimen is much smoother, in fact as perfectly smooth as any *Porites*. The calices are nearer together, and would be quite invisible to the naked eye if the walls did not rise very slightly. The pali are less conspicuous, tending to merge with the other spinulose granules. Otherwise it is like the preceding.

These specimens are the encrusting, first growth-stage of the species described by Hoffmeister, which is the reason for giving an independent description. It is also possible that the Samoan specimens are the young of larger, possibly branching, species (c.f. the note on *Porites sp.* above.) It is to be noted, however, that Hoffmeister had three specimens all, like these, dredged.

They are also the young of the species described by Vaughan and Bernard, differing in that the ridges characteristic of *Synaraea* are present only as traces in the larger Barrier Reef specimen, and are absent in the smaller—a difference due only to youth. In his text Vaughan gives the diameter of the calices and their distance apart as only 0.5 mm., but both his figures show 1 mm. The columellar tubercle also is rarely seen in these specimens, more often in the smaller. It is in all cases minute.

Distribution: Macclesfield Bank; Hawaii; Samoa; and now Great Barrier Reef. Always dredged.

HYDROCORALLINAE.

[Order MILLEPORINA.]

Genus *Millepora*.

Stephenson and others describe the wide distribution of *Millepora* from the mangrove swamp to the reefs. S. Manton also finds it widely distributed on the reef flats to the crest of Yonge Reef, but of large size only below low water (p. 298). On the third 100 feet of the slope of Traverse III (to windward) "*Millepora* forms very large branching colonies" and, further out, "other corals identifiable from a boat are luxuriant, such as large Montiporas, branching *Millepora*, etc." Otherwise, judging from her scale drawings, the specimens seen are very small, except those on the coral head (pillar) of Plate XII, where a finely branched colony, 72 cm. across, and dome-shaped, occupies the summit. Apparently the big, upright plates of *M. dichotoma* or the solid honeycombs of *M. platyphyllia* do not exist on the Great Barrier Reef, nor any of the Tahitian or Marquesan forms. Hickson (1898, p. 256) gave it as his opinion that all the species of this genus are really one, though, in conversation, he said that he could generally say where any given specimen had come from. Vaughan (1918, p. 206), after quoting Hickson says, "but it is at least convenient, if not systematically sound, to recognize by distinctive names the different aspects presented by colonies." In 1941 I gave reasons for thinking that there are three species, genetically

distinct, in the Red Sea, though I am still unable to decide whether the Tahaitian forms I described (1928, p. 727) are one or several species. *M. alcicornis*, of the West Indies, I believe to be distinct. So far as the small samples from the Barrier Reef are evidence I believe we have two or three species here, one of which is the first species in which a distinction has been based upon the actual structure of the corallum.

Millepora tortuosa Dana.

(Plate LIII, figs. 1 and 2.)

1848. Dana, p. 545, pl. 52, figs. 3, 3a-b.

The four small pieces present might possibly be taken for early stages of colonies of *M. dichotoma* F., but, as far as my recollection goes, growths of this size would show the beginnings of regular reticulate plates, whereas these show no regularity at all. For the growth-form of a full-sized colony we have the diagrammatic figure given by S. Manton on Plate XII, which shows a low dome, 81 cm. across, covered with comparatively short branches (*i.e.*, the form is truly cespitose).

According to Dana the small size of the pores is diagnostic. I find here that in some specimens the pores are quite large, but all agree in being remarkably shallow, and therefore inconspicuous. The variation in their numbers is large, but this is often the case in other species. Specimen No. 189 shows an unusual regularity of form, but is in no way different from the others. No. 409 is a solid plate with few irregular branches, much infested by cirripedes. No. B.M. 427 may or may not be a distinct species. It is broken to pieces, but the illustration shows its peculiarly loose and round branches. It was dredged from Stn. XXVII, so the habitat may account for these peculiarities. It agrees with the reef-specimens in the scarcity and shallowness of the pores. The species differs physiologically from *M. dichotoma* F. in becoming white on drying, as does the species, described by Vaughan from Cocos Keeling, to which he gives this latter name; but *M. dichotoma* of the Red Sea keeps its rusty brown colour after drying, and even after maceration.

Distribution: It is impossible to give the distribution of any form of this genus. It can be said, however, that this one does not occur in the Red Sea, nor in Tahaiti, and, apparently, not east of Fiji.

Millepora forcolata sp. n.

(Plate LIII, fig. 3.)

Four specimens, P. 20, 31, 411 and 252, encrusting dead coral; with a note that it often covers unattached pieces.

They are now [12.iii.1942] of a light greenish colour, and all have a nodular surface, which, unlike "*M. verrucosa*," is not due to parasites. The most nodular, P. 20, is infested with cirripedes, but they choose the flat sites between nodules, or, if they occupy a projection they actually flatten it and the area round them. No. 31 is much smoother; over most of its surface it is undulating rather than nodular. Certain parts of it are infested with numbers of small polychaeta, probably Spionids, as well as a few cirripedes; but these have no effect upon the structure of the surface now to be described. The projections are not wart-shaped, but rather irregularly columnar, as shown on Plate LIII.

Similar encrusting growths of the same colour and smooth or not are common every-

where, abounding in the northern Red Sea for instance ; but the present ones differ even to the naked eye, to which they seem to be crowded with large pores. Under a lens this is seen to be due to each pore, or a short row of dactylopores, being at the bottom of a funnel-shaped depression formed by a sharp ridge. Dactylopores surround gastropores in the usual way ; the former are more numerous than usual, and often two circles round one gastropore can be made out. The ridges do not surround a set of gastro- and dactylopores, but each separately.

No. P.20 is practically the same on all sides, but with smooth areas between the projections on one side ; No. 31 is completely foveolate on one side, most of the underside smooth ; No. 252, an irregular growth which does not extend onto the underside of its foundation, has considerable smooth areas between the projections ; No. 411, a very small piece broken from a fixed mass, is typical.

Millepora sp.

Possibly *M. platyphyllia* Dana, which is not Ehrenberg's species of the same name from the Red Sea, as Hoffmeister has already remarked ; specimens resembling these of the Great Barrier Reef have not been seen in the Red Sea.

They consist of three small pieces broken from the tops of small plates, ending in irregular, flattened, finger-shaped lobes, two or three of which may fuse to make a broader expansion.

An interesting point is their heavy infection with a cirripede, the same as that found rarely in *M. foveolata*, which, unlike the case of "*verrucosa*" examined by Hickson and verified by me in the Red Sea, do not produce wart-like projections of the surface. Many make no alteration at all ; others are on low flat raised areas ; but it is doubtful how far these are caused or modified by the cirripede, as there is generally a mere film of *Millepora* over the cirripede, which has a quite flat, not conical, upper surface. It is impossible to give a name to these few pieces of such a general type of *Millepora* without an intimate personal knowledge of the Great Barrier Reef fauna. Hoffmeister may or may not be right in placing Dana's *platyphyllia* and *squarrosa* var. *incrassata* under *M. truncata* Dana. This species is perfectly smooth, with numerous and conspicuous pores. It is white when dry.

[Sub-class] ALCYONARIA.*

[Order COENOTHECALIA.]

Helopora coerulea.

The single specimen brought home, No. 58, is of the form in which solid plates end in slender vertical branches. Some of them are fused together, others free, as illustrated by Milne Edwards and Haime (1857a), pl. F. 1, fig. 3a. Another form, in which large radiating plates end in rounded lobes, is shown in Yonge's Year on the Great Barrier Reef, pl. xvii A ; and in Gardiner's (1931) Coral Reefs and Atolls, pl. xii. Hickson (1924, p. 118) says : " The form of the colony is very variable. It may be branched like a stag's horn Madrepor, laminate, or almost massive, but the ends of the branches are usually blunt and lobed. It sometimes reaches a size of three or four feet in diameter by two or more in height." It

* Crossland wrote "*Alcyonariidae*."

is a great reef builder, though usually best developed in lagoons; witness the frequent references to it in Gardiner's descriptions of Indian Ocean and Pacific reefs.

Distribution: Indian Ocean, from the Laccadives to the Seychelles, but not in the Red Sea. Present in Malaysia and the Pacific to Funafuti; not recorded from Samoa, and not present in Tahiti.

Tubipora musica.

Stephenson and others describe this species as present almost everywhere, from Low Isles to the crest of Yonge Reef, on which S. Manton shows (pl. xiv) two large colonies, the larger 63 × 36 cm. As she did not meet it on the traverses it is presumably rare at Low Isles; † it is generally more abundant and larger on outer reefs, always so in the Red Sea.

For the specific identity of all varieties see Hickson‡ (1924 p. 115). He examined many hundreds of specimens from the beach of Celebes, and many scores alive, and found that every variety known could be found on that one shore.

It was sold in Arab drug shops in Jerusalem at least as late as 1918.

Distribution: Northern Red Sea: throughout the Indian Ocean and Pacific; but not recorded from Samoa; and not present in Tahiti.

REFERENCES.

- ALCOCK, A. 1902. Report on the Deep-sea Madreporaria of the Siboga Expedition. Res. expl. zool. bot. . . . Siboga, Monogr. XVIa, 52 pp., pls. i-v.
- AUDOUIN, V. 1826. In: Savigny, J. C., Description de l'Égypt. Vol. 1, part 4. Explication sommaire des Planches de Polypes . . . , pp. 225-244, 14 pls.
- BAKER, J. R. 1925. 40. A Coral Reef in the New Hebrides. Proc. zool. Soc. London, pp. 1007-1019, 8 text-figs.
- BEDOT, M. 1907. Madréporaires d'Amboine. Rev. suisse Zool. Genève, 15, pp. 143-292, 50 pls.
- BERNARD, H. B. 1896. The Genus Turbinaria, The Genus Astraeopora. Cat. Madrep. Corals British Museum (Nat. Hist.) II, 106 pp., 33 pls.
- 1897. The Genus Montipora, The Genus Anacropora. Cat. Madrep. Corals British Museum (Nat. Hist.) III, 192 pp., 34 pls.
- 1903. The Family Poritidae. I: The Genus Goniopora. Cat. Madrep. Corals British Museum (Nat. Hist.) IV, 206 pp., 14 pls.
- 1905. The Family Poritidae. II: The Genus Porites. Part 1: Porites of the Indo-Pacific Region. Cat. Madrep. Corals British Museum (Nat. Hist.) V, vi + 303 pp., 35 pls.
- BERTRAM, G. C. L. 1936. Some Aspects of the Breakdown of Coral at Ghardaqa, Red Sea. Proc. zool. Soc. London, 1936, pp. 1011-1026, 1 pl.
- BOSCHMA, H. 1923. The Madreporaria of the Siboga Expedition. Part IV: *Fungia patella*. Res. expl. zool. bot. . . . Siboga, Monogr. XVIId, 20 pp., 2 pls.
- 1929. The Fungidae (*Anthozoa*) Collected by Mr. Cyril Crossland at Tahiti and Neighbouring Islands. Proc. zool. Soc. London, 1929, pp. 43-47, 1 pl.
- BROOK, G. 1893. The genus Madrepora. Cat. Madrep. corals Brit. Mus. (Nat. Hist.) 1, 212 pp., 35 pls.
- BRUGGEMANN, F. 1877. Notes on Stony Corals in the Collection of the British Museum. III: A Revision of the Recent Solitary Mussaceae. Ann. Mag. Nat. Hist. (4) XX, pp. 300-313.
- CROSSLAND, C. 1928a. The Island of Tahiti [and discussion]. Geogr. Journal London, LXXI, pp. 561-585, text-illustr.
- 1928b. Notes on the Ecology of the Reef-builders of Tahiti. Proc. zool. Soc. London, 1928, pp. 717-735. 1 text-fig., 5 pls. [For corrections see *ibid.*, 1931, pp. 391-392.]

† Yonge (1930, p. 49) says "absent." Stephenson and others (1931, p. 71) say "rare."

‡ Crossland, in his typescript, referred also to Hickson's paper in Quart. J. micr. Sci. London, XXIII, 1883. But in it there appears to be no reference to the specific identity of all varieties of *Tubipora*.— [A.K.T.]

- 1931. The Reduced Building Power and Other Variation in the Astrean Corals of Tahiti, with a Note on *Herpetolitha limax* and *Fungia* spp. Proc. zool. Soc. London, 1931, pp. 351-392, 13 text-figs., 22 pls.
- 1935. Coral Faunas of the Red Sea and Tahiti. Proc. zool. Soc. London, 1935, pp. 499-504, 3 pls.
- 1939. The Coral Reefs at Ghardaqa, Red Sea. Proc. zool. Soc. London, series A, 108, pp. 513-523, 3 text-figs.
- 1939a. Further Notes on the Tahitian Barrier Reef and Lagoons. Journ. Linn. Soc. London, 40, pp. 459-474, 2 pls.
- 1941. On Forskaal's Collection of Corals in the Zoological Museum of Copenhagen . . . Skr. Univ. Zool. Mus. Kjøbenhavn, 1, 63 pls., 12 pls.
- 1948. Reef corals of the South African Coast. Ann. Natal Mus. XI, pt. 2, pp. 169-205, 10 pls.
- DANA, J. D. 1848. Zoophytes. U.S. Expl. Exp. 1838-42. . . . VII, 740 pp., 61 pls.
- 1849. Atlas. Zoophytes. U.S. Expl. Exp. 1838-42. . . . I2 pp., 61 pls.
- DÖDERLEIN, L. 1902. Die Korallengattung *Fungia*. Abh. senckenb. naturf. Ges. 27, pp. 1-162, 25 pls.
- DUNCAN, M. 1883. Observations on the Madreporarian Family—the Fungidae, with Special References to the Hard Structures. J. Linn. Soc. London, 17, pp. 137-162, pls. 5-6.
- EDWARDS, H. MILNE. 1849. In: Cuvier, G. L. C. F. D., 1836-49. Le Règne animal . . . Paris, Third ("Disciples") Ed. Tom. 20, Zoophytes, Atlas, 100 pls. col.
- — 1857a. Hist. Nat. des Coralliaires, Atlas, pp. 11, 31 pls.
- — 1860. Hist. Nat. des Coralliaires. III: Suite de la section des Madréporaires Apores, 560 pp.
- — and HAIME, J. 1848. Recherches sur les polypiers. III. Monographie des Eupsammides. Ann. Sci. nat. Paris (3) Zool. X, pp. 65-114, pls. 1.
- — 1848. Recherches sur les polypiers. IV. Monographie des Astréides. Ann. Sci. nat. Paris (3), Zool. X, pp. 209-320, pls. 5-9.
- — 1850. A Monograph of the British Fossil Corals. I. Introduction; Corals from the Tertiary and Cretaceous Formations. Palaeontographical Soc. London, Monogr.
- — 1857. Hist. Nat. des Coralliaires. II: Madréporaires, 633 pp.
- EGUCHI, M. 1938. A Systematic Study of the Reef-building Corals of the Palao Islands. Studies Palao Trop. Biol. Sta. Tokyo, 3, pp. 1-390.
- ELLIS, J., and SOLANDER, D. 1786. Natural History of . . . Zoophytes . . . London, pp. xii + 208, 63 pls.
- ESPER, E. J. C. 1797. Fortsetzungen der Pflanzenthier, etc. Theil, I, 230 pp. Illust.
- FAUSTINO, L. A. 1927. Recent Madreporaria of the Philippine Islands. Monogr. Bur. Sci. Manila P.I. 22, 310 pp., 100 pls.
- FOWLER, G. H. 1885. The anatomy of the Madreporaria: I. Quart. J. Micr. Sci. London, n.s. C, pp. 577-597, pls. xl-xlii.
- 1887. The Anatomy of the Madreporaria: III. Quart. J. Micro. Sci. London, n.s. CIX (XXVIII), pp. 1-19, pls. 1-2.
- GARDINER, J. S. 1898. On the Turbinolid and Oculinoid Corals Collected by the Author in the South Pacific. Proc. zool. Soc. London, 1898, pp. 994-1000, pl. lxii.
- 1899. On the Solitary Corals, Collected by Dr. A. Willey. Willey, A., Zoological Results, Part II, pp. 161-180, pls. xix and xx.
- 1899a. On the Astreid Corals Collected by the Author in the South Pacific. Proc. Zool. Soc. London, 1899, pp. 734-764, pls. xlvi-xlix.
- 1904. South African Corals of the Genus *Flabellum*, with an Account of their Anatomy and Development. Mar. Invest. S. A. II, pp. 115-154, 4 pls.
- 1904a. The Turbinolid Corals of South Africa, with Notes on their Anatomy and Variation. Mar. Invest. S. A. III, pp. 95-129, 3 pls.
- 1904b. Madreporaria. Parts I and II. The Fauna and Geography of the Maldivé and Laccadive Archipelagoes, II, Part III, pp. 755-790. Pls. lix-lxiv.
- 1905. Madreporaria. Parts III and IV. The Fauna and Geography of the Maldivé and Laccadive Archipelagoes, II, Suppl. I, pp. 933-957, pls. lxxxix-xciii.
- 1909. The Madreporarian Corals: I. The Family Fungiidae, with a Revision of its Genera and Species and an Account of their Geographical Distribution. Rep. Percy Sladen Trust Exped. Indian Ocean, 1905. Trans. Linn. Soc. (Zool.) London, (2) XII, pp. 257-290, pls. 33-39.
- 1938. The Flabelloid and Turbinolid Corals. Sci. Rep. John Murray Exped. 1933-34, V, pp. 167-202, 6 text-figs., 7 pls.

- GARDINER, J. S., and WAUGH, P. 1939. Madreporaria excluding Flabellidae and Turbinolidae. Sci. Rep. John Murray Exped. 1933-34. VI. pp. 225-242, 2 pls., 3 text-figs.
- GRAVIER, Ch. 1911. Les récifs de coraux et les Madréporaires de la baie de Tadjourah. Ann. Inst. Oceanogr. Paris, II, fasc. 3, 96 pp., 12 pls.
- HARRISON, R. M., and POOLE, M. 1909. Marine Fauna from the Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson . . . and R. N. Rudmose-Brown . . . Madreporaria. Proc. zool. Soc. London, 1909, pp. 897-912, pls. lxxxv-lxxxvi.
- HICKSON, J. S. 1898. On the Species of the Genus *Millepora*: Proc. zool. Soc. London, 1898, pp. 246-257.
— 1924. An Introduction to the Study of Recent Corals. Manchester. XIV + 257 pp. 110 text-illustrations.
- HOFFMEISTER, J. E. 1925. Some Corals from American Samoa and the Fiji Islands. Paper Dept. Mar. Biol. Carnegie Instn. Washington, XXII, iv + 90 pp., 23 pls.
— 1929. Some Reef-corals from Tahiti. J. Wash. Acad. Sci. 19, No. 16, pp. 357-365, 2 pls.
- HORST, J. D. VAN DER. 1921. The Madreporaria of the Siboga Expedition. Part II: Madreporaria. Fungidae. Res. expl. zool. bot. . . Siboga. XVIIb, 46 pp., 6 pls.
— 1922. No. IX: Madreporaria: Agariciidae. Trans. Linn. Soc. (Zool.) London (2) XVIII, Pt. 1, pp. 417-429, 2 pls.
— 1922a. The Madreporaria of the Siboga Expedition. Part III: Eupsammidae. Res. expl. zool. bot. . . Siboga, Monogr. XVIc, 75 pp., pls. vii, viii.
- KENT, W. SAVILLE. 1871. On some New and Little-known Species of Madrepores, or Stony Corals, in the British Museum Collection. Proc. zool. Soc. London, 1871, pp. 275-286, pls. xxiii-xxv.
— 1893. The Great Barrier Reef of Australia; its Products and Potentialities, 387 pp., 64 pls., text-illustr.
- KOCH, G. VON. 1886. Über das Verhältnis von Skelet und Weichtheilen bei den Madreporen. Morph. Jahrb. XII, pp. 154-160, tafel ix.
- KLUNZINGER, C. B. 1879. Die Korallthiere des Rothen Meeres. II: Die Steinkorallen. I: Die Madreporeen und Oculinaceen. 88 pp., 10 pls.
— 1879a. Die Korallthiere des Rothen Meeres. III: Die Steinkorallen. II: Die Astraeaceen und Fungaceen. 100 pp., 10 pls.
- LAMARCK, J. B. P. A. DE M. DE. 1816. Histoire naturelle des Animaux sans vertèbres, présentant les caractères généraux et particuliers de ces Animaux. . . précédée d'une introduction offrant la détermination des caractères essentiels de l'animal . . . enfin l'exposition des principes fondamentaux de la Zoologie, Tome II, 568 pp.
- MANTON, M. S. 1935. Ecological Surveys of Coral Reefs. Sci. Rep. Gt. Barrier Reef Exped. III, No. 10, pp. 273-312, 2 text-figs., 16 pls.
- MARENZELLER, E. VON. 1901. Ostafrikanische Steinkorallen. Jahrb. Hamburg wiss. Anst. XVIII for 1900, pp. 117-134, 1 pl.
— 1904. Steinkorallen. Wiss. Ergebn. Valdivia Exped. VII, Lief. 3, pp. 261-318, pls. xiv-xvii.
— 1906. Riffkorallen. Denkschr. Akad. Wiss. Wien, 80, XXVI, Fortsetzung, pp. 27-97, 29 pls.
— 1906a. Über den Septennachwuchs der Eupsammien. E. H. Denkschr. Akad. Wiss. Wien, 80, XXIV, Fortsetzung, pp. 1-12, 7 text-figs.
- MARSHALL, S. M., and STEPHENSON, T. A. 1933. The Breeding of Reef animals. Part I: The Corals. Sci. Rep. Gt. Barrier Reef Exped. III, No. 8, pp. 219-245, 1 pl.
- MATTHAI, G. 1924. Report on the Madreporarian Corals in the Collection of the Indian Museum. Part I: Mem. Ind. Mus. Calcutta. VIII, pp. 1-59, pls. i-xi.
— 1928. A Monograph of the Recent Meandroid Astracidae. Brit. Mus. (Nat. Hist.) Cat. Madrep. Corals, VII, 288 pp., 72 pls.
- MAYER, (afterwards MAYOR), A. G. 1918. Ecology of the Murray Island Coral Reef. Papers Dept. Mar. Biol. Carnegie Instn. Washington, IX, pp. 1-48, pls. 1-19.
- MAYOR, A. G. 1924. Growth-rate of Samoan Corals. Papers Dept. Mar. Biol. Carnegie Instn. Washington, XIX, 4, pp. 51-72, 26 pls.
- MOSELEY, H. N. 1881. Report on Certain Hydroid, Alcyonarian and Madreporarian Corals Procured . . . 1873-1876. Report Sci. Res. H.M.S. "Challenger" . . . Zoology: II. Part III, On the Deep-Sea Madreporaria, pp. 127-248, 16 pls.
- PARADICE, W. E. J. 1925. The Pinnacle- or Mushroom-shaped Coral Growths in Connection with the Reefs of the Outer Barrier. Trans. Roy. Geogr. Soc. Australasia (Queensland), I, pp. 52-60, pls. vi, vii, 4 diagrams, 9 sections.
- QUELCH, J. J. 1886. Report on the Reef-corals Collected by H.M.S. Challenger during the years 1873-76. Report Sci. Res. H.M.S. "Challenger" . . . Zoology, XVI, 203 pp., 12 pls.

- SAVIGNY, J. C. [1809-1829] 1817. Description de l'Egypte Hist. Nat. Planches, Vol. 2. [Vol. 1, part 4, Explication des Planches de Polypes, pp. 225-244, 14 pls., 1826, by Audouin, V. (no MS. by Savigny).]
- STEPHENSON, T. A. 1931. Development and the Formation of Colonies in Pocillopora and Porites: Part I. Sci. Rep. Gt. Barrier Reef Exped. III, No. 3, pp. 113-134, 6 pls.
- STEPHENSON, T. A., STEPHENSON, A., TANDY, G., and SPENDER, M. 1931. The Structure and Ecology of Low Isles and Other Reefs. Sci. Rep. Gt. Barrier Reef Exped. III, No. 2, pp. 17-112, 15 text-figs., 27 pls.
- STUDER, TH. 1901. Madreporarier von Samoa, den Sandwich-Inseln und Laysan. Zool. Jahrb. Jena (Syst.) 14, pp. 388-428, pls. 23-31.
- THIEL, M. E. 1932. Madreporaria zugleich ein Versuch einer Vergleichenden Oekologie der gefundenen Formen. Mem. Mus. Hist. nat. Belg. Hors. Sér., 2, 12, 177 pp., 21 pls.
- UMBGROVE, J. H. F. 1939. Madreporaria from the Bay of Batavia. Zool. Meded. Leiden, XXII, pp. 1-64, 4 text-figs., 18 pls.
- VAUGHAN, T. W. 1907. Recent Madreporaria of the Hawaiian Islands and Laysan. Bull. U.S. nat. Mus. 59, 427 pp., 96 pls.
- 1917. Some Corals from Kermadec Islands. Trans. Proc. N.Z. Inst. XLIX, pp. 275-279, pls. xvii-xx.
- 1918. Some Shoal-water Corals from Murray Island (Australia), Cocos-Keeling Islands, and Fanning Island. Papers Dept. Mar. Biol. Carnegie Instn. Washington, IX, pp. 49-219, 2 text-figs., pls. 20-93.
- and WELLS, J. W. 1943. Revision of the Sub-orders, Families, and Genera of the Scleractinia. Geol. Soc. Amer. Special Pap. No. 44, pp. xv, 363, 51 pls.
- VERRILL, A. E. 1863. List of the Polyps and Corals sent by the Museum of Comparative Zoology to Other Institutions in Exchange, with Annotations. Bull. Mus. Comp. Zool. Harvard, 1, pp. 29-60.
- 1868. Synopsis of the Polyps and Corals of the North Pacific Exploring Expedition, . . . 1853-1856 . . . Additional Species from the West Coast of North America. Communications of the Essex Inst. Salem, V, for 1866-7, pp. 17-50, 2 pls.
- 1901. Variations and Nomenclature of Bermudian, West Indian and Brazilian Reef Corals, with Notes on Various Indo-Pacific Corals: IV. Conn. Acad. Arts Sci. XI, pt. 1, pp. 63-168, pls. x-xxxv.
- VERWEY, J. 1931. Coral Reef Studies, II. The Depth of Coral Reefs in Relation to their Oxygen Consumption and the Penetration of Light in the Water. III: Geomorphological Notes on the Coral Reefs of Batavia Bay. Treubia, XIII, livraison 2, pp. 169-215, 1 pl.
- WAUGH, P. 1936. The Variation and Species of Red Sea *Turbinaria* and *Astraeopora*, with a Discussion of the Genera. Proc. zool. Soc. London, 1936, pp. 913-929, 2 pls.
- WELLS, J. 1936. The Madreporarian Genus *Polyaster* Ehrenberg. Ann. Mag. Nat. Hist. (10), XVIII, pp. 549-552, 2 pls.
- WOOD-JONES, F. 1907. On the Growth-forms and Supposed Species in Corals. Proc. zool. Soc. London, 1907. Pp. 518-556, text-figs. 145-161, pls. xxvii-xxix.
- 1910. Coral and Atolls, London, xxiii + 392 pp., 79, text-figs, portrait, map, 27 pls.
- YABE, H. and EGUCHI, H. 1935. Revision of Reef Coral Genera *Echinopora*, *Oxyphyllia*, *Mycedium*, *Oxypora*, and *Physophyllia*. Proc. Imp. Acad. Tokyo, XI, pp. 429-431.
- YABE, H., SUGIYAMA, T., and EGUCHI, M. 1936. Recent Reef-building Corals from Japan and the South Sea Islands under the Japanese Mandate: I. Sci. Rep. Tôhoku Univ. 2nd ser. (Geol.), special Vol. I, 66 pp., 59 pls.
- YONGE, C. M. 1930. Studies on the Physiology of Corals. I: Feeding Mechanisms and Food. Sci. Rep. Gt. Barrier Reef Exped. I, No. 2, pp. 13-57, 34 text-figs., 2 pls.

INDEX

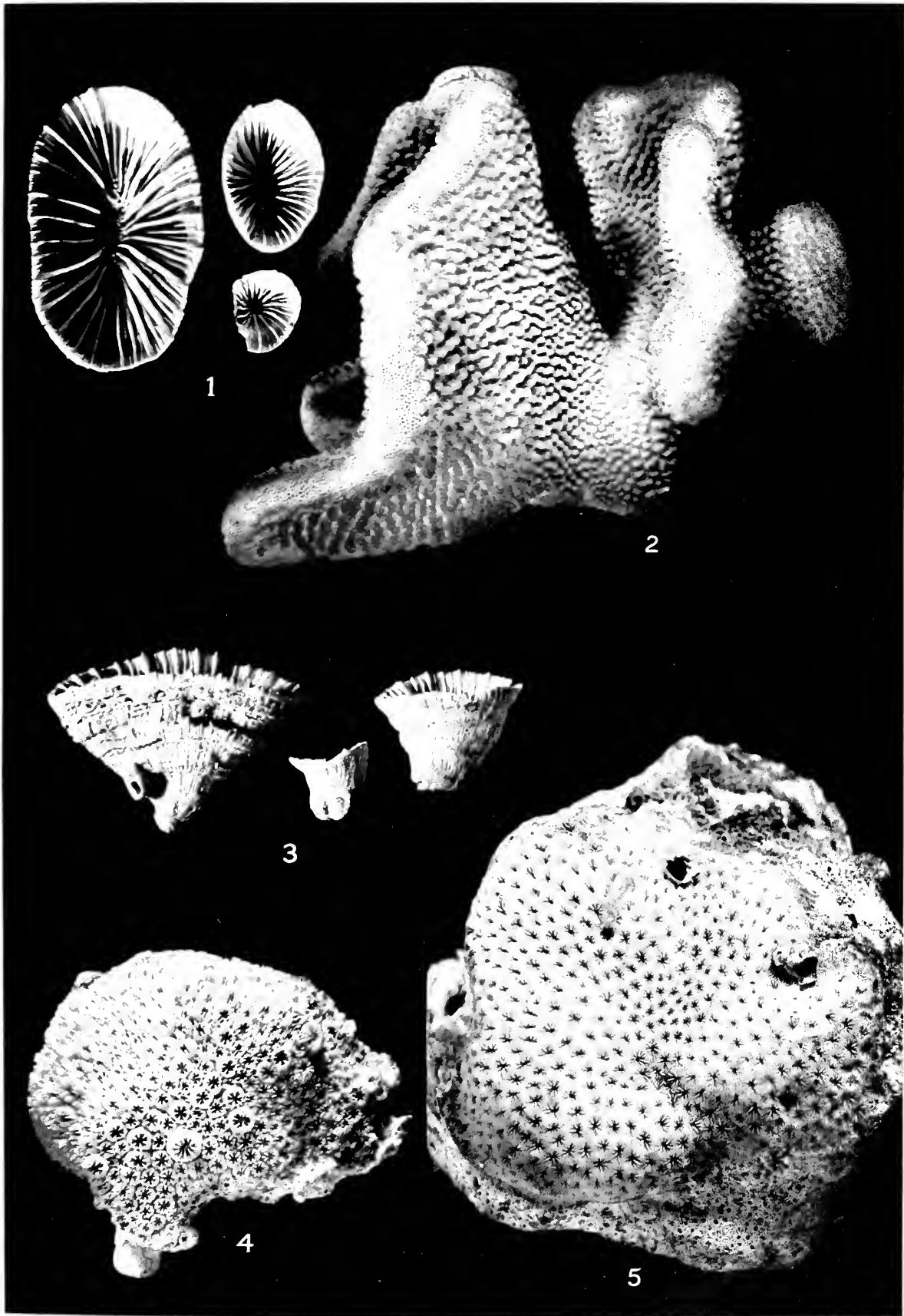
	PAGE		PAGE
<i>abdita</i> , <i>Favites</i>	129	<i>danae</i> , <i>Pocillopora</i>	110
<i>abrotanoides</i> , <i>Acropora</i>	204	<i>danai</i> , <i>Pavona</i>	161
<i>Acanthastrea</i>	140	<i>decussata</i> , <i>Pavona</i>	161
<i>Acropora</i>	198	<i>Dendrophyllia</i>	169
<i>actiniformis</i> , <i>Fungia</i>	152	<i>densa</i> , <i>Porites</i>	244
<i>aequicostatus</i> , <i>Heterocyathus</i>	102	<i>digitata</i> , <i>Montipora</i>	183
<i>affinis</i> , <i>Acropora</i>	205	<i>digitifera</i> , <i>Acropora</i>	207
<i>Alveopora</i>	234	<i>doreyensis</i> , <i>Favia</i>	127
<i>ampliata</i> , <i>Merulina</i>	151	<i>duerdeni</i> , <i>Pavona</i>	163
<i>andrewsi</i> , <i>Porites</i>	244		
<i>angularis</i> , sp. n., <i>Montipora</i>	197	<i>echinata</i> , <i>Acanthastrea</i>	141
<i>annae</i> , nom. nov., <i>Porites</i>	246	<i>echinata</i> , <i>Fungia</i>	152
<i>arbuscula</i> , <i>Dendrophyllia</i>	170	<i>Echinopora</i>	118
<i>armata</i> , <i>Acropora</i>	212	<i>ehrenbergana</i> , <i>Leptastrea</i>	115
<i>aspera</i> , <i>Acropora</i>	205	<i>elseyi</i> , <i>Acropora</i>	223
<i>aspera</i> , <i>Favites</i>	132	<i>erythraea</i> , <i>Montipora</i>	193
<i>aspera</i> , <i>Oxypora</i>	159	<i>evermanni</i> , <i>Porites</i>	243
<i>astraeiformis</i> , <i>Coeloria</i>	147	<i>exesa</i> , <i>Psammocora</i>	165
<i>Astraeopora</i>	180	<i>exilis</i> , <i>Acropora</i>	223
<i>australiensis</i> , <i>Porites</i>	243	<i>eydouxii</i> , <i>Pocillopora</i>	112
<i>benhami</i> , <i>Goniastrea</i>	136	<i>fascicularis</i> , <i>Galaxea</i>	172
<i>bifrons</i> , <i>Turbinaria</i>	176	<i>favus</i> , <i>Favia</i>	125
<i>bottae</i> , <i>Leptastrea</i>	116	<i>favus</i> var. <i>crassidens</i> , var. n., <i>Favia</i>	126
<i>brookii</i> , sp. n., <i>Acropora</i>	228	<i>fimbriata</i> , <i>Euphyllia</i>	105
<i>bruggemanni</i> , <i>Acropora</i>	221	<i>foliosa</i> , <i>Montipora</i>	194
		<i>formosissima</i> , <i>Stephanophyllia</i>	154
<i>cactus</i> , <i>Pavona</i>	162	<i>fossae</i> , sp. n., <i>Montipora</i>	186
<i>canalis</i> , <i>Acropora</i>	219	<i>foveolata</i> , sp. n., <i>Millepora</i>	249
<i>cancellata</i> , <i>Acropora</i>	225	<i>foveolata</i> , <i>Montipora</i>	188
<i>Caulastrea</i>	139	<i>frondens</i> , <i>Turbinaria</i>	176
<i>chalcidicum</i> , <i>Cyphastrea</i>	117	<i>fruticosa</i> , <i>Acropora</i>	220
<i>clavigera</i> , <i>Acropora</i>	226	<i>fruticosa</i> , <i>Montipora</i>	184
<i>clavus</i> , <i>Galaxea</i>	122	<i>fungites</i> , <i>Fungia</i>	153
<i>Coeloria</i>	147	<i>furcata</i> , <i>Caulastrea</i>	140
<i>coerulea</i> , <i>Heliopora</i>	250		
<i>composita</i> , sp. n., <i>Montipora</i>	195	<i>Galaxea</i>	121
<i>contigua</i> , <i>Psammocora</i>	165	<i>geoffroyi</i> , <i>Trachyphyllia</i>	101
<i>corymbosa</i> , <i>Acropora</i>	211	<i>glabrescens</i> , <i>Euphyllia</i>	104
<i>corymbosa</i> , <i>Lobophyllia</i>	142	<i>glochicladus</i> , <i>Acropora</i>	213
<i>crispa</i> , <i>Oulophyllia</i>	147	<i>Goniastrea</i>	132
<i>crustacea</i> , <i>Podobacia</i>	156	<i>Goniopora</i>	231
<i>curta</i> , <i>Orbicella</i>	124	<i>grandis</i> , <i>Acropora</i>	202
<i>cyclolites</i> , <i>Fungia</i>	153	<i>granulosa</i> , <i>Montipora</i>	181
<i>Cynarina</i>	137		
<i>Cyphastrea</i>	117	<i>haddoni</i> , <i>Porites</i>	241
		<i>haimei</i> , <i>Acropora</i>	207
<i>daedalea</i> , <i>Coeloria</i>	148	<i>halicora</i> , <i>Favites</i>	128
<i>damicornis</i> , <i>Pocillopora</i>	110	<i>hawaiiensis</i> , <i>Porites</i> (<i>Synaraea</i>)	247

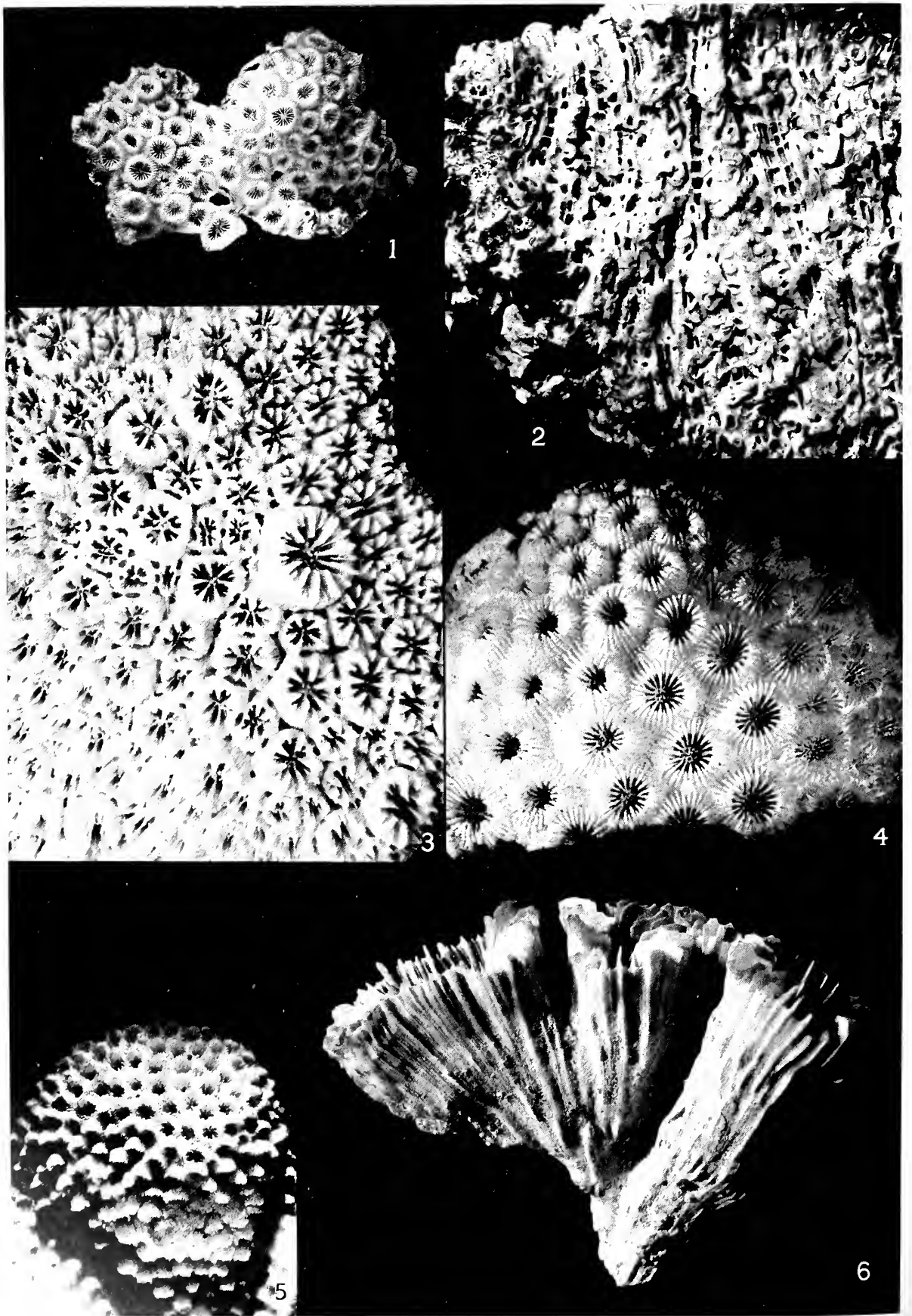
	PAGE		PAGE
<i>hebes</i> , <i>Acropora</i>	217	<i>Pachyseris</i>	163
<i>heliopora</i> , <i>Diploastrea</i>	166	<i>pacifica</i> , <i>Acropora</i>	202
<i>hemprichii</i> , <i>Lobophyllia</i>	143	<i>paeonia</i> , <i>Tridacophyllia</i>	160
<i>hirsuta</i> , <i>Goniopora</i>	233	<i>palifera</i> , <i>Acropora</i>	218
<i>horrescens</i> , <i>Acrohelia</i>	123	<i>patelliformis</i> , <i>Fungia</i>	154
<i>horrida</i> , <i>Echinopora</i>	120	<i>patula</i> , <i>Acropora</i>	215
<i>humilis</i> , <i>Acropora</i>	221	<i>paumotuensis</i> , <i>Fungia</i>	153
<i>hystrix</i> , <i>Seriatopora</i>	107	<i>Pavona</i>	160
		<i>pectinata</i> , <i>Goniastrea</i>	135
<i>incisa</i> , sp. n., <i>Balanophyllia</i>	166	<i>peltata</i> , <i>Turbinaria</i>	174
<i>informis</i> , <i>Montipora</i>	195	<i>peltata</i> var. <i>gibitari</i> var. n., <i>Turbinaria</i>	175
<i>intermedia</i> , <i>Acropora</i>	200	<i>phrygia</i> , <i>Leptoria</i>	150
<i>irregularis</i> , sp. n., <i>Alveopora</i>	234	<i>pistillata</i> , <i>Stylophora</i>	107
<i>irregularis</i> , <i>Anomastrea</i>	165	<i>Pocillopora</i>	108
		<i>Podobacia</i>	155
<i>jeulini</i> , sp. n., <i>Acropora</i>	227	<i>Porites</i>	237
		<i>prolifera</i> , <i>Montipora</i>	190
<i>kauaiensis</i> , <i>Madrepora</i>	121	<i>prolixa</i> , <i>Acropora</i>	226
		<i>prominula</i> , sp. n., <i>Montipora</i>	182
<i>lacera</i> , <i>Oxypora</i>	158	<i>pruinosa</i> , sp. n., <i>Leptastrea</i>	116
<i>lactuca</i> , <i>Tridacophyllia</i>	160	<i>pulchra</i> , <i>Acropora</i>	203
<i>laevis</i> , sp. n., <i>Acropora</i>	230	<i>pulchra</i> var. <i>alveolata</i> , <i>Acropora</i>	204
<i>lamellina</i> , <i>Coeloria</i>	149	<i>pulchra</i> , var. <i>stricta</i> , <i>Acropora</i>	204
<i>lamellosa</i> , <i>Echinopora</i>	119	<i>punctata</i> , <i>Stylaraea</i>	236
<i>lanuginosa</i> , <i>Porites</i>	243	<i>purpurea</i> , <i>Leptastrea</i>	115
<i>latistella</i> , <i>Acropora</i>	216		
<i>Leptastrea</i>	114	<i>quelchi</i> , <i>Acropora</i>	209
<i>Leptoria</i>	150		
<i>limax</i> , <i>Herpolitha</i>	154	<i>radians</i> , <i>Symphyllia</i>	146
<i>Lithophyllia</i>	138	<i>ramosa</i> , <i>Montipora</i>	184
<i>lobata</i> , <i>Goniopora</i>	232	<i>recta</i> , <i>Symphyllia</i>	144
<i>lobata</i> , <i>Porites</i>	242	<i>retiformis</i> , <i>Goniastrea</i>	133
<i>Lobophyllia</i>	142	<i>robusta</i> , <i>Halomitra</i>	155
<i>lutkeni</i> , sp. n., <i>Acropora</i>	229	<i>rosaria</i> , <i>Acropora</i>	224
		<i>rubrum</i> , <i>Flabellum</i>	105
<i>macrostoma</i> , <i>Acropora</i>	214		
<i>Madrepora</i>	121	<i>savignyi</i> , <i>Cynarina</i>	137
<i>mantonae</i> , sp. n., <i>Goniastrea</i>	136	<i>scutaria</i> , <i>Fungia</i>	152
<i>mantonae</i> , sp. n., <i>Turbinaria</i>	179	<i>septata</i> , <i>Stylophora</i>	108
<i>mayeri</i> , <i>Coeloseris</i>	164	<i>serailia</i> , <i>Cyphastrea</i>	118
<i>micranthus</i> , <i>Dendrophyllia</i>	171	<i>Seriatopora</i>	106
<i>micranthus</i> var. <i>grandis</i> , var. n. <i>Dendrophyllia</i>	173	<i>simplex</i> , sp. n., <i>Caulastrea</i>	139
<i>microconos</i> , <i>Hydnophora</i>	151	<i>socialis</i> , <i>Montipora</i>	188
<i>microphthalmia</i> , <i>Cyphastrea</i>	118	<i>solida</i> , <i>Porites</i>	242
<i>Millepora</i>	248	<i>speciosa</i> , <i>Favia</i>	127
<i>millepora</i> , sp. n., <i>Montipora</i>	182	<i>speciosa</i> , <i>Pachyseris</i>	164
<i>minor</i> , nom. nov., <i>Goniopora</i>	233	<i>spectabilis</i> , <i>Acropora</i>	220
<i>minor</i> , <i>Thecocyathus</i>	103	<i>squamosa</i> , <i>Acropora</i>	216
<i>Montipora</i>	180	<i>stelligera</i> , <i>Favia</i>	128
<i>mortenseni</i> , sp. n., <i>Alveopora</i>	235	<i>Stephanophyllia</i>	154
<i>musica</i> , <i>Tubipora</i>	251	<i>stephensoni</i> , sp. n., <i>Porites</i>	238
<i>myriophthalma</i> , <i>Astraeopora</i>	180	<i>stephensoni</i> , sp. n., <i>Turbinaria</i>	178
		<i>Stylaraea</i>	236
<i>Orbicella</i>	123	<i>Stylophora</i>	107
<i>otteri</i> , sp. n., <i>Acropora</i>	229	<i>sulcata</i> , <i>Montipora</i>	191
<i>Oulophyllia</i>	146	<i>suppressa</i> , sp. n., <i>Porites</i>	245
<i>Oxypora</i>	158	<i>surculosa</i> , <i>Acropora</i>	214
		<i>Symphyllia</i>	144

	PAGE		PAGE
<i>talpina</i> , <i>Polyphyllia</i>	155	<i>vacua</i> , sp. n., <i>Orbicella</i>	124
<i>tenuidens</i> , <i>Goniopora</i>	231	<i>vacuum</i> , sp. n., <i>Flabellum</i>	106
<i>tertia</i> , sp. n., <i>Montipora</i>	192	<i>valenciennesi</i> , <i>Favia</i>	126
<i>Thecocyathus</i>	103	<i>variabilis</i> var. <i>pachyelados</i> , <i>Acropora</i>	222
<i>torresiana</i> , <i>Pachyseris</i>	164	<i>varians</i> , <i>Pavona</i>	162
<i>tortuosa</i> , <i>Millepora</i>	249	<i>vaughani</i> , sp. n., <i>Porites</i> (<i>Synaraea</i>)	247
<i>Trachyphyllia</i>	101	<i>velata</i> , sp. n., <i>Dendrophyllia</i>	173
<i>transversa</i> , <i>Leptastrea</i>	115	<i>venosa</i> var. <i>angulosa</i> , <i>Montipora</i>	188
<i>Tridacophyllia</i>	159	<i>verrucosa</i> , <i>Montipora</i>	193
<i>tubigera</i> , <i>Acropora</i>	208	<i>verrucosa</i> , <i>Pocillopora</i>	111
<i>Turbinaria</i>	174	<i>virens</i> , <i>Favites</i>	130
		<i>vitiensis</i> , <i>Lithophyllia</i>	138
<i>undans</i> , sp. n., <i>Montipora</i>	190	<i>yongei</i> , sp. n., <i>Balanophyllia</i>	167

DESCRIPTION OF PLATE I.

- FIG. 1.—*Flabellum vacuum*, sp. n. × 1·1.
B.M. Reg. No. 1934.5.14.620.
- FIG. 2.—*Pocillopora eydouxi* M. E. and H. × ·5.
G.B.R.E. No. 629.
- FIG. 3.—*Flabellum vacuum*, sp. n. × 1.
B.M. Reg. No. 1934.5.14.620.
- FIG. 4.—*Leptastrea bottae* M. E. and H. × 1.
G.B.R.E. No. 407.
- FIG. 5.—*Leptastrea purpurea* Dana. × 1.
B.M. Reg. No. 1934.5.14.420.





DESCRIPTION OF PLATE II.

- FIG. 1.—*Orbicella vacua*, sp. n. × 8.
G.B.R.E. No. 400.
- FIG. 2.—*Leptastrea bottae* M. E. and H. × 3·5.
B.M. Reg. No. 1934.5.14.444.
- FIG. 3.—*Leptastrea bottae* M. E. and H. × 3·8.
B.M. Reg. No. 1934.5.14.444.
- FIG. 4.—*Orbicella vacua*, sp. n. × 2.
G.B.R.E. No. 433.
- FIG. 5.—*Stylophora septata* Gardiner. × 3.
G.B.R.E. No. 369.
- FIG. 6.—*Euphyllia glabrescens* (Chamisso). × 1·6.
G.B.R.E. No. 431.

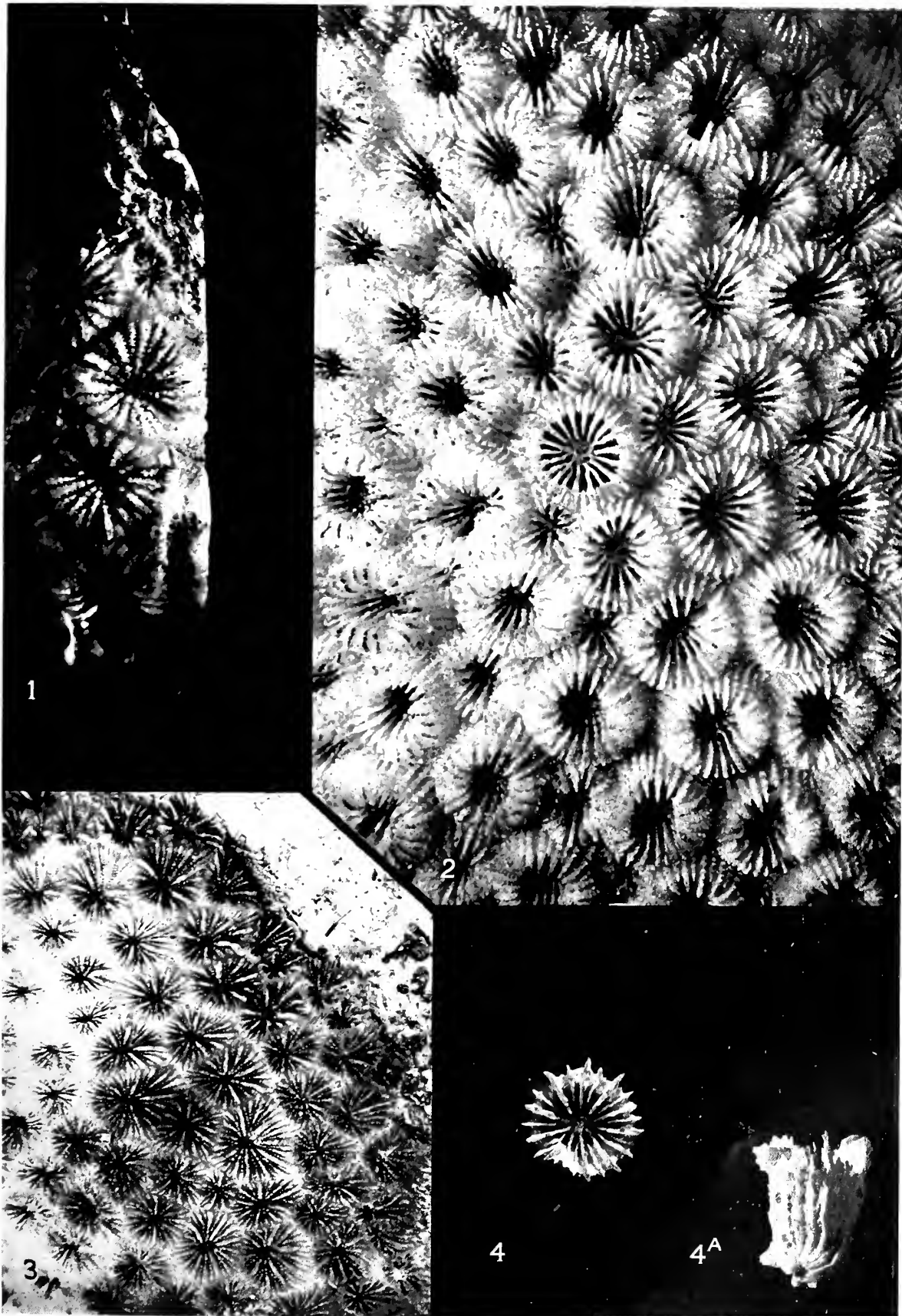
DESCRIPTION OF PLATE III.

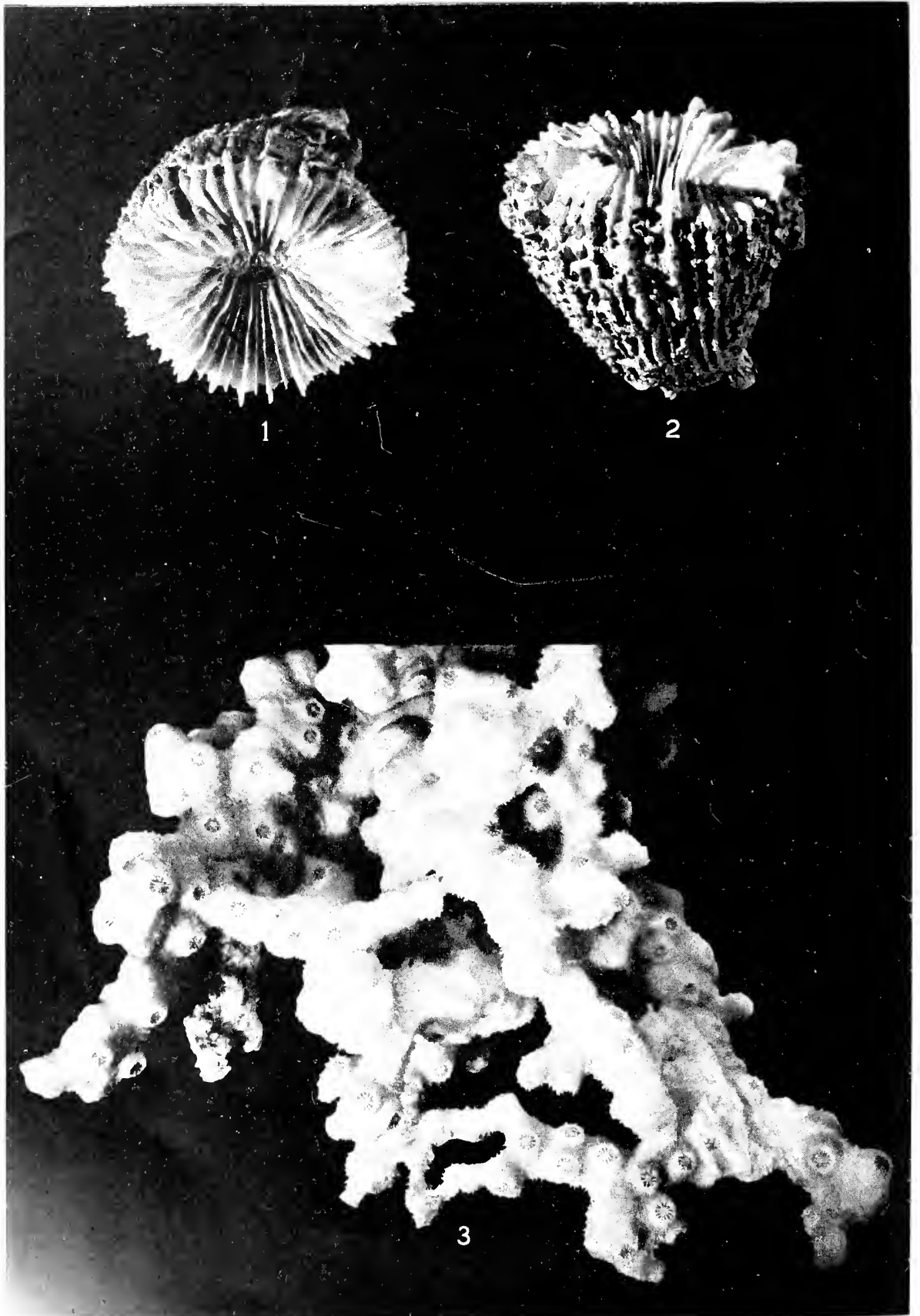
FIG. 1.—*Leptastrea pruinosa*, sp. n., Holotype. × 4·9.
B.M. Reg. No. 1934.5.14.630.

FIG. 2.—*Orbicella vacua*, sp. n. × 3.
G.B.R.E. No. 433.

FIG. 3.—*Leptastrea purpurea* Dana. × 3.
B.M. Reg. No. 1934.5.14.420.

FIGS. 4-4*a*.—*Caulastrea simplex*, sp. n., Holotype. × 2.
B.M. Reg. No. 1934.5.14.615.





DESCRIPTION OF PLATE IV.

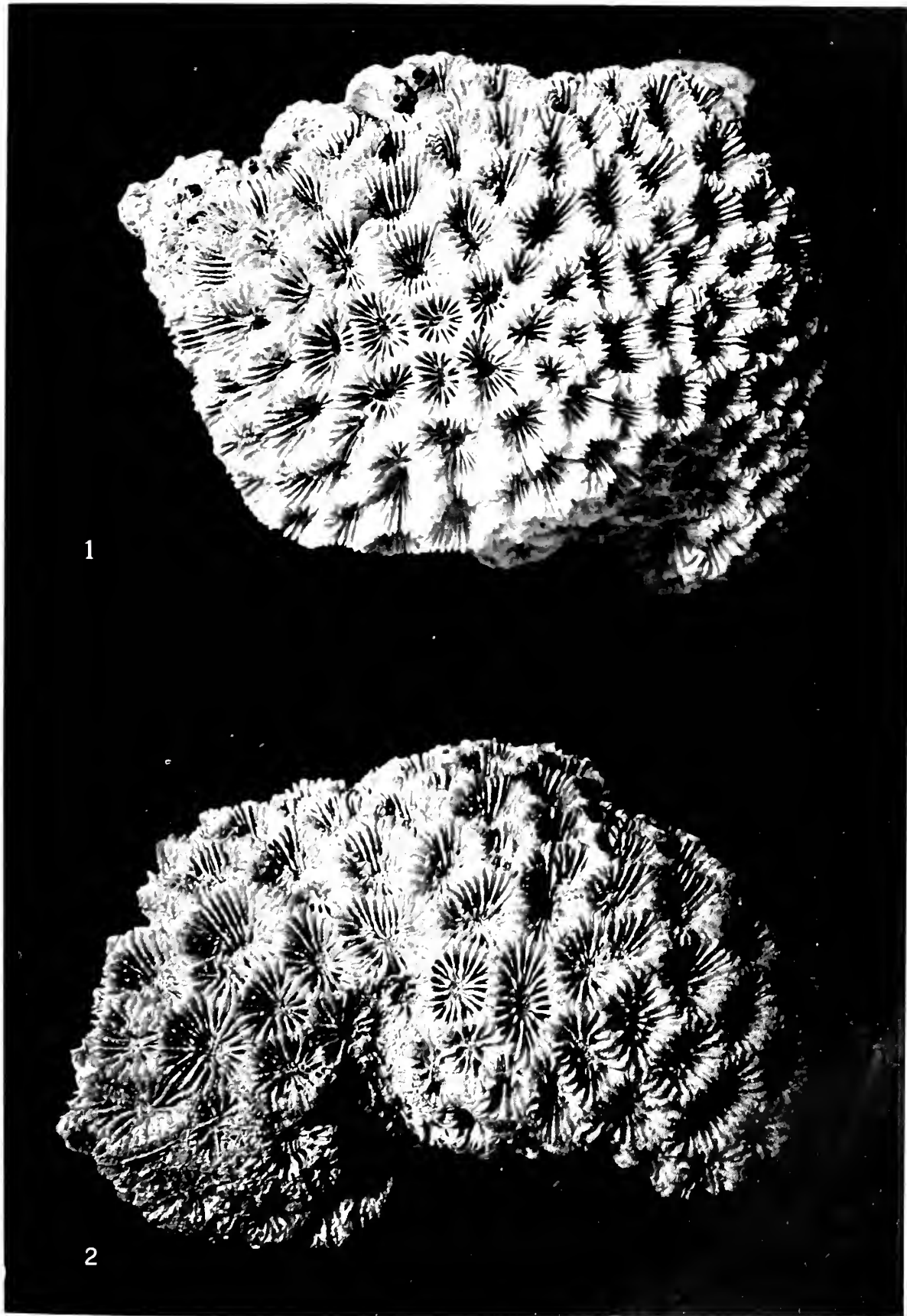
FIGS. 1 and 2.—*Cynarina savignyi* Brügg. × 1.
B.M. Reg. No. 1934.5.14.492.

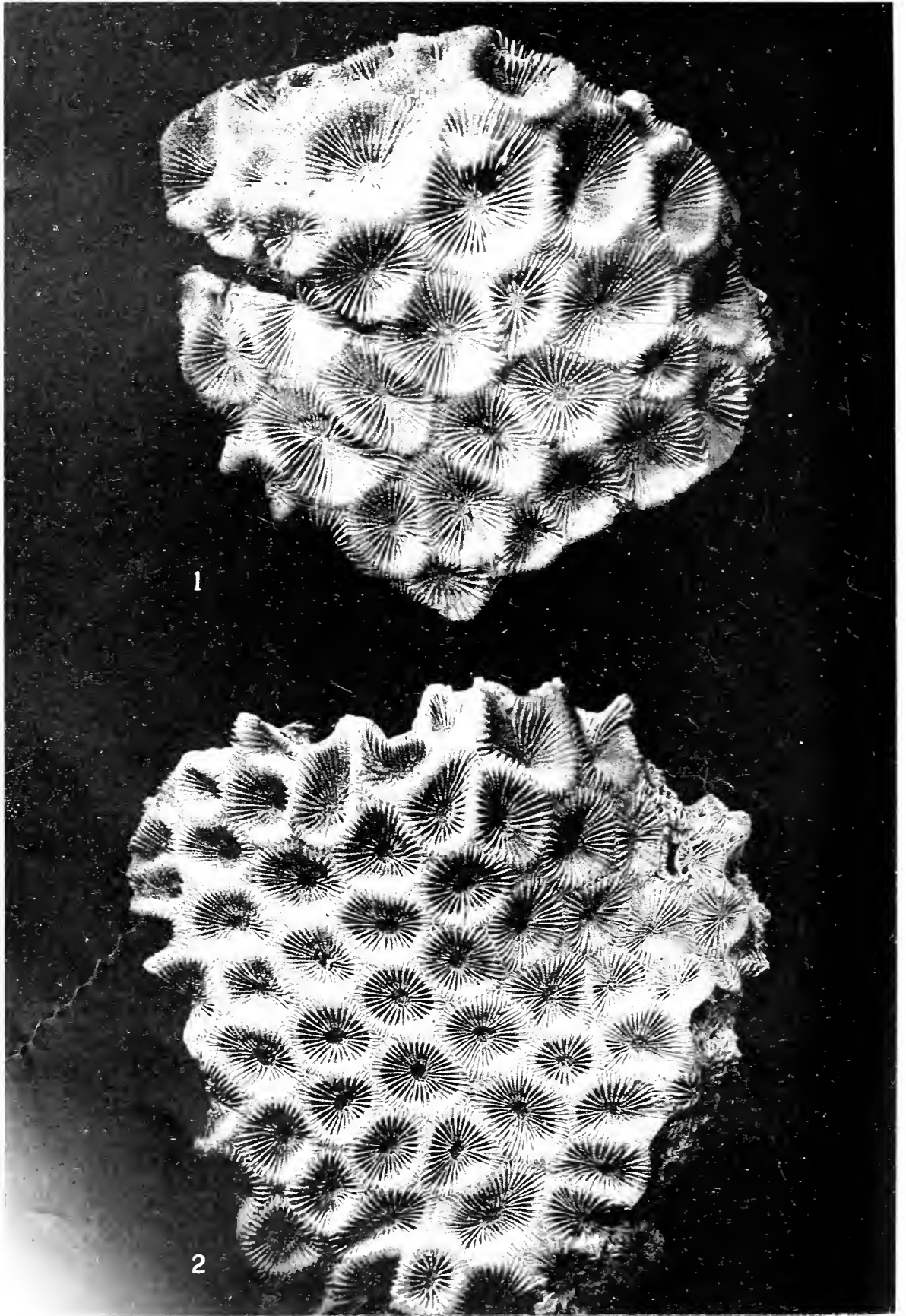
FIG. 3.—*Echinopora horrida* Dana. × 1.
G.B.R.E. No. 26.

DESCRIPTION OF PLATE V.

FIG. 1.—*Favites aspera* Verrill. × 1·3.
G.B.R.E. No. 166.

FIG. 2.—*Favites aspera* Verrill. × 1·5.
G.B.R.E. No. 155.





DESCRIPTION OF PLATE VI.

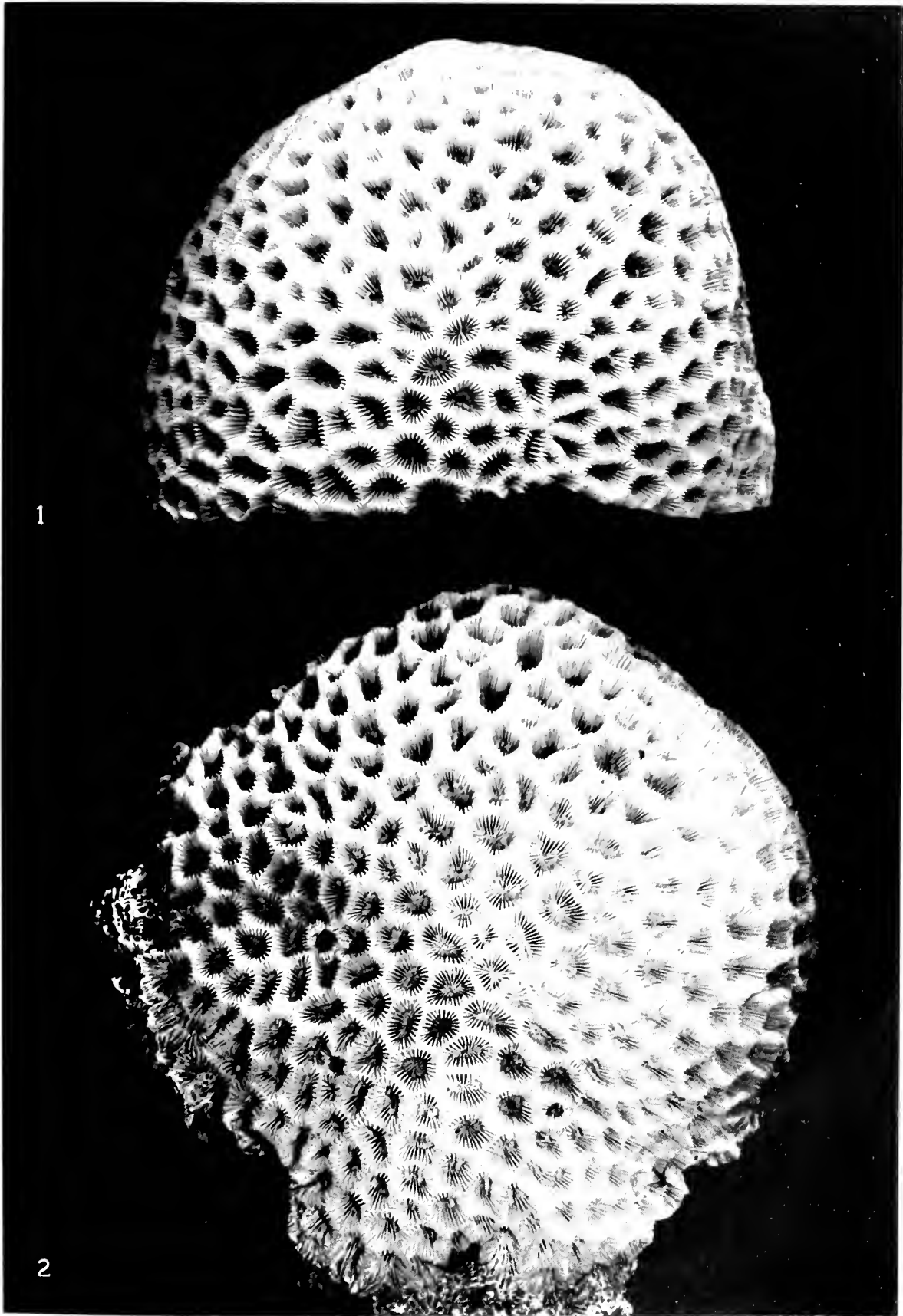
FIG. 1.—*Favites virens* Dana. × 1.
G.B.R.E. No. 114.

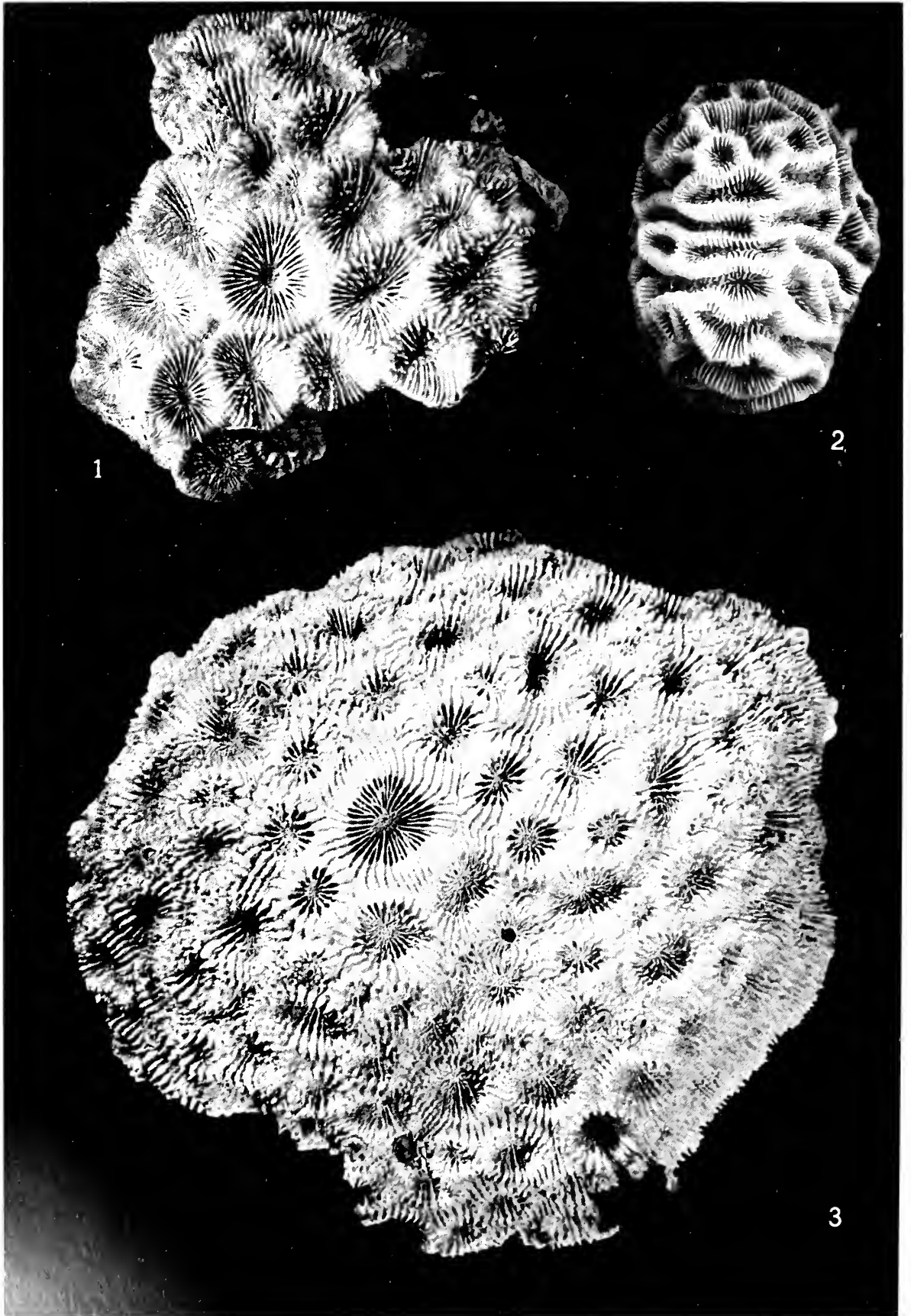
FIG. 2.—*Favites virens* Dana. × 1.
G.B.R.E. No. 115.

DESCRIPTION OF PLATE VII.

FIG. 1.—*Goniastrea mantonae*, sp. n. × 1.
G.B.R.E. No. 120. K5.

FIG. 2.—*Goniastrea mantonae*, sp. n. × 1.
G.B.R.E. No. 128.





DESCRIPTION OF PLATE VIII.

FIG. 1.—*Acanthastrea echinata* Dana. × 2.
G.B.R.E. No. 151.

FIG. 2.—*Goniastrea benhami* Vaughan. × 1.
G.B.R.E. No. 51.

FIG. 3.—*Acanthastrea echinata* Dana. × 1·2
G.B.R.E. No. 144.

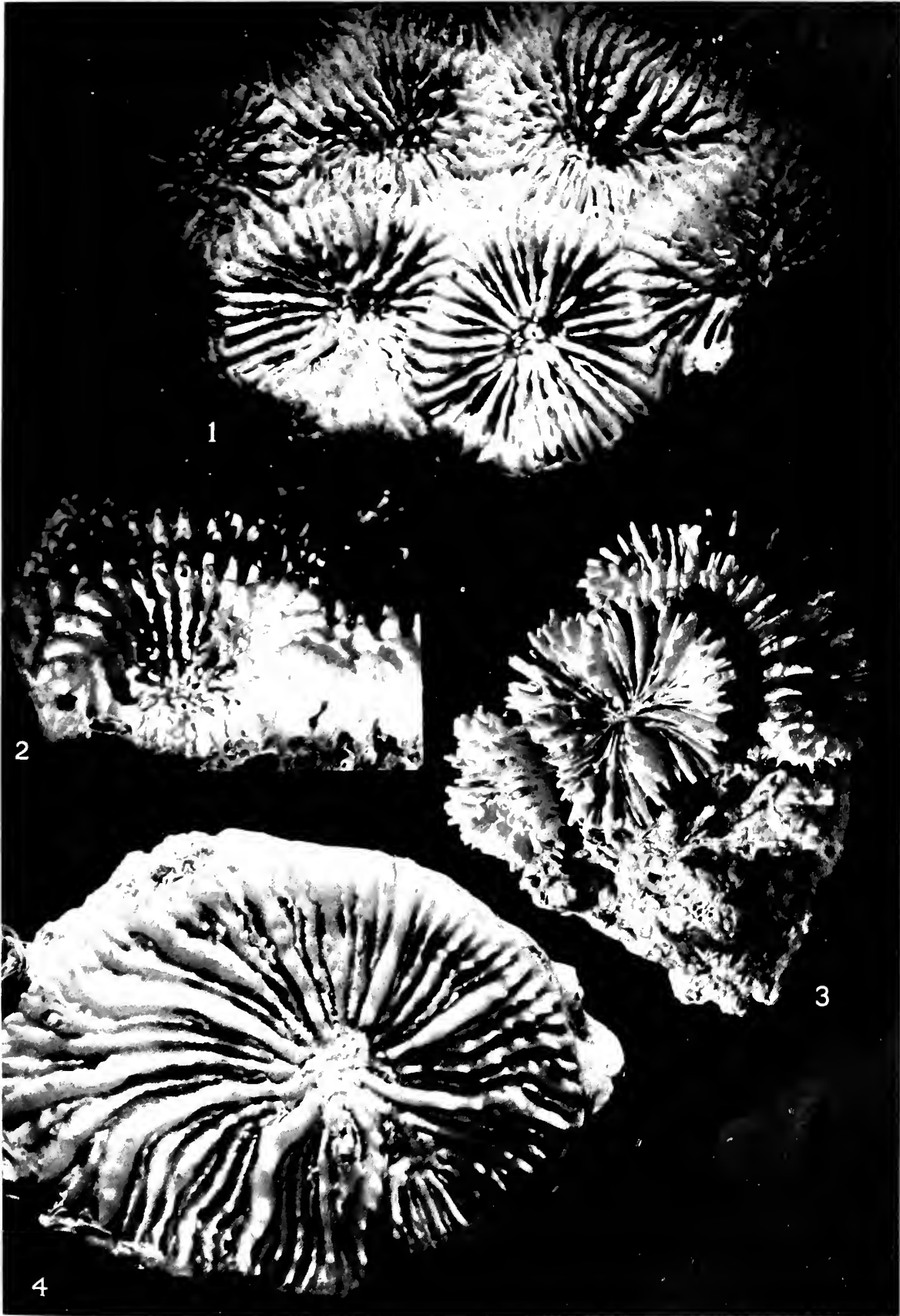
DESCRIPTION OF PLATE IX.

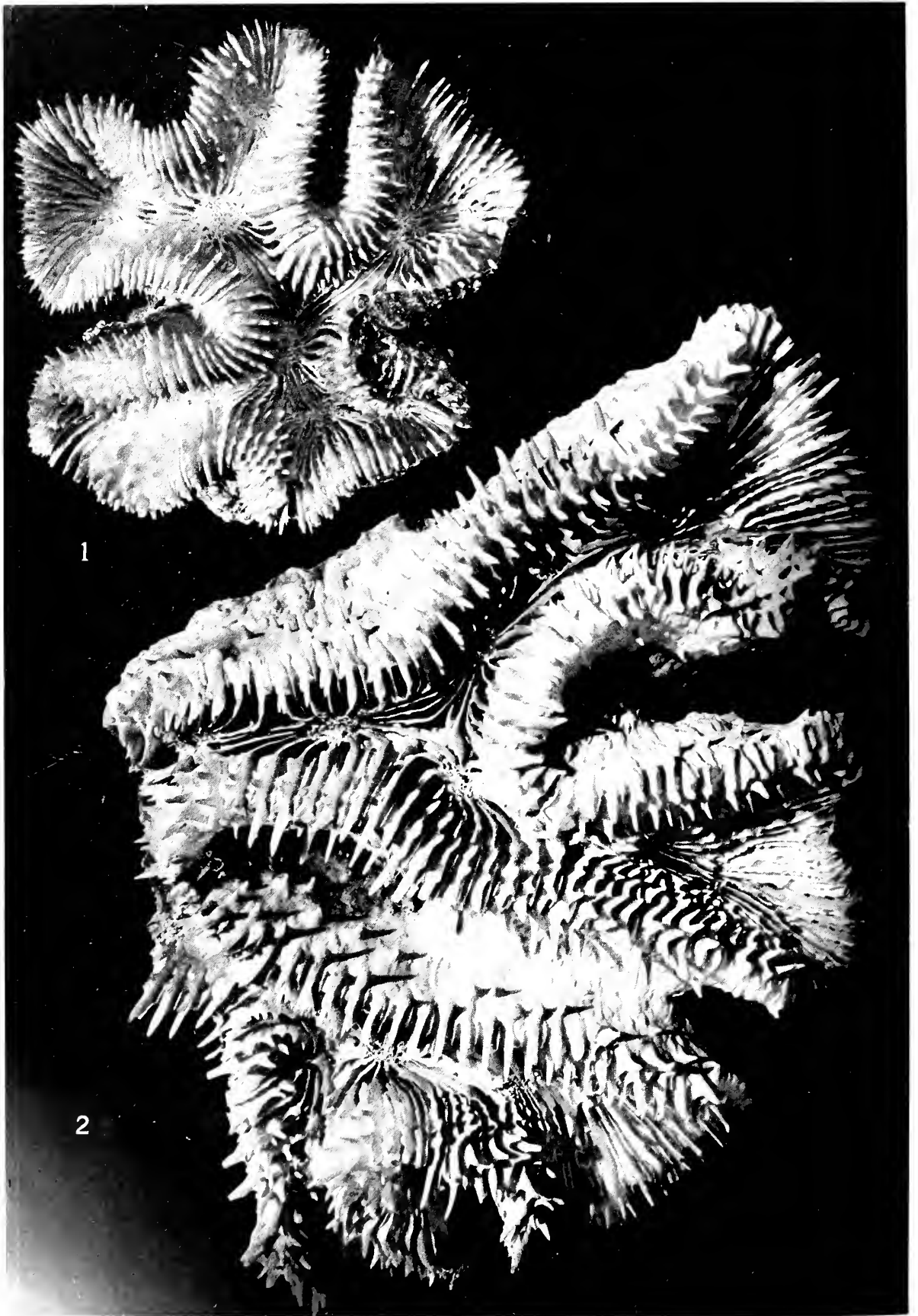
FIG. 1.—*Acanthastrea echinata* Dana. × 3.
G.B.R.E. No. 151.

FIG. 2.—*Acanthastrea echinata* Dana. × 3.
G.B.R.E. No. 144.

FIG. 3.—*Lobophyllia corymbosa* (Forskål). × 1.
G.B.R.E. No. 447.

FIG. 4.—*Lithophyllia vitiensis* (Brügg). × 3.
Stn. XXIV.
B.M. Reg. No. 1934.5.14.410c.





DESCRIPTION OF PLATE X.

FIG. 1.—*Lobophyllia hemprichii* (Ehr.) × 1.
G.B.R.E. No. 450.

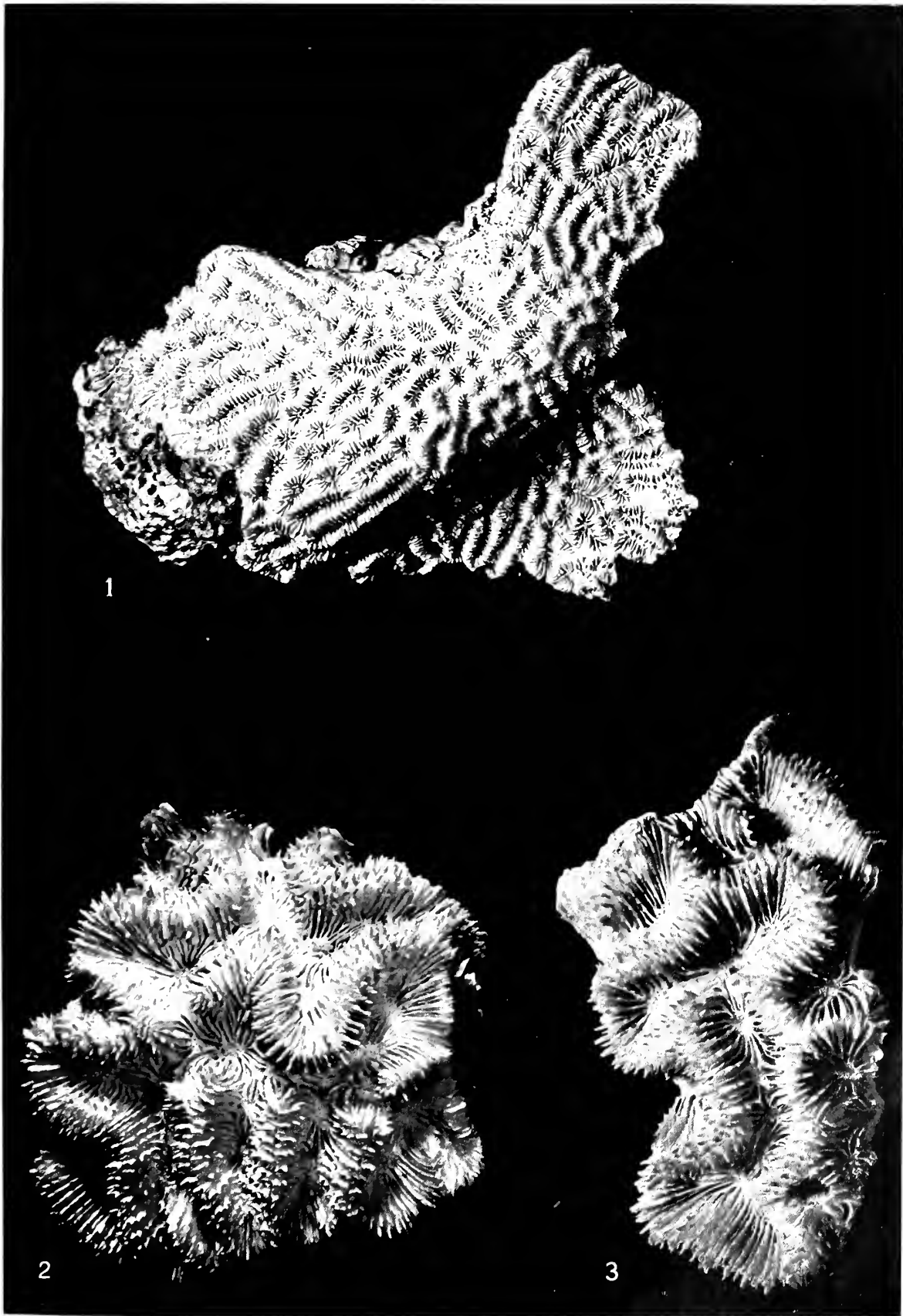
FIG. 2.—*Lobophyllia hemprichii* (Ehr.) × 1.
B.M. Reg. No. 1934.5.14.380. Stn. No. 2, Low Island.

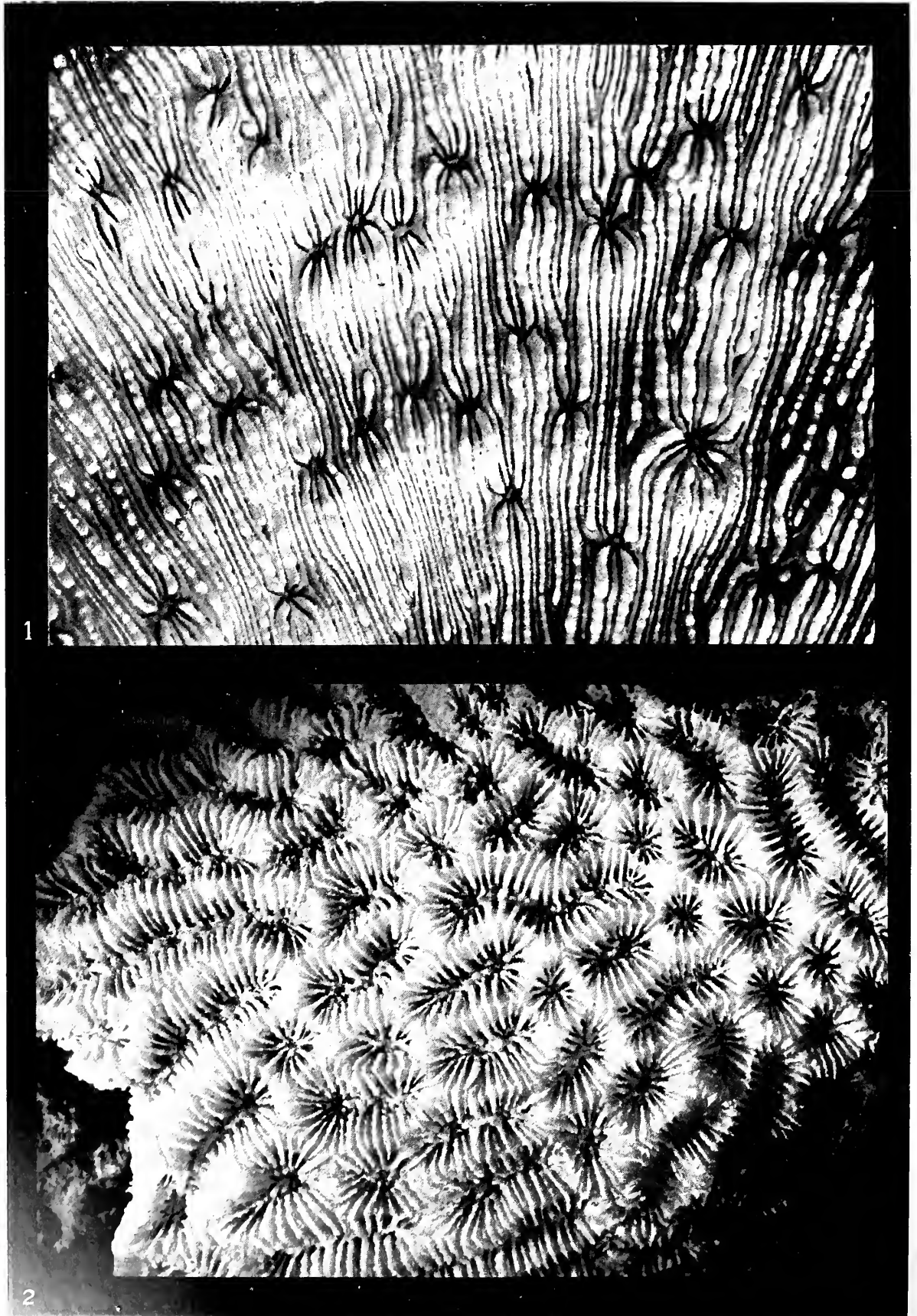
DESCRIPTION OF PLATE XI.

FIG. 1.—*Coeloria daedalea* (Ell. and Sol.) × 1.
G.B.R.E. No. 138.

FIG. 2.—*Symphylia recta* M. E. and H. × 1.
B.M. Reg. No. 1934.5.14.405.

FIG. 3.—*Symphylia recta* M. E. and H. × 1.
B.M. Reg. No. 1934.5.14.365.





DESCRIPTION OF PLATE XII.

FIG. 1.—*Podobacia crustacea* (Pallas). × 3.
G.B.R.E. No. 36.

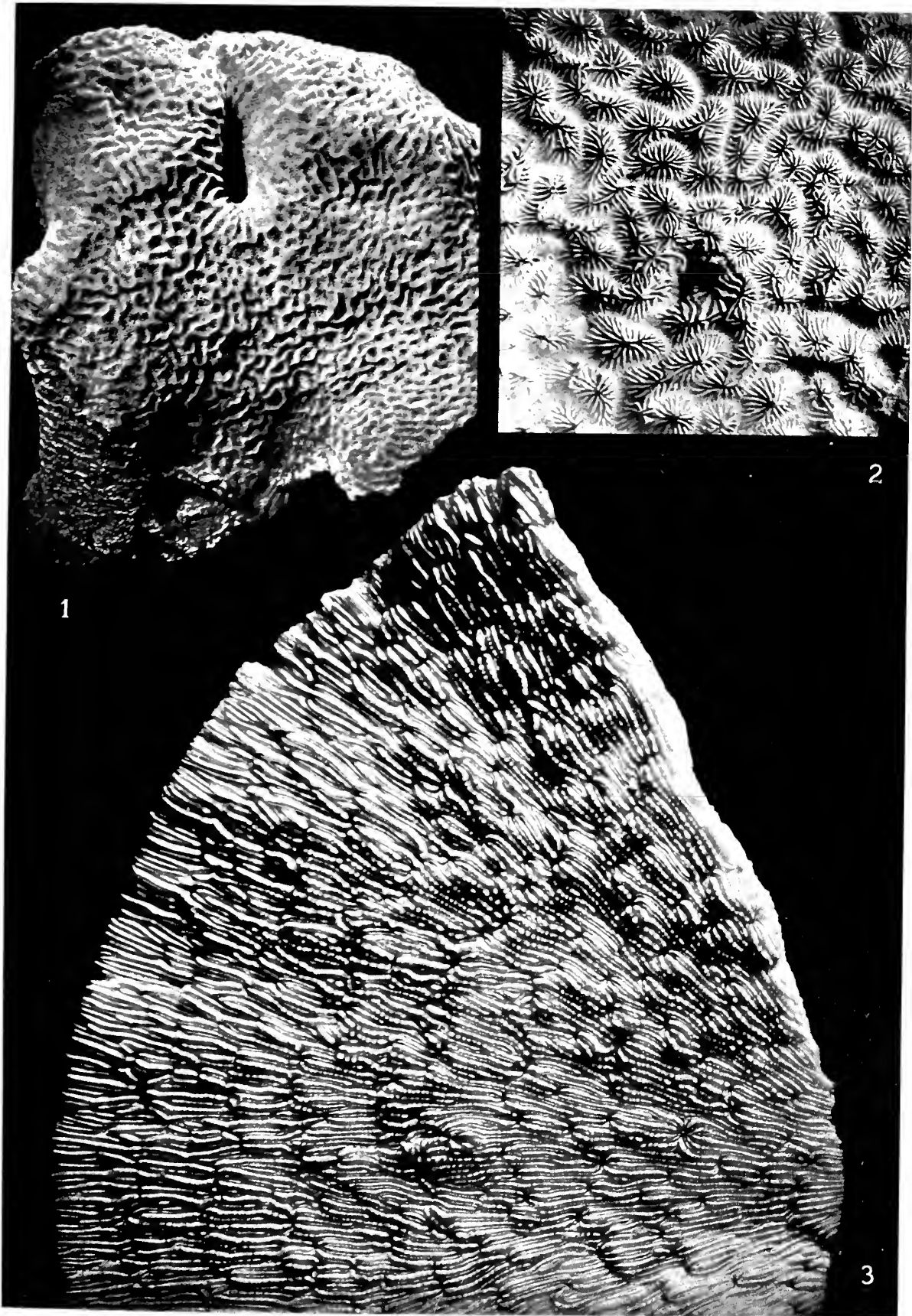
FIG. 2.—*Coeloria daedalea* (Ell. & Sol.). × 3.
G.B.R.E. No. 138.

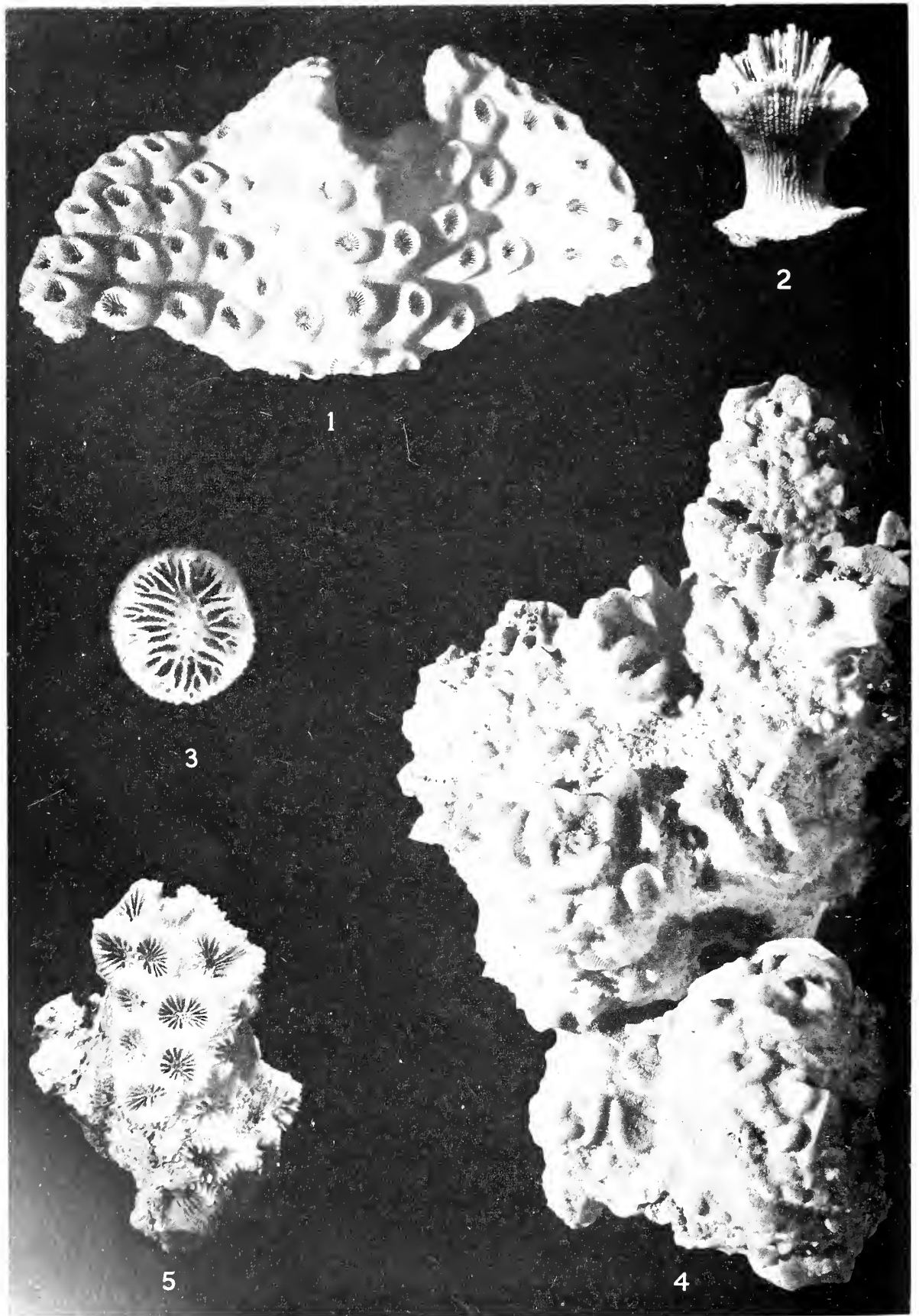
DESCRIPTION OF PLATE XIII.

FIG. 1.—*Pavona varians* Verrill. × 1.
G.B.R.E. No. 117.

FIG. 2.—*Pavona varians* Verrill. × 3.
G.B.R.E. No. 117.

FIG. 3.—*Podobacia crustacea* (Pallas). × 1.
G.B.R.E. No. 36.





DESCRIPTION OF PLATE XIV.

FIG. 1.—*Turbinaria peltata*, var. *gibiari*, var. n. × 1.
G.B.R.E. No. 193.

FIG. 2.—*Balanophyllia yongei*, sp. n. × 2.
Specimen No. 6. Holotype.
B.M. Reg. No. 1934.5.11.491.

FIG. 3.—*Dendrophyllia arbuscula* Horst. × 4.3.
Fragments of corallite 5.
B.M. Reg. No. 1934.5.11.490.

FIG. 4.—*Parona varians* Verrill. × 1.
G.B.R.E. No. 55.

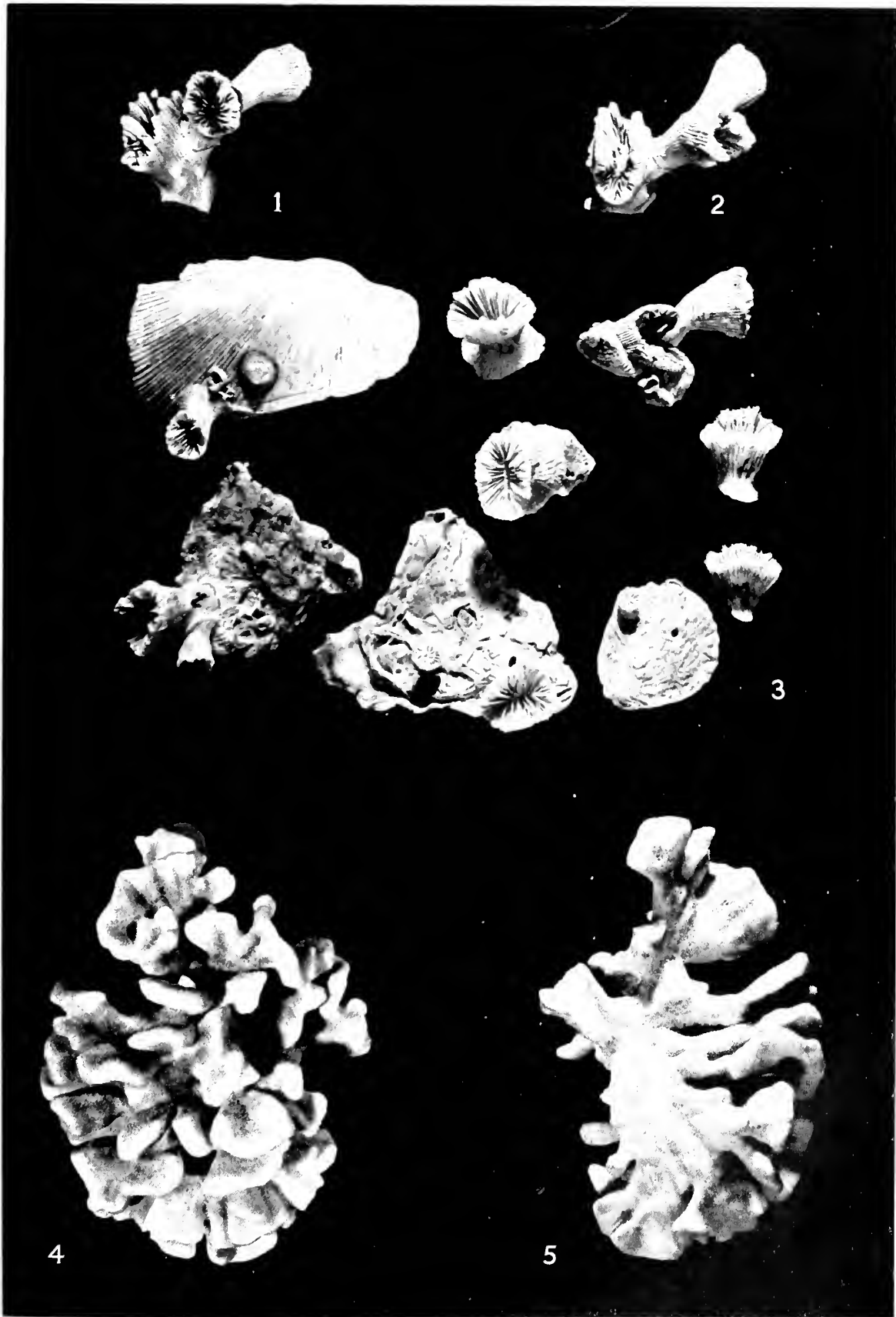
FIG. 5.—*Favia fava* (Forskål) var. *crassidens*, var. n. × 1.
G.B.R.E. No. 410.

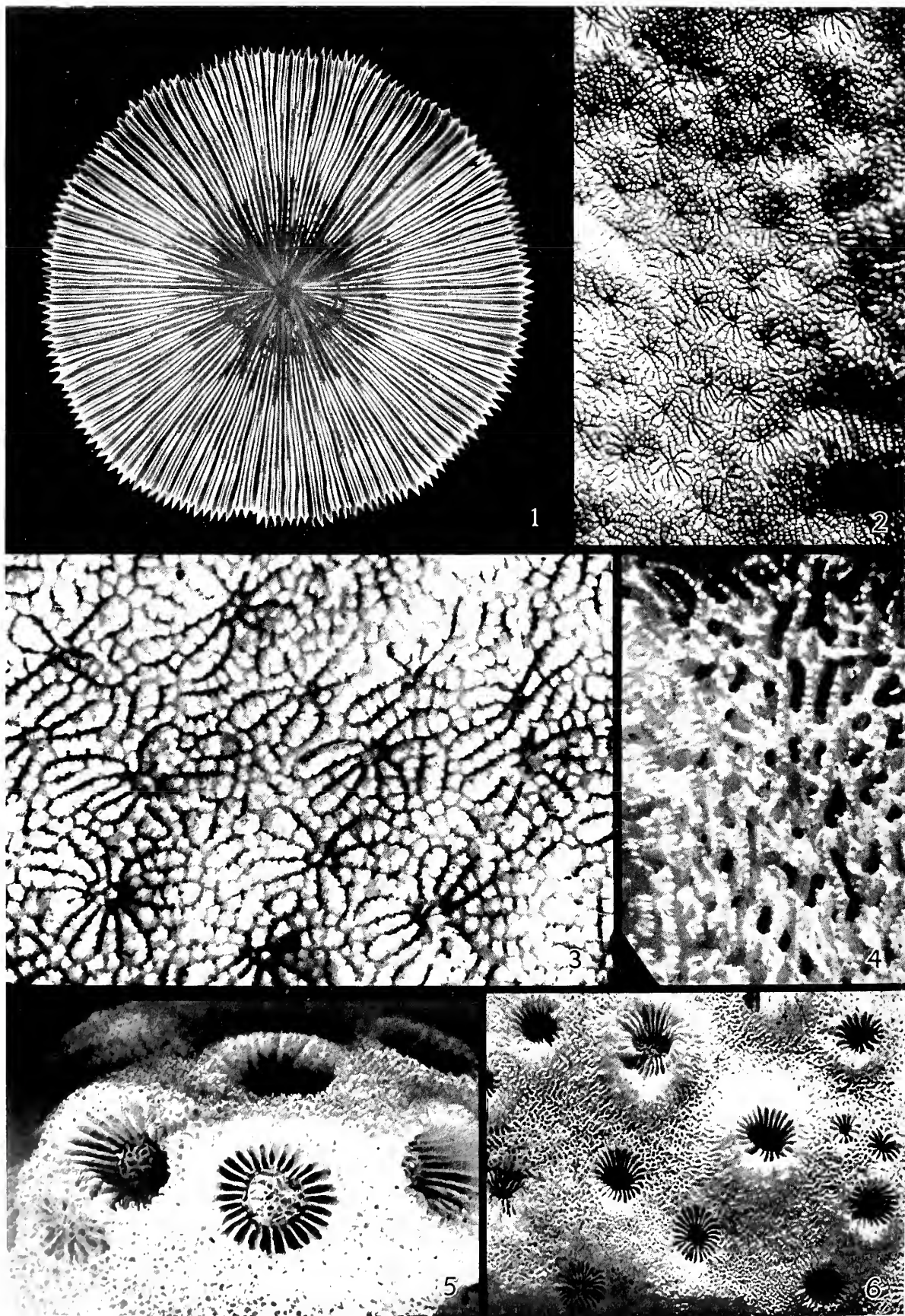
DESCRIPTION OF PLATE XV.

FIGS. 1 and 2.—*Balanophyllia incisa*, sp. n. Holotype. × 1.
B.M. Reg. No. 1934.5.14.369.

FIG. 3.—*Balanophyllia yongei*, sp. n. × 1.
B.M. Reg. No. 1934.5.14.491.

FIGS. 4 and 5.—*Psammocora contigua* (Esper). × 1.
G.B.R.E. No. 11.





DESCRIPTION OF PLATE XVI.

- FIG. 1.—*Fungia patelliformis* Boschma. × 1·5.
Photographed by transmitted light.
B.M. Reg. No. 1934.5.14.610.
- FIG. 2.—*Psammocora exesa* Dana. × 4·2.
G.B.R.E. No. 17.
- FIG. 3.—*Psammocora exesa* Dana. × 12·3.
G.B.R.E. No. 17.
- FIG. 4.—*Turbinaria peltata* var. *gibiari*, var. n. × 16.
G.B.R.E. No. 193.
- FIG. 5.—*Turbinaria peltata*. × 4.
G.B.R.E. No. 435.
- FIG. 6.—*Turbinaria mantoniae*, sp. n. × 4.
G.B.R.E. No. 323.

DESCRIPTION OF PLATE XVII.

FIG. 1.—*Turbinaria peltata* var. *gibiari*, var. n. × 4.
G.B.R.E. No. 193.

FIG. 2.—*Turbinaria mantonae*, sp. n. × 1.
G.B.R.E. No. 323.

FIG. 3.—*Psammocora contigua* (Esper). × 3.
G.B.R.E. No. 11.

FIG. 4.—*Psammocora exesa* Dana. × 8.
G.B.R.E. No. 17.



1



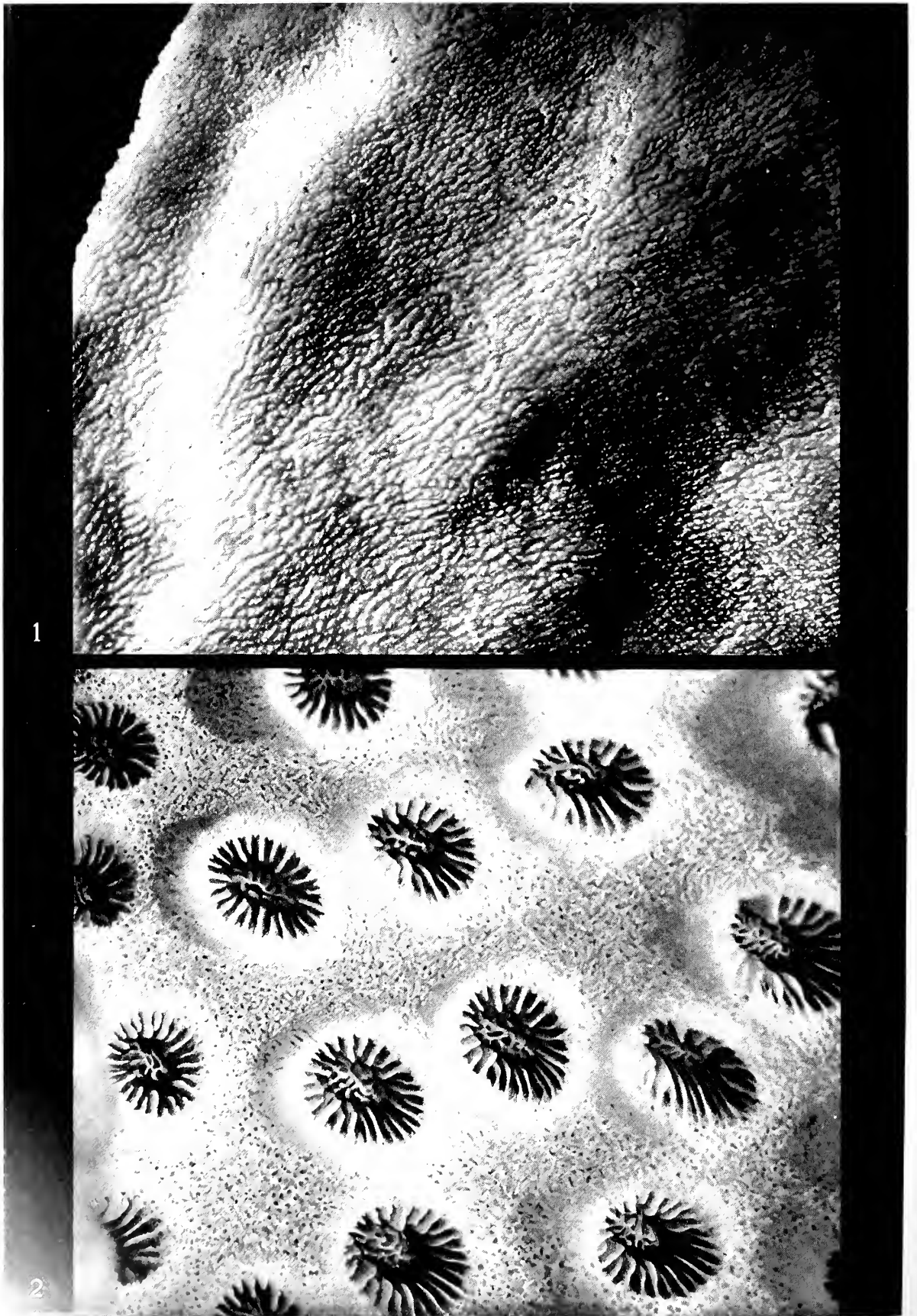
2



3



4



DESCRIPTION OF PLATE XVIII.

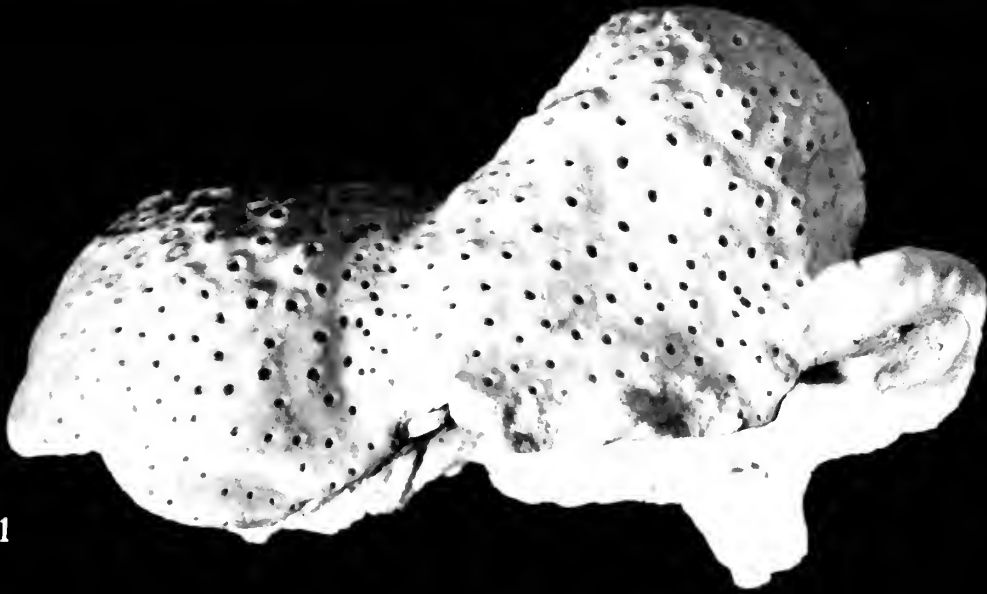
FIG. 1.—*Turbinaria peltata* var. *gibiari* var. n. × 4.
G B.R.E. No. 193.

FIG. 2.—*Turbinaria peltata*. × 4·7.
G.B.R.E. No. 435.

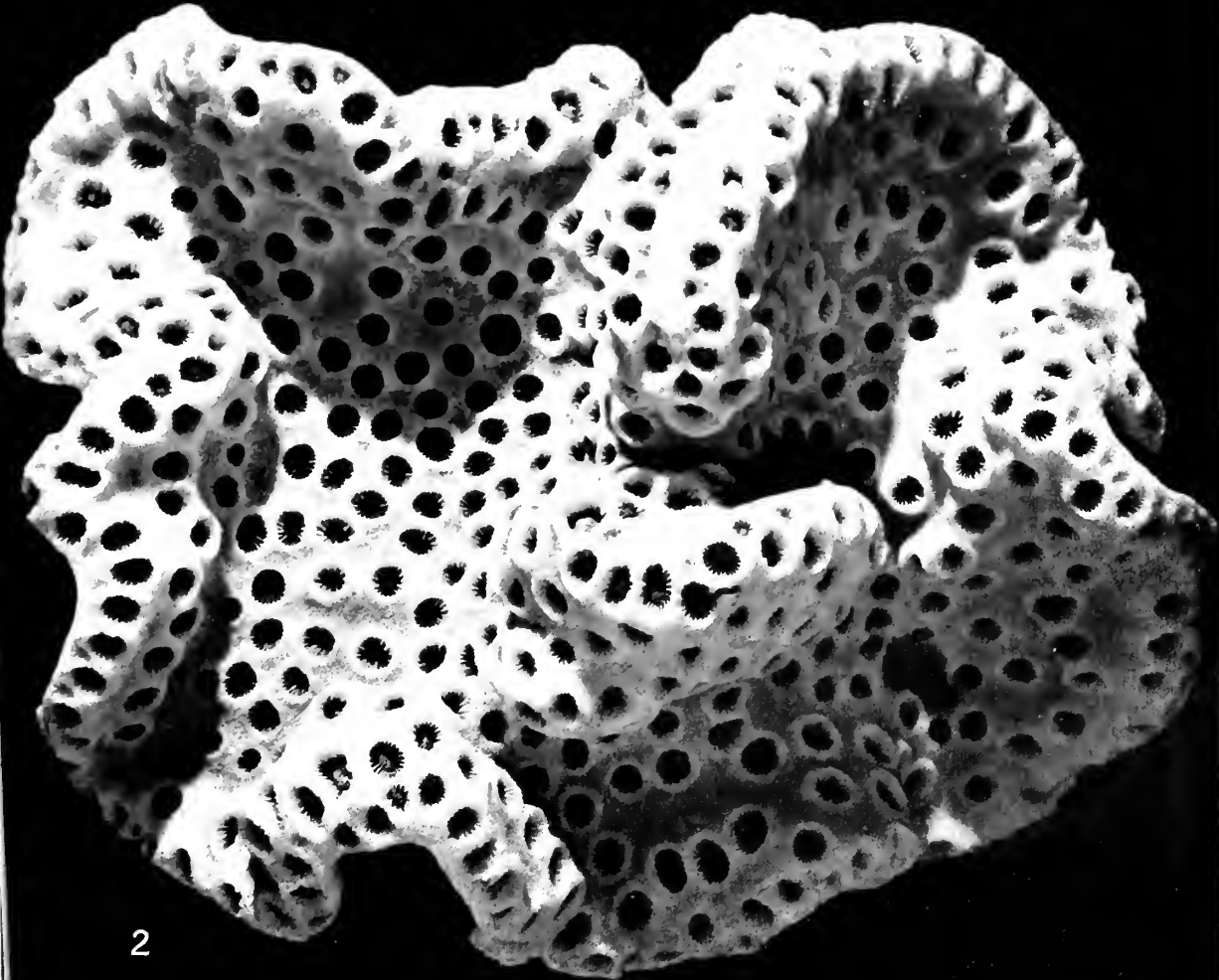
DESCRIPTION OF PLATE XIX.

FIG. 1.—*Turbinaria mantonae*, sp. n. × 1.
G.B.R.E. No. 323.

FIG. 2.—*Turbinaria peltata*. × 1.
G.B.R.E. No. 435.



1



2

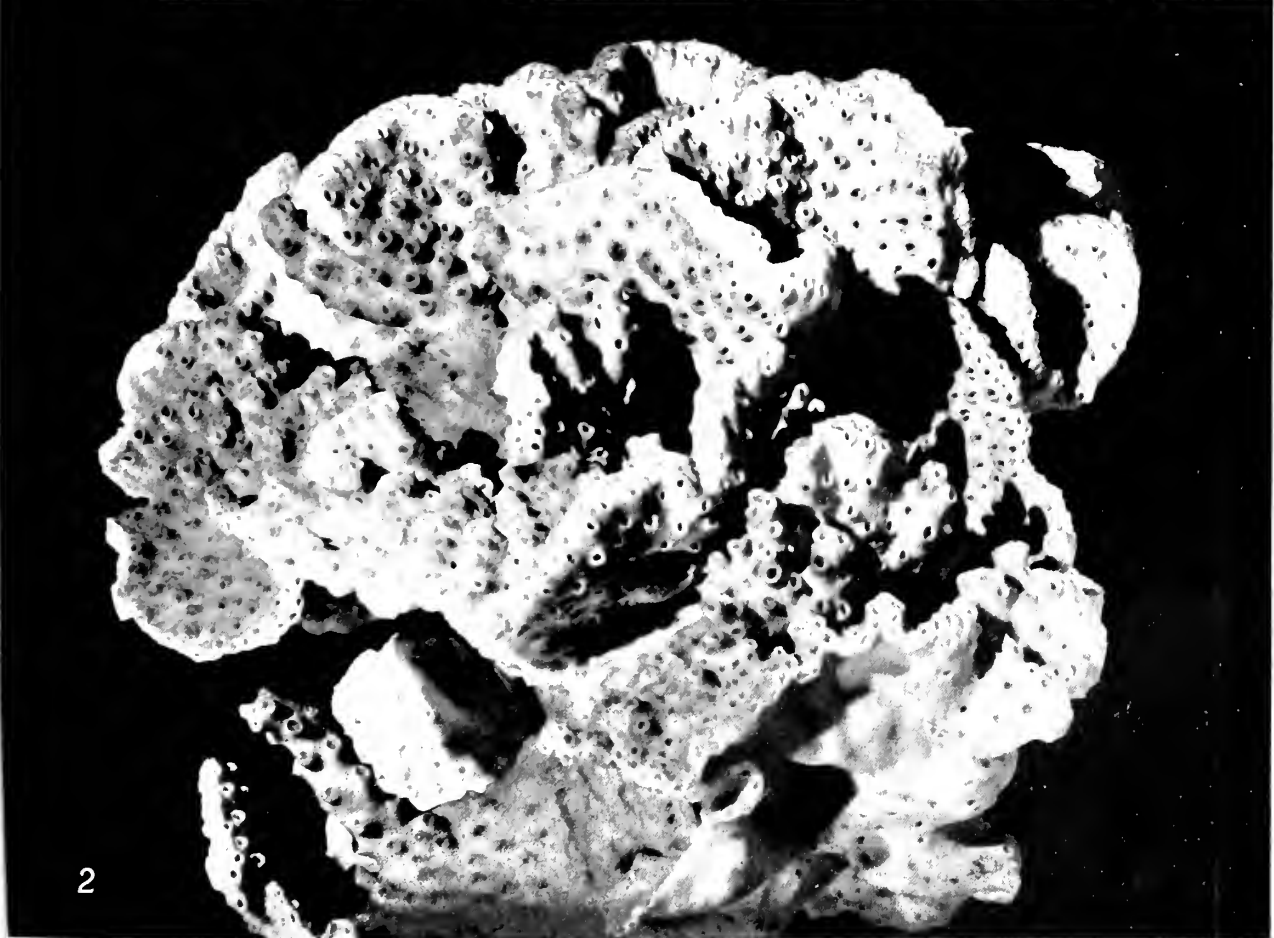


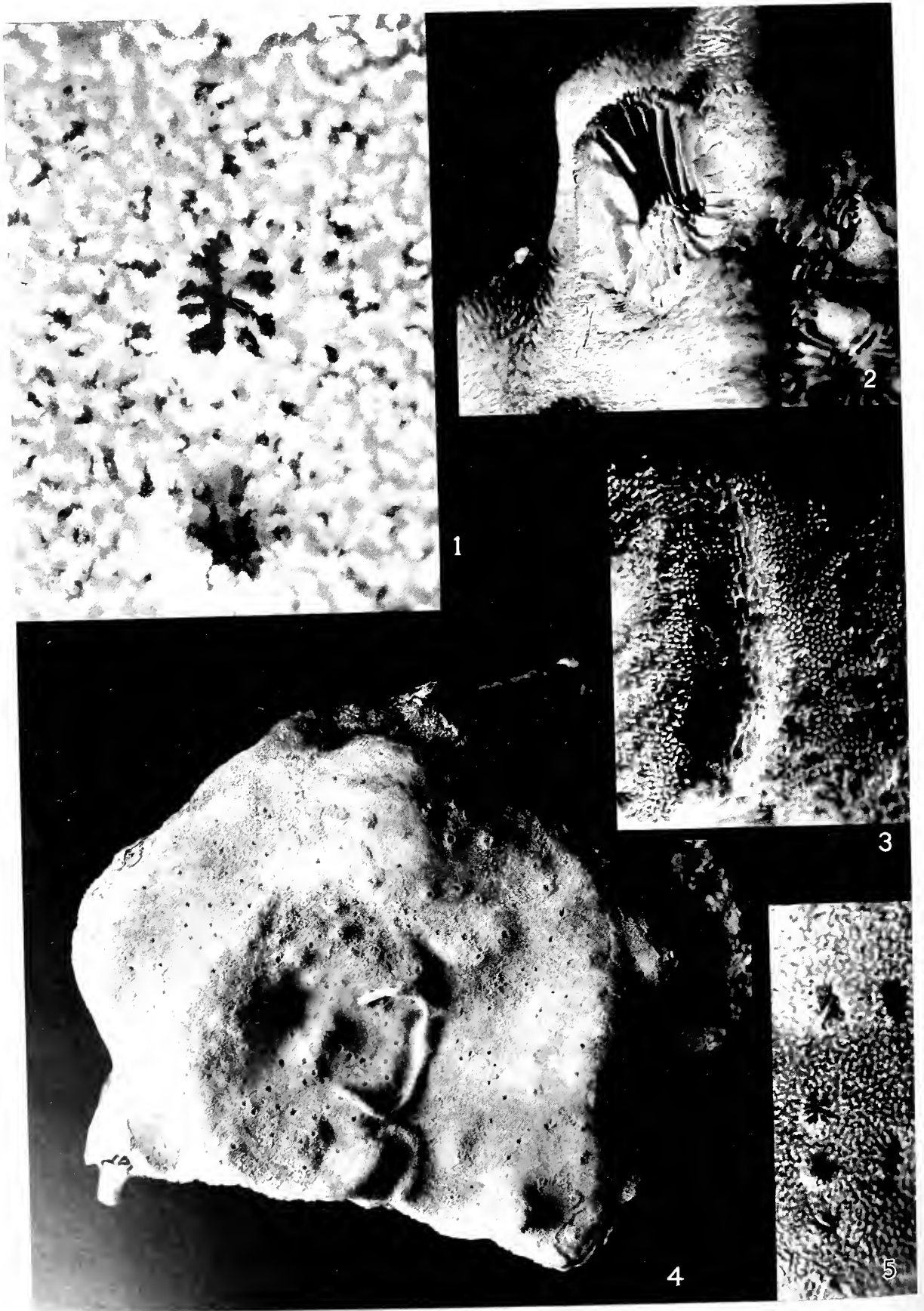
DESCRIPTION OF PLATE XX.

FIGS. 1 and 2.—*Montipora millepora*, sp. n. × 4.
B.M. Reg. No. 1934.5.14.410.

DESCRIPTION OF PLATE XXI.

Figs. 1 and 2.—*Turbinaria bifrons* Brügg. × 1.
B.M. Reg. No. 1934.5.14.272.





DESCRIPTION OF PLATE XXII.

- FIG. 1.—*Montipora millepora*, sp. n. × 30.
B.M. Reg. No. 1934.5.14.410.
- FIG. 2.—*Turbinaria peltata* var. *gibiari*, var. n. × 4.5.
G.B.R.F. No. 193.
- FIG. 3.—*Montipora millepora*, sp. n. × 10.
B.M. Reg. No. 1934.5.14.410.
- FIG. 4.—*Montipora millepora*, sp. n. × 2.
B.M. Reg. No. 1934.5.14.410.
- FIG. 5.—*Montipora millepora*, sp. n. × 10.
B.M. Reg. No. 1934.5.14.410.

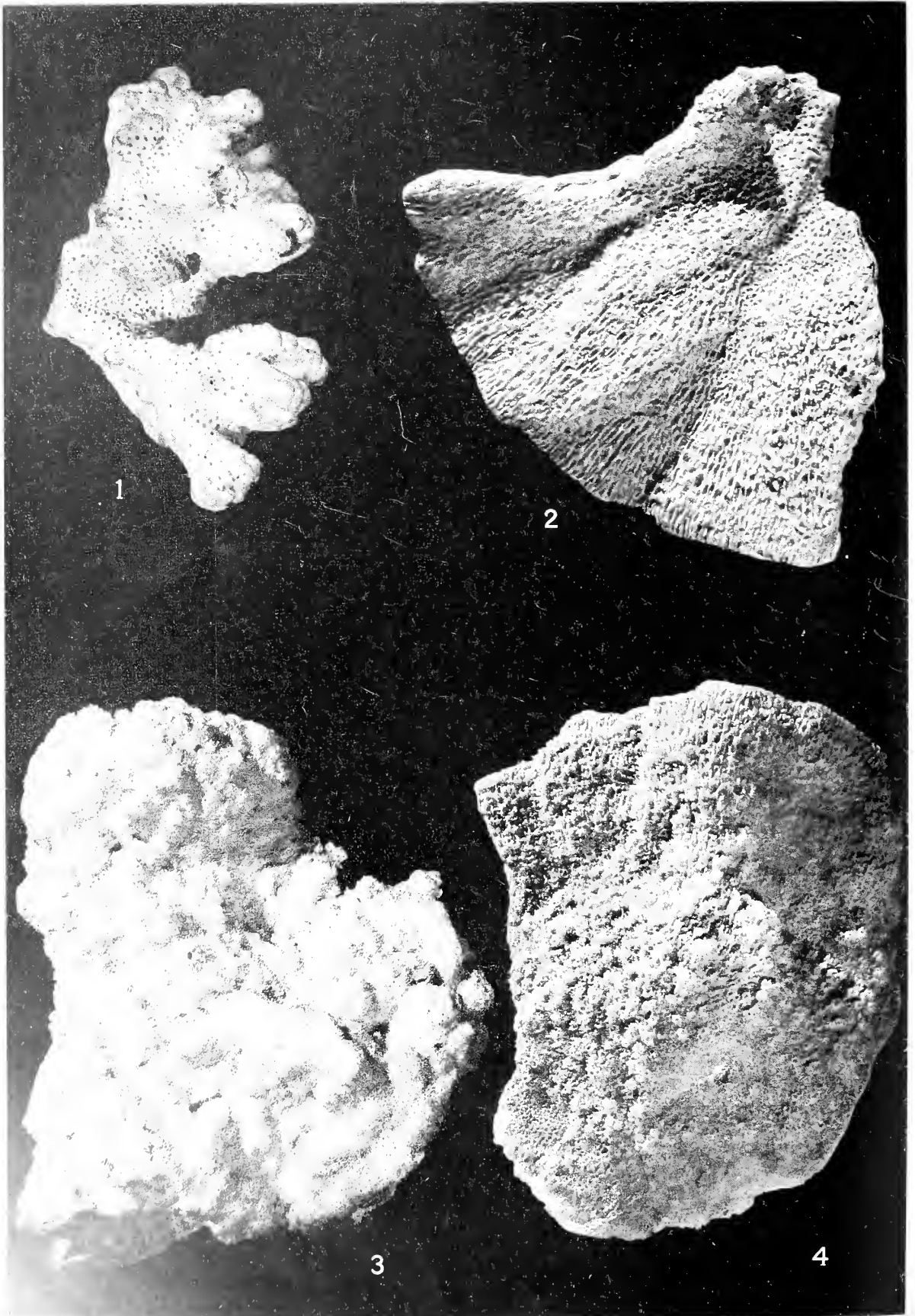
DESCRIPTION OF PLATE XXIII.

FIG. 1.—*Turbinaria frondens* (Dana). × 1.
G.B.R.E. No. 326.

FIG. 2.—*Montipora fruticosa* Bernard. × 1.
B.M. Reg. No. 1934.5.14.193.

FIG. 3.—*Montipora undans*, sp. n. × 1.
G.B.R.E. No. 13.





DESCRIPTION OF PLATE XXIV.

- FIG. 1.—*Montipora prominula*, sp. n. × ·8.
G.B.R.E. No. 327.
- FIG. 2.—*Montipora erythraca* Marenz. × ·8.
G.B.R.E. No. 30.
- FIG. 3.—*Montipora erythraca* Marenz. × ·8.
G.B.R.E. No. 136.
- FIG. 4.—*Montipora erythraca* Marenz. × ·8.
G.B.R.E. No. 319.

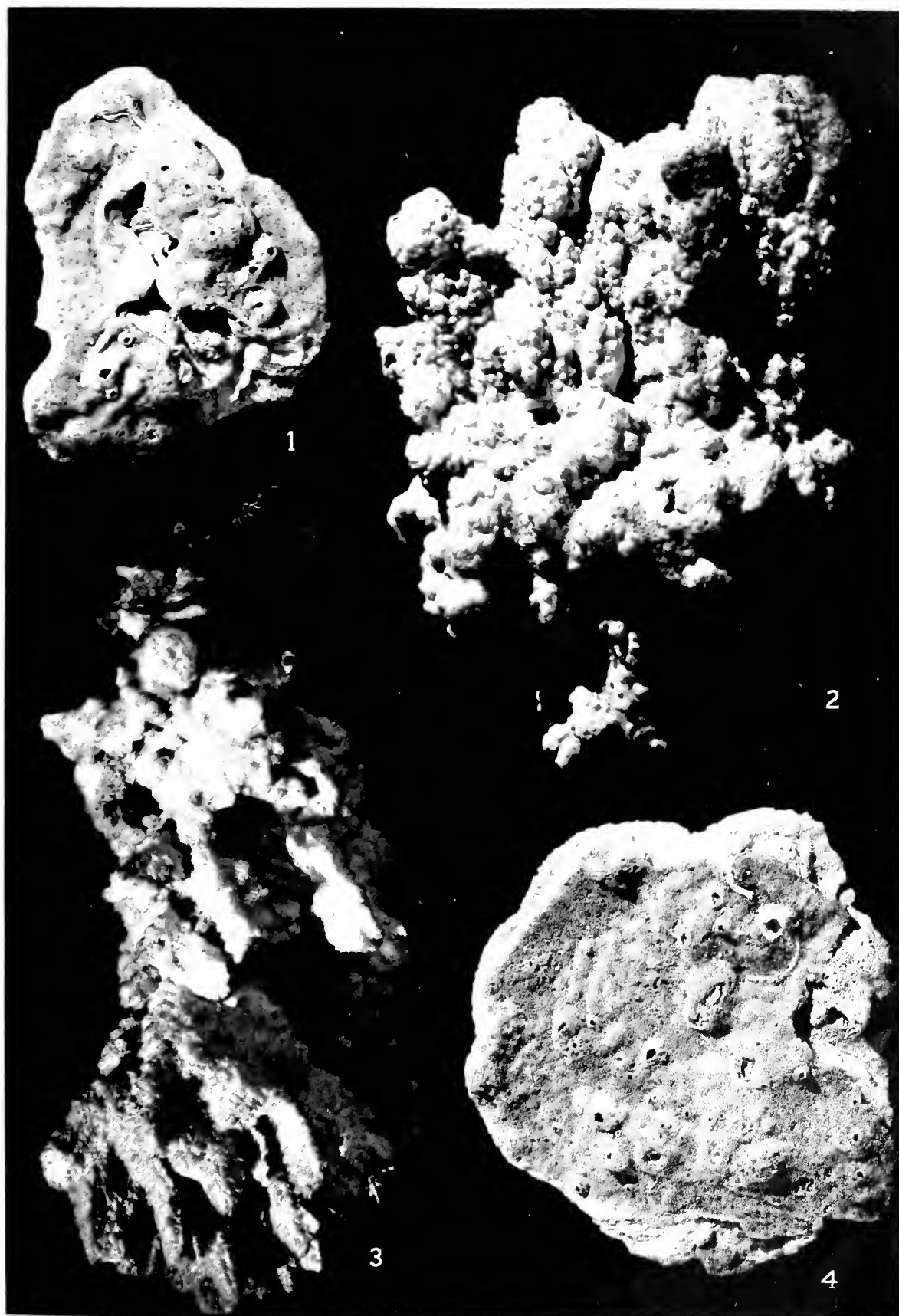
DESCRIPTION OF PLATE XXV.

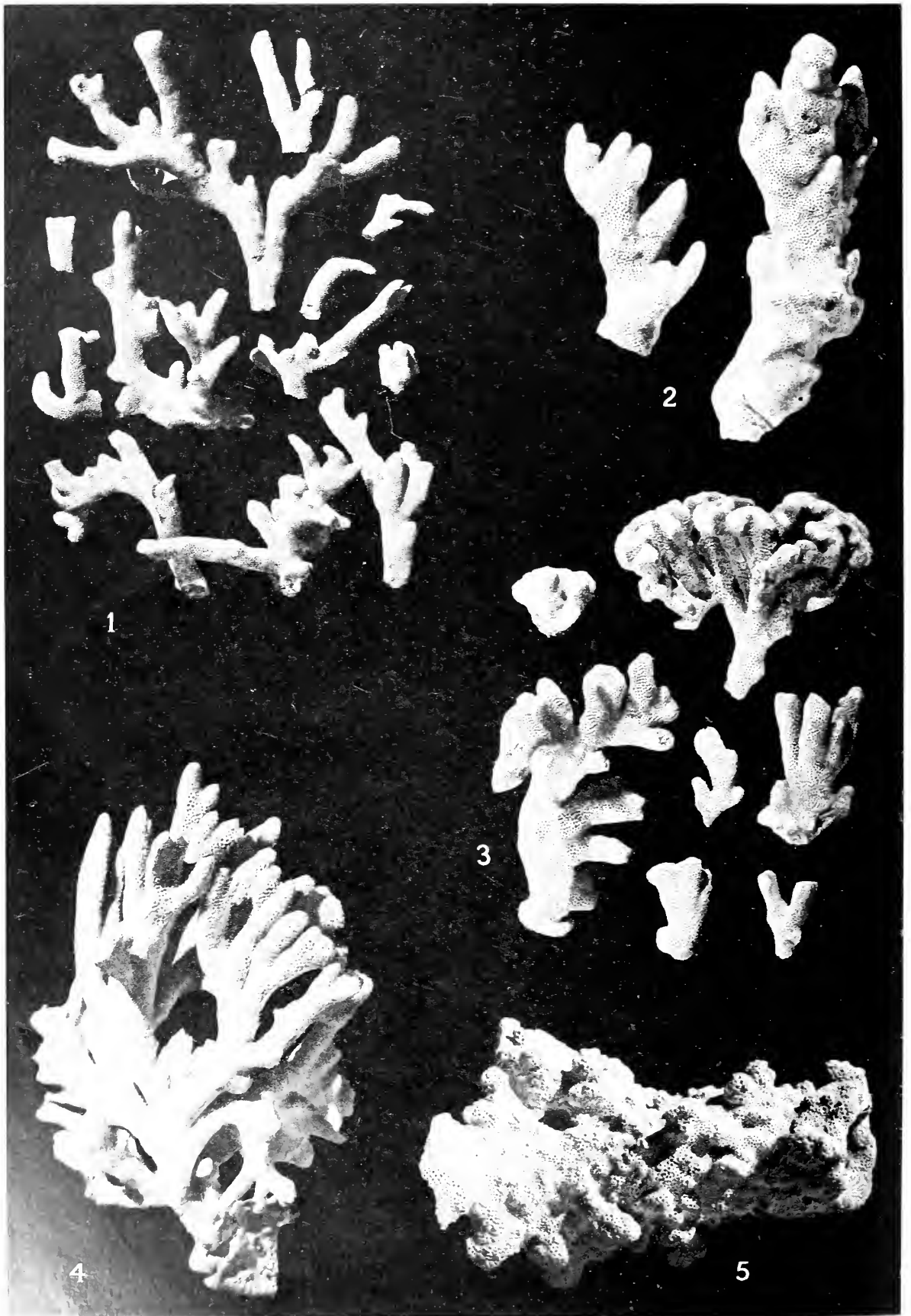
FIG. 1.—*Montipora granulosa* Bernard. × 1.
G.B.R.E. No. 113.

FIG. 2.—*Montipora tertia* sp. n. × 1.
G.B.R.E. No. 11.

FIG. 3.—*Montipora angularis*, sp. n. × 1.
G.B.R.E. No. 137.

FIG. 4.—*Montipora granulosa* Bernard. × 1.
G.B.R.E. No. 113.



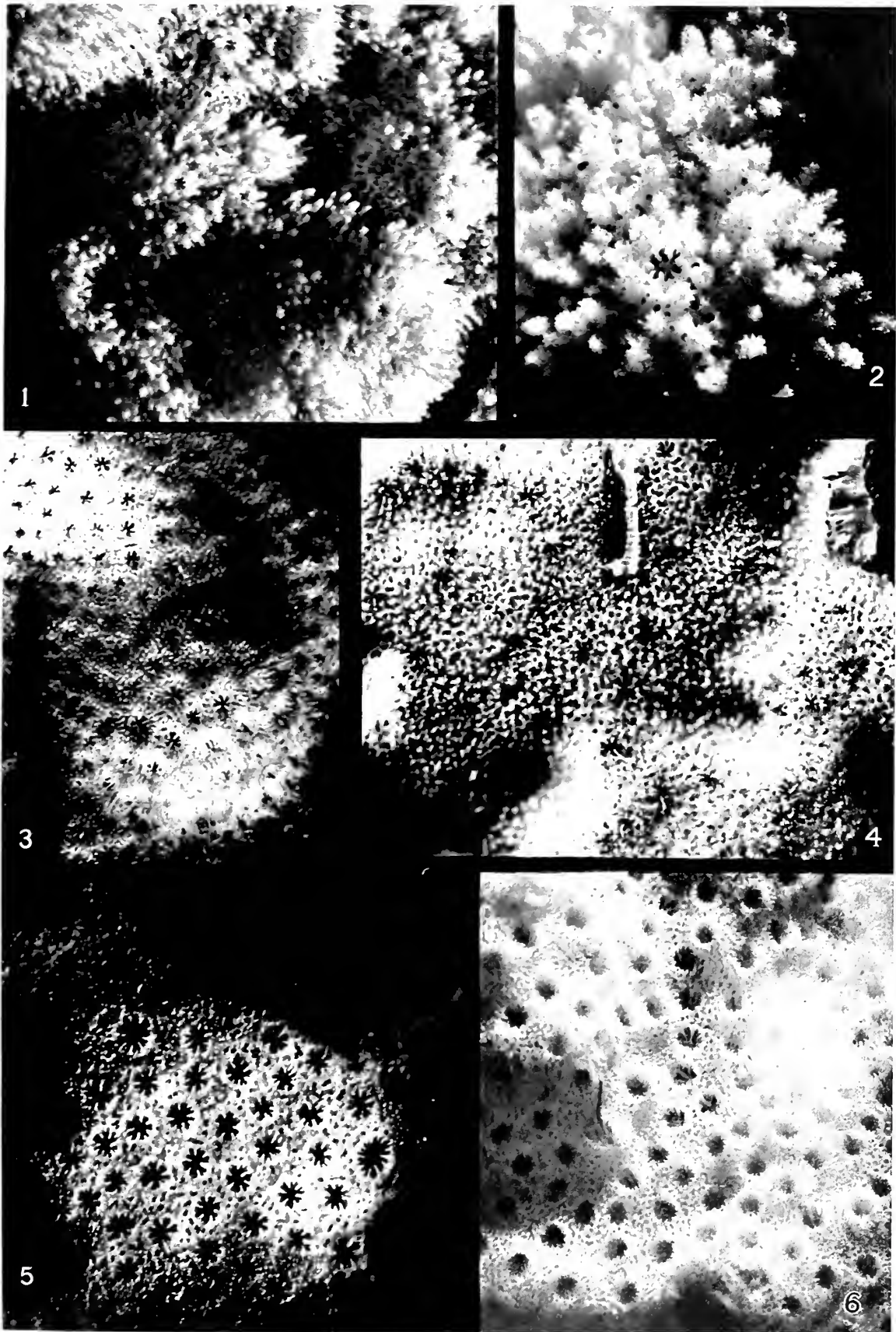


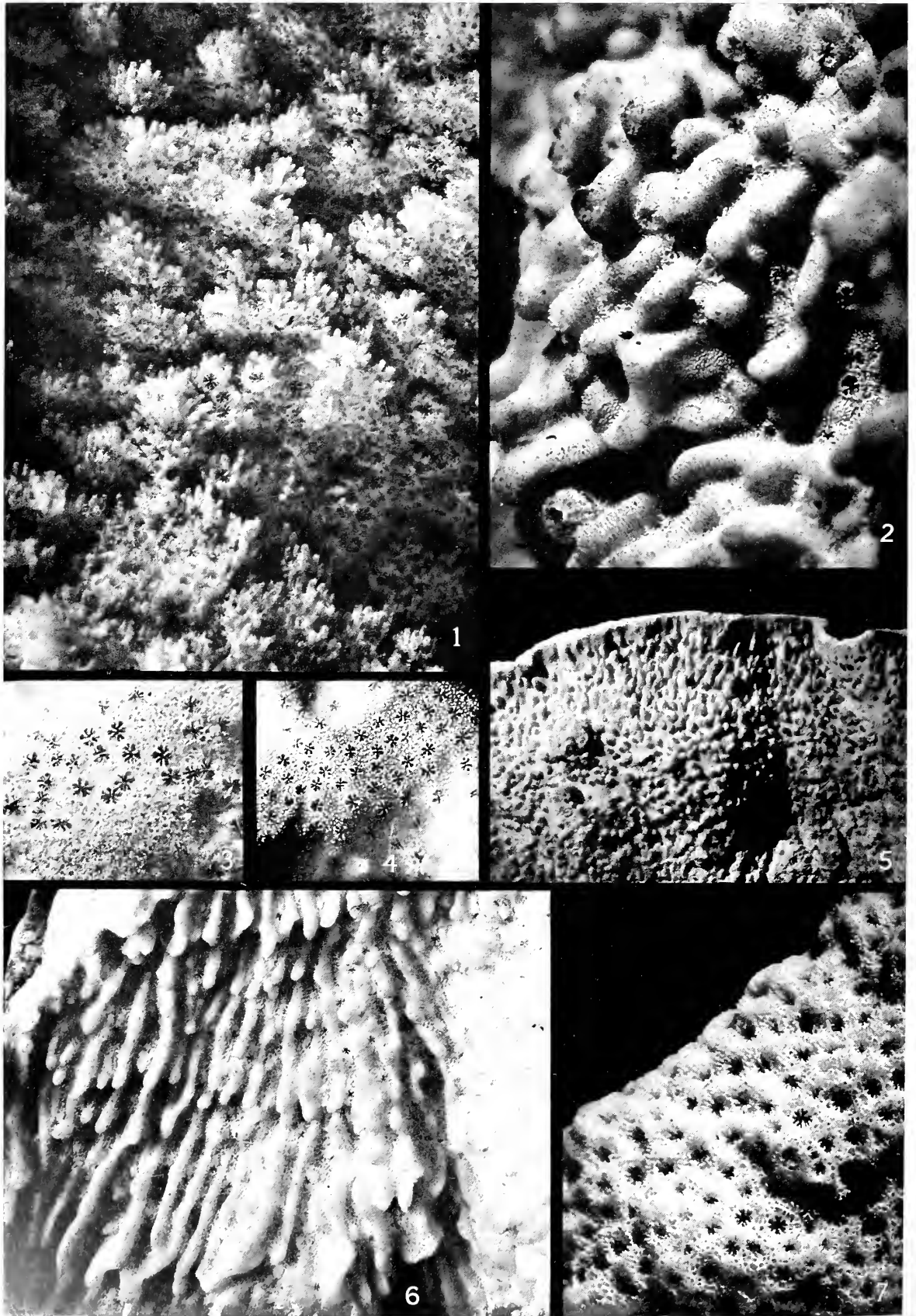
DESCRIPTION OF PLATE XXVI.

- FIG. 1.—*Montipora digitata* (Dana). × 4.
B.M. Reg. No. 1934.5.11.281.
- FIG. 2.—*Montipora fossae* sp. n. × 4.
B.M. Reg. No. 1934.5.11.286.
- FIG. 3.—*Montipora ramosa* Bernard. × 5.
B.M. Reg. No. 1934.5.11.275.
- FIG. 4.—*Montipora ramosa* Bernard. × 5.
B.M. Reg. No. 1934.5.11.273.
- FIG. 5.—*Montipora venosa*, var. *angulosa*, Klz. × 4.
B.M. Reg. No. 1934.5.11.394.

DESCRIPTION OF PLATE XXVII.

- FIG. 1.—*Montipora erythraea* Marenz. × 4.
G.B.R.E. No. 136.
- FIG. 2.—*Montipora erythraea* Marenz. × 8.
G.B.R.E. No. 136.
- FIG. 3.—*Montipora ramosa* Bernard. × 5.
B.M. Reg. No. 1934.5.14.300.
- FIG. 4.—*Montipora granulosa* Bernard. × 5·8.
G.B.R.E. No. 113.
- FIG. 5.—*Montipora venosa* var. *angulosa* Klz. × 6.
B.M. Reg. No. 1934.5.14.394.
- FIG. 6.—*Montipora prominula*, sp. n. × 5.
G.B.R.E. No. 327.





DESCRIPTION OF PLATE XXVIII.

- FIG. 1.—*Montipora composita*, sp. n. × 4.
G.B.R.E. No. 186.
- FIG. 2.—*Montipora undans*, sp. n. × 8.
G.B.R.E. No. 13.
- FIG. 3.—*Montipora angularis*, sp. n. × 4.
G.B.R.E. No. 137.
- FIG. 4.—*Montipora tertia*, sp. n. × 4.
G.B.R.E. No. 11.
- FIG. 5.—*Montipora composita*, sp. n. × 8
G.B.R.E. No. 186.
- FIG. 6.—*Montipora sulcata*, sp. n. × 4.
G.B.R.E. No. 16.
- FIG. 7.—*Montipora venosa*, var. *angulosa* Klz. × 5.
B.M. Reg. No. 1934.5.14.394.

DESCRIPTION OF PLATE XXIX.

FIG. 1.—*Montipora composita*, sp. n. × ·4.
G.B.R.E. No. 186.

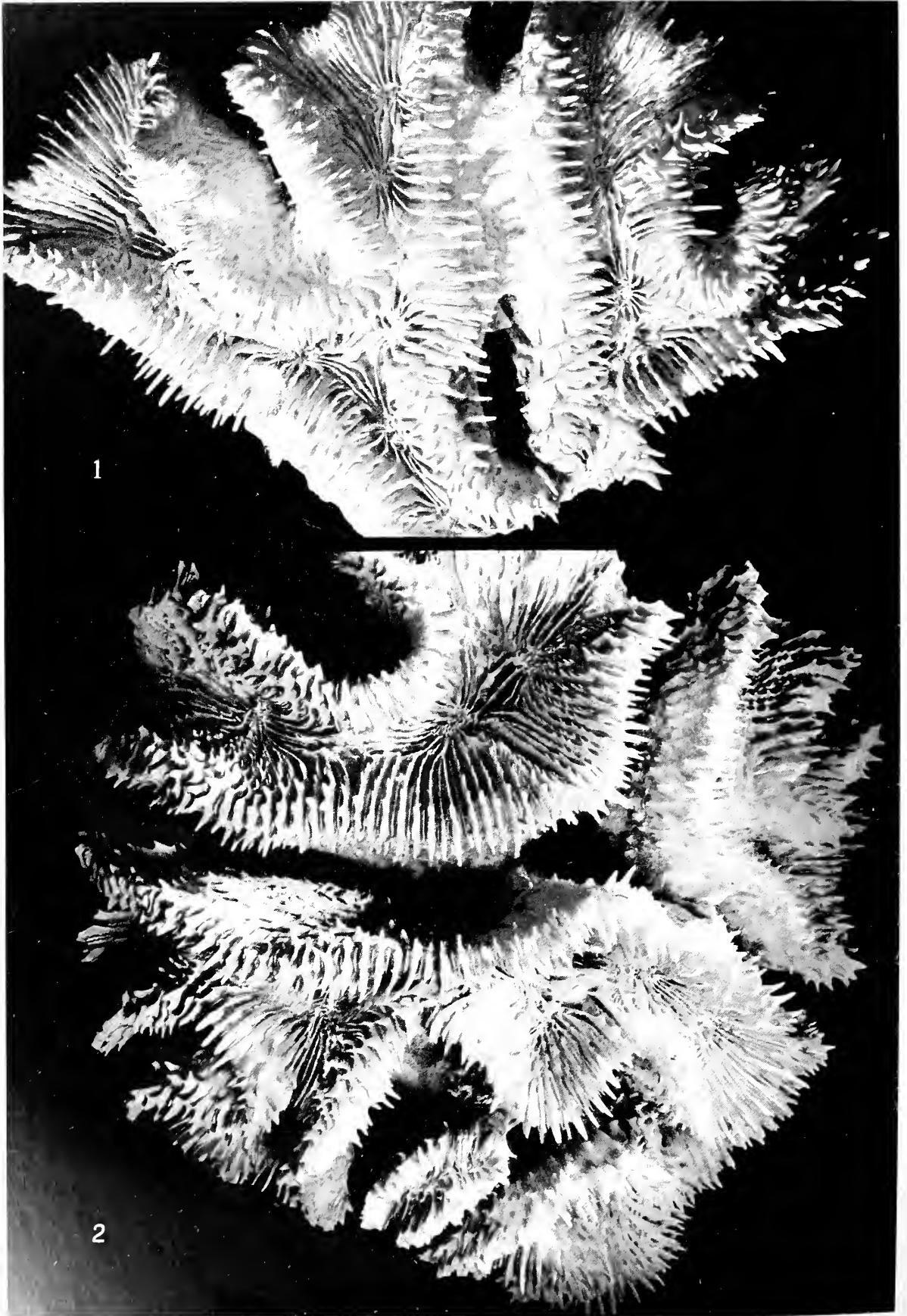
FIG. 2.—*Montipora sulcata*, sp. n. × ·6.
G.B.R.E. No. 16.

FIG. 3.—*Montipora composita*, sp. n. × ·4.
G.B.R.E. No. 23.

FIG. 4.—*Montipora composita*, sp. n. × ·4.
G.B.R.E. No. 186.

FIG. 5.—*Montipora sulcata*, sp. n. × ·6.
G.B.R.E. No. 16.





DESCRIPTION OF PLATE XXX.

FIG. 1.—*Lobophyllia hemprichii* (Ehr.). × 1.
B.M. Reg. No. 1934.5.14.380.

FIG. 2.—*Lobophyllia hemprichii* (Ehr.). × ·9.
G.B.R.E. No. 94.

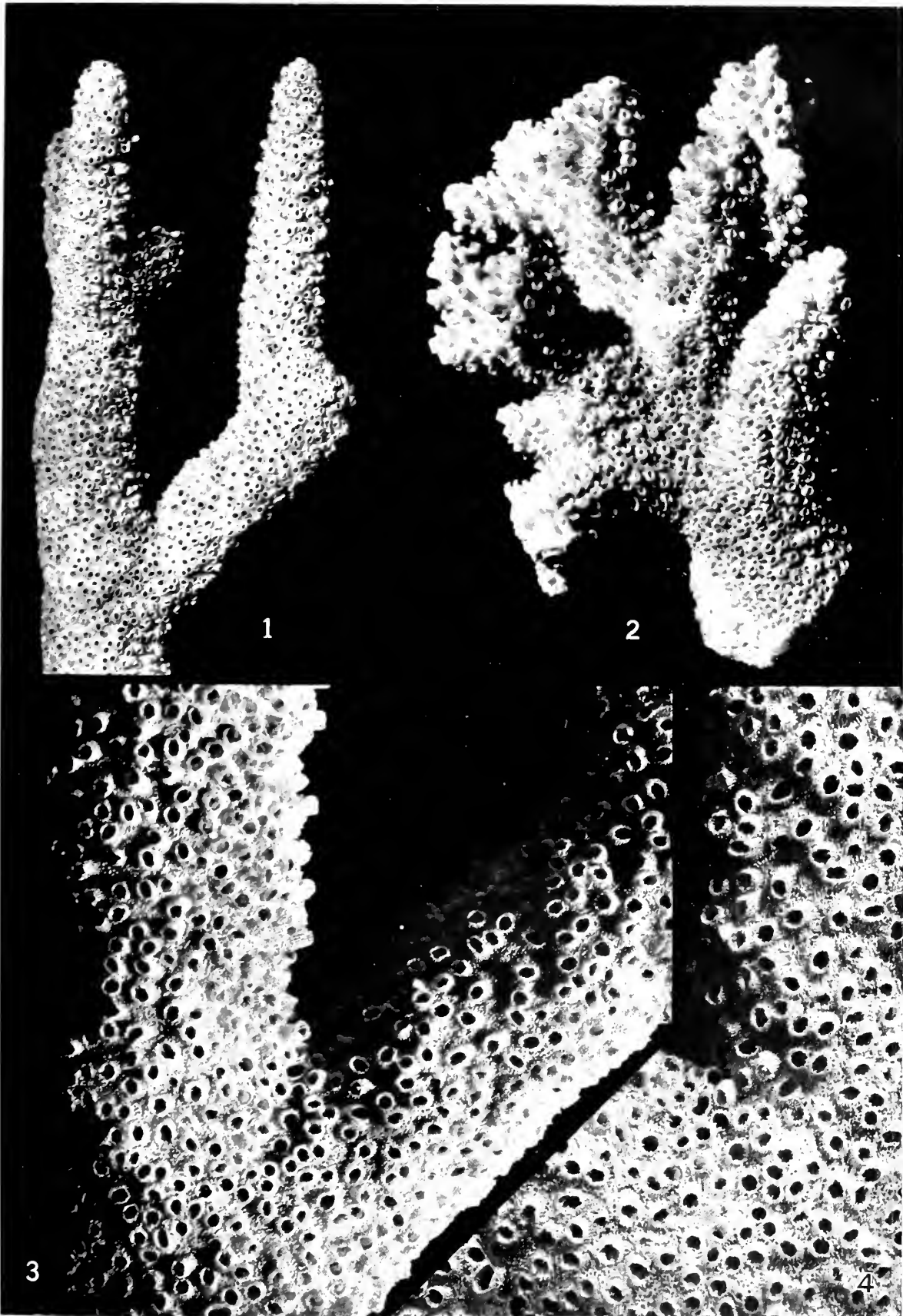
DESCRIPTION OF PLATE XXXI.

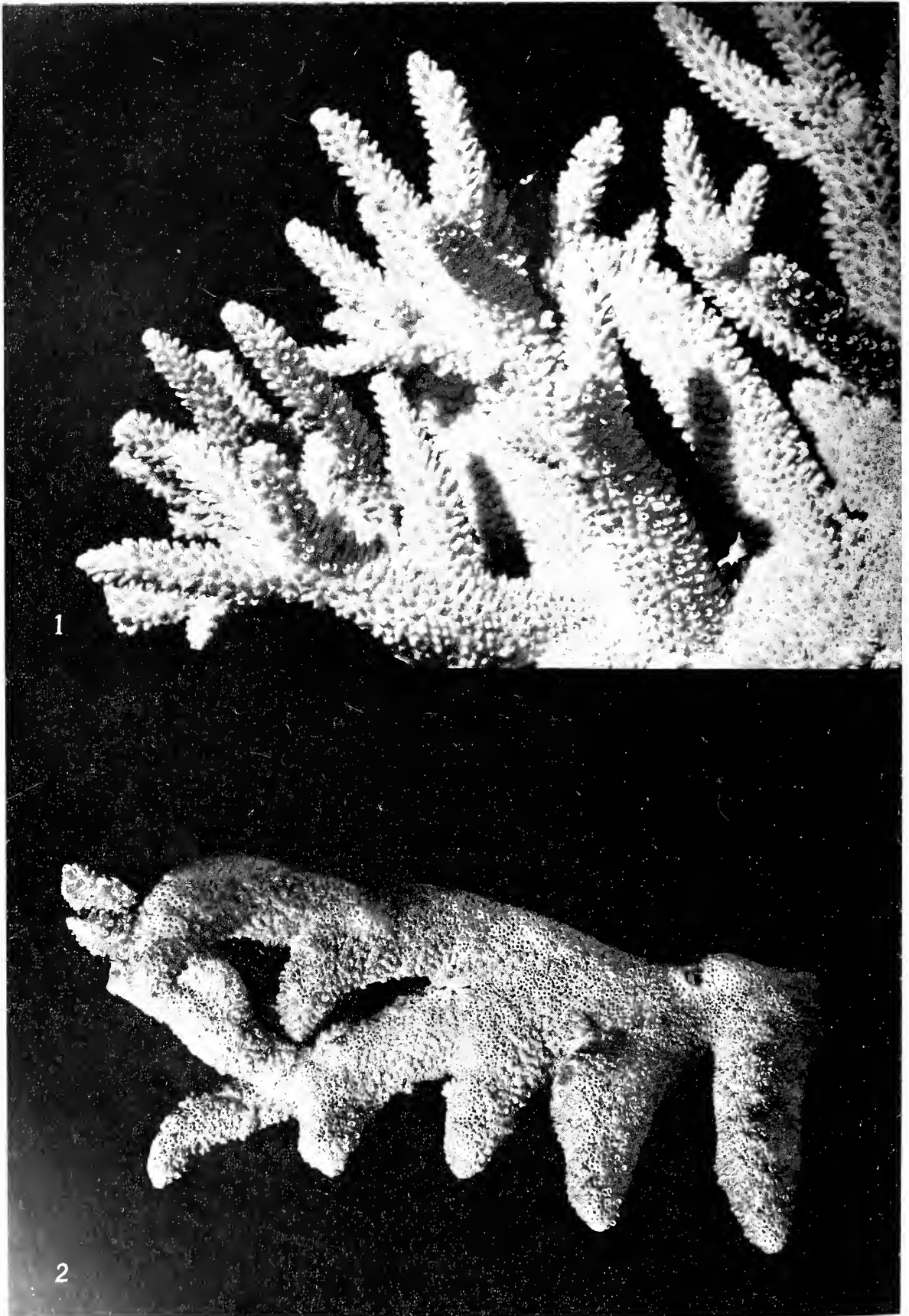
FIG. 1.—*Acropora grandis* (Brook). × 1.
G.B.R.E. No. 266.

FIG. 2.—*Acropora pacifica* (Brook). × 1.
G.B.R.E. No. 345.

FIG. 3.—*Acropora grandis* (Brook). × 3.
G.B.R.E. No. 266.

FIG. 4.—*Acropora grandis* (Brook). × 3.
G.B.R.E. No. 266.





DESCRIPTION OF PLATE XXXII.

FIG. 1.—*Acropora intermedia* (Brook). × 1.
G.B.R.E. No. 78.

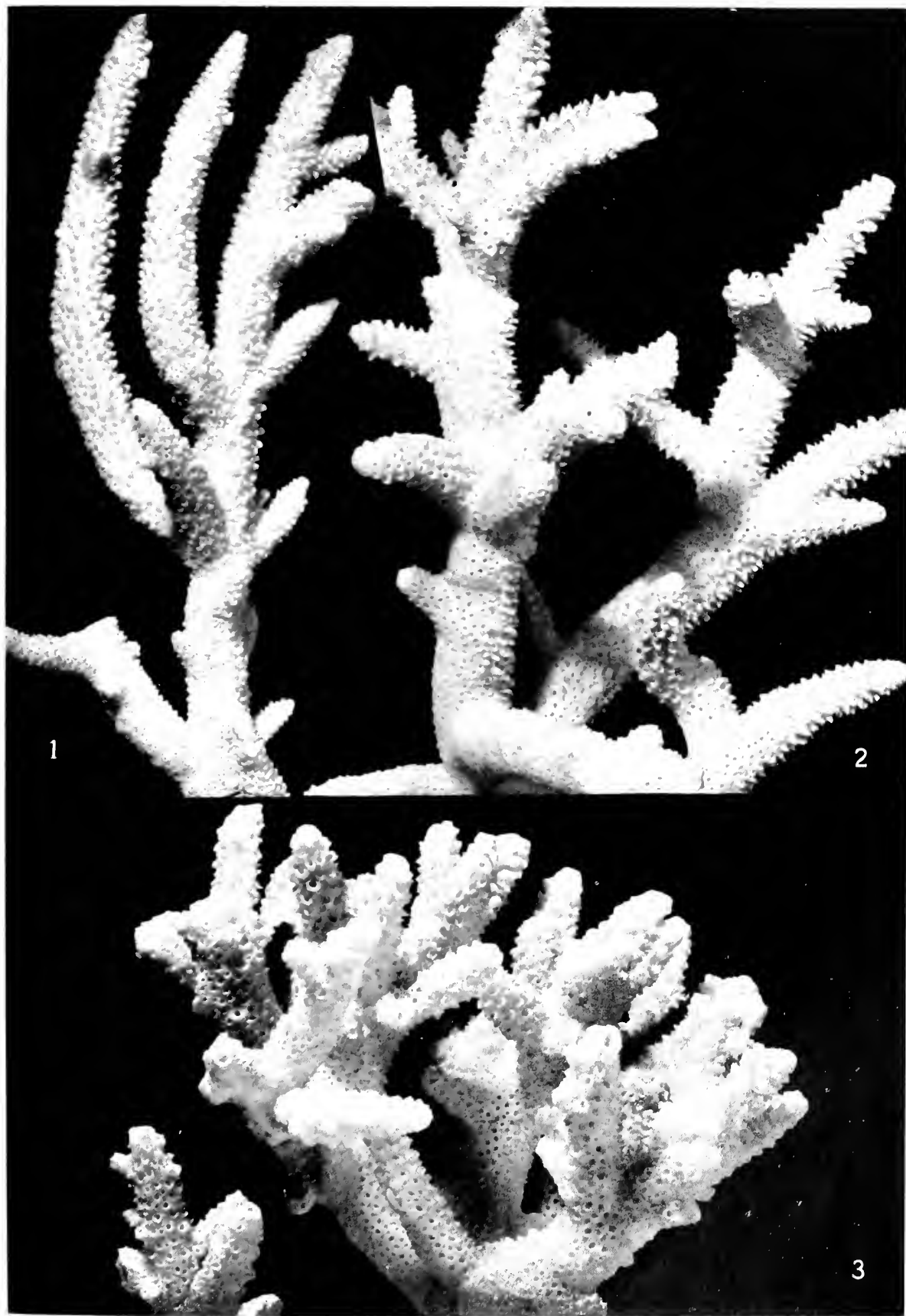
FIG. 2.—*Acropora pacifica* (Brook). × 5.
G.B.R.E. No. 270.

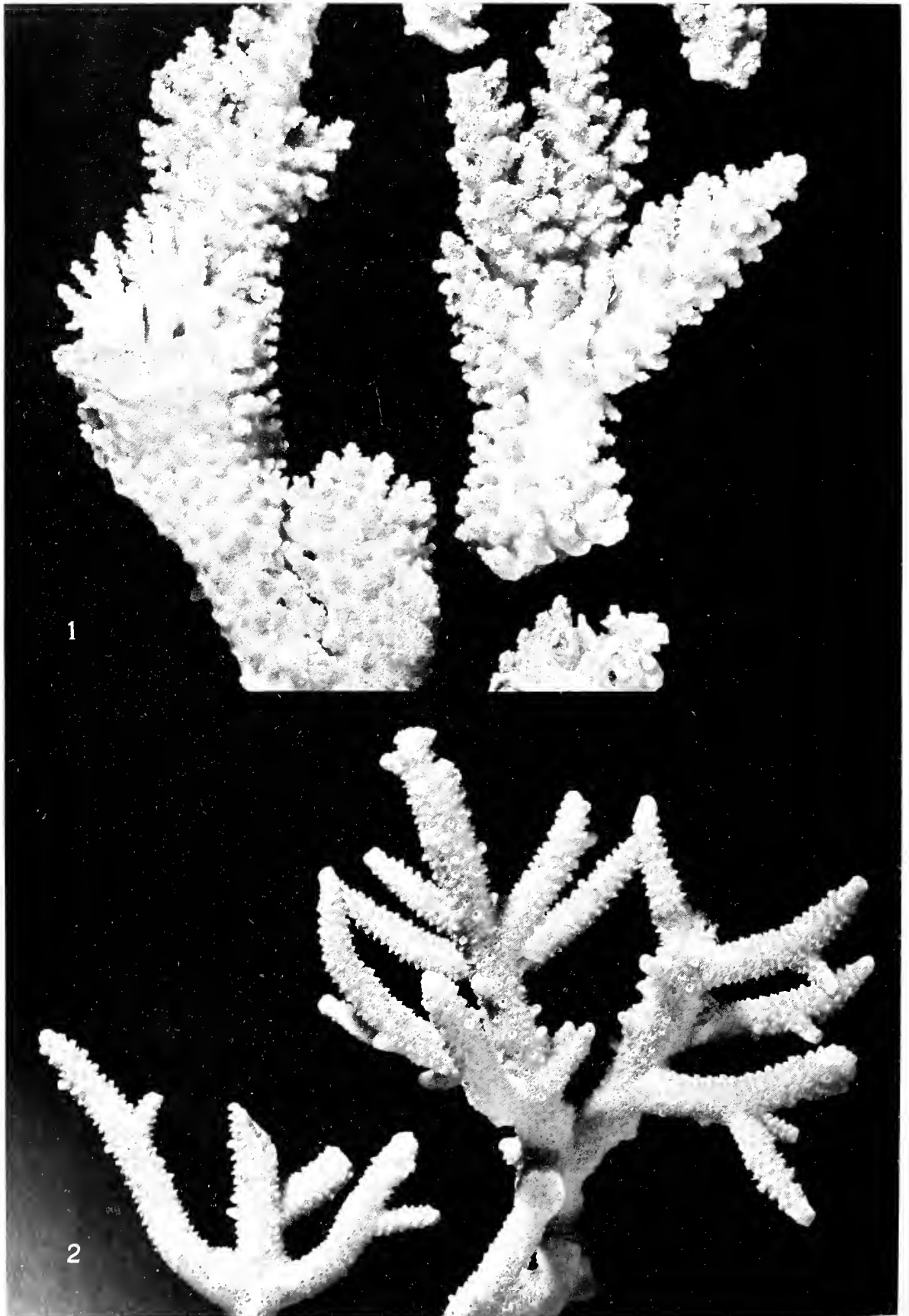
DESCRIPTION OF PLATE XXXIII.

FIG. 1.—*Acropora haimi* M. E. and H. × 1.
G.B.R.E. No. 234.

FIG. 2.—*Acropora aspera* (Dana). × 1.
G.B.R.E. No. 304.

FIG. 3.—*Acropora aspera* (Dana). × 1.1.
G.B.R.E. No. 285.





DESCRIPTION OF PLATE XXXIV.

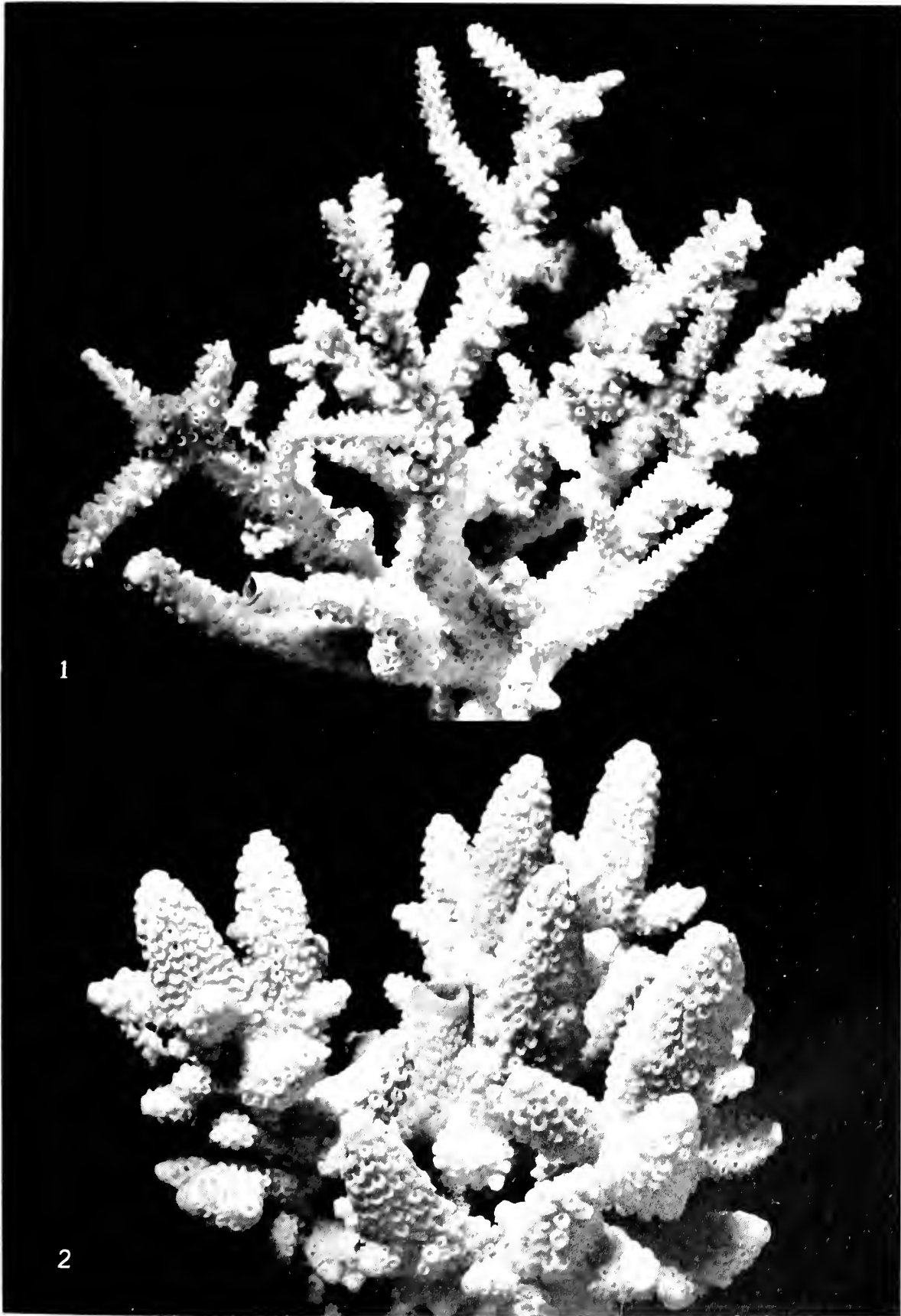
FIG. 1.—*Acropora affinis* (Brook). × 5.
G.B.R.E. No. 384.

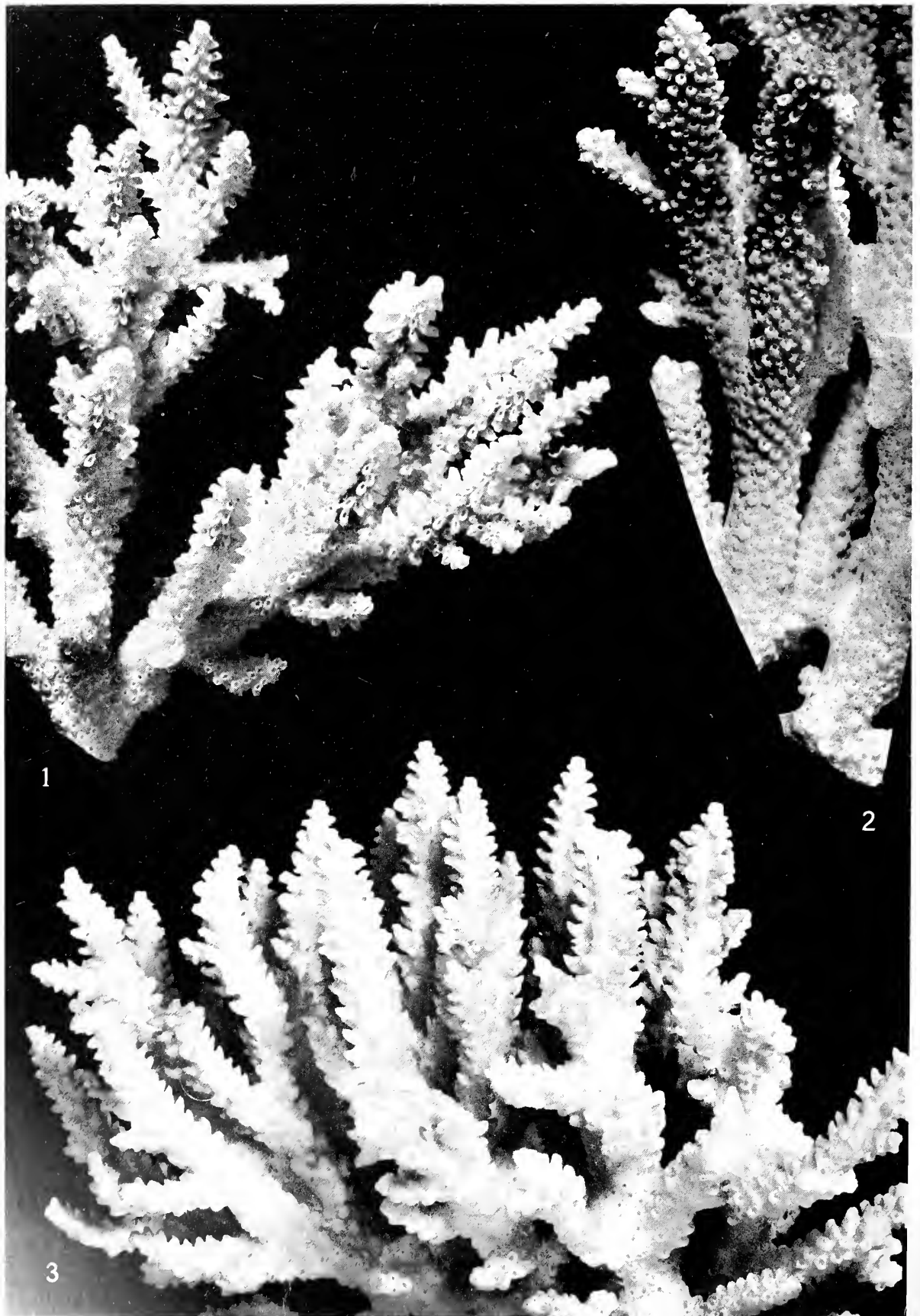
FIG. 2.—*Acropora pulchra* var. *stricta* (Brook). × 1.
G.B.R.E. No. 92.

DESCRIPTION OF PLATE XXXV.

FIG. 1.—*Acropora haimeii* M. E. and H. × 1.
G.B.R.E. No. 296.

FIG. 2.—*Acropora digitifera* (Dana). × 1.1.
G.B.R.E. No. 308.





DESCRIPTION OF PLATE XXXVI.

FIG. 1.—*Acropora quelehi* (Brook). × 1.
G.B.R.E. No. 279.

FIG. 2.—*Acropora quelehi* (Brook). × 1.
G.B.R.E. No. 284.

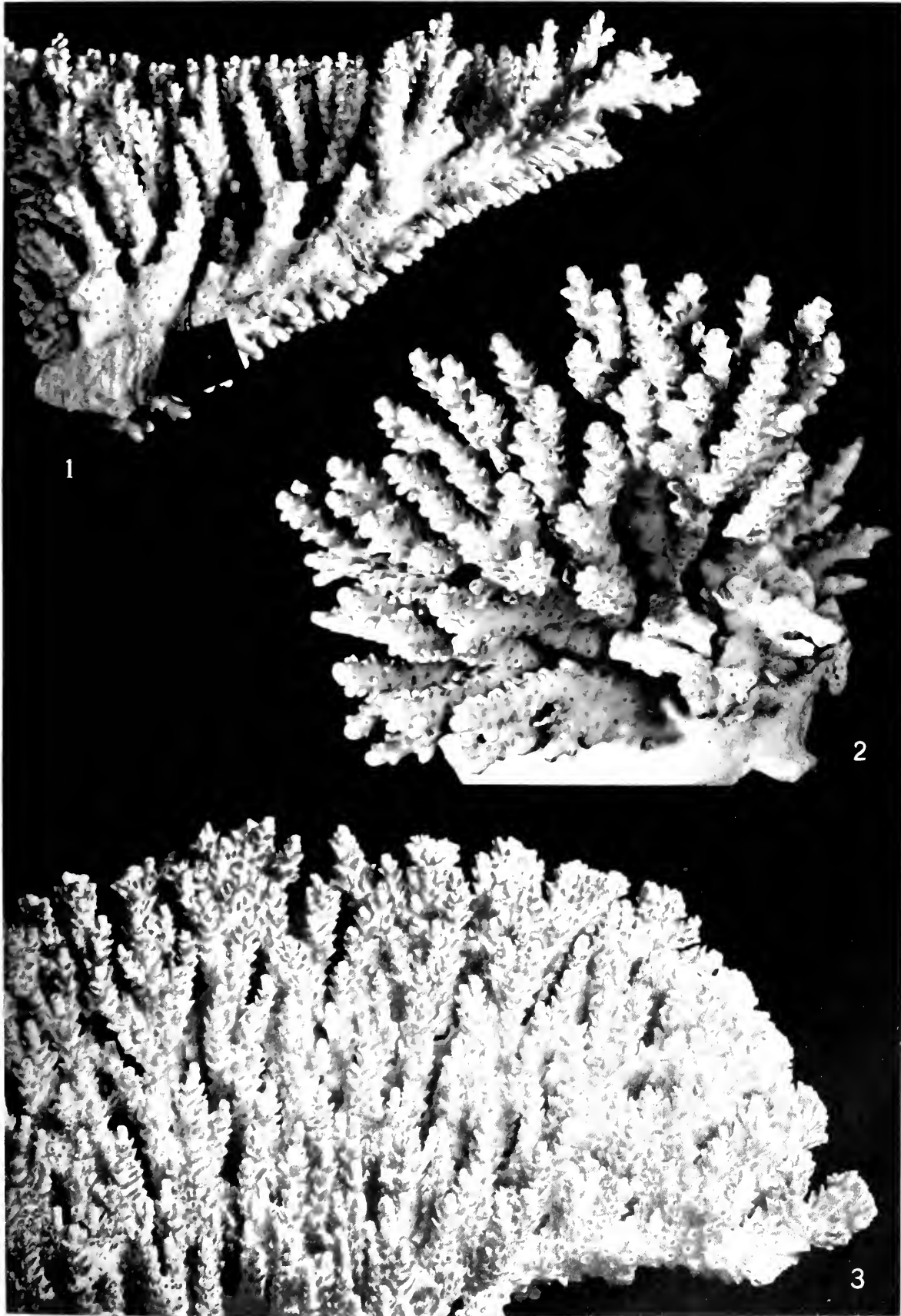
FIG. 3.—*Acropora quelehi* (Brook). × 1.
G.B.R.E. No. 272.

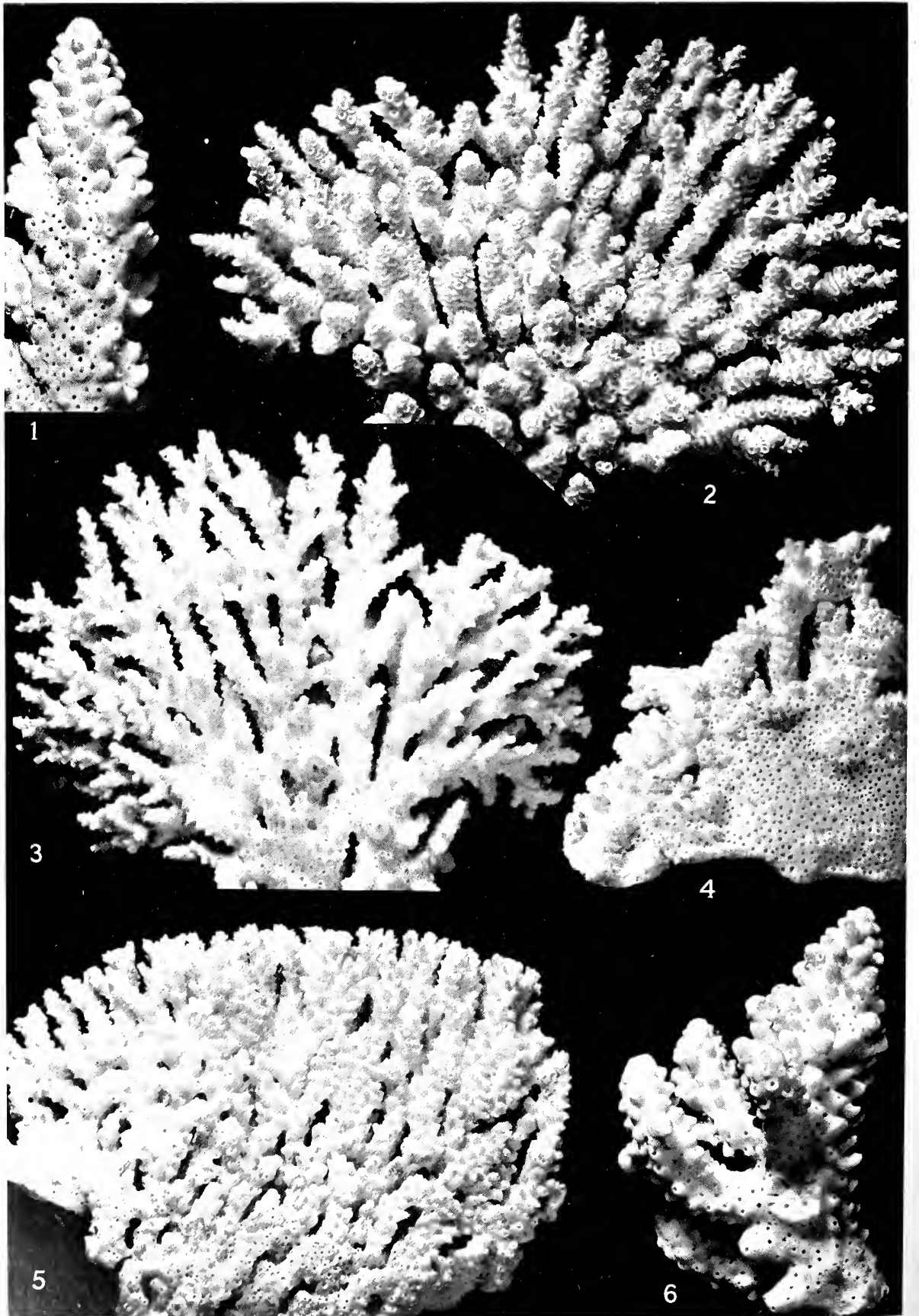
DESCRIPTION OF PLATE XXXVII.

FIG. 1.—*Acropora armata* (Brook). × 9.
G.B.R.E. No. 76.

FIG. 2.—*Acropora armata* Brook var. × 1.1.
G.B.R.E. No. 326.

FIG. 3.—*Acropora armata* (Brook). × 1.
G.B.R.E. No. 238.





DESCRIPTION OF PLATE XXXVIII.

FIG. 1.—*Acropora variabilis* var. *pachyclados* Klz. × 1.
G.B.R.E. No. 343.

FIG. 2.—*Acropora surculosa* (Dana). × ·9.
G.B.R.E. No. 287.

FIG. 3.—*Acropora surculosa* (Dana). Underside. × ·8.
G.B.R.E. No. 287.

FIG. 4.—*Acropora surculosa* (Dana). Underside. × ·8.
G.B.R.E. No. 339.

FIG. 5.—*Acropora surculosa* (Dana). Underside. × ·8.
G.B.R.E. No. 288.

FIG. 6.—*Acropora variabilis* var. *pachyclados* Klz. × 1.
G.B.R.E. No. 343.

DESCRIPTION OF PLATE XXXIX.

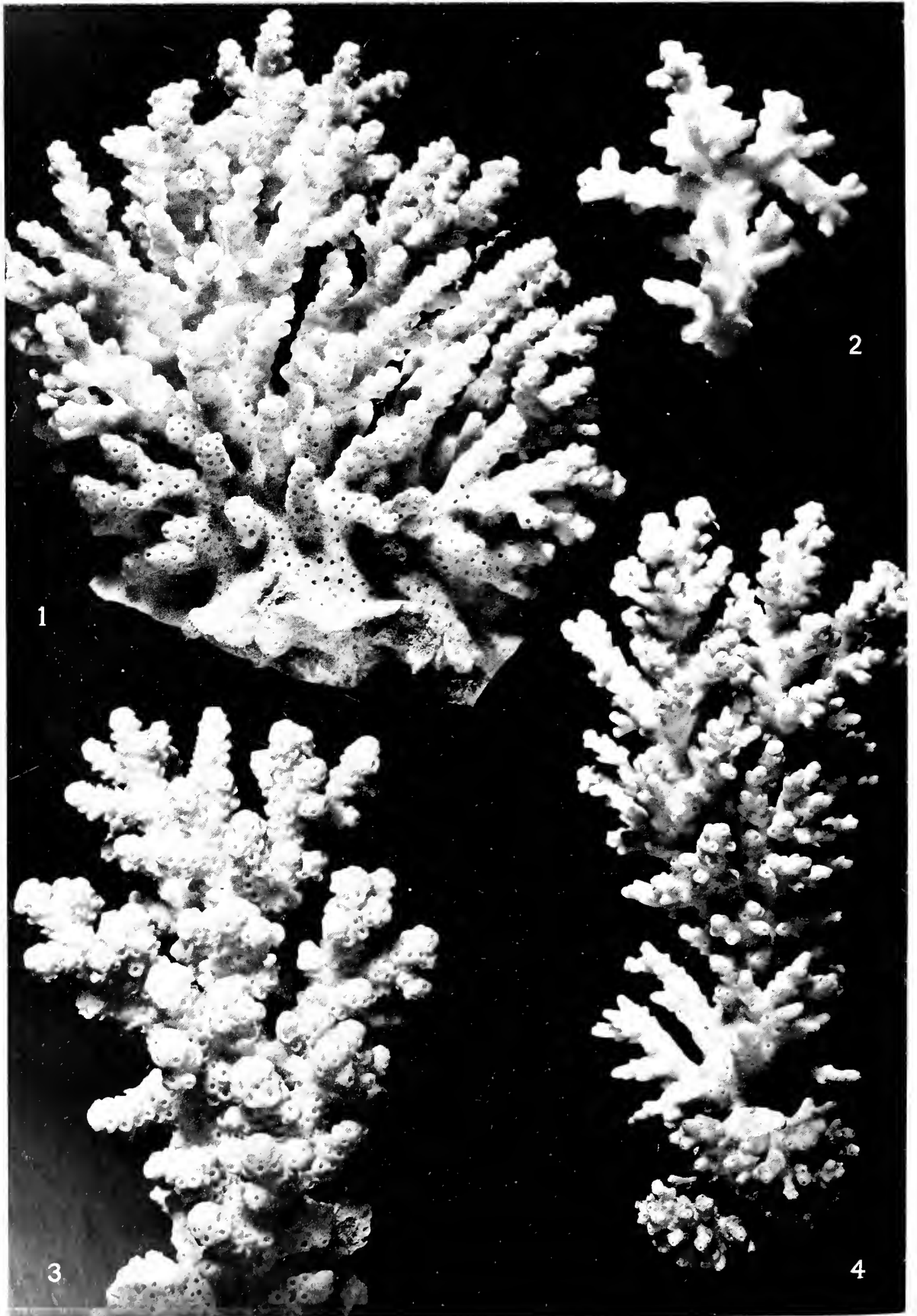
FIG. 1.—*Acropora glochiados* (Brook). × 1.1.
G.B.R.E. No. 64.

FIG. 2.—*Acropora glochiados* (Brook). × 5.
G.B.R.E. No. 64.

FIG. 3.—*Acropora exilis* (Brook). × 1.
G.B.R.E. No. 45.

FIG. 4.—*Acropora exilis* (Brook). × 1.
G.B.R.E. No. 199.





DESCRIPTION OF PLATE XL.

FIG. 1.—*Acropora rosaria* (Dana). Form II. $\times 1.1$.
G.B.R.E. No. 108.

FIG. 2.—*Acropora clavigera* (Brook). $\times 1$.
B.M. Reg. No. 1934.5.14.611.

FIG. 3.—*Acropora rosaria* (Dana). Form I. $\times 1$.
G.B.R.E. No. 310.

FIG. 4.—*Acropora rosaria* (Dana). Form III. $\times 1$.
G.B.R.E. No. 216.

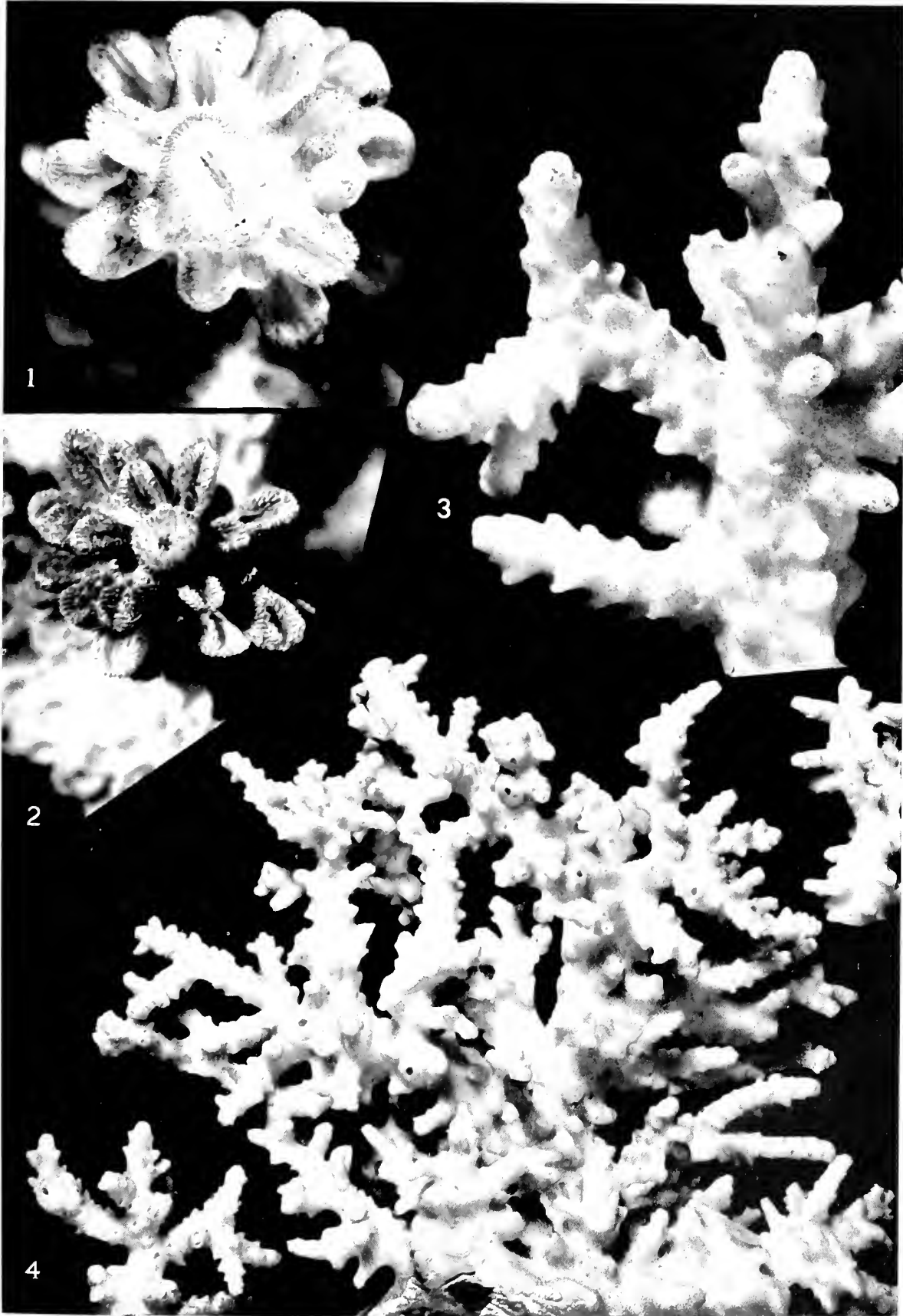
DESCRIPTION OF PLATE XLI.

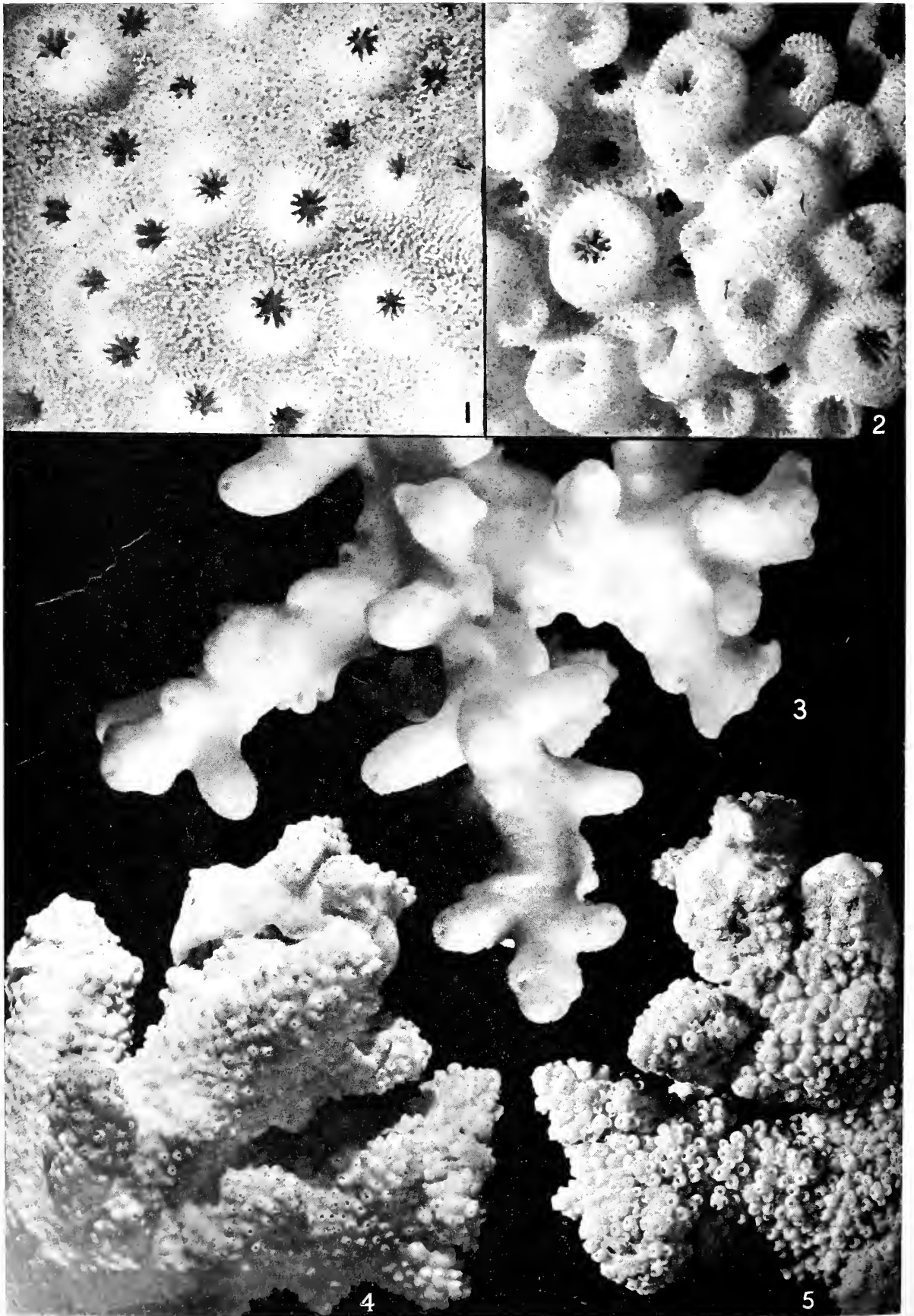
FIG. 1.—*Acropora lutkeni*, sp. n. × 7.
G.B.R.E. No. 271.

FIG. 2.—*Acropora brooki*, sp. n. × 5.5.
G.B.R.E. No. 290.

FIG. 3.—*Acropora cancellata* (Brook). × 3.
B.M. Reg. No. 1934.5.14.415.

FIG. 4.—*Acropora cancellata* (Brook). × 1.
B.M. Reg. No. 1934.5.14.415.





DESCRIPTION OF PLATE XLII.

FIG. 1.—*Acropora jeulini*, sp. n. × 9.
G.B.R.E. No. 330.

FIG. 2.—*Acropora jeulini*, sp. n. × 9.
G.B.R.E. No. 330.

FIG. 3.—*Acropora clavigera* (Brook). × 3.
B.M. Reg. No. 1934.5.14.611.

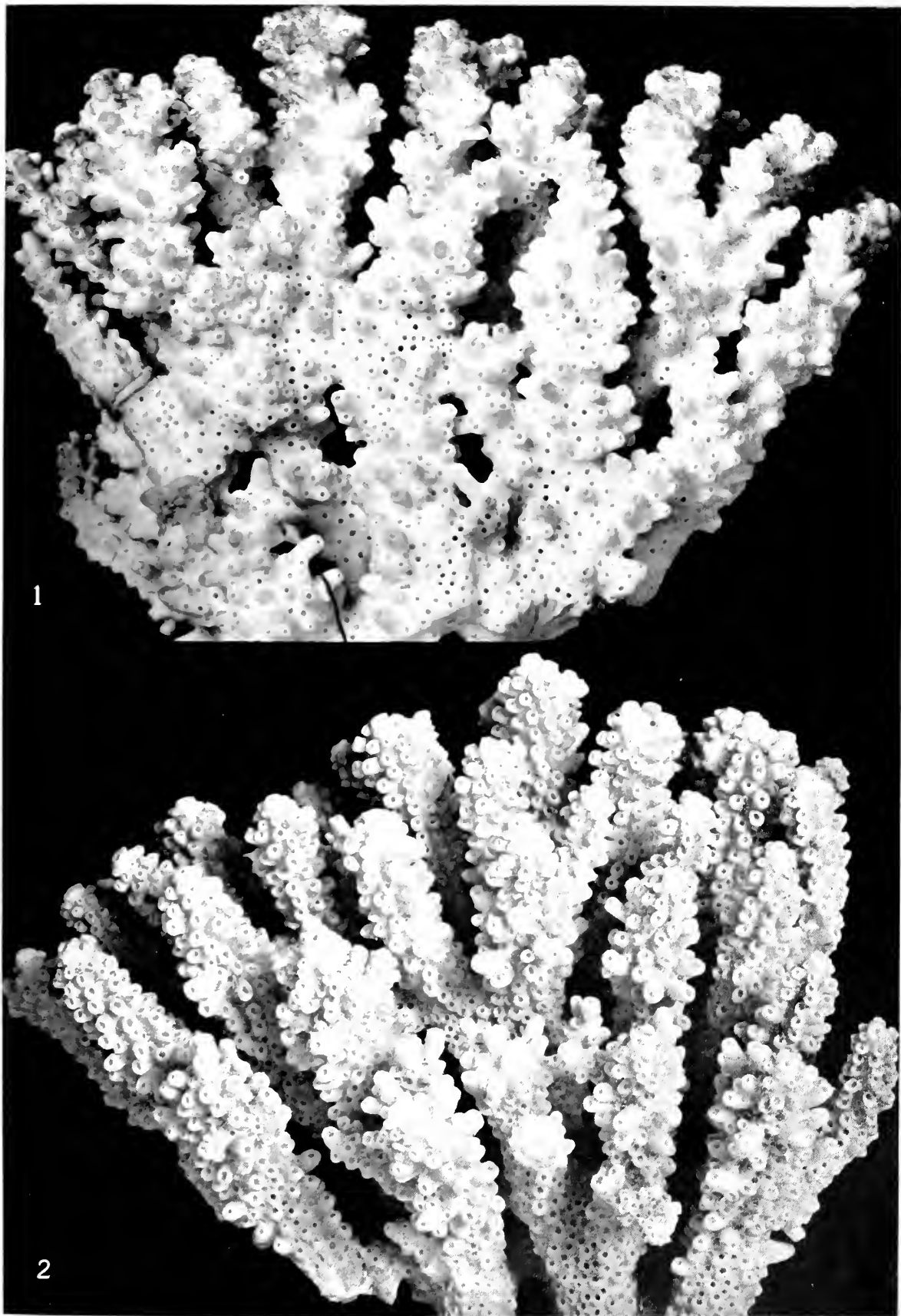
FIG. 4.—*Acropora jeulini*, sp. n. Underside. × 1.
G.B.R.E. No. 330.

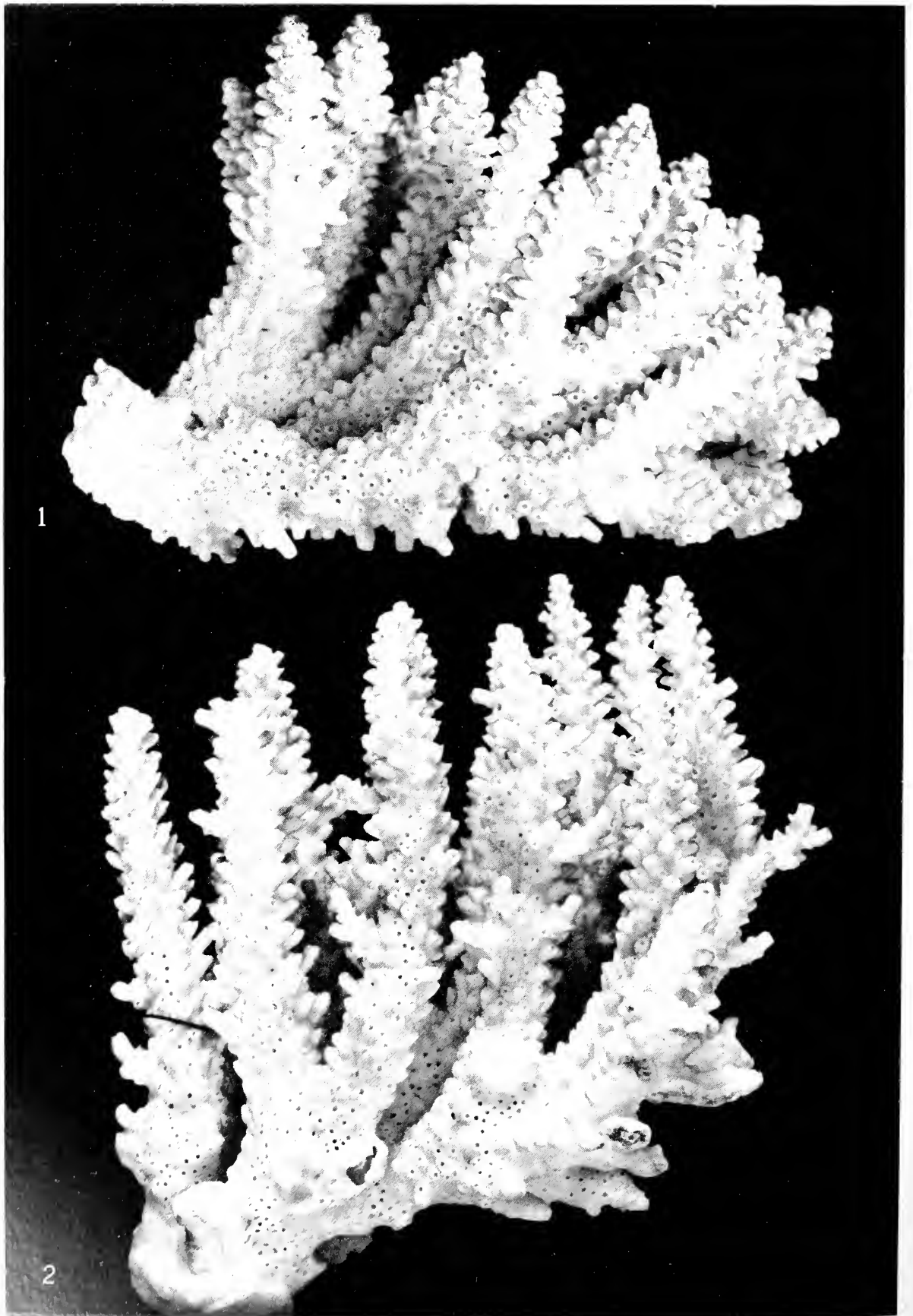
FIG. 5.—*Acropora jeulini*, sp. n. Upper surface. × 1.
G.B.R.E. No. 330.

DESCRIPTION OF PLATE XLIII.

FIG. 1.—*Acropora otteri*, sp. n. Holotype. Underside. × 1.
G.B.R.E. No. 338.

FIG. 2.—*Acropora otteri*, sp. n. Holotype. Upper surface. × 1.
G.B.R.E. No. 338.





[Adlard & Son, Ltd., Imp.]



DESCRIPTION OF PLATE XLIV.

FIG. 1.—*Acropora otteri*, sp. n. Paratype. × 1.
G.B.R.E. No. 306.

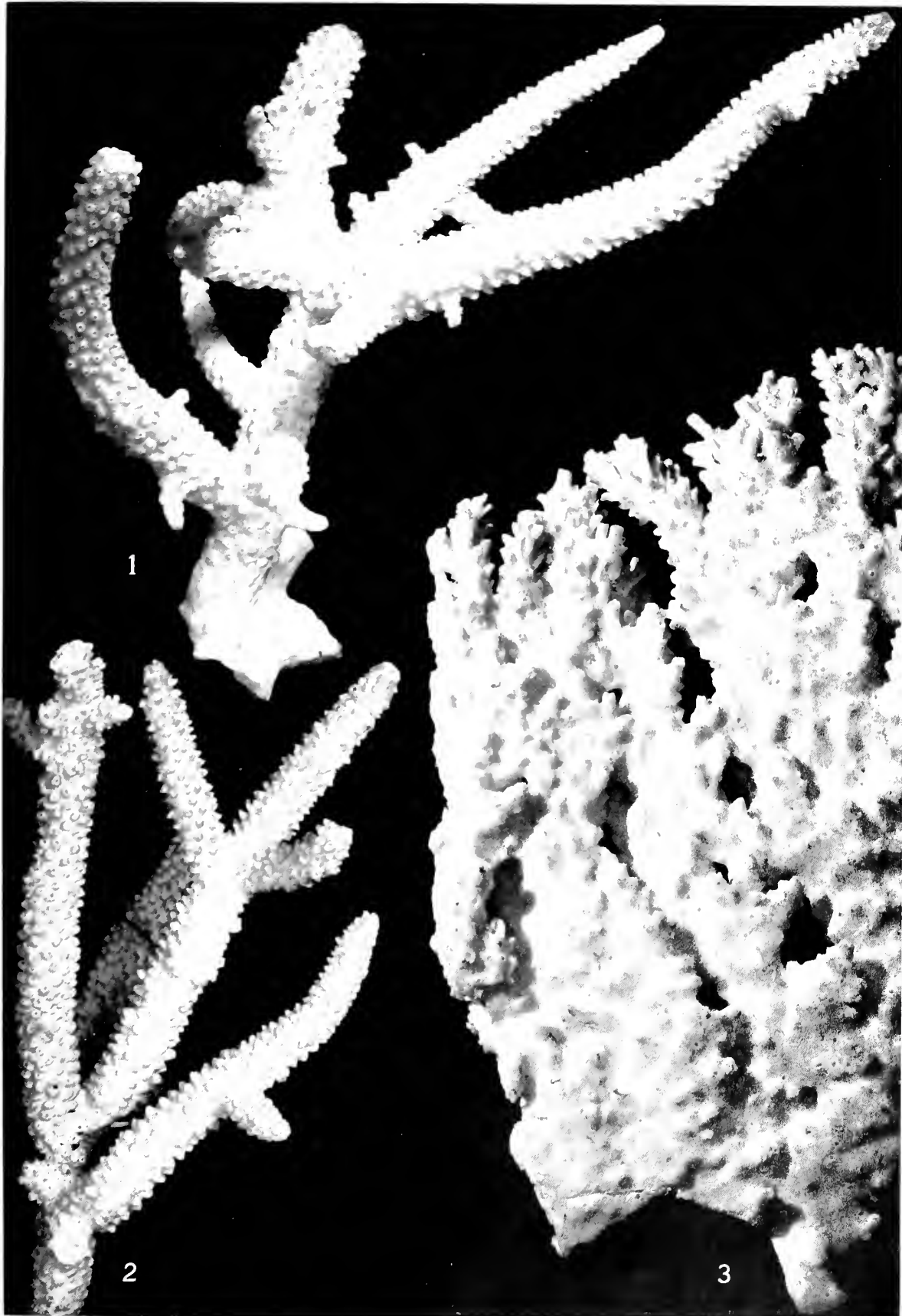
FIG. 2.—*Acropora otteri*, sp. n. Paratype. × 1.
G.B.R.E. No. 60.

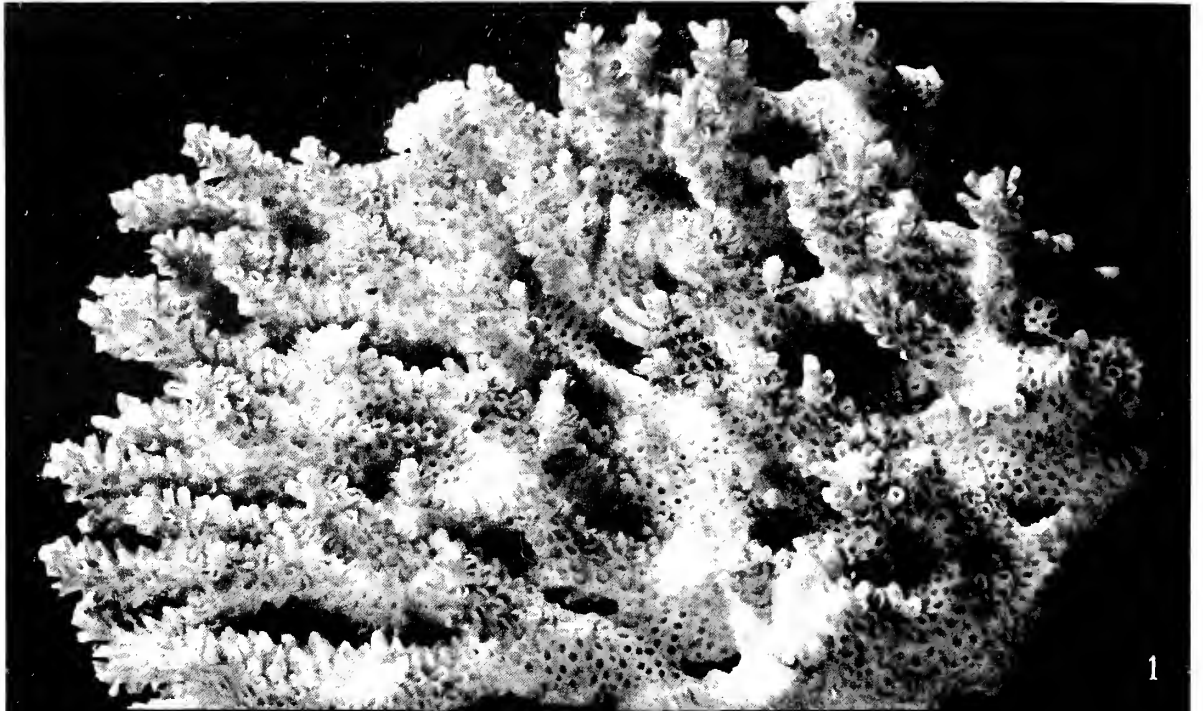
DESCRIPTION OF PLATE XLV.

FIG. 1.—*Acropora laevis*, sp. n. × 1.
G.B.R.E. No. 79.

FIG. 2.—*Acropora laevis*, sp. n. × 1.
G.B.R.E. No. 93.

FIG. 3.—*Acropora brooki*, sp. n. Underside. × 1·2.
G.B.R.E. No. 290.





DESCRIPTION OF PLATE XLVI.

FIG. 1.—*Acropora brooki*, sp. n. Upper surface. $\times 1.1$.
G.B.R.E. No. 290.

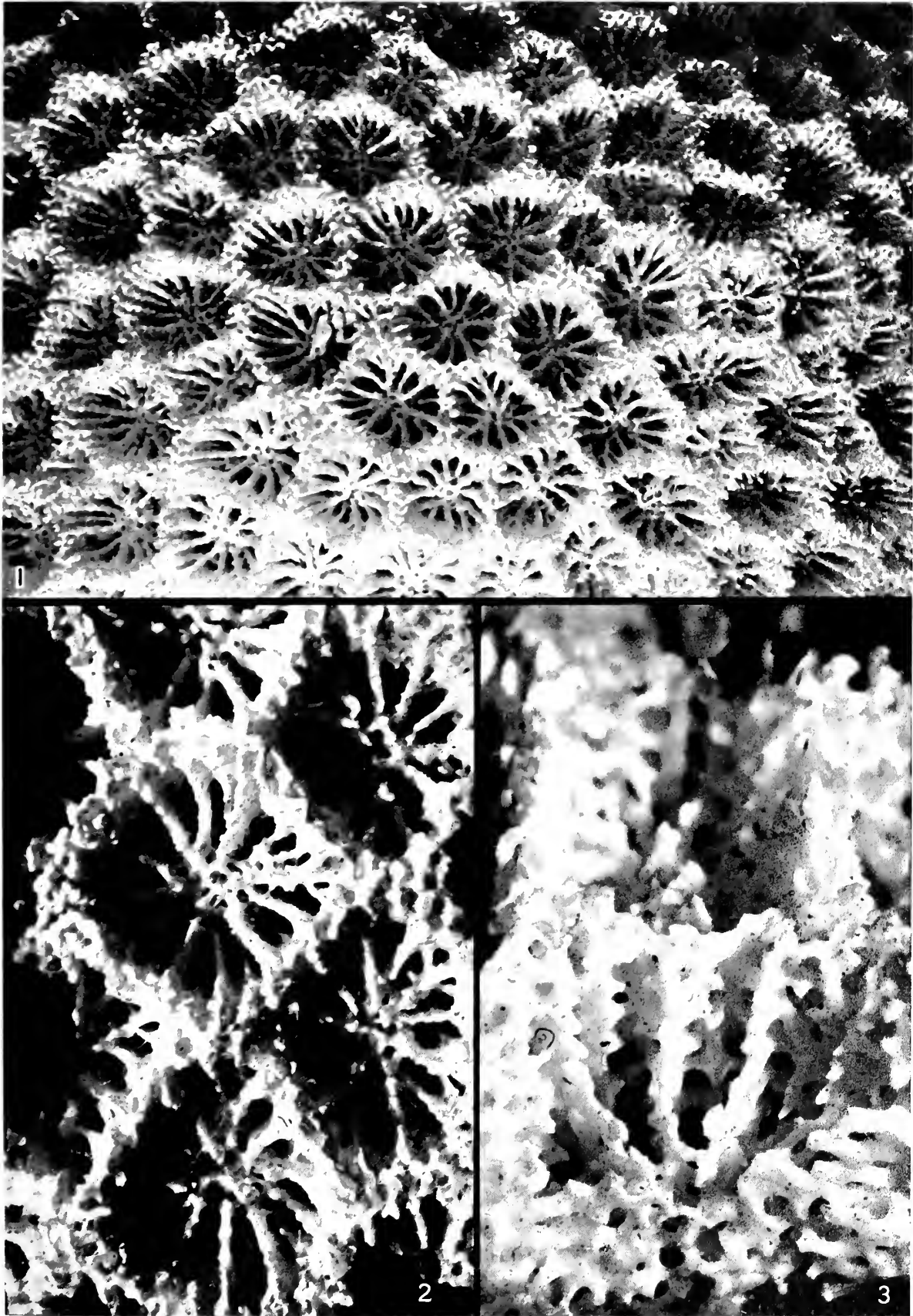
FIG. 2.—*Acropora tulkeni*, sp. n. $\times 1$.
G.B.R.E. No. 271.

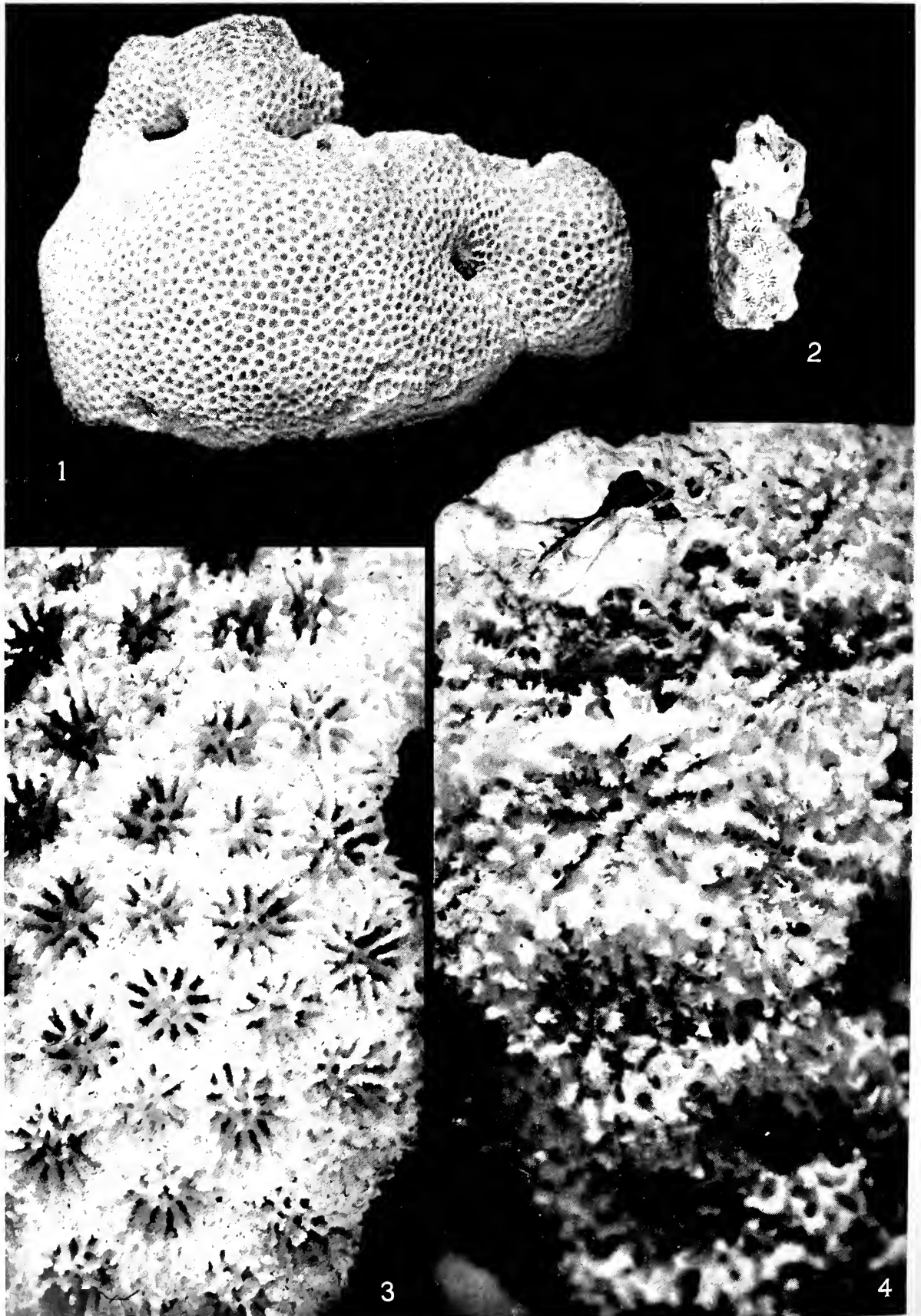
DESCRIPTION OF PLATE XLVII.

FIG. 1.—*Goniopora lobata* M. E. and H., Bedot. × 4.
G.B.R.E. No. P37.

FIG. 2.—*Goniopora lobata* M. E. and H., Bedot. × 10.
G.B.R.E. No. P37.

FIG. 3.—*Goniopora lobata* M. E. and H., Bedot. × 18.
G.B.R.E. No. P37.





DESCRIPTION OF PLATE XLVIII.

- FIG. 1.—*Goniopora minor*, nom. n. × 1.
G.B.R.E. No. 56.
- FIG. 2.—*Goniopora hirsuta*, sp. n. × 2.
B.M. Reg. No. 1934.5.14.424.
- FIG. 3.—*Goniopora minor*, nom. n. × 10.
G.B.R.E. No. 56.
- FIG. 4.—*Goniopora hirsuta*, sp. n. × 18.
B.M. Reg. No. 1934.5.14.424.

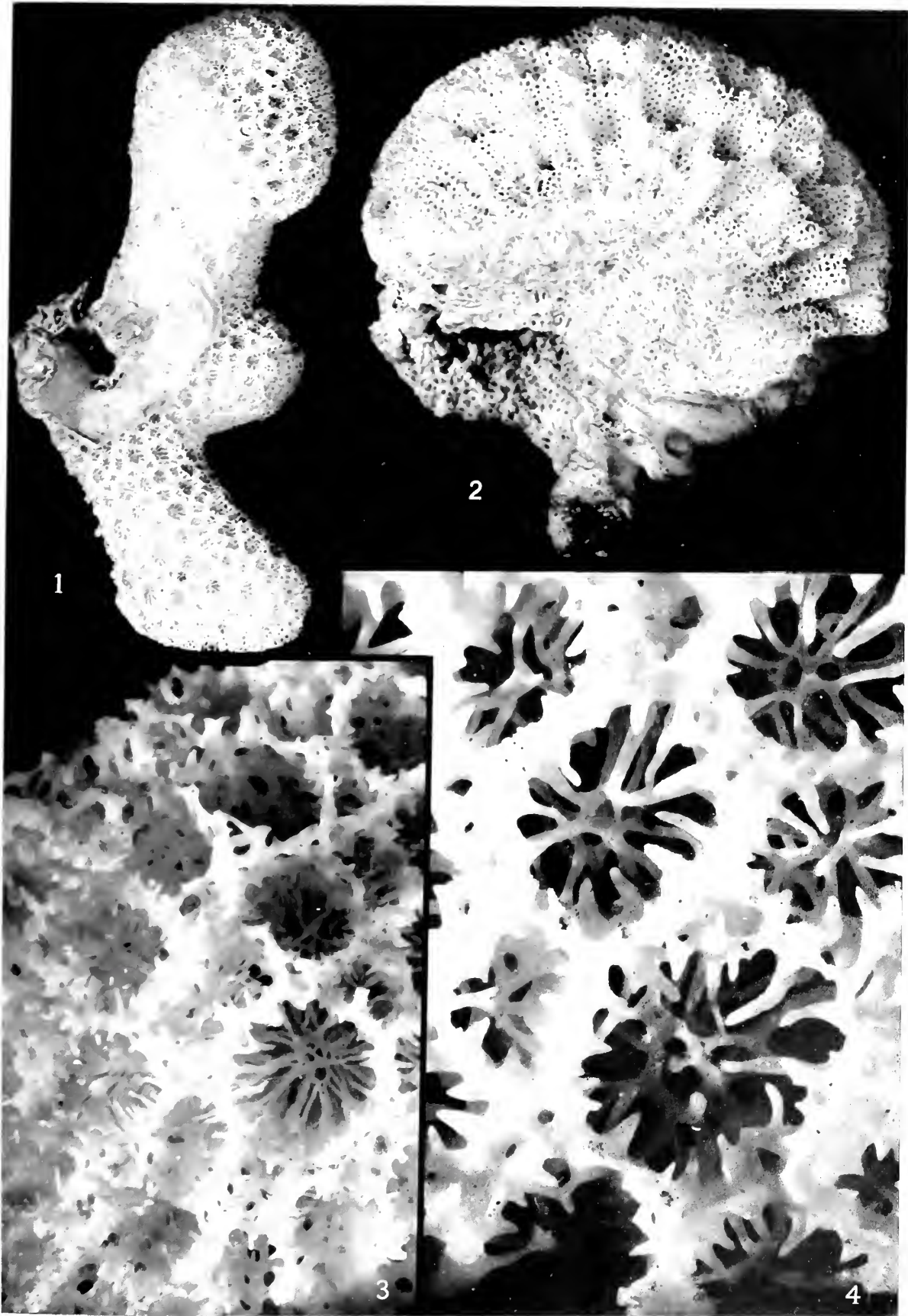
DESCRIPTION OF PLATE XLIX.

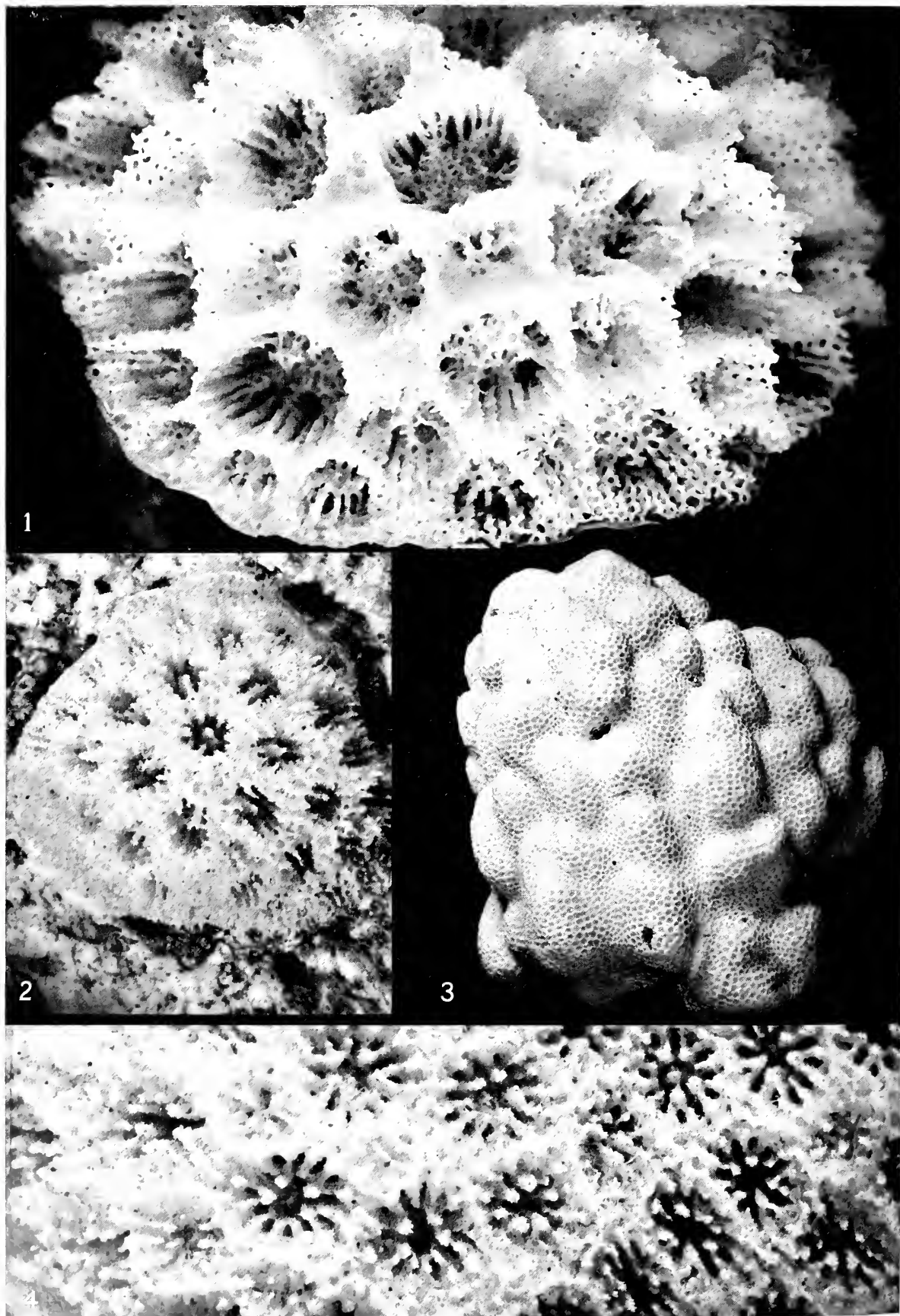
FIG. 1.—*Alveopora mortenseni*, n. sp. × 1.5.
B.M. Reg. No. 1934.5.14.411.

FIG. 2.—*Alveopora irregularis*, sp. n. × 3.
B.M. Reg. No. 1934.5.14.607.

FIG. 3.—*Alveopora mortenseni*, sp. n. × 8.
B.M. Reg. No. 1934.5.14.411.

FIG. 4.—*Alveopora mortenseni*, sp. n. × 16.
B.M. Reg. No. 1934.5.14.411.





DESCRIPTION OF PLATE L.

FIG. 1.—*Alveopora irregularis*, sp. n. × 6.
B.M. Reg. No. 1934.5.14.607.

FIG. 2.—*Stylaraca punctata* Klz. × 7.
B.M. Reg. No. 1934.5.14.387.

FIG. 3.—*Porites stephensoni*, sp. n. × 1.
B.M. Reg. No. 1934.5.14.377.

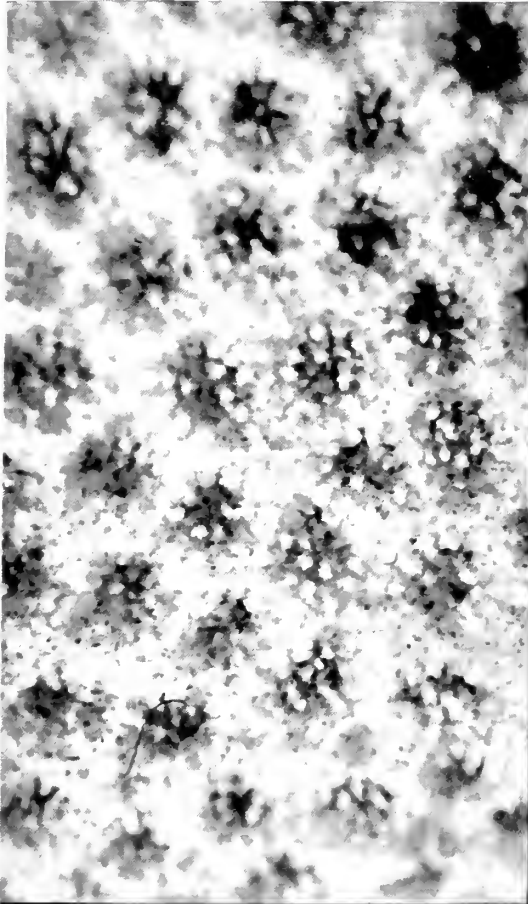
FIG. 4.—*Porites stephensoni*, sp. n. × 18.
B.M. Reg. No. 1934.5.14.377.

DESCRIPTION OF PLATE LI.

FIG. 1.—*Porites lanuginosa* Studer. × 13.
B.M. Reg. No. 1934.5.14.423.

FIG. 2.—*Porites suppressa*, sp. n. × 1.
B.M. Reg. No. 1934.5.14.371.

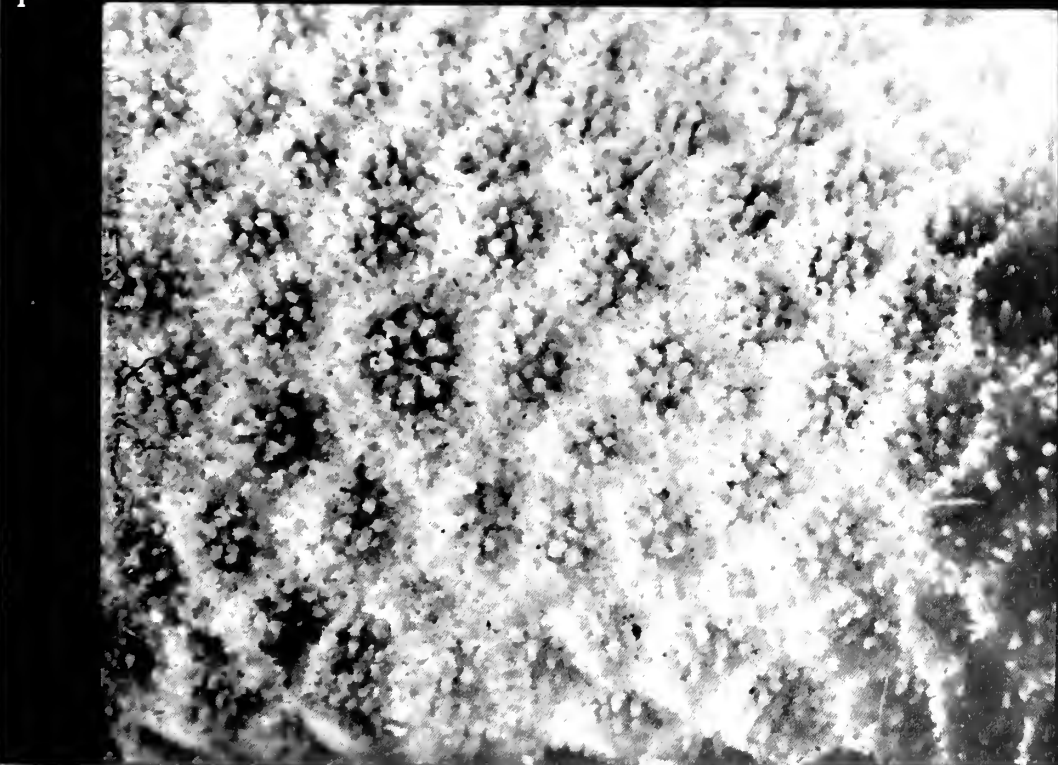
FIG. 3.—*Porites suppressa*, sp. n. × 13.
B.M. Reg. No. 1934.5.14.371.



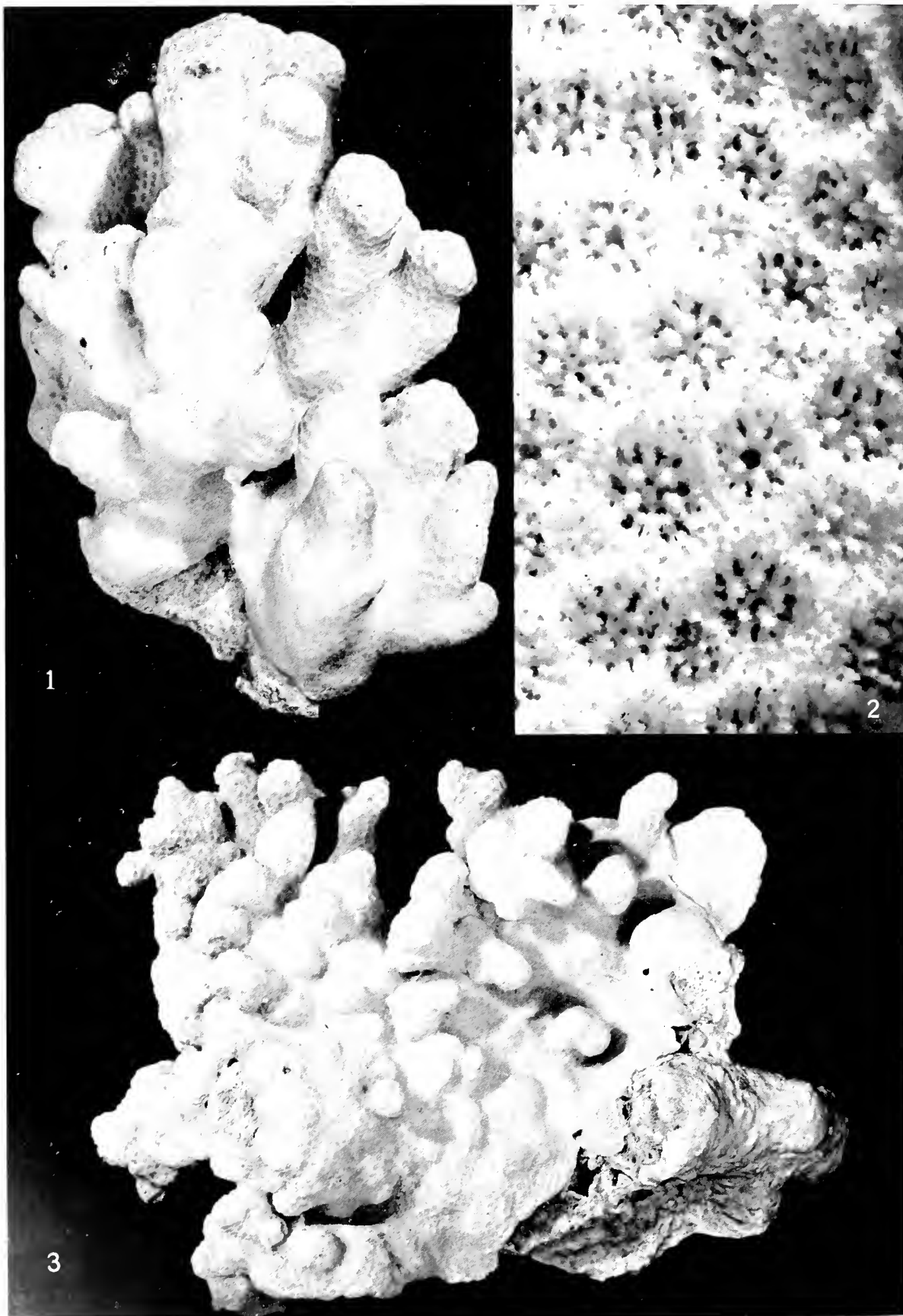
1



2



3



DESCRIPTION OF PLATE LII.

FIG. 1.—*Porites annae*, nom. nov. × 1·5.
G.B.R.E. No. 15.

FIG. 2.—*Porites annae*, nom. nov. × 17.
G.B.R.E. No. 15.

FIG. 3.—*Porites annae*, nom. nov. × 1.
G.B.R.E. No. 4.

DESCRIPTION OF PLATE LIII.

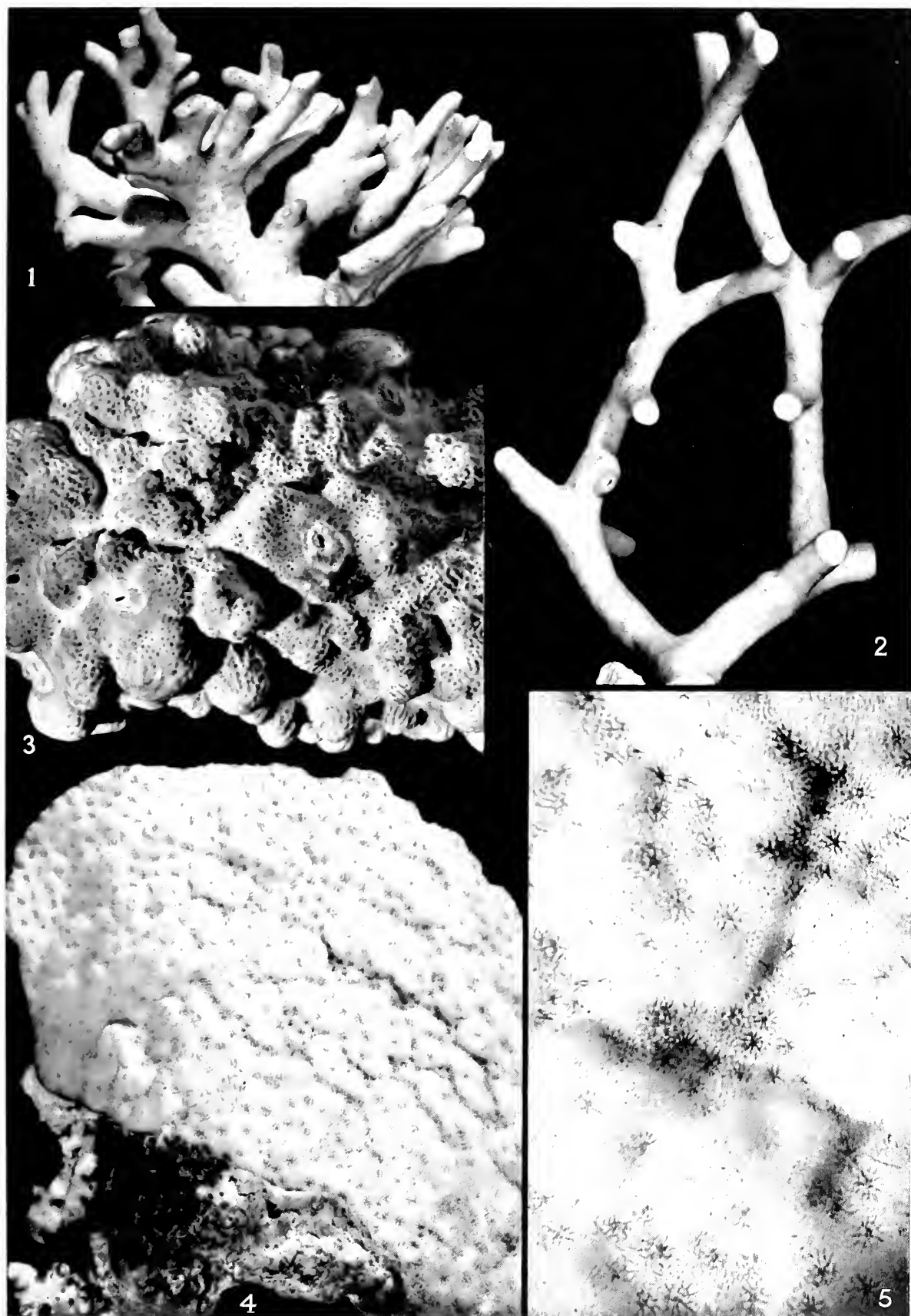
FIG. 1.—*Millepora tortuosa* Dana. × 1.
G.B.R.E. No. 96.

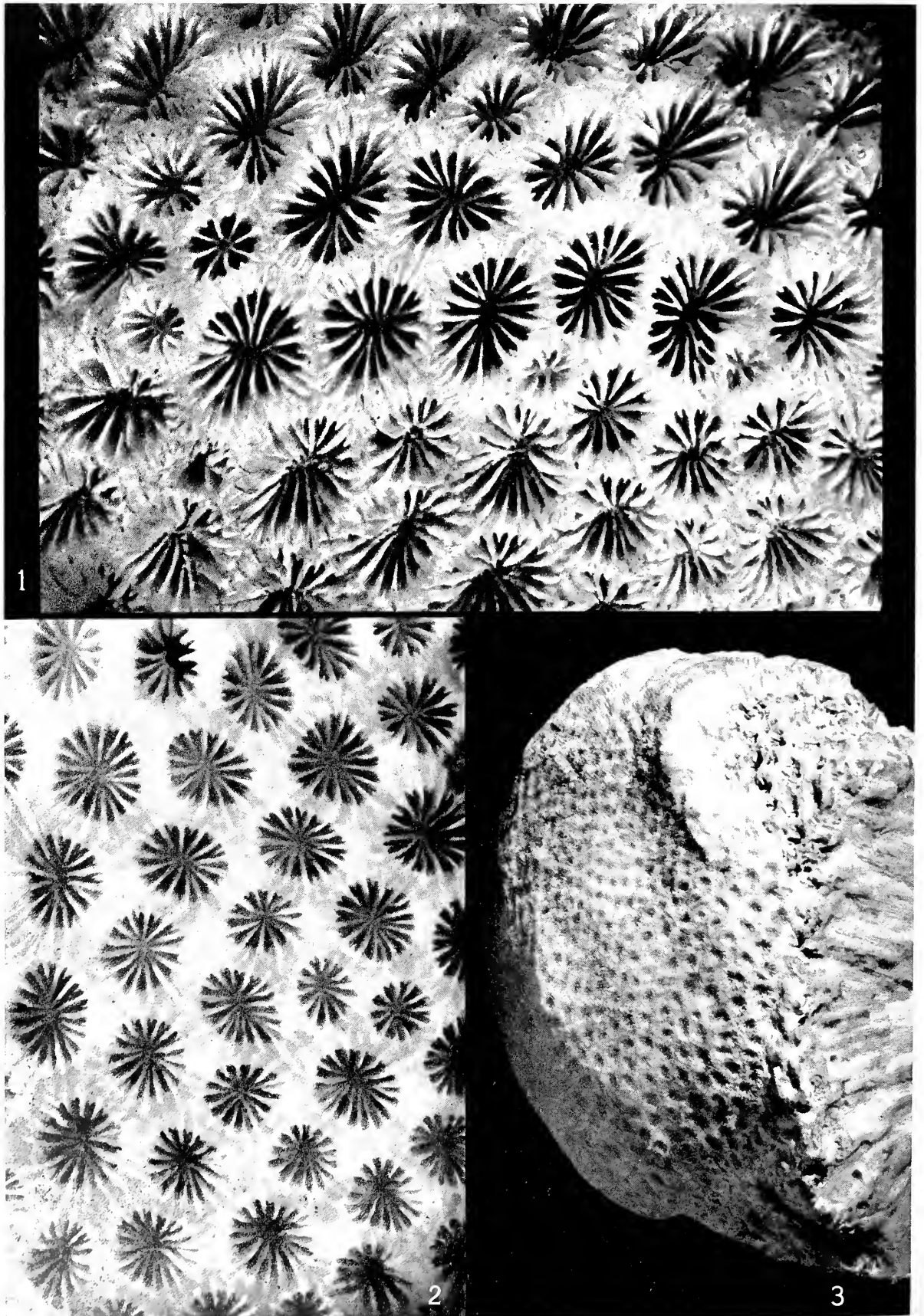
FIG. 2.—*Millepora tortuosa* Dana. × 1.
B.M. Reg. No. 1934.5.14.427.

FIG. 3.—*Millepora foveolata*, sp. n. × 2.
G.B.R.E. No. P20.

FIG. 4.—*Porites (Synaraea) vaughani*, sp. n. × 2.
B.M. Reg. No. 1934.5.14.491A.

FIG. 5.—*Porites (Synaraea) vaughani*, sp. n. × 6.5.
B.M. Reg. No. 1934.5.14.491A.





DESCRIPTION OF PLATE LIV.

FIG. 1.—*Leptastrea transversa* Klz. × 4.5.
G.B.R.E. No. 227.

FIG. 2.—*Leptastrea transversa* Klz. × 4.5.
G.B.R.E. No. 227.

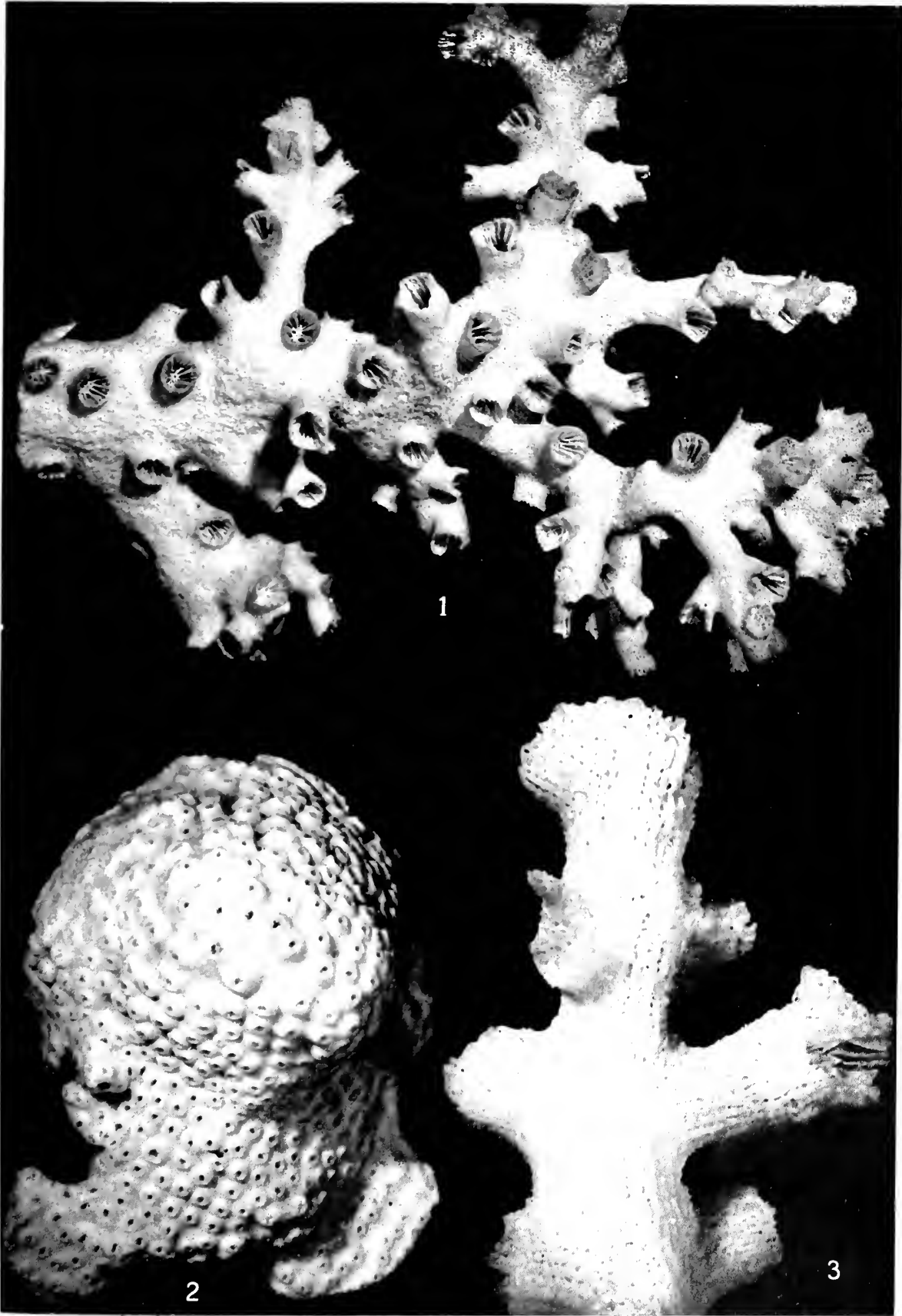
FIG. 3.—*Leptastrea transversa* Klz. × 1.
G.B.R.E. No. 227.

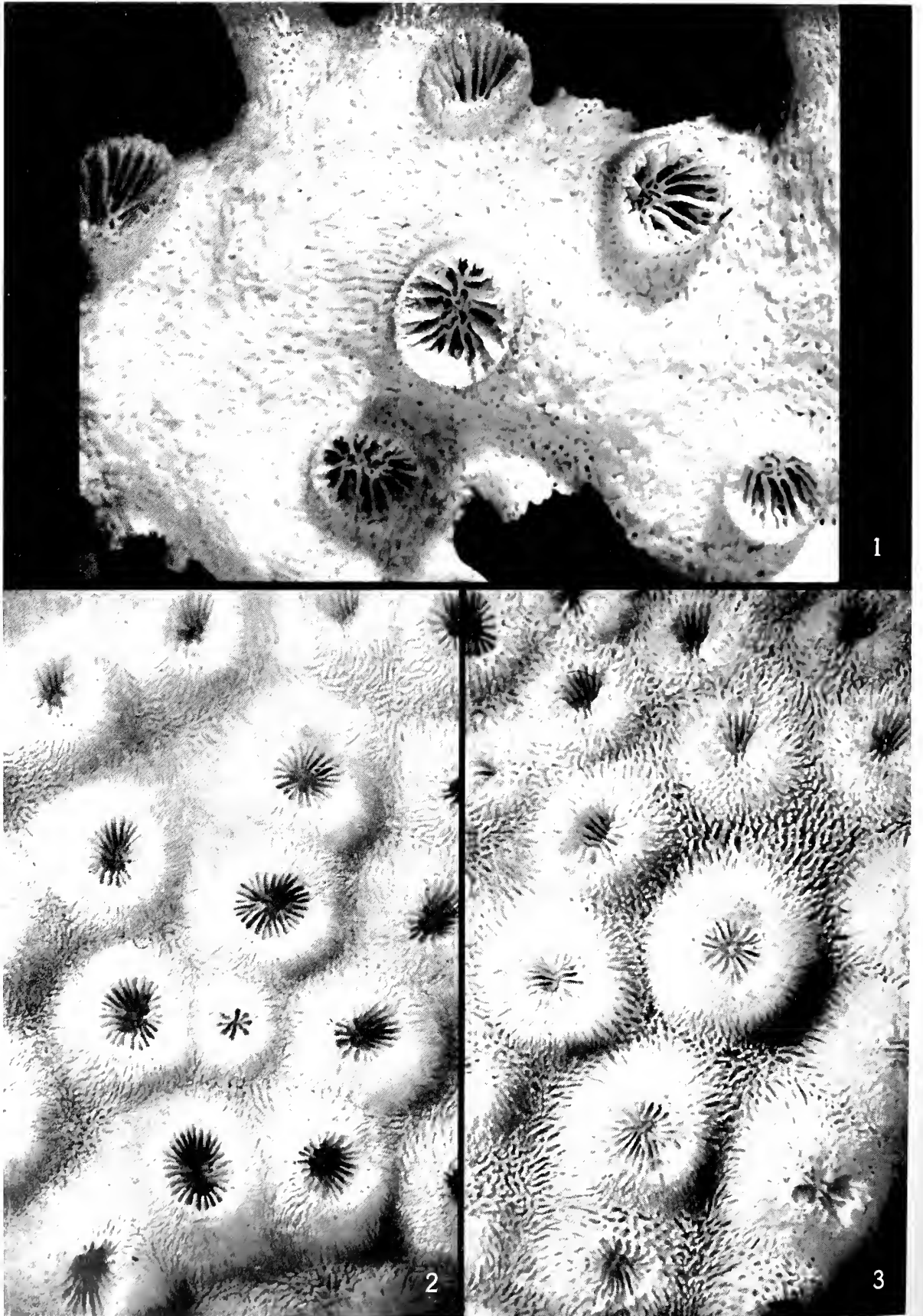
DESCRIPTION OF PLATE LV.

FIG. 1.—*Dendrophyllia micranthus* var. *grandis* var. n. × 1.
G.B.R.E. No. 75.

FIG. 2.—*Turbinaria stephensoni*, sp. n. × 1.
G.B.R.E. No. 449.

FIG. 3.—*Dendrophyllia velata*, sp. n. × 6.2.
B.M. Reg. No. 1934.5.14.390.





DESCRIPTION OF PLATE LVI.

FIG. 1.—*Dendrophyllia micranthus* var. *grandis* var. n. × 3.
G.B.R.E. No. 75.

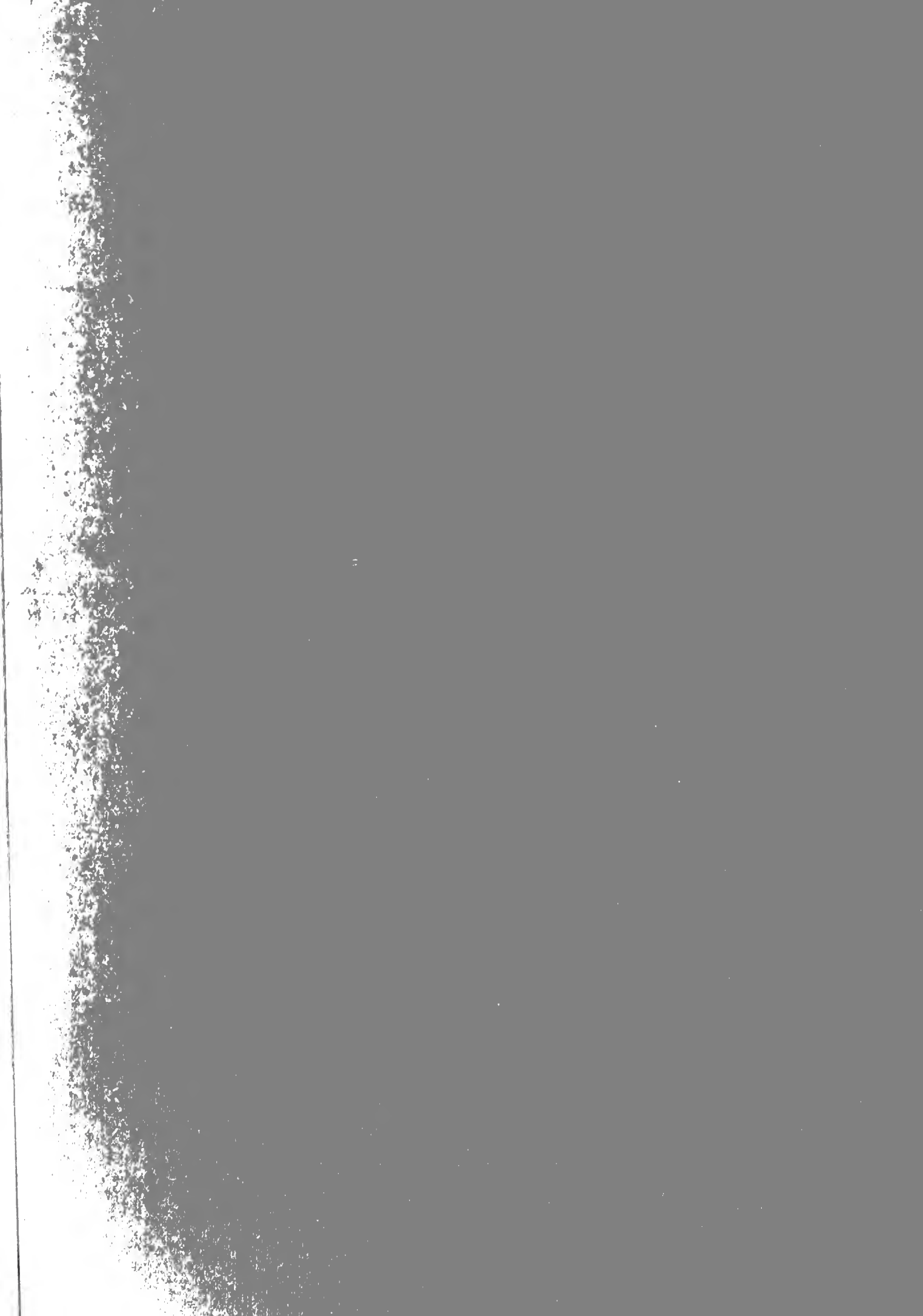
FIG. 2.—*Turbinaria stephensoni*, sp. n. × 6.3.
G.B.R.E. No. 449.

FIG. 3.—*Turbinaria stephensoni*, sp. n. × 6.3.
G.B.R.E. No. 449.

PRESENTED

25 OCT 1952





BRITISH MUSEUM (NATURAL HISTORY)

GREAT BARRIER REEF EXPEDITION
1928-29

SCIENTIFIC REPORTS

VOLUME VI, No. 1

PRESENTED

24 JUL 1953

HYDROMEDUSAE

BY

P. L. KRAMP, D.Sc.,

Zoological Museum, Copenhagen

WITH NINE TEXT-FIGURES AND TWO PLATES



LONDON

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

SOLD BY

B. QUARITCH, LTD., 11 GRAFTON STREET, NEW BOND STREET, LONDON, W.1
H.M. STATIONERY OFFICE, LONDON, S.W.1

AND AT

THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, LONDON, S.W.7

1953

[All rights reserved]

Price One Pound

[Issued 22nd July, 1953]

DESIGNED AND
PRINTED
BY
ADLARD & SON
LIMITED



AT
BARTHOLOMEW PRESS
DORKING

HYDROMEDUSAE

BY

P. L. KRAMP, D.Sc.,
Zoological Museum, Copenhagen.

WITH NINE TEXT-FIGURES AND TWO PLATES.

CONTENTS.

	PAGE
INTRODUCTION	259
LIST OF SPECIES	261
SYSTEMATIC ACCOUNT	262
PREVIOUS RECORDS OF HYDROMEDUSAE IN AUSTRALIAN WATERS	305
ZOOGEOGRAPHICAL REMARKS	312
REMARKS ON SEASONAL OCCURRENCE	314
LIST OF LITERATURE	317
LIST OF STATIONS WHERE HYDROMEDUSAE WERE COLLECTED	320

INTRODUCTION.

Hydromedusae were taken by the Great Barrier Reef Expedition in almost every pelagic haul, from 27th July, 1928, to 17th July, 1929. The nets used were:

- (S) 1 meter stramin net, with 16 strands to the inch.
- (C) Coarse silk net, with 58 strands to the inch.
- (F) Fine silk net, with 200 strands to the inch.

In the following pages the types of net are indicated by the letters S, C, and F. As a rule the nets were towed obliquely for 30 minutes, and such hauls were taken regularly every week. The majority of the hauls were taken in a locality 3 miles east of the laboratory on Low Isles, a little north of Cairns; at this locality, referred to as "3 miles E.," the depth of the water was about 32 m.

Other localities, where Hydromedusae were collected, are as follows:

- St. I. 27.vii.28. 2 miles N.E. of Low Isles. Depth 31 m. (2 miles N.E.).
- St. IV. 7.viii.28. 1 mile N. of Low Isles. Depth 16 m. Horizontal hauls (1 mile N.).
- St. VIII. 24.viii.28. 16° 39' S. 145° 52' E. Depth 45 m. (in Trinity Opening—I.T.O.).
- St. XI. 6.ix.28. 16° 24' S. 145° 52' E. Depth 61 m. (in Trinity Opening—I.T.O.).

	19. ix. 28.	Reef flat, entrance to anchorage, Low Isles. (R.F.)
	28. ix. 28.	The same.
St. XIX.	20. x. 28.	16° 20' S. 146° 03' E. Depth 225 m. (outside Trinity Opening—O.T.O.).
St. XX.	20. x. 28.	16° 19' S. 146° 07' E. Depth more than 600 m. (outside Trinity Opening—O.T.O.).
St. XXVI.	19. xi. 28.	16° 24' S. 145° 53' E. Depth 57 m. (in Trinity Opening—I.T.O.).
St. XXVIII.	23. xi. 28.	16° 19' S. 146° 05' E. Depth more than 600 m. (outside Trinity Opening—O.T.O.).
	25. xi. 28.	Lagoon over Reef flat (L.O.R.F.).
St. XLIII.	26. ii. 29.	15° 16' S. 144° 26' 5 E. Depth 30 m. (off Cape Bedford—C.B.).
St. XLIV.	27. ii. 29.	14° 44' S. 145° 27' 5 E. Depth 31 m. (off Lizard Island—Li.I.).
St. XLV.	28. ii. 29.	14° 31' S. 145° 35' E. Depth more than 600 m. (outside Cook's Passage—O.C.P.).
St. XLVI.	28. ii. 29.	14° 32' S. 145° 32' E. Depth 33 m. (inside Cook's Passage—I.C.P.).
St. XLIX.	17. iii. 29.	15° 47' S. 145° 47' E. Depth 46 m. (inside Papuan Pass—I.P.P.).
St. L.	18. iii. 29.	Outside Papuan Pass. Depth more than 400 m. (O.P.P.).

These localities are mentioned in abbreviated form in the lists of occurrence of the species.

At St. XVI, 3. x. 28, 3 miles E., a series of six horizontal hauls was made at different depths with a coarse silk net provided with closing apparatus.

I have counted all the specimens in the collection, but the countings of the preserved specimens give no accurate conception of the actual numbers caught in the nets. When a sample contained only a small or moderate number of specimens, all were picked out; but from larger samples the largest and best preserved specimens only were picked out, the remainder being sub-sampled and their numbers calculated. Some few recognizable species were identified on the spot, but in the counts of most samples a considerable number of species are united under the designation "other medusae." The total figures for the collections taken by the stramin net and the coarse silk net have been available to me, and from these I have tried to make a rough estimate of the complete numbers of the most important species at different seasons. We can rely fairly well on the figures given for *Aglaura* and *Liriope*, and these figures are given in the tables. The numbers of specimens of the other species are obtained by dividing up the total number of medusae, other than *Aglaura* and *Liriope*, in proportion to the numbers of preserved specimens of each species. This method is, of course, liable to considerable error, but it gives an approximate idea of the variations in quantity of the most common species during the time of the investigations.

In the tables I have given the estimated average number of specimens per haul with the stramin net and the coarse silk net, combined, in each month for the following species: *Bougainvillia fulva*, *Laodicea indica*, *Phialucium carolinae*, *Eirene hexanemalis*, *Helgicirrha*

malayensis, *Aequorea australis* and *Cunina octonaria*, these being the most abundant species next to *Aglaura hemistoma* and *Liriope tetraphylla*. The samples from the few stations over deep water outside the reefs are not included in the calculations.

The results will be discussed, partly under the separate species, partly in some general remarks on seasonal occurrence.

The collection contains 44 species of Hydromedusae. Two species are not specifically identified (*Eucheilota* sp. I and sp. II). Three are described as new species: *Octotiarra russelli* n. g., n. sp., *Phialucium condensum* n. sp. and *Eirene menoni* n. sp.

Only 8 of the 44 species had previously been recorded from Australian waters.

In addition a parasitic Narcomedusan larva is described.

The collection is in the British Museum (Natural History), London.

LIST OF SPECIES.

ANTHOMEDUSAE.

	PAGE
<i>Euphysora bigelowi</i> Maas	262
<i>E. annulata</i> Kramp	263
<i>Zanclaea costata</i> Gegenbaur	263
<i>Cytaeis tetrastyla</i> Eschscholtz	263
<i>Bougainvillia fulva</i> Agassiz & Mayer	264
<i>Merga violacea</i> (Agassiz & Mayer)	265
<i>Amphinema dinema</i> (Péron & Lesueur)	265
<i>Octotiarra russelli</i> n. g., n. sp.	266
<i>Leuckartiara octona</i> (Fleming)	267
<i>L. gardineri</i> Browne	267
<i>Cirrhitiara superba</i> (Mayer)	267
<i>Heterotiarra minor</i> Vanhöffen	268

LEPTOMEDUSAE.

<i>Laodicea indica</i> Browne	268
<i>Eucheilota</i> sp. I	270
<i>Eucheilota</i> sp. II	270
<i>Phialidium hemisphaericum</i> (L.)	271
<i>P. simplex</i> Browne	272
<i>P. rangiroae</i> Agassiz & Mayer	273
<i>Phialidium</i> sp.	273
<i>Phialucium mbenga</i> (Agassiz & Mayer)	275
<i>P. carolinae</i> (Mayer)	276
<i>P. condensum</i> n. sp.	279
<i>Eirene hexanemalis</i> (Goette)	281
<i>E. palkensis</i> Browne	283
<i>E. kambara</i> Agassiz & Mayer	283
<i>E. ceylonensis</i> Browne	285
<i>E. menoni</i> n. sp.	286
<i>Helgicirrho malayensis</i> (Stiasny)	286
<i>Eutima levuka</i> (Agassiz & Mayer)	288
<i>E. curva</i> Browne	288
<i>Aequorea conica</i> Browne	289
<i>A. australis</i> Uchida	290
<i>A. macrodactyla</i> (Brandt)	294
<i>A. pensilis</i> (Haeckel)	295

LIMNOMEDUSAE.		PAGE
<i>Olindias singularis</i> Browne		298
<i>Proboscidactyla ornata</i> (McCrary)		299
TRACHYMEDUSAE.		
<i>Halicreas minimum</i> Fewkes		299
<i>Rhopalonema velatum</i> Gegenbaur		299
<i>Amphogona apsteini</i> (Vanhöffen)		300
<i>Aglaura hemistoma</i> Péron & Lesueur		300
<i>Geryonia proboscidalis</i> (Forskål)		301
<i>Liriope tetraphylla</i> (Chamisso & Eysenhardt)		301
NARCOMEDUSAE.		
<i>Solmundella bitentaculata</i> (Quoy & Gaimard)		302
<i>Solmaris rhodoloma</i> (Brandt)		302
<i>Cunina octonaria</i> McCrary		304
Parasitic stolon-larvae of <i>Cunina</i>		305

SYSTEMATIC ACCOUNT.

ANTHOMEDUSAE.

Euphysora bigelowi Maas.

Euphysora bigelowi Maas, 1905, Siboga Exped., 10, 26, p. 7, pl. 1, figs. 1-3; Maas, 1906, p. 84, pl. 2, figs. 1, 2; Browne, 1916, p. 174; Kramp, 1928, p. 35, figs. 8-12; Kramp, 1948, p. 20.
Euphysa bigelowi, Uchida, 1927, p. 189, pl. 10, fig. 3, text-fig. 28; Uchida, 1947, p. 300.
Steenstrupia bigelowi, Mayer, 1910, p. 36, fig. 9.

This is the type-species of the genus *Euphysora* Maas. The genus is distinguished from *Euphysa* by the fact that one of the four tentacles differs from the others not merely in size but also in structure. A survey of the five species belonging to this genus was given by Kramp (1948).

Material—

- St. XXVI, F. 19.xi.28. 1 specimen; height of bell 2.5 mm.
- St. XLIV, C. 27.ii.29. 1 specimen; height of bell 4 mm.
- St. XLVII, S. 4.iii.29. 2 specimens; height of bell 2-4 mm.
- " C. 4.iii.29. 1 specimen; height of bell 4 mm.
- St. XLIX, C. 17.iii.29. 2 specimens; height of bell 2-3 mm.
- St. L, S. 18.iii.29. 1 specimen; height of bell 4.5 mm.
- St. LVIII, S. 25.v.29. 1 specimen; height of bell 3.5 mm.
- St. LIX, C. 31.v.29. 1 specimen; height of bell 3 mm.

With the exception of the specimen from St. XXVI, this species occurred only during late summer and autumn, from February to May.

Distribution.—*Euphysora bigelowi* is widely distributed in the tropical parts of the Indian and Pacific Oceans, but up to now it has not been recorded from Australia.

Euphysora annulata Kramp.

Euphysora annulata Kramp, 1928, Vidensk. Medd. Dansk. nat. For., 85, p. 39, fig. 13.

Material:

St. LVIII, S. 25.v.29. 1 specimen; height of bell 3 mm.

This specimen is very like the type-specimen in general shape and has an equally well-developed apical canal. The manubrium is much contracted, being only half as long as the depth of the bell cavity; in the type-specimen the stomach was greatly dilated, because it contained a copepod. This species is distinguished by the main tentacle having complete rings of nematocysts; in the type-specimen there were 17 rings, in the present specimen there are 12 and a well-marked terminal knob. In the type-specimen the ectoderm of the three other tentacles was rubbed off, in the present specimen it is intact, showing that these tentacles are likewise provided with rings of nematocysts. The tentacle opposite the principal one is shorter and thinner than the main tentacle, the rings of nematocysts are very indistinct, about eight in number and almost confluent; the two lateral tentacles have 1-3 indistinct rings each.

Distribution.—The type-specimen was found in Sunda Strait, and it is possible that the medusa from Madras in India mentioned by Menon (1932, p. 6, pl. 1, fig. 8) under the name of "*Sarsia* sp. II" belongs to the same species.

Zanclaea costata Gegenbaur.

Zanclaea costata + *gemmosa* + *implexa* + *cladophora*, Mayer, 1910, pp. 87-90.

Material.—

St. XLVII, S. 4.iii.29. 1 specimen; 2.5 mm. high.

St. XLVIII, S. 15.iii.29. 2 specimens; 1.5-2 mm. high.

St. L, S, vertical haul 170-0 m. 18.iii.29. 1 specimen, 2 mm. high.

All these specimens have only two, opposite tentacles; the two other marginal bulbs are quite rudimentary.

Distribution.—Atlantic coasts of Europe and North America; the Mediterranean and the Red Sea. Pacific coast of Mexico. Nicobar Islands in the Indian Ocean and Pelew Islands (Palao Islands) in the western Pacific.

Cytaeis tetrastyla Eschscholtz.

It is now generally acknowledged that most of the different forms of *Cytaeis* described from several parts of the three great oceans belong to one species, *C. tetrastyla* Eschscholtz, 1829, including *C. nigritina* and *macrogaster* Haeckel, 1879, and most of the Pacific and Malayan specimens referred to *C. vulgaris*. It is also certain that *C. herdmani* Browne, 1905, belongs to *C. tetrastyla*. *C. pusilla* Gegenbaur, 1856, from the Mediterranean, is doubtful; Browne (1916, p. 177) is inclined to regard it as a valid species. Mayer (1910, p. 133) would use the name of *tetrastyla* only for Eschscholtz' type-specimen, and he employs the specific name *atlantica* Steenstrup, 1837, for the common and widely distributed species. That name was, however, never published by Steenstrup, but is only found in his handwritten catalogue of the collections in the Zoological Museum of Copenhagen. Hartlaub (1911, p. 142) and Browne (1916, p. 177) are inclined to regard *C. vulgaris* Agassiz & Mayer,

from the Fiji Islands, as a distinct species, though they admit that other specimens from the Pacific area belong to *C. tetrastyla*. In a previous paper (Kramp, 1928, p. 44) I considered some specimens from the Philippine Islands examined by me as specifically distinct from *C. tetrastyla*, mainly because their gonads were horseshoe-shaped, and I referred them to *C. vulgaris*. The present specimens from the Great Barrier Reef are all typical *C. tetrastyla*, and none of them have horseshoe-shaped gonads.

The specimens from the Great Barrier Reef are very variable as far as size of tentacle bulbs and development of a stomachal peduncle are concerned; some of them, which have particularly small tentacle bulbs, agree perfectly with *C. japonica* Uchida (1927, p. 215, pl. 10, fig. 7, text-fig. 39); others are intermediate between this latter and the typical *C. tetrastyla*. We may therefore safely state that these two species are identical.

Material.—As seen from Table XVIII, this species was taken almost throughout the period of investigation, from 22nd August, 1928, to 31st May, 1929, in 21 hauls altogether, but never in great abundance. The specimens were all very small, very few being more than 2 mm. in diameter (2.5 mm. at Sts. VII and XLV, 3 mm. at St. LVIII), and there was no distinct difference in the size at different seasons.

Distribution.—*Cytaeis tetrastyla* is widely distributed and very common in the tropical parts of all the oceans. In the Pacific it occurs as far north as the south of Japan, and in the Atlantic north to the vicinity of the Canary Islands; it also occurs in the Mediterranean. It belongs to the surface layers, but it is not absolutely restricted to the coastal waters, its ability to reproduce by budding enabling it to be carried away by the currents for considerable distances. Though it is very abundant in the Malayan Archipelago it has been recorded from Australian coasts only once before, when a single specimen was found in Torres Strait (Mayer, 1915, p. 200, *Cytaeis atlantica*).

Bougainvillia fulva Agassiz & Mayer.

Bougainvillia fulva Agassiz & Mayer, 1899, Bull. Mus. comp. Zool., Harvard, 32, p. 162, pl. 2, fig. 6; Maas, 1905, p. 10, pl. 1, fig. 8, pl. 2, figs. 9, 10; Mayer, 1910, p. 160, 492; Kramp, 1928, p. 47, figs. 21–23.

Material.—Taken in 18 hauls between 4th January (St. XXXVI) and 31st May (St. LIX), sometimes in considerable numbers (see Table XVIII), especially in February, when the estimated numbers of specimens per one haul amounted to 55. The seasonal occurrence of this species thus seems to be restricted to the late summer and autumn. Young specimens, 1.5 mm. wide, were taken in January to March; in April and May the youngest specimens were 2.5 mm. in diameter. The largest individuals, 5–6 mm. wide, occurred in February and March.

Two other species of *Bougainvillia*, *B. prolifera* and *trinema* have been described from Australia (New South Wales, von Lendenfeld, 1884); both of them are of doubtful validity. Mayer (1910, p. 171) is inclined to regard *B. trinema* as a young specimen of *B. fulva*; *B. trinema* is a small medusa with 3 tentacles on each of the marginal bulbs, the oral tentacles have only 3 terminal branches, and the branching is not dichotomous. In the small specimens from the Great Barrier Reef, 1.5 mm. in diameter, with 3 tentacles on each marginal bulb, the oral tentacles are dichotomously divided 2–3 times, each of them with at least 8 terminal branches. If the description of *B. trinema* is correct, its identity with *B. fulva* therefore seems improbable.

The rate of development of the oral and marginal tentacles in *B. fulva* from the Philippine Islands has been discussed by me in a previous paper (Kramp, 1928).

Distribution.—*Bougainvillia fulva* is a common medusa in the coastal waters of the tropical parts of the Indian and Pacific Oceans. It is particularly common in the Malayan Archipelago, but has also been recorded from as far afield as Djibouti in East Africa, Madras in India, Japan, various islands in the tropical Pacific, and the Pacific coast of Mexico.

Merga violacea Agassiz & Mayer.

Pandea violacea Agassiz & Mayer, 1899. Bull. Mus. comp. Zool. Harvard, **32**, p. 160; Mayer, 1900*b*, p. 34, pl. 1, fig. 1; Bigelow, 1909, p. 205, pl. 41, figs. 10, 11; Mayer, 1910, pp. 119, 490, pl. 11, fig. 7, pl. 12, fig. 1.

Merga violacea, Hartlaub, 1913, p. 249, fig. 204; Menon, 1932, p. 7, pl. 1, fig. 10.

Mergintha lobianci Hartlaub, 1913, p. 250, fig. 205.

Material.—

St. XXII, C. 23.x.28. 2 specimens; diam. 3–4 mm.

St. XXXII, S. 5.xii.28. 2 specimens; diam. 4 mm.

St. XXXIV, C. 19.xii.28. 1 specimen; diam. 2 mm.

St. XXXV, S. 27.xii.28. 3 specimens; diam. about 4 mm.

„ C. 27.xii.28. 6 specimens; diam. 3–5 mm.

St. XXXVII, C. 14.i.29. 4 specimens; diam. 3–4.5 mm.

The only difference between *Merga violacea* and *Mergintha lobianci* is the possession of frilled lips in the latter. The largest specimen from St. XXII, which is 4 mm. wide and 6 mm. high, likewise has frilled lips. It has 8 fully developed tentacles and 3 small rudiments between each successive pair of tentacles; the other specimen from the same station, 3 mm. wide, has also 8 tentacles. One of the specimens from St. XXXVII, 4.5 mm. wide, has 10 tentacles.

On the Great Barrier Reef the occurrence of this species was restricted to a fairly short period.

Distribution.—“*Mergintha lobianci*” has only been found near Capri in the Mediterranean. *Merga violacea* seems to have a wide distribution, though it has only been observed on few occasions: Tortugas (Florida) and the Bahamas in the Atlantic, west coast of Mexico and Fiji Islands in the Pacific, and Madras in the Indian Ocean.

Amphinema dinema (Péron & Lesueur).

Amphinema dinema, Browne, 1896, p. 475 (with previous references); Menon, 1932, p. 8, pl. 1, fig. 7.

Stomotoca apicata Mayer, 1910, p. 109, pl. 9, figs. 8–10, pl. 10, figs. 1–4.

Material.—

St. XV, C. 2.x.28. 1 specimen; diam. 2 mm.

St. XXV, S. 16.xi.28. 2 specimens; diam. 1.8 mm.

„ ? 16.xi.28. 2 specimens; diam. 2 mm.

St. LI, C. 25.iii.29. 6 specimens; diam. 1.5–2 mm.

St. LIV, C. 20.iv.29. 1 specimen; diam. 1.5 mm.

St. LIX, C. 31.v.29. 1 specimen; diam. 3 mm.

These specimens agree so perfectly with the North-European *A. dinema* that I do not hesitate to refer them to the same species. There are three rudimentary marginal bulbs

in each quadrant, besides the two perradial ones, and they are all very small, slightly conical, and have no ocelli.

The occurrence of this species on the Great Barrier Reef was very scattered.

Distribution.—*Amphinema dinema* occurs in the coastal waters of north-western Europe and the Atlantic coast of North America. The medusa from Amirante Islands in the western part of the Indian Ocean described by Browne (1916, p. 181) as *Amphinema* sp. probably belongs to the same species, and I also feel sure that the record by Menon (1932) of *A. dinema* as occurring near Madras in India is correct. This species thus seems to have an extensive distribution, though apparently it is fairly rare within all the areas, whence it has been recorded.

Octotiarra nov. gen.

Pandeidae with 8 radial canals ; with a well-developed stomachal peduncle ; with transversely folded gonads ; without mesenteries.

Octotiarra russelli n. g., n. sp.

(Plate I, figs. 1-3).

Material.—

St. L, C. 18.iii.29. 1 specimen.

Description (figs. 1-3).—The umbrella of the single specimen is somewhat crumpled and the margin turned inwards ; apparently it has been watchglass-shaped or perhaps approximately hemispherical ; it is 7 mm. in diameter in its present condition. Mesogloea fairly thin. There is a stout and broad gelatinous stomachal peduncle, a barrel-shaped stomach carrying the gonads, and a long mouth tube destitute of gonads. The length of the entire manubrium is 7 mm., of which the peduncle, the stomach and the mouth tube make about one-third each. The 8 radial canals are fairly narrow, with smooth edges, and the circular canal is very narrow. The peduncle is nearly circular in transverse section, whereas the stomach is longitudinally folded with 8 deep, interradianal furrows and 8 prominent perradial edges, which are continued along the sides of the mouth tube. The mouth has 8 short, simple, triangular lips with a slightly frilled margin.

The gonads are placed along each side of the perradial edges of the stomach, deeply transversely folded, each with 6-8 folds.

There are 8 large, perradial tentacles, spirally coiled, finely transversely wrinkled, and densely beset with nematocysts throughout their length. The basal bulbs are conical, distinctly heart-shaped on the adaxial side and with a slight indication of an abaxial spur. There are no ocelli. In each of the spaces between the tentacles there are 8 minute marginal warts.

The velum is narrow and delicate.

Colour as preserved in formalin : stomach, gonads, and tentacular bulbs yellowish-brown, rudimentary marginal bulbs nearly colourless.

I have great pleasure in naming this interesting new species after my friend F. S. Russell, Director of the Marine Laboratory, Plymouth, formerly zoologist on the Great Barrier Reef Expedition.

The most striking feature of this species is the possession of 8 radial canals never

observed in any other members of the family Pandeidae. In several details it resembles the species of the genus *Stomotoca* (*sensu strictu*), which have likewise a well-developed stomachal peduncle, transversely folded gonads, and a number of minute rudimentary bulbs upon the umbrella margin. The shape of the tentacle bulbs is also very similar in the two genera, which are evidently closely related. The number of radial canals and fully developed tentacles, however, distinguishes the present species from *Stomotoca*, which has only 2 tentacles and 4 radial canals.

Leuckartiara octona (Fleming).

For the complicated synonymy of this species, see Hartlaub, 1913, p. 285.

Material.—Taken in 14 hauls at 12 stations between 3rd October, 1928 (St. XVI), and 17th March, 1929 (St. XLIX) (see Table XVIII).

Only young specimens were found, ranging in size from 1 to 3 mm. in diameter.

Distribution.—Very abundant in the coastal waters of north-western Europe, and also found in the Mediterranean and off the Atlantic coast of North America. Also recorded from several localities in the Pacific and Indian Oceans and the Malayan Archipelago, but now for the first time taken in Australian waters.

Leuckartiara gardineri Browne.

Leuckartiara gardineri Browne, 1916, Trans. Linn. Soc. London (2), Zool. 17, p. 181, pl. 39, fig. 4.

Material.—

St. XXXV, S. 27.xii.28. 1 specimen; diam. 4 mm.

St. XLVI, S. 28.ii.29. 1 specimen; diam. 2 mm.

The specimen from St. XXXV is much crumpled, and the stomach as well as the umbrella are turned inside out. It has four perradial tentacles and 5–6 minute bulbs in each of the four quadrants.

The most characteristic structures in this species are the 4 conspicuous exumbrellar, canal-like bands extending from the tentacles nearly to the summit of the umbrella (Browne, 1916); Bigelow (1918, p. 375) is inclined to think that they are canals like the 8 exumbrellar ribs in his new species *Eutiara mayeri*. Owing to the scarcity of the material I have not cut sections of the present specimens; the 4 exumbrellar bands are very conspicuous, and as far as I am able to see in optical section they really seem to be hollow.

Distribution.—One single individual was found at the Amirante Islands in the western part of the Indian Ocean.

Cirrhitiara superba (Mayer).

Tiara superba Mayer, 1900b, Bull. Mus. comp. Zool. Harvard, 37, p. 34, pl. 16, fig. 39; Mayer, 1904, p. 8, pl. 2, fig. 11.

Turris pileata var. *superba* Mayer, 1910, p. 126, pl. 27, fig. 8, pl. 28, figs. 3, 4; Vanhöffen, 1913, p. 416.

Cirrhitiara superba, Hartlaub, 1913, p. 284, fig. 237; Thiel, 1938, p. 296, fig. 2.

Material.—

St. XXXII, S. 5.xii.28. 1 specimen; diam. 5 mm.

St. XXXV, S. 27.xii.28. 1 specimen; diam. 4 mm.

In the specimens from the Tortugas and the Bahamas described by Mayer in the three papers quoted above there were 3 rudimentary marginal bulbs, all of about equal size, in each quadrant; the characteristic cirri, one beside each rudimentary bulb, were not mentioned in his descriptions, but they are seen in the figure (1910, pl. 28, fig. 3). The presence of these cirri induced Hartlaub (1913) to establish a new genus for this medusa, which in most other respects agrees with *Leuckartiara*.

The specimens from the Great Barrier Reef differ from the original description of the species in that the interradial marginal bulbs are somewhat larger than the adradial ones and clasp the margin of the umbrella; moreover they are destitute of cirri. In specimens from the tropical Atlantic, however, the interradial bulbs may sometimes develop into true tentacles, though smaller than the perradial ones, as observed by Vanhöffen (1913) and Thiel (1938), so that the present specimens may be regarded as transitional stages and not as representatives of a new species. In all other respects they agree perfectly with the descriptions of *C. superba*.

Distribution.—Tortugas (Florida), Bahamas, and the coast of Brazil.

Heterotiara minor Vanhöffen.

Heterotiara minor Vanhöffen, 1911, Wiss. Ergeb. deutsch. Tiefsee Exp. 19, p. 212, pl. 22, fig. 5, text-fig. 8a, b; Browne, 1916, p. 183; Bigelow, 1919, p. 287, pl. 39, fig. 9, pl. 40, figs. 2-4; Kramp, 1928, p. 58, figs. 27-30.

Material.—

St. XLIV, C. 27.ii.29. 2 specimens; height of bell 2.5 mm.

One of the specimens, a female, is fairly well preserved; the other specimen, with male gonads, is much crumpled, and there are some irregularities in the course of its radial canals, but owing to the state of preservation these anomalies can not be properly described. The gonads of the female specimen contain fairly large eggs. On account of their small size both specimens must, however, be regarded as young stages. Both of them have 8 tentacles.

There is no indication of a differentiation of the radial canals into an upper narrow portion and a lower portion "suddenly slightly widened and ragged on the edge," which should be characteristic of the genus *Kanaka* (Uchida, 1947, p. 303) with the Japanese species *K. pelagica* Uchida. The latter is a small medusa, 1.8 mm. high, with 8 tentacles, so much like a small *Heterotiara* that I am inclined to think that the differentiation of the radial canals is due either to abnormal development or to the state of preservation of the single specimen observed.

Distribution.—*Heterotiara minor* has been found in the Indian Ocean near the Nias and the Cocos-Keeling Islands and north of Chagos, in several localities around the Philippine Islands, and near Hong Kong. Its area of distribution is now extended to the north-east coast of Australia.

LEPTOMEDUSAE.

Laodicea indica Browne.

Laodicea indica Browne, 1905, Ceylon Pearl Oyster Fish., Supp. Rep. 27, p. 136, pl. 1, fig. 5, pl. 4, figs. 7-11; Browne, 1907, p. 466.

Laodicea cruciata Mayer, 1910, p. 202 (part).

Probably also:

Laodice fijiana var. *indica*, Maas, 1905, p. 25, pl. 2, figs. 14, 15, pl. 5, figs. 32-35.

Laodice fijiana, Maas, 1906, p. 89.

Laodice maasi Browne, 1907, p. 466; Vanhöffen, 1911 p. 221, fig. 14.

Laodicea fijiana, Mayer, 1910, p. 205 (part).

Laodicia fijiana, Mayer, 1915, p. 200.

The limitation of the various species of *Laodicea* which have been described is very difficult, partly owing to the considerable variability of these medusae, partly because the description of some of the species was based on juvenile specimens. We may state without doubt that *L. pulchra* Browne, which has only been found at the Falkland Islands, is a distinct species; it was established by Browne (1902, p. 280), and further described and figured by Browne & Kramp (1939, p. 291, pl. 16, figs. 3-5). Several authors regard all the other species as synonyms or varieties of *L. undulata* (Forbes & Goodsir, 1851). I have previously been of the same opinion (Kramp, 1919, pp. 22 et seq.), but since I have seen specimens from various parts of the world, it seems to me a safer course to keep four or five species separate, at least provisionally. The Atlantic and Mediterranean forms probably all belong to *L. undulata*, but the Indo-Pacific forms are more or less distinct. The two species *L. marama* and *fijiana* Agassiz & Mayer (1899) have never been found since they were recorded from the Fiji Islands, where both of them were common. *L. marama* differs from all other Indo-Pacific forms by its large number of cordyli, usually 2-3 between each successive pair of tentacles, and by the possession of an ocellus upon the bulb of most of the tentacles. *L. fijiana* seems to be well characterized by the gonads being situated upon complex diverticulae of the radial canals. At any rate, Maas (1905 and 1906) and Mayer (1910 and 1915) were entirely wrong in identifying specimens from the Malayan Archipelago and Torres Strait as *L. fijiana* and considering *L. maasi* Browne a synonym of *fijiana*.

L. indica Browne was described from two localities on the west coast of Ceylon. I have seen the type-specimen in the British Museum, and I consider it beyond doubt that the numerous specimens taken on the Great Barrier Reef expedition belong to the same species. Cordyli are present in about the same number as the tentacles, and there is an ocellus upon the basal part of almost every second tentacle, notwithstanding the stage of development of the specimens. In *L. indica* the tentacles are said to be destitute of a basal spur; in the specimens from the Great Barrier Reef an abaxial spur is actually present in the young tentacles, but it is difficult to see, and during the growth of the tentacle the abaxial side of its basal part is pushed upwards on the outer side of the umbrella margin engulfing the spur, which at last entirely disappears, just as was described in *L. undulata* (Kramp, 1919, p. 18).

The name of *L. maasi* was proposed by Browne (1907) for the Malayan medusa described by Maas (1905) as *L. fijiana* var. *indica*. It is a somewhat larger medusa than *L. indica*, and Maas was unable to find cirri in his specimens. On the other hand, basal spurs were present on the tentacles. Cirri are, however, readily lost; in the specimens from the Great Barrier Reef some few cirri can be found by careful examination; presumably they were present in greater numbers before the preservation of the specimens. Although Maas was unable to find cirri in *L. maasi* and Browne failed to observe tentacular spurs in *L. indica*, I consider it most probable that both structures are actually present in both species, which in other respects are very similar to one another. The presence of spurs as well as cirri

in the Great Barrier Reef specimens seems to me to support the supposition that *L. maasi* is identical with *L. indica*.

Material.—*Laodicea indica* occurred on the Great Barrier Reef throughout almost the whole period of investigation, from 22nd August, 1928 (St. VII), to 7th June, 1929 (St. LX). It was particularly common in November and December, when it was sometimes found in great abundance (see Table XVIII). The estimated average numbers of specimens per one haul in December was more than 500.

TABLE I.—*Seasonal Occurrence of Laodicea indica.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	.	I.	II.	III.	IV.	V.	VI.	VII.
Estimated average number of specimens per one haul	0	0.5	2	3	19	555	.	9	3	6	0	1	2	0
Diameter of umbrella (mm.)	-	2-5.5	3-5	2.5-9	2-10	2-10	.	4-6	4-8	1-6	-	3	3-6	-

As will be seen from the adjoining table (Table I), young specimens were taken at all seasons, but specimens of larger size, more than 8 mm. in diameter, were only found during the summer months. The largest individuals measured 10 mm. in diameter and possessed about 150 tentacles. They occurred in November and December, at the time when the species was particularly abundant in the samples.

Distribution.—*Laodicea indica*, as described by Browne (1905), has only been found on the west coast of Ceylon, but *L. maasi*, which is probably the same species, was taken by the "Siboga" expedition in several localities in the Malayan Archipelago (Maas, 1905), and has also been recorded from Amboina (Maas, 1906), the Gulf of Aden (Vanhöffen, 1911), and from a locality off Maër Island in Torres Strait, where it was quite common in September and October (Mayer, 1915).

Eucheilota sp. I.

Material.—Entrance to anchorage, Low Isles, 28. ix. 28, coarse silk net. One juvenile specimen.

The specimen is 4 mm. in diameter; the gonads are hardly visible as tiny dilatations in the middle parts of the radial canals. There are 4 perradial and 4 interradian tentacles and 24 small rudimentary marginal bulbs, 8 adradial and 16 eradial. The tentacles and the rudimentary bulbs are all flanked by one pair of lateral cirri. Eight marginal vesicles.

This may possibly be a young stage of *Eucheilota ventricularis* McCrady, which is common on the Atlantic coast of North America, and also has been recorded from the Red Sea and the Chagos Islands in the Indian Ocean. There are, however, several other possibilities, and I prefer therefore to leave the question of the specific identity of this young medusa open.

Eucheilota sp. II.

Material.—

St. LII, S. 6. iv. 29. 1 specimen.

It is a pity that the single specimen is in a poor state of preservation, crumpled and covered with debris which impede a satisfactory examination of the structure of this little

medusa, apparently a form of some interest. The umbrella is 3 mm. in diameter, with thin walls. The stomach is somewhat elongated, containing a doubled-up *Sagitta* with head and tail protruding from the mouth of the medusa. Small, oval immature gonads are situated in the middle portion of the 4 narrow radial canals. There are 8 marginal tentacles with conical basal bulbs, and also one or two young marginal bulbs and some few minute wart-like protuberances. There are no lateral cirri on the tentacle bulbs, but between adjacent tentacles there are a number, apparently 6-8, of spiral cirri and about 4 small, closed marginal vesicles.

The only species of *Eucheilota* which bears some resemblance to the present form is *E. bermudensis* (Fewkes), which occurs on the coasts of Florida and the Bermudas. According to the description of this species, each of the 8 tentacle bulbs is flanked by a pair of lateral cirri (Mayer, 1910, p. 282), but in the figure (pl. 38, fig. 3) these cirri are distinctly separated from the tentacle bulbs. All other species of *Eucheilota* have only lateral cirri adjacent to the marginal bulbs, and each of the so-called marginal cirri in *E. bermudensis* is placed immediately beside a small rudimentary marginal bulb, and they should really be termed lateral cirri attached to these minute bulbs. In the specimen from the Great Barrier Reef some of the cirri are apparently independent of the minute wart-like protuberances and somewhat more numerous than these latter, but owing to the state of preservation I am unable to determine the relation between the cirri and the warts. I do not venture, therefore, to refer this Australian medusa to the Atlantic species *Eucheilota bermudensis*.

Phialidium hemisphaericum (L.).

Material (see also Table XVIII).—

- St. XIII, S. 20.ix.28. 1 specimen.
 St. XXVI, F. 19.xi.28. 1 specimen.
 St. XXVII, S. 21.xi.28. 1 specimen.
 Lagoon over reef flat, 25.xi.28. 4 specimens.
 St. L, S. 170-0 m. 18.iii.29. 3 specimens.

These specimens are in every respect indistinguishable from the common European medusa *Phialidium hemisphaericum*, and as the corresponding hydroid, *Campanularia johnstoni*, has a very extensive distribution and has even been recorded from New Zealand and the Malayan Archipelago, it is not astonishing to find the medusa on the Australian coast.*

Ten specimens of this medusa were taken on the Great Barrier Reef at different seasons; all of them were rather small. The numbers of tentacles and young tentacular bulbs were as follows:

Diam. mm.	2	2	3	3	4	5	5.5	6	6	6
Tentacles	c. 8	12	14	16	17	17	c. 22	23	24	c. 32
Young bulbs	c. 8	4	2	2	4	c. 5	2	0	2	?

Distribution.—European waters from southern parts of Norway and Iceland into the Mediterranean.

* On the "Galathea" expedition 1951 I found this medusa in several localities between India and the Philippine Islands, and the Danish "Atlantide" expedition in 1946 has collected it on the west coast of Africa.

Phialidium simplex Browne.

Phialidium simplex Browne, 1902, Ann. Mag. nat. Hist. (7), 9, p. 282; Browne, 1908, p. 236; Mayer, 1910, p. 274; Thiel, 1938, p. 328; Browne & Kramp, 1939, p. 299, pl. 17, figs. 5-9; Kramp, 1948a, p. 5.

non *Phialidium simplex* Uchida, 1947, p. 305.

Material (see also Table XVIII).—

St. I, C.	27.vii.28.	2 specimens.
St. IX, S.	31.viii.28.	1 specimen.
St. XI, C.	6.ix.28.	1 specimen.
St. LVII, S.	18.v.29.	4 specimens.
„ C.	18.v.29.	1 specimen.
St. LVIII, S.	25.v.29.	8 specimens.
St. LIX, S.	31.v.29.	3 specimens.
„ C.	31.v.29.	2 specimens.

All the specimens are small, ranging in size between 2.5 and 5 mm. in diameter, but they agree very well with the intermediate stages of *P. simplex* from the Falkland Islands, with the exception that they have a greater number of tentacles. This species was briefly described from the Falkland Islands by Browne (1902), who also recorded a single specimen from the same locality in 1908; a full description was given by Browne & Kramp (1939). In this description it was emphasized that “the number of tentacles is very variable and is not correlated with the size of the umbrella, nor the size of the gonads.” In spite of the relatively great number of tentacles in the specimens from the Great Barrier Reef, I therefore do not hesitate to refer them to the same species, as in all other respects the agreement is perfect, and no other species of *Phialidium* is likely to be confounded with it.

Remarks on the specimens from the Great Barrier Reef.—

Diam. (mm.).	Number of tentacles.	Length of gonads in relation to radial canals.	Number of specimens examined.
2.5	44-46	$\frac{2}{3}$	2
3	38-50	$\frac{1}{2}-\frac{2}{3}$	4
3.5	42-48	$\frac{1}{2}$	2
4	41-52	$\frac{1}{3}-\frac{4}{5}$	8
4.5	c. 50	$\frac{3}{4}$	2
5	54	$\frac{3}{4}$	1

At the Falkland Islands the medusa may attain a size of 22 mm. in diameter, with 60-85 tentacles and a few young tentacular bulbs. The basal bulbs of the tentacles are globular, nearly as broad as the spaces between them. In all the specimens examined there are only few young bulbs. One statocyst between successive tentacles. In one of the specimens 4 mm. wide the gonads contain well-developed eggs.

As in the specimens from the Falkland Islands abnormalities are of rather frequent occurrence in the Great Barrier Reef specimens. One specimen, 3 mm. wide, has 3 radial canals, another (5 mm. wide) has 5. In one specimen, 4 mm. wide, the stomach is 5-rayed,

but the fifth radial canal is not developed. In one specimen two of the gonads are connected by a transverse anastomosis.

Distribution.—*Phialidium simplex* is very abundant from November to March at the Falkland Islands, whence it has been recorded by Browne (1902 & 1908), Browne & Kramp (1939) and Kramp (1948a). According to Thiel (1938) a small specimen has also been taken on the Patagonia Bank, off the east coast of South America, about 30° S., and I think the identification is correct.

On the Great Barrier Reef some few specimens were taken in July to September, 1928, and several in May, 1929, whereas the medusa was completely lacking during the intervening period.

Phialidium rangiroae (Agassiz & Mayer).

Epenthesis rangiroae Agassiz & Mayer, 1902, Mem. Mus. comp. Zool. Harvard, 26, p. 145, pl. 1, fig. 4.

Clytia rangiroae, Mayer, 1910, p. 165.

Material.—

St. XIV, S. 26.ix.28. 1 specimen.

The specimen is 4 mm. in diameter, thin and flat. It has 12 tentacles with small globular bulbs and also one tiny young bulb in each quadrant. About 16 very small statocysts. The gonads, male, are short and oval, situated very near the ring-canal. The stomach is very small, quadrate, not cross-shaped, and the mouth has 4 small, simple lips.

Distribution.—Rangiroa Island, Paumotus, South Pacific.

Phialidium sp.

The following specimens from St. XXXII, 5.xii.28, probably belong to *Phialidium*, but could not be identified.

Diam. 2.5 mm. ; 12 tentacles ; fairly large stomach.

Diam. 7 mm. ; about 30 tentacles ; no young bulbs. Gonads linear, near stomach.

Diam. 8 mm. ; 16 tentacles and 14 young bulbs ; one statocyst between tentacles and bulbs. Gonads linear, in middle parts of radial canals ; stomach lost.

Genus *Phialucium* Maas.

The name *Phialucium* was introduced by Maas (1905) as a subgenus of *Phialidium* to include *Oceania virens* Bigelow (1904), *Mitrocoma mbenga* Agassiz & Mayer (1899), and *Oceania carolinae* Mayer (1900a). Bigelow (1909) and Mayer (1910) elevated it to the rank of a genus, and Bigelow added a new species, *P. comata*, which, however, has cirri and is a *Phialopsis*.

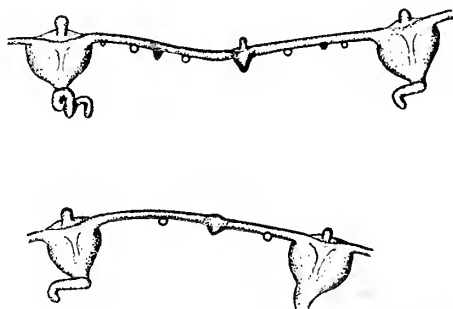
Phialucium is generally stated to differ from *Phialidium* by the possession of permanently rudimentary tentacle-bulbs on the bell margin, but there is another and far more characteristic difference : in contradistinction to *Phialidium* the tentacle-bulbs of *Phialucium* have excretory pores mounted upon well-developed papillae. As demonstrated below, the small marginal bulbs are not always permanently rudimentary.

The limitation of the species has been discussed by several authors. Maas (1905, 1906 & 1909) was inclined to think that *Mitrocoma mbenga* Agassiz & Mayer and *Phialidium tenue* Browne were identical with *Phialucium virens*. Bigelow (1909) came to the same

conclusion. Mayer (1910) likewise regarded *P. mbenga* as probably identical with *P. virens*, but agreed with Browne (1905) that *Phialidium tenue* is probably an abnormal specimen of *Irenopsis hexanemalis*. Hartlaub (1909) was inclined to think that also *P. virens* and *mbenga* were aberrant specimens of *Irenopsis hexanemalis*. Vanhöffen (1911) regarded *P. carolinae* as possibly a stunted form of *P. mbenga* (= *P. virens*). Bigelow (1919) has thoroughly studied the various species, counting tentacles, rudimentary bulbs and statocysts, and arrives at the conclusion that *P. carolinae* is a distinct species, restricted to the Atlantic region, and mainly characterized by its great number of statocysts, whereas he unites the Indo-Pacific forms *mbenga* and *virens*, because there is no discontinuity between their relative numbers of marginal organs. Stiasny (1928) agrees with him in this respect. Menon (1932) added a new species, *P. multitentaculata*. Uchida (1947) records *P. carolinae* from the Pelew Islands, and that is the first record of this species from the Pacific. As mentioned below, I consider the vast majority of the numerous specimens from the Great Barrier Reef belong to that species.



TEXT-FIG. 1.—*Phialucium mbenga*, St. L. Margin of umbrella. $\times 35$.



TEXT-FIG. 2.—*Phialucium carolinae*, St. XXXIX. Margin of umbrella. $\times 35$.

Bigelow (1919) carefully counted the rudimentary marginal bulbs in his specimens of *Phialucium*, but he paid no attention to the size of the bulbs, and that is really where we find the distinguishing mark between *P. mbenga* and the other species. In *P. mbenga*, as it is described by Agassiz & Mayer (1899), Maas (1905 as *P. virens*), and Vanhöffen (1911), and as I have seen it in the collection from the Great Barrier Reef (Text-fig. 1) the rudimentary bulbs between the tentacles are all alike, tenon-like or slightly conical, of equal size, and they are really "permanently rudimentary." They are also, as a rule, present in somewhat larger numbers than in the other species. In *P. carolinae*, as figured by Mayer (1900a, pl. 3, fig. 9, and pl. 4, fig. 11; 1910, pl. 36, fig. 1') and in the numerous specimens from the Great Barrier Reef (Text-fig. 2), the number of rudimentary bulbs between successive tentacles is usually 3, and the median one is distinctly larger than the others and is frequently seen in the act of developing into a true tentacle. Also in *P. multitentaculata* Menon (1932) the median rudiment in each space between the tentacles is larger than the two or three other ones. *P. carolinae* is also distinguished by its greater number of statocysts.

The original specimens of *P. virens* (Bigelow, 1904) from the Maldive Islands are distinctly different from *P. carolinae*. and Bigelow (1919) and the other authors mentioned above may be right in referring them to *P. mbenga*. and placing the name *P. virens* in the synonymy. On the other hand, it seems to me most probable that the octoradial form from the Philippine Islands, described by Bigelow (1919) as *P. mbenga* var. *polynema*, is identical with the polyradial form of *P. carolinae*, of which I have found numerous specimens in the collection from the Great Barrier Reef and which will be described below. The same probably applies to the following medusae: *Octocanna polynema* Browne, 1905, Maas, 1905 (but not Maas, 1906). and Menon, 1932. *Phialidium heptactis* Vanhöffen, 1911, and *Phialidium phosphoricum* forma *polynema* Vanhöffen, 1912b. *Octocanna polynema* Bigelow, 1909, from the coast of Mexico, is a different species.

"*Phialidium tenue*" Browne, 1905, which has a short but distinct stomachal peduncle, does not belong to the genus *Phialucium* as has been supposed by some authors, and the various forms of *Pseudoclytia*, with 5 radial canals, are most probably abnormal specimens of *Phialidium*.

Phialucium mbenga (Agassiz & Mayer).

Mitrocoma mbenga Agassiz & Mayer, 1899. Bull. Mus. comp. Zool. Harvard, 32, p. 168, pl. 8, figs. 24, 25.

? *Oceania virens* Bigelow, 1904, p. 252, pl. 1, figs. 3, 4.

Phialucium virens, Maas, 1905, p. 32, pl. 6, figs. 36, 37.

Phialucium mbenga, Mayer, 1910, p. 276; Vanhöffen, 1911, p. 225, pl. 22, fig. 12, text-fig. 16.

? *Phialucium mbenga*, Stiasny, 1928, p. 208.

? *Phialucium virens*, Maas, 1906, p. 93; Mayer, 1910, p. 276, text-fig. 149.

Material (see also Table XVIII).—

- St. XV, F. 3 miles E. 2.x.28. 1 specimen; 7 mm. wide.
 St. XIX, S. 180-0 m. O.T.O. 20.x.28. 1 specimen; 9 mm. wide.
 ,, N. 180-0 m. O.T.O. 20.x.28. 1 specimen; 11 mm. wide.
 St. XX, N. 250-0 m. O.T.O. 20.x.28. 1 specimen; 12 mm. wide.
 St. XLV, S. 500-0 m. O.C.P. 28.ii.29. 1 specimen; 6 mm. wide.
 St. XLIX, S. I.P.P. 17.iii.29. 2 specimens; 5-7 mm. wide.
 ,, C. I.P.P. 17.iii.29. 1 specimen; 6 mm. wide.
 St. L, S. 170-0 m. O.P.P. 18.iii.29. 1 specimen; 8 mm. wide.

This species was fairly rare in the collection, and it was taken in two separate periods, October, 1928, and February-March, 1929. Only on one occasion (St. XV) was it taken at the fixed station, 3 miles east of Low Isles, all the other catches are from the outside waters or (St. XLIX) from one of the channels between the reefs, and mainly in vertical hauls from considerable depths. It seems probable, therefore, that this species mainly occurs in the deeper strata.

As mentioned above *P. mbenga* is distinguished by the rudimentary marginal bulbs being tenon-like and of equal size; moreover the rudimentary bulbs are not provided with an adaxial excretory papilla (Text-fig. 1). In the present specimens their number varies between 4 and 9 between two successive tentacles. The excretory papillae of the tentacle-bulbs are conspicuous. The specimen from St. XV, 7 mm. in diameter, has 11 tentacles; all the other specimens have 16. As a rule there are two statocysts between adjacent tentacles. The number of radial canals is always four, but one specimen (St. XIX, 11 mm.

wide) is slightly abnormal, in so far as one of its radial canals communicates with the ring-canal very near one of the other canals.

Distribution.—Fiji Isles (Agassiz & Mayer); Malayan Archipelago (Maas); north point of Sumatra (Vanhöffen). If the determination by Stiasny is correct, it has also been taken in Java Sea and near Singapore. *P. virens* is recorded from the Maldivé Islands (Bigelow, 1904) and Amboina (Maas, 1906).

Phialucium carolinae (Mayer).

Oceania carolinae Mayer, 1900a, Bull. Mus. comp. Zool. Harvard, **37**, p. 7, pl. 3, fig. 9, pl. 4, figs. 10, 11.

Octocanna polynema Browne, 1905, p. 144, pl. 2, figs. 8-10; Maas, 1905, p. 38; Menon, 1932, p. 23, pl. 3, fig. 25.

Phialucium carolinae, Maas, 1905, p. 32; Bigelow, 1909, p. 157; Mayer, 1910, p. 275, pl. 36, fig. 1', 1''; Uchida, 1947, p. 307.

Phialidium heptactis Vanhöffen, 1911, p. 225, text-fig. 15, pl. 22, fig. 11.

Phialidium phosphoricum f. *polynema*, Vanhöffen, 1912b, p. 19.

Phialucium mbenga, Bigelow, 1919, p. 295.

Phialucium mbenga var. *polynema*, Bigelow, 1919, p. 296, pl. 41, fig. 8.

? *Phialucium mbenga*, Stiasny, 1928, p. 208.

Material.—The present material of this medusa consists of 290 specimens taken within the period 30th July, 1928, to 6th June, 1929 (see Table XVIII and the discussion below).

Remarks on the Morphology.—Most of the specimens have 4 radial canals, but the number of canals varies from 2 to 9, a considerable number of specimens having 6, 7 or 8 (see below). Apart from this numerical variation the individuals are all alike in morphological respects.

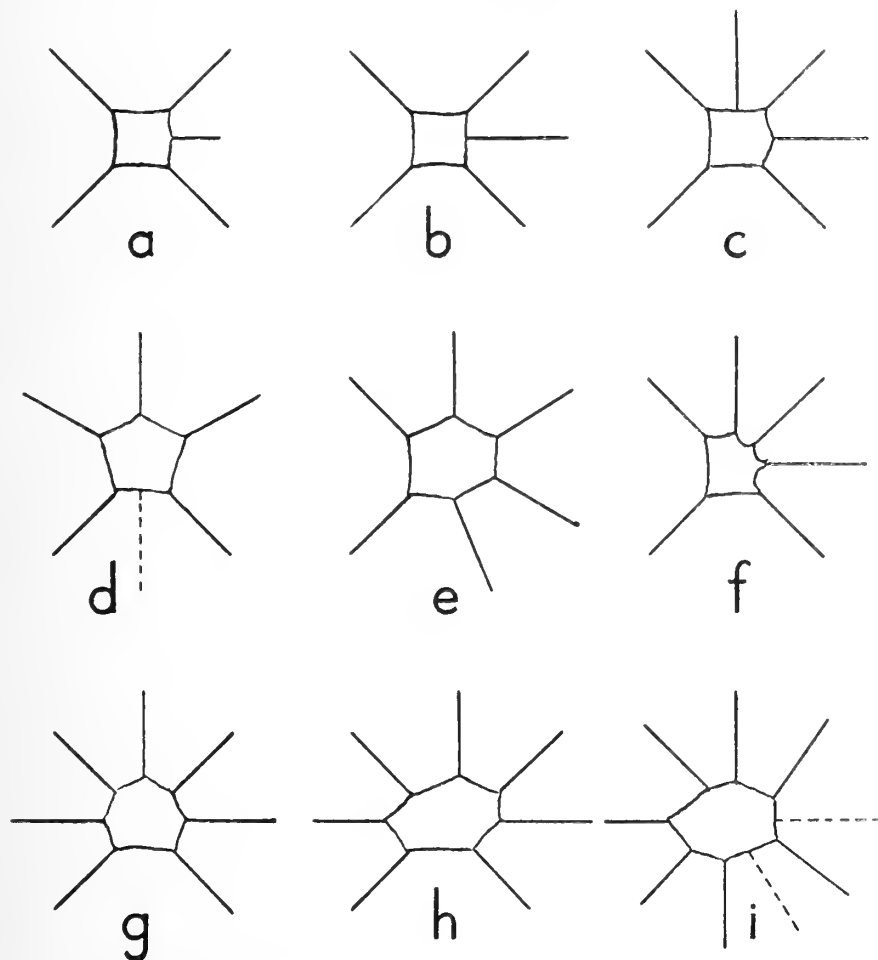
The mesogloal jelly of the umbrella is fairly thick, sometimes very much so. The base of the stomach is broad and quadrate, the stomach is short, and the mouth is provided with long, pointed, frilled lips. Originally there are 4 lips corresponding to the 4 primary radial canals, but when a greater number of radial canals is developed, the supernumerary canals are secondary, frequently issuing from the sides of the stomach in an irregular way; and simultaneously with the development of the secondary canals the shape of the stomach is altered, and the lips are cleft, but the final number of lips is not always the same as the number of radial canals. As seen from the adjacent diagrams (Text-fig. 3) a secondary canal frequently takes its origin from the side of the still square stomach between two of its corners, afterwards drawing the stomach-wall outwards, so that in the end the base of the stomach attains a more or less regular star-shaped outline. Some of the secondary canals may be seen ending blindly at some distance from the stomach (Text-fig. 3a), or they may be distinctly narrower than the others (Text-fig. 3d and i). This latter is the only specimen I have seen with as many as 9 radial canals. There is a marginal tentacle opposite the end of each of the 4 primary radial canals, but not always at the termination of the secondary canals.

Among 253 specimens, in which I have counted the radial canals, I found the following numbers :

Number of radial canals .	2	.	3	.	4	.	5	.	6	.	7	.	8	.	9
Number of specimens .	2	.	3	.	165	.	5	.	13	.	37	.	27	.	1

Thus altogether 65% had 4 canals, 25% had 7 or 8 (most of them 7), and only 7% had 5 or 6. According to the size of the specimens I found the following percentages :

Diam. of umbrella.	2-3 canals.	4 canals.	5-6 canals.	7-9 canals.	Total number of specimens.	Average number of canals.
2-5 mm.	2	84	8	7 ⁰ / ₀	61	4.5
6-10 mm.	2	70	9	19 ⁰ / ₀	106	4.8
11-15 mm.	3	46	5	46 ⁰ / ₀	65	5.6
16-20 mm.	0	53	0	47 ⁰ / ₀	19	5.7



TEXT-FIG. 3.—*Phialucium carolinae*. Diagrams showing examples of arrangement of the radial canals. *a*, St. XXXIII, diam. 5 mm., the fifth canal short and blind. *b*, St. XXXV, diam. 5 mm., the fifth canal fully developed. *c*, St. XXXIX, diam. 3 mm. (4 lips). *d*, St. XXXIV, diam. 4 mm., the sixth canal very thin (stippled), but reaching out to the ring-canal. *e*, St. XXXIX, diam. 6 mm. (5 lips). *f*, St. XXXIX, diam. 9 mm. *g*, St. XXXXI, diam. 13 mm. *h*, St. XXXIX, diam. 7 mm. *i*, St. XXXIX, diam. 5 mm. (7 lips), two of the nine canals thin, but reaching out to the ring-canal.

The only specimen more than 20 mm. wide had 7 radial canals. These figures show that there is a marked increase in number of radial canals in proportion to the size of the individuals. The majority of the specimens keep the number of 4 throughout their life, but in several of them additional canals are developed during their growth. The final conclusion from this investigation is that specimens with supernumerary radial canals do not constitute a special variety in contrast to a typical four-rayed form, but that in certain geographical areas (as on the Great Barrier Reef and in the Philippine waters, c.f. Bigelow, 1919) this species exhibits considerable individual variation in the number of

radial canals, whereas in the numerous specimens observed by Mayer in Charleston Harbour the number was constantly four.

The radial canals and the ring-canal are very narrow. The gonads are linear, somewhat sinuous when mature, and, as a rule, they occupy the distal half of the radial canals, not quite reaching the ring-canal. According to the description by Mayer (1900) the gonads "are developed upon the radial tubes at about one-quarter the distance from the circular vessel to the proboscis," and in his figure of the whole medusa (pl. 3, fig. 9) they are shown as short and oval (as also occasionally seen in Australian specimens), but in his pl. 4, fig. 10, the gonads correspond exactly in shape and position with those of most of the Australian specimens.

The marginal organs are exactly as described and figured by Mayer (pl. 4, fig. 11). The tentacle-bulbs are large, globular or broadly conical, the tentacle being sharply demarcated from the bulb. The adaxial excretory papillae are usually very conspicuous, but by contraction they may sometimes be difficult to see; they are present on all the tentacle bulbs and on the larger of the rudimentary bulbs (Text-fig. 2). The statocysts are very small.

The distribution of the marginal organs is more or less irregular, the spaces between fully developed tentacles varying in breadth. When the space is narrow, it contains only 1 rudimentary bulb; when it is broad there are usually 3 rudimentary bulbs (rarely four) and 4 statocysts (rarely 5 or 6). If the number of rudiments between two tentacles is 3 the middle one is larger than the others, and is frequently seen in a progressive stage of development into a tentacle. As a matter of fact, the small marginal bulbs in this species are not "permanently rudimentary bulbs" as in *P. mbenga*, but every one of them has the potentiality of developing into a tentacle. New small marginal bulbs are, however, constantly added, so that even in the largest specimens there are always a number of rudiments between the tentacles. The rate of development is irregular, and there is no correlation between the size of the specimens and the relative number of tentacles and rudimentary bulbs.

Three specimens from St. XXXV, all with four radial canals, show the following arrangements of marginal organs:

Diam. 6 mm.

Perradial tentacles . . .	I.	II.	III.	IV.	Total 4.
Other tentacles . . .	2 .	2 .	2 .	2 .	8
Rudimentary bulbs . . .	3 3 3 .	3 3 4 .	5* 3 3 .	3 3 3 .	39
Statocysts . . .	6 4 4 .	4 4 6 .	7 3 4 .	4 4 4 .	54

Diam. 12 mm.

Perradial tentacles . . .	I.	II.	III.	IV.	Total 4.
Other tentacles . . .	5 .	5 .	4 .	3 .	17
Rudimentary bulbs . . .	1 1 3 3 1 2 .	2 1 3 3 1 2 .	2 1 3 2 3* .	3* 3 3 3 .	46
Statocysts . . .	3 2 4 4 2 3 .	2 2 3 3 2 2 .	4 2 4 3 5 .	4 4 3 4 .	65

Diam. 15 mm.

Perradial tentacles . . .	I.	II.	III.	IV.	Total 4.
Other tentacles . . .	4 .	5 .	4 .	5 .	18
Rudimentary bulbs . . .	3 2 3 3 4 .	2 2 3 3 3 2 .	1 2 1 3 4 .	4 1 3 2 1 1 .	53
Statocysts . . .	4 6 4 3 5 .	4 4 4 4 3 3 .	3 4 3 5 5 .	6 3 3 3 1 2 .	82

* One especially large, developing into a tentacle.

The number of fully developed tentacles is independent of the number of radial canals. In specimens of different sizes I have counted the following number of tentacles :

Diam. (mm.).	Tentacles.	Diam. (mm.).	Tentacles.	Diam. (mm.).	Tentacles.
2	4-12	8	14-18	14	23-29
3	8-12	9	17-24	15	22-32
4	9-12	10	16-23	16	29
5	8-16	11	18-20	17	26
6	10-20	12	20-28	18	36
7	18-23	13	28	19	28-36

The Australian specimens thus seem to have a somewhat larger number of tentacles than the Atlantic-American specimens. Though the species was "extremely abundant" in Charleston Harbour, Mayer described only one specimen, which was 14 mm. wide with 16 tentacles; presumably the numerous specimens in this locality were subject to some variation, of which, however, no information is given.

Occurrence in the Great Barrier Reef area.—*Phialucium carolinae* was never taken in the hauls over deep water outside the reefs, whereas it was very common in the shallow-water areas. It occurred almost throughout the period of investigation, but in varying number, as will be seen from Table II, in which are also given the size-limits of the specimens in each month.

TABLE II.—*Seasonal Occurrence of Phialucium carolinae.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.
Estimated average number of specimens per one haul	0.2	0.1	0	7	8	65	60	2	16	87	2	1	0
Diameter of umbrella (mm.)	9	14	-	4-6	3-19*	3-19	2-18	5-19	2-19	3-16	3-12	5	-

* Also one 26 mm.

The species was particularly abundant from the middle of November to the end of January, and again from the end of March to the middle of April. The scarcity in February and the greater part of March may be due to hydrographical conditions. The medusa was rare during the winter, but apparently, as seen from the last column in the table above, it has no definite breeding season, young as well as adult specimens occurring at any time.

Distribution.—This species was originally described from Charleston Harbour, South Carolina, on the southern part of the east coast of North America (Mayer, 1900) and later recorded from the Tortugas, Florida (Mayer, 1910). It is most probably the same species which has been recorded under different names from Ceylon (Browne, 1905), Madras in India (Menon, 1932), the Malayan Archipelago (Maas, 1905; Vanhöffen, 1911; Stiasny, 1928), the Philippine Islands (Bigelow, 1919), Amoy in China (Vanhöffen, 1912b) and the Pelew Isles (Uchida, 1947).

Phialucium condensum n. sp.

(Pl. I, fig. 4.)

Material.—

St. LI, S. 25.iii.29. 1 specimen; 5 mm. wide.

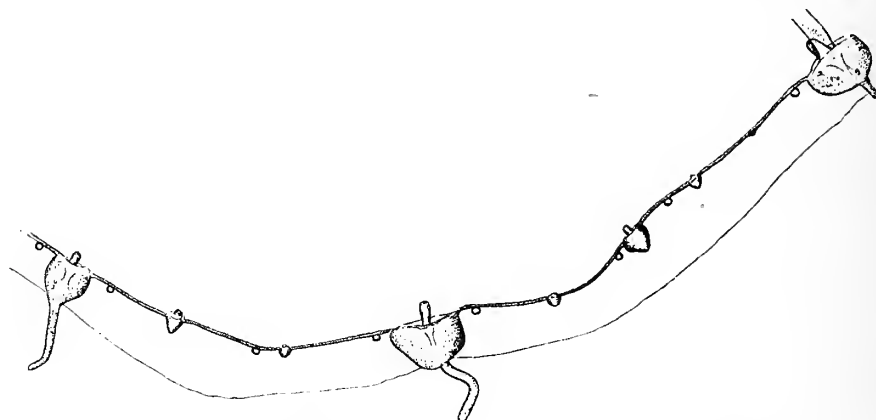
St. LIV, S. 20.iv.29. 1 specimen; 5 mm. wide.

St. LIX, S. 31.v.29. 1 specimen; 6 mm. wide.

„ C. 31.v.29. 1 specimen; 6 mm. wide.

St. LXI, S. 14.vi.29. 1 specimen; 7 mm. wide.

Description.—Umbrella almost as high as wide, with dome-shaped apex, jelly very thick, tapering in thickness towards the margin. Stomach quadrate, broad and flat, attached to the subumbrella along the sides of a perradial cross. Mouth tube short; mouth with 4 short simple lips. Four radial canals and ring-canal very narrow. Gonads about one-fourth to one-third as long as the radial canals, situated very near the corners of the stomach. About 12 marginal tentacles, placed at somewhat irregular distances from each other, with globular or broadly conical bulbs, each provided with a well-developed adaxial excretory papilla (Text-fig. 4). Between each successive pair of tentacles there are 1, 2 or 3 small rudimentary bulbs; when there are 3 the median one is larger than the others; the rudimentary bulbs have excretory papillae, except when very small. The



TEXT-FIG. 4.—*Phialucium condensum*, n. sp., St. LIX. Margin of umbrella. $\times 35$.

statocysts are very small, alternating with tentacles and rudimentary bulbs; when the number of bulbs between two tentacles is 3 there are 4 statocysts. Velum fairly narrow.

It is with some hesitation that I describe these specimens as belonging to a new species. They differ from *P. carolinae* only in the position of the gonads, which are placed at a very short distance from the corners of the stomach. This might be considered a juvenile state, but in one of the specimens, 6 mm. wide, the gonads contain well-developed eggs, and specimens of *P. carolinae* of the same size have not the slightest trace of gonads, and when the gonads appear, their position is in the distal parts of the radial canals.

One of the specimens, 6 mm. wide, is abnormal; it has only 3 radial canals, but 14 tentacles. All the other specimens have 12 tentacles.

This species was only taken in March and April, and only 5 specimens were found. The specimen from St. LIV is chosen as the type and figured in Pl. I, fig. 4.

Genus *Eirene* Eschscholtz.

I provisionally retain this genus with the 12 species which have been referred to it (see Kramp, 1936), but it is possible that in future we must subdivide it. Some of the species are evidently closely related to species of *Phialucium* and *Octocanna*, from which they only differ in the possession of a gelatinous stomachal peduncle of very variable

size and shape; excretory pores are present in some species, lacking in others; in some species additional tentacles soon attain the same size as the previous ones, so that in any stage of development the majority of the tentacles are of the same shape and size, in other species the development of new tentacles is retarded, and one or more tiny rudimentary bulbs are always present in each of the spaces between two fully developed tentacles, exactly as in *Phialucium carolinae* as described above. *E. heranemalis* has been separated from the other species on account of its number of radial canals normally being six, but the newly liberated medusae have only 4 radial canals, and in adult specimens the number varies from 4 to 8 (see below). The whole question of the taxonomy of these medusae and their relatives is very complicated, and until further investigations have been carried out, it seems the safer course to regard species with a stomachal peduncle, with gonads restricted to the subumbrellar parts of the radial canals, with a large and undetermined number of statocysts, and without cirri, as belonging to the genus *Eirene*. Five species of *Eirene* are represented in the collection from the Great Barrier Reef Expedition.



TEXT-FIG. 5.—*Eirene heranemalis*. Margin of umbrella. $\times 35$.

Eirene heranemalis (Goette).

Irenopsis heranemalis Goette, 1886, Sitz. ber. Akad. Wiss. Berlin, p. 832; Mayer, 1910, p. 310, text-figs. 171, 171a.

For further synonymy, see Kramp, 1936, p. 248.

Material.—255 specimens were preserved; they were taken within the period from 3rd October, 1928, to 14th June, 1929 (see Table XVIII and the discussion below).

Remarks on the Morphology and Variation.—This species has been described and figured by several authors, and I shall add only some few remarks. The stomachal peduncle is always distinct, though in several cases it is very low and broad. The base of the stomach is narrow, more or less star-shaped. The mouth-lips are pointed and crenulated. The gonads are linear, comparatively short and placed in the distal portions of the radial canals, terminating at a short distance from the ring-canal; they surround the radial canals completely and are not longitudinally divided along the subumbrellar edge. The number of radial canals is usually 6, but the distance between them is frequently somewhat irregular, and there is not always a tentacle exactly opposite every canal. The adaxial excretory papillae on the tentacle bulbs are distinct. In each inter-tentacular space (Text-fig. 5) there is at least 1 and usually 3 very small rudimentary marginal bulbs, the median one somewhat larger than the others, sometimes so large that it must be designated as a young tentacle. Between two successive tentacles there are usually 4, but sometimes 2 or 6 small statocysts; the number depends on the distance between the tentacles, which is rather variable. The shape and arrangement of the marginal organs bear a very close resemblance to the conditions in *Phialucium carolinae*.

The gonads make their first appearance as tiny dots, when the medusa is 4–5 mm in diameter (see Table III); the greatest length observed was 7 mm. in a specimen 19 mm. wide; even in adult specimens the length of the gonads is very variable.

TABLE III.—*Variation in Eirene hexanemalis.*

Diam of umbrella (mm.).	Number of radial canals.					Number of specimens examined.	Length of gonads (mm.).		Number of tentacles.
	4.	5.	6.	7.	8.		Limits.	Average.	
2	—	1	1	—	—	2	none	—	6
3	—	—	2	—	—	2	„	—	10-12
4	1	1	4	1	—	7	dots	—	12-16
5	—	1	10	—	—	11	„	—	12-15
6	—	3	13	3	—	19	dots to 0.5	—	12-22
7	—	2	11	4	—	17	0.5	0.5	18-29
8	—	—	21	—	—	21	1	1	19-31
9	—	—	14	—	—	14	1-2	1.3	20-29
10	—	3	12	1	—	16	2-3	2.25	23-38
11	—	2	15	3	—	20	1-4	2.6	24-40
12	—	—	23	3	—	26	2-5	3.3	23-46
13	—	1	17	2	—	20	2-6	3.75	25-47
14	—	1	15	1	—	17	3-6	4.7	34-48
15	—	1	5	—	—	6	3-5	4.3	30-46
16	—	—	10	—	—	10	4-6	5.3	38-51
17	—	—	5	—	1	6	3	(3)	43
18	—	—	2	—	—	2	6	(6)	—
19	1	—	6	—	—	7	4-7	(5.5)	34-48
20	—	—	—	—	—	0	—	—	—
21	—	—	—	—	—	0	—	—	—
22	—	—	—	1	—	1	6	(6)	49
Totals	2	16	186	19	1	224			
%	0.9	7.1	83.0	8.5	0.4				
Average diam. (mm.)	(11.5)	8.6	11.5	10.5	(17)				

The variation in number of radial canals is seen in Table III, from which it appears that the normal number of 6 is found in the vast majority of the specimens, 83%, and the variants are grouped very regularly towards both sides, in contrast to the variation in *Phialucium carolinæ*, where the curve of variation has two summits. Within the size-limits represented in this collection there is no correlation between the number of radial canals and the size of the specimens, but in specimens less than 2 mm. wide the number is always four.*

The number of fully developed tentacles in specimens of different sizes is seen in Table III, from which it immediately appears that specimens of equal size may have a very variable number of tentacles; the greatest number observed was 51 in a specimen 16 mm. wide.

TABLE IV.—*Seasonal Occurrence of Eirene hexanemalis.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.
Estimated average numbers of specimens per one haul	0	0	0	1	12	78	112	17	50	7	1	1	0
Diameter of umbrella (mm.)	—	—	—	4-17	4-18	6-22	4-17	2-15	2-19	7-14	8	7-8	—
Average diam. (mm.)	—	—	—	8.2	10.2	12.1	10.2	8.1	8.6	10.6	(8)	(7.5)	—

* On the Danish "Galathea" expedition, 1951, I found a complete developmental series of specimens 1-16 mm. wide on the coast of Mindanao in the Philippines.

Seasonal Occurrence (see Table IV).—*E. hexanemalis* was very seldom taken over deep water outside the reefs. It was completely lacking in July, August and September, and very few were found in October and in May and June, whereas it was very common during the summer from November to March (though less abundant in February), with a distinct maximum of occurrence in December to January. The occurrence of this medusa thus seems to be restricted to a definite season of the year. Nevertheless young as well as adult specimens were taken at any time within this period. Among the 6 specimens found in October, 5 were young ones 4–7 mm. wide, but there was also one adult, 17 mm., and during the following months specimens of all sizes were taken. Thus the liberation of medusae from the (unknown) hydroid of this species evidently takes place throughout the year, but is more active in one part of the year than during the remainder, corresponding to the second of the four "types of breeding" in tropical bottom animals as set forth by A. Stephenson (1934, p. 270).

Distribution.—*Eirene hexanemalis* is widely distributed in the Indian Ocean and western Pacific; it has been recorded from Zanzibar, Ceylon, Madras, Nicobar Islands, Singapore, numerous localities in the Malayan Archipelago, Hong Kong, and southern Japan. It is recorded here from Australia for the first time.

Eirene palkensis Browne.

Irene palkensis Browne, 1905, Ceylon Pearl Oyster Fish., Supp. Rep. 27, p. 141, pl. 3, figs. 12–16.

Phortis palkensis, Mayer, 1910, p. 309.

Further synonymy, see Kramp, 1936, p. 250.

Material.—

St. XXXVI, S. 4.i.1929. 1 specimen.

This is another of the species of *Eirene*, in which 1–3 rudimentary bulbs are present in each space between two successive tentacles. I have seen the type-specimen in the British Museum and can state that it is a valid species. It differs from 4-rayed specimens of *E. hexanemalis* by the slender shape of its stomachal peduncle and much longer gonads. Only one specimen was taken on the Great Barrier Reef; it was 17 mm. in diameter, the peduncle very slender, $\frac{3}{4}$ length of bell-radius; gonads narrow, linear, extending from the base of the peduncle almost to the ring-canal. Forty fully-developed tentacles; intertentacular spaces with 1–3 rudimentary bulbs, the median one somewhat larger than the others, and 2–4 statocysts. An excretory papilla is visible on some of the tentacle-bulbs, but in most of them it cannot be seen, exactly as in the type-specimen. As Browne rightly points out, this may be due to contraction.

Distribution.—This species was first described from Ceylon. According to Vanhöffen (1911, 1912a, 1912b) it has also been found at the Nicobar Islands, near Amoy and Hong Kong, and at Port Natal in East Africa. It has not previously been recorded from Australia.

Eirene kambara Agassiz & Mayer.

(Pl. II, fig. 5.)

Eirene kambara Agassiz & Mayer, 1899, Bull. Mus. comp. Zool. Harvard, 32, p. 169, pl. 8, fig. 29; Bigelow, 1909, p. 161; Kramp, 1936, p. 248.

Phortis kambara. Mayer, 1910, p. 309; Bigelow, 1919, p. 303.

Material.—

- St. XVIII, C. 15.x.1928. 3 miles E. 2 specimens ; diam. 4 mm.
 St. XXV, S. 16.xi.1928. 3 miles E. 2 specimens ; diam. 5–7 mm.
 St. XLIII, S. 26.ii.1929. C.B. 2 specimens ; diam. 3–7 mm.
 St. XLV, S. 28.ii.1929. O.C.P. 1 specimen ; diam. 5 mm.
 St. XLVIII, S. 15.iii.1929 3 miles E. 1 specimen ; diam. 4 mm.
 St. XLIX, C. 17.iii.1929. I.P.P. 1 specimen ; diam. 5 mm.

The only description of this species was based on a single specimen taken at the Fiji Isles. Bigelow was inclined to regard it as a young specimen of *E. ceylonensis*, partly because it was supposed to be destitute of gonads. It is true that gonads are not indicated in the figure of the medusa, but in the description it is stated that the gonads occupy the lower portions of the radial canals. The present specimens, however, differ distinctly from specimens of *E. ceylonensis* of similar size, as I have seen them in the collection from the Great Barrier Reef. In specimens of this latter species, 3.5–8 mm. wide, the peduncle is very slender, $\frac{1}{2}$ – $\frac{2}{3}$ of bell radius length, and the mouth-lips are long and pointed with frilled margin ; moreover the gonads are elongated, and the number of the tentacles is considerably larger. Even in such young specimens of *E. ceylonensis* there are no, or very few, rudimentary marginal bulbs between the tentacles.

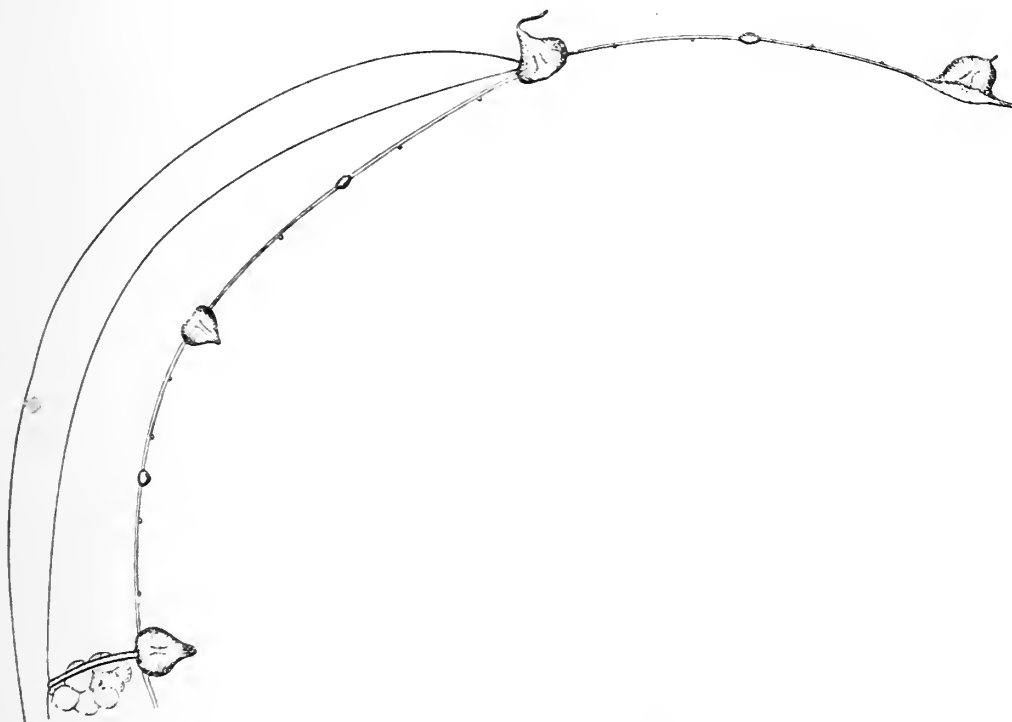
Remarks on the Specimens.—The young specimens from St. XVIII, 4 mm. wide, have 8 tentacles, 8 young marginal bulbs and some few very tiny ones ; the gonads are just visible as tiny swellings near the ring-canal. In the specimens 5–7 mm. in diameter the jelly of the exumbrella is very thick, evenly rounded, the peduncle short and very broad, distinctly marked off from the concave peripheral portion of the subumbrella, with a tendency to form 4 interradial protuberances near the stomach ; this is evidently a result of contraction. The stomach is narrow and elongated, cross-shaped in transverse section ; the mouth has 4 short and simple lips. The gonads are short and oval, placed near the ring-canal ; in one specimen (St. XLIII, 7 mm. wide, Plate II, fig. 5) 2 of the 4 gonads contain large, ripe eggs. The radial canals and ring-canal are very narrow. These specimens have 15–19 tentacles with broad basal bulbs (Text-fig. 6) ; excretory pores are not visible, and are apparently lacking. Between every successive pair of tentacles there is one small rudimentary bulb and usually four remarkably small statocysts ; the total number of statocysts in all specimens 5–7 mm. wide is about 64. The velum is fairly narrow.

These specimens seem to me to differ from the type-specimen of *E. kambara* in one point only, *viz.*, the number of fully developed tentacles. The type was slightly larger, 8 mm. in diameter, with 32 small tentacles and no rudimentary bulbs ; if the rudimentary bulbs of the Australian specimens develop into tentacles, their number will likewise be about 32, and the number of statocysts is the same as in the type. I do not hesitate, therefore, to refer these Australian specimens to a species originally described from the Fiji Isles, and after seeing the present specimens I am sure that *E. kambara* is a distinct species which cannot be confounded with any other species of *Eirene*.

The specimen from St. XLVIII, 4 mm. wide, is abnormal ; it has 12 tentacles and 12 rudimentary bulbs and 2 stomachs. There is a central stomach of normal shape, but in the middle portion of one of the four radial canals a second and somewhat smaller stomach is developed ; it has the same elongated shape as the normal one, but the mouth has only

2 lips; from one side of the base of this secondary stomach a canal issues perpendicularly, making a bend outwards and approaching the ring-canal, which, however, is not reached. This abnormality recalls the conditions in the different species of *Gastroblasta*, all of which are most certainly abnormal specimens of *Phialidium* or similar medusae, or specimens in the act of asexual reproduction by fission.

Distribution.—Previously known only from the Fiji Isles.



TEXT-FIG. 6.—*Eirene kambara*, St. XLIII. Margin of umbrella. $\times 35$.

Eirene ceylonensis Browne.

Irene ceylonensis Browne, 1905, Ceylon Pearl Oyster Fish., Supp. Rep. 27, p. 140, pl. 3, figs. 9–11.

Phortis ceylonensis, Mayer, 1910, p. 309.

For further synonymy, see Kramp, 1936, p. 249.

Material.—

St. XXV, C. 16.xi.28. 3 miles E. 3 specimens; diam 8, 18, 22 mm.

St. XXXVI, S. 4.i.29. 3 miles E. 2 specimens; fragmentary.

St. LI, S. 25.iii.29. 3 miles E. 1 specimen; diam. 3.5 mm.

Of this well-known and well-described species only some few individuals were taken on the Great Barrier Reef. I have counted the following numbers of tentacles:

Diam. of umbrella (mm.)	3.5	8	18	22
Number of fully developed tentacles	32	42	c. 70	c. 84

Young bulbs may sometimes be present among the fully developed tentacles; in the specimen 8 mm. wide there are 12, in the largest specimen (22 mm.) even as many as about 50 (they could only be counted in half the circumference). The smallest specimen, 3.5 mm. wide, has no rudiments between the 32 tentacles. In the largest specimen the

gonads occupy the entire length of the radial canals from the base of the peduncle to the ring-canal; they are very thin and seem to have shed their contents of sexual products.

Distribution.—Ceylon, brackish water in the Ganges estuary, Java Sea, and the Philippine Islands. Not previously recorded from Australia.

Eirene menoni n. sp.

(Plate II, fig 6.)

Phortis sp. Menon, 1932, p. 18.

Phortis lactea Mayer, Ling, 1937, p. 357, figs. 9-10.

Material.—

St. XXXII, S. 5.xii.28. 3 mi. E. 1 specimen.

Description (Plate II, fig. 6).—Umbrella 12 mm. wide and 5 mm. high, evenly rounded; jelly fairly thin, tapering towards the margin; stomachal peduncle slender, slightly widened at the base, its length somewhat less than the height of the subumbrellar cavity. Stomach short; mouth with four well-developed, pointed lips with frilled margins. Four radial canals and ring-canal narrow, gonads linear and somewhat sinuous, extending from the base of the peduncle almost to the ring-canal. Forty-six tentacles with conical bulbs and two young marginal bulbs. No excretory papillae. The tentacles are all of nearly the same size, but the distance between them is variable. The number of statocysts between two successive tentacles is 1-3, dependent on the distance between the tentacles. Velum moderately broad. In formalin the stomach, gonads and tentacle-bulbs are reddish brown.

This medusa evidently belongs to the same species as that described by Ling (1937) from the Chekiang Coast, China. He referred it to *Phortis lactea* Mayer, a small medusa found at the Tortugas, Florida. In that species, however, the peduncle is considerably longer, extending well beyond the subumbrella cavity and broader at its base; the lips are short and simple, and the gonads, which were ripe, did not quite reach either the ring-canal or the base of the peduncle. It therefore seems to me rather improbable that the Chinese and Australian medusae belong to this western Atlantic species. On the other hand, it seems to me very probable that the medusae described (but unfortunately not figured) by Menon from the coast of India near Madras are identical with the Chinese and Australian forms. Menon's medusae were up to 7 mm. wide with about 48 tentacles; the Chinese form has about 32 tentacles when 8 mm. wide; the single Australian specimen is 12 mm. wide with 48 tentacles (including two young bulbs). I name this species in honour of Mr. Menon, who gave the first description of it.

Distribution.—Coral Sea; China Sea; Bay of Bengal.

Helgicirrha malayensis (Stiasny).

Eirene malayensis Stiasny, 1928, Zool. Meded. Mus. Nat. Hist. Leiden, 14, 4, p. 210, text-fig. 1; Menon, 1932, p. 20, pl. 3, fig. 23.

Helgicirrha malayensis, Kramp, 1936, p. 255.

Eirene madrasensis Menon, 1932, p. 20, pl. 3, fig. 24.

Material.—234 specimens were preserved; they were taken during the period from 20th September, 1928, to 14th June, 1929. See Table XVIII and the discussion below.

Since I have seen these numerous specimens, which evidently belong to *H. malayensis* Stiasny, I now doubt very much the supposed identity of this species with *H. danduensis*

(Bigelow, 1904 : see Kramp, 1936, pp. 255–256). The single specimen of *H. danduensis*, taken at the Maldive Islands, might perhaps be considered as an aberrant individual with an especially elongated stomach and comparatively short gonads : but not one of the Australian specimens showed these features : in all of them the stomach is short, and the gonads, except in the very young specimens, always reach from the ring-canal at least to the base of the peduncle and frequently somewhat down the sides of the peduncle. I prefer, therefore, to regard *H. malayensis* as a distinct species. The medusae from India, described by Menon, undoubtedly belong to the same species.

The specimens from the Great Barrier Reef differ from the Malayan and Indian specimens only in one respect, *viz.*, the number of tentacles. According to Stiasny specimens 20 mm. wide have up to 45 tentacles, and Menon counted about 50 tentacles in specimens 25 mm. in diameter. In the specimens examined by me I found the following number of tentacles, some of which were quite small but with distinctly pointed tips :

Diameter of umbrella (mm.)	3–5	6–10	11–15	16–20	21–25
Number of tentacles	16–34	30–60	48–91	90–141	114–141

The relative number of tentacles and rudimentary bulbs (all of which have the potentiality of developing into tentacles) is very variable and independent of the size of the individuals. There is frequently an equal number of both, or twice (rarely 3 times) as many young bulbs as tentacles, but sometimes there are two or three or even four times as many tentacles as young bulbs. In two specimens (St. XVIII), 17 mm. wide, there are about 120 tentacles of different sizes and only some few young bulbs. These specimens lead me to the conclusion that the medusae from Madras described by Menon as a new species, *H. madrasensis*, are similar specimens of *H. malayensis*, in which most of the marginal bulbs have developed into tentacles.

The cirri are readily lost in the preserved specimens, but in a few specimens I have found almost all of them retained, and they were present on the tentacle bulbs as well as on the largest of the young bulbs.

The number of statocysts is somewhat variable : as a rule they are present in about the same number as tentacles + young bulbs, but in some of the larger specimens the number of statocysts does not exceed the number of tentacles.

The succession of the marginal organs on the umbrella margin is somewhat irregular. In a specimen 23 mm. wide I have found the following succession (*t* = tentacles of all sizes, *b* = young bulbs, *s* = statocysts) : *bstbstbstbstbstbstststbstbstbstbstbstbststst*, altogether 23 tentacles (large and small ones), 15 young bulbs, and 19 statocysts.

Adaxial excretory papillae may be difficult to see, but sometimes they are quite distinct.

Two small specimens, 5 and 7 mm. wide (St. XXVII) had swallowed one or two appendicularians, tail first, the bodies hanging outside the mouth of the medusae ; another specimen in the same catch had swallowed a *Sagitta*, head first.

TABLE V.—*Seasonal Occurrence of Helgicirrha malayensis.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	.	I.	II.	III.	IV.	V.	VI.	VII.
Estimated average number of specimens per one haul	0	0	0.2	7	7	39	.	17	32	15	6	7	1	0
Diam. of umbrella (mm.).	-	-	6–10	8–17	4–20	11–25	.	4–28	5–24	6–20	10–22	6–24	9	-

Seasonal Occurrence (see Table V).—*Helgicirrha malayensis* was entirely lacking in the samples from July and August, and it was scarce until the middle of November; it then increased rapidly in numbers with maximal occurrence in December to February and thenceforward occurred in variable quantities until May; one single specimen was taken as late as 14th June, and after that date the species disappeared completely. Within the period of common occurrence, October to May, young as well as adult specimens were found at any time, so that medusae are presumably liberated from the unknown hydroid throughout the year, though with a considerably greater activity during the summer and autumn.

Distribution.—Java Sea and east coast of India.

Eutima levuka (Agassiz & Mayer).

Eutimeta levuka Agassiz & Mayer, 1899, Bull. Mus. comp. Zool. Harvard, **32**, p. 163, pl. 9, figs. 30, 31.

Eutima levuka var. *ocellata* Maas, 1905, p. 35, pl. 7, figs. 43, 44.

Eutima lactea Bigelow, 1904, p. 253, pl. 2, figs. 7, 8; Mayer 1910 p. 300, text-fig. 164.

Eutima levuka, Mayer, 1910, p. 301; Bigelow, 1919, p. 299; Stiasny, 1928, p. 208.

Eutimeta levuca, Apstein, 1913, p. 611.

non *Eutima levuka*, Bigelow, 1909, p. 165, pl. 5, figs. 2, 3, pl. 35, figs. 1, 2.

Material.—The preserved collection contains 54 specimens which were taken during the period 11th September, 1928, to 25th May, 1929 (see Table XVIII), usually in very small numbers. The specimens varied from 4.5 to 14 mm. in diameter, apparently without correlation to the season.

I agree with Bigelow (1919) that *E. lactea* from the Maldive Islands is the same species. On the other hand, I do not think that the specimens from the west coast of Mexico, described by Bigelow (1909), belong to this species. The specimens were 6 mm. in diameter with no trace of interradial tentacles. In the present collection there are two small specimens only 4.5 mm. wide; one of them has eight well-developed tentacles, and in the other the interradial tentacles are represented by large bulbs. Bigelow (1919, p. 301) describes another medusa from the Philippines and refers it with a query to *E. levuka*; it was 11 mm. wide and had 23 large tentacles. It seems to me impossible that this species should ever be able to develop such a large number of tentacles; none of the specimens from the Great Barrier Reef have more than eight tentacles, though some of them are 12–14 mm. wide.

Two of the present specimens are somewhat abnormal. In one of them (9 mm. wide) one of the radial canals is bifurcated; in the other (8 mm. wide) one of the quadrants is narrower than the others and has no interradial tentacle, whereas in the opposite quadrant there are 2 tentacles close together in the interradius.

Distribution.—*Eutima levuka* occurs in the Malayan Archipelago and at the Maldive Islands, the Philippines and the Fiji Isles. Not previously recorded from Australia.

Eutima curva Browne.

Eutima curva Browne, 1905, Ceylon Pearl Oyster Fish., Supp. Rep. **27**, p. 138, pl. 3, figs. 1–3; Mayer, 1910, p. 300.

Eutima australis Mayer, 1915, p. 201, pl. 3, fig. 5.

Material.—Several specimens were taken between 6th September, 1928, and 7th June, 1929 (see Table XVIII). The occurrence was fairly evenly scattered over this period. The size of the specimens varied from 6 to 11 mm. in diameter without any relation to the season.

Distribution.—The only previous record of this species is from Ceylon, but the medusa from Torres Strait, described by Mayer (1915) as a new species, *Eutima australis*, seems to be the same species. It has a similar hook-like abaxial process on the four tentacle bulbs and a patch of black pigment in the tips of the marginal warts. It is said to have eight gonads, but they "appear to reach maturity only over the peduncle." The presumed subumbrellar gonads may, therefore, be only slight dilatations of the walls of the radial canals, and if so the species is in almost perfect agreement with *E. curva*.

Genus *Aequorea* Péron & Lesueur.

It has repeatedly been emphasized that the numerous species of *Aequorea* need a revision. The collection of the Great Barrier Reef Expedition is of considerable interest in this respect. It contains the following four species *A. conica* Browne, *australis* Uchida, *pensilis* Haeckel, and *macrodaetyla* Brandt, all of them represented by juvenile as well as adult specimens, and they give occasion to a discussion of the limitation and affinities of these and related species.

In the literature *A. conica* is mainly characterized by the peculiar shape of the umbrella, which is provided with a highly vaulted and very thick apical mass of jelly; very young individuals of the other species may, however, have a similar shape. Nevertheless *A. conica* is well distinguished by other features and should be considered a valid species.

A. australis was described as a new species as late as 1947: it resembles *A. globosa* Eschscholtz, but the numerous specimens in the present collection have convinced me of its validity as a distinct species.

A. pensilis and *macrodaetyla* are old and well-known species observed and described by several authors. Russell (1939) is inclined to regard the latter as a variety of *pensilis*; his conclusion is based on the careful examination of specimens from British waters. In the present collection, however, the two forms seem to be so distinctly separable that I must regard them as two independent species. Specimens less than 7–8 mm. in diameter have not previously been described; in the samples from the Great Barrier Reef both species are represented by very young stages only 2 mm. wide.

Aequorea conica Browne.

Aequorea conica Browne, 1905, Ceylon Pearl Oyster Fish., Supp. Rep. 27, p. 145, pl. 1, fig. 2, pl. 2, figs. 16, 17, 18; Stiasny, 1928, p. 213.

Material.—

St. XLI, C. 13.ii.29. 3 miles E. 1 specimen; diam. 2.2 mm.

St. XLIV, S. 27.ii.29. Li.I. 2 specimens; diam. 5 and 6 mm.

Description of the Specimens.—Diam. 2.2 mm., as high as wide, with a very thick and vaulted apical projection; stomach 1 mm. wide. Fifteen radial canals, seven of which carry a well-developed, swollen gonad occupying a little less than the proximal half portion of the radial canal; in the remaining eight canals the gonads are only slightly indicated. The mouth-lips opposite the seven canals with well-developed gonads are long and pointed, considerably longer than the other ones. The umbrella margin is somewhat damaged, and the number of tentacles could not be determined.

Diam. 5 mm., height 3 mm., of which the apical jelly makes about one-half. Stomach 2 mm. wide. Sixteen radial canals, two of them without gonads; on the other canals the gonads are well developed, more or less swollen, along a little less than the proximal half of the canals. Sixteen mouth-lips, all of them long and pointed; 12 fully developed tentacles and some young bulbs.

Diam. 6 mm., height 4 mm., apical jelly 2 mm. Stomach 2.5 mm. wide. Sixteen radial canals, all alike, with well-developed gonads along the entire half portion of the canals nearest to the stomach; the gonads are linear and only moderately swollen. Sixteen long and pointed mouth-lips; 27 tentacles. In about half the number of inter-tentacular spaces there is a minute rudimentary bulb and usually two statocysts; in the spaces without a rudimentary bulb there is only one statocyst.

The tentacle bulbs are pear-shaped or almost globular, with no indication of abaxial spur or adaxial excretory papilla. In comparison with specimens of similar size of other species the long and pointed mouth-lips are very remarkable.

This little medusa, remarkably small for an *Aequorea*, was described from the Gulf of Manaar between Ceylon and the south coast of India. Browne saw six specimens, 5–7 mm. in width and 6–8 mm. in height with 15–18 radial canals (usually 16) and about 26–30 tentacles. Between two successive tentacles there was a very minute marginal bulb and two statocysts, sometimes only one. In spite of their small size the specimens all had ripe gonads, confined to the proximal half of the radial canals. Also in these specimens the oral lips are stated to be long and slender. The agreement between the present specimens and the types is so perfect in all essential features that I refer them without any doubt to the same species.

Stiasny examined a considerable number of specimens of this species collected in the Java Sea and near Singapore, some of them somewhat larger than the types, being up to 9 mm. in diameter and 10–12 mm. in height, and with somewhat longer gonads; the number of radial canals varied between 14 and 20, but was usually 17 or 18.

There is only one other species of *Aequorea* which has ripe gonads at a similar small umbrella-diameter, viz., *A. parva* Browne (1905). The original specimens from Ceylon were only up to 6 mm. wide, but somewhat larger specimens have been observed from Djibouti in the Gulf of Aden (Hartlaub, 1909), Java Sea and Singapore (Stiasny, 1928) and Madras (Menon, 1932). This species differs from *A. conica* in that the numbers of tentacles never exceed eight (usually only four), in the position of the gonads in the middle portion of the radial canals, and in having a much larger number of rudimentary marginal bulbs and statocysts. The two species are quite distinct.

Aequorea australis Uchida.

Aequorea australis Uchida, 1947, Journ. Fac. Sci. Univ. Hokkaido (4) Zool. 9, p. 307, text-fig. 8.

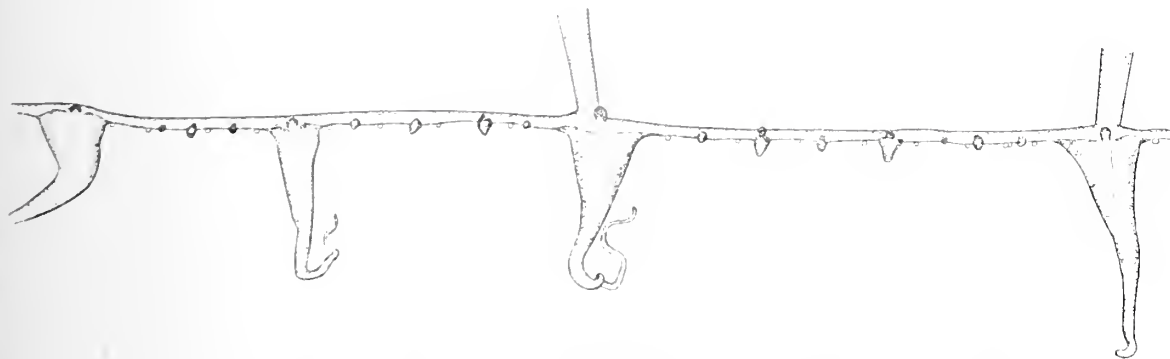
Material.—157 specimens of this medusa were preserved by the Great Barrier Reef Expedition. It occurred in varying numbers throughout the whole duration of the expedition, with only short interruptions (see Table XVIII and the discussion below).

The original specimens were taken on the coast of Arnhem Land, Northern Australia, and at the western part of New Guinea. The specimens from the Great Barrier Reef agree perfectly with the original description, but many of them are of smaller or larger size, ranging from 2 mm. to 38 mm. in diameter, whereas the type-specimens only varied between

11 and 31 mm. The question must, however, be considered whether it is a valid species distinct from *A. globosa* Eschscholtz.

Remarks on the Morphology.—Among the Australian species of *Aequorea* this species is immediately conspicuous by the comparatively small size of the stomach, the distal position of the gonads, and the approximately equal number of tentacles and radial canals. The umbrella is rather flat, the gelatinous substance moderately thick, thinner towards the margin, which is generally bent inwards in preserved specimens. In very young specimens the umbrella is sometimes, but not always, highly vaulted and provided with a thick, dome-shaped apical projection. I have measured almost all the specimens and counted their radial canals and tentacles, except in some few which were badly preserved. The diameter of the umbrella was measured in the actual condition of the specimens regardless of the margin being more or less bent inward; this evidently causes a certain degree of inexactitude in the calculations of the relative dimensions and numbers given in Table VI.

The stomach is flat and the mouth usually widely open, but in some specimens the mouth is narrowed, and then the stomach attains a funnel-shaped appearance. The lips are fairly short.



TEXT-FIG. 7.—*Aequorea australis*, St. XXXII. Margin of umbrella. $\times 25$.

The counts of the radial canals include all the canals reaching from the stomach to the ring canal, even if some of them are quite narrow, recently developed and still destitute of gonads. As a rule the development of additional canals seems to proceed irregularly, but in some few specimens new and thin canals alternate almost regularly with the fully differentiated ones; this has been observed in specimens of the following sizes: 5, 9, 14 and 16 mm. in diameter. Short, blindly ending canals are occasionally seen; they are not included in the counts. Anastomoses and other irregularities of the radial canals may occur, but not very frequently.

Gonads may begin to appear, when the diameter of the umbrella is only 8 or 9 mm., but even in specimens about 17 mm. wide the gonads may still be very slightly developed. In adult specimens the gonads are linear, slightly wavy, about half as long as the radial canals and placed considerably nearer to the ring canal than to the stomach, being separated from the ring canal by a very short space, but widely apart from the stomach.

The tentacle bulbs (Text-fig. 7) are remarkably slender and have no indication of an abaxial spur. Between the tentacles there are a varying number of minute marginal bulbs, slightly conical or tenon-like; some of them are usually a little larger than the others and are in reality developing into tentacles. The largest of these young bulbs as well as

the tentacle bulbs are each provided with a distinct adaxial excretory papilla (this is not mentioned in the description by Uchida). In some few of the specimens the tentacles are well extended and almost as long as the diameter of the umbrella. The distance between the tentacles is more or less irregular, and not all of them are placed opposite the end of a radial canal. According to the distance between two successive tentacles the number of young marginal bulbs may vary from 3 to 12; in a specimen 17 mm. wide with 19 tentacles I counted 105 tiny bulbs. As a rule the statocysts are present in the same number as the tentacles + rudimentary bulbs, one between each successive pair, regardless of the size of the bulbs.

The relative size of the stomach is seen from Table VI. The variation is rather considerable, but on an average the diameter of the stomach is a little more than one-third the bell-diameter, and it never attains half the width of the umbrella. The rate of development of the radial canals and tentacles is somewhat irregular (see Table VI). In the youngest stage observed, 2 mm. wide, there were eight radial canals, but I have also seen specimens 3-5 mm. wide with only eight canals; on the other hand, a small individual, 2.5 mm wide, already had 16 canals, and the same number was found in some fairly large specimens, 11, 15 and 17 mm. wide. The largest number of radial canals observed was 32; in one exceptional case this number was found in a specimen only 9 mm. in diameter. In adult specimens more than 25 mm. wide the number of radial canals was at least 26.

TABLE VI.—*Dimensions of Aequorea australis.*

Diameter of umbrella (mm.)	Diameter of stomach (mm.).		Number of radial canals.		Number of tentacles.		Ratio of diameters of stomach and umbrella.	Ratio of number of tentacles and radial canals.
	Variation.	Average.	Variation.	Average.	Variation.	Average.		
2-5	1-2	1.55	8-19	11.8	4-16	9.0	1:2.4	1:1.3
6-10	2-5	3.1	12-32	19.0	9-23	15.1	1:2.6	1:1.27
11-15	3.5-5	4.55	16-32	24.0	14-31	21.4	1:2.9	1:1.14
16-20	5-8	6.5	16-32	26.9	18-33	25.4	1:2.8	1:1.06
21-25	5-10	7.8	16-32	26.7	24-36	28.6	1:2.9	1:0.93
26-30	7-11	9.8	26-32	30.2	27-32	29.8	1:2.8	1:1.0
33	12	12	28	28	35	35	1:2.8	1:0.8

The number of fully developed tentacles may amount to 36 (in a specimen 25 mm. wide), but is rarely more than 32, and this number may be attained, when the bell-diameter is about 18 mm. The average, as well as the limits of variation, in number of tentacles in specimens of different sizes are seen from Table VI. One young specimen, 2.5 mm. wide had only four tentacles and 12 young bulbs; another of the same size had eight fully developed tentacles. In specimens up to 5 mm. in diameter I have counted the following numbers:

Diam. (mm.)	2.5	3	4	5
Number of tentacles	4, 8	7, 8, 8, 10	12	8, 8, 12, 16

The average ratios of numbers of tentacles to radial canals are seen from Table VI; in young specimens the number of canals is almost always somewhat larger than the number of tentacles (ratio 1:1.3 in specimens up to 5 mm.), but the tentacles increase a little more rapidly in number than the canals, and when the umbrella is more than 15 mm.

wide there are usually about as many tentacles as canals. There is some variation, however; extreme cases were:

Diameter (mm.)	.	.	13	.	17	.	21	.	22
Tentacles	.	.	14	.	30	.	28	.	26
Radial canals	.	.	24	.	19	.	19	.	16

The numbers found in the specimens from the Great Barrier Reef are in good accordance with the figures given by Uchida.

Comparison with A. globosa.—The description of *A. globosa* by Eschscholtz (1829, p. 110, pl. 10, fig. 2) was based on specimens taken in the Pacific near the Equator; they were about 40 mm. high and wide, with a thick, dome-shaped apex, 30–32 radial canals and as many tentacles, and gonads reaching from the periphery of the stomach nearly to the ring-canal. Maas (1905, p. 43, pl. 8, figs. 48, 49, 50) and Stiasny (1928, p. 214) were probably right that their specimens from the Malayan Archipelago belong to the same species, which is mainly characterized by the shape of the umbrella, the comparatively small stomach, the approximately equal numbers of tentacles and radial canals, and the slender tentacle bulbs. It is not stated whether excretory papillae are present. Uchida has, in tabular form, compared it with his new species *A. australis*, and he found that “the relative numbers of tentacles and radial canals to the bell diameter given by Maas and Stiasny are distinctly different in these two species.”

The extensive collection from the Great Barrier Reef has augmented the limits of variation in *A. australis*, and to some degree effaced the numerical difference between the two species, as far as young individuals are concerned, as will appear from the following table:

TABLE VII.—*Aequorea australis and globosa.*

Diam. of umbrella (mm.).	Width of stomach (mm.).		Number of radial canals.		Number of tentacles.	
	<i>australis.</i>	<i>globosa.</i>	<i>australis.</i>	<i>globosa.</i>	<i>australis.</i>	<i>globosa.</i>
8	3–4	3	15–25	29	10–23	29
9	4–5	4	19–32	30	12–18	28
10	3–4·5	4	17–27	27	12–19	27
11	4–4·5	5	16–20	30	14–19	30
12	5	5–6	20–32	32–48	20–25	30–48
14	3·5–5	–	25–32	44	20–31	45
16	5–7	7	24–32	38	18–32	38
20	8	9	22–30	48–49	26–30	48–49

The relative width of the stomach presents no difference between these species, but with increasing age *A. globosa* attains a considerably higher number of radial canals and tentacles than *A. australis*. The characteristic highly vaulted shape of the umbrella in *A. globosa* is only occasionally seen in very young specimens of *A. australis*. Moreover it is expressly stated by Maas and Stiasny that the gonads of *A. globosa* occupy almost the entire length of the radial canals, even in fairly young specimens, which is in striking contrast to the conditions in *A. australis*. I have been able to examine the specimens of

A. globosa previously described by Stiasny and kindly lent to me by the Rijksmuseum van Natuurlijke Historie in Leiden. They are very different from *A. australis* and, above all, there is not the slightest trace of an excretory papilla on the tentacle bulbs. This removes any doubt, and I consider *A. australis* a well-distinguished form specifically different from *A. globosa*.

TABLE VIII.—*Seasonal Occurrence of Aequorea australis.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.	
Estimated average number of specimens per one haul	1	2	1	9	3	33	.	1	2	10	4	2	3	4
Diam of umbrella (mm.).	2-17	3-15	7-10	2-22	4-25	2-33	.	5	12-18	3-15	7-22	5-38	4-18	?
Average diam (mm.).	10.3	8.3	7.75	9.9	16.0	19.0	.	5	15.5	6.8	13.0	17.0	9.2	?

Seasonal Occurrence of Aequorea australis (see Table VIII).—This species occurred in slightly varying numbers throughout the whole period from 30th July, 1928, to 17th July, 1929, but as a rule only some few specimens were taken in each of the numerous hauls. It was only plentiful in December, when the estimated average number of specimens per one haul was 33. The collection from this month contains specimens of all sizes, 8–33 mm. at St. XXXII, 2.5–29 mm. at St. XXXV. Its habitat is distinctly neritic; only on one occasion (St. XXVIII) was it taken outside the reefs. Young specimens were taken at all seasons; the irregular seasonal occurrence of adult specimens, as it appears from Table VIII, may be due to the scarcity of the species in some periods, during which the samples are not representative, the more so because adult specimens of a medusa of this size are not easily caught in nets of the types used by this expedition.

Aequorea macrodactyla (Brandt).

Mesonema macrodactylum Brandt, 1838, Mém. Ac. St. Pétersbourg, 4, 2, p. 359, pl. 4.

Polycanna purpurostoma Agassiz & Mayer, 1899, p. 169, pl. 8, figs. 26–28.

Aequorea maldivensis Browne, 1904, p. 732, pl. 56, figs. 4–12.

Mesonema macrodactylum, Maas, 1905, p. 40, pl. 8, figs. 51, 54.

Aequorea macrodactylum, Bigelow, 1909, p. 174, pl. 36, figs. 5–10; Bigelow, 1919, p. 313, pl. 43, fig. 7.

Aequorea macrodactyla, Mayer, 1910, p. 333; Browne, 1916, p. 189; Menon, 1932, p. 23; Thiel, 1938, p. 332, text-fig. 9; Uchida, 1938, p. 146; Russell, 1939, p. 350.

Mesonema coelum pensile, Vanhöffen, 1911, p. 230 (in part).

Material.—20 specimens were taken in 13 hauls between 2nd October and 13th February (Sts. XV–XLI, see Table XVIII). Their occurrence was rather scattered within this period. The majority of the specimens were young stages, from 2 mm. wide upwards, only three being more than 20 mm. in diameter (up to 35 mm.).

Remarks on Morphology and Development.—In all specimens, from the youngest stages to the largest individuals, the tentacle bulbs have the shape characteristic of *A. macrodactyla*, with a distinct abaxial “clasp” or “spur” in contradistinction to *A. pensilis*. This difference between the two species has been pointed out mainly by Browne and Bigelow; in *A. pensilis* the marginal bulbs have an excretory pore, but no trace of a papilla, as shown by Browne (1905, p. 148) in microtome sections. The distance between the tentacles is more or less irregular, and accordingly the number of young marginal bulbs between successive tentacles is variable; in a specimen 30 mm. in diameter with 32 fully developed

tentacles the number of young bulbs was most frequently three, the median one being somewhat larger than the others; when it has reached a certain size, two more minute bulbs appear in the same space. In reality all the small marginal warts have the potentiality of developing into tentacles. In this specimen the statocysts alternate, more or less, with the tentacles + bulbs.

. *Development* (see Table X).—Two individuals are only 2 mm. in diameter; one of them has eight radial canals and nine tentacles, in the other one the number of canals is 16 alternately well developed and very thin and narrow, and it has only seven tentacles. One specimen is 3 mm. wide with 12 canals and only four tentacles. Diameter 4 mm., three specimens, each with eight tentacles (in one of them four of the tentacles are very small); one has 28 radial canals, another 30, and in the third there are 16 fully developed and 16 blindly ending canals. In one of these specimens the umbrella is as high as wide with a thick gelatinous projection similar in shape to *A. conica* (see above). The further development of tentacles and radial canals is very irregular. Most of the specimens up to 14 mm. in diameter have only eight tentacles, but two (about 6 mm. wide) have 14 and 21; 32 canals are counted in specimens 6 to 14 mm. wide. One specimen, 23 mm. wide, has only 16 tentacles, and the largest specimen, 35 mm. in diameter, has 62 radial canals but only 12 fully developed tentacles. Blindly ending canals are observed in specimens of the following sizes: diam. 4 mm. (16 fully developed + 16 blind canals), 6 mm. (26 + 3), 7.5 mm. (31 + 11), 15 mm. (23 + more than 21), and 23 mm. (20 + about 15).

Affinities.—*A. macrodactyla* has been well described and figured by Maas (1905), Bigelow (1909 and 1919), and Browne (1916); all these authors regard it as distinct from *A. pensilis*, whereas Russell (1939) is inclined to consider them as two varieties of one species. This question will be discussed below. *A. maldivensis* was described by Browne (1904), but Bigelow (1909) and Browne himself (1916) have realized that it is identical with *macrodactyla*. Bigelow (1919, p. 310) has also discussed its relation to *A. aequorea*, and I think he is right in the following conclusion: ". . . we have here, as so often, a bimorphic Medusa with two fairly distinct types, with the great majority of specimens belonging to one or the other. However, since intermediates seem to be rare, the species *macrodactylum* may be retained, until the normal range of variation is better understood." In the same paper Bigelow opposed Vanhöffen (1911) in his attempt to unite several species under the name of *Mesonema coelum pensile*.

Distribution.—*Aequorea macrodactyla* is widely distributed in the warm parts of the Indian and Pacific Oceans from Africa to America, and Thiel (1938) records it from Walvis Bay on the west coast of Africa. According to Russell (1939) it may also be met with in the English Channel. Mayer (1915, p. 160) includes this species in his list of medusae found in the Torres Strait.

Aequorea pensilis (Haeckel).

Medusa coelum pensile Modeer, 1791, p. 32.

Mesonema pensile Haeckel, 1879, *Das System der Medusen*, p. 226; Browne, 1904, p. 733, pl. 55, fig. 4, pl. 57, figs. 2-9; Browne, 1905, p. 147, pl. 2, figs. 11-15; Maas, 1905, p. 42, pl. 8, fig. 52; Browne, 1916, p. 188.

Aequorea pensilis, Mayer, 1910, p. 333.

Mesonema coelum pensile, Vanhöffen, 1911, p. 230 (in part).

Aequorea pensile, Bigelow, 1913, p. 41; Bigelow, 1919, p. 311, pl. 42, figs. 3, 4; Menon, 1932, p. 24.

I agree with Bigelow (1919) that Haeckel and not Modeer should be quoted as the author of this species.

Material.—This species had a scattered occurrence; 11 specimens were collected between 16th November, 1928 (St. XXV) and 18th March, 1929 (St. L). This latter station was outside Papuan Pass, where two specimens were taken in vertical hauls 170–0 m. (the largest specimen in the collection, about 60 mm. in diameter) and 150–0 m. (young stage, only 3 mm. wide). The other finds were on or inside the reefs (see Table XVIII).

Remarks on the Specimens.—The specimens varied in diameter from 2 to about 60 mm., without any relation to the seasons. The dimensions are as follows (see Table IX):

TABLE IX.—*Dimensions of Aequorea pensilis.*

Station no.	Diam. of umbrella (mm.).	diam. of stomach (mm.).	Number of radial canals.	Number of tentacles.
XXXIV .	2 .	1 .	? .	4 .
L .	3 .	2 .	27 .	? .
XLI .	4 .	3 .	16 .	4 .
XLVI .	4 .	3 .	27 .	8 .
XXXV .	8 .	5.5 .	33 .	8 .
XXXV .	9 .	5 .	31 .	8 .
XXXV .	12 .	6 .	36 .	8 .
XXXII .	14 .	10 .	c. 85 .	8 .
XXV .	29 .	16 .	57 .	16 .
XXXII .	52 .	32 .	142 .	12 .
L .	c. 60 .	c. 35 .	c. 190 .	c. 17 .

It is generally stated that the umbrella of this medusa is plano-convex or almost lens-shaped; this does not apply to the young specimens, in which the subumbrella is flat or slightly concave, whereas the exumbrella is more or less vaulted. Two of the small specimens, 2 and 4 mm. in diameter, are almost as high as wide, the apical mass of jelly being highly vaulted and constituting almost three-quarters of the entire height of the umbrella.

In the youngest specimen, 2 mm. wide, I could not see the radial canals; it has four tentacles and four large marginal bulbs. In the next specimen, 3 mm. wide, the margin is somewhat damaged and the number of tentacles could not be counted. One of the specimens 4 mm. wide has four tentacles, four large and eight small marginal bulbs; alternating with the 16 fully developed radial canals are 16 very short, blindly ending canals; no traces of gonads. The specimen 8 mm. wide has 11 blind canals between the 33 fully developed, and in the specimen 12 mm. wide there are five blind canals; in this specimen almost every alternate fully developed canal is quite thin. In the specimen from St. XXXII, 52 mm. in diameter, the development of additional radial canals is irregular; some few canals without gonads are scattered here and there, but within a space of nearly one-quarter of the circumference canals with and without gonads are almost regularly alternating; altogether it has 142 canals and about the same number of short, narrow, almost linear mouth-lips. The largest specimen, about 60 mm. wide, is discoloured by rust and quite opaque,

and the umbrella is split in various directions: exact measurements and counts could, therefore, not be carried out in this specimen.

Comparison between A. macrodactyla and pensilis.—All records in the literature agree that as a rule adult specimens of *A. macrodactyla* have only about half the number of radial canals as *A. pensilis*, but the number of canals as well as tentacles is variable in both species. Russell (1939), who has examined a considerable number of specimens from the English Channel, has discussed the relation between the two species, and by means of all the counts and measurements available in the literature he arrives at the following conclusion (p. 354): “. . . there is a tendency towards two distinct groupings into *Aequorea macrodactyla* and *A. pensilis*. Yet this distinction does not seem to be sufficiently clear to warrant their separation into two species. It is preferable to regard them all as belonging to one species, *A. pensilis*, with a variety, *macrodactyla*, in which only half the full number of radial canals is developed.”

TABLE X.—*Relative Dimensions of Aequorea macrodactyla (m) and pensilis (p).*

Diam. of umbrella (mm.).	Diam. of stomach (mm.).		Number of radial canals.		Number of tentacles.	
	<i>m.</i>	<i>p.</i>	<i>m.</i>	<i>p.</i>	<i>m.</i>	<i>p.</i>
2	1	1	8	?	9	4
2	1.2	—	16	—	7	—
3	2	2	12	27	4	?
4	2	—	28	—	8	—
4	2.5	3	16	16	4	4
4	2.5	3	28	27	8	8
4.5	3	—	30	—	8	—
6	3.5	—	14	—	8	—
6	3.5	—	26	—	8	—
6	3	—	16	—	21	—
6	5	—	32	—	14	—
8	4	5.5	31	33	8	8
9-10	5	5	32	31	8	8
12	—	6	—	36	—	8
14	8	10	32	c. 85	8	8
15	8	—	23	—	18	—
20	13	—	50	—	28	—
23	9	—	20	—	16	—
29-30	16	16	70	57	32	16
35	17	—	62	—	12	—
52	—	32	—	142	—	12
c. 60	—	c. 35	—	c. 190	—	c. 17

In Table X are given the dimensions of all the specimens taken by the Great Barrier Reef Expedition; they are separated into two groups by means of the shape of the tentacle bulbs, and the figures in the table show that in young specimens the numerical values are very similar in both, and in larger specimens they are very variable. Quite exceptional

cases may occur, such as the two specimens of *macrodactyla*, 23 and 35 mm. wide, with respectively only 16 and 12 tentacles. The width of the stomach gives no clue whatever to distinguish between two forms within the size-limits represented in this collection. So far I agree with Russell that a numerical distinction between these two forms cannot be recognised with certainty in all cases.

On the other hand, the difference in the shape of the tentacle bulbs seems to me to establish a perfectly sound foundation for a specific separation. The presence of a distinct abaxial clasp or spur and a prominent adaxial excretory papilla in the tentacle bulbs of *A. macrodactyla* in contradistinction to *A. pensilis*, in which the bulbs have "long lateral extensions," has repeatedly been emphasized by Browne and Bigelow. Russell has seen the same difference and given an excellent drawing of the bulb of *A. macrodactyla* (1939, p. 352, fig. 2*d*), but "the true condition of spur and ridge is only seen when the specimens are perfectly preserved." The present specimens from the Great Barrier Reef cannot be said to be in perfect condition, but, nevertheless, the abaxial spur with its longitudinal ridge and the prominent adaxial papilla are clearly visible in some specimens (which I refer to *macrodactyla*) and as clearly absent in the others (referred to *pensilis*); in no instance was I in doubt. I am very much inclined, therefore, to retain *A. macrodactyla* and *pensilis* as two distinct species in spite of their occasional overlap in numerical characters.

Distribution of Aequorea pensilis.—Widely distributed in the tropical parts of the Indian and Pacific Oceans, recorded with certainty from the Red Sea, the Maldive Islands, the coasts of India and Ceylon, the Chagos Archipelago, French Indo-China, the Malayan Archipelago, the Philippines, Japan, and as far east as Tahiti, but not previously known from Australia. Vanhöffen's records from the Galapagos Islands, China, South Africa, and Ascension and the Tortugas in the Atlantic are uncertain, because at least some of his specimens belonged to other species. The numerous specimens from the British waters mentioned by Russell all seem to belong to *A. macrodactyla*, considered by him to be a variety of *A. pensilis*.

LIMNOMEDUSAE.

Olindias singularis Browne.

Olindias singularis Browne, 1904, Fauna and Geogr. of Maldive and Laccadive Archips. 2, p. 737, pl. 56, fig. 2, pl. 57, fig. 1; Bigelow, 1909, p. 109, pl. 4, fig. 1, pl. 31, figs. 1-10, pl. 32, fig. 8; Mayer, 1910, p. 357; Browne, 1916, p. 192; Bigelow, 1919, p. 318; Stiasny, 1931, p. 27; Menon, 1932, p. 27.

Material.—

- St. XLIV, S. 27.ii.29. Li.I. 11 specimens; diam. 3-10 mm.
 St. XLIV, C. 27.ii.29. Li.I. 2 specimens; diam 3-7 mm.
 St. XLVI, S. 28.ii.29. I.C.P. 1 specimen; diam 2 mm.
 St. XLVII, S. 4.iii.29. 3 miles E. 2 specimens; diam. 3 mm.

I agree with Bigelow (1919) that this is a distinct species which is mainly characterized by the statocysts being single at the base of the primary tentacles and not paired as in all other species of *Olindias*. It is true that in large specimens paired statocysts may be found at the bases of a few of the tentacles as observed by all the authors quoted above, and also by Browne himself (1916). Bigelow emphasizes the interesting fact that "when paired otocysts are developed, they are both distinguishable when the tentacle is very small. There is no evidence that tentacles which have one otocyst during the greater

part of their history ever acquire a second one at a late stage." In the specimens from the Great Barrier Reef, all of which are young ones, the statocysts are invariably single.

TABLE XI.—*Dimensions of the Present Specimens of Olindias singularis.*

Diam. (mm.).	Height (mm.).	Number of centripetal canals per quadrant.	Number of primary tentacles.	Number of secondary tentacles.	Gonads.
3	2.5	1	8	Tiny rudiments	Lacking
3	2.5	1	8	" "	"
3	2	1	8	" "	"
4	?	1	8	" "	"
5	4	3	16	" "	"
5.5	4	3	16	2 + rudiments	"
6	4	3	16	4 + "	"
7	6	3 + rudiments	17	6 + "	Tiny.
8	6	3	16	4 + "	"
9	7	3 + rudiments	c. 24	8 + "	"

Distribution.—Maldive Islands (Browne, 1904), Chagos Archipelago (Browne, 1916), Madras (Menon, 1932), Philippines (Bigelow, 1919), Low Archipelago (Bigelow, 1909); Michaelmas Reef, Cay, off Cairns, Queensland (Stiasny, 1931). Thus this species has an extensive distribution in the Indo-Pacific region, and it has been found on the coast of Queensland before it was taken there by the Great Barrier Reef Expedition.

Proboscidactyla ornata (McCrady).

Material.—

St. XXXIV, S. 19.xii.28. 3 miles E. 1 specimen, 3 mm. wide with 16 tentacles.

The specimen does not in any way differ from the usual appearance of this species, which has a wide distribution in the warm parts of the Indo-Pacific and Atlantic Oceans. It has not previously been recorded from Australia.

TRACHYMEDUSAE.

Halicreas minimum Fewkes.

Halicreas minimum Fewkes, 1882, Bull. Mus. comp. Zool. Harvard, 9, p. 306.

Halicreas papillosum Vanhöffen, 1902, p. 68, pl. 9, figs. 7-8, pl. 11, fig. 30.

Material.—

St. XXVIII, O.T.O. 23.xi.28. S. 600-0 m. 1 specimen; 10 mm. wide.

Distribution.—Widely distributed in the deep parts of all the oceans, except in the Mediterranean and the arctic seas.

Rhopalonema velatum Gegenbaur.

Rhopalonema velatum Gegenbaur, 1856, Zeitschr. f. wiss. Zool. 8, p. 251, pl. 9, figs. 1-5.

Rhopalonema clavigerum Haeckel, 1879, p. 263, pl. 17, figs. 1, 2.

Rhopalonema coeruleum Haeckel, 1879, p. 264, pl. 17, figs. 3-6.

Rhopalonema striatum Maas, 1893, p. 15, pl. 1, figs. 3, 4.

Material.—

St. XVI, closing silk townet, 20 m. wire.	3.x.28.	3 miles E.	1 specimen.
St. XIX, N. 180-0 m.	20.x.28.	O.T.O.	2 specimens.
„ do. 2nd haul.	20.x.28	O.T.O.	1 specimen.
St. XXVIII, S. 600-0 m.	23.xi.28.	O.T.O.	1 specimen.
„ C. 580-0 m.	23.xi.28.	O.T.O.	1 specimen.
St. L, S. 400-0 m.	18.iii.29.	O.P.P.	2 specimens.
„ 170-0 m.	18.iii.29.	O.P.P.	1 specimen.

The specimens varied in size between 2.5 and 8 mm. in diameter. Most of them were taken in the deep areas outside the reefs.

Distribution.—Common in the warmer parts of all the oceans, including the Mediterranean, in the upper as well as in the deep strata. Recorded from the Torres Strait by Mayer (1915, p. 202).

Amphogona apsteini (Vanhöffen).

Pantachogon apsteini Vanhöffen, 1902, Wiss. Ergeb. deutsch. Tief-See Exp. 3, p. 65, pl. 10, fig. 18, pl. 11, fig. 28.

Amphogona apsteini, Browne, 1904, p. 740, pl. 54, fig. 5, pl. 56, fig. 1, pl. 57, figs. 10-15; Bigelow, 1909, p. 126, pl. 2, figs. 1, 2, pl. 34, figs. 12-15, pl. 45, fig. 10.

Material.—27 specimens of this little medusa were collected in October to December, 1928, and March to June, 1929, mainly in the inshore waters and rarely more than one or two specimens in each haul (see Table XVIII). The size of the specimens varied between 2 and 4 mm. in diameter.

Distribution.—Kathiawar in north-western India; Maldive Islands; Farquhar Islands, Cargados Carajos, and Chagos Islands in the Indian Ocean; Sumatra; Pelew Islands in the Pacific; Japan; Pacific coast of Mexico.

Aglaura hemistoma Péron & Lesueur.

Material.—This was the most abundant of all the species of Hydromedusae in the collection from the Great Barrier Reef Expedition. The number of specimens preserved amounts to 891 (see Table XVIII), but the species was not equally common at any time. The size of the specimens varied between 1.5 and 4 mm. in height of the umbrella, and the limits of variation were the same throughout the year, so that this truly oceanic medusa has no definite breeding season. Nevertheless its occurrence in the Great Barrier Reef

TABLE XII.—*Seasonal Occurrence of Aglaura hemistoma.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	.	I.	II.	III.	IV.	V.	VI.	VII.
Average number of specimens per haul	22	60	6	65	5	70	.	3	0.1	11	530	105	170	40

area falls within two distinctly separated periods, as will be seen from Table XII. It was common in August, October and December (less frequent in September and November) and particularly abundant in April-June the next year, whereas it was almost completely lacking from January to March. This may be due either to hydrographical conditions or to a temporary decrease in the activity of breeding.

Distribution.—Generally distributed in the warm parts of all the oceans, including the Mediterranean, approximately between the isotherms of 20° C. for the warmest months in north and south. It occurs as far north as Japan and California in the Pacific, and the Gulf of Maine and the Bay of Biscay in the Atlantic. In spite of its evident abundance in the surrounding regions it has been recorded from Australian waters only once before (Torres Strait, by Mayer, 1915, p. 160).

Geryonia proboscidalis (Forskål).

Material.—

St. XVI, closing silk townet, 10 m. wire. 3.x.28. 3 miles E. 1 specimen; 4 mm. wide.

St. XIX, stramin net, 180-0 m. 20.x.28. O.T.O. 1 specimen; 8 mm. wide.

St. XX, N. 250-0 m. 20.x.28. O.T.O. 1 specimen; about 10 mm. wide.

The specimen from St. XIX was in fair condition with well-extended tentacles.

Distribution.—Widely distributed in the warm parts of all the oceans, including the Mediterranean. Recorded from Endracht's Land in Western Australia under the names of *Dianaca endrachtensis* Quoy & Gaimard, 1824, and *Geryonia dianaca* Haeckel, 1879, and from the coast of Australia (without further details) as *Carmaris giltschii* Haeckel, 1879.

Liriope tetraphylla (Chamisso & Eysenhardt).

When I first examined the extensive collection of *Liriope* from the Great Barrier Reef I thought I could distinguish two or perhaps three different species, but after a closer examination I must admit that the authors (Browne, Thiel, Bigelow, Russell) who consider all the numerous forms which have been described as belonging to one species are probably right. The majority of the specimens are very small and present no specific characters at all. The largest specimens are mainly of the *compacta* type with broadly triangular gonads with rounded angles and touching each other in the interradial. In middle-sized specimens the gonads are generally more or less trapezoid, and the distal end of the radial canals is very broad, but sometimes the gonads are heart-shaped, placed near the proximal end of the radial canals. The length and width of the centripetal canals were likewise very variable. Altogether it has proved impossible to divide the specimens into characteristic groups, and I prefer, therefore, to deal with the entire collection as belonging to one species.

TABLE XIII.—*Seasonal Occurrence of Liriope tetraphylla.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	.	I.	II.	III.	IV.	V.	VI.	VII.
Average number of specimens per one haul	1	3	1	3	5	23	.	95	68	46	6	6	3	13
Diam. of umbrella (mm.).	5	3-9	1-8	2-9	1-8	2-13	.	2-8	2-7	1-7	3-7	4-17	3-6	4-11

Material.—*Liriope* was found in almost every haul, and altogether 834 specimens were preserved (see Table XVIII). The medusae were not equally numerous throughout the time of investigation (see Table XIII); there was a rapid increase in number of speci-

mens from November to January, when a distinct maximum was reached, to be followed by a decrease during the following months. The short and very distinct period of maximal occurrence is remarkable considering the truly oceanic habitat of this medusa. Young and middle-sized specimens were found at any time; adult specimens were altogether rare in the samples and were taken only occasionally and at irregular intervals. Breeding evidently takes place throughout the year, but with a distinct maximum of intensity in December to February.

Distribution.—*Liriope tetraphylla* is generally distributed in the tropical and subtropical parts of all the oceans, mainly in the upper strata, but it may also sometimes be taken deeper down. The southern limit of distribution is at about 40° S., coinciding with the 20° isotherm. It is common in the Mediterranean, and in the Atlantic it reaches as far north as the Gulf of Maine on the American coast and to the entrance of the English Channel. In the Pacific it is found on the coasts of California and Japan. It was recorded from the Torres Strait by Mayer (1915, p. 160) as *L. rosacea*.

NARCOMEDUSAE.

Solmundella bitentaculata (Quoy & Gaimard).

Solmundella bitentaculata, Browne, 1904, p. 741, pl. 56, fig. 3; Browne, 1905, p. 153, pl. 4, figs. 1-6; Vanhöffen, 1908, p. 45, pl. 3, figs. 11-15; Bigelow, 1909, p. 77, pl. 2, fig. 3; Mayer, 1910, p. 455, text-fig. 301.

Material.—

- St. XXXII, S. 5.xii.28. 3 miles E. 1 specimen; diam. 4 mm.
 St. XXXV, S. 27.xii.28. 3 miles E. 1 specimen; diam. 1.2 mm.
 St. XXXVI, S. 4.i.29. 3 miles E. 1 specimen; diam. 2 mm.
 St. L, S. 400-0 m. 18.iii.29. O.P.P. 4 specimens; diam. 2 mm.
 „ C. 150-0 m. 18.iii.29. O.P.P. 1 specimen; diam. 3 mm.

Distribution.—This small, oceanic medusa is widely distributed in all the great oceans, including the Mediterranean. It is particularly common in the southern hemisphere, even in the immediate neighbourhood of the Antarctic Continent, but it also penetrates northwards as far as the Sea of Ochotsk in the Pacific and to about 45° N. in the Atlantic. It is probably this species which is recorded from the Torres Strait by Mayer (1915, p. 160) as *Solmundella mediterranea*.

Solmaris rhodoloma (Brandt).

Aequorea rhodoloma Brandt, 1838, Mém. Acad. Sci. St. Pétersbourg, 4, 2, p. 357, pl. 3, figs. 1-5.
Solmaris rhodoloma, Haeckel, 1879, p. 358; Maas, 1909, p. 39, pl. 3, fig. 20; Uchida, 1928, p. 85, text-fig. 5.
 non *Solmaris rhodoloma*, Vanhöffen, 1908, p. 60, pl. 7, fig. 5.

Material.—

- St. XXXIX, F. 30.i.29. 3 miles E. 80 specimens.

It is rather peculiar that a shoal of this medusa should suddenly turn up and be taken in one single haul with the fine silk net, whereas it was not taken in the hauls with the coarse silk net and the stramin net on the same day, nor on any other occasion during the investigations at the Great Barrier Reef. Seventy-three specimens were measured as follows:

Diam. (mm.).	Number of specimens.	Number of lappets and tentacles.	
		Limits of variation.	Average.
1	1	14	14
1.5	0	—	—
2	13	19–25	21.7
2.5	24	20–28	23.9
3	30	21–28	25.1
3.5	4	22–25	23.5
4	1	28	28

The number of marginal lappets and tentacles thus increases during the growth of the medusa. In the largest specimens the gonads are well developed, though apparently not quite ripe. The umbrella margin is rolled more or less inwards in all the specimens; the marginal sense organs are therefore difficult to see, but in some cases I have been able to state that there are one or two on each marginal lappet, occasionally three. Most of the tentacles are well extended, and considerably longer than the diameter of the umbrella.

These specimens undoubtedly belong to the same species as that described and beautifully figured by Maas (1909) from Sagami Bay in Japan and later by Uchida (1928) from the same locality. According to Maas specimens 3 mm. wide have 24–28 tentacles; Uchida gives the following numbers: diam. 2.2 mm. 17 tentacles, 3.2 mm. 28 tentacles, 7.0 mm. 32 tentacles. Both authors agree that each of the marginal lappets carries one or two sense organs. The agreement between the Japanese and the Australian specimens is thus complete, and though Brandt's description of the original specimens from Concepcion Bay on the coast of Chile (about 37° S.) is rather vague, it seems to me very probable that the Japanese as well as the Australian specimens belong to the same species.

Mayer (1910, p. 437) is inclined to refer Brandt's medusa to *S. corona*; this is, however, a larger medusa, up to 15 mm. in diameter, and young specimens 2–4 mm. wide have only 12–18 tentacles. Thiel (1936, p. 58) refers it to *S. flavescens* together with several other species of this genus, but when *flavescens* has attained a size of 23 mm. it has only 12–17 tentacles. It seems to me open to objection to refer *S. rhodoloma* to these or any other of the Mediterranean and Atlantic species of *Solmaris*. Uchida (1947, p. 314) records *S. corona* from the Pelew Islands in Central Pacific, but he gives no information of the dimensions of the specimens; they may have belonged to *rhodoloma*. All Vanhöffen's determinations of Solmarids (1908, 1912*a* and *b*) are open to doubt; his specimens of "*Solmaris rhodoloma*" from Cape of Good Hope and south of St. Paul, which were 71–82 mm. in diameter, most probably belong to the genus *Solmissus*. *Solmaris rhodoloma* might still be compared with *S. lenticula* Haeckel (1879, p. 357). This is a small medusa, found in the Indian Ocean, 5 mm. wide, with 16 tentacles, and with one sense organ on each of the 16 marginal lappets; Mayer (1910, p. 438) considered it an immature form of uncertain affinities. While on the "Galathea" expedition I visited the Philippines in 1951; I found several specimens of a small medusa, which I believe may be referred to *S. lenticula*; they were 2–3 mm. wide with 13 tentacles, and accordingly quite different from *S. rhodoloma*.

Distribution of Solmaris rhodoloma: Concepcion Bay, Chile; Sagami Bay, Japan; perhaps Pelew Islands in Central Pacific, and now taken at the Great Barrier Reef, Australia.

Cunina octonaria McCrady.

Cunina octonaria McCrady, 1857, Proc. Elliot Soc. Nat. Hist. 1, p. 109, pl. 12, figs. 4, 5.
Cunoctantha octonaria, Haeckel, 1879, p. 316.

Bigelow (1909, p. 51) has demonstrated that a peripheral canal system may or may not be present in *Cunina* as well as in *Cunoctantha*, so that the two genera differ only in the number of tentacles, eight in *Cunoctantha* and other numbers in *Cunina*, usually nine or more, but sometimes seven. In a subsequent paper (Bigelow, 1918, p. 391) he further points out that the two genera "are so closely allied (differing only in the number of tentacles) that they may finally be united. But until an intergradation is actually observed, it is wisest to retain both." Such intergradations have really been observed. Already Haeckel, who established the genus *Cunoctantha*, found individual variation in the number of tentacles, which was not absolutely constant ("bald 7, bald 9, selten höhere Zahlen"). Uchida (1928, p. 87) describes some young medusae from Japan under the name of *Cunina* sp.; they were 1.6–3.0 mm. in diameter, and among the six specimens observed three had eight tentacles, two had nine, and one 11 tentacles. In the collection from the Great Barrier Reef expedition the majority of the specimens have eight tentacles, but there are also two specimens with only seven, one with nine tentacles (one of which is quite small), and one with 10 tentacles, which are approximately but not quite equidistant, and one of them is very small. All these specimens are of almost the same size, 2.7–3.2 mm. wide, and in structure they are exactly like the typical specimens with eight tentacles. The number of tentacles seems to me, therefore, to be of specific value only and not sufficient to distinguish between two genera. In a previous paper (Kramp, 1948b, p. 18) I described a new species, *Cunina frugifera*, in which larvae were developed by external budding from the stomach wall; the parent medusa had nine tentacles, whereas the larvae had eight, and I indicated the possibility of a metagenesis "in which an asexual generation with nine (or more) tentacles alternates with a sexual generation with eight tentacles." We also know that the small medusae developed inside the stomach cavity of the 8-rayed *Cunina octonaria* may have 9–13 tentacles.

TABLE XIV.—*Seasonal Occurrence of Cunina octonaria.*

Month.	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.	
Estimated average number of specimens per haul	0	1	0.1	0.3	12	66	.	36	0	1	0	1	1	0
Diam. of umbrella (mm.)	-	2-3.5	3	2.7-	2-6	2-5	.	2.5-4	-	2-4	-	3	3	-
				3.2										

The limitation of the numerous species of *Cunina* and *Cunoctantha* which have been described will not be discussed here. In the present collection the number of sense organs on the marginal lappets varied from 3 to 5, sometimes even within one and the same individual.

Material.—119 specimens were preserved, varying in size from 2 to 6 mm. in diameter. The species had a scattered occurrence almost throughout the period of investigation (see Tables XIV and XVII), with a distinct maximum in December, but there was no correlation between the seasons and the sizes of the specimens.

Distribution.—Widely distributed in the warm parts of all the oceans, including the

Mediterranean, though apparently rather scarce in the Indian and Pacific Oceans; mainly found in the upper strata. According to Thiel (1936, p. 85) it penetrates as far north in the Atlantic as to the Bay of Biscay; the only specimen taken there, however, was *C. fowleri* Browne, which seems to be a distinct species.

Parasitic Stolon-larvae of Cunina.

(Plate II, fig. 7.)

In the sample from St. L, outside Papuan Pass, 18.iii.29, stramin net 170–0 m., was found a specimen of *Liriope tetraphylla* with two narcomedusan larvae attached to the inner wall of the stomach. Each of them consists of a stolon carrying numerous medusa buds. Both are attached to the upper part of the stomach; one is about 2 mm., the other 2.4 mm. in length, with respectively 1 mm. and 1.6 mm. hanging outside the mouth of the *Liriope*. There are medusa buds in all stages of development from tiny globular knobs to well-developed small medusae 0.5–0.6 mm. in diameter with a somewhat conical manubrium, a simple, round mouth opening, eight marginal lappets and eight short, egg-shaped tentacles. Buds in different stages of development are scattered irregularly over the surface of the stolons.

These larvae are very similar to the stolon-larvae of various species of *Cunina* found in the mouth of *Geryonia* or *Liriope*, described and discussed by several authors, first by F. Müller (1861), who saw this peculiar structure in the mouth of a *Liriope* on the coast of Brazil; he found that the small medusae budded off from the stolon were so like the 8-rayed form of his *Cunina köllikeri* (which is generally considered identical with *C. octonaria*) that most probably they were derived from that species. Later on similar stolons were observed attached to *Geryonia* in the Mediterranean. Mayer (1910, p. 465, pl. 54, fig. 4) found a stolon-larva floating in the ocean at Tortugas, Florida, and considered it as probably one of the generations of *Cunioctantha köllikeri*. Maas (1905, p. 67) described the development of *Cunina* larvae in the stomach of *Cunioctantha octonaria* from the Malayan Archipelago, but stolon-larvae in the mouth of Geryonidae were not seen by him.

Stolon-larvae of this peculiar appearance have now for the first time been observed outside the Mediterranean and Atlantic Oceans. The structure of the medusa buds leaves no doubt of their affinity; they are undoubtedly the asexual offspring of a *Cunina*, and I suspect that they belong to *C. octonaria*, the only species of this genus hitherto recorded from the surroundings of Australia, though of course we cannot exclude the possibility of their belonging to some other species.

PREVIOUS RECORDS OF HYDROMEDUSAE IN AUSTRALIAN WATERS.

Very little attention has been paid to the fauna of medusae in the waters around Australia. Hydromedusae are mentioned in 11 papers (Lendenfeld's series counted as one) dating from 1809 to 1947, and most of the "species" are insufficiently described or quite obsolete in the sense that they cannot be identified with any known species.

In the classical work by Péron & Lesueur (1809) no less than 27 species of medusae are recorded from Australian coasts, and all of them were described as new species. Seven species were Scyphomedusae, 20 seem to be Hydromedusae. The atlas, which was intended to accompany the text, was never issued, but some of the figures were published

later on, partly by De Blainville (1834, Manuel d'Actinologie), partly by Milne Edwards in Cuvier's Règne Animal (1839); Haeckel saw the unpublished plates in the library in Jardin des Plantes in Paris and gave his opinion on the affinities of the species (Haeckel, 1879).

The following eight species of Hydromedusae were rightly designated by him as obsolete: *Aequorea sphaeroidalis*, *A. amphicurta*, *A. bunogaster*, *A. phosperiphora*, *Phorcynia cudo-noidea*, *P. petasella*, *P. istiphora*, and *Callirhoë micronema*. It may be worth while to say a few words about the remaining 12 species, though none of them can be identified with certainty.

Eudora undulosa, Péron & Lesueur, p. 326, found at De Witt's Land in north-western Australia; Blainville, pl. 30, figs. 1-3; Cuvier, pl. 54, figs. 5, 5a, 5b. Haeckel (p. 648) is inclined to regard this as the umbrella of a "Canotide." It seems to me very probable that it was the same species, which was described by Stiasny (1928, p. 218, text-figs. 5a-7) as *Zygocanna buitendijki* from the Java Sea. The repeatedly branched radial canals and the numerous prominent radial ridges on the exumbrella are very characteristic in both species. *E. undulosa* was, however, considerably larger, being 80 mm. in diameter against 33 mm. in *Z. buitendijki*.

Berenix thalassina, P. & L., p. 327, Arnhem Land in northern Australia. Haeckel (p. 160) considers this species identical with *Berenix euchroma*, described by Péron on the same page. This latter was found in the tropical Atlantic, and a figure of it is reproduced by Blainville (pl. 32, fig. 1) and Cuvier (pl. 53, fig. 2). For the two species combined Haeckel used the name *Cladocanna thalassina*; as locality he only gives Arnhem Land. Maas (1904a, p. 441) and Mayer (1910, p. 228) referred the species to *Toxorthis*, and this may be right, but it seems to me far from being a certainty. At least, it is rather different from the two other species of that genus, *arcuatus* Haeckel from the Canary Islands and *kellneri* Mayer from Florida.

Favonia octonema, P. & L., p. 328, Arnhem Land; Blainville, pl. 40, fig. 1. Haeckel (p. 94) referred this species to *Nemopsis* and called it *Nemopsis favonia*. According to Mayer (1910, p. 173) it was probably an imperfect specimen of some species of *Lymnoria*. Another species, *Favonia hexanema* from the tropical Atlantic, was described by Péron & Lesueur (p. 328) and figured in Cuvier, pl. 52, fig. 2; this as well as the following species probably belong to the same genus as *F. octonema*, which raises a question regarding the generic name *Lymnoria*.

Lymnoria triedra, Péron & Lesueur, p. 329, Bass Strait on the south coast of Australia; Blainville, pl. 40, fig. 2; Cuvier, pl. 52, figs. 1, 1a. Haeckel (p. 87) changed the specific name to *proboscidea*. Mayer (1910, p. 153) is inclined to identify this species with *Lymnoria ocellata* Agassiz & Mayer, which was found at Makemo Island, Paumotus, in the South Pacific.

In Haeckel's monograph *L. triedra* was still the only species of *Lymnoria*, but he erected a new genus, *Thamnostoma* for two species, *dibalia* Busch, 1851, and *macrostoma* n. sp., in which the number of marginal tentacles was only eight.

Mayer (1900a, p. 6, pl. 5, figs. 16-18) described a new species, *Lymnorea borealis* from the coast of Maine and referred it without comment to *Lymnoria*, and later on he added two more species, *L. ocellata* Agassiz & Mayer (1902) from the Paumotus in the Pacific and *L. alexandri* Mayer (1906) from the Bahamas and Florida. It is difficult to understand why Mayer should regard these species as congeneric with *L. triedra* Péron & Lesueur, as this

species (together with the somewhat similar two species of *Favonia*) is absolutely unrecognizable, though almost certainly entirely different from any of the new species he himself described. Bigelow (1909, p. 192) took this view and ignored *L. triedra* P. & L. as unrecognizable. But he retained the generic name *Lymnorea* with Mayer as the author, *non* Péron & Lesueur, and suggested *L. alexandri* Mayer as the type-species. Mayer (1910, p. 153) further included Haeckel's two species of *Thamnostoma* in the genus *Lymnorea*.

Hartlaub (1911, p. 226) called attention to the fact that Mayer had not distinguished between true oral tentacles inserted above the mouth and mere dilatations (branched or unbranched) of the mouth lips, such as are present in *Podocoryne*. Rees (1938, pp. 22-25) reinstated the genus *Thamnostoma* Haeckel for species with solitary marginal tentacles and four branched oral tentacles above the mouth and so, since all species with solitary marginal tentacles and with four simple or branched mouth-lips armed with nematocyst clusters are referable to *Podocoryne*, the generic name *Lymnoria*, applicable only to the unrecognizable *L. triedra*, virtually disappears.

The following three medusae evidently belong to the genus *Aequorea*, but their specific identity cannot be determined:

Aequorea eurodina, P. & L., p. 336, Bass Strait.

Aequorea cyanea, P. & L., p. 337, Arnhem Land; Blainville, pl. 32, figs. 2, 2a.

Aequorea thalassina, P. & L., p. 337, Arnhem Land.

Haeckel (p. 222), who had seen Lesueur's original figures, united the two latter species under the name of *A. thalassina*. Mayer (1910, p. 326) placed them together with *A. eurodina* as doubtful synonyms of *A. forskalea*; as, however, all of them are stated to have the same number of tentacles as of radial canals, they can hardly belong to that species.

The following three species are doubtfully referable to *Zygocanna*:

Aequorea purpurea, P. & L., p. 337, Endracht's Land, western Australia; figured in Cuvier, pl. 43, figs. 3, 3a. The figure shows no bifurcation of the radial canals, but from the description we may presume that the 24 radial canals issue in pairs from the 12 "bandelettes à l'estomac," so that its affinity to *Zygocanna* seems probable.

Aequorea pleuronota, P. & L., p. 338, Arnhem Land. Mayer (1910, p. 338) may be right that *Zygocanna costata* Haeckel (1879, p. 214) from the coast of New Guinea is the same species. Mayer designated *pleuronota* as the type-species of *Zygocanna*, which is regrettable, since its identity remains doubtful and it was really for *costata* that Haeckel established his new genus *Zygocanna*.

Aequorea undulosa, P. & L., p. 338, Arnhem Land; *Zygocannula undulosa* Haeckel (p. 217). Mayer (1910, p. 339) makes it a synonym of *Zygocannula diploconus* Haeckel from the Sunda Strait, and in this case he assigns the priority to Haeckel's species and not to Péron's. At any rate the identity remains doubtful.

Pegasia cylindrella, P. & L., p. 341, Arnhem Land; Haeckel (p. 331), who had seen Lesueur's unpublished figure, was probably right that this was an *Aglaura*.

(*Pegasia dodecagona*, P. & L., p. 341, was certainly a Narcomedusa, and Haeckel made it the type-species of *Petasia*. Blainville (1834, p. 281) records it as an Australian species, but it was found in the southern Atlantic, "Océan Atlantique Austral")

Melicerta pleurostoma, P. & L., p. 353, De Witt's Land in north-western Australia. Haeckel (p. 67) referred this species to *Turritopsis*, and Mayer (1910, p. 146) indicates the possibility that it might be identical with *Turritopsis lata* Lendenfeld. It was, however, a

much larger medusa, 20–40 mm. The description gives no conception of a *Turritopsis*, but the unpublished figure by Lesueur induced Haeckel to place it in that genus. I even doubt if it be an Anthomedusa and prefer to leave it as *incertae sedis*.

Thus, unfortunately, of the 20 species of Australian Hydromedusae described by Péron & Lesueur, only two (*Eudora undulosa* and *Pegasia cylindrella*) can, with some degree of probability, be identified; three are doubtful (*Berenix thalassina*, *Aequorea pleuronota* and *Aequorea undulosa*) and the remaining 15 are unrecognizable.

Quoy & Gaimard (1824, in Freycinet, Voyage autour du monde de l'Uranie, etc., p. 566, pl. 84, fig. 2) described one medusa from Australia, *Dianaea endrachtensis*; Haeckel (1879, p. 295) called it *Geryonia dianaea*. It was most probably identical with *Geryonia proboscidalis* (Forskål), which is the only species of this genus. It was found off Endracht's Land in Western Australia.

From another circumnavigation R. Lesson (1830, p. 130, pl. 14, figs. 5, 5') gave a vague description of a medusa taken on the coast of New Guinea, *Microstoma ambigua*. Lesson himself (1843, p. 295) was in doubt of its affinity. Haeckel (1879, p. 102) referred it to his genus *Pteronema*, and according to Mayer (1910, p. 92) it may possibly be identical with *Pteronema darwini* Haeckel, which is also an Australian medusa.

Haeckel, in his well-known monograph (1879), has described nine Australian Hydromedusae, all of them new species, collected partly by Dr. Faber, partly by Captain Weber. One of the species differs in no way from *Geryonia proboscidalis*, another is doubtful (*Aeginura myosura*), and the remainder may be valid species that have not been observed since they were described by Haeckel. Two species are from the coast of New Guinea, but, for the others, the locality is given only as "coast of Australia," without further details.

Dicodonium dissonema (p. 27) was not figured; it seems to differ from the other species of this genus by its very large tentacle bulbs.

Pteronema darwini (p. 101, pl. 7, figs. 1, 2) is a most peculiar medusa, and it would be highly desirable to see it again.

Dissonema saphenella (p. 126, pl. 8, fig. 3) was placed by Haeckel among the "Thaumantidae," but Mayer (1910, p. 115) is probably right in considering it to be an Anthomedusa of the family Pandoridae. If the description is correct it differs from the only other species of the genus (*D. turrida* Mayer, from Florida and the Bahamas) by the umbrella margin being destitute of any kind of appendages.

Cladocanna polyclada (p. 161) from New Guinea is probably a *Toxorchis*. Mayer (1910, p. 228) regards it as a synonym of "*Berenix thalassina*" Péron & Lesueur (see above), but as this is a doubtful species, it seems to me better to retain Haeckel's specific name and provisionally to regard *Toxorchis polyclada* as a valid species.

Eutimalphes pretiosa (p. 195, pl. 11, fig. 8) is a large and apparently very beautiful medusa. Mayer (1910, p. 305) refers it to *Eutima*, and according to the usual definition of this genus it does belong there. It differs, however, considerably from all the other species by its very broad peduncle, the enormous size of its complexly folded lips, and by the curtain-like gonads, which occupy nearly the whole length of the radial canals without interruption at the basal portion of the peduncle. The only specimen was somewhat mutilated, and the description may, therefore, be not quite reliable. The genus *Eutimalphes* was erected by Haeckel for this species, also to include "*Tiaropsis indicans*" Romanes, which, however, is destitute of cirri, and was long ago removed from *Eutima* and *Eutimalphes* and made the type-species of the genus *Eutonina*. Bigelow (1909, p. 166)

points out the resemblance of *Eutimalphes pretiosa* to the species of *Tima*, but as Haeckel expressly states that his medusa has only eight marginal vesicles, it would be premature to refer it to *Tima*. Provisionally I think we should retain the generic name *Eutimalphes* for the Australian medusa, its affinities remaining doubtful.

Zygocanna costata (p. 214, pl. 15, figs. 7, 8), found off New Guinea. As mentioned above it seems to me uncertain whether this can be identified with *Aequorea pleuronota* Péron & Lesueur. Haeckel's species should be retained and regarded as the type-species of *Zygocanna*.

Stauraglaura tetragonima (p. 277, pl. 16, figs. 10, 11) may be an *Aglaura hemistoma*, in which four of the normal eight gonads have not been developed. Haeckel contradicts the supposition that four gonads might have fallen off, because in both specimens at his disposal the four globular gonads were close together: but if four of the gonads were retarded in their development, the remaining four might well expand laterally so as to come into contact with each other.

Carmaris giltschi (p. 296, pl. 18, fig. 8) is identical with *Geryonia proboscidalis*.

Aeginura myosura (p. 343, pl. 19, figs. 8, 9) was originally described from the coast of Australia (this seems to have escaped the attention of Mayer, 1910, p. 468); another specimen was taken by the "Challenger" in deep water south of Australia and described by Haeckel (1881, p. 41, pls. 13 and 14, figs. 1-12). Bigelow (1938, p. 132, and 1940, p. 309) has discussed the species of *Aeginura* and is very much inclined "to treat Haeckel's old names as doubtful synonyms of *grimaldii*."

Cannota dodecantha Haeckel (p. 151) was taken at "Nieder Guinea." It is a mistake, therefore, for Lendenfeld (1884, p. 600) and Mayer (1910, p. 221) to mention it as occurring in New Guinea.

The only special account of Australian medusae is that given in a series of papers, 1883-87, by R. von Lendenfeld, who collected 15 species of Hydromedusae on the coast of New South Wales and described them all as new species.

It is generally understood that Lendenfeld's descriptions are unreliable and most of his species unrecognizable, and, unfortunately, this is not far from being true. It was a disappointment, therefore, when in 1951 I had the great pleasure of visiting the Australian Museum in Sydney to find that Lendenfeld's collection was not there. Some years ago, however, I saw some of his original specimens in the British Museum, London, and I found that his descriptions, though brief and insufficient, are fairly correct, whereas the figures are utterly wrong and misleading.

In 1883 (p. 497, pl. 27-32) Lendenfeld described the abortive medusa of a campanularian hydroid, *Eucopeella campanularia*, from the southern coasts of Australia. Mayer (1910, p. 233) may be right that the hydroid is identical with *Campanularia bilabiata* Coughtrey from New Zealand.

The following of Lendenfeld's species are so vaguely described that they will probably never be recognized:

Sarsia radiata (1884, p. 583, pl. 20, figs. 31, 32).

Sarsia minima (1884, p. 584, pl. 21, figs. 34, 35; 1885, p. 915). Some specimens are in the British Museum; they are embedded in Canada balsam and mounted on a slide, and it is impossible to discern their structure.

Euphysa australis (1884, p. 586, pl. 21, fig. 33).

Pennaria rosea (1884, p. 594, pl. 24, figs. 40-42).

Pennaria adamsia (1884, p. 595, pl. 25, figs. 43-48, pl. 26, fig. 49).

Pandea minima (1885, p. 916, pl. 42, figs. 10-12).

Obelia australis (1885, p. 920, pl. 43, figs. 19-22). First described from the east coast of New Zealand, 1884, p. 604.

The following species present certain characteristic structures which may possibly in future lead to their recognition, if specimens of similar appearance are found :

Lizusa prolifera (1884, p. 589, pl. 23, figs. 38, 39). This seems to be a *Bougainvillia* with medusa buds on the manubrium and with unbranched oral tentacles ; it may possibly be a juvenile stage.

Tiaropsis macleayi (1884, p. 605, pl. 23, fig. 37). There is a faint possibility of this species belonging to the Mitrocomidae ; but nothing is said as to whether the eight statocysts are open or closed, only that they are large, and nothing about ocelli at the base of the statocysts. On the other hand, some of the numerous marginal tentacles are said to have a basal ocellus.

Mitrocomium annae (1884, p. 606, pl. 29, figs. 58-60). Mayer (1910, p. 290) referred this species to *Mitrocoma*, and changed the specific name to *lendenfeldi* in order to distinguish it from *Mitrocoma annae* Haeckel. Lendenfeld's medusa is very similar to *Mitrocomium cirratum* Haeckel. In a previous paper (Kramp, 1932, p. 320) I have stated that *M. cirratum* has closed statocysts and accordingly does not belong to the Mitrocomidae. Later on I came to the conclusion that this Mediterranean medusa belongs to the genus *Eucheilota*. The tropical Atlantic *Eucheilota multicirrata* Thiel (1938) is the same species. It seems to me highly probable that *Mitrocomium annae* Lendenfeld is likewise an *Eucheilota*, but it does not agree with any of the two species of that genus described by me in the present paper. (p. 270). Lendenfeld found five specimens at Port Jackson, and in this case his description seems sufficient to recognize the species, if more specimens are found.

Margelis trinema (1885, p. 918, pl. 41, fig. 13). As mentioned above (p. 264) it seems to me improbable that this is the young of *Bougainvillia fulva* as supposed by Mayer (1910, p. 171).

Some of the original specimens of the following three species are in the British Museum, London, where I have seen them :

Turritopsis lata (1884, p. 588, pl. 22, figs. 36, 36a) : This is a valid species distinct from *T. nutricula* but certainly belonging to the same genus. What is stated in Lendenfeld's description is correct, but the vacuolated endoderm cells characteristic of *Turritopsis* are not mentioned, and it is mainly in the extension of this vacuolization that *T. lata* differs from the other species. The large stomach is mounted on a short, broad peduncle, which is gelatinous, and vacuolated endoderm cells are only present in the proximal parts of the 4 radial canals from the upper wall of the stomach to the base of the peduncle ; the vacuolated parts of the radial canals are funnel-shaped, tapering upwards, and fairly narrow, without the broad lateral extensions characteristic of *T. nutricula*, and they are attached to the gelatinous peduncle by narrow lines, in which the cells are not vacuolated. *T. lata* was very abundant at Port Jackson in March-April, and it should be possible to find it again.

Octorhopalon fertilis (1885, p. 919, pl. 42, figs. 14, 15) : Mayer (1910, p. 206) refers this species to *Laodicea* with some hesitation. The specimen in the British Museum has been dried, but I was able to see that Lendenfeld's description is not bad, though very insufficient.

The figures are absolutely misleading. The eight marginal "clubs" are typical cordyli, very large and broad, though not larger than the interradial tentacle bulbs. As far as I was able to see, the tentacle bulbs have no abaxial spurs. The stomach and the gonads are as in a *Laodicea*, and the medusa must probably be referred to that genus. In spite of the small size of the specimen, 2 mm. in diameter and 2.5 mm. in height, the gonads are rather well developed, and the specimen cannot be regarded as a young stage. Apparently it must provisionally be retained as a good species of *Laodicea*.

Eucope hyalina (1885, p. 920, pl. 42, figs. 16-18): The figure of the entire medusa is utterly wrong and misleading, but the description is not quite so bad. There are two specimens in the British Museum: one of them is fairly well preserved, the umbrella is exactly as high as wide, the manubrium very short, about one-fourth the height of the bell cavity: the four interradial tentacles are undeveloped, the basal bulbs of the four perradial tentacles are almost cylindrical, not conic as stated by Lendenfeld. In the other specimen, which is somewhat smaller, the umbrella is likewise at least as high as wide, but it is somewhat crumpled. The interradial tentacles are developed, their basal bulbs about half as large as the perradial. The filiform part of the tentacles is retained, provided with rings of nematocysts. The eight statocysts are distinct, but I could not see whether they are surrounded by "long ciliae." This is evidently a *Phialella*, a genus which highly needs a revision, and provisionally I think we should retain *Phialella hyalina* (Lendenfeld) as a proper species.

Mayer (1915) has given a short account of some medusae collected at Murray Islands, Torres Strait; six species of Scyphomedusae and 10 species of Hydromedusae are recorded. Some of them are only listed (p. 160), others are mentioned again later on:

Cytaeis atlantica (p. 200, pl. 1, fig. 2) is *C. tetrastyla* (see p. 263).

Stomotoca turrida (p. 199, pl. 1, fig. 1) really seems to be identical with *Amphinema turrida* (Mayer), previously known from Florida, the Bahamas, and the Pacific coast of Mexico, and recorded from Japan by Uchida (1938). It is not the same species as *A. dinema*, which I have mentioned above.

Laodicea fijiana (p. 200).—The specimens collected in the Torres Strait undoubtedly belong to *L. indica* (see above, p. 269).

Phialidium pacificum (p. 201, pl. 2, fig. 3). The original specimens from the Fiji Islands (Agassiz & Mayer, 1899), which were 6 mm. in diameter, had 16 tentacles, two statocysts between each successive pair of tentacles, and eight mouth-lips; the specimens from Torres Strait, up to 5 mm. wide, had 43 tentacles, but only 26 statocysts, and the mouth had only four lips. It seems improbable, therefore, that they belong to the same species. On the other hand, they do not agree with any of the species of *Phialidium* found on the Great Barrier Reef and mentioned by me in the present paper, and I cannot refer them to any known species.

Eutima australis (p. 201, pl. 3, fig. 5) is described as a new species. As mentioned above (p. 289), it is probably identical with *E. curva* Browne, which was found on the Great Barrier Reef.

Aequorea macrodactyla is only mentioned in the list (p. 160) without comments.

Rhopalonema velatum (p. 202, pl. 2, fig. 4).

Aglaura hemistoma, only mentioned in the list (p. 160).

Liriope rosacea, likewise in the list (p. 160), is identical with *L. tetraphylla*.

Solmundella mediterranea (p. 160) is most certainly *S. bitentaculata*.

Considering the rich collection brought home by the Great Barrier Reef Expedition it seems strange that Mayer (p. 160) emphasizes "the poverty of the Great Barrier Reef of Queensland and the southern coast of Papua, east of Torres Strait."

Since that time I have found only a few scattered remarks on Australian Hydromedusae in the literature.

Cnidonema haswelli, a new crawling medusa, was described by Briggs (1920, p. 97, pl. 17, figs. 1-4, pl. 18, figs. 1-5). It is closely related to *Staurocladia capense* (Gilchrist, 1919) from Cape of Good Hope and *Staurocladia vallentini* (Browne, 1902), originally described from the Falkland Islands (further mentioned by Browne & Kramp, 1939, p. 277), and later recorded from the Bermudas and from Wellington, New Zealand (Ralph, 1947).

Neoturris pelagica (Agassiz & Mayer, 1902) was recorded by Kramp (1928, p. 55) from south-eastern Australia, 38° 05' S., 149° 45' E.; originally described from the Pacific coast of Lower California and also recorded from Vancouver Island (Foerster, 1923).

Olindias singularis Browne was recorded by Stiasny (1931, p. 27) from Michaelmas Reef, off Cairns, Queensland.

Obelia sp.: During their investigations of the marine plankton in the coastal waters of New South Wales, Dakin & Colefax (1933, p. 198) found only one species of Hydromedusae, an *Obelia*, which could not be specifically identified.

Finally, the original description of *Aequorea australis* Uchida (1947, p. 307, text-fig. 8) was based on specimens from northern Australia and New Guinea.

ZOOGEOGRAPHICAL REMARKS.

Forty-four species of Hydromedusae were collected by the Great Barrier Reef Expedition; two of them are undetermined (*Eucheilota* sp. I and II); three are described as new species: *Octotiarra russelli*, *Phialucium condensum*, and *Eirene menoni*; the last had previously been found on the coasts of India and China.

Halicreas minimum is a bathypelagic, holoplanktonic medusa with an almost cosmopolitan distribution; it was taken in one haul over deep water outside the reefs.

Eight species are holoplanktonic and occur mainly in the upper strata. One of them, *Solmaris rhodoloma*, is only known from the Pacific (southern Japan and Chile, probably also at the Pelew Islands). *Amphogona apsteini* occurs across the tropical parts of the Indian and Pacific Oceans but is not known from the Atlantic. The remaining six species are circumtropical, widely distributed in the tropical, partly also in the subtropical, belts of all the great oceans including the Mediterranean: *Rhopalonema velatum*, *Aglaura hemistoma*, *Geryonia proboscidalis*, *Liriope tetraphylla*, *Solmundella bitentaculata*, and *Cunina octonaria*.

The distribution of the thirty meroplanktonic species (Anthomedusae, Leptomedusae and Limnomedusae) is seen from Table XV. They may be divided into the following groups according to their further distribution:

I. Four species mainly occurring in northern waters, but also known from several localities in the Tropics. They all occur in the Mediterranean. *Amphinema dinema* has not previously been recorded from the Pacific, but the other species occur in all the great oceans.

TABLE XV.—Further Distribution of Meroplanktonic Species of Hydromedusae found on the Great Barrier Reef.

	Indian Ocean.			Pacific Ocean.		Atlantic Ocean.		Mediterranean.
	W.	C.	E.	W.	E.	W.	E.	
I. <i>Zanclaea costata</i> . . .	×	×	×	×	×	×	×	×
<i>Leuckartiara octona</i> . . .	—	×	×	×	×	×	×	×
<i>Phialidium hemisphaericum</i> . . .	—	×	×	×	—	×	×	×
<i>Amphinema dinema</i> . . .	?	×	—	—	—	×	×	×
II. <i>Cytacis tetrastyla</i> . . .	×	×	×	×	×	×	×	×
<i>Proboscidactyla ornata</i> . . .	—	×	—	×	×	×	×	?
<i>Merga violacea</i> . . .	—	×	—	—	×	×	—	×
<i>Aequorea macrodactyla</i> . . .	×	×	×	×	×	—	×	—
<i>Phialucium carolinae</i> . . .	—	×	×	×	—	×	—	—
III. <i>Euphysora bigelowi</i> . . .	×	×	×	×	×	—	—	—
<i>Bougainvillia fulva</i> . . .	×	×	×	×	×	—	—	—
<i>Eirene hexanemalis</i> . . .	×	×	×	×	—	—	—	—
<i>Eirene palkensis</i> . . .	×	×	×	×	—	—	—	—
<i>Aequorea pensilis</i> . . .	×	×	×	×	—	—	—	—
<i>Olindias singularis</i> . . .	×	×	×	×	—	—	—	—
<i>Eutima levuka</i> . . .	—	×	×	×	—	—	—	—
<i>Heterotiara minor</i> . . .	—	—	×	×	—	—	—	—
<i>Phialucium mbenga</i> . . .	—	?	×	×	—	—	—	—
<i>Eirene ceylonensis</i> . . .	—	×	×	×	—	—	—	—
IV. <i>Laodicea indica</i> . . .	×	×	×	—	—	—	—	—
<i>Helgicirrho malayensis</i> . . .	—	×	×	—	—	—	—	—
<i>Aequorea conica</i> . . .	—	×	×	—	—	—	—	—
<i>Eutima curva</i> . . .	—	×	—	—	—	—	—	—
<i>Aequorea australis</i> . . .	—	—	×	—	—	—	—	—
<i>Euphysora annulata</i> . . .	—	—	×	—	—	—	—	—
<i>Leuckartiara gardineri</i> . . .	×	—	—	—	—	—	—	—
V. <i>Phialucium rangiroae</i> . . .	—	—	—	×	—	—	—	—
<i>Eirene kambara</i> . . .	—	—	—	×	—	—	—	—
VI. <i>Cirrhitiara superba</i> . . .	—	—	—	—	—	×	—	—
<i>Phialidium simplex</i> . . .	—	—	—	—	—	×	—	—

Twenty-four species are only known from tropical, or partly also from sub-tropical seas.

II. Five species more or less widely distributed in the Atlantic as well as the Indian and Pacific Oceans; two or three of them also known from the Mediterranean.

III. Ten species unknown in the Atlantic and the Mediterranean, but occurring in the Indian Ocean and in the western parts of the Pacific; two of them also recorded from

the eastern Pacific. Four of the species have not yet been found in the western parts of the Indian Ocean.

IV. Seven species only known from the Indian Ocean, mainly from its eastern parts, now for the first time found in the western Pacific.

V. Two species only known from the western Pacific (Paumotus and Fiji Islands).

VI. Two species hitherto known only from a few localities in the Atlantic, one of them, *Cirrhitiara superba*, from the tropical West-Atlantic, the other one, *Phialidium simplex*, from the southern West-Atlantic.

As might be expected, the fauna of Hydromedusae occurring in the Great Barrier Reef area has a predominantly tropical character. If we exclude the four species of the groups V and VI, which are only known from a few scattered localities, we find that among the remaining 26 species only six or seven occur in the Mediterranean, eight in the Atlantic, and likewise only eight in the eastern Pacific, whereas 17 have previously been recorded from the western Pacific. Twenty-three were known from the eastern part of the Indian Ocean, 21 or 22 from the central and 12 or 13 from the western part of the Indian Ocean.

Thus the fauna on the Great Barrier Reef is not merely tropical, but also distinctly Indo-West Pacific. It must be admitted that our knowledge of the medusae on the west coast of South America is insufficient, but we know something about the faunas off the Californian and Mexican coasts, and it is striking that, apart from the species which also occur in the Atlantic, only two of the Great Barrier Reef species are known from the eastern Pacific. This accords with the contrast, pointed out by Ekman (1934), and illustrated by numerous examples, between an Indo-West Pacific and an Atlanto-East Pacific fauna of littoral warm-water animals.

TABLE XVI.—*Number of Species of Hydromedusae in each Month.*

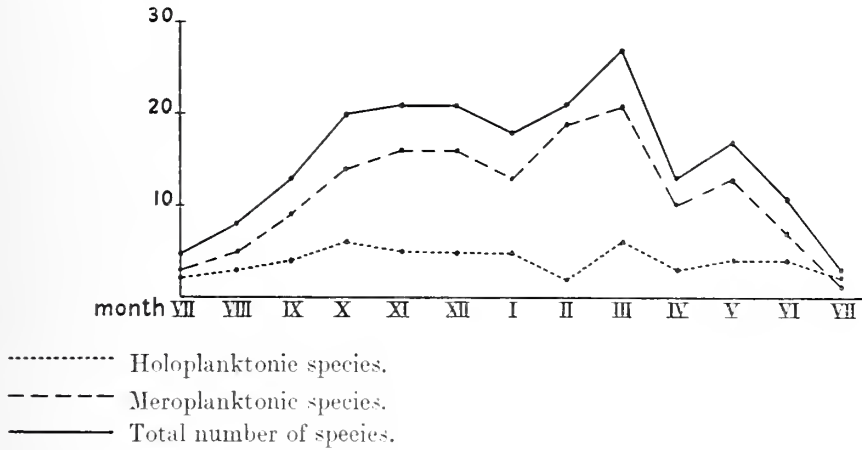
Month	1928.						1929.							Total.
	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.	
Holoplanktonic species	2	3	4	6	5	5	5	2	6	3	4	4	2	9
Meroplanktonic species	3	5	9	14	16	16	13	19	21	10	13	7	1	35
Total number of species	5	8	13	20	21	21	18	21	27	13	17	11	3	44

REMARKS ON SEASONAL OCCURRENCE.

Rare species are not included in Table XVIII, but in Table XVI and the accompanying curves (Text-fig. 8) the actual numbers of species of Hydromedusae found in each month during the investigations in the Great Barrier Reef area are given. The total number of holoplanktonic species was nine and, as will be seen from the table, the variation in the number of species during the year was very slight; the temporary decrease in February may be due to the heavy rainfall in this month, which lowered the salinity of the upper strata; hydrographical and meteorological conditions may have prevented or diminished the influx of oceanic water at this time.

On the other hand, the meroplanktonic species showed a remarkable increase in number from July (only three species found) to March the next year (21 species), followed by a somewhat more rapid decrease. On the whole the number of species was fairly

constant during a period of about six months of the summer. In North-European waters the occurrence of Hydromedusae is divided into two more or less sharply separated periods, some species predominating in spring, others in autumn, the former mainly belonging to northern seas, the latter mainly with a southern distribution.



TEXT-FIG. 8.—Number of species of Hydromedusae in each month.

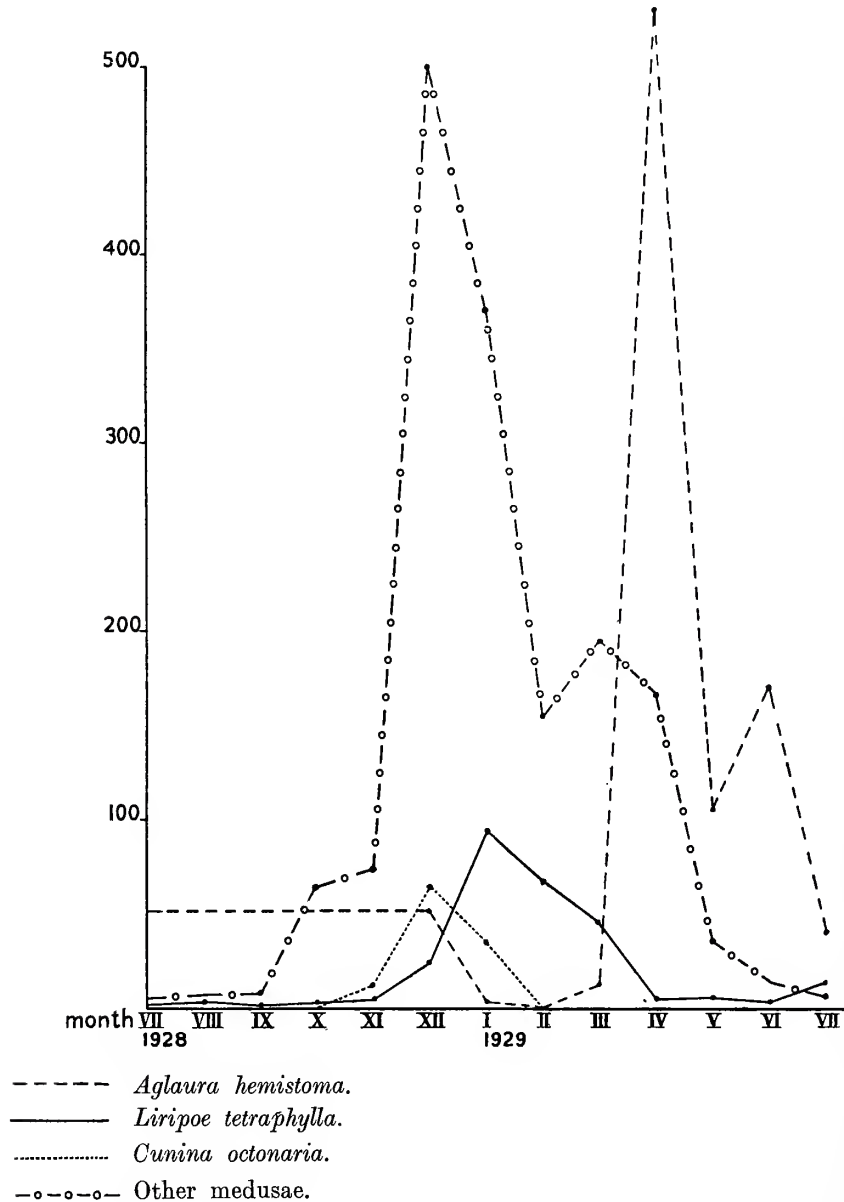
As mentioned in the Introduction (p. 260), an exact enumeration of the number of specimens of each species caught by the investigations is not possible, because only parts of the samples were sorted for identification; but an approximate calculation may give some idea of the quantities at different seasons of some of the most common species. Such calculations have been carried out for six meroplanktonic species, and for the Narcomedusa, *Cunina octonaria*, which together with the Trachymedusae *Aglaura hemistoma* and *Liriope tetraphylla*, constitutes the vast majority of the holoplanktonic species. Table XVII and

TABLE XVII.—Estimated Average Number of Specimens of Hydromedusae per Haul with 1 m. Stramin-net and Coarse Silk Net in each Month.

Month.	1928.						1929.						
	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.
<i>Aglaura hemistoma</i>	22	60	6	65	5	70	3	0.1	11	530	105	170	40
<i>Liriope tetraphylla</i>	1	2	1	2	5	23	95	68	46	5	6	3	13
<i>Cunina octonaria</i>	0	1	0.1	0.3	12	66	36	0	0	0	1	1	0
Other medusae	4	7	7	65	74	500	370	155	195	166	36	14	7
Total	27	70	14	132	96	659	504	223	252	701	148	188	60

the curves (Text-fig. 9) illustrate the seasonal occurrence of these three species compared with that of all the other species together. The table only includes the catches taken with the stramin-net and the coarse silk net; moreover the samples taken outside the reefs have been omitted. It will be seen that although the holoplanktonic medusae occurred at all seasons, they varied considerably in numbers at different times. During the first six months, July–December, 1928, *Aglaura* was the subject of considerable variations;

the average number per haul in this period was 51, and for the sake of simplicity this figure has been used in the diagram, Text-fig. 9. The species was accordingly rather common during that period, whereas it was very rare during the following three months; but then it suddenly increased enormously in numbers, the average for April being 530; one haul (St. LV, C) even contained 1,600 specimens. *Liriope* had its maximal occurrence



TEXT-FIG. 9.—Estimated average number of specimens in each month.

during the period when *Aglaura* was rare, *Cunina* one month earlier. These three holoplanktonic species thus behaved rather differently.

The other species, the majority of which are meroplanktonic, were rare in winter, May–September, but abundant in summer; the very large number in December was mainly due to the great quantities of *Laodicea indica*. As mentioned above (p. 234) *Bougainwillia fulva* was entirely absent outside the period January–May, whereas the other common

species occurred almost throughout the year, though with distinct periods of maximal occurrence. *Phialucium carolinae* had two maxima, December–January and June. The maxima of *Laodicea indica*, *Eirene hexanemalis*, *Helgicirrhia malayensis* and *Acquorea australis* were in December or January. Most of the less common species likewise had their principal time of occurrence during the summer, though some of them might also be taken at other seasons, and for all the common species and several of the others it has been demonstrated that young specimens occurred at any time. So, with few exceptions, medusae are liberated from the hydroids throughout the year, but with a distinct maximal periodicity, usually in summer.

A. P. Orr (1933) has discussed the biological significance of the physical and chemical conditions as observed on the Great Barrier Reef Expedition (p. 61) and called attention to the different circumstances which might be expected to affect the occurrence of the planktonic animals. The fluctuations in the salinity of the water were not great, there being only a temporary summer-time reduction, caused by rainfall. The amount of phytoplankton is only of indirect importance for carnivorous animals like medusae, and from the paper by Russell & Colman (1934) it appears that copepods, molluscs, echinoderm larvae and other pelagic animals are always present in considerable numbers throughout the year. The reason for the distinct increase in production of meroplanktonic Hydromedusae during the summer must evidently be the temperature. In comparison with northern waters the fluctuations in temperature were certainly slight, the annual range being only 8.6° C., from 21.24° in July to 29.88° in February at a depth of 23 m. Nevertheless this difference in the temperature of the water seems to affect these tropical species of medusae to a remarkable degree; the comparatively low temperature in winter does not completely stop the production, but the high summer temperature causes a great increase in productivity.

LIST OF LITERATURE.

- AGASSIZ, A., & MAYER, A. G. 1899. Acalephs from the Fiji Islands. Bull. Mus. comp. Zool., Harvard Coll. XXXII.
- 1902. Medusae. Rep. Sci. Res. Exped. Trop. Pacific, "Albatross," from August, 1899, to March, 1900. Mem. Mus. comp. Zool., Harvard Coll. XXVI.
- APSTEIN, J. 1913. Beiträge zur Kenntnis der Leptomedusen. Zool. Jahrb. Abt. Anat. u. Ontog. Bd. 36.
- BIGELOW, H. B. 1904. Medusae from the Maldive Islands. Bull. Mus. comp. Zool., Harvard Coll. XXXIX.
- 1909. The Medusae. Rep. Sci. Results, Eastern Tropical Pacific, "Albatross," 1904–05. Mem. Mus. comp. Zool., Harvard Coll. XXXVII.
- 1913. Medusae and Siphonophorae collected by the U.S. Fisheries Steamer "Albatross" in the northwestern Pacific, 1906. Proc. U.S. Nat. Mus. XLIV.
- 1918. Some Medusae and Siphonophorae from the Western Atlantic. Bull. Mus. comp. Zool., Harvard Coll. LXII.
- 1919. Hydromedusae, Siphonophores, and Ctenophores of the "Albatross" Philippine Expedition. U.S. Nat. Mus. Bull. 100, I.
- 1938. Plankton of the Bermuda Oceanographic Expeditions, VIII. Medusae taken during the years 1929 and 1930. Zoologica, New York Zool. Soc. XXIII.
- BLAINVILLE, H. M. D. 1834. Manuel d'actinologie ou de zoophytologie. Paris.
- BRANDT, J. F. 1838. Ausführliche Beschreibung der von C. H. Mertens auf seiner Weltumsegelung beobachteten Schirmquallen. Mém. Acad. Imp. Sc. St. Pétersbourg, IV, part 2.
- BRIGGS, E. A. 1920. On a New Species of Crawling Medusa (*Cnidonema haswelli*) from Australia. Rec. Australian Mus. XIII.

- BROWNE, E. T. 1896. On British Hydroids and Medusae. Proc. Zool. Soc. London.
- 1902. A preliminary Report on Hydromedusae from the Falkland Islands. Ann. Mag. Nat. Hist. ser. 7, IX.
- 1904. Hydromedusae. Fauna and Geography of the Maldive and Laccadive Archipelagoes, II, part 3.
- 1905. Report on the Medusae. Ceylon Pearl Oyster Fisheries. Suppl. Rep. 27.
- 1907. A Revision of the Medusae belonging to the Family Laodiceidae. Ann. Mag. Nat. Hist., ser. 7, XX.
- 1908. The Medusae of the Scottish National Antarctic Expedition. Trans. Roy. Soc. Edinb. XLVI.
- 1916. Medusae from the Indian Ocean. Trans. Linn. Soc. London, 2nd ser., Zool. XVII.
- & P. L. KRAMP. 1939. Hydromedusae from the Falkland Islands. Discovery Reports, XVIII.
- CUVIER, G. 1839. Le règne animal . . . Les Zoophytes par MILNE EDWARDS. Paris.
- DAKIN, W. J., & COLEFAX, A. 1933. The Marine Plankton of the Coastal Waters of New South Wales. I. Proc. Linn. Soc. N.S.W. LXVIII, parts 3-4.
- EDWARDS, H. MILNE. 1839, in CUVIER, Règne animal.
- EKMAN, S. 1934. Indo-Westpazifik und Atlanto-Ostpazifik, eine tiergeographische Studie. Zoogeographica, Bd. 2.
- ESCHSCHOLTZ, FR. 1829. System der Acalephen.
- FEWKES, J. W. 1882. On the Acalephae of the East Coast of New England. Bull. Mus. comp. Zool., Harvard Coll. IX.
- FOERSTER, R. E. 1923. The Hydromedusae of the West Coast of North America, with Species Reference to those of the Vancouver Region. Contrib. to Canadian Biol., n.s. I.
- GEGENBAUR, C. 1856. Versuch eines Systemes der Medusen . . . Zeitschr. f. wiss. Zool. Bd. 8.
- GOETTE, A. 1886. Verzeichniss der Medusen, welche von Dr. Sander, "Prinz Adalbert" gesammelt wurden. Sitzungsber. K. Preuss. Akad. d. Wiss. zu Berlin.
- HAECKEL, E. 1879. Das System der Medusen.
- 1881. Report on the deep-sea Medusae. Rep. scient. results Challenger (Zool.), vol. 4.
- HARTLAUB, CL. 1909. Ueber einige von Ch. Gravier in Djibuti gesammelte Medusen. Zool. Jahrb., Abt. Syst. Bd. 27.
- 1907-17. Craspedote Medusen. Nordisches Plankton, Bd. 12.
- KRAMP, P. L. 1919. Medusae I. Leptomedusae. The Danish Ingolf Exped. V, part 8.
- 1928. Hydromedusae I, Anthomedusae. Papers from Dr. Th. Mortensen's Pacif. Exped. 1914-16, 43. Vidensk. Medd. Dansk Naturhist. Foren. Bd. 85.
- 1932. A Revision of the Medusae belonging to the Family Mitrocomidae. Vidensk. Medd. Dansk Naturhist. Foren, Bd. 92.
- 1936. On the Leptomedusae of the Genera *Eirene* and *Helgicirra*. Vidensk. Medd. Dansk Naturhist. Foren, Bd. 99.
- 1948a. Medusae Collected by the Swedish Antarctic Expedition 1901-03. Further Zool. Res. Swedish Antarctic Exped. 1901-03 under the Direction of Dr. Otto Nordenskjöld, IV, no. 1.
- 1948b. Trachymedusae and Narcomedusae from the "Michael Sars" North Atlantic Deep-Sea Expedition 1910 . . . Rep. Sci. Res. "Michael Sars" North Atlantic Deep-Sea Exped., 1910, V, no. 9.
- LENDENFELD, R. VON. 1883. Ueber Coelenteraten der Südsee. IV: *Eucopeella campanularia* nov. gen. Zeitschr. wiss. Zool. Bd. 38.
- 1884-86. The Australian Hydromedusae. Proc. Linn. Soc. New South Wales, IX-X.
- LESSON, R. P. 1830. Zoophytes.—Voyage autour du monde . . . sur "La Coquille." Zoologie par M. LESSON, II, part 2. Paris.
- LING, S. 1937. Studies on Chinese Hydrozoa. I. On some Hydromedusae from the Chekiang Coast. Peking nat. hist. Bull. XI.
- MAAS, O. 1893. Die craspedoten Medusen der Plankton-Expedition. Ergebn. d. Plankton-Exped. Bd. 2, K.c.
- 1904a. Bemerkungen zum System der Medusen. Revision der Cnobotiden Haeckels. Sitzungsber. math. phys. Kl. Akad. Wiss. München, Bd. 34.
- 1904b. Méduses . . . Résultats des campagnes scientifiques . . . par Albert I. Prince de Monaco, fasc. 28.
- 1905. Die craspedoten Medusen der Siboga-Expedition. Siboga-Expedition, Monogr. 10.
- 1906. Méduses d'Amboine. Revue Suisse de Zool. tome 14, fasc. 1.

- 1909. Japanische Medusen. Beitr. z. Naturgesch. Ostasiens (F. Doflein). Abhandl. d. II. Kl. d. K. Akad. d. Wissensch. Suppl. Bd. I, Abhandl. 8.
- MAYER, A. G. 1900a. Descriptions of New and Little-known Medusae from the Western Atlantic. Bull. Mus. comp. Zool., Harvard Coll. XXXVII, no. 1.
- 1900b. Some Medusae from the Tortugas, Florida. Bull. Mus. comp. Zool., Harvard Coll. XXXVII, no. 2.
- 1904. Medusae of the Bahamas. Mus. Brooklyn Inst. Mem. Nat. Sci. I, no. 1.
- 1910. Medusae of the World, I-III.
- 1915. Medusae of the Philippines and of Torres Straits. Carnegie Instit. of Washington, Publ. 212.
- MCCRADY, J. 1857. Gymnophthalmata of Charleston Harbor. Proc. Elliott Soc. Nat. Hist. I.
- MENON, M. G. K. 1932. The Hydromedusae of Madras. Bull. Madras Government Museum. n.s. Nat. Hist. Section, III, no. 2.
- MÜLLER, F. 1861. *Cunina Köllikeri* n. sp. Arch. f. Naturgesch., Jahrg. 27, Bd. 1.
- ORR, A. P. 1933. Physical and chemical conditions in the sea in the neighbourhood of the Great Barrier Reef. Great Barrier Reef Exped. 1928-29. Sci. Rep. II, no. 3.
- PÉRON & LESUEUR. 1809. Tableau des caractères génériques et spécifiques de toutes les espèces de Méduses connues jusqu'à ce jour. Paris.
- QUOY & GAIMARD. 1824, in L. de FREYCINET: Voyage autour du monde . . . sur les corvettes de S.M. l'Uranie . . . Paris.
- RALPH, P. M. 1947. The Hydroid and Medusa of *Cnidonema vellentini* (Anthomedusae) from Wellington, New Zealand. Trans. R. Soc. New Zealand, LXXVI, part 3.
- REES, W. J. 1938. Observations on British and Norwegian Hydroids and their Medusae. Journ. Mar. Biol. Ass., Plymouth, XXIII.
- RUSSELL, F. S., & COLMAN, J. S. 1935. The Zooplankton. IV. The Occurrence and Seasonal Distribution of the Tunicata, Mollusca and Coelenterata (Siphonophora). Great Barrier Reef Exped. 1928-29. Sci. Rep. II, no. 7.
- RUSSELL, F. S. 1939. On the nematocysts of Hydromedusae. II. Journ. Mar. Biol. Ass. Plymouth, XXIII.
- STEPHENSON, ANNE. 1934. The Breeding of Reef Animals. Part II: Invertebrates other than Corals. Great Barrier Reef Exped. 1928-29. Sci. Rep. III, no. 9.
- STIASNY, G. 1928. Hydromedusen aus der Java-See. Zool. Mededeel. 'sRijks Museum van Natuurl. Hist. te Leiden. Deel XIV, Afl. 4.
- 1931. Ueber einige Coelenterata von Australien. Zool. Mededeel. 'sRijks Museum van Natuurl. Hist. te Leiden, Deel. XIV, Afl. 1-2.
- THIEL, M. E. 1936. Systematische Studien zu den Trachylinae der Meteor-expedition. Zool. Jahrb., Abt. Syst. Bd. 69.
- 1938. Die Leptolinae der Meteor-Expedition in systematischer Betrachtung. I: Anthomedusae. II: Leptomedusae. Zoolog. Anzeiger, Bd. 121.
- UCHIDA, T. 1927. Studies on Japanese Hydromedusae. I: Anthomedusae. Journ. Faculty of Sci. Imp. Univ. Tokyo. Sect. IV. Zool. I, part 3.
- 1928. Studies on Japanese Medusae. II: Trachomedusae and Narcomedusae. Japanese Journ. of Zool. II, no. 1.
- 1938. Medusae in the Vicinity of the Amakusa Marine Biological Station. Bull. Biogeograph. Soc. of Japan, VIII.
- 1947. Some Medusae from the Central Pacific. Journ. Faculty of Sci. Hokkaido Univ. ser. VI, Zool. IX.
- VANHÖFFEN, E. 1902. Die craspedoten Medusen der deutschen Tiefsee-Expedition. I. Trachymedusen. Wiss. Ergebn. d. deutschen Tiefsee-Exped. Bd. 3.
- 1908. Die Narcomedusen. Wiss. Ergebn. d. deutschen Tiefsee-Exped. Bd. 19.
- 1911. Die Anthomedusen und Leptomedusen der Deutschen Tiefsee-Expedition. Wiss. Ergebn. d. deutschen Tiefsee-Exped. Bd. 19.
- 1912a. Die craspedoten Medusen der deutschen Südpolar-Expedition 1901-03. Deutsche Südpolar-Exped. Bd. 13, Zool. 5.
- 1912b. Die craspedoten Medusen des "Vettor Pisani". Zoologica, Heft 67.
- 1913. Ueber westindische Medusen. Zool. Jahrb. Suppl. Bd. 11.

TABLE XVIII.—List of Stations where Hydromedusae were Collected, with Number of Specimens in the Preserved Collection.

Station number.	Date.	Position.	Depth (m.)	Temp. (° C.)	Net.	<i>Euphyrsora bigelowi</i> .	<i>Cyrtæis tetrastyla</i> .	<i>Bougainvillia fulva</i> .	<i>Merya violacea</i> .	<i>Amphinema dinema</i> .	<i>Leucartiara octonu</i> .	<i>Laodicea indica</i> .	<i>Phidippium hemisphaericum</i> .	<i>Phidippium simplex</i> .	<i>Phidippium mbegu</i> .	<i>Phidippium carolinæ</i> .	<i>Eirene hexanemalis</i> .	<i>Helgicirrha malayensis</i> .	<i>Eutima levuka</i> .	<i>Eutima curra</i> .	<i>Aequorea australis</i> .	<i>Aequorea macrodactyla</i> .	<i>Aequorea pensilis</i> .	<i>Amphogona apsteinii</i> .	<i>Aglaura hemistoma</i> .	
1	1928. 27.vii	2 miles N.E.	31	21°90	S C	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	4	
2	30. "	3 miles E.	"	22°58	S C	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	-	-	1	
3	4.viii	"	32	22°28	S C	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	11	-	-	-	4	
4	7. "	1 mile N.	16	"	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
5	11. "	3 miles E.	32	21°52	S C F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9 12 9	
6	17. "	"	"	"	S C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39 29	
7	22. "	"	"	22°42	S C	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	4 10	
8	27. "	I.T.O.	45	23°22	S C	-	-	-	-	-	-	2 1	-	-	-	-	-	-	-	-	-	-	-	-	4 3	
9	31. "	3 miles E.	32	23°00	S C	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	7 6	
10	4.ix	"	"	23°45	S C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 2	-	-	-	2	
11	6. "	I.T.O.		23°91	S C N	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-	-	
12	11. "	3 miles E.	32	24°13	S C	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	5 12	
	19. "	R.F.			C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
13	20. "	3 miles E.	"	24°53	S C F	-	-	-	-	-	-	10 5 1	1	-	-	-	-	1	1	8 4 1	-	-	-	-	-	1 2
14	26. "	"	"	25°11	S	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	
	28. "	R.F.			C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
15	2.x	3 miles E.	"	25°10	S C F	-	-	-	-	1	-	7	-	-	1	-	-	1	1	3 5	-	1	-	-	2 23 11	
16	3. "	"	"	-	m. wire 0 10 20 30 40 25	-	3	-	-	-	-	-	-	-	-	-	-	-	1	1	3 2	-	-	-	-	
17	8. "	"	"	25°40	S	-	-	-	-	-	-	1	-	-	-	-	1	1	1	-	1	-	-	-	5	
18	15. "	"	"	25°93	S C F	-	-	-	-	-	1 1 2	-	-	-	-	4 1	3	1	2	-	9 1	-	-	3	5 17	
19	20. "	O.T.O.	225	26°05	S N	180-0	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2 7 5	
20	" "	"	> 600	-	N 0 m.	250-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	
21	22. "	3 miles E.	32	-	S C F	-	-	-	-	-	1	2	-	-	-	-	1	-	1	-	-	-	-	1	4 16 10	
22	23. "	"	"	26°50	S C	-	-	-	2	-	-	2 1	-	-	-	-	-	-	1	-	-	-	-	-	9	
23	2.xi	"	"	27°24	S C	-	-	-	-	-	-	-	-	-	-	-	1 1	1	-	-	1	1	-	-	18 37	
24	6. "	"	"	27°33	S C	-	-	-	-	-	1	2	-	-	-	-	2	-	1	3 3	4	1	-	-	2 15	

TABLE XVIII.—List of Stations where Hydromedusae were Collected, with Number of Specimens in the Preserved Collection.—Continued.

Station number.	Date, 1928.	Position.	Depth (m.)	Temp. (° C.)	Net.	<i>Euphyasora bigelowi</i> .	<i>Cyrtopsis tetrasphala</i> .	<i>Bougainvillia fabra</i> .	<i>Meryu viduata</i> .	<i>Amphibiaea diuana</i> .	<i>Leuckartia octona</i> .	<i>Londicea ludica</i> .	<i>Phialidium hemisphaericum</i> .	<i>Phialidium simplex</i> .	<i>Phialactaea rubrona</i> .	<i>Phialactaea carolinæ</i> .	<i>Eirene hexanemalis</i> .	<i>Heliocircha nuttyensis</i> .	<i>Eutima brecki</i> .	<i>Eutima curra</i> .	<i>Aequorea australis</i> .	<i>Aequorea macrocalypha</i> .	<i>Aequorea pensilis</i> .	<i>Amphopoda apsteinii</i> .	<i>Aglaura hemistoma</i> .	<i>Liriopse tetraphylla</i> .	<i>Cucina octonaria</i> .	
25	16.xi	3 miles E.	32	26°57	S C ?	-	-	-	-	12	-	-	-	-	5 3	2 10	-	-	-	-	1	1	-	-	-	-	-	10 7
26	19. "	I.T.O.	57	26°61	S C F N 50-0	-	1 3 1	-	-	-	22 7 1	-	-	-	-	4 2 1	7 6 1	2 2 1	2 2 -	-	1	1	-	-	-	-	1	3
27	21. "	3 miles E.	32	26°90	S C F	-	-	-	-	-	14 3 1	1	-	-	3	5	9	1	1	1	1	-	-	-	11	11	3	
28	23. "	O.T.O.	>600	26°91	S 600-0 C 580-0 S	-	-	-	-	-	-	1	-	-	-	-	3	-	1	-	2	-	-	-	2	2	-	
	25. "	L.O.R.F.	-	-	-	-	6	-	-	3	-	4	-	-	2	-	1	-	-	-	-	-	-	3	-	10	-	
30	28. "	3 miles E.	32	27°34	S	-	1	-	-	-	13	-	-	-	5	1	2	-	-	3	-	-	-	2	9	-		
30a	29. "	"	"	"	C	-	-	-	-	-	25	-	-	-	1	-	3	2	-	-	1	-	-	1	14	-		
31	2.xii	"	"	"	B.S.	-	-	-	-	-	11	-	-	-	3	-	5	-	1	1	-	-	-	1	13	-		
32	5. "	"	"	"	S C	-	2	-	2	-	113 23	-	-	-	1 3	14 3	6 10	10 6	2 1	15 2	2 2	2 2	-	18	30	2		
33	13. "	"	"	"	S C	-	-	-	-	-	3 6	-	-	-	20 11	-	19 4	-	-	3 1	-	-	-	1	1	2		
34	19. "	"	"	"	S C	-	-	-	1	-	3	-	-	-	29 3	17 3	32 4	-	-	2 1	2 1	2 1	1 1	2 1	2 1	8 7	27	
35	27. "	"	"	"	S C	-	2	-	3	-	17 4	-	-	-	8 3	44 9	12 -	1	-	25 4	4	3	-	7	63	7		
36	1929. 4.i	"	"	"	S C	-	-	10	-	1	5 1	-	-	-	39 4	6 1	9 -	2 1	-	1	-	-	-	3	33	-		
37	14. "	"	"	"	S C	-	-	-	4	-	1	-	-	-	2 3	10 3	3 -	-	-	-	-	-	-	-	16	1		
38	21. "	"	"	"	S C	-	1	-	-	-	1	-	-	-	3 1	2 2	3 -	-	1	-	-	-	-	1	125	-		
39	30. "	"	"	"	S C F	-	-	-	-	-	-	-	-	-	20 3	5 1	4 1	-	-	-	-	-	-	-	20	1		
41	13.ii	"	"	"	S C	-	-	1	-	-	-	-	-	-	1 1	2 16	1 1	-	1	1	1	1	-	-	36	-		
42	18. "	"	"	"	C	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	4	-		
43	26. "	C.B.	30	28°81	S C	-	-	1	-	-	-	-	-	-	3 8	16 -	-	1	2	1	-	-	-	-	13	-		
44	27. "	Li. I.	31	27°97	S C	-	-	16	-	-	2	-	-	-	11 2	1 1	2 1	1	1	1	-	-	-	1	13	-		
45	28. "	O.C.P.	>600	"	S 500-0	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-		
46	" "	I.C.P.	33	27°61	S C	-	-	6 1	-	1	3	-	-	-	1	-	-	-	1	1	1	-	1	-	25	-		
47	4.iii	3 miles E.	31	28°42	S C	2 1	1	4	-	-	-	-	-	-	-	1 2	-	-	1	-	-	-	-	-	24	-		
48	15. "	"	"	"	S C	-	-	7	-	-	-	-	-	-	5 2	13 4	3 1	-	-	-	-	-	-	-	1	24		
49	17. "	I.P.P.	46	28°23	S C	2	1	-	-	1	1	-	-	2 1	-	3 1	3 1	3	1	3	1	-	-	-	1	4	-	
50	18. "	O.P.P.	>400	28°24	S 400-0 S 170-0 C 150-0	1	-	3	-	-	2	3	-	1	-	-	-	-	1	1	1	-	1	2	5	8	4	
51	25. "	3 miles E.	33	27°68	S C	-	-	15	-	-	1	-	-	-	15 10	7 2	-	-	-	2 1	-	-	-	-	-	3	-	
52	6.iv	"	"	"	S C	-	-	-	-	-	-	-	-	-	10 1	1	2	-	-	-	-	-	-	1	11	5		

TABLE XVIII.—List of Stations where Hydromedusae were Collected, with Number of Specimens in the Preserved Collection.—Continued.

Station number.	Date.	Position.	Depth (m.)	Temp. (°C.)	Net.	<i>Euphyrsora bigelowi</i> .	<i>Cyloaetes tetrastyla</i> .	<i>Bougainvillia fulva</i> .	<i>Merga violacea</i> .	<i>Amphinema dincana</i> .	<i>Leuckartiana octona</i> .	<i>Laotica inatica</i> .	<i>Phialidium henisphaerium</i> .	<i>Phialidium simplex</i> .	<i>Phialucium mbenga</i> .	<i>Phialucium carolinae</i> .	<i>Eirene hexanemalis</i> .	<i>Helgicirrha malayensis</i> .	<i>Eutima leruka</i> .	<i>Eutima curva</i> .	<i>Aequorea australis</i> .	<i>Aequorea macrodactyla</i> .	<i>Aequorea pensilis</i> .	<i>Amphogona apsteinii</i> .	<i>Aglaura henistoma</i> .	<i>Liviope tetraphylla</i> .
53	13.iv	3 miles E.	32	26°90	S C	-	-	-	-	-	-	-	-	-	17 12	1	2	1	1	2	-	-	-	-	8	-
54	20. "	"	31	25°96	S C	-	-	2 3	-	1	-	-	-	-	4 4	3	3	-	-	-	-	-	-	1	13 20	5 1
55	26. "	"	"	26°52	S C	-	-	-	-	-	-	-	-	-	-	-	1 3	-	-	-	6 3	-	-	-	4 48	8 2
56	7.v	"	"	25°27	S C	-	-	-	-	-	-	-	-	-	4	-	3	1	-	2	-	-	-	-	3 2	2 1
57	18. "	"	32	24°68	S C	-	-	3	-	-	-	-	-	4 1	1	1	4	7	1	-	3	-	-	-	13 11	5 2
58	25. "	"	"	24°09	S	1	1	5	-	-	-	1	-	8	-	-	-	2	1	-	-	-	-	1	12	3
59	31. "	"	"	23°63	S C	-	1	1	-	-	-	-	-	3 2	-	2	-	5	-	-	1	-	-	7	15 18	7 1
60	7.vi	"	"	23°99	S C	-	-	-	-	-	-	3 1	-	-	-	1	1	-	-	-	3 3	-	-	-	13 25	- 2
61	14. "	"	31	22°55	S C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	8 15	1 4
63	24. "	"	32	22°10	S C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12 15	- 1
66	11.vii	"	30	21°41	S C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	7 15	6 4
67	17. "	"	32	21°27	S C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 13	13 7
Total number of specimens						10	33	81	18	13	19	335	10	22	9	290	255	234	54	45	157	20	11	27	891	834

S : stramin net.
 C : coarse silk net.
 F : fine silk net.
 N : Nansen net, vertical.
 B.S. : bottom stramin net.

3 miles E. : 3 miles E. of Low Isles.
 2 miles N.E. : 2 miles N.E. of Low Isles.
 I.T.O. : in Trinity Opening.
 O.T.O. : outside Trinity Opening.
 Li. I. : off Lizard Island.
 L.O.R.F. : lagoon over reef flat.
 C.B. : off Cape Bedford.

O.C.P. : outside Cook's Passage.
 I.C.P. : inside Cook's Passage.
 I.P.P. : inside Papuan Pass.
 O.P.P. : outside Papuan Pass.
 R.F. : reef flat, entrance to anchorage, Low Isles.

PRESENTED

24 JUL 1955





EXPLANATION OF PLATES.

PLATE I.

FIG. 1.—*Octotiarā russelli* n. sp. Lateral view of the medusa. × 7.

FIG. 2.—*Octotiarā russelli* n. sp. Part of umbrella margin. × 25.

FIG. 3.—*Octotiarā russelli* n. sp. Tentacle bulb, *cc* circular canal, *rc* radial canal. × 40.

FIG. 4.—*Phialucium condensum* n. sp. Oral view of the medusa. × 15.

PLATE II.

FIG. 5.—*Eirene kambara*. Oral view of the medusa. × 14.

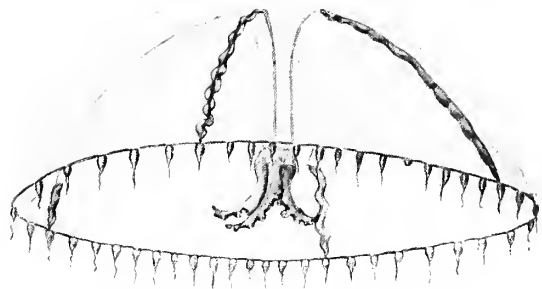
FIG. 6.—*Eirene menonī* n. sp. Lateral view of the medusa. × 6.

FIG. 7.—Stomach of *Liriope tetraphylla* with medusiferous stolons of *Cunina*. × 35.

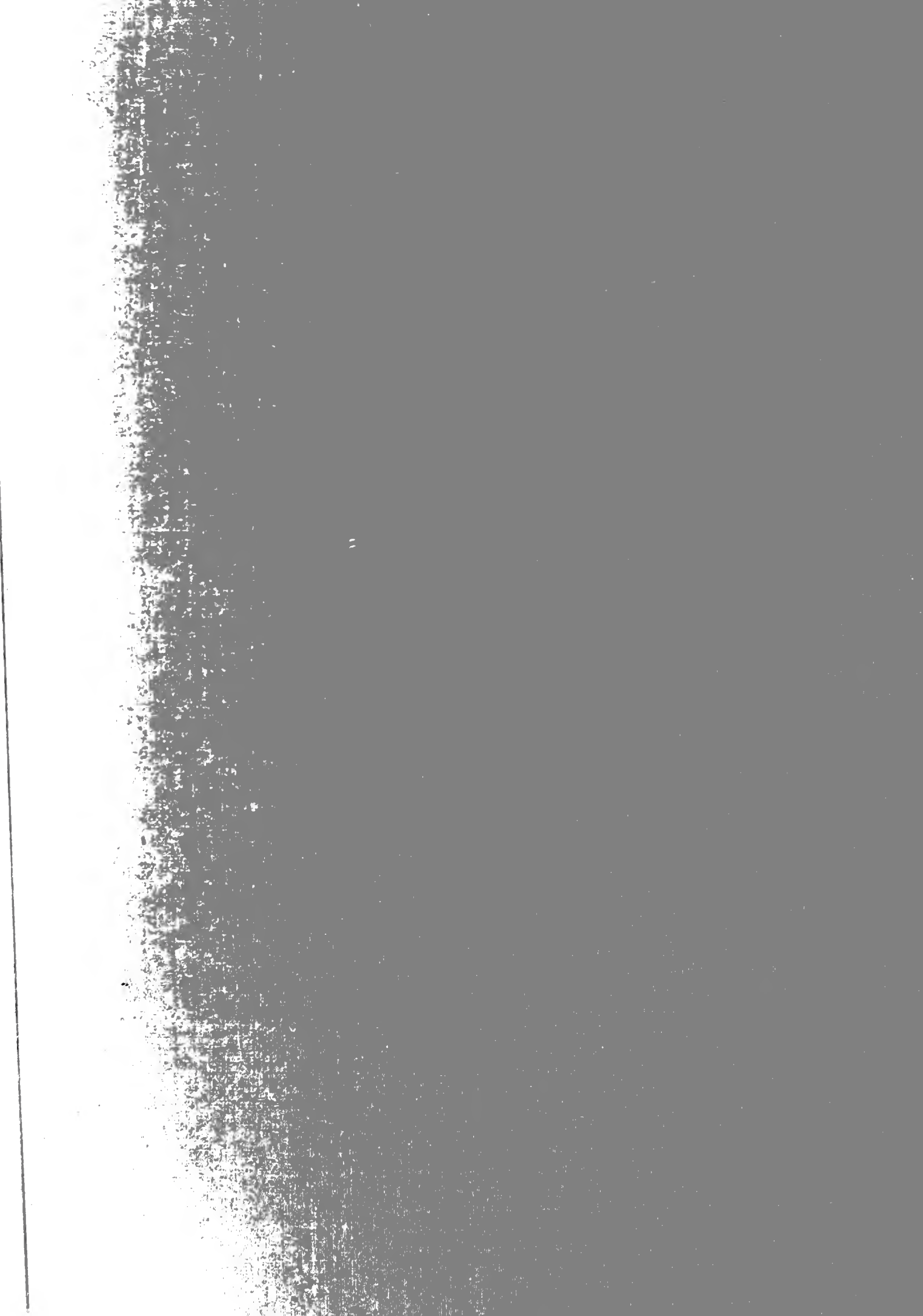
cc rc

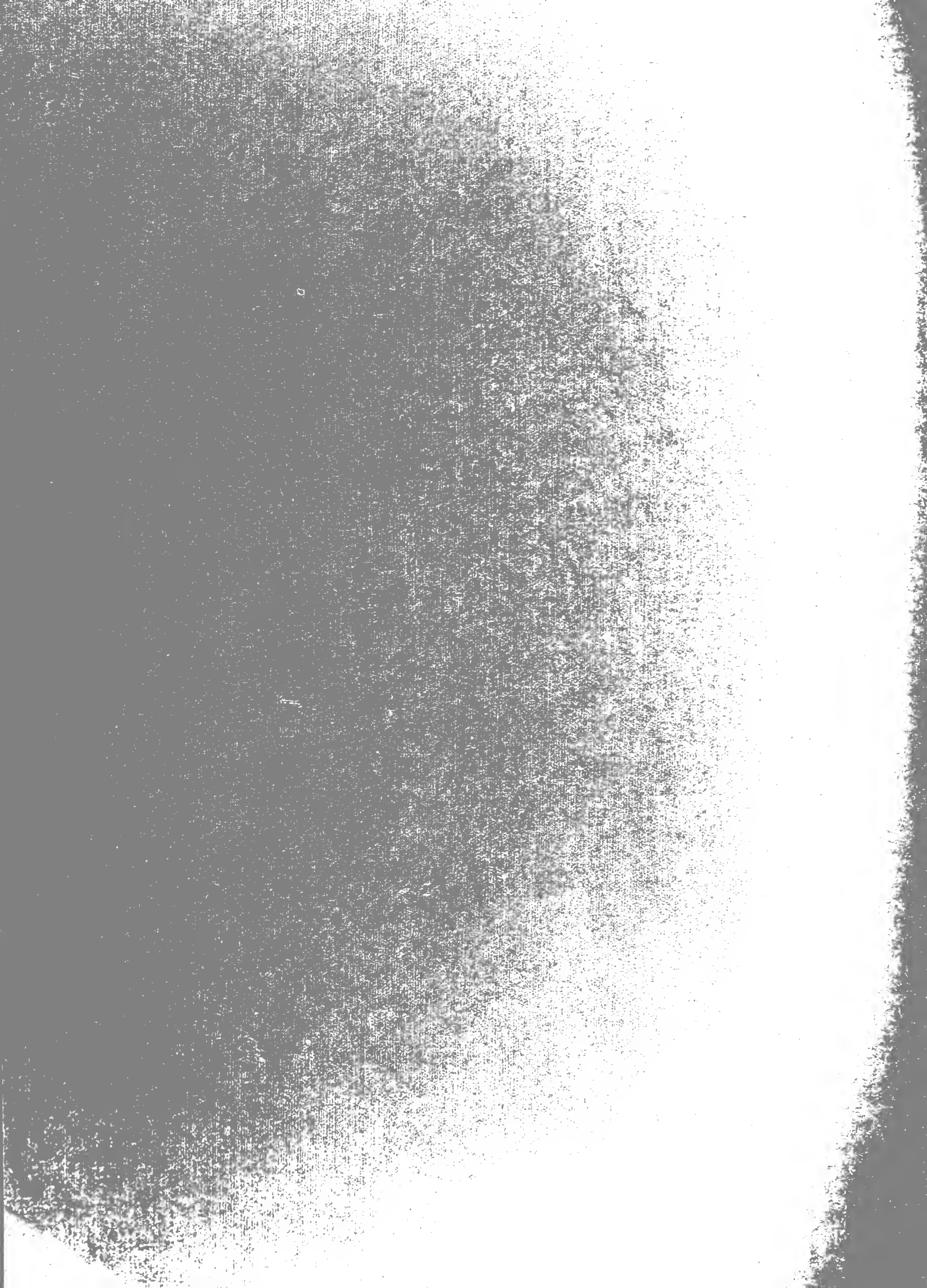












BRITISH MUSEUM (NATURAL HISTORY)

GREAT BARRIER REEF EXPEDITION
1928-29

SCIENTIFIC REPORTS

VOLUME VI, No. 5

THE SERGESTIDAE OF THE
GREAT BARRIER REEF EXPEDITION

BY

ISABELLA GORDON, D.Sc., Ph.D.

WITH SIX TEXT-FIGURES



LONDON:

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

SOLD BY

B. QUARITCH, LTD., 11 GRAFTON STREET, NEW BOND STREET, LONDON, W. 1;

WHELDON & WESLEY, LTD., 83-84 BERNICK STREET, LONDON, W. 1

H.M. STATIONERY OFFICE, LONDON, S.W. 1

AND AT

THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, LONDON, S.W. 7

1956

[All rights reserved]

Price Five Shillings

(Issued 31st January, 1956)

DESIGNED AND
PRINTED
BY
ADLARD & SON
LIMITED

AT
BARTHOLOMEW PRESS
BORKING

THE SERGESTIDAE OF THE GREAT BARRIER REEF EXPEDITION

BY

ISABELLA GORDON, D.Sc., Ph.D.

SYNOPSIS.

The paper gives the occurrence of two species of the genus *Lucifer* in the Great Barrier Reef area during the year July 1928–July 1929. *L. penicillifer* Hansen is by far the commoner species; it occurred with fair regularity throughout the year, the month of September excepted. Spermatophores were present, in the distal portion of one vas deferens only, practically throughout the year, suggesting that there is no fixed breeding period. *L. typus* H. M.-Edw. occurred in small numbers between the end of July and the end of November 1928 but the two species were seldom present at the same time.

INTRODUCTION

THE Sergestidae of the Great Barrier Reef Expedition all belong to the subfamily Luciferinae which comprises the single aberrant genus *Lucifer* V. Thompson (= *Leucifer* H. Milne-Edwards). This genus was revised by Hansen (1919, pp. 48–65, pls. iv and v) who reduced the number of known species to three, adding that "all the remaining names in the literature must be cancelled for ever either as synonyms or as quite unrecognizable" (p. 50). In addition, he described three new species from the "Siboga" material. These six species fall into two groups, one with long eye-stalks comprising *L. typus* H. M.-Edwards and *L. orientalis* Hansen, the other with short eye-stalks including the remaining four species—*L. faxoni* Borradaile, *L. hanseni* Nobili, *L. intermedius* Hansen and *L. penicillifer* Hansen. Hansen also gives keys to the determination of the species in each group and good figures of the petasma of each male (1919, pp. 52–57 and pls. iv and v.).

Only two species are represented in the abundant material of the Great Barrier Reef Expedition, namely *L. typus* H. Milne-Edwards and *L. penicillifer* Hansen—in each the petasma agrees with Hansen's illustrations. The latter species is by far the more plentiful, over 1,350 specimens having been obtained at 48 Stations as against 67 of *L. typus* from 15 Stations. *L. penicillifer* occurred with fair regularity throughout the year from 27th July, 1928, to 17th July, 1929, except for the period between 24th August and 2nd October, 1928. *L. typus*, on the other hand, was present during the weeks when *L. penicillifer* seemed to be absent and, although it was obtained in small numbers between 30th July and 29th November, 1928, the two species were rarely present in the same hauls of the townets (Stations 2, 8, 15 and 21).

Dakin and Colefax (1940, pp. 149–150) record only two species from the coastal waters of New South Wales, namely *L. typus* and *L. hanseni* Borradaile. Here the former species is stated to be rare, the latter being much more common. The pair of tiny spinules near the distal end of the ventral margin of the last abdominal somite in the female of *L. hanseni* figured by Dakin in fig. 241a is present also in *L. typus* and in *L. penicillifer*.

Note—The males frequently have a spermatophore in the distal portion of either the left or the right vas deferens; to avoid repetition these males are listed under each Station as “adult males.” Special mention is made only of specimens in which the spermatophore was protruding from the genital opening of the male, or from the thelycum of the female.

Family SERGESTIDAE.

Subfamily LUCIFERINAE.

Genus *Lucifer* Vaughan Thompson.

Lucifer, J. Vaughan Thompson, 1829, p. 58, pl. vii, fig. 2.

Lucifer, H. J. Hansen, 1919, p. 48.

Lucifer, H. Milne-Edwards, 1837, p. 467; Barnard, 1950, p. 644.

GROUP A.—EYE-STALK LONG.

Lucifer typus H. Milne-Edwards.

Lucifer typus H. Milne-Edwards, 1837, p. 469.

Lucifer typus, Hansen, 1919, p. 53, pl. iv, figs. 6a-6k; also references and synonymy.

(*non Lucifer typus* Stebbing 1914, p. 28 which = *L. penicillifer*).

Lucifer typus, Edmondson, 1925, p. 5; Cecchini, 1928, p. 52; Zariquiey, 1946, p. 58, fig. 58; Hiatt, 1947, p. 241-2.

OCCURRENCE :

- St. 2, 30.vii.28. 3 miles east of Low Islands. 1 metre stramin net. 1 adult and 1 immature ♂ (with *L. penicillifer*).
- St. 8, 24.viii.28. 16° 30' S., 145° 52' E. (Trinity Opening). 1 metre stramin net. 1 ♀ (with *L. penicillifer*).
- St. 9, 31.viii.28. 3 miles east of Low Islands. 1 metre stramin net. 1 ♂.
- St. 11, 6.ix.28. 16° 24' S., 145° 52' E. (Trinity opening). 1 metre stramin net. 2 ♀ and one incomplete ♀ minus head region.
Coarse silk townet. 1 ♀.
- St. 12, 11.ix.28. 3 miles east of Low Islands. 1 metre stramin net. 1 ♀, 3 adult ♂ (one has the spermatophore projecting from the genital duct) and 3 immature ♂.
- St. 13, 20.ix.28. 3 miles east of Low Islands. 1 metre stramin net 2 ♀ and 6 young, 1 adult ♂
- St. 13. Fine Silk International net. 1 ♀.
,, Coarse Silk International net. 2 immature ♂.
- St. 14, 26.ix.28. 3 miles east of Low Islands. 1 metre stramin net. 1 immature ♂,
,, Coarse silk townet. 1 ♀, 1 immature ♂.

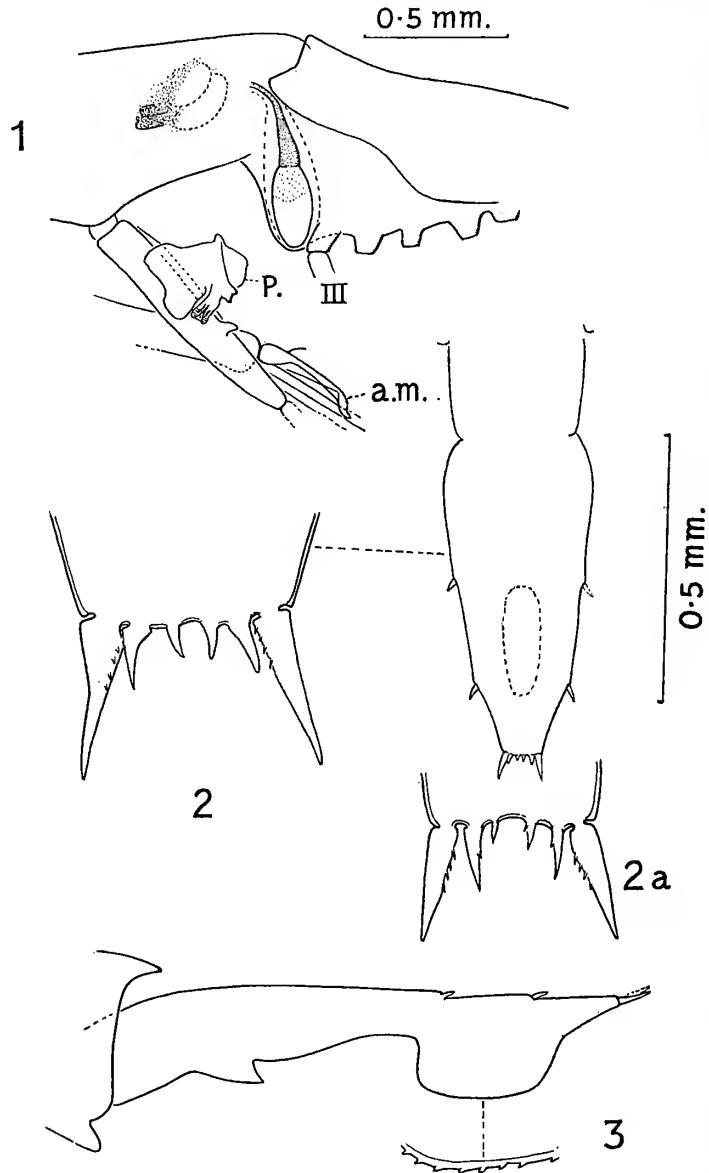
- St. 15, 2.x.28. 3 miles east of Low Islands. Coarse silk townet, 1 ♀ (with *L. penicillifer*).
 ,, 1 metre stramin net. 1 ♀.
 St. 16, 3.x.28. 3 miles east of Low Islands. Closing coarse silk townet. Surface. Horizontal haul. 2 ♀.
 ,, II. 10 m. (Vert. dist.) 1 ♀.
 ,, III. 20 m. (Vert. dist.) 1 immature ♂.
 St. 18, 15.x.28. 3 miles east of Low Islands. 1 metre stramin net. 2 ♀.
 ,, Coarse silk townet. 1 ♀.
 ,, Fine silk townet. 2 ♀, 1 young.
 St. 19, 20.x.28. 16° 20' S., 146° 3' E. (outside Trinity Opening). 1 metre stramin net. 1 immature ♀.
 St. 20, 20.x.28. 16° 19' S., 146° 7' E. (outside Trinity Opening). Coarse silk townet. 1 ♀.
 St. 21, 22.x.28. 3 miles east of Low Islands. Fine silk townet. 1 ♀ (with *L. penicillifer*).
 St. 28, 23.xi.28. 16° 19' S., 146° 5' E. (outside Trinity Opening). 1 metre stramin net. 5 ♀, 3 adult and 1 immature ♂.
 ,, Coarse silk townet. Tube broken—1 ♀ and 1 immature ♂ adhering to sides of tube.
 St. 29, 29.xi.28. 16° 17' S., 146° 2' E. (outside Trinity Opening). Bottom stramin net. 6 ♀ and young (one ♀ with empty spermatophore case projecting from the thelycum); 3 adult and 2 immature ♂.

RECORDED DISTRIBUTION.—This species is very common in the warmer parts of the Atlantic Ocean—southern parts of the Gulf Stream, Sargasso Sea, North and South Equatorial Currents and Guinea Current—see map given under the specific name *L. reynaudi* by Ortmann (1893, Tafel x). The most southern Atlantic records are 28° 43' S., 25° 14' W. and 40° 32' S., 52° 2' W. It is rather rare in the Bay of Bengal and in the Pacific Ocean from the Great Barrier Reef area to Manilla. *L. orientalis* Hansen is much commoner in the Pacific and Indian Oceans but writers prior to Hansen (1919) did not realize that these two species are distinct and many of the earlier records of *L. typus* or its synonyms refer to *L. orientalis*.

REMARKS.—Hansen, 1919, p. 52, states that females of *L. typus* are not easily distinguishable from those of *L. orientalis*. All the males in the present collection agree with Hansen's figures and description of *L. typus* as regards the telson and the petasma, which possesses a long-stalked hook, so it is reasonable to suppose that the females belong to the same species. The telson of the male is represented, in dorsal and in lateral aspect, in figs. 2 and 3 respectively. The large ventral cushion (which is lacking in the female and in immature males) is situated some distance from the apex; beyond the distal pair of lateral spines the telson narrows rather abruptly and the apex bears 3 pairs of spines. The longest pair are shorter than the width of the apical margin of the telson and each has 4 spinules on the proximal half of the inner side.

Burkenroad (1934, pp. 133–134) found a great preponderance of males in his material of *L. faxoni* Borradaile; he thought that the females probably mate with two males since only one spermatophore is formed at a time. Although the present samples of *L. typus* are

small, the total number of specimens being only 67, the sexes appear to be almost equally well represented—if anything the females are slightly in excess of the males. Text-fig. 1 represents part of the thorax and first abdominal somite of a male from St. 29, which has



TEXT-FIGS. 1-3.—*Lucifer typus* (H. M.-Edw.). (1) Posterior part of thorax and first abdominal somite of a male from St. 29, in lateral aspect, showing fully formed spermatophore in distal part of right vas deferens and two developing spermatophores in abdominal parts of the vasa deferentia. *p.*, Petasma; *a.m.*, appendix masculina; III, base of third pereopod. (2) Telson of male, in dorsal aspect, with apex more highly magnified. (2a) Apex of telson of another specimen, highly magnified. (3) Telson of male, in lateral aspect.

been stained with lignin pink and mounted in polyvinyl-lacto-phenol. The contents of the spermatophore reacted in three ways to the stain, becoming dark red in the stalk or neck, pinkish-white in the distal two thirds of the flask and rather brownish in between. In the abdominal region of the vasa deferentia the contents of two other spermatophores are being assembled. The oval areas indicated by broken lines, the "gelbe Secretmasse"

of Rosenstadt (1896, Taf. 33, fig. 41) stain pinkish-white like the distal part of the flask; the larger developing spermatophore seems to belong to the left, the smaller to the right, vas deferens, suggesting that the two sides function alternately. In Text-fig. 1 the position of the petasma and of the appendix masculina on pleopod 2 is shown: Bargmann (1937, p. 346) thinks that in *Euphausia superba* Dana the spermatophore is received by the modified portions of the second pair of pleopods and passed to the first pair of pleopods (petasma) during copulation. When males are found with the spermatophore protruding from the vas deferens, as they sometimes are, this is doubtless due to the shock received by fully ripe specimens at the time of fixation. Many years ago I figured what I called spermatophores in *Euryrhynchus wrzesniewskii* Miers, but these are undoubtedly artefacts; the males must have been very ripe at the time of fixation and the shock of sudden immersion in the fixative must have caused emission of the seminal fluid, which hardened into irregular lumps (Gordon, 1935, p. 333, Fig. 18a-e). I know of no species of the Caridea having spermatophores of the kinds usually found in Euphausiacea and in the Peneidea, to which the Sergestidae belong. Unfortunately this mis-statement of mine has been repeated by Dr. Balss in his recent monumental work, now nearing completion, namely the Decapoda in Bronn's Klassen und Ordnungen des Tierreichs (Balss, 1944, Lief. 5, p. 619).

GROUP B.—EYE-STALK SHORT.

Lucifer penicillifer Hansen.

Lucifer penicillifer Hansen, 1919, p. 59, pl. v, figs. 2 a-k.

Lucifer penicillifer, Barnard, 1950, p. 645, fig. 121.

Lucifer typus Stebbing, 1914, p. 28—see Barnard, 1947, p. 384.

OCCURRENCE :

- St. 1, 27.vii.28. 3 miles east of Low Islands. 1 metre stramin net. About 30 specimens, ♀, ♂ and young.
 ,, Coarse silk net. 8 ♀ and young, 5 ♂.
 St. 2, 30.vii.28. 3 miles east of Low Islands. 1 metre stramin net. 10 ♀, 6 adult ♂, 6 young (with *L. typus*).
 ,, Coarse silk net. 1 ♀, 4 adult ♂.
 St. 3, 4.viii.28. 3 miles east of Low Islands. 1 metre stramin net. (Tube broken, but some specimens adhering to sides.) 8 ♀ and young, 2 adult ♂.
 ,, Coarse silk net. 2 ♀, 2 adult ♂, 2 young.
 St. 4, 7.viii.28. 1 mile north of Low Islands. Coarse silk townet. 3 ♀, 2 adult and 1 immature ♂.
 St. 5, 11.viii.28. 3 miles east of Low Islands. 1 metre stramin net. 10 ♀, 14 adult ♂ (2 with spermatophore projecting from ejaculatory duct), 6 young ♂, 3 young ♀.
 ,, Coarse silk net. 8 ♀, 9 ♂, 3 young.
 St. 6, 17.viii.28. 3 miles east of Low Islands. 1 metre stramin net. 10 ♀, 1 young and 5 adult ♂ (one with spermatophore projecting from duct).
 ,, Coarse silk net. (Tube broken.) 1 ♀, 1 ♂.
 St. 8, 24.viii.28. 16° 30' S., 145° 52' E. (Trinity Opening). 1 ♀ with *L. typus*.

- St. 15, 2.x.28. 3 miles east of Low Islands. Coarse silk net. 1 ♂, with *L. typus*.
- St. 21, 22.x.28. 3 miles East of Low Islands. 1 metre stramin net. 2 ♀, 2 adult ♂ (part of stalk of spermatophore projecting from duct of one ♂, the rest may have been broken off).
 ,, Coarse silk townet. 2 ♀.
 ,, Fine silk townet. 1 ♀, with *L. typus*.
- St. 23, 2.xi.28. 3 miles east of Low Islands. Coarse silk townet. 2 ♀.
- St. 24, 6.xi.28. 3 miles east of Low Islands. Coarse silk townet. 1 slightly immature ♀, 1 ♂.
- St. 25, 16.xi.28. 16° 19' S., 146° 5' E. (outside Trinity Opening). Coarse silk townet. (Tube broken.) 1 immature ♀, 1 ♂ adhering to plug of cotton wool.
 ,, 1 metre stramin net. (Tube broken, specimens missing) ?
- St. 27, 21.xi.28. 3 miles east of Low Islands. 1 metre stramin net. 1 ♀.
- St. 30, 28.xi.28. 3 miles east of Low Islands (outside Trinity Opening). 1 metre stramin net. 5 ♀, 2 young ♂.
- St. 30a, 29.xi.28. Coarse silk townet. 5 ♀, 3 adult ♂.
- St. 31, 3.xii:28 (or 2.xii). Bottom stramin net. About 30 specimens, ♀, ♂ and young.
- St. 32, 5.xii.28. 3 miles east of Low Islands. 1 metre stramin net. 1 ♀.
- St. 33, 14.xii.28. 3 miles east of Low Islands. 1 metre stramin net. 2 ♀ (one slightly immature), 1 adult and 2 young ♂.
- St. 34, 19.xii.28. 3 miles east of Low Islands. 1 metre stramin net. 10 specimens, ♀, ♂ and young.
 ,, Coarse silk net. 16 ♀ and young, 3 ♂.
- St. 35, 27.xii.28. 3 miles east of Low Islands. 1 metre stramin net. About 35 specimens, ♀, ♂ and young; a few of the males are adult.
 ,, Coarse silk townet. 9 ♀ and young, 5 ♂.
- St. 36, 4.i.29. 3 miles east of Low Islands. 1 metre stramin net. 15 ♀ and young, 5 ♂.
 ,, Coarse silk net. 10 ♀ and young, 5 immature ♂.
- St. 37, 14.i.29. 3 miles east of Low Islands. 1 metre stramin net. 30 specimens, mostly ♀ and young, a few rather immature ♂.
 ,, Coarse silk townet. 20 specimens, ♂ (a few adult), ♀ and young.
- St. 38, 21.i.29. 3 miles east of Low Islands. 1 metre stramin net. 15 ♀ and young, 5 ♂.
- St. 39, 30.i.29. 3 miles east of Low Islands. 1 metre stramin net. About 50 specimens, ♀ and young, and ♂ (some adult; one with spermatophore projecting from duct).
 ,, Coarse silk townet. 16 ♀ and young, 2 adult and 2 immature ♂.
- St. 40, 6.ii.29. 3 miles east of Low Islands. 1 metre stramin net. 14 ♀ and young, 8 ♂ (mostly adult).
 ,, Coarse silk townet. About 50 specimens, mostly ♀ and young (one ♀ has a spermatophore projection from the thelycum); 8 are ♂, but not all are fully grown.

- St. 42, 18.ii.29. 3 miles east of Low Islands. 1 metre stramin net. 6 ♀ and young, 3 ♂.
- ,, Coarse silk townet. 22 specimens, ♀, ♂ and young.
- St. 43, 26.ii.29. 15° 16' S., 145° 26' 30" E. (off Cape Bedford). 1 metre stramin net. 22 ♀ and young, 8 ♂—some rather young.
- ,, Coarse silk townet. 10 ♀ and young, 8 ♂, mostly adult.
- St. 44, 27.ii.29. 14° 44' S., 145° 27' 30" E. (off Lizard Island). 1 metre stramin net. 10 ♀, 10 ♂—most of the specimens rather immature.
- ,, Coarse silk townet. 30 specimens, ♀, young, and rather immature ♂.
- St. 45, 28.ii.29. 14° 31' S., 145° 35' E. (outside Cook's Passage). 1 metre stramin net. Vertical haul, 500 metres of wire out. 8 ♀ and young, 2 young ♂.
- ,, Coarse silk townet. 4 ♀ and young.
- St. 46, 28.ii.29. 14° 31' S., 145° 35' E. (outside Cook's Passage). 1 metre stramin net. 28 specimens, mostly ♀ and young, about 8 are ♂.
- ,, Coarse silk townet. 35 specimens, ♀, young and adult ♂ (one ♂ has the spermatophore projecting from the genital duct).
- St. 47, 4.iii.29. 3 miles east of Low Islands. 1 metre stramin net. 11 ♀ and young, 4 ♂ (one with spermatophore projecting from duct.)
- ,, Coarse silk townet. 2 ♀, 2 ♂.
- St. 48, 15.iii.29. 3 miles east of Low Islands. Coarse silk townet. 2 ♀, 1 immature ♂, 3 young.
- ,, 1 metre stramin net. 22 ♀ (three have each one spermatophore projecting from the thelycum), 17 adult and young ♂, 15 young specimens.
- St. 49, 17.iii.29. 15° 47' S., 145° 41' E. (inside Papuan Pass). 1 metre stramin net. 20 specimens, ♀, ♂ and young.
- ,, Coarse silk townet. 15 ♀ and young, 5 ♂.
- St. 50, 18.iii.29. Outside Papuan Pass. 1 metre stramin net. 2 ♀, 2 adult and 1 immature ♂.
- St. 51, 25.iii.29. 3 miles east of Low Islands. 1 metre stramin net. 15 ♀ and young, 7 ♂ some immature.
- ,, Coarse silk townet. 4 ♀ and young.
- St. 52, 6.iv.29. 3 miles east of Low Islands. 1 metre stramin net. 8 ♀ and young, 2 adult and 2 immature ♂.
- ,, Coarse silk townet. 9 ♀ and young (one ♀ with an empty spermatophore case projecting from the thelycum), 1 ♂.
- St. 53, 13.iv.29. 3 miles east of Low Islands. 1 metre stramin net. 9 ♀ and young, 2 adult and 2 rather immature ♂.
- ,, Coarse silk townet. 15 ♀ and young, 11 ♂ some of which are not fully grown.
- St. 54, 20.iv.29. 3 miles east of Low Islands. 1 metre stramin net. 27 ♀ and young, 2 adult and 1 immature ♂.
- ,, Coarse silk townet. 16 ♀ and young (one ♀ with spermatophore projecting from thelycum), 4 ♂.
- St. 55, 26.iv.29. 3 miles east of Low Islands. 1 meter stramin net. 30 specimens, mostly ♀ and young, a few immature ♂.

- St. 55, Coarse silk townet. 30 ♀ and young, 7 adult and 6 immature ♂.
- St. 56, 7.v.29. 3 miles east of Low Islands. 1 metre stramin net. 3 ♀, 11 young, 7 adult ♂ (the spermatophore projecting from the duct in two ♂).
- „ Coarse silk townet. 18 ♀ and young, 8 ♂.
- St. 57, 18.v.29. 3 miles east of Low Islands. 1 metre stramin net. 20 specimens—adult ♀, and ♂, and young (one ♂ has the spermatophore projecting from the duct).
- „ Coarse silk townet. 2 ♀, 4 adult ♂ (one ♂ with the spermatophore projecting from the duct).
- St. 58, 25.v.29. 3 miles east of Low Islands. Coarse silk townet. 5 ♀ and young, 5 adult ♂ (2 each with a projecting spermatophore), 1 immature ♂.
- St. 59, 31.v.29. 3 miles east of Low Islands. 1 metre stramin net. 12 ♀ (one with two large ova attached to right pereopod III, the other ova presumably had been shaken off), 6 adult ♂, 3 young.
- „ Coarse silk townet. 17 specimens, ♀, adult ♂ and young.
- St. 60, 7.vi.29. 3 miles east of Low Islands. 1 metre stramin net. 11 ♀ and young, 3 adult ♂ (one with the spermatophore projecting from duct), 1 immature ♂.
- „ Coarse silk townet. 5 ♀, 5 ♂.
- St. 61, 14.vi.29. 3 miles east of Low Islands. 1 metre stramin net. 12 ♀ and young, 8 adult and 4 immature ♂.
- „ Coarse silk townet. 8 ♀ and young, 4 adult and 2 immature ♂.
- St. 63, 24.vi.29. 3 miles east of Low Islands. 1 metre stramin net. 11 ♀ and young, 7 adult and 2 immature ♂.
- „ Coarse silk townet. 8 ♀ and young, 6 adult and 2 immature ♂.
- St. 66, 11.vii.29. 3 miles east of Low Islands. 1 metre stramin net. 5 ♀ and young, 2 adult, 2 immature ♂.
- „ Coarse silk townet. 5 ♀, 8 adult and 1 immature ♂.
- St. 67, 17.vii.29. 3 miles east of Low Islands. 1 metre stramin net. 5 ♀, 5 ♂.
- „ Coarse silk townet. 7 ♀ and young, 5 ♂.

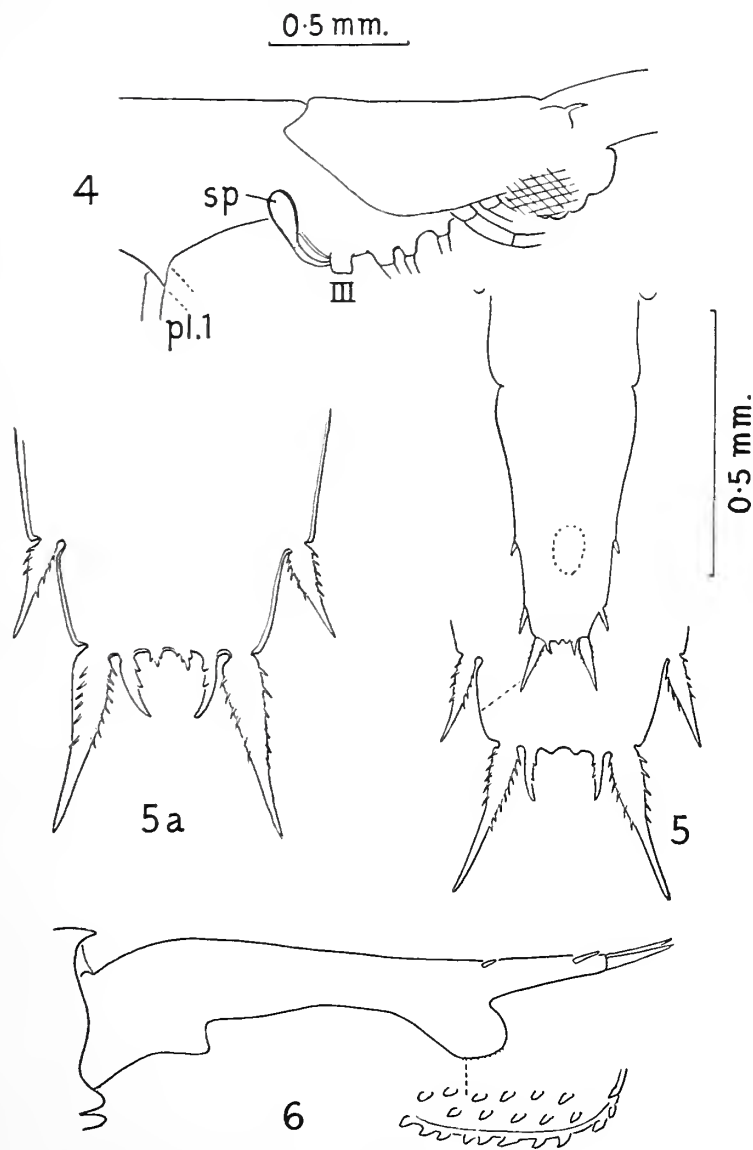
RECORDED DISTRIBUTION.—Common in the Dutch East Indies area explored by the "Siboga" Expedition, and in the Great Barrier Reef area. Other localities mentioned by Hansen are Bay of Bengal, China Sea, Formosa Strait, Manilla and Gulf of Yedo.

REMARKS.—The telson of the male is represented in dorsal aspect in Text-fig. 5 and in lateral aspect in Text-fig. 6. The protuberance or cushion on the ventral surface is much smaller than that of *L. typus* and is situated further from the apex of the telson. The distal pair of lateral spines are situated nearer to the apex, are larger and beset with spinules on the proximal half of either side (*cf.* Text-figs. 2 and 3 with 5 and 6). The median pair of apical spines is poorly developed but the outer pair are equal to, or rather longer than, the width of the apical margin and have 5 to 8 spinules on each side.

Owing to the small size and extreme lateral compression of the specimens it is by no means easy to detect the genital openings in either sex. Early writers thought that, as an adaptation to the compression of the body, there was a median unpaired opening in each sex. Brooks, however, corrected this in his classic study of the morphology and development of *Lucifer* (Brooks, 1882, p. 58) in the case of the male in which he found that the vasa deferentia are equally well developed on both sides. In the female he thought that

there was but one duct and one receptaculum seminis opening medially on the thoracic sternum.

Even as late as 1927 Balss states that, in the subfamily Luciferinae "Geschlechtsöffnungen unpaarig" is one of the characters (Kükenthal & Krumbach's Handbuch der Zoologie, p. 1000). He has corrected this statement in his recent volume dealing with Crustacea Decapoda in Bronn's Klassen und Ordnungen des Tierreichs (1944, Lief. 5, pp. 595 and 627-8). In the Great Barrier Reef collection most samples include adult males; right and left vasa deferentia are equally developed, although only one is (as already mentioned on p. 327) functional at a time. When the spermatophore projects from the duct, as it does in some specimens, it is seen to lie slightly to one side of the median line thus proving the presence of two openings.



TEXT-FIGS. 4-6.—*Lucifer penicillifer* Hansen. (4) Thorax and first abdominal somite of a female from St. 52, in lateral aspect, showing an empty spermatophore case inserted into thelycum. *sp.*, Spermatophore case; III, base of third pereiopod; *pl. 1*, first pair of pleopods. (5) Telson of male, in dorsal aspect, with apex more highly magnified. (5a) Apex of telson of another specimen, highly magnified. (6) Telson of male, in lateral aspect.

Burkenroad (1934, p. 133) says that the genital ducts of the female "appear to open on the postero-median surface of the coxae of pereopods III in a position equivalent to that in *Acetes*. . . . The paired pear-shaped, sac-like sperm receptacles lie side by side in the protruding posterior part of the perionic sternum, which they fill in impregnated females. The sacs open separately between the third pair of legs into a common atrium formed by a median depression of the sternum." I have sometimes detected the paired female genital openings on the coxae of pereopods III. When a spermatophore case is present it is inserted firmly by its narrow neck into the thelycum between pereopods III (the last pair in *Lucifer*, IV and V being absent) see Text-fig. 4. Rosenstadt (1896, Taf. 35, figs. 56-59), who figured a cross section of the thelycum and longitudinal sections of three developmental stages, apparently mistook this structure for the supposed median genital opening or vagina as he called it. None of his sections passes through the place where a receptaculum seminis communicates with the narrow cavity which lies between the developing thelycal plate and the sternal wall. His fig. 56, which Dr. Bargmann who studied the structure and development of the thelycum in *Euphausia superba* (1937, pp. 342-346) considers not quite accurate, shows one receptaculum seminis full of spermatozoa, the other empty: in a hermaphrodite which functioned as a male an incipient thelycum is present on the sternum immediately anterior to the vas deferens with its spermatophore (Rosenstadt's fig. 60). Kishinouye (1928, lower right hand figure on p. 126) figures the thelycum which he describes as consisting of "a single median invagination, opening with a longitudinal slit, and protected behind by a triangular plate." The morphology and development of the male and female reproductive systems of *Lucifer* require more critical study and there is sufficient material of *L. penicillifer* for this purpose if it is sufficiently well preserved for histological work.

Burkenroad saw no females with projecting spermatophores but thought that the female probably receives one from each of two separate males, the contents of one sufficing to fill one sperm sac. Certainly females of *Euphausia superba* may have up to seven spermatophore cases in the thelycum, although two is the normal number (Bargmann, 1937, p. 347). No female of *L. penicillifer* in the abundant Barrier Reef material has more than one spermatophore and Brooks did not find more than one (1882, p. 60) in the species studied by him. Nor is there a marked preponderance of males over females in the 1,350 specimens of *L. penicillifer* (cf. Burkenroad, 1934, p. 134). Since the ova are few in number the contents of one spermatophore should suffice; perhaps the adaptation to the extreme bodily compression is that one spermatophore at a time is ample for the propagation of the species. Brooks (1882, pl. 9, fig. 74, and p. 60) shows the eggs "attached, in a loose bunch of twenty or more, to the last pair of thoracic limbs." Only one female in the Barrier Reef material had attached ova, two were adhering to pereopod III and another was loose in the tube. They are certainly easily detachable and it is doubtful whether they actually remain attached to the parent for the 36 hours required for the development of the nauplii which emerge.

LIST OF WORKS CITED.

- BALSS, H. 1927. Decapoda in Kükenthal and Krumbach's Handbuch der Zoologie, III (1) : 840-1038, text-figs. 903-1119.
- 1940-1955 (not yet complete). Decapoda in Bronn's Klassen und Ordnungen des Tierreichs, V, I, 7 : Lief. 1 : 1-160, 1940 ; 2 : 161-320, 1941 ; 3-5 : 321-669, 1944 ; and 10, 1955 ; with numerous text-figs.
- BARGMANN, H. E. 1937. The reproductive system of *Euphausia superba*. "Discovery" Reports, XIV : 325-350, 26 text-figs., pls. I-V.
- BARNARD, K. H. 1946. Description of new species of South African Decapod Crustacea, with notes on synonymy and new records. Ann. Mag. nat. Hist. (11) XIII : 361-392 (dated June 1946, but publ. 49.iv.47).
- 1950. Descriptive Catalogue of South African Decapod Crustacea. Ann. S. Afr. Mus., XXXVIII : 1-837, 154 text-figs.
- BROOKS, W. K. 1882. *Lucifer* : a Study in Morphology. Phil. Trans. r. Soc., London, CLXXIII : 57-138, xi pls.
- BURKENROAD, M. D. 1934. The Penaeidea of Louisiana, with a discussion of their world relationships. Bull. Amer. Mus. nat. Hist., LXVIII : 61-143, 15 text-figs.
- CECCHINI, C. 1928. Sergestidi in Raccolte planctoniche fatte dalla R. Nave "Liguria" . . . 1903-05. . . Pubbl. Univ. Stud., Firenze, III (2) pt. 5 : 31-60, 2 pls.
- DAKIN, W. J. and COLEFAX, A. N. 1940. The plankton of the Australian coastal waters of New South Wales. Part 1. Publ. Univ. Sydney, Zool. Dept. Monogr., I : Decapoda pp. 143-190, figs. 234-275.
- EDMONDSON, C. H. 1925. Crustacea in : Marine Zoology of Tropical Central Pacific (Tanager Exped. Publ. 1). Bul. Bishop Mus., Honolulu, XXVII : 3-62, 8 text-figs., 4 pls.
- GORDON, I. 1935. On new or imperfectly known species of Crustacea Macrura. J. Linn. Soc. (Zool.), London, XXXIX : (no. 266) : 307-351, 27 text-figs.
- HANSEN, H. J. 1919. The Sergestidae of the "Siboga" Expedition. "Siboga Expedition Monogr., XXXVIII : 65 pp., 5 pls.
- HIATT, R. W. 1947. Ghost prawns (Sub-family Luciferinae) in Hawaii. Pacif. Sci., Honolulu, 1 : 241-242.
- KISHINOUE, K. 1928. Notes on the Sergestidae. Proc. imp. Acad. Japan, IV (3) : 125-127.
- MILNE-EDWARDS, H. 1837. Histoire Naturelle des Crustacés, II : 467-469, pl. 26, fig. 10. Roret's Suite à Buffon. Paris.
- ORTMANN, A. 1893. Decapoden und Schizopoden der Plankton-Expedition. Ergebn. der Plankton-Exped. der Humboldt-Stiftung. II. G. b. : 120 pp., 7 pls., 3 maps, 1 text-fig.
- ROSENSTADT, B. 1896. Untersuchungen über die Organisation und postembryonale Entwicklung von *Lucifer reynaudi* M.-Edw. Zool. Jahrb. Anat. und Ontog., IX (3) : 427-476, Taf. 30-35.
- STEBBING, T. R. R. 1914. South African Crustacea. Pt. vii. Ann. S. Afr. Mus., XV : 1-55, 12 pls.
- THOMPSON, J. VAUGHAN. 1830. Zoological Researches. . . . Vol. I, Mem. 3 : On the luminosity of the Ocean . . . four new genera *Nocticula* (sic), *Cynthia*, *Lucifer* and *Podopsis* . . . (1828-34).
- ZARIQUIEY ALVAREZ, R. 1946. Crustáceos Decápodos Mediterráneos. Inst. Esp. Estud. Mediterr. Biología, II : 181 pp., 174 text-figs. and 27 pls. (one not numbered).

23 FEB 1956
PRESENTED







BRITISH MUSEUM (NATURAL HISTORY)

GREAT BARRIER REEF EXPEDITION
1928-29

SCIENTIFIC REPORTS

VOLUME VI, No. 6

FORAMINIFERA

BY

A. C. COLLINS,

Geelong, Victoria.

WITH THREE TEXT-FIGURES AND FIVE PLATES



-1 OCT 1958
PRESENTED

LONDON:

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

SOLD BY

B. QUABITZ, LTD., 11 GRAFTON STREET, NEW BOND STREET, LONDON, W.1;

WHELDON & WESLEY, LTD., LYTTON LODGE, COXICOTE NEAR HITCHIN

H.M. STATIONERY OFFICE, LONDON, S.W.1

AND AT

THE BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, LONDON, S.W.7

1958

[All rights reserved]

Price Two Pounds

[Issued 16th September, 1958]

DESIGNED AND
PRINTED
BY
W. B. BARNES & SON
LIMITED
AT
BARTHOLOMEW PRESS
DOCKING

FORAMINIFERA

BY

A. C. COLLINS,
Geelong, Victoria.



-1 OCT 1958

WITH THREE TEXT-FIGURES AND FIVE PLATES.

CONTENTS.

	PAGE
INTRODUCTION	335
DESCRIPTION OF MATERIAL	336
LIST OF PROPOSED NEW GENERA	340
LIST OF NEW SPECIES AND SUBSPECIES	340
SYSTEMATIC ACCOUNT	341
PREVIOUS WORK IN THE REGION	427
ZOOGEOGRAPHICAL RELATIONSHIPS	428
DEPTH INDICATIONS IN RELATIONSHIP TO REEF BORINGS	429
LIST OF LITERATURE	430

INTRODUCTION.

THIS report deals with the foraminifera collected at Low Islands and other Barrier Reef localities by the Great Barrier Reef Expedition of 1928-29. The material was entrusted to the late W. J. Parr, F.R.M.S., with the present author as collaborator, in 1949. Unfortunately, before the material was received, Parr was stricken with the illness which led to his untimely death on the 21st August, 1949, and the present author was left to carry out the work without the benefit of Parr's long experience and deep knowledge of the foraminifera of the Australian region.

Much of the material had been washed down and graded by the late Mr. A. Earland, who at the time prepared short notes on the general characteristics of the samples. I am glad to acknowledge the value of these notes, which have been incorporated in the descriptions following. I also owe thanks to Mr. Earland for the opportunity of examining a beautiful series of mounted specimens from the classic locality of "Challenger" Station 185, Raine Island, sent by him originally to W. J. Parr, which has materially assisted the present work.

The samples of sediments received were of a heterogenous nature and were obviously collected incidentally to other work, and without any systematic plan which might have thrown light on the ecology of the foraminifera present. This is not surprising, since at the time of collection the detailed ecological and quantitative study of foraminiferal distribution was little, if at all, practised. Consequently, the present report is confined almost

entirely to faunal record, which is in any case needed in this region as a basis for more detailed studies.

A large proportion of the samples consisted of current- and wave-sorted coral sand from the inter-tidal zone, in which the foraminifera present were mostly badly-eroded specimens of the stronger and heavier shallow-water species. The collection of reef specimens from sheltered locations, bearing sessile species, was apparently not attempted in relation to foraminifera, and in general such forms were only found where dredged samples included fragments of shells and calcareous algae forming bases for attachment.

Somewhat less than half the samples were dredged in shallow water, ranging from low-tide level to 28 fathoms. These samples in most cases yielded large and varied assemblages, including many new species and interesting records. In addition, there were three samples from medium depths, one of which (no. 45), from a depth of 600 metres, yielded a rich and varied assemblage of medium-depth benthonic species together with oceanic pelagic forms.

A total of 391 species and subspecies is recorded from the material, of which 46 are described as new.

DESCRIPTION OF MATERIAL.

Fifty-nine samples were submitted for examination. The system of labelling was found to be rather confusing, and in the end the samples were serially numbered 1 to 59, the Expedition station number being quoted in the description of each sample. Fifty sets of station slides were mounted, the remaining nine samples being either barren of foraminifera or otherwise not worth mounting.

The ecological data available is sufficient only for drawing the broadest conclusions as to local distributions. However, considering the samples broadly, they fall into four groups of some ecological significance, as follows :—

- Group 1.—Mangrove-swamp pools, from the interior of Low Island. Samples 1, 5, 6, 9, 10, 11, 13 and 14. The foraminifera present are nearly all common shallow-water species, the larger forms usually eroded after transportation by wave action. However, there are a few species which are consistently found in greater relative numbers in these samples than in those from adjacent shallow-water deposits. This would appear to indicate that these species are actually living in the mangrove pools, though not confined to them ; having developed a tolerance of the wide temperature and salinity ranges which tend to operate in these conditions. Such species are : *Ammomarginulina australiensis* n. sp., *Quinqueloculina milletti* (Wiesner) and *Triloculina littoralis* n. sp.
- Group 2.—Reef Flat collections. Samples 2, 3, 4, 7, 8, 12, 15, 16, 17, 18, 19, 20, 21, 22, 48, 53, 55, 56, 57, 58 and 59. These range from beach sands to shallow-water sediment collections and have the general characteristics of being wave- and current-sorted and subjected to considerable attrition. As with most Queensland coral sands, the discoidal foraminifer *Marginopora vertebralis* Quoy and Gaimard is dominant in the coarser fractions, while the stellate species *Baculogypsina sphaerulata* (Parker and Jones) is frequently found in a fresh and unworn condition, indicating its existence in the living state in this environment. In general, these samples are of little interest, their foraminiferal content being mainly a selection of the more resistant tests from adjacent shallow-water deposits. The best preserved material was obtained from one of the samples taken in the process of estimating the rate of sedimentation on the reef flat and in the lagoon.
- Group 3.—Shallow-water dredgings. Samples 23, 24, 25, 26, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 40, 41, 42, 43, 44, and 47. These are from depths ranging from low-tide level to 28 fathoms. Some consisted of small collections of larger foraminifera selected from the dredging, while others were washed muds which yielded larger assemblages of smaller forms in perfect condition. While the assemblages had much in common, there were differences which may have been due to current-

sorting or to ecological factors such as the nature of the bottom. To evaluate these differences, systematic collection by a quantitative method capable of statistical interpretation is needed. As this condition is lacking, no such attempt has been made. The fauna of these bottom samples is the typical shallow-water assemblage of the region, from which the thanatocoenoses of Groups 1 and 2 were obviously derived.

Group 4.—Deeper-water dredgings. Samples 39, 45 and 46. No. 39 was dredged at 210 fathoms, while nos. 45 and 46 were accidental collections at 600 metres and 205 metres respectively, derived from the bottoming of tow-nets during plankton investigations. The assemblages of these samples, as might be expected, was distinctively different from those of Group 3, deriving as they did from the deeper waters of the continental shelf. Many species were identical with those found at similar depths as far south as Tasmania, and it appears probable that still greater correlation will be found when the off-shore deposits of the eastern Australian coast have been more exhaustively examined.

In addition, there were four miscellaneous samples, Nos. 49, 50, 51 and 52 for which localities were not given. They were in any case of little interest.

To avoid cumbering the report with statistics of no ecological or other useful significance the distribution of species listed in the systematic account is given in terms of the groups 1 to 4 described above. Reference to the occurrence of a species in the samples of a particular group does not, of course, mean that it occurs in all the samples of that group, as some are composed of coarse fractions only and others consist of pre-selected specimens of the larger forms. Such references should be taken to mean that the species occurs generally in samples large enough to include a representative faunule and containing material of the appropriate size grade for the species under consideration. Precise locations are of course quoted in the case of new species, and where locality is of some special significance.

SAMPLE LISTS.

Note.—Serial numbers have been given by the author. Symbols, where quoted, refer to the "Key Chart of Low Isles".

Sample No.

1. P.5. Channel into mangrove swamp. About 100 c.c. of coarse and dirty sand in spirit. Foraminifera worn and eroded.
2. F.8. Reef flat. About 40 e.e. of coarse sand in spirit, black and foetid. Foraminifera mostly worn and eroded, *Tinoporos* and *Baculogypsina* predominating.
3. F.8. Reef flat. 25 c.c. coarse calcareous sand, dry. Foraminifera few and worn.
4. F.6. Reef flat. 20 c.c. coarse calcareous sand, dry. Few foraminifera, no slide mounted.
5. Mangrove Park. 32 c.c. dry calcareous sand with some fine material. *Baculogypsina*, *Tinoporos* and *Amphistegina* dominant in coarse fractions, Miliolidae in the finer fractions.
6. Between F.5 and the Mangrove Park. 35 c.c. dry calcareous sand, coarse and fine. Smaller forms better preserved than in sample 5.
7. F.5. Reef flat. 30 c.c. dry calcareous sand, mostly coarse. A few well-preserved smaller species.
8. The Sand Flat. 25 e.e. dry coarse calcareous sand. Finer fractions contained a small assemblage of foraminifera.
9. I.M.1. Inside mangrove swamp. 32 c.c. muddy calcareous sand, mostly fine. Floatings contained large quantities of vegetable fibre. Foraminifera fall into three groups—shallow-water forms such as *Marginopora*, usually eroded; pelagic forms such as *Cymbaloporetta*, obviously tide-deposited; and a few species which by their fresh condition and relative abundance suggest that they find the muddy pools of the mangrove swamps a specially favourable habitat. This sample was fairly typical of those of Group 1.
10. Mangrove Park. 32 c.c. muddy calcareous sand, a mixture of coarse and fine. Generally similar to no. 9.
11. Mangrove Park. 30 c.c. material similar to 9 and 10.

12. Clam Spit. 23 c.c. coarse calcareous sand. A few larger foraminifera, badly worn. Fine material mostly alcyonarian spicules. No slide mounted.
13. M.13. Mangrove Park. 30 c.c. coarse calcareous sand in spirit, containing *Baculogypsina*, *Tinoporos* and *Marginopora*.
14. M.7. Mangrove Park. 35 c.c. material similar to No. 9.
15. Porites Pond. 40 c.c. dry calcareous sand, with few foraminifera.
16. North-east Moat. 30 c.c. dry calcareous sand, coarse and fine, wave- and current-sorted sediments with an assemblage of shallow-water foraminifera.
17. Western Moat. 40 c.c. coarse beach sand in spirit, generally similar to 16.
18. Labelled "South Eastern Moat", a reference which is not found on the Key Chart of Low Isles. 40 c.c. coarse calcareous sand, containing worn larger foraminifera.
19. The Madrepore Moat. 30 c.c. calcareous sand in spirit, foraminifera common, mostly worn specimens of the larger species.
20. Labelled "Railway Spit", a reference which does not appear on the Key Chart. 27 c.c. coarse coral sand. No slide mounted.
21. Labelled "North West Shore of Island". 25 c.c. dry calcareous sand, coarse and wind-polished. No slide mounted.
22. P.1. Luana Creek, Luana Harbour. 70 c.c. coarse calcareous sand in spirit, containing worn specimens of larger foraminifera.
23. Off NNW. Low Isles, 5-6 fathoms. 50 c.c. fine muddy sand in spirit. Many species of shallow-water foraminifera in medium fractions, most of the remainder being fine angular sand passing 150 mesh.
24. Off NNW. Low Isles, about 10 fathoms. 50 c.c. fine muddy sand in spirit. Foraminifera varied and abundant, other organic remains including radiolaria, diatoms, a holothurian anchor plate, alcyonarian and sponge spicules, and pteropod and other molluscan shells.
25. Mud from 8 fathoms, about $\frac{1}{2}$ mile NW. of Low Isles. Generally similar to no. 24.
26. Boulder Tract. 45 c.c. dark muddy sand, collected from between coral "niggerheads" outside western rampart, and containing a large assemblage of shallow-water foraminifera, also diatoms, alcyonarian spicules and pteropod shells.
27. Boulder Tract. Practically a duplicate of no. 26.
28. The Anchorage. 75 c.c. dark muddy sand, depth probably not more than 20 ft. Alcyonarian spicules account for about 30 per cent of the washed material. Large assemblage of shallow-water foraminifera, mostly Miliolidae and Rotaliidae.
29. Jukes Reef, anchorage zone. (A linear reef of the Outer Barrier, lying in lat. $14^{\circ} 35' S.$) 50 c.c. coarse white coral sand in spirit, probably from shallow water *ca.* 20 ft. An interesting foraminiferal assemblage with many sessile forms and the rare genus *Ungulatella*.
30. Duplicate of no. 29.
31. Dredge Stations II and III, Linden Bank, 28 fathoms, shell and sand. A small tube containing large specimens of *Operculina*, *Marginopora* and *Discobotellina*.
32. Dredge Station IV, Linden Bank, 38 fathoms, mud. About 5 c.c. of coarse material consisting of mollusca, bryozoa and large specimens of *Operculina*, the latter forming the bulk of the material. A few other large foraminifera were present, and a very small quantity of fine material yielded a surprisingly large list of species.
33. Dredge Station V, Linden Bank, 37 fathoms, mud. A small tube containing *Marginopora*, *Operculina* and *Discobotellina*.
34. Dredge Station VIII, $1\frac{1}{2}$ miles NW. of Low Isles, 11 fathoms, mud. 5 c.c. fairly fine coral sand, containing a large assemblage of smaller shallow-water species.
35. Dredge Station XI, vacuum grab, inside Wentworth Reef, 7 fathoms, mud and rock. There is some confusion due to two labels, one Stn. XI and one Stn. IX, accompanying this sample. No grab is recorded for either station. XI has been accepted as the station for this sample, as the label recording this is in ink and dated, the other being a rough pencil note. A small quantity of foraminiferal sand, washed from a fine mud in spirit, containing a fair assemblage of foraminifera, some large diatoms and radiolaria.
36. Dredge Station XII, vacuum grab, Penguin Channel, 10-15 $\frac{1}{2}$ fathoms, rock and shell gravel, mud in edges of pit. 50 c.c. of fine brown mud in spirit. Residue two-thirds coral sand with a rich foraminiferal assemblage, one-third fine angular sand passing 120 mesh.
37. Dredge Station XIII, $\frac{1}{2}$ mile west of Two Isles, 16 $\frac{1}{2}$ fathoms, hard. Coarse coral sand in spirit, with some fine material. Foraminifera abundant, particularly larger species.

38. Dredge Station XIV, $\frac{1}{2}$ mile south-east of Lizard Island, 19 fathoms, shell gravel. A small quantity of coarse debris in spirit, with a variety of well-preserved larger foraminifera.
39. Dredge Station XV, $\frac{1}{2}$ mile outside Cook Passage, drifting north, 210 fathoms, clean sand and coral debris. About 5 c.c. whitish cemented material, containing a small assemblage of pelagic species and benthic Rotaliidae.
40. Dredge Station XVI, about $\frac{1}{2}$ mile west of North Direction Island, 20 fathoms. A small quantity of washed material, coarse and fine, containing a representative shallow-water assemblage.
41. Dredge Station XIX, about $\frac{1}{2}$ mile north of Eagle Island, 10 fathoms, shell gravel, rich *Halimeda*. One tube of coarse washed material containing a variety of larger foraminifera, together with molluscan and algal debris.
42. Dredge Station XXI, $\frac{1}{2}$ mile north-west of Howick Islands, 10 fathoms, mud and shell, foraminifera. Three tubes of larger foraminifera, mainly *Marginopora*, *Alveolinella* and *Operculina*, with a small amount of finer material yielding a fair assemblage of smaller species.
43. Dredge Station XXII, to East of Snake Reef, 13 $\frac{1}{2}$ fathoms, mud with foraminifera and shells. A tube of light grey coarse material with some mud, the coarser fraction mainly foraminifera including *Operculinella*, together with molluscan, algal and alcyonarian debris.
44. Dredge Station XXIII, in lee of Turtle Islands, 8 fathoms, mud and shell. A small quantity of coral sand with a fairly large shallow-water foraminiferal assemblage.
45. "Outside Trinity Opening, Nov. 23rd, 1929, 600 metres." Five small bottles of cleaned material, mostly fine. This material was received direct from Mr. Earland. It corresponds in date, position and depth with Plankton Station 28, and presumably is the result of a tow-net touching bottom, though this is not recorded for this station. Foraminifera are varied and abundant, including both pelagic and benthic species. The latter include species usually found in deeper water and also many others characteristic of the shallow reef area, these being pauperate in comparison with specimens from shallower water. Other organisms include pteropod shells, providing a base for many sessile foraminifera, also mollusca, ostracoda, echinoid spines, sponge spicules, radiolaria and diatoms.
46. Plankton Station 29 (bottom). Outside Trinity Opening. A small amount of coarse material, containing six specimens of *Heterostegina operculinoides* Hofker and one of *Cycloclypeus carpenteri* Brady, the remainder being shell fragments.
47. Dredging, Penguin Channel, 16 fathoms, mud, 2. xii. 28. There is no record of this collection in either the dredging or tow-net list. One tube containing *Marginopora* and *Discobotellina*.
48. Sand from patch No. 1, Batts Reef. One tube of coral sand with a small but typical shallow-water assemblage, the larger species eroded.
49. Washings from *Tubipora*, no locality. 20 c.c. of *Tubipora* fragments with a small amount of finer material containing a good deal of vegetable fibre. Foraminifera were mostly juvenile specimens.
50. General Survey M.S, sandy foraminifera on *Thalassia*. A ribbon-like frond with circular whitish marks corresponding in size to small detached specimens of *Marginopora* in the same tube, which were evidently attached when collected. No arenaceous forms were present. No slide was mounted.
51. "Great Barrier Reef of Australia." One small tube of material consisting almost entirely of specimens of *Baculogypsina*, *Tinoporos*, and *Amphistegina*. No slide mounted.
52. "Foraminifera from *Halimeda*." A tube of well-preserved specimens of *Marginopora*, evidently collected in the living condition from attachment to *Halimeda*. No slide mounted.
53. "Sediment IV 5a." A jar and three tubes of washed material ranging from coarse to fine. This and the following six samples presumably derive from collections made in the process of determining the rate of sedimentation in different parts of the reef flat. This sample contained a fairly large assemblage of shallow-water foraminifera, better preserved than in the case of beach collections.
54. "Sediment, A.22, 5.5.29-12.5.29." A small quantity of grey tenacious clay containing vegetable fibre and a small assemblage of foraminifera which had a good deal in common with the mangrove-pool samples, small Miliolidae and Cymbaloporidae predominating.
55. "Sediment B.22, 5.5.29-12.5.29." Two tubes of coarse material, mostly algal and molluscan fragments, with a small shallow-water foraminiferal assemblage.
56. "Sediment C.22, 5.5.29-12.5.29." One tube of material similar to no. 54.
57. "Sediment D.22, 5.5.29-12.5.29." One tube of material similar to 54, but containing a good deal of flocculent organic matter and fibre, leaving a very small residue with a few foraminifera. No slide mounted.

58. "Sediment E.21, 5.5.29-12.5.29." One tube containing a felted mass of green algal threads coagulated with mud, leaving a very small sandy residue with a few foraminifera. No slide mounted.
59. "Sediment F.1, 5.5.29-12.5.29." One tube of dark brown hardened material consisting almost wholly of vegetable fibre and giving a strong red-brown solution when boiled with soda. Probably derived from mangrove debris. No slide mounted.

All of the above material was received in the dry condition, the samples originally preserved in spirit having been cleaned and washed down by Mr. Earland.

LIST OF PROPOSED NEW GENERA.

DISCOBOTELLINA, type species *D. biperforata* n. sp., Astrorhizidae.

EDENTOSTOMINA, type species *E. cultrata* (Brady), Miliolidae.

NUBECULOPSIS, type species *N. queenslandica*, n. sp., Ophthalmitidae.

GLOBULOTUBA, type species *G. entosoleniformis*, n. sp., Polymorphinidae.

LIST OF NEW SPECIES AND SUBSPECIES.

- Discobotellina biperforata* n. sp.
Proteonina cushmani n. name.
Glomospira elongata n. sp.
Lituotuba minuta n. sp.
Ammomarginulina australiensis n. sp.
Nouria textulariformis Hada, *armata* n. subsp.
Trochammina chitinoza n. sp.
Gaudryina (Pseudogaudryina) concava n. sp.
Eggerella australis n. sp.
E. polita n. sp.
Dorothia inepta n. sp.
Karrieriella (Karrerulina) attenuata n. sp.
Quinqueloculina crassicarinata n. sp.
Q. cuvieriana d'Orbigny, *queenslandica* n. subsp.
Q. quinquecarinata n. sp.
Massilina subrugosa n. sp.
M. secans d'Orbigny, *tropicalis* n. subsp.
M. corrugata n. sp.
M. minuta n. sp.
Spirosigmoilina bradyi n. sp.
S. parri n. sp.
Articulina tricarinata n. sp.
A. queenslandica n. sp.
Hauerina pacifica Cushman, *rugosa* n. subsp.
Triloculina littoralis n. sp.
T. quadrata n. sp.
Nodophthalmidium gracilis n. sp.
Ophthalmidium circularis Chapman, *tropicalis* n. subsp.
Planispirinella involuta n. sp.
Nubeculopsis queenslandica n. gen., n. sp.
Globulotuba entosoleniformis n. gen., n. sp.
Glandulina semistriata n. sp.
Buliminella latissima n. sp.
Bulimina oblonga n. sp.

Globobulimina australiensis n. sp.
Trimosina milletti Cushman, *multispinata* n. subsp.
Bolivina alata Seguenza, *fimbriata* n. subsp.
Bifarina queenslandica n. sp.
Discorbis subvesicularia n. sp.
Conorbella earlandi n. sp.
Discorinopsis tropica n. sp.
Patellinella carinata n. sp.
Epistomariella milletti n. sp.
Streblus convexus n. sp.
Robertina australis n. sp.
Elphidium pacificum n. sp.

SYSTEMATIC ACCOUNT.

Recent researches by Wood, Hofker and others have indicated that a satisfactory natural classification of the foraminifera is still to be attained. The long-standing classification of Cushman (1928-48) though widely known and used, has features which are not acceptable in the light of present knowledge, though no other published classification has approached it in completeness. The classification of Chapman and Parr (1936) suffers from basic errors derived from a misconception of the antiquity of certain genera, since clarified by Wood (1947). The important petrological research by Wood into the shell-structure of foraminifera has yet to be fully evaluated in its effect on classification, while the more recent work by Hofker on the minute morphology of the foraminiferal test must have a profound effect on the understanding of natural relationships, once the unfortunate difficulties introduced by invalid nomenclature are resolved.

For the purposes of this report the author has adopted in general the classification of Glaessner (1947). Additional families and subfamilies have been added where the original scheme made no provision for certain recent forms, and other changes have been made where more recent work has indicated the necessity, such as the removal of the genera *Nonion* and *Nonionella* to the Chilostomellidae on the basis of shell-structure as elucidated by Wood. For the superfamily Rotalidea, the recent classification of Bermudez (1952) has been followed, with the exception noted above.

Superfamily ASTRORHIZIDEA.

Family ASTRORHIZIDAE.

Subfamily ASTRORHIZINAE.

Genus *Astrorhiza* Sandahl, 1858.

(1) *Astrorhiza* sp. cf. *arenaria* Norman.

cf. *Astrorhiza arenaria* Norman, 1876, Proc. Roy. Soc. XXV, p. 213; Brady, 1884, p. 232, pl. xix, figs. 5-10.

Four specimens from sample 45, one furcate, the others variously rounded or flattened, are doubtfully referred to this species. They are rather small, *ca.* 3 mm. in length, but otherwise resemble "Goldseeker" specimens in the author's possession.

Subfamily RHIZAMMININAE.

Genus *Marsipella* Norman, 1878.(2) *Marsipella cylindrica* Brady.

Marsipella cylindrica Brady, 1882, Proc. Roy. Soc. Edinburgh, XI, p. 714; 1884, p. 265, pl. xxiv, figs. 20-22; Heron-Allen and Earland, 1932, p. 334.

Some specimens are neatly constructed of sponge spicules cemented parallel with the axis of the test. Others are more roughly constructed of sand-grains with occasional large spicules built in. Heron-Allen and Earland make the same observation in regard to their Antarctic specimens.

Frequent in sample 45.

Subfamily HYPERAMMININAE.

Genus *Hyperammina* Brady, 1878.(3) *Hyperammina friabilis* Brady.

Hyperammina friabilis Brady, 1884, Rep. Voy. Chall., Zool. IX, p. 258, pl. xxiii, figs. 1-3, 5, 6.

Several broken specimens from sample 45 are referable to this species.

(4) *Hyperammina mestayeri* Cushman.

Hyperammina mestayeri Cushman, 1919, Proc. U.S. Nat. Mus. 56, no. 2302, p. 596, pl. 74, fig. 3.

Several fragments of a thick-shelled tubular form, with the wall composed almost wholly of short, fine fragments of sponge spicules, projecting so as to give the test a finely hispid appearance, are referred to this species.

Rare in sample 45.

Genus *Botellina* Carpenter, 1869.(5) *Botellina tasmanica* Parr.

Botellina tasmanica Parr, 1950, Rep. B.A.N.Z.A.R. Exped. V, 6, p. 256, pl. iii, figs. 9, 10.

This recently-described species was fairly common in sample 38, in 19 fathoms off Lizard Island. Parr records it from a shallow-water dredging off Eden, on the south-east coast of New South Wales. The present specimens closely match toptype specimens from off Tasmania.

Genus *Discobotellina* n. gen.

Test arenaceous, complanate, circular to ellipsoidal in outline, consisting of a thick inner layer of large sand-grains loosely cemented together, leaving a considerable proportion of void space between grains; and a thin outer layer of small sand-grains, neatly cemented, with a fairly smooth and imperforate finish, except along the rounded periphery, where numerous open chinks between the grains communicate with the labyrinthic inner layer. Concentric growth ridges appear on the flat surfaces of the test.

Two forms are distinguishable, as follows:

Form 1, in which the test is circular, with or without a central swelling which indicates a separation of the inner layer to form a small lens-shaped cavity. This swelling is sometimes accidentally punctured, owing to the thinness of the wall at this point.

Form 2, in which the test is ellipsoidal in outline and has two slot-like holes penetrating the test from side to side, regularly spaced at approximately the third points of the major diameter, and set a little to one side of the longer axis. The outer fine-grained layer is continuous through these holes.

(6) *Discobotellina biperforata* n. sp.

(Plate I, figs. 1*a*, *b* ; 2*a*, *b* ; 3.)

Species with the characters of the genus.

Holotype from 4–6 fathoms, Moreton Bay, South Queensland.

Dimensions of holotype : Major diameter 20·5 mm., minor diameter 18·0 mm., thickness approximately 2·0 mm.

Paratype from sample 33, Linden Bank.

Dimensions of paratype : Diameter 10·3 mm., thickness approximately 1·0 mm.

This form is very different from any previously described genus, and at first raised considerable doubts as to its foraminiferal nature. However, the structure of the test was found to be similar to that of *Botellina*, especially the large branching species *B. pinnata* Pearcey, with specimens of which it was compared. The differences are only in the plan of growth, which in the present form is circumferential with peripheral apertures, rather than axial with end apertures as in *Botellina*.

The two forms described above are found together in all the material in which the species occurs, and are clearly conspecific. It appears probable that as in other foraminifera they are the result of alternation of generations, but as their relation is not clear to the author, they have been deliberately recorded as Forms 1 and 2 to avoid possible false analogies with the “forma A, B” etc. of other authors in cases where the relationship has been well established.

The circular form is analogous to many other discoidal foraminifera, growing by the addition of concentric layers on the periphery of the test. Some of the smaller specimens expose the large sand-grains of the inner layer around the periphery, whereas in the larger specimens the outer fine-grained layers cover the periphery also, leaving small chinks through which pseudopodia presumably emerge.

The ellipsoidal form is similar in general structure and circumferential growth, but differs in having two regularly spaced holes passing through the test. The proportional spacing of these holes is the same for specimens of all sizes, suggesting migration of the holes in a radial direction during growth. This is supported by the radial slot-like form of the holes in the larger specimens, which may indicate breaking-down and re-sealing of the distal end of the hole at a rather faster rate than the building-up at the proximal end. In one small specimen the holes are represented by two dimples in either face, suggesting that the holes are not formed until a certain growth-stage is reached. The function of these holes is not at present apparent.

Specimens from the Barrier Reef material were found in samples 31, 33 and 47, in depths ranging from 16 to 37 fathoms. A series of specimens are in the author's possession from the collection of the late W. J. Parr, noted as having been collected by Mr. E. J. Riek from Moreton Bay, South Queensland in 4–6 fathoms. These specimens reached a maximum diameter of 2·3 cm., more than twice the size of Barrier Reef specimens, and were rather darker in colour and coarser in texture than the latter. They are, however,

considered to be conspecific, and one of the large ellipsoidal Moreton Bay specimens has been selected as the holotype, with a circular Barrier Reef specimen as paratype.

Subfamily DENDROPHRYINAE.

Genus *Sagenina* Chapman, 1900.

(7) *Sagenina frondescens* (Brady).

Sagenella frondescens Brady (not *Sagenella* Hall), 1879, Quart. Journ. Micr. Sci. XIX, n.s., p. 41, pl. v, fig. 1; 1884, p. 278, pl. xxviii, figs. 14, 15.

Sagenina frondescens (Brady). Chapman, 1900, p. 4, pl. 1, figs. 1, 2; pl. 2, figs. 1, 2.

Occasional specimens attached to shell fragments were found in the samples of groups 1, 2 and 3.

(8) *Sagenina divaricans* Cushman.

Sagenina divaricans Cushman, 1910a, Proc. U.S. Nat. Mus. 38, no. 1759, p. 437, text-fig. 1.

This species, distinguished from *S. frondescens* (Brady) by its smaller diameter and the neater construction of its tubular adherent test, was occasionally found on fragments of calcareous algae and molluscan shells in the samples of group 3.

Family SACCAMMINIDAE.

Subfamily PSAMMOSPHAERINAE.

Genus *Psammosphaera* Schulze, 1875.

(9) *Psammosphaera parva* Flint.

Psammosphaera parva Flint, 1899, Rep. U.S. Nat. Mus. for 1897, p. 268, pl. 9, fig. 1.

Frequent in sample 45, most specimens being built around one or more acicular sponge spicules.

(10) ? *Psammosphaera fusca testacea* Flint.

? *Psammosphaera fusca* Schulze, var. *testacea* Flint, 1899, Rep. U.S. Nat. Mus. for 1897, p. 268, pl. 8, fig. 2.

Four specimens from sample 45 appear to be referable to this subspecies. All are roughly hemispherical, corresponding to Flint's specimen "b", noted as an "accidental section". Apparently they have been attached, though if so the attachment must have been light, as the base of the tests consists of the rounded surfaces of the globigerine tests which form the wall, and there is no sign of cement. Nor do the tests appear to have been originally spherical and accidentally broken. Their generic position is somewhat doubtful.

Subfamily SACCAMMININAE.

Genus *Saccamina* M. Sars, 1869.

(11) *Saccamina consociata* Flint.

(Plate I, fig. 4.)

Saccamina consociata Flint, 1899, Rep. U.S. Nat. Mus. for 1897, p. 269, pl. 9, fig. 3.

Two specimens from sample 45, one free and one adherent to a pteropod shell, are referable to this species. Each consists of two chambers roughly constructed of sand-grains

and joined by a stolon similarly constructed, with tubular projections both free and attached, the ends forming apertures. Flint's specimens were from deep water off Brazil.

Genus *Proteonina* Williamson, 1858.

(12) *Proteonina difflugiformis* (Brady).

Reophax difflugiformis Brady, 1879 etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 51, pl. 4, figs. 3a, b; 1884, p. 289, pl. xxx, figs. 2, 4 (not 1, 5).

Proteonina difflugiformis (Brady). Rhumbler, 1903, p. 245, text-figs. 80a, b.

Three specimens from sample 45 are armed with projecting sponge spicules as in Brady's fig. 4 (1884). A broken specimen shows that the wall is constructed of clear sand-grains, the spicules being cemented in interstices and not projecting inwards.

(13) *Proteonina cushmani* n. name.

Proteonina difflugiformis Brady, var. *lagenarium* Cushman (not *Haplophragmium lagenarium* Berthelin), 1910, U.S. Nat. Mus. Bull. 71, p. 42, text-fig. 42.

Specimens are fairly common in sample 45. Bolli and Saunders (1954) have shown that Berthelin's "Lower Cretaceous" *Haplophragmium lagenarium* is almost certainly a recent species of the fresh-water Thecamoebid genus *Difflugia*, derived by contamination of the material by river water. They also suggest that the forms referred to this species by Cushman and McCulloch (1939), Parker (1952) and Parker, Phleger and Peirson (1953) are also *Difflugiae*. As these records are from brackish water or inshore localities, the suggestion is probably correct, but it cannot apply to the closely similar forms recorded by Cushman from depths of 299 and 2,175 fathoms in the North Pacific, nor to the present specimens from 600 metres. It is evidently a case of isomorphism between *Difflugia* and the marine foraminiferal genus *Proteonina*. Considering the simple unilocular type of test common to both genera, this appears to be the simplest and most likely explanation of the occurrence.

(14) *Proteonina micacea* Cushman.

Proteonina micacea Cushman, 1918 etc., U.S. Nat. Mus. Bull. 104, p. 49, pl. xix, figs. 6, 7.

Six specimens of this small and delicate species were found in sample 45. The neck in each case was oblique to the axis of the test, apparently a consistent feature.

Genus *Thurammia* Brady, 1879.

(15) *Thurammia albicans* Brady.

Thurammia albicans Brady, 1879 etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 46; 1884, p. 323, pl. xxxvii, figs. 2-7.

One specimen from sample 45, finely arenaceous and whitish in colour, with about 8 mammillate projections, appears to be referable to this species, although it is rather larger than as described by Brady, *ca.* 0.5 mm. in diameter.

Genus *Technitella* Norman, 1878.

(16) *Technitella legumen* Norman.

Technitella legumen Norman, 1878, Ann. Mag. Nat. Hist., ser. 5, 1, p. 279, pl. 16, figs. 3, 4; Brady, 1884, p. 246, pl. xxv, figs. 8-12.

Two specimens were found in sample 45, one showing a collar-like aperture as in Brady's fig. 9. The species was recorded by Brady from off Sydney, N.S.W.

Subfamily WEBBINELLINAE.

Genus *Webbinella*, Rhumbler, 1903.

(17) *Webbinella hemisphaerica* (Jones, Parker and Brady).

Webbina hemisphaerica Jones, Parker and Brady (not *Webbina* d'Orbigny), 1866 etc., Monogr. Foram. Crag, p. 27, pl. iv, fig. 5.

Webbinella hemisphaerica (Jones, Parker and Brady). Rhumbler, 1903, p. 228, fig. 54.

Three specimens were found in sample 45 and three in sample 38, the latter a dredge station from which only coarse debris was received, all adherent to shell fragments.

Genus *Diffusilina* Heron-Allen and Earland, 1924.

(18) *Diffusilina humilis* Heron-Allen and Earland.

Diffusilina humilis Heron-Allen and Earland, 1924, Journ. Linn. Soc., Zool. 35, p. 614, pl. 35, figs. 13-16.

One example from sample 38, agreeing with a specimen identified by Earland in the collection of the late W. J. Parr. This rarely-recorded species was described from Lord Howe Island, and is probably more common in Queensland waters than the present record would suggest, a comment which applies to other sessile foraminifera, in which the present collections are rather deficient.

Family INVOLUTINIDAE.

Subfamily INVOLUTININAE.

Genus *Involutina* Terquem, 1862.

(19) *Involutina* sp.

(Plate I, fig. 5.)

Ammodiscus incertus Parr (not *Operculina incerta* d'Orbigny) 1950, B.A.N.Z.A.R. Exped. Rept. V, pt. 6, p. 251.

Test finely arenaceous, planispiral, consisting of a clear chitinous proloculus and 12 whorls, periphery rounded, surface highly polished and reddish-brown in colour. One specimen from sample 45, 1.21 mm. in diameter.

The specimen is closely comparable with several specimens in the collection of the late W. J. Parr from the B.A.N.Z.A.R.E. dredgings off Tasmania. It is also very similar to a specimen sent to Parr by Dr. P. J. Bermudez, from off Cuba. Parr identified his specimens with d'Orbigny's "*Operculina*" *incerta*, then considered to be the type species of the genus *Ammodiscus* Reuss 1862. Loeblich and Tappan (1954) have since shown that *Ammodiscus*

is a junior synonym of *Spirillina* Ehrenberg 1843, and that "*Operculina*" *incerta* is in fact a *Cornuspira*, leaving this arenaceous form un-named.

The species is apparently widely distributed in Recent seas and is probably the "*Ammodiscus incertus*" of Brady and later authors. For this reason it is thought that any re-naming should take into account material from a much wider range of localities than those from which specimens are available to the author, and the present specimen is therefore recorded by open nomenclature, and referred to the genus *Involutina*, stated by Loeblich and Tappan to be the next available name for species formerly included in the now invalid genus *Ammodiscus*.

Genus *Glomospira* Rzehak, 1888.

(20) *Glomospira charoides* (Jones and Parker).

Trochammina squamata charoides Jones and Parker, 1860, Quart. Journ. Geol. Sci. XVI, p. 304.

Glomospira charoides (Jones and Parker). Cushman, 1918, p. 100, pl. xxxvi, figs. 10-15.

Three typical specimens were found in sample 45.

(21) *Glomospira elongata* n. sp.

(Plate I, figs. 6a, b; 7a, b.)

Test finely arenaceous, smooth, coloured reddish-brown, consisting of a proloculus and a long undivided tubular chamber coiled in an elongated ellipse, the axis of coiling changing in successive whorls so as to form an approximately fusiform test; later whorls added in one plane so that the fully developed test assumes a flattened elliptical form with a raised, elongate, elliptical central portion. Aperture formed by the open end of the tube.

Holotype from sample 45.

Dimensions of holotype: Major diameter 0.59 mm., thickness 0.11 mm.

This species differs from *G. gordialis* (Jones and Parker) in its elongate form and more regular growth-plan. It is common in sample 45 and is occasionally found in the samples of group 3.

Genus *Lituotuba* Rhumbler, 1895.

(22) *Lituotuba minuta* n. sp.

(Plate I, fig. 8).

Test minute, arenaceous, light reddish-brown in colour, proloculus indistinct, tubular chamber at first coiling in an irregular spiral and later uncoiling but irregular in direction, not constricted. Aperture formed by the open end of the tube.

Holotype from sample 42.

Dimensions of holotype: Diameter of coiled part 0.36 mm., total length 0.63 mm.

This species is distinguished from *L. lituiformis* (Brady) by its much smaller size and the absence of constrictions in the tubular test.

Genus *Tolypammmina* Rhumbler, 1895.

(23) *Tolypammmina vagans* (Brady).

Hyperammmina vagans Brady, 1879, etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 33, pl. v, fig. 3.

Tolypammmina vagans (Brady). Cushman, 1910 etc., p. 67, text-figs. 84, 85; Earland, 1934, p. 96; Parr, 1950, p. 252.

One specimen, adherent to a large *Cibicides* test, was found in sample 45.

Genus *Ammolagena* Eimer and Fickert, 1899.

(24) *Ammolagena clavata* (Jones and Parker).

(Plate 1, fig. 9).

Trochammina irregularis clavata Jones and Parker, 1860, Quart. Journ. Geol. Sci. XVI, p. 304.

Ammolagena clavata (Jones and Parker). Eimer and Fickert, 1899, p. 673; Cushman, 1910 etc., p. 68, text-figs. 86-89; 1919, p. 597.

Five specimens were found in sample 45. Two exhibited nodosariform growth, a second pyriform chamber arising from the tubular extension of the first in a slightly curved axis as in *Dentalina*. As these specimens are otherwise indistinguishable from single-chambered specimens found in the same sample, it would appear that the definition of the genus should be amended to include the multilocular condition. Cushman has evidently made the same observation (1919) when he refers to "a double-chambered proloculum with the tubular portion broken away".

Superfamily LITUOLIDEA.

Family REOPHACIDAE.

Genus *Reophax* Montfort, 1808.

(25) *Reophax micaceus* Earland.

Reophax micaceus Earland, 1934, "Discovery" Repts., Cambridge, X, p. 82, pl. ii, figs. 37-40.

Five specimens of a slender and fragile form from sample 45 agree with Earland's description, particularly in regard to the wall structure, which consists of mica plates of varying sizes, with fine sand-grains used to build the apertural neck.

(26) *Reophax dentaliniformis* Brady.

Reophax dentaliniformis Brady, 1879 etc., (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 49; 1884, p. 293, pl. xxx, figs. 21, 22.

Seven specimens of 3 to 4 chambers each were found in sample 45.

(27) *Reophax scotti* Chaster.

Reophax scotti Chaster, 1892, Southport Soc. Nat. Sci. I, p. 57, pl. 1, fig. 1; Millett, 1898 etc. (1899), p. 255, pl. iv, fig. 13.

Occasional specimens were found in the samples of groups 1, 2 and 3, the majority being somewhat collapsed and flattened. One specimen from sample 1, consisting of 3 chambers only, was armed with sponge spicules built into the test parallel with the axis and projecting backwards over the suture to form a basal fringe. The species is apparently widely distributed in shallow water around the Australian coast, as similar specimens have been found by the author on tidal mud-flats in Port Phillip, Victoria.

(28) *Reophax* sp. cf. *catenatus* Höglund.

cf. *Reophax catenatus* Höglund, 1947, Zoolog. Bidr. Från Uppsala, 26, p. 99, text-figs. 75, 76.

One specimen belonging to the *R. scotti* group was found with specimens of that species in sample 23. It differs from *R. scotti* in the shape of the chambers which are elongate and

bullet-shaped, and in the character of the wall, which is composed of much smaller mica-plates, only just visible at a magnification of $120\times$. Unlike most specimens of *R. scotti*, it shows no tendency to collapse, though flexible in the wetted state. It is referred provisionally as above on account of the form of the chambers and the thin, finely constructed wall, though the chambers are rather smaller than in *R. catenatus* as described, 15 in a total length of 0.77 mm. as against 11 in a total length of 0.8 mm.

(29) *Reophax guttifer* Brady.

Reophax guttifer Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 49; 1884, p. 295, pl. xxxi, figs. 10-15.

R. guttifer Brady. Cushman, 1910, p. 88, text-fig. 123; Parr, 1950, p. 266.

Four small but fairly characteristic specimens were found in sample 45. This species has a wide distribution in both hemispheres.

(30) *Reophax* sp. aff. *aduncus* Brady.

aff. *Reophax aduncus* Brady, 1882, Proc. Roy. Soc. Edinburgh, IX, p. 715; 1884, p. 296, pl. xxxi, figs. 23-26.

The specimens consist of a series of subglobular chambers, coarsely arenaceous with sponge spicules incorporated, irregularly uniserial with the chambers added at varying angles. The mode of growth is that of *R. aduncus*, but the tests are more irregular and coarsely-constructed than in the illustrations of that species. As no typical material is available for comparison, the identification is left open. Specimens are not uncommon in sample 45.

(31) *Reophax spiculifer* Brady.

Reophax spiculifera Brady, 1879 etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 54, pl. 4, figs. 10, 11; 1884, p. 295, pl. xxxi, figs. 16, 17.

R. spiculifer Brady. Wiesner, 1931, p. 91, pl. ix, fig. 113; Parr, 1950, p. 269.

Three typical specimens were found in sample 45.

(32) *Reophax scorpiurus testaceus* Wiesner.

Reophax scorpiurus Montfort, var. *testacca* Wiesner, 1931, in Drygalski, Deutsche Sud Pol. Exped., 1901-03, 20, p. 89, pl. viii, fig. 100; Parr, 1950, p. 269, pl. iv, fig. 19.

Specimens were not uncommon in sample 45. They resemble *R. scorpiurus scorpiurus* (which has not been found in this material) in size and general form, but differ in the consistent use of globigerine and other small foraminiferal tests instead of mineral grains in the construction of the wall. This feature does not appear to be fortuitous or conditioned by the availability of material, as other species of the genus present in the same sample use mineral grains exclusively.

(33) *Reophax agglutinatus* Cushman.

Reophax agglutinatus Cushman, 1921, U.S. Nat. Mus. Bull. 100, p. 73, pl. 14, figs. 2a, b.

Large roughly-constructed specimens up to 3 mm. in length, using small Amphisteginae and Operculinae in the construction of the wall, are referred to this species. This is

a very much larger form than *R. scorpiurus*, to which such specimens have been referred. In the present material it is characteristic of the shallow-water dredgings of group 3, *R. scorpiurus testacea* occurring only in the deeper-water sample 45.

Family LITUOLIDAE.

Subfamily HAPLOPHRAGMINAE.

Genus *Haplophragmoides* Cushman, 1910.

(34) *Haplophragmoides canariensis* (d'Orbigny).

Nonionina canariense d'Orbigny, 1839, Foram. Canaries, p. 128, pl. 11, figs. 33, 34.

Haplophragmium canariense (d'Orbigny). Brady, 1884, p. 310, pl. xxxv, figs. 1-5; Millett, 1898 etc. (1899), p. 359; Heron-Allen and Earland, 1914 etc. (1915), p. 614.

Haplophragmoides canariensis (d'Orbigny). Cushman, 1910, p. 101, fig. 144.

Five good specimens were found in sample 45. This is a wide-ranging form which has been recorded from various localities in the Indo-Pacific region.

Genus *Cribrostomoides* Cushman, 1910.

(35) *Cribrostomoides* sp. aff. *wiesneri* (Parr).

aff. *Labrospira wiesneri* Parr, 1950, B.A.N.Z.A.R. Exped. Rep. V, part 6, p. 272, pl. iv, figs. 25, 26.

One specimen from sample 45 is close to Parr's species but rather more compressed and red-brown in colour. The interioareal aperture of this species places it in the genus *Cribrostomoides* Cushman, which, as shown by Frizzell and Schwartz (1950), takes precedence over *Labrospira* Höglund, 1947.

Genus *Ammobaculites* Cushman, 1910.

(36) *Ammobaculites reophaciformis* Cushman.

Ammobaculites reophaciformis Cushman, 1910, Proc. U.S. Nat. Mus. 38, no. 1759, p. 440, text-figs. 12, 13, 14; Chapman and Parr, 1935, p. 5, pl. 1, figs. 5, 6.

Three typical specimens were found in sample 45. The species was described from the Philippines and is recorded from the Great Australian Bight by Chapman and Parr.

(37) *Ammobaculites agglutinans* (d'Orbigny).

Spirolina agglutinans d'Orbigny, 1846, For. foss. Vienne, p. 137, pl. 7, figs. 10-12.

Ammobaculites agglutinans (d'Orbigny). Cushman, 1910, p. 115, text-fig. 176.

Two typical specimens were found in sample 45 and one in sample 23.

(38) *Ammobaculites americanus* Cushman.

Haplophragmium fontinense Brady (not of Terquem), 1884, p. 305, pl. xxxiv, figs. 1-4.

Ammobaculites americanus Cushman, 1910, U.S. Nat. Mus. Bull. 71, p. 117, text-figs. 184, 185.

Six specimens from sample 45 appear to be referable to this species, hitherto known only from the Atlantic and Pacific coasts of America. They are considerably smaller than those recorded by Cushman, the largest being ca. 1.1 mm. in length, but compare well with the smaller specimens figured by Brady as *H. fontinense*.

Genus *Ammomarginulina* Wiesner, 1931.(39) *Ammomarginulina ensis* Wiesner.

Ammomarginulina ensis Wiesner, 1931, in Drygalski, Deutsche Sud Pol. Exped. 20, p. 97, pl. xii, fig. 147; Earland, 1933, p. 82, pl. iii, figs. 1-4; Parr, 1950, p. 273.

This species was described from the Antarctic. Parr (loc. cit.) records specimens from Tasmanian and Victorian waters, and mentions specimens sent to him by Earland from the Barrier Reef. Apparently it has a wide range in the Australian region and the Southern Ocean. Five specimens were found in sample 45.

(40) *Ammomarginulina australiensis* n. sp.

(Plate I, figs. 10a, b.)

Test arenaceous, built up of sand-grains cemented with a whitish cement, early chambers plani-piral and compressed, somewhat involute, with a depressed umbilicus; later chambers marginuline tending towards uniseriality, periphery rounded, aperture slit-like and distal. The majority of specimens have no more than one uniserial chamber. Chamber divisions correspond with the external sutures and are thin cemented-sand structures, not chitinous.

Holotype from sample 9.

Dimensions of holotype: Length 0.90 mm., breadth 0.40 mm., thickness 0.20 mm.

This species is similar in outline to *Ammobaculites salsus* Cushman and Bronnimann, but is compressed throughout its growth. It is frequent in the samples of groups 2 and 3 and common in the mangrove-pool samples of group 1. Similar specimens have been found by the author on tidal mud-flats in Corio Bay, Victoria. Both habitats suggest considerable tolerance of variation in temperature and salinity, the Victorian record being from shallow land-locked waters where rainfall and summer heat can vary conditions considerably.

Genus *Placopsilina* d'Orbigny, 1850.(41) *Placopsilina bradyi* Cushman and McCulloch.

Placopsilina cenomana Brady (not of d'Orbigny), 1884, p. 315, pl. xxxvi, figs. 1-3.

P. bradyi Cushman and McCulloch, 1939, Allen Hancock Pacific Exped. 6, no. 1, p. 112, pl. 12, figs. 14, 15.

Typical specimens were not uncommon in the samples of group 3, wherever bottom conditions were such as to favour the growth of sessile forms.

Genus *Nouria* Heron-Allen and Earland, 1914.(42) *Nouria polymorphinoïdes* Heron-Allen and Earland.

Nouria polymorphinoïdes Heron-Allen and Earland, 1914, Trans. Zool. Soc. London, 20, p. 376, pl. 37, figs. 1-15.

Specimens are elongate and built of large flaky calcareous fragments, but appear to fall within the limits of variation of this species. Not uncommon in samples of group 3.

(43) *Nouria tenuis* Hada.

Nouria tenuis Hada, 1931, Sci. Rep. Tohoku Imp. Univ., ser. 4, 6, no. 1, p. 94, text-fig. 46.

Two specimens close to Hada's figure were found in sample 23, the largest 1.1 mm. in length. The species is easily distinguished from others of the genus by its extreme compression and sharp-edged periphery.

(44) *Nouria textulariformis* Hada, *armata* n. subsp.

(Plate I, figs. 11a, b.)

The characteristics are generally those of the species s. str., but include also the use of sponge spicules built into the test and projecting at the periphery, directed backward from the aperture. This is a constant feature of the Barrier Reef specimens and appears to warrant some distinction.

Holotype from sample 23.

Dimensions of holotype: Length 0.90 mm., breadth 0.62 mm., thickness ca. 0.15 mm.

Occasional in the samples of group 3.

Subfamily LITUOLINAE.

Genus *Haddonia* Chapman, 1898.

(45) *Haddonia minor* Chapman.

Haddonia minor Chapman, 1901, Journ. Linn. Soc. London, 28, p. 384, pl. 36, figs. 1, 2.

Chapman's description and figures of this species could be clearer. Apparently it differs from *H. torresiensis* Chapman in its much smaller size and simple aperture. One specimen from sample 29, 4 mm. in length and having the general characteristics of *Haddonia* in free growth and low, flattened chambers is referred to this species. The apertural end is unfortunately broken.

Family TEXTULARIIDAE.

Genus *Textularia* Defrance, 1824.

(46) *Textularia fistulosa* Brady.

Textularia sagittula Defrance, var. *fistulosa* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 362, pl. xlii, figs. 19-22.

Six specimens from sample 45 are referable to Brady's variety, though the fistulose projections are more strongly developed. The presence of these tubular extensions of the chamber wall is a major feature of the morphology of this form, and appears to justify specific distinction.

(47) *Textularia candeiana* d'Orbigny.

Textularia candeiana d'Orbigny, 1839, in de la Sagra, Hist. phys. pol. nat. Cuba, "Foraminifères", p. 143, pl. 1, figs. 25-27.

This species is widely distributed in the tropics but is not well represented in the Barrier Reef material, a few specimens only being found in the samples of group 3.

(48) *Textularia vola* Lalicker and McCulloch.

Textularia vola Lalicker and McCulloch, 1940, Allen Hancock Pacific Exped. 6, no. 2, p. 142, pl. 16, figs. 27a-c.

Four typical examples of this species were found in sample 45. It was described from the Galapagos Islands.

(49) *Textularia orbica* Lalicker and McCulloch.

Textularia trochus Brady (not of d'Orbigny), 1884, p. 366, pl. xciii, figs. 15, 16, and 18.

T. orbica Lalicker and McCulloch, 1940, Allen Hancock Pacific Exped. **6**, no. 2, p. 136, pl. 15, figs. 17a, b, c.

This is one of the commonest textularians in the shallow-water samples of groups 1, 2 and 3. It is widely distributed in the Pacific.

(50) *Textularia kerimbaensis* Said.

Textularia conica d'Orbigny, var. *corrugata* Heron-Allen and Earland (not *T. corrugata* Costa), 1914, etc. (1915), Trans. Zool. Soc. London. **20**, p. 629, pl. 47, figs. 24-27.

T. corrugata Cushman (not of Costa), 1932 etc. (1932), p. 12, pl. 3, figs. 2, 4; Lalicker and McCulloch, 1940, p. 126, pl. 14, figs. 9a-d.

T. kerimbaensis Said, 1949, p. 6, pl. 1, fig. 8.

Specimens show the downward curve of the sutures at the periphery and the inflation of the upper part of the later chambers, characteristic of this species. It is common in the samples of groups 1, 2 and 3.

(51) *Textularia foliacea* Heron-Allen and Earland.

Textularia foliacea Heron-Allen and Earland, 1914 etc. (1915), Trans. Zool. Soc. London, **20**, p. 628, pl. 47, figs. 17-20.

Common in the samples of groups 1, 2 and 3.

(52) *Textularia porrecta* Brady.

Textularia agglutinans d'Orbigny, var. *porrecta* Brady, 1884, Rep. Voy. Chall., Zool **9**, p. 363, pl. xliii, fig. 4.
T. porrecta Brady, Egger, 1893, p. 269, pl. iv, figs. 17, 18; Heron-Allen and Earland, 1914 etc. (1915), p. 627.

Occasional specimens in the samples of groups 1, 2 and 3, not common.

(53) *Textularia conica* d'Orbigny.

Textularia conica d'Orbigny, 1839, in de la Sagra, Hist. phys. pol. nat. Cuba, "Foraminifères," p. 143, pl. 1, figs., 19, 20; Heron-Allen and Earland, 1914, etc. (1915), p. 629; Lalicker and McCulloch, 1940, p. 126, pl. 14, figs. 8a, b, c.

This widely-distributed species is represented by occasional specimens in the samples of groups 1, 2 and 3.

(54) *Textularia vertebralis* Cushman.

Textularia vertebralis Cushman, 1913, Proc. U.S. Nat. Mus. **44**, no. 1973, p. 633, pl. 78, fig. 1; Parr, 1950, p. 274, pl. iv, fig. 29.

Well-developed specimens were found in sample 29. As in Parr's specimens from off Tasmania, the concave projection of the lower part of the chamber is poorly developed in the earlier part of the test, though typical in the latter two-thirds.

Family TROCHAMMINIDAE.

Genus *Trochammina* Parker and Jones, 1859.(55) *Trochammina globigeriniformis* (Parker and Jones).

Lituola nautiloidea, var. *globigeriniformis* Parker and Jones, 1865, Trans. Roy. Soc. London, **155**, p. 407, pl. 15, figs. 46, 47.

Trochammina globigeriniformis (Parker and Jones). Cushman, 1910 etc. (1910), p. 124, text-figs. 193-195 (synonymy).

Seven small specimens were found in sample 45. The species has a general distribution in deep water.

(56) *Trochammina rotaliformis* J. Wright.

Trochammina rotaliformis J. Wright, 1911, in Heron-Allen and Earland, Journ. Roy. Micr. Soc. for 1911, p. 309; Heron-Allen and Earland, 1914 etc. (1915), p. 620.

Specimens are frequent in the samples of group 3, occasional in those of groups 1 and 2.

(57) *Trochammina chitinsa* n. sp.

(Plate I, figs. 12a, b, c.)

? *Trochammina ochracea* (Williamson), var., Heron-Allen and Earland, 1914 etc. (1915), p. 619, pl. xlvi, figs. 27, 28.

Test subcircular in outline, thin, dorsal side convex, early chamber walls brown and chitinous with scattered sand-grains imbedded, later chambers whitish and sandy on a chitinous base, sutures slightly depressed and irregularly recurved. Ventral side slightly concave with depressed umbilicus, chamber walls chitinous, clear and brown, sutures strongly recurved, limbate, consisting of whitish cement and ending in a bulb short of the umbilicus. Periphery sharp with a thin chitinous keel, aperture obscure.

Holotype from sample 1.

Dimensions of holotype: Diameter 0.37 mm., thickness 0.08 mm.

This species differs from *T. ochracea* (Williamson) in its much less regular form, fewer chambers to the whorl, greater size and more convex form. It is apparently the form described by Heron-Allen and Earland (loc. cit.) as a variety of *T. ochracea*. Specimens were rare in the samples of groups 1, 2 and 3.

Genus *Remaneica* Rhumbler, 1938.(58) *Remaneica* sp. aff. *plicata* (Terquem).

aff. *Patellina plicata* Terquem, 1875 etc. (1876), Essai Class. Anim. Dunkerque, **2**, p. 72, pl. viii, fig. 9.

Trochammina plicata (Terquem). Balkwill and Millett, 1884, p. 26, pl. ii, fig. 8; Millett, 1898 etc. (1899), p. 363, pl. v, fig. 13; Heron-Allen and Earland, 1914 etc. (1915), p. 619.

Five specimens were found in sample 45. The plications of the ventral side are fine and regular as noted by Heron-Allen and Earland in connection with their Kerimba specimens, and the Pacific form may be distinct from Terquem's species.

Genus *Carterina* Brady, 1884.(59) *Carterina spiculotesta* (Carter).

Rotalia spiculotesta Carter, 1877, Ann. Mag. Nat. Hist., ser 4, **20**, p. 470, pl. 16.

Carterina spiculotesta (Carter). Brady, 1884, p. 346, pl. 41, figs. 7-10.

Typical specimens were rare in the samples of groups 3 and 4. All were rotaliform, the largest reaching a diameter of 1.75 mm., and no specimens of the "amoeboid" irregular form figured by Carter were found.

Genus *Ammosphaeroidina* Cushman, 1910.

(60) *Ammosphaeroidina sphaeroidiniformis* (Brady).

Haplophragmium sphaeroidiniforme Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 313.

Ammosphaeroidina sphaeroidiniformis (Brady). Cushman, 1910 etc. (1910), U.S. Nat. Mus. Bull. 71, p. 128, text-fig. 202; Parr, 1950, p. 281, pl. v, fig. 21.

Two specimens of this widely-distributed species are recorded from sample 45.

Family VERNEULINIDAE.

Subfamily VERNEULININAE

Genus *Gaudryina* d'Orbigny, 1839.

Subgenus *Siphogaudryina* Cushman, 1935.

(61) *Gaudryina* (*Siphogaudryina*) *rugulosa* Cushman.

Gaudryina rugulosa Cushman, 1932 etc. (1932), U.S. Nat. Mus. Bull. 161, pt. 1, p. 15, pl. 4, figs. 1a, b.

Typical examples were found in group 3 samples from offshore localities, particularly no. 30.

(62) *Gaudryina* (*Siphogaudryina*) sp. cf. *wrightiana* Millett.

(Plate I, figs. 13a, b, c.)

Gaudryina Wrightiana Millet, Journ. Roy. Micr. Soc., 1900, p. 10, pl. 1, figs. 11 and 12.

One small specimen from sample 29 is referred to this species with some doubt. The general form agrees with Millett's description, but the angles of the test are fistulose, the broken ends showing as rounded cavities. Neither Millett's figures nor his description indicate any such structure, but it is one of the characters of the subgenus, to which the species is referred on other evidence (Cushman, 1937, p. 82). It is possible that Millett's specimens were better preserved and did not show this fistulose structure.

(63) *Gaudryina* (*Siphogaudryina*) *siphonifera* (Brady).

Textularia siphonifera Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 53; 1884, p. 362, pl. xlii, figs. 25-29.

Gaudryina siphonifera (Brady). Cushman, 1928, p. 109, pl. 16, figs. 1-5.

G. (Siphogaudryina) siphonifera (Brady). Cushman, 1937, p. 83, pl. 12, figs. 9, 10.

One well-developed specimen was found in sample 30. It has a general Indo-Pacific distribution.

Subgenus *Pseudogaudryina* Cushman, 1936.

(64) *Gaudryina* (*Pseudogaudryina*) *concava*, n. sp.

(Plate I, figs. 14a, b, c.)

Test finely arenaceous, triangular in section throughout, with slightly concave faces and sharp, somewhat serrate edges, chambers not inflated, sutures indistinct, later chambers

developing an overhanging margin giving the appearance of excavation in the lower part of the chamber; aperture a slit in a shallow re-entrant in the middle of the inner margin of the last chamber.

Holotype from sample 45, in which the species is rare.

Dimensions of holotype: Length 0.93 mm., width 0.64 mm.

This species differs from *G. (Ps.) jarvisi* Cushman from the Miocene of Buff Bay, Jamaica, in its more roughly-constructed test and in the overlapping of the later chambers. It does not appear to closely resemble any Recent species.

Genus *Pseudoclavulina* Cushman, 1936.

(65) *Pseudoclavulina juncea* Cushman.

Pseudoclavulina juncea Cushman, 1936, Sp. Publ. No. 6, Cushman Lab. Foram. Res., p. 19, pl. 3, figs. 8a, b.

This elongate and slender form is referred to Cushman's species which was described from the Philippines, though the aperture differs to some extent, being crescentic as in some other species of the genus, rather than rounded. Two specimens were found in sample 45.

(66) *Pseudoclavulina scabra* Cushman.

Pseudoclavulina scabra Cushman, 1936, Sp. Publ. No. 6, Cushman Lab. Foram. Res., p. 20, pl. 3, figs. 11a, b.

Three short, stout specimens with low uniserial chambers, from sample 45, are referred to this species, which was described from the Philippines. The aperture is terminal and rounded, differing in this respect from *P. juncea*, found in the same sample.

Subfamily EGGERELLINAE.

Genus *Eggerella* Cushman, 1933.

(67) *Eggerella australis* n. sp.

(Plate II, figs. 1a, b.)

Test minute, rather coarsely arenaceous, conical, early chambers obscure, apparently trochospiral, later chambers triserial, inflated, aperture loop-shaped, at the interior margin of the last chamber.

Holotype from sample 24.

Dimensions of holotype: Length 0.29 mm., greatest diameter 0.19 mm.

This small species is fairly common in the finer fractions of the samples of group 3. Similar specimens in the collection of the late W. J. Parr were from off Gabo Island, at the east end of Bass Strait. It differs from *E. subconica* Parr, described from off Tasmania, in its coarser construction, more tapering form and invariably triserial arrangement of the final chambers.

(68) *Eggerella polita* n. sp.

(Plate II, figs. 2a, b.)

Test finely arenaceous, smoothly finished and shining, reddish-brown in early chambers, white in the last one or two; subconical with bluntly pointed initial end, oral end broadly lobed by the last three chambers. Chambers slightly inflated with depressed sutures, arranged in a trochoid spiral of 4 to 5 whorls, earlier chambers 4 to the whorl, later chambers triserial. Aperture a minute hole near the base of the apertural face of the last chamber.

Holotype from sample 45, where it is not uncommon.

Dimensions of holotype: Length 0.37 mm., greatest diameter 0.25 mm.

This species is perhaps closest to *E. scabra* (Williamson), but in comparison with specimens of the latter species from the British coast it differs in its finer and smoother construction, less inflated chambers, minute aperture and much smaller size.

Genus *Dorothia* Plummer, 1931.

(69) *Dorothia arenata* Cushman.

Dorothia arenata Cushman, 1936, Sp. Publ. No. 6, Cushman Lab. Foram. Research, p. 32, pl. 5, figs. 11a,c

Fine examples of this species were common in sample 45.

(70) *Dorothia inepta* n. sp.

(Plate II, figs. 3 and 4.)

Test arenaceous, early chambers subconical and trochospiral with 4 or 5 chambers to the whorl, later chambers biserial, finally becoming irregular in form, roughly biserial but modified by attachment to other bodies. Aperture either an arched slit at the inner margin of the last-formed chamber or a rounded opening in the septal face, apparently depending upon the conditions of attachment. Some specimens are regularly biserial and show their relationship by the flattened and irregular shape of the final chambers, others become wild-growing and change the axis of growth by as much as 45°, or twist in various directions.

Holotype from sample 30.

Dimensions of holotype: Length 1.6 mm., greatest width 0.7 mm.

This species shows a parallel development to that of the genus *Rudigaudryina* Lalicker and McCulloch, but has apparently evolved from a regular species of *Dorothia* rather than from *Gaudryina*. It is fairly common in the samples of group 3. This is apparently the form occurring at Lord Howe Island, referred by Heron-Allen and Earland to *Haddonina torresiensis* Chapman (Journ. Linn. Soc., Zool. 35, 1924, pl. 35, figs. 17–20, 22–32, not 21). The growth habit of *Haddonina* is the reverse of that of this species, being attached in the early stages and free in the later chambers, whereas *D. inepta* is apparently attached by successive oral faces throughout life. Evidence of this attachment in most cases rests in the variable and frequently concave shape of the apertural faces of the final chambers, appearing to be the reverse mould of variously rounded and flattened surfaces. The holotype, however, is attached to a shell fragment which has apparently broken away with the test, the last chamber of which partially envelops it. Probably the species is attached in life by extruded protoplasm to a surface, the contours of which are closely followed by the chamber wall as it is formed.

Genus *Karrieriella* Cushman, 1933.

Subgenus *Karrerulina* Finlay, 1940.

(71) *Karriella* (*Karrerulina*) *apicularis* (Cushman).

Gaudryina siphonella Brady, 1884 (not of Reuss), 9, p. 382, pl. xlvi, figs. 17–19.

G. apicularis Cushman, 1910 etc. (1911), U.S. Nat. Mus. Bull. 71, pt. 2, p. 69, text-figs. 110a, b.

Plectina apicularis Cushman, 1937, p. 110, pl. 12, figs. 22–26.

Karrieriella (*Karrerulina*) *apicularis* (Cushman). Finlay, 1939 etc., (1940), 69, pt. 4, p. 450.

Nine specimens of this well-known form were found in sample 45.

(72) *Karrieriella (Karrerulina) attenuata* n. sp.

(Plate II, fig. 5.)

Test arenaceous, slender, tapering, commencing with a short trochospiral series with 5 chambers to the whorl, then becoming biserial with up to 9 pairs of chambers, sutures depressed, chambers somewhat inflated and increasing in size, last chamber pyriform with terminal spout-like aperture. Occasional large sand-grains are built into the wall of the test.

Holotype from sample 45.

Dimensions of holotype: Length 0.46 mm., breadth 0.14 mm., thickness 0.10 mm.

This small species is characterized by the very abbreviated initial series of chambers, the long biserial portion and the regular taper of the test. Apart from the apertural characters it closely resembles *Textularia tenuissima* Earland, but does not seem to be close to any described species of its genus.

Subfamily VALVULININAE.

Genus *Valvulina* d'Orbigny, 1826.

(73) *Valvulina conica* Parker and Jones.

Valvulina triangularis d'Orbigny, var. *conica* Parker and Jones, 1865, Phil. Trans. **155**, p. 406, pl. 15, fig. 27.
V. conica Parker and Jones. Brady, 1884, p. 392, pl. xlix, figs. 15, 16.

Not uncommon in sample 45, some specimens being adherent to shell fragments.

Genus *Clavulina* d'Orbigny, 1826.

(74) *Clavulina multicamerata* Chapman.

Clavulina parisiensis d'Orbigny, var. *multicamerata* Chapman, 1909, Journ. Quekett Micr. Club, ser. 2, **10**, p. 127, pl. 9, fig. 5.
C. multicamerata Chapman. Cushman, 1937a, p. 24, pl. 3, figs. 13-16.

Common in most of the samples of groups 1, 2 and 3. This species, described from Shoreham, Victoria, evidently has a wide Indo-Pacific range, as the author has collected typical specimens from shallow water near Dar-es-Salaam, Tanganyika Territory.

(75) *Clavulina pacifica* Cushman.

Clavulina pacifica Cushman, 1924, Publ. 342, Carnegie Inst. Washington, p. 22, pl. 6, figs. 7-11.

Occurs generally in the same groups as *C. multicamerata* but is not so common as that species.

Superfamily MILIOLIDEA.

Family MILIOLIDAE.

Genus *Quinqueloculina* d'Orbigny, 1826.

(76) *Quinqueloculina anguina arenata* Said.

Miliolina anguina Terquem, var. *agglutinans* Wiesner, 1915 (not *Quinqueloculina agglutinans* d'Orbigny), in Heron-Allen and Earland, Trans. Zool. Soc. London, **XX**, pt. 2, p. 575.
Quinqueloculina anguina (Terquem), var. *arenata* Said, 1949, Sp. Publ. No. 26, Cushman Lab. Foram. Research, p. 9, pl. 1, fig. 25.
Q. anguina (Terquem) var. *wiesneri* Parr, 1950, p. 290, pl. vi, figs. 9, 10.

This species, which is recorded from Indo-Pacific localities ranging from the Red Sea to the Pacific Islands, and from as far south as Tasmania, is fairly common in the samples of group 3. Owing to the delay in publication of his Antarctic monograph, Parr's new name for this form was antedated by that of Said, which therefore takes precedence.

(77) *Quinqueloculina berthelotiana* d'Orbigny.

Quinqueloculina berthelotiana d'Orbigny, 1839, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, 2, pt. 2, "Foraminifères," p. 142, pl. 3, figs. 25-27; Cushman, 1932 etc., p. 19, pl. 5, figs. 2-4.

Specimens with produced neck, rounded aperture and the chambers irregularly keeled and sinuous are referred to this species, recorded by Cushman from the tropical Pacific. Occasional specimens were found in the samples of groups 1, 2 and 3.

(78) *Quinqueloculina bicarinata* d'Orbigny.

Quinqueloculina bicarinata d'Orbigny, 1826, Ann. Sci. Nat., p. 302, no. 35; Cushman, 1921, p. 428, pl. 86, figs. 2, 3; pl. 100, fig. 7.

Occasional specimens of this double-keeled form were found in some of the samples of groups 1, 2 and 3.

(79) *Quinqueloculina bidentata* d'Orbigny.

Quinqueloculina bidentata d'Orbigny, 1839, in de la Sagra, Hist. phys. pol. nat. Cuba, "Foraminifères", p. 197, pl. 12, figs. 18-20; Cushman, 1932 etc., p. 20, pl. 5, fig. 5.

This large coarsely-built arenaceous species with truncate periphery occurs sparsely in the samples of groups 1, 2 and 3. It was recorded from the tropical Pacific by Cushman.

(80) *Quinqueloculina crassicarinata* n. sp.

(Plate II, 7 figs. 6a, b, c.)

Test porcellaneous, smooth, quinqueloculine, subcircular in frontal view, chambers wedge-shaped in section with a strong square-edged keel, somewhat sinuate in outline. Aperture oval with a flared lip and small simple tooth, produced on a short neck.

Holotype from sample 34.

Dimensions of holotype: Length 0.81 mm., breadth 0.69 mm., thickness 0.49 mm.

This species is distinguished from *Q. lamarchiana* d'Orbigny by its produced neck and the square-edged keel. It is not uncommon in the samples of groups 1, 2 and 3.

(81) *Quinqueloculina crenulata* Cushman.

Quinqueloculina crenulata Cushman, 1932 etc., U.S. Nat. Mus. Bull. 161, p. 21, pl. 5, figs. 11a-c.

This slender and elegant species was described from the Caroline Islands, and evidently has a fairly wide Pacific range. It occurs in small numbers in many of the samples of groups 1, 2 and 3.

(82) *Quinqueloculina cuvieriana* d'Orbigny, *queenslandica*, n. subsp.

(Plate II, figs. 7a, b, c.)

Test porcellaneous, smooth, polished, subcircular in outline, quinqueloculine, periphery truncate or rounded with 2 or 3 low costae, aperture large, loop-shaped with a short bifurcate tooth.

Holotype from sample 7.

Dimensions of holotype : Length 0.50 mm., breadth 0.44 mm., thickness 0.29 mm.

This subspecies varies from *Q. cuvieriana cuvieriana*, which has not been found in these samples, in its bluntly-rounded or truncate periphery, more rounded aperture, shorter tooth and somewhat more inflated chambers. A few specimens were found in many of the samples of groups 1, 2 and 3.

(83) *Quinqueloculina quinquecarinata* n. sp.

(Plate II, figs. 8a, b, c.)

Test minute, quinqueloculine, elongate, chambers wedge-shaped with sharp keel, chamber wall translucent, keel opaque and white, apertural end produced as a short neck with a slightly flaring lip, aperture rounded with a small simple tooth.

Holotype from sample 34.

Dimensions of holotype : Length 0.47 mm., breadth 0.18 mm., thickness 0.13 mm.

This small species is found in most of the samples of group 3 and in the finer fractions, where present, of groups 1 and 2. It bears some resemblance to *Q. ferussacii* d'Orbigny, but lacks the strong lateral costae which are developed on the later chambers of that species.

(84) *Quinqueloculiana lamarckiana* d'Orbigny.

Quinqueloculina lamarckiana d'Orbigny, 1839, in de la Sagra, Hist. phys. pol. nat. Cuba, "Foraminifères", p. 189, pl. 11, figs. 14, 15.

This widely distributed species was found occasionally in the samples of groups 1, 2 and 3.

(85) *Quinqueloculina milletti* (Wiesner).

Miliolina bosci Millett, 1898 (not *Quinqueloculina bosci* d'Orbigny), Journ. Roy. Micr. Soc., 1898 etc., p. 267, pl. vi, fig. 1.

M. milletti Wiesner, 1912, Arch. Prot. 25, p. 220.

This small, smooth-surfaced and elongate species was common in the finer fractions of most of the samples of groups 1, 2 and 3, and was particularly characteristic of the mangrove-pool habitat of group 1.

(86) *Quinqueloculina neostriatula* Thalmann.

Quinqueloculina striatula Cushman, 1932 etc. (not of Deshayes), p. 27, pl. 7, figs. 3, 4.

Q. neostriatula Thalmann, 1950, Contr. Cushman. Found. Foram. Foram. Research, 1, pts. 3 and 4, p. 45.

The broad crescentic aperture and narrow lip of this finely-striate species is distinctive. It was common in many of the samples of groups 1, 2 and 3.

(87) *Quinqueloculina polygona* d'Orbigny.

Quinqueloculina polygona d'Orbigny, 1839, in de la Sagra, Hist. phys. pol. nat. Cuba, "Foraminifères", p. 198, pl. 12, figs. 21, 23.

This species, which was common in the samples of groups 1, 2 and 3, is quite distinct from the cool-water form figured by Parr (1945) as *Q. subpolygona*, being more elongate, with the keels sharp-edged and regularly curved.

(88) *Quinqueloculina pseudoreticulata* Parr.

Miliolina reticulata Brady, 1884 (not *Triloculina reticulata* d'Orbigny), p. 177, pl. ix, figs. 2, 3 (not fig. 4).
Quinqueloculina pseudoreticulata Parr, 1941, p. 305.

This common large Barrier Reef species was found in most of the samples of groups 1, 2 and 3.

(89) *Quinqueloculina samoensis* Cushman.

Quinqueloculina samoensis Cushman, 1924, Publ. No. 342, Carnegie Inst. Washington, p. 59, pl. 21, figs. 4-7; 1932 etc., p. 26, pl. 7, figs. 1a-c.

Rare in the samples of group 3. Its squarish periphery, produced neck and encrustation of sand-grains are distinctive.

(90) *Quinqueloculina semireticulosa* Cushman.

Quinqueloculina semireticulosa Cushman, 1932 etc., U.S. Nat. Mus. Bull. 161, pt. 1, p. 27, pl. 7, figs. 2a, b.

Two specimens from sample 44 agree with Cushman's figure and description in the character of the ornament and in the small oval aperture separated from the sutural margin of the last chamber.

(91) *Quinqueloculina sulcata* d'Orbigny.

Quinqueloculina sulcata d'Orbigny, 1826, Ann. Sci. Nat. 7, p. 301, no. 17; Fornasini, 1900, p. 363, text-fig. 9; Cushman, 1932 etc., p. 28, pl. 7, figs. 5-8.

This large striking species was described from the Red Sea and is recorded from the Pacific Islands. It is common in many of the samples of groups 1, 2 and 3.

(92) *Quinqueloculina tropicalis* Cushman.

Miliolina gracilis Brady, 1884 (not *Triloculina gracilis* d'Orbigny), p. 160, pl. v, figs. 2a-c.
Quinqueloculina tropicalis Cushman, 1924, Publ. 342, Carnegie Inst. Washington, p. 63, pl. 23, figs. 9, 10.

Rare in the shallow-water samples, one specimen each from samples 1 and 44.

(93) *Quinqueloculina rugosa* d'Orbigny.

Quinqueloculina rugosa d'Orbigny, 1826, Ann. Sci. Nat. 7, p. 302, No. 24; Cushman, 1910 etc. (1917), p. 53.

This species, with truncate and inflated periphery and rough pitted surface, is rare in samples of group 3.

Genus *Massilina* Schlumberger, 1893.(94) *Massilina subrugosa* n. sp.

(Plate II, fig. 9.)

Massilina secans d'Orbigny, var. *rugosa* Heron-Allen and Earland (not *Massilina rugosa* Sidebottom), 1914 etc. (1915), Trans. Zool. Soc. London, XX, pt. 17, p. 583, pl. xlv, figs. 5-12.

This species is common in many of the shallow-water samples of groups 2 and 3. The test is heavily built, porcellaneous and coated with a thin layer of sand-grains except near the aperture, where the smooth white shell wall appears. The form of the test is somewhat variable, the periphery varying from bluntly carinate to truncate. Heron-Allen and Earland's varietal name *rugosa* is a homonym of *M. rugosa* Sidebottom, 1904. There is little

resemblance between this form and the compressed and laterally expanded *M. secans*, so that it is here raised to specific rank under the name *subrugosa*.

(95) *Massilina secans* d'Orbigny, *tropicalis* n. subsp.

(Plate II, figs. 10a, b, c.)

Test ovate, porcellaneous, with slightly roughened surface, thickest at the centre where the early quinqueloculine chambers project, periphery sharp-edged, aperture large, loop-shaped, recurved, with a slight lip and large bifurcate tooth.

Holotype from sample 11.

Dimensions of holotype: Length 1.05 mm., breadth 0.75 mm., thickness 0.30 mm.

This subspecies is consistently smaller and proportionately thicker than *M. secans secans*, when compared with Mediterranean specimens. It does not attain the broad complanate form of fully-developed specimens of the latter, but compares closely with immature specimens. The author has similar specimens from Dar-es-Salaam, Tanganyika Territory. Heron-Allen and Earland (1915) state that, in regard to Kerimba specimens, "the large compressed form is not represented at all in the dredgings . . .", and it is considered that their figured specimens (pl. xlv, figs. 24-27) are referable to this subspecies.

(96) *Massilina corrugata* n. sp.

(Plate II, figs. 11a, b, c; 12a, b, c.)

Test porcellaneous, dull and chalky, ovate, periphery truncate, surface of chambers transversely ridged. Microspheric specimens are quinqueloculine in form with a tendency toward complanate expansion in the last chamber, megalospheric specimens are complanate or excavated centrally. Aperture elongate, subrectangular, slightly produced and recurved, with a long, plate-like tooth.

Holotype from sample 9 (microspheric form), paratype from sample 1 (megalospheric form).

Dimensions: Holotype, length 1.14 mm., breadth 0.78 mm., thickness 0.39 mm.; paratype, length 0.89 mm., breadth 0.58 mm., thickness 0.39 mm.

This species is common in the shallow-water samples of groups 1, 2 and 3. The quinqueloculine microspheric form at first sight resembles *Quinqueloculina parkeri* (Brady), but the periphery is truncate rather than acute as in the latter species. Cushman (1921) has described a variety *occidentalis* of *Q. parkeri* having a truncate periphery, but this variety is described as having a greater number of transverse ridges than the species, which does not apply to the present form. The characters of fully-developed megalospheric specimens are those of *Massilina*, and it is hence referred to that genus.

(97) *Massilina minuta* n. sp.

(Plate III, figs. 1a, b; 2.)

Test minute, finely arenaceous, smooth, elongate-ovate in outline, compressed, chambers narrow and rounded with slightly depressed sutures, early stages quinqueloculine, last three chambers massiline, apertural end produced as a neck, aperture circular, edentate, with a narrow lip.

Holotype from sample 24.

Dimensions of holotype : Length 0.34 mm., breadth 0.16 mm., thickness *ca.* 0.08 mm.

This minute but very distinctive species occurs in small numbers in most of the samples of group 3 and is common in sample 45. It has some resemblance to *Ammomassilina*, but the aperture is simple, not cribrate.

Genus *Pseudomassilina* Lacroix, 1938.

(98) *Pseudomassilina australis* (Cushman).

Massilina australis Cushman, 1932 etc., U.S. Nat. Mus. Bull. 161, pt. 1, p. 32, pl. 8, figs. 2a, b.

? *Massilina pacificiensis* Cushman, 1924, Publ. 342, Carnegie Inst. Washington, p. 66, pl. 24, figs. 1, 2.

Pseudomassilina australis (Cushman). Lacroix, 1938, p. 3.

The specimens referred here are rather variable both in shape and decoration. Many are unornamented as in Cushman's figure of *M. australis* (loc. cit.), others have the crenulations of *M. pacificiensis*, with intermediate forms connecting the two. Cushman does not mention the obvious relationship between these two species in his description of the later one, *M. australis*, though he describes the later chambers of that species as "wrinkled". It seems possible that the two forms are the same, in which case *M. australis* would have to be placed in the synonymy of *M. pacificiensis*. This can only be decided by examination of the types, and the question is therefore left open, the present specimens being referred to *M. australis* as the majority agree with the figure of this species.

Loeblich and Tappan (1953, p. 42) have included this species in the new genus *Patcoris*. It is however the genotype of *Pseudomassilina* Lacroix, 1938, and this name must have taken precedence, had the species been congeneric with the genotype of *Patcoris*, *P. hauerinoides* Loeblich and Tappan. However, the peculiar pitted and canaliculate shell-structure of *Pseudomassilina* is not described as a characteristic of *Patcoris*, and this genus is apparently distinct from the tropical massilines separated by Lacroix.

Genus *Spiroloculina* d'Orbigny, 1826.

(99) *Spiroloculina angulata* Cushman.

Spiroloculina grata Terquem, var. *angulata* Cushman, 1910 etc. (1917), U.S. Nat. Mus. Bull. 71, pt. 6, p. 36, pl. 7, fig. 5.

S. angulata Cushman. Cushman and Todd, 1944, p. 50, pl. 7, figs. 18-22.

This costate species with ridged periphery is common in the samples of groups 1, 2 and 3. It has a very wide distribution in the tropical Indo-Pacific, and has been recorded from as far south as Sydney, N.S.W.

(100) *Spiroloculina aperta* Cushman and Todd.

Spiroloculina aperta Cushman and Todd, 1944, Sp. Publ. No. 11, Cushman Lab. Foram. Research, p. 66, pl. 9, figs. 21, 22.

This delicate species with concave periphery, 2 sharp keels and a produced apertural neck is fairly common in the samples of groups 2 and 3.

(101) *Spiroloculina communis* Cushman and Todd.

Spiroloculina communis Cushman and Todd, 1944, Sp. Publ. No. 11, Cushman Lab. Foram. Research, p. 63, pl. 9, figs. 4, 5, 7, 8.

This strongly-built, excavated species is one of the commonest in the samples of groups 1, 2 and 3.

(102) *Spiroloculina disparilis* Terquem.

Spiroloculina disparilis Terquem, 1878, Mém. soc. géol. France, ser. 3, 1, p. 55, pl. 5 (10), fig. 12; Cushman and Todd, 1944, p. 35, pl. 5, figs. 22-31 (synonymy).

Occurs sparsely in the samples of groups 3 and 4. This species has a wide warm-water distribution, and is common in the Miocene sediments of Victoria.

(103) *Spiroloculina foveolata* Egger.

Spiroloculina foveolata Egger, 1893, Abhandl. Kön. bay. Akad. Wiss. München, cl. ii, 18, p. 274, pl. 1, figs. 33, 34; Cushman and Todd, 1944, p. 48, pl. 7, figs. 7-12 (synonymy).

Fine specimens of this reticulate species were not uncommon in the samples of groups 1, 2 and 3. It has a wide Indo-Pacific distribution.

(104) *Spiroloculina lucida* Cushman and Todd.

Spiroloculina lucida Cushman and Todd, 1944, Sp. Publ. No. 11, Cushman Lab. Foram. Research, p. 70, pl. 9, figs. 30, 31.

Rare in sample 10 (2 specimens). Widely distributed in the Indo-Pacific area.

(105) *Spiroloculina rugosa curvatura* Cushman and Todd.

Spiroloculina rugosa Cushman and Todd, var. *curvatura* Cushman and Todd, 1944, Sp. Publ. No. 11, Cushman Lab. Foram. Research, p. 66, pl. 9, figs. 18-20.

Occasional specimens of this subspecies were found in the samples of group 3. It was described from Samoa and is recorded also from the Red Sea and Sydney Harbour (N.S.W.).

(106) *Spiroloculina scita* Cushman and Todd.

Spiroloculina antillarum Parr, 1932 (not of d'Orbigny), p. 9, pl. 1, fig. 11.
S. scita Cushman and Todd, 1944, Sp. Publ. No. 11, Cushman Lab. Foram. Research, p. 60, pl. 8, figs. 20, 21.

Common in practically all the shallow-water samples. The specimens are generally not so large as those from southern Australian waters, but are otherwise typical.

Genus *Sigmoilina* Schlumberger, 1887.(107) *Sigmoilina schlumbergeri* Silvestri.

Planispirina celata Brady, 1884 (not of Costa), p. 197, pl. viii, figs. 1-4.
Sigmoilina schlumbergeri Silvestri, 1904, Mem. Pont. Accad. Nuovi Lincei, 22, p. 267; Cushman 1946, p. 36, pl. 6, figs. 1-4 (synonymy).

Three specimens from sample 45 had the outward appearance of this species, including the very small aperture with a rudimentary tooth, giving it a crescentic appearance. On

sectioning one, it proved to be a typical *Sigmoilina*. Records of this species are mostly from the Atlantic, though Brady states that the form recorded by him is found in all the great oceans, and it is recorded by Le Roy from the late Tertiary of Siboeret Island, off Sumatra.

(108) *Sigmoilina australis* (Parr.)

Quinqueloculina australis Parr, 1932, Proc. Roy. Soc. Victoria, 44 (n.s.), pt. 1, p.6, pl. 1, figs. 7a, b.

Sigmoilina australis (Parr). Parr, 1945, p. 197.

Three typical examples were found in sample 45. It is common in shallow water on the Victorian coast.

Genus *Spirosigmoilina* Parr, 1942.

(109) *Spirosigmoilina bradyi* n. sp.

Spiroloculina crenata Brady, 1884 (not of Karrer), p. 156, pl. x, figs. 24-26.

Massilina crenata (Karrer). Cushman, 1910 etc. (1917) (not *S. crenata* Karrer), p. 57, pl. 20, fig. 2.

Specimens of the form figured by Brady (loc. cit.) were frequent in the samples of group 3. A close examination of the early chambers reveals that they are sigmoiline rather than quinqueloculine, as has been previously stated. There is some variation in the degree to which the later massiline chambers embrace the earlier-formed portion, some specimens having the sigmoiline chambers obscured. Brady's fig. 26, however, shows this character clearly. The figured specimen is one in which the crenulate development is not taken on so early as in other specimens from the same material, and hence exhibits the earlier chambers better.

As this form has the characteristic growth-plan of the genus *Spirosigmoilina* Parr, described from the Miocene of Victoria, it is accordingly removed to that genus. Cushman and Todd (1944, p. 75) have examined the types of Karrer's *Spiroloculina crenata*, and state that it is a species of *Hauerina*. A new specific name is therefore required for this recent species.

(110) *Spirosigmoilina parri* n. sp.

(Plate III, figs. 2a, b ; 3.)

Test porcellaneous, subtranslucent, subcircular, smooth, complanate except for the raised fusiform initial portion, consisting of a proloculus and about 8 tubular chambers arranged in a sigmoid curve, followed by 3 or 4 compressed complanate spiroloculine chambers. Aperture simple, compressed, edentate.

Holotype from sample 45.

Dimensions of holotype : Length 0.33 mm., breadth 0.28 mm., thickness 0.06 mm.

This species resembles *S. tateana* (Howchin) to some extent, but differs from the Miocene species in its much smaller size and more compressed and spreading later chambers. It is named in honour of my old friend the late W. J. Parr, the author of the genus. The species occurs rarely in the samples of groups 3 and 4.

Genus *Articulina* d'Orbigny, 1826.

(111) *Articulina pacifica* Cushman.

Articulina pacifica Cushman, 1944, Sp. Publ. No. 10, Cushman Lab. Foram. Research, p. 17, pl. 4, figs., 14-18.

Rare in the samples of groups 2 and 3. It has a wide Indo-Pacific distribution.

(112) *Articulina tricarinata* n. sp.

(Plate III, figs. 5a, b ; 6.)

Test minute, translucent, surface somewhat rough, early chambers apparently spiroloculine, with sharply keeled periphery, later chambers uniserial, triangular in cross-section, edges sharply keeled, widest at the base of each chamber and slightly truncate. Aperture rounded, at the end of a produced and slightly flaring neck.

Holotype from sample 45.

Dimensions of holotype : Length 0.38 mm., breadth 0.05 mm.

Only two specimens were found, but the unusual and distinctive characteristics appear to justify describing it as a new species. The tricarinate form of the later chambers distinguishes it from other species of the genus.

(113) *Articulina sagra* d'Orbigny.

(Plate III, fig. 7.)

Articulina sagra d'Orbigny, 1839, in de la Sagra, Hist. phys. pol. nat. Cuba, "Foraminifères", p. 183, pl. 9, figs. 23-26 ; Cushman, 1944, p. 11, pl. 2, figs. 6-10.

Cushman (loc. cit.) considers that records of this species from localities outside the West Indian region are erroneous, but the present specimens compare closely with specimens of *A. sagra* from La Chorrera, Cuba, and are considered to be conspecific. Common in some of the dredgings of group 3, a few specimens in the deeper-water sample 45. Most of the larger specimens, including the one illustrated, lack the initial series of chambers, which is triloculine, costate and usually (but not invariably) smaller in relation to the later series than in Cuban specimens.

(114) *Articulina queenslandica* n. sp.

(Plate III, figs. 8, 9 and 10.)

Test elongate, slender, commencing with a compressed spiroloculine series of from 1 to 5 chambers after the proloculus, periphery rounded, chambers sometimes taking up a complete whorl. Later chambers, up to 4 in number, are cylindrical, slightly widened at the base and ornamented with low costae, increasing from 4 or 5 on the first uniserial chamber to 12 in the last. Costae increase in height toward the oral end of each chamber and relatively so in successive chambers. Aperture terminal, round, with a narrow everted lip.

Holotype from sample 45.

Dimensions of holotype : Length 0.42 mm., breadth 0.06 mm.

Three specimens were found in sample 45. The best-developed specimen (fig. 10) which is 0.86 mm. long, would have been referred to *Nodobaculularia* had it been found alone, as the early series consists of a proloculus and one spiral chamber taking up a complete whorl. Another specimen (fig. 9) shows 2 spiroloculine chambers followed by one which takes up nearly one whorl, and a third (fig. 8) which has been selected as the type, has 5 spiroloculine chambers after the proloculus, which is much smaller than in the other two specimens.

This species resembles *A. pauciloculata* Cushman, described from the West Atlantic, in its elongate form and gradation in number of costae, but the latter species has a triloculine initial series of chambers. It is noteworthy that *A. queenslandica* and *A. tricarinata* (vide

supra) appear to have been derived from a spiroloculine ancestor, rather than triloculine or quinqueloculine as with other species of the genus. However, as *Articulina* is evidently a polyphyletic genus, it does not appear necessary to make any distinction other than specific.

Genus *Tubinella* Rhumbler, 1906.

(115) *Tubinella funalis* (Brady).

Articulina funalis Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 186, pl. xiii, figs. 6-11.

Tubinella funalis (Brady). Rhumbler, 1906, p. 26, pl. 2, fig. 3; Cushman, 1924, p. 54, pl. 19, figs. 7, 8.

Not uncommon in the samples of group 3.

(116) *Tubinella inornata* (Brady).

Articulina funalis Brady, var. *inornata* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 186, pl. xiii, figs. 3-5.

Tubinella inornata (Brady). Rhumbler, 1906, p. 27, pl. 2, fig. 4; Cushman, 1924, p. 54.

One specimen of this smooth form was found in sample 45. The globose proloculus is followed by a second spiral chamber, attached and forming half a whorl, from which develops the tubular rectilinear portion.

Genus *Nubeculina* Cushman, 1924.

(117) *Nubeculina divaricata advena* Cushman.

Nubeculina divaricata (Brady), var. *advena* Cushman, 1924, Publ. 342, Carnegie Inst. Washington, p. 53, pl. 19, figs. 1-4.

Common in the samples of group 3. All the specimens were referable to this subspecies, which differs from *N. divaricata divaricata* by the close apposition of the chambers and the clavate form of the test.

Genus *Hauerina* d'Orbigny, 1839.

(118) *Hauerina diversa* Cushman.

Hauerina diversa Cushman, 1946, Contr. Cushman Lab. Foram. Research, 22, pt. 1, p. 11, pl. 2, figs. 16-19.

This small species was described from the Paumotus. It occurs rarely in the samples of group 3.

(119) *Hauerina pacifica* Cushman, *rugosa* n. subsp.

(Plate III, figs. 11a, b, c.)

This subspecies differs from *H. pacifica pacifica* in the development of oblique ridges or crenulations on the later chamber walls. There is considerable variation in the degree of crenulation, some specimens being nearly smooth, others strongly ridged with fine longitudinal striae on the last chamber. Rare in the samples of group 3.

Holotype from sample 27.

Dimensions of holotype: Length 0.60 mm., breadth 0.56 mm., thickness 0.28 mm.

(120) *Hauerina fragilissima* (Brady).

Spiroloculina fragilissima Brady 1884, Rep. Voy. Chall., Zool. 9, p. 149, pl. ix, figs. 12-14.

Hauerina fragilissima (Brady). Cushman, 1946, p. 10, pl. 2, figs. 1-6, 8 (synonymy).

Not uncommon in the samples of group 3. In the recent state the species appears to be confined to the Pacific.

(121) *Hauerina involuta* Cushman.

Hauerina ornatissima (part) Brady, 1884 (not of d'Orbigny), p. 192, pl. vii, figs. 15-17.

H. involuta Cushman, 1946, Contrib. Cushman Lab. Foram. Research, 22, pt. 1, p. 13, pl. 2, figs. 25-28.

This is the commonest species of the genus in the present material, occurring generally in the samples of groups 1, 2 and 3. It appears to be a restricted Pacific species.

(122) *Hauerina bradyi* Cushman.

Hauerina compressa Brady, 1884 (not of d'Orbigny), p. 190, pl. xi, figs. 12, 13; Millett, 1898 etc. (1898), p. 610, pl. 13, fig. 11.

Hauerina bradyi Cushman 1910 etc. (1917), U.S. Nat. Mus. Bull. 71, pt. 6, p. 62.

Frequent in the samples of group 3. It has a general Indo-Pacific distribution.

Genus *Schlumbergerina* Munier-Chalmas, 1882.

(123) *Schlumbergerina alveoliniformis* (Brady).

Miliolina alveoliniformis Brady, 1879, Quart. Journ. Micr. Sci. XIX, n.s., p. 268; 1884, p. 181, pl. viii, figs. 15-20.

Schlumbergerina alveoliniformis (Brady). Cushman, 1918 etc. (1929), p. 56.

Not uncommon in the samples of group 3. Fine specimens were found in sample 26.

Genus *Ammomassilina* Cushman, 1933.

(124) *Ammomassilina alveoliniformis* (Millett).

Massilina alveoliniformis Millett, 1898, Journ. Roy. Micr. Soc., p. 609, pl. 13, figs. 5-7; Heron-Allen and Earland, 1914 etc. (1915), p. 584, pl. xlv, fig. 15.

Ammomassilina alveoliniformis (Millett). Cushman, 1933, p. 32, pl. 3, figs. 5a, b.

Common in samples of group 3, especially those from off-shore stations.

Genus *Triloculina* d'Orbigny, 1826.

(125) *Triloculina bertheliniana* (Brady).

Miliolina bertheliniana Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 166, pl. cxiv, figs. 2a, b.

M. tricarinata d'Orbigny, reticulated form, Millett, 1898 etc. (1898), p. 503, pl. xi, figs. 12a, b.

M. tricarinata d'Orbigny, var. *bertheliniana* Brady. Chapman, 1900a, p. 174.

Triloculina bertheliniana (Brady). Cushman, 1918a, p. 290; 1921, p. 457; 1932, p. 60, pl. 13, fig. 5.

This well-known Indo-Pacific species is common in most of the samples of groups 1, 2 and 3. The larger specimens are not quite so regular as Brady's figure, tending to develop sinuate edges.

(126) *Triloculina bicarinata* d'Orbigny.

Triloculina bicarinata d'Orbigny, 1839, in de la Sagra, Hist. phys. pol. nat. Cuba, "Foraminifères", p. 158, pl. 10, figs. 18–20; Cushman, 1922, p. 76, pl. 12, fig. 7; 1932, p. 60, pl. 13, figs. 6a, c.

This irregularly-reticulate form with truncate chambers is not uncommon in the samples of groups 1, 2 and 3. Cushman has recorded it from various stations in the tropical Pacific.

(127) *Triloculina littoralis* n. sp.

(Plate III, figs. 12a, b, c.)

Test porcellaneous, white and polished, ovate in side view with 3 chambers visible, subtriangular in end view with broadly-rounded periphery. Chambers strongly embracing at ends, costate. Apertural end produced as a short neck, aperture oval with everted lip and large thin tooth.

Holotype from sample 7.

Dimensions of holotype: Length 0.40 mm., breadth 0.22 mm., thickness 0.16 mm.

This small species is common in most of the samples of groups 1, 2 and 3, and is more frequent than usual in the mangrove-pool samples. It resembles the form figured by Heron-Allen and Earland (1915, pl. xlii, figs. 7–9) as *Miliolina cultrata* Brady, striate form, but differs in its rounded periphery.

(128) *Triloculina oblonga* (Montagu).

Vermiculum oblongum Montagu, 1803, Test. Brit., p. 522, pl. 14, fig. 9.

Triloculina oblonga (Montagu). d'Orbigny, 1826, p. 304, no. 16.

Elongate smooth triloculine specimens with rounded periphery, large rounded aperture and narrow simple tooth are referred to this species. They are common in the samples of groups 1, 2 and 3.

(129) *Triloculina quadrata* n. sp.

(Plate III, figs. 13a, b, c.)

Test porcellaneous, 3 chambers visible externally, surface irregularly pitted but shining, ovate in side view, chambers broadly truncate with a rounded keel on each angle, apertural end produced in a short neck, aperture oval with a small simple tooth.

Holotype from sample 25.

Dimensions of holotype: Length 0.90 mm., breadth 0.65 mm., thickness 0.53 mm.

This species is somewhat similar to *T. quadrilateralis* d'Orbigny, but differs in its produced neck and circular aperture. It also resembles *Massilina annetensis* d'Orbigny, from which it differs in being clearly triloculine, and also in the apertural features.

(130) *Triloculina sublineata* (Brady) ?

(Plate III, figs. 14a, b.)

? *Miliolina circularis* Bornemann, var. *sublineata* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 169, pl. iv, figs. 7a–c.

M. circularis Bornemann, var. *sublineata* Brady. Millett, 1898 etc. (1898), p. 501, pl. xi, fig. 4; Heron-Allen and Earland, 1914 etc. (1915), p. 558, pl. xli, figs. 9–11.

All the specimens found were thin-shelled and translucent, with the cribrate aperture figured by Millett. Whether this is the same form as Brady's var. *sublineata* is open to doubt.

Brady's figure shows an arcuate aperture without a tooth, and appearing to be closed by what might be interpreted as a finely cribrate plate (fig. 7c), but his description does not mention this. Heron-Allen and Earland's fig. 11 shows an oval cribrate aperture which may be somewhat conventionalized. The question can only be resolved by the examination of Brady's figured specimens, and is therefore left open.

The species is not uncommon in the samples of groups 1, 2 and 3.

(131) *Triloculina subrotunda* (Montagu).

Vermiculium subrotundum Montagu, 1803, Test. Brit., p. 521.

Triloculina subrotunda Parr, 1950, p. 293 (synonymy).

Typical examples were fairly common in the shallow-water samples of groups 1 and 2.

(132) *Triloculina terquemiana* (Brady).

Miliolina terquemiana Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 166, pl. cxiv, figs. 1a, b.

The degree of striation in this species appears to be variable, also the degree of inflation of the chambers, as noted by Heron-Allen and Earland (1915, p. 563). It is common throughout the samples of groups 1, 2 and 3. Records range from the western Indian Ocean to the Ellice Islands.

(133) *Triloculina transversistriata* (Brady).

Miliolina transversistriata Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 45; 1884, Rep. Voy. Chall., Zool. 9, p. 177, pl. iv, figs. 6a.c.

This well-marked species occurred in small numbers in many of the samples of groups 1 and 2.

(134) *Triloculina tricarinata* d'Orbigny.

Triloculina tricarinata d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 299, no. 7, Modèles no. 94.

Specimens referable to this wide-ranging species were frequent in most of the samples of groups 1, 2 and 3.

Genus *Edentostomina*, n. gen.

Test triloculine or rarely biloculine, compressed, ovate in outline, last 2 chambers added at approximately 180°, periphery sharp or carinate, aperture oval with a thickened rim and no tooth. Genotype *Miliolina cultrata* Brady.

Millett (1898), in describing *Miliolina durrandii*, states "This is one of an interesting group in which the aperture is a large elliptical or fusiform opening without teeth", and includes *M. cultrata* and *M. rupertiana* in this edentate group.

Heron-Allen and Earland, 1914 etc. (1915) group the same species together as the "Group of *M. cultrata* (edentate)". This appears to be a useful natural grouping which should be recognized in nomenclature, the main point of difference from *Triloculina* s. str. being the large oval and edentate aperture. It is considered that *Pyrgo milletti* Cushman, which was originally described as a variety of *Miliolina durrandii*, should also be included in this genus, as its affinities appear to be closer to this group than to any described species of *Pyrgo*.

The species included in this genus appear to be confined to the Indo-Pacific region, where the genus has developed in Recent times.

(135) *Edentostomina cultrata* (Brady).

Miliolina cultrata Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 45; 1884, p. 161, pl. v, figs. 1, 2.

Found in small numbers in many of the samples of group 3.

(136) *Edentostomina durrantii* (Millett).

Miliolina durrantii Millett, 1898, Journ. Roy. Micr. Soc., p. 268, pl. vi, figs. 7-16; Heron-Allen and Earland, 1914 etc. (1915), p. 565, pl. xlii, figs. 11-16.

Not uncommon in the samples of group 3. Practically all the specimens are striate, only the immature tests being smooth, and then having slight striations near the apertural end of the chamber.

(137) *Edentostomina rupertiana* (Brady).

Miliolina rupertiana Brady 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 46; 1884, p. 178, pl. vii, figs. 7-12; Millett, 1898 etc. (1898), p. 269, pl. vi, fig. 13; Heron-Allen and Earland, 1914 etc. (1915), p. 565.

This beautifully decorated species was fairly common in the samples of group 3, some very large specimens being found.

(138) *Edentostomina milletti* (Cushman).

Miliolina durrantii Millett (part), 1898, Journ. Roy. Micr. Soc., p. 268, pl. vi, figs. 8-10 (not 7).

Biloculina milletti Cushman, 1910 etc. (1917), U.S. Nat. Mus. Bull. 71, 4, p. 479.

Pyrgo milletti (Cushman). Cushman, 1918 etc. (1929), p. 68, pl. 19, fig. 1.

Biloculine specimens referable to Cushman's species occurred in the samples of group 3. In their compressed form, keeled edge and oval toothless aperture they resemble other species in this group, in which some specimens occur with the antepenultimate chamber only just visible between the embracing later chambers. The small increase in overlap of the last chamber needed to make the test biloculine instead of triloculine is considered to be of little weight as a character compared with the points of resemblance with other species of the genus, and it is therefore included in *Edentostomina*.

Genus *Pyrgo* Defrance, 1824.(139) *Pyrgo striolata* (Brady).

Biloculina ringens (Lamarck), var. *striolata* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 143, pl. iii, figs. 7, 8.

Occasional specimens were found in samples of all groups, but it was best represented in the deeper-water samples of group 4.

(140) *Pyrgo denticulata* (Brady).

Biloculina ringens (Lamarck), var. *denticulata* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 143, pl. iii, figs. 4, 5.

Pyrgo denticulata (Brady). Cushman, 1918 etc. (1929), p. 69, pl. xviii, figs. 3, 4; Parr, 1950, p. 296.

Occasional specimens were found in the samples of groups 1, 2 and 3, and it was common in sample 53. Specimens without the basal serration occur, as noted by Parr in southern

Australian waters, but these are otherwise inseparable from serrate specimens in the same material.

(141) *Pyrgo subglobulus* Parr.

Pyrgo subglobulus Parr, 1950, B.A.N.Z.A.R. Exped. Rept. V, pt. 6, Foram., p. 298, pl. vii, figs. 10a-c.

Four specimens were found in sample 45. This species was described from off Tasmania.

(142) *Pyrgo depressa* (d'Orbigny).

Biloculina depressa d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 298, no. 7; Modèles no. 91; Brady, 1884, p. 145, pl. ii, figs. 12, 15-17, pl. iii, figs. 1, 2.

Pyrgo depressa (d'Orbigny). Cushman, 1918 etc. (1929), pt. 6, p. 71, pl. 19, figs. 4, 5.

This wide-ranging species occurred fairly frequently in the samples of groups 1, 2 and 3.

Family OPTHALMINIDAE.

Genus *Cornuspira* Schultze, 1854.

(143) *Cornuspira involvens* Reuss.

Operculina involvens Reuss, 1850, Denkschr. d. k. Akad. Wiss. Wien, 1, p. 370, pl. xiv, fig. 20.

Cornuspira involvens Reuss, 1863, Sitzungsab. d. k. Akad. Wiss. Wien, XLVIII, p. 39, pl. i, fig. 2; Brady, 1884, p. 200, pl. xi, figs. 1-3.

Frequent in the finer fractions of the samples of groups 1, 2 and 3. Specimens were invariably small, not more than 0.25 mm. in diameter, with 4 to 5 convolutions.

Genus *Cornuspirella* Cushman, 1928.

(144) *Cornuspirella diffusa* (Heron-Allen and Earland).

(Plate III, fig. 16.)

Cornuspira diffusa Heron-Allen and Earland, 1913, Journ. Roy. Micr. Soc., pp. 272-276, pl. 12; Earland, 1933, p. 51, pl. 1, figs. 5-7; 1934, p. 52.

Cornuspirella diffusa (Heron-Allen and Earland). Cushman, 1928a, p. 4, pl. 1, fig. 14.

Two fragments of tests, from samples 24 and 25 respectively, are referable to this widely-distributed species, which was described from the eastern North Atlantic and is recorded also from the Antarctic. The occurrence is noteworthy, since records are generally from cold-water areas.

Genus *Nodophthalmidium* MacFadyen, 1939.

(145) *Nodophthalmidium simplex* Cushman and Todd.

Nodophthalmidium simplex Cushman and Todd, 1944, Contrib. Cushman Lab. Foram. Research, 20, pt. 3, p. 67, pl. 11, fig. 8.

Five specimens from sample 45, lacking initial chambers, are referable to this species. One has 4 elongate-pyriform chambers and reaches a length of 1.1 mm.

(146) *Nodophthalmidium gracilis* n. sp.

(Plate III, fig. 15.)

Articulina conico-articulata Millett 1898 (not of Batsch), Journ. Roy. Micr. Soc., p. 511, pl. xii, figs. 9, 10a-c.

Test elongate, slightly curved, circular in cross-section, early portion consisting of a spherical proloculus and a short planispiral tube of less than one whorl in length, merging

into a rectilinear series of long slender chambers, widest just above the suture and tapering to the oral end, wall ornamented by 8-10 high sharp costae, in some specimens terminated by a basal spine, aperture terminal, round, with an everted lip.

Holotype from sample 45.

Dimensions of holotype: Length 0.75 mm., breadth 0.12 mm.

This is the species figured by Millett and later referred by Cushman to his *N. milletti*, described from Fiji. It differs from the latter species in the consistently longer and more slender chambers with fewer costae. Common in sample 45 and occasional in the samples of group 3.

Genus *Nodobaculariella* Cushman and Todd.

(147) *Nodobaculariella rustica* Cushman and Todd.

Nodobaculariella rustica Cushman and Todd, 1944, Contrib. Cushman Lab. Foram. Research, 20, pt. 3, p. 73, pl. 12, figs. 4, 5.

This species, described from the Phillippines and recorded also from the Paumotus, was rare in sample 26.

Genus *Vertebralina* d'Orbigny, 1826.

(148) *Vertebralina striata* d'Orbigny.

Vertebralina striata d'Orbigny, 1826, Ann. Sci. Nat. XII, p. 283; Modèles no. 81.

This widely-distributed species was not uncommon in the samples of group 3.

Genus *Ophthalmidium* Zwingli and Kubler, 1870.

(149) *Ophthalmidium inconstans* (Brady).

Hauerina inconstans Brady, 1879 etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 54.

Ophthalmidium inconstans (Brady). Brady, 1884, p. 189, pl. xii, figs. 5, 7, 8.

One large winged specimen was found in sample 45.

(150) *Ophthalmidium circularis* (Chapman), *tropicalis* n. subsp.

(Plate IV, figs. 1a, b.)

Test subcircular, commencing with a proloculus and a short spiral tube, then becoming septate and irregularly spiroloculine. Chambers narrow and deep, connected to the chambers of earlier whorls by a thin plate which is discontinuous, being broken by gaps along the line of attachment to earlier whorls. Periphery slightly concave, chambers irregular in outline, apertural end tapering to a small round aperture at the end of a long neck.

Holotype from sample 45.

Dimensions of holotype: Diameter 0.25 mm., thickness 0.10 mm.

This subspecies differs from *O. circularis circularis* (Chapman, 1915, p. 7, pl. 1, fig. 1; 1941, p. 186) in the more angular and irregular outline of the later chambers and in the discontinuity of the plate connecting successive whorls. Young specimens are hardly separable from Chapman's species, but the adult test is quite distinctive. Eleven specimens were found, all in sample 45.

Genus *Polysegmentina* Cushman, 1946.

(151) *Polysegmentina circinata* (Brady).

Hauerina circinata Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 17 ; 1884, p. 191, pl. xi, figs. 14-16.

Polysegmentina circinata (Brady). Cushman, 1946, p. 1, pl. 1, figs. 1-4 (synonymy).

This species was common in the shallow-water samples, particularly in those of group 3. It is a characteristic species of the muddy coastal waters of North Queensland.

Genus *Planispirinella* Wiesner, 1931.

(152) *Planispirinella exigua* (Brady).

Planispirina exigua Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 196, pl. xii, figs. 1-4, text-figs. 5, 6.

Planispirinella exigua (Brady). Wiesner, 1931, p. 69.

Common in the samples of groups 3 and 4.

(153) *Planispirinella involuta* n. sp.

(Plate IV, figs. 2a, b.)

Test porcellaneous, planispiral, with 3 chambers making up the last whorl, compressed and discoidal, thickest at the centre, involute. Sutures radial, straight, recurved near periphery, very slightly depressed. Chambers commence with a proloculus followed by a spiral tube of 2-3 whorls, then becoming septate with 3 chambers to the whorl. The chambers are tubular and peripheral, but have alar extensions reaching to the centre of the test and covering the earlier whorls ; the hollow tubular portion of the last 3 chambers appears as a semi-translucent border. The aperture is oblique to the periphery and consists of the open end of the tubular chamber.

Holotype from sample 45.

Dimensions of holotype : Diameter 0.41 mm., thickness 0.09 mm.

This species is distinct from *P. exigua* (Brady) which occurs in the same material, the difference lying in the more circular outline and the involute character of the later chambers. Four specimens were found in sample 45 only.

Genus *Wiesnerella* Cushman, 1933.

(154) *Wiesnerella auriculata* (Egger).

Planispirina auriculata Egger, 1893, Abhandl. kön. bay. Akad. Wiss. Munchen, cl. ii, 18, Abt. 2, p. 245, pl. iii, figs. 13, 15 ; Heron-Allen and Earland, 1914 etc. (1915), p. 590, pl. xlvi, figs. 3-7.

Ophthalmidium cornu Chapman, 1901, p. 408, pl. 36, fig. 1.

Wiesnerella auriculata (Egger). Cushman, 1933, p. 33.

Not uncommon in the samples of groups 1, 2 and 3. Chapman's species from Funafuti is apparently the same as Egger's earlier-described form. A closely allied species is found in the Miocene clays of Batesford, Victoria.

Genus *Nubecularia* Defrance, 1825.

(155) *Nubecularia decorata* Heron-Allen and Earland.

Nubecularia lucifuga Defrance, var. *decorata* Heron-Allen and Earland, 1914 etc. (1915), Trans. Zool. Soc. London, 20, pt. 17, p. 549, pl. xl, figs. 6, 7.

A small form occurring attached to shell fragments in sample 2 is referred to the above species, though the surface appears to be granular rather than pustulate. The invariably rectilinear growth of this species is sufficient to separate it from *N. lucifuga*, which occurs commonly in the coastal waters of southern Australia.

Genus *Nubeculopsis* n. gen.

Test porcellaneous, adherent, chambers low-domed, commencing with a proloculus followed by 2 reniform chambers each taking up nearly half a whorl, continuing with a series of arcuate chambers in a spiral which may reverse its direction after the first 3 or 4 chambers, becoming irregularly uniserial or with tubular chambers piled above the earlier spiral series. Aperture in the early chambers a simple opening at the distal end of the chambers, in the later tubular chambers a flaring lipped opening of the full width of the chamber.

This genus differs from *Nubecularia* in being septate throughout, without any cornu-spirine spiral tube.

(156) *Nubeculopsis queenslandica* n. sp.

(Plate IV, figs. 3a, b, c.)

Species with the characters of the genus.

Holotype from sample 40, at which the species is rare.

Dimensions of holotype: Greatest diameter 0.82 mm.

Genus *Parrina* Cushman, 1931.

(157) *Parrina bradyi* (Millett).

Nubecularia inflata Brady 1884 (not of Terquem), p. 135, pl. i, figs. 5-8.

N. bradyi Millett, 1898, Journ. Roy. Micr. Soc., p. 261, pl. v, figs. 6a, b.

Parrina bradyi (Millett). Cushman, 1931, p. 20.

Not uncommon in the samples of groups 1, 2 and 3.

Family PENEROPLIDAE.

Genus *Peneroplis* Montfort, 1808.

(158) *Peneroplis planatus* (Fichtel and Moll).

Nautilus planatus, var. β , Fichtel and Moll, 1798, Test. Micr., p. 91, pl. xvi, figs. 1d, e, f.

Peneroplis planatus (Fichtel and Moll). d'Orbigny, 1826, p. 285, no. 1; Modèles no. 16.

Common in the samples of groups 1, 2 and 3. This species is widely distributed on the Australian coast, except for the cooler waters of Bass Strait.

(159) *Peneroplis pertusus* (Forskål).

Nautilus pertusus Forskål, 1775, Descr. Anim., p. 125, no. 65.

Peneroplis pertusus (Forskål). Jones, Parker and Brady, 1865, p. 19.

Present in most of the samples of groups 1, 2 and 3, but not so common as *P. planatus*.

(160) *Peneroplis arietinus* (Batsch).

Nautilus (Lituus) arietinus Batsch, 1791, Conch. Seesandes, p. 4, pl. vi, fig. 15c.

Peneroplis arietinus (Batsch). Parker, Jones and Brady, 1865, p. 26, pl. 1, fig. 18.

Well-grown specimens were fairly common in the samples of group 3.

Genus *Spirolina* Lamarck, 1804.(161) *Spirolina cylindraceus* Lamarck.

Spirolina (Spirolinites) cylindraceus Lamarck, 1804, Ann. Mus. V, p. 245, No. 2.

Fine specimens were found in the samples of group 3, with as many as 18 chambers in the rectilinear portion. Occasional specimens occurred in the samples of groups 1 and 2.

Genus *Monalysidium* Chapman, 1900.(162) *Monalysidium politum* Chapman.

Peneroplis (Monalysidium) polita Chapman, 1900, Journ. Linn. Soc., Zool. 28, p. 4, pl. 1, fig. 5.

Monalysidium polita Chapman. Heron-Allen and Earland, 1914 etc. (1915), p. 603, text-fig. 43g.

Occasional specimens were found in the samples of groups 1, 2 and 3. Specimens with as many as 10 chambers were found, but in each case the earliest chamber was exactly the same as the rest, and perforated at the base.

Genus *Sorites* Ehrenberg, 1839.(163) *Sorites marginalis* (Lamarck).

Orbulites marginalis Lamarck, 1816, Hist Nat. Anim. sans Vert. II, p. 196, No. 1.

Sorites marginalis (Lamarck). Cushman, 1918 etc. (1930), p. 49, pl. 18, Figs. 1-4.

Rather rare in the samples of group 3. Specimens up to 3.9 mm. in diameter were found. A few juvenile specimens were present in the deeper-water sample 45.

Genus *Amphisorus* Ehrenberg, 1840.(164) *Amphisorus duplex* (Carpenter).

Orbitolites duplex Carpenter, 1883, Zool. Chall. Exped., pt. XXI, p. 25, pl. iii, figs. 8-14; pl. iv, figs. 6-10; pl. v, figs. 1-13; Brady, 1884, p. 216, pl. xiv, fig. 7.

Amphisorus duplex (Carpenter). Said, 1949, p. 25, pl. 3, fig. 1.

This species, recently re-established by Said for forms which differ from the genotype (*A. hemprichii* Ehrenberg) in being thinner, with rounded periphery and oval chambers, is usually present in small numbers together with *Marginopora vertebralis* (*vide infra*) in the samples of groups 1, 2 and 3. The record by the author of *A. hemprichii* from the Pleistocene of western Victoria (Collins, 1953) was erroneous, and should refer to the present

species. It has, however, not been recorded from southern Australian waters, and its southward limit in the coastal waters of eastern Australia does not appear to have yet been established.

Genus *Marginopora* Blainville, 1830.

(165) *Marginopora vertebralis* Quoy and Gaimard.

Marginopora vertebralis Quoy and Gaimard, 1833, Voy. de Astrolabe, *vide* Blainville 1834, Man. d'Actinologie, p. 412, pl. lxxix, figs. 6a-c; Cushman, 1932 etc. (1933), p. 67, pl. 19, figs. 11, 12.
Orbitolites complanata of authors (not of Lamarck).

This is the commonest large foraminifer of the Barrier Reef islands, forming a major constituent of the beach sands of the region. So well known is it that the tests are dyed in various colours and strung into necklaces for sale to tourists visiting the island resorts.

It is recorded from the Upper Pliocene of Adelaide and the Pleistocene of York Peninsula, South Australia. Chapman and Parr have recorded it in the Recent state from the Great Australian Bight, but it does not occur in the cooler waters of the south-east coast. Its southward limits on the east coast do not appear to have been determined. Specimens in the present material range up to 2.2 cm. in diameter (sample 31) but the usual shore-sand specimens rarely reach more than 1 cm.

Family ALVEOLINIDAE.

Genus *Alveolinella* H. Douvillé, 1906.

(166) *Alveolinella quoyi* (d'Orbigny).

Alveolina quoyi d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 306, pl. 17, figs. 11, 13.
Alveolinella quoyi (d'Orbigny). Douvillé, 1906, p. 585.
Alveolina boscii of authors (not of DeFrance).

Both the megalospheric and microspheric forms were found in the samples of group 3, the former being much more common. It was not usually present in the beach sands, possibly because its elongate shape resists transportation by waves and currents to a greater degree than the discoidal forms which are predominant in the coarser fractions of these samples. Occasional juvenile specimens were found in the deeper-water samples of group 4, where local currents had probably transported them in the embryonic stage.

Family FISCHERINIDAE.

Genus *Fischerina* Terquem, 1878.

(167) *Fischerina pellucida* Millett.

(Plate IV, fig. 4.)

Fischerina pellucida Millett, 1898, Journ. Roy. Micr. Soc., p. 611, pl. xiii, figs. 14, 15.

Two specimens were found in sample 45. One has the shell wall finely pitted and may be distinct.

Superfamily LAGENIDEA.

Family LAGENIDAE.

Genus *Lagena* Walker and Jacob, 1798.(168) *Lagena ampulla-distoma* Rymer Jones.

Lagena vulgaris Williamson, var. *ampulla-distoma* Rymer Jones, 1872, Trans. Linn. Soc., London, XXX, p. 63, pl. xix, fig. 52.

Rare, one specimen from sample 44.

(169) *Lagena auriculata* Brady ?

? *Lagena auriculata* Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 61 ; 1884, p. 487, pl. lx, figs. 29, 31, 33.

L. auriculata Brady. Sidebottom, 1912, p. 420, pl. 20, figs. 13, 14.

One specimen of the variety illustrated by Sidebottom in figs. 13 and 14 was found. This variety has very little in common with Brady's fig. 29, which, as the first illustrated, must presumably be taken as the type of *L. auriculata*. It appears to be closer to *L. formosa* Schwager, from which it differs only in the splitting of the single keel to form a loop-shaped double keel.

(170) *Lagena chasteri* Millett.

Lagena chasteri Millett, 1901, Journ. Roy. Micr. Soc., p. 11, pl. 1, fig. 11.

Typical specimens were found in sample 23.

(171) *Lagena elongata* (Ehrenberg).

Miliola elongata Ehrenberg, 1854, Mikrogeologie, pl. xxv, fig. 1.

Lagena elongata (Ehrenberg). Brady, 1884, p. 457, pl. lvi, fig. 29.

This elongate, parallel-sided species was frequent in the finer fractions of the shallow-water samples of groups 1, 2 and 3.

(172) *L. gracillima* (Seguenza).

Amphorina gracillima Seguenza, 1862, Foram. Monotal. Messina, p. 51, pl. 1, fig. 31.

Lagena gracillima (Seguenza). Jones, Parker and Brady, 1866, p. 45, pl. 1, figs. 36, 37.

Fusiform specimens, widest at the middle and tapering conically toward the extremities and having a phialine neck and lip, are referred to this species. They were common in the samples of groups 1, 2 and 3.

(173) *Lagena laevis* (Montagu).

Vermiculum laeve Montagu, 1803, Test. Brit., p. 524.

Lagena laevis (Montagu). Williamson, 1848, p. 12, pl. 1, figs. 1, 2.

Smooth bottle-shaped specimens with rounded base and phialine neck and lip are referred to this species. They were occasional in the samples of group 3.

(174) *Lagena pacifica* Sidebottom.

Lagena pacifica Sidebottom, 1912, Journ. Quekett Micr. Club, II, p. 398, pl. 16, fig. 29.

One specimen identical with Sidebottom's figure was found in sample 45.

(175) *Lagena perlucida* (Montagu).

Vermiculum perlucidum Montagu, 1803, Test. Brit., p. 525, pl. 14, fig. 3.

Lagena perlucida (Montagu). Cushman and McCulloch, 1950, p. 342, pl. 46, figs. 1, 2 (synonymy).

Common in samples of groups 1, 2 and 3.

(176) *Lagena spiralis* Brady.

Lagena spiralis Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 468, pl. cxiv, fig. 9.

L. striato-punctata Parker and Jones, var. *spiralis* Brady. Millett, 1898 etc. (1901), p. 489, pl. viii, fig. 7 ;
Cushman and McCulloch, 1950, p. 353, pl. 47, figs. 17, 18 (synonymy).

Occasional specimens were found in the samples of group 3. Quite similar specimens are found in the Miocene of Victoria, and the consistent variation of this form from *L. striato-punctata* s. str. over a long period of time appears to justify its specific rank as originally described by Brady.

(177) *Lagena striato-punctata* Parker and Jones.

Lagena striata (d'Orbigny), var. *striato-punctata* Parker and Jones, 1865, Phil. Trans. CLV, p. 350, pl. xiii, figs. 25-27.

L. striato-punctata Parker and Jones. Brady, 1884, p. 468, pl. lviii, figs. 37, 40.

Rare in sample 45 (one specimen).

(178) *Lagena striata* (d'Orbigny).

Oolina striata d'Orbigny, 1839, Foram. Amer. Merid., p. 21, pl. v, fig. 12.

Lagena striata (d'Orbigny). Brady, 1884, p. 460, pl. lvii, figs. 22, 24, 28, 29 etc.

Flask-shaped, finely-striate specimens with an apiculate base and a produced annulate neck have been referred to this species. This is perhaps the commonest species of the genus in the samples of groups 1, 2 and 3.

(179) *Lagena sulcata* Walker and Jacob.

Serpula (Lagena) sulcata Walker and Jacob, 1798, Adams' Essays, Kanmacher's Edn., p. 634, pl. xiv, fig. 5.

Flask-shaped specimens with bold costae set widely apart have been referred to this species. They are common in samples of all groups.

Genus *Oolina* d'Orbigny, 1839.(180) *Oolina hexagona* (Williamson).

Entosolenia squamosa (Montague) var. *hexagona* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, p. 20, pl. ii, fig. 23.

Oolina hexagona (Williamson). Parr, 1950, p. 304.

Rare in sample 45.

(181) *Oolina pseudocatenulata* (Chapman and Parr).

Lagena pseudocatenulata Chapman and Parr, 1937, Aust. Antarctic Exped. 1911-14, 1, pt. 2, 332, pl. vi, figs. 75, 76.

Oolina pseudocatenulata (Chapman and Parr). Parr, 1950, p. 301, pl. viii, fig. 5.

Common in sample 45. This species was described from the Antarctic.

(182) *Oolina squamosa* (Montagu).

Vermiculum squamosum Montagu, 1803, Test. Brit., p. 526, pl. xiv, fig. 2.

Oolina squamosa (Montagu). Parr, 1950, p. 303.

Rare in sample 45.

Genus *Fissurina* Reuss, 1850.

(183) *Fissurina contusa* Parr.

Fissurina contusa Parr, 1945, Proc. Roy. Soc. Victoria, 56, n.s., pt. ii, p. 203, pl. xix, fig. 6.

This is the form recorded by Brady (1884) from Raine Island, as ? *Lagena castrensis* Schwager. One specimen from sample 23 is closely similar to Brady's fig. 3, pl. cx, on which Parr's species was based.

(184) *Fissurina clathrata* (Brady).

Lagena clathrata Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 485, pl. lx, fig. 4.

Fissurina clathrata (Brady). Parr, 1950, p. 310.

Two good examples from sample 45.

(185) *Fissurina formosa brevis* (Brady).

Lagena formosa Schwager, var. *brevis* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 484, pl. cxiv, fig. 10.

One specimen of this beautiful form was found in sample 45. It was described from Raine Island. It is considered here as a subspecies of *F. formosa*, which in the typical form does not occur in this material, but may prove to be a separate species.

(186) *Fissurina lacunata* (Burrows and Holland).

Lagena castrensis Brady (not of Schwager), 1884, Rep. Voy. Chall., Zool. 9, p. 485, pl. lx, figs. 1, 2.

L. lacunata Burrows and Holland, 1895, in Jones, Pal. Soc., vol. for 1895, p. 205, pl. 7, figs. 12a, b.

Fissurina lacunata (Burrows and Holland). Parr, 1945, p. 203.

Specimens similar to Brady's fig. 2, which was drawn from a Raine Island specimen, occur occasionally in the samples of groups 3 and 4. The species ranges as far south as Bass Strait. In sample 45 there were several examples of the form in which the surface pitting is replaced by a delicate hexagonal network merging into costae, *vide* Cushman 1932 etc. (1933), p. 27, pl. 7, figs. 2, 3, 4 and 5. Insufficient material was available to confirm Cushman's opinion that this form intergrades with the typical pitted form.

(187) *Fissurina lagenoides* (Williamson).

Entosolenia marginata Walker and Boys, var. *lagenoides* Williamson, 1858, Rec. Foram. Gt. Brit., p. 11, pl. i, figs. 25, 26.

Lagena lagenoides (Williamson). Brady, 1884, p. 479, pl. lx, figs. 6, 7, 9 and 12.

Fissurina lagenoides (Williamson). Parr, 1947, p. 122.

Rare in sample 29 (1 specimen).

(188) *Fissurina sublagenoides* (Cushman).

Lagena lagenoides (Williamson). Brady, 1884, Rep. Voy. Chall., Zool. 9, (pars), pl. lx, figs. 13, 14.
L. sublagenoides Cushman, 1910 etc. (1913), U.S. Nat. Mus. Bull. 71, pt. 3, p. 40, pl. 16, fig. 4.

Occasional specimens were found in samples of groups 3 and 4.

(189) *Fissurina lucida* (Williamson).

Entosolenia marginata Walker and Boys var. *lucida* Williamson, 1858, Rec. Foram. Gt. Brit., p. 10, pl. 1, figs. 22, 23.

Lagena lucida (Williamson). Sidebottom, 1904 etc. (1906), p. 6, pl. i, figs. 9.12.

Common in the finer fractions of samples of groups 1, 2 and 3. Specimens are of the type illustrated by Sidebottom's figs. 10a, b.

(190) *Fissurina marginato-perforata* (Seguenza).

Lagena marginato-perforata Seguenza, 1880, Atti. Accad. Lincei, ser. 3, 6, p. 332, pl. 17, fig. 34; Cushman, 1932 etc. (1933), p. 19, pl. 5, figs. 1a, b, pl. 6, figs. 1a, b, pl. 4, figs. 13a, b.

Frequent in samples of all groups.

(191) *Fissurina orbignyana* Seguenza.

Fissurina orbignyana Seguenza, 1862, Foram. Monotal. Messina, p. 66, pl. ii, figs. 25, 26.

Not uncommon and generally distributed in all groups.

(192) *Fissurina walleriana* (Wright).

Lagena orbignyana (Seguenza) var. *walleriana* Wright, 1886, Proc. Roy. Irish Acad., ser. 2, 4, p. 611.

Rare in sample 45 (2 specimens).

(193) *Fissurina radiato-marginata* (Parker and Jones).

Lagena radiato-marginata Parker and Jones, 1865, Phil. Trans. CLV, p. 355, pl. xviii, figs. 3a, b.

One example of this species was found in sample 45.

(194) *Fissurina semistriata* (Uchio).

Entosolenia semistriata Uchio, 1950, Assoc. Petr. Technol. Journ. (Tokyo).

A compressed, pyriform, keeled *Fissurina* with 6 or more fine costae curving up from the base for about one-third the height of the test is referred to this species, which was described from the Upper Pliocene of Japan. The generic name *Entosolenia* was shown by Parr (1945, p. 119) to be a synonym of d'Orbigny's *Oolina*. Rare in sample 45.

(195) *Fissurina staphyllearia* Schwager.

Fissurina staphyllearia Schwager, 1866, Novara-Exped., Geol. Theil. 2, p. 209, pl. 5, fig. 24.

Three typical specimens from sample 45.

(196) *Fissurina wrightiana* (Brady).

Lagena wrightiana Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, n.s., p. 62; 1884, p. 482, pl. lxi, figs. 6, 7.

Rare in sample 32.

(197) *Fissurina varioperforata* (Buchner).

Lagena varioperforata Buchner, 1940, Nova Acta Leop. 9, 62, p. 494, pl. 18, figs. 353-358.

This species is characterized by the coarse tubulation of the wall, leaving a narrow elliptical area of clear shell-wall in the centre of the test, through which can be seen a straight entosolenian tube extending about half-way down the test. Specimens from sample 45 appear to fall within the limits of variation illustrated by Buchner. The type was from the Mediterranean.

Genus *Parafissurina* Parr, 1945.(198) *Parafissurina unguis* (Heron-Allen and Earland).

Lagena unguis Heron-Allen and Earland, 1913a, Proc. Roy. Irish Acad. 31, p. 86, pl. 7, figs. 1-3.

One specimen of this wide-ranging but rare species was found in sample 45.

Genus *Nodosaria* Lamarck, 1812.(199) *Nodosaria calomorpha* Reuss.

Nodosaria calomorpha Reuss, 1865, Denschr. d. k. Akad. Wiss. Wien. XXV, p. 129, pl. 1, figs. 15-19.

Eight specimens of this small but distinctive species were found in sample 45.

(200) *Nodosaria proxima* Silvestri.

Nodosaria proxima Silvestri, 1872, Nodos. Foss. e Viv. d'Ital., p. 63, pl. vi, figs. 138-147.

Two-chambered nodosarians with 8-10 costae occur rarely in the samples of groups 3 and 4, and are referred to this species, which was recorded from Raine Island by Brady.

(201) *Nodosaria pyrula* d'Orbigny.

Nodosaria pyrula d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 253, no. 13.

Eight specimens were found in sample 45. Several show the elongate fusiform initial chamber which is usually missing from the fragile test of this species.

Genus *Dentalina* d'Orbigny, 1826.(202) *Dentalina antarctica* Parr.

Dentalina antarctica Parr, 1950, B.A.N.Z.A.R. Exped. Rep. V, pt. 6, p. 320, pl. xi, figs. 26, 27.

One specimen from sample 45 is very close to the megalospheric specimen illustrated by Parr (fig. 27).

(203) *Dentalina californica* Cushman and Gray.

Dentalina californica Cushman and Gray, 1946, Contrib. Cushman Lab. Foram. Res. 22, pt. 2, p. 66, pl. 12, figs. 3-5.

A slender form with oblique chambers and a long acuminate proloculus is referred to this species, described from the Pliocene of Timms Point, California. Rare in sample 45.

(204) *Dentalina inflexa* (Reuss).

Nodosaria inflexa Reuss, 1865, Denkschr. d. k. Akad. Wiss. Wien, XXV, p. 131, pl. ii, fig. 1; Brady, 1884, p. 498, pl. lxii, fig. 9.

Two specimens from sample 45 having elongate pyriform chambers but lacking a connecting neck between the chambers appear to be referable to this species.

Genus *Vaginulina* d'Orbigny, 1826.(205) *Vaginulina bassensis* Parr.

Vaginulina bassensis Parr, 1945, Proc. Roy. Soc. Victoria, 56, n.s., pt. 2, p. 200, pl. 12, figs. 4a, b.

One specimen was found in sample 45, comparing well with specimens from the type locality on the shores of Bass Strait.

Genus *Marginulina* d'Orbigny, 1826.(206) *Marginulina glabra* d'Orbigny.

Marginulina glabra d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 259, no. 6, Modèles no. 55.

Rare in sample 45 (2 specimens).

Genus *Amphicoryne* Schlumberger, 1881.(207) *Amphicoryne scalaris* (Batsch).

Nautilus (Orthoceras) scalaris Batsch, 1791, Conchyl. Seesandes, No. 4, pl. ii, figs. 4a, b.
Nodosaria scalaris (Batsch). Brady, 1884, p. 510, pl. lxiii, figs. 28-31.

Eight specimens were found in sample 45, all megalospheric. The writer has followed Parr (1950) in referring this species to the genus *Amphicoryne*. One specimen had the final chamber separated from the earlier ones by the full length of the apertural neck, a condition rather similar to Brady's variety *separans*, in which, however, the final chamber commences at the base of the apertural neck of the penultimate chamber. Such forms occur, in the writer's experience, in any large series of specimens of *A. scalaris*, and therefore represent an individual modification rather than a geographical variety or subspecies, as suggested by Brady.

(208) *Amphicoryne hirsuta* (d'Orbigny).

Nodosaria hirsuta d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 252, no. 7.
Amphicoryne hirsuta (d'Orbigny). Parr, 1950, p. 328.

Two specimens were found in sample 45, both megalospheric.

Genus *Planularia* DeFrance, 1824.(208) *Planularia* sp. aff. *P. tricarinella* (Reuss).

Cristellaria tricarinella Reuss. Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 540, pl. lxviii, figs. 3 and 4.

One specimen from sample 45. This form has 17 chambers after the proloculus, and its dorsal edge is tricarinate as figured by Brady. It is not referable to *P. australis* Chapman (1941), which has fewer chambers and a rounded periphery.

Genus *Lenticulina* Lamarck, 1804.

(210) *Lenticulina iota* (Cushman).

Cristellaria iota Cushman, 1918 etc. (1923), U.S. Nat. Mus. Bull. **104**, pt. 4, p. 111, pl. xxix, fig. 2, pl. xxx, fig. 1.
Lenticulina iota (Cushman). Parr, 1950, p. 320.

Specimens are not uncommon in sample 45. As noted by Parr in the case of a Tasmanian specimen, the chambers are rather more recurved than in Cushman's figures.

(211) *Lenticulina peregrina* (Schwager).

Cristellaria peregrina Schwager, 1866, Novara-Exped., Geol. Theil., p. 245, pl. vii, fig. 89.
Lenticulina peregrina (Schwager). Parr, 1950, p. 321.

Three good examples were found in sample 45.

Subgenus *Robulus* Montfort, 1808.

(212) *Lenticulina (Robulus) altifrons* Parr.

Cristellaria acutiauricularis Brady (not of Fichtel and Moll), 1884, Rep. Voy. Chall., Zool. **9**, p. 543, pl. cxiv, fig. 17.
Lenticulina (Robulus) altifrons Parr, 1950, B.A.N.Z.A.R. Exped. Rep. V, pt. 6, p. 323, pl. xi, figs. 12a, b.

Five small specimens were found in sample 45. Brady's figured specimen was from Raine Island, and Parr records the species from off Tasmania.

(213) *Lenticulina (Robulus) sp. cf. cultratus* Montfort.

cf. *Robulus cultratus* Montfort 1808, Conchyl. Syst. **1**, p. 214, 54e genre; Cushman and McCulloch, 1950, p. 296, pl. 37, figs. 7, 8.

Specimens close to those figured by Cushman and McCulloch from the Western Pacific were common in sample 45.

(214) *Lenticulina (Robulus) formosus* (Cushman).

Cristellaria formosa Cushman, 1918 etc. (1923), U.S. Nat. Mus. Bull. **104**, pt. 4, p. 110, pl. xxix, fig. 1, pl. xxx, fig. 6.

One large specimen of this well-marked species was found in sample 45.

(215) *Lenticulina (Robulus) vortex* (Fichtel and Moll).

Nautilus vortex Fichtel and Moll, 1803, Test. Micr., p. 33, pl. ii, figs. d.i.

Cristellaria vortex (Fichtel and Moll) of authors.

Robulus vortex (Fichtel and Moll). Cushman, 1932 etc. (1933), p. 6, pl. 2, figs. 1a, b.

One large specimen from sample 30, with strongly recurved, narrow chambers and limbate sutures is referred to this species.

Family POLYMORPHINIDAE.

Genus *Guttulina* d'Orbigny, 1839.

(216) *Guttulina regina* (Brady, Parker and Jones).

Polymorphina regina Brady, Parker and Jones, 1871, Trans. Linn. Soc. **27**, p. 241, pl. 41, figs. 32a, b.
Guttulina regina (Brady, Parker and Jones). Cushman and Ozawa, 1930, p. 34, pl. 6, figs. 1 and 2.

Two juvenile specimens from sample 45 are referable to this well-marked species, which is widely distributed in Australian waters.

Genus *Globulotuba* n. gen.

Test hyaline, perforate, circular in cross-section. "triloculine" in chamber arrangement, later chambers successively further removed from the base, aperture radiate with internal, free, entosolenian tube curved back toward but not directly connected with the aperture of the preceding chamber.

Genotype *Globulotuba entosoleniformis* n. sp.

This genus is erected for the reception of species having the general arrangement of *Globulina* d'Orbigny, but having a free internal entosolenian tube. It is basically different from *Siphoglobulina* Parr in that the "siphon" in the latter genus is within the wall and opens to the exterior at its proximal end. The existence of an entosolenian tube has been considered to be a character of generic value in the Lagenae (*vide* Parr, 1947), and has also been made the distinguishing feature of the polymorphine genus *Laryngosigma* Loeblich and Tappan.

(217) *Globulotuba entosoleniformis* n. sp.

(Plate IV, figs. 5a, b.)

Species with the characters of the genus.

Holotype from sample 45.

Dimensions of holotype: Length 0.36 mm., diameter 0.22 mm.

Rare in sample 45. The specimens show the feature described by Sidebottom in his Delos paper, in the absorption of the septal faces of earlier chambers, leaving the interior of the test as one clear space, the earlier chambers being marked only by their sutural junctions.

Genus *Pyrulina* d'Orbigny.

(218) *Pyrulina extensa* (Cushman).

Polymorphina longicollis Brady (not of Karrer), 1884, Rep. Voy. Chall., Zool. 9, p. 572, pl. lxxiii, figs. 18 and 19.

P. extensa Cushman, 1910 etc. (1913), U.S. Nat. Mus. Bull. 71, p. 90, pl. 41, figs. 1-3.

Pyrulina extensa (Cushman). Cushman and Ozawa, 1930, p. 53, pl. 12, figs. 5a-c.

One specimen of this deep-water species was found in sample 45.

Genus *Glandulina* d'Orbigny.

(219) *Glandulina laevigata* d'Orbigny.

Nodosaria (*Glandulina*) *laevigata* d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 252, no. 1, pl. 10, figs. 1-3.

This smooth form occurs in the samples of group 3 and is rather more common than other species of the genus. Both microspheric and megalospheric specimens were present.

(220) *Glandulina semistriata* n. sp.

(Plate IV, figs. 6a, b.)

Test fusiform, oral end bluntly rounded with a radiate aperture, apical end sharply pointed and surrounded by a very few small spines, surface finely striate except near the aperture, where it is smooth. The microspheric form (fig. 6) has 2 pairs of biserial chambers following the proloculus, then 2 uniserial, embracing chambers. The megalospheric form has a large proloculus followed by 3 uniserial embracing chambers.

Holotype from sample 23.

Dimensions of holotype: Length 0.34 mm., diameter 0.20 mm.

The megalospheric form of this species is very close to Batsch's fig. 2c of *Nautilus* (*Orthoceras*) *comatus* (1791, pl. 1), which has been identified by Cushman as *Pseudoglandulina glans* d'Orbigny, but the presence of the microspheric form establishes the species as a true *Glandulina*. Millett's figure of *Nodosaria* (*Glandulina*) *comata* (Batsch), (1898 etc. (1902), pl. xi, fig. 2), is also referable to this species.

(221) *Glandulina echinata* Millett.

Nodosaria (*Glandulina*) *echinata* Millett, 1898 etc. (1902), Journ. Roy. Micr. Soc., p. 512, pl. xi, figs. 4a, b.

Two specimens from sample 23 and one from 45 agree with Millett's figure in being ovate-fusiform with a short-lipped apertural neck and a development of short spines over the surface. An entosolenian tube is attached to the wall of the test from the aperture about half-way to the aboral end.

Millett does not indicate the nature of the early chambers in his species, but they are definitely biserial in the present specimens. While, therefore, the identification with Millett's species cannot be absolutely certain, it is considered to be likely, since the importance of the arrangement of the early chambers separating the nodosarian *Glandulinas* (= *Pseudoglandulina* Cushman) from the polymorphine (= *Glandulina* s. str.) was not then recognized.

Genus *Sigmomorphina* Cushman and Ozawa, 1928.(222) *Sigmomorphina terquemiana* (Fornasini).

Polymorphina amygdaloides Reuss var. *terquemiana* Fornasini, 1902, Mem. Accad. Istut. Sci. Bologna, ser. 5, 9, p. 72, text-fig. 25.

Sigmomorphina semitecta (Reuss) var. *terquemiana* (Fornasini). Cushman and Ozawa, 1930, p. 129, pl. 33, figs. 4, 5. pl. 34, figs. 2, 3, pl. 35, fig. 1; Cushman, 1932 etc. (1933), p. 40, pl. 9, figs. 6-9.

Two specimens from sample 45 are referable to this species, which has been recorded as Recent from the Mediterranean and the tropical Pacific. Since it has apparently been differentiated from *S. semitecta* s. str. since the Eocene, it appears best to treat it as a related but distinct species.

Genus *Laryngosigma* Loeblich and Tappan.(223) *Laryngosigma williamsoni* (Terquem).

Polymorphina williamsoni Terquem, 1878, Mém. Soc. Géol. France, ser. 3, 1, p. 37.

Sigmomorphina williamsoni (Terquem). Cushman and Ozawa, 1930, p. 138, pl. 38, figs. 3, 4.

Laryngosigma williamsoni (Terquem). Loeblich and Tappan, 1953, p. 84, pl. 16, fig. 1.

Specimens from sample 45 are somewhat smaller but otherwise closely similar to specimens from the coast of England with which they were compared. The

entosolenian tube distinguishing this genus from *Sigmomorphina* is clearly evident in these specimens.

Superfamily BULIMINIDEA.

Family BULIMINIDAE.

Subfamily TURRILININAE.

Genus *Buliminella* Cushman, 1911.

(224) *Buliminella* sp. cf. *parallela* Cushman and Parker.

Bulimina elegantissima Millett (not of d'Orbigny), 1898 etc. (1900), Journ. Roy. Micr. Soc., p. 276, pl. 2, fig. 4.

cf. *Buliminella parallela* Cushman and Parker, 1931, Proc. U.S. Nat. Mus. 80, art. 3, p. 13, pl. 3, figs. 15a-c.

A few specimens were found in most of the samples of groups 1, 2 and 3. They were of the type figured by Millett from the Malay Archipelago, questionably identified by Cushman and Parker as referable to their species *B. parallela*, the type of which was from the South Atlantic. The identification is probably correct, as there is sufficient variation in proportions and sutural depression in the Queensland specimens to include both figured specimens.

(225) *Buliminella latissima* n. sp.

(Plate IV, figs. 7a, b, c.)

cf. *Bulimina elegantissima* d'Orbigny var. *compressa* Millett (not *B. compressa* Bailey), 1898 etc. (1900), Journ. Roy. Micr. Soc., p. 277, pl. 2, fig. 5.

Test irregularly ovate in outline, compressed, of 2-3 whorls with 5-6 chambers in the last whorl, chambers narrow with slightly depressed, limbate, sinuate sutures, spiral suture distinct, sutural margin of chambers lobed, aperture semicircular at the base of the flattened semicircular apertural face of the last chamber, with radiating striae.

Holotype from sample 45.

Dimensions of holotype: Length 0.26 mm., breadth 0.16 mm., breadth 0.16 mm., thickness 0.11 mm.

Only two specimens of this form were found, but its compressed form and proportions are so distinctive that it was considered worthy of description as new. Millett's var. *compressa* has many points of resemblance, the main difference being the more regular shape of the chambers and the absence of sutural lobing. Cushman and Parker (1947) have placed Millett's form questionably in the synonymy of *B. parallela*, but the compressed form is a distinctive character, unusual in this genus, which justifies separation. The present specimens would have been referred provisionally to Millett's variety had the name been available for use. In the circumstances it appears best to describe it as a new species.

(226) *Buliminella milletti* Cushman.

Buliminella milletti Cushman, 1933, Contr. Cushman Lab. Foram. Res. 9, pt. 4, p. 78, pl. 8, figs. 5, 6.

Rare in the samples of groups 1, 2 and 3. The species is recorded from many localities in the Indo-Pacific area and also from the West Indies.

(227) *Buliminella spicata* Cushman and Parker.

Buliminella madagascariensis (d'Orbigny) var. *spicata* Cushman and Parker (in Cushman), 1932 etc. (1942), U.S. Nat. Mus. Bull. **161**, pt. 3, p. 8, pl. 3, figs. 5, 6.

Frequent in samples 26 and 45. As this form has a similar geological range and occurs in the same geographical areas as *B. madagascariensis* s. str., it cannot be regarded as a subspecies, and is therefore here considered as a related but distinct species.

Genus *Buliminoides* Cushman, 1911.

(228) *Buliminoides williamsonianus* (Brady).

Bulimina williamsoniana Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. **XXI**, p. 56; 1884, p. 408, pl. li, figs. 16, 17.

Buliminoides williamsonianus (Brady). Cushman, 1910 etc. (1911), U.S. Nat. Mus. Bull. **71**, pt. 2, p. 90, text-fig. 144.

This species is well distributed and common in the warmer waters of the Australian region, and is recorded by Parr (1945) from Bass Strait. Occasional in the samples of groups 1, 2 and 3.

Genus *Ungulatella* Cushman, 1931.

(229) *Ungulatella pacifica* Cushman.

(Plate IV, fig. 8.)

Ungulatella pacifica Cushman 1931, Contrib. Cushman Lab. Foram. Res. **7**, p. 82, pl. 10, figs. 11, 12.

Four specimens of this rare species were found in samples 29 and 30 from Jukes Reef, Outer Barrier. The species was described from the island of Rangiroa in the South Pacific, and it does not appear to have been recorded since then.

Subfamily BULIMININAE.

Genus *Bulimina* d'Orbigny, 1826.

(230) *Bulimina barbata* Cushman.

Bulimina barbata Cushman, 1927, Scripps Inst. Oceanog. Bull., Tech. ser. **1**, no. 10, p. 151, pl. 2, fig. 11.

Specimens were common in sample 45. The species was described from the Western Pacific and has been recorded by Cushman from the Philippines.

(231) *Bulimina marginata* d'Orbigny.

Bulimina marginata d'Orbigny, 1826, Ann. Sci. Nat. **VII**, p. 269, no. 4, pl. 12, figs. 10-12.

This widely-distributed species was occasionally found in the samples of group 3 and was common in sample 45.

(232) *Bulimina rostrata* Brady.

Bulimina rostrata Brady, 1884, Rep. Voy. Chall., Zool. **9**, p. 408, pl. li, figs. 14, 15.

Two specimens were found in sample 26. This species has a general Pacific distribution.

(233) *Bulimina oblonga* n. sp.

(Plate IV, figs. 9a, b, c.)

Test short, thick, with both ends bluntly rounded, slightly increasing in width toward the oral end, in 2-3 whorls with 3 chambers to a whorl, sutures very slightly depressed and limbate, about 12 weak costae developed in the earlier part of the test, extending about half-way toward the oral end. Aperture loop-shaped, almost axial and commencing at the suture between the last 2 chambers.

Holotype from sample 45.

Dimensions of holotype: Length 0.25 mm., diameter 0.16 mm.

Three specimens only were found, but the characters appear distinct enough for it to be described as new. It does not appear to be closely related to any described form.

Genus *Globobulimina* Cushman, 1927, emend. Höglund 1947.

(234) *Globobulimina australiensis* n. sp.

(Plate IV, figs. 10a, b, c.)

Test fusiform, both ends bluntly rounded, brownish in colour, wall transparent in later chambers, conspicuously perforate, chambers distinct, slightly inflated, the last extending about two-thirds of the length of the test proximally, chambers 3 to a whorl in the later part of the test. Aperture open, virguline, turning inwards without any collar, toothplate projecting slightly if at all, rolled into two-thirds of a circle, free edge smooth.

Holotype from sample 45, where it is fairly common.

Dimensions of holotype: Length 0.80 mm., diameter 0.42 mm.

This species is very close to that described by Höglund (1947) as *Globobulimina* sp. "b", but the chambers are rather more inflated in adult specimens and the test wall is thick and translucent in the earlier chambers, transparent in the last one or two. Höglund makes a point of the opacity of the wall in his specimens, but it is doubtful whether this can be considered to be a specific feature. All the specimens found were apparently megalo-spheric.

Genus *Virgulina* d'Orbigny, 1826.

(235) *Virgulina complanata* Egger.

Virgulina schreibersiana Czjzek, var. *complanata* Egger, 1893, Abhandl. kön. bay. Akad. Wiss. Munchen, cl. ii, 18, p. 292, pl. 8, figs. 91, 92.

V. complanata Egger. Cushman, 1937b, p. 26, pl. 4, figs. 13-17.

A compressed biserial form which occurs occasionally in the samples of all groups is referred to this species, which was described from off Western Australia and has been recorded from the Pacific islands, the Antarctic and south-eastern Australia.

(236) *Virgulina pauciloculata* Brady.

Virgulina pauciloculata Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 414, pl. lii, figs. 4 and 5.

This species, distinguished by its elongate chambers extending proximally, is not uncommon in the samples of groups 3 and 4. It has a wide Pacific distribution.

Subfamily DELOSININAE.

Genus *Delosina* Wiesner, 1931.(237) *Delosina complexa* (Sidebottom).

Polymorphina complexa Sidebottom, 1904, etc. (1907), Mem. Manchester Lit. Phil. Soc. LI, no. 9, p. 16, pl. iv, figs. 1-3; 1918, p. 145, pl. v, figs. 6, 7.

Delosina complexa (Sidebottom). Earland, 1934, p. 127, pl. v, fig. 16.

Two characteristic specimens were found in sample 36. The species has been recorded from the coast of New South Wales and from the Antarctic.

Subfamily REUSSELLININAE.

Genus *Reussella* Galloway, 1933.(238) *Reussella spinulosa* (Reuss).

Verneuilina spinulosa Reuss, 1850, Denkschr. Akad. Wiss. Wien, 1, p. 374, pl. 47, fig. 12.

Reussella spinulosa (Reuss). Galloway, 1933, p. 360, pl. 33, fig. 4.

Fairly common in all groups. The specimens are closely comparable with topotype material from Nussdorf, being broadly triangular in side view with short blunt spines on the basal edge of each chamber.

(239) *Reussella spinosissima* (Costa).

Verneuilina spinosissima Costa, 1856, Atti Acad. Pont. 7, pt. 2, p. 263, pl. 23, figs. 5a-c.

Reussella spinosissima (Costa). Cushman, 1937, p. 20; 1945, p. 38, pl. 7, figs. 1-3.

A somewhat elongate form, with blunt spines at the basal angles of the chambers and a rather large, triangular aperture is referred to this species, which was described from the Pliocene of Italy and is recorded in the Recent state from the Mediterranean and the Red Sea. Rare in the samples of groups 1, 2 and 3.

Genus *Chrysalidinella* Schubert, 1907.(240) *Chrysalidinella dimorpha* (Brady).

Chrysalidina dimorpha Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, p. 24; 1884, p. 388, pl. xlvi, figs. 20, 21; Millett, 1898 (1900), p. 12, pl. 1, fig. 14; Heron-Allen and Earland, 1914 etc. (1915), p. 632, pl. xlvii, figs. 29-31.

Chrysalidinella dimorpha (Brady). Schubert, 1907, p. 243.

C. earlandi Cushman, 1945, p. 53, pl. 8, fig. 23.

This species is fairly common in the samples of groups 1, 2 and 3. Many of the specimens are of the elongate parallel-sided form figured by Heron-Allen and Earland (1915) and re-named by Cushman as *C. earlandi*. However, considerable variation in proportions is shown both in the present material and in a large series of specimens collected by the author from the coast near Dar-es-Salaam, East Africa. Both typical *dimorpha* and *earlandi* occur in the same material together with other variations in shape, and the separation of the latter form does not appear to be justified.

Genus *Mimosina* Millett, 1900.

(241) *Mimosina affinis* Millett.

Mimosina affinis Millett, 1898 etc. (1900), Journ. Roy. Micr. Soc., p. 548, pl. iv, fig. 11; Heron-Allen and Earland, 1914 etc. (1915), p. 650; Cushman, 1945, p. 43, pl. 7, figs. 15, 16.

This species was not uncommon in the samples of group 3. Specimens were close to Millett's figures in general form and surface characteristics, but the sutural aperture was in all cases a simple curved slit, not cribrate. However, Millett describes the aperture as "a slit, usually cribrate", so that this feature is apparently variable.

(242) *Mimosina rimosa* Heron-Allen and Earland.

(Plate IV, fig. 11.)

Mimosina rimosa Heron-Allen and Earland, 1914 etc. (1915), Trans. Zool. Soc. London, 20, p. 650, pl. 1, figs. 5-11.

Typical specimens were found in the samples of group 3. This species does not appear to have been recorded since its original description from the Kerimba Archipelago.

(243) *Mimosina echinata* Heron-Allen and Earland.

Mimosina echinata Heron-Allen and Earland, 1914 etc. (1915), Trans. Zool. Soc. London, 20, p. 651, pl. 50, figs. 12-18; Sidebottom; 1918, p. 128; Cushman, 1945, p. 44, pl. 7, figs. 20-22.

Typical specimens were not uncommon in the samples of groups 3 and 4. The species is recorded by Sidebottom from off New South Wales.

Genus *Trimosina* Cushman, 1927.

(244) *Trimosina milletti* Cushman, subsp. *multispinata*, n. subsp.

(Plate IV, fig. 12.)

This species differs from *T. milletti milletti* in the development of a fringe of short spines on the lower margin of all the chambers, except the last 2 or 3. In the early part of the test the septation is largely obscured by this spinous development. The apertures are variable, that at the junction of the last and penultimate chambers varying from slit-like to arched, and the supplementary aperture in the distal face rounded to triangular. These differences, while constant, do not appear to justify specific distinction, and as the typical form does not occur in this material, the spinous variation is treated as a geographical subspecies.

Holotype from sample 44. Distribution generally in group 3, rare.

Dimensions of holotype: Length 0.31 mm., greatest diameter 0.24 mm.

Subfamily UVIGERININAE.

Genus *Uvigerina* d'Orbigny, 1826.

(245) *Uvigerina proboscidea* Schwager.

Uvigerina proboscidea Schwager, 1866, Novara-Exped., Geol. Theil. II, p. 250, pl. 7, fig. 96.

U. proboscidea Schwager. Cushman and Todd, 1941, p. 73, pl. 17, fig. 9, pl. 19, figs. 3-9; Parr, 1950, p. 340.

A few specimens were found in most of the samples of groups 1, 2 and 3.

(246) *Uvigerina porrecta* Brady.

Uvigerina porrecta Brady, 1879 etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 60, pl. viii, figs. 15, 16; 1884, p. 577, pl. lxxiv, figs. 22, 23.

Rare in samples of group 3, rather more common in sample 45.

Genus *Siphovigerina* Parr, 1950.(247) *Siphovigerina fimbriata* (Sidebottom).

Uvigerina porrecta Brady, var. *fimbriata* Sidebottom, 1918, Journ. Roy. Micr. Soc. for 1918, p. 147, pl. v, fig. 23.

Siphovigerina fimbriata (Sidebottom). Parr, 1950, p. 342, pl. xii, fig. 22.

This beautiful little species was found to be rare in samples 23, 24 and 45. Its recorded range is from off Java to the colder waters east of Tasmania.

Genus *Siphogenerina* Schlumberger, 1883.(248) *Siphogenerina striata curta* Cushman.

Sagrina striata Brady, 1884 (not of Schwager), p. 584, pl. lxxv, figs. 25, 26.

Siphogenerina striata (Schwager), var. *curta* Cushman, 1926, Proc. U.S. Nat. Mus. 67, art. 25, p. 8, pl. 2, fig. 5, pl. 5, figs. 5, 6.

Fairly common in samples of groups 1, 2 and 3.

(249) *Siphogenerina virgula* (Brady).

(Plate IV, figs. 13a, b, c.)

Sagrina virgula Brady, 1879 etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 61, pl. viii, figs. 19-21; 1884, p. 583, pl. lxxvi, figs. 4-7 (not 8-10).

S. australiensis Goddard and Jensen, 1907, p. 294, pl. 6, figs. 3a-c.

Siphogenerina virgula (Brady). Cushman, 1926, p. 14, pl. 2, figs. 7, 8, pl. 4, figs. 8, 9 (synonymy).

Rectobolivina virgula (Brady). Hofker, 1951, p. 93, text-fig. 52.

This species occurs in three forms in the present material. The megalospheric form has a proloculus nearly as big as the following uniserial chamber, and appears to be the rarest of the three forms. A microspheric form has a bolivine series of from 4 to 6 chambers, usually set at an angle to the later axis of growth, and another microspheric form has a reduced biserial portion of 2-3 chambers, practically circular in section and in line with the later axis. This latter form is by far the commonest and is met with in most of the samples.

The author has topotype material of Goddard and Jensen's *Sagrina australiensis* from the collection of the late W. J. Parr. The specimens are all of the microspheric form with reduced biserial portion referred to above, and lack the development of long spines pointing proximally from the apertural lip of each uniserial chamber. This is a common occurrence in shallow-water material and can be ascribed to erosion, as closely similar specimens from other shallow deposits show the full development of these delicate spines. In the author's opinion, *S. australiensis* as described by Goddard and Jensen is no more than a somewhat eroded microspheric specimen of Brady's *S. virgula*.

The present material bears out Hofker's statement that the early portion of the test is biserial rather than uvigerine, as previously accepted. However, Bandy (1952) has shown that the type species of *Siphogenerina*, *S. raphanus* (Parker and Jones), includes forms

with either biserial or triserial early chambers. so that *S. virgula* cannot be separated on this character. *Rectobolivina* is not available for this species, since by definition it includes only compressed forms such as the type, *R. bifrons*.

The feature which appears to separate *S. virgula* from other Siphogenerinae is the absence of any connecting structure (siphon or toothplate) between successive apertures. The rudimentary toothplate observed by Hofker, which the present author has been unable to discern, hardly takes the place of the elaborate and well-developed structures seen in other species. It rather suggests the small tooth found in the genus *Siphonodosaria*, and it may be that the present species represents a stage in evolution between *Siphogenerina* and *Siphonodosaria*; in fact, the megalospheric form in the absence of the others could well be referred to the latter genus.

Considering the present state of uncertainty in the classification of the species once included in "*Sagrina*", it is perhaps best to retain this species in *Siphogenerina* pending further revision.

Genus *Trifarina* Cushman, 1923.

(250) *Trifarina bradyi* Cushman.

Rhabdogonium tricarinatum Brady, 1884 (not *Vaginulina tricarinata* d'Orbigny), p. 525, pl. lxxvii, figs. 1-3. *Trifarina bradyi* Cushman, 1918 etc. (1923), p. 99, pl. xxii, figs. 3-9.

Typical specimens were found in sample 45.

Subfamily GÜMBELININAE.

Genus *Gümbelitra* Cushman, 1933.

(251) *Gümbelitra vivans* Cushman.

(Plate IV, fig. 14.)

Verneuilina pygmaea Millett, 1898 etc. (1900) (not of Egger), p. 11, pl. 1, figs. 13a, b.

Gümbelitra ? vivans Cushman, 1934, Contrib. Cushman Lab. Foram. Res. 10, pt. 4, p. 105, pl. 13, figs. 9, 10.

This rare species was not uncommon in the samples of group 3 and in sample 45. The specimens were all triserial throughout, none showing the irregular addition of the later chambers noted by Cushman. The first record of this form appears to be that of Millett (loc. cit) who considered it to be a hyaline isomorph of *Verneuilina pygmaea* Egger, and recorded it as "scattered over the region". His Malay Archipelago material was mostly from shallow water, Cushman's specimens were from off New Guinea in 129 fathoms, and the present specimens are from 600 metres and from shallow-water dredgings.

As the characters of the species are substantially those of the Upper Cretaceous and Eocene genus *Gümbelitra*, it is here referred accordingly, though the absence of records of the genus from the later Tertiary suggests that there may not be a direct phylogenetic relationship, and that the Recent species may be a parallel development deriving from some other triserial form.

Subfamily PLECTOFRONDICULARIINAE.

Genus *Bolivinella* Cushman, 1927.

(252) *Bolivinella elegans* Parr.

Textularia folium Parker and Jones. Brady, 1884 (pars.), pl. xliii, figs. 3-5, (not 1, 2).

Bolivinella elegans Parr, 1932, Proc. Roy. Soc. Victoria, 44, n.s., pt. II, p. 224.

B. folia (Parker and Jones). Cushman, 1929 (not of Parker and Jones), p. 29, pl. 5, figs. 1, 2; 1932 etc. (1942), p. 3, pl. 2, figs. 1-4, 6.

B. folia (Parker and Jones), var. *ornata* Cushman. Cushman, 1932 etc. (1942) (not of Cushman, 1929), p. 5, pl. 2, figs. 5, 8.

Considerable confusion has arisen between *Bolivinella folium* (Parker and Jones) and *B. elegans* Parr. It was shown by Parr (1932) that *B. folium (typica)* is a southern Australian species, characterized by broadly limbate sutures broken by fine diagonal striae which converge toward the distal end of the test, giving the effect of fine beading. This is the form described by Cushman (1929) as *B. folia* var. *ornata*, a name which should be relegated to the synonymy of *B. folium*. *B. elegans* is a species of the warmer waters of the Indo-Pacific, and is characterized by raised, thin ridge-like sutures without beading.

Cushman (1942) records a single specimen of "*B. folia* var. *ornata*" from Levuka, Fiji, but illustrates two different specimens (figs. 5 and 8) which do not show the ornament of the southern Australian species, and in general fall within the rather wide limits of variation of *B. elegans*. This record is considered to be of doubtful authenticity.

B. elegans is not uncommon in sample 45.

Subfamily BOLIVININAE.

Genus *Bolivina* d'Orbigny, 1839.

(253) *Bolivina abbreviata* Heron-Allen and Earland.

Bolivina limbata Brady, var. *abbreviata* Heron-Allen and Earland, 1924, Journ. Linn. Soc., Zool. **35**, p. 622, pl. 36, figs. 25-27.

B. abbreviata Heron-Allen and Earland. Cushman, 1937, p. 143, pl. 18, figs. 24, 25.

Rare in the samples of groups 1, 2 and 3. Records are all from the Pacific.

(254) *Bolivina alata* Seguenza subsp. *fimbriata*, n. subsp.

(Plate V, figs. 1a, b.)

This subspecies differs from *B. alata alata* in the keel being blunt and fimbriate, due to a row of tubules within it, rather than thin and imperforate as in the typical form. Otherwise the characters are those of the typical species, which was not found in the material.

Holotype from sample 45, where it was fairly frequent.

Dimensions of holotype: Length 0.34 mm., breadth 0.17 mm., thickness 0.06 mm.

(255) *Bolivina compacta* Sidebottom.

Bolivina robusta Brady, var. *compacta* Sidebottom 1904 etc. (1905), Mem. Proc. Manchester Lit. Phil. Soc. **49**, no. 5, p. 15, pl. 3, fig. 7.

B. compacta Sidebottom. Cushman 1937, p. 135, pl. 17, figs. 22-24 (synonymy).

Rare in the samples of groups 1, 2 and 3.

(256) *Bolivina hantkeniana* Brady.

Bolivina hantkeniana Brady 1879 etc. (1881), Quart. Journ. Micr. Sci. **XXI**, p. 58; 1884, p. 424, pl. lii, figs. 16-18; Cushman, 1937, p. 127, pl. 16, figs. 18-20 (synonymy).

Rare in sample 45.

(257) *Bolivina quadrilatera* (Schwager).

Textularia quadrilatera Schwager, 1866, Novara-Exped., Geol. Theil. II, p. 253, pl. 7, fig. 10.

Bolivina quadrilatera (Schwager). Wright, 1891, p. 475; Hofker, 1951a, p. 102 *et seq.*

Bolivinita quadrilatera (Schwager). Cushman, 1927, p. 90; 1932 etc. (1942), p. 2, pl. 1.

As pointed out by Hofker, this species has all the characteristics of a typical *Bolivina*, and is not congeneric with the Cretaceous "*Bolivinita*" *eleyi*. Rare in sample 45.

(258) *Bolivina rhomboidalis* (Millett).

Textularia rhomboidalis Millett, 1898 etc. (1899), Journ. Roy. Micr. Soc., p. 559, pl. 7, fig. 4.

Bolivina rhomboidalis (Millett). Cushman, 1922, p. 28; 1937, p. 138, pl. 18, fig. 7 (synonymy).

Occasional in samples of groups 1, 2 and 3.

(259) *Bolivina subtennis* Cushman.

Bolivina tenuis Brady (not of Marsson) 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, p. 57; 1884, p. 419, pl. lii, fig. 29.

B. subtennis Cushman, 1936, p. 57, pl. 8, fig. 10; Collins, 1953, p. 101, pl. 1, fig. 7.

Most of the records of this species are from the Fiji and Samoan islands, but it has been recorded by the author from Pleistocene deposits in western Victoria and is present in "Challenger" Stn. 185 material from Raine Island. Rare in sample 45.

(260) *Bolivina tortuosa* Brady.

Bolivina tortuosa Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, p. 57; 1884, p. 420, pl. lii, figs. 31, 32; Cushman, 1937, p. 133, pl. 17, figs. 11-19 (synonymy).

This typical Indo-Pacific species was common in the finer fractions of most of the samples.

(261) *Bolivina zanzibarica* Cushman.

Bolivina zanzibarica Cushman, 1936, Sp. Publ. no. 6, Cushman Lab. Foram. Research, p. 58, pl. 8, figs. 12a, b.

This small species will probably be found to have an Indo-Pacific range similar to other East African species which occur in the Australian region. Rare in samples 24.

Genus *Loxostomum* Ehrenberg, 1854.(262) *Loxostomum convallarium* (Millett).

(Plate V, fig. 2.)

Bolivina convallaria Millett, 1898 etc. (1900), Journ. Roy. Micr. Soc., p. 544, pl. lv, figs. 6a, b.

Loxostoma convallarium (Millett). Cushman, 1937, p. 191, pl. 22, figs. 11-13.

Hofker (1951) has referred this species to the genus *Bitubulogenerina* Howe, stating that the early chambers are triserial. No specimens with triserial early chambers were found in the present material, all being biserial throughout, with a tendency toward uniseriality in the later chambers. The specimens are very close to Millett's original figures, which show smooth rounded chambers deeply undercut and crenulate at the base, features which are not apparent in Hofker's figures of his specimens. The shell wall is smooth, polished

and hyaline with scattered pores, not opaque as stated by Hofker; nor do the chamber walls present nodular outgrowths as his figures indicate.

It is therefore considered that the species is correctly placed in the genus *Loxostomum*. Specimens were not infrequent in the samples of groups 2 and 3.

(263) *Loxostomum strigosum* (Brady).

Bolivina lobata Brady, var. *strigosa* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 425, pl. cxiii, fig. 7.
Loxostoma strigosum (Brady). Cushman, 1937, p. 189, pl. 22, fig. 1 (synonymy).

Two typical specimens of this rarely-recorded species were found in sample 45.

(264) *Loxostomum mayori* (Cushman).

Bolivina mayori Cushman, 1922, Publ. 311, Carnegie Inst. Washington, p. 27, pl. 3, figs. 5 and 6.
Loxostoma mayori (Cushman). Cushman, 1937, p. 195, pl. 22, figs. 16-21 (synonymy).

Rare in samples 32 and 45. It was described from the Tortugas and is widely recorded in the Pacific.

(265) *Loxostomum limbatum* (Brady).

Bolivina limbata Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, p. 27; 1884, p. 419, pl. lii, figs. 26-28.
Loxostoma limbatum (Brady). Cushman, 1937, p. 186, pl. 21, figs. 36-39.

This widely-distributed species was common in most of the samples.

Genus *Bifarina* Parker and Jones, 1872.

(266) *Bifarina elongata* Millett.

(Plate V, fig. 3.)

Bifarina elongata Millett, 1898 etc. (1900), Journ. Roy. Micr. Soc., p. 281, pl. 2, fig. 15.

Two specimens from samples 38 and 45 appear to be referable to this species, which has apparently not been recorded since its original description. Its distinctive features are the triangular later chambers with spinous projections, the ornamentation with longitudinal rows of puncta, and the slit-like terminal aperture which takes up practically all of the distal end of the last chamber. The specimens are more regular in form than Millett's figured specimen.

(267) *Bifarina queenslandica* n. sp.

(Plate V, figs. 4a, b.)

Test elongate, irregularly tapering, about 5 times the breadth in length, compressed oval in cross-section, chambers biserial in early stages with the axis of growth somewhat curved or twisting, becoming straight in later portion, last two or three chambers uniserial. Periphery rounded, slightly lobulate, sutures limbate and slightly depressed, chamber wall coarsely punctate giving a reticulate and semi-opaque appearance. Aperture terminal, within a roughly oval depression into which on one side projects a tooth-like extension of the chamber wall. The actual aperture is obscure, apparently slit-like. In broken specimens the apertural foramen is seen to be an oval hole surrounded by a raised rim or low collar, but there is no indication of any connecting structure between successive apertures.

Holotype from sample 11.

Dimensions of holotype: Length 0.57 mm., breadth 0.16 mm., thickness 0.11 mm.

Rare in the samples of groups 1, 2 and 3, seldom more than one or two specimens in a sample. This species does not seem to be closely related to any described form.

Genus *Rectobolivina* Cushman, 1927.

(268) *Rectobolivina bifrons* (Brady).

Sagrina bifrons Brady, 1879 etc. (1881). Quart. Journ. Micr. Sci. XXI, p. 64; 1884, p. 582, pl. lxxii, figs. 18-20. *Rectobolivina bifrons* (Brady). Cushman, 1927a, p. 68, pl. 14, fig. 11; 1937, p. 204, pl. 23, figs. 13 and 14 (synonymy).

Two specimens were found in sample 45.

Family CASSIDULINIDAE.

Genus *Cassidulina* d'Orbigny, 1826.

(269) *Cassidulina elongata* Sidebottom.

Cassidulina bradyi Norman, var. *elongata* Sidebottom, 1904 etc. (1905), Mem. Proc. Manchester Lit. Phil. Soc. 49, no. 5, p. 17, pl. 3, fig. 11; Heron-Allen and Earland, 1914 etc. (1915), p. 653, pl. 1, fig. 20.

One specimen of this widely-distributed but seldom recorded form was found in sample 30. It appears to have as wide a range of occurrence as *C. bradyi* s. str., from the NW. Atlantic to the Indo-Pacific, so that it is best considered as a separate species.

(270) *Cassidulina laevigata* d'Orbigny.

Cassidulina laevigata d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 282, pl. xv, figs. 4 and 5; Brady, 1884, p. 428, pl. liv, figs. 1-3.

Four specimens of this wide-ranging species were found in sample 32.

Genus *Orthoplecta* Brady, 1884.

(271) *Orthoplecta clavata* Brady.

Cassidulina (*Orthoplecta*) *clavata* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 432, pl. cxiii, fig. 9.

One specimen was found in sample 32. The species was described from the Admiralty Islands.

Family CHILOSTOMELLIDAE.

Genus *Chilostomella* Reuss, 1850.

(272) *Chilostomella oolina* Schwager.

Chilostomella oolina Schwager, 1878, Bull. Com. Geol. Ital. 9, p. 527, pl. 1, fig. 16; Cushman, 1926a, p. 74, pl. 11, figs. 3-10.

Three small, elongate, thin-walled specimens from sample 45 are referred to this species.

Genus *Seabrookia* Brady, 1890.

(273) *Seabrookia pellucida* Brady.

Seabrookia pellucida Brady, 1890, Journ. Roy. Micr. Soc., p. 567, text-fig. 60, 1a-c; Millett, 1898 etc. (1901), p. 3, pl. 1, figs. 4a-d; Chapman, 1910, p. 406; Heron-Allen and Earland, 1922, p. 141; Parr, 1950, p. 346.

Not uncommon in sample 45. Occasional specimens were found in the samples of group 3.

Genus *Pullenia* Parker and Jones, 1862.

(274) *Pullenia quinqueloba* (Reuss).

Nonionina quinqueloba Reuss, 1851, Zeitschr. deutsch. Geol. Ges. 3, p. 71, pl. 5, fig. 31.

Pullenia quinqueloba (Reuss). Brady, 1882, xi, p. 712; Cushman and Todd, 1943, p. 10, pl. 2, fig. 5; pl. 3, fig. 8 (synonymy).

Three specimens were found in sample 45. The two smaller ones had 5 chambers in the final whorl, the larger had 4 but they are considered to be conspecific.

Genus *Sphaeroidina* d'Orbigny, 1826.

(275) *Sphaeroidina bulloides* d'Orbigny.

Sphaeroidina bulloides d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 267, no. 1; Brady, 1884, p. 620, pl. lxxxiv, figs. 1 to 5 (not 6, 7).

Common in sample 45, occasional in the samples of group 3.

Genus *Nonionella* Cushman, 1926.

(276) *Nonionella pulchella* Hada.

Nonionella pulchella Hada, 1931, Tohoku Imp. Univ. Sci. Repts., ser. 4, Biol. 6, p. 120, Text-fig. 79.

Rare in sample 24 (2 specimens). This species was described from Mutsu Bay, Japan.

Genus *Nonion* Montfort, 1808.

(277) *Nonion subturgidus* (Cushman).

Nonionina subturgida Cushman, 1924, Publ. 342, Carnegie Inst. Washington, p. 47, pl. 16, fig. 2.

Nonion subturgidum (Cushman). Cushman, 1932 etc. (1933), p. 43, pl. 10, figs. 4-7.

Not uncommon in the samples of group 3, many specimens in sample 27.

(278) *Nonion* cf. *'depressulus* (Walker and Jacob).

cf. *Nautilus depressulus* Walker and Jacob, 1798, in Adams' Essays (Kanmacher's Edn.) p. 64, pl. 14, fig. 33.

cf. *Nonion depressulus* (Walker and Jacob). Cushman, 1939, p. 20, pl. 5, figs. 22-25.

Occasional specimens in the samples of groups 1, 2 and 3 are doubtfully referred to this species.

(279) *Nonion scapha* (Fichtel and Moll).

Nautilus scapha Fichtel and Moll, 1798, Test. Micr., p. 105, pl. 19, figs. d-f.

Nonion scaphum (Fichtel and Moll). Cushman, 1939, p. 20, pl. 5, figs. 18-21 (synonymy).

Rare, one specimen being found in sample 9.

Superfamily ROTALIDEA.

Family SPIRILLINIDAE.

Subfamily SPIRILLININAE.

Genus *Spirillina* Ehrenberg, 1843.(280) *Spirillina vivipara* Ehrenberg.*Spirillina vivipara* Ehrenberg, 1843, K. Akad. Wiss. Berlin, Physik Abh., p. 442, pl. iii, sec. 7, fig. 41.

This widely-distributed species is frequent in the finer fractions of most of the samples.

(281) *Spirillina limbata* Brady.*Spirillina limbata* Brady, 1879 etc., Quart. Journ. Micr. Sci. XIX, n.s., p. 278, pl. viii, figs. 6a, b; 1884, p. 632, pl. lxxxv, figs. 18-21; Parr, 1950, p. 348.

Rare in sample 29 (1 specimen).

(282) *Spirillina decorata* Brady.*Spirillina decorata* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 632, pl. lxxxv, figs. 22-25.

Rare in sample 45 (1 specimen).

(283) *Spirillina inaequalis* Brady.*Spirillina inaequalis* Brady, 1879, Quart. Journ. Micr. Sci. XIX, p. 278, pl. viii, figs. 25a, b; 1884, p. 631, pl. lxxxv, figs. 8-11.Occasionally found in samples of group 3 with *S. vivipara*, but less common than that species.Genus *Planispirillina* Bermudez, 1952.(284) *Planispirillina denticulata* (Brady).*Spirillina limbata* Brady, var. *denticulata* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 632, pl. lxxxv, fig. 17.*S. denticulogranelata* Chapman, 1909, p. 133, pl. x, fig. 6.*S. denticulata* Brady. Ovey, 1947, pp. 17, 18; Parr, 1950, p. 351.

The recorded range of this species is from Raine Island to Bass Strait. It was found to be rare in the samples of group 3.

Genus *Mychostomina* Berthelin, 1881.(285) *Mychostomina revertens* (Rhumbler).*Spirillina vivipara* Ehrenberg, var. *revertens* Rhumbler, 1906, Zool. Jahrb. Abt. Syst. Geol. Biol. 24, p. 32, pl. 2, figs. 8-10.*Mychostomina revertens* (Rhumbler). Galloway, 1933, p. 88, pl. 7, figs. 6, 7; Bermudez, 1952, p. 27, pl. 1, figs. 4-6.

Occasional specimens were found in the finer fractions of samples of all groups

Subfamily PATELLINAE.

This subfamily is usually considered as containing four genera, *Patellina*, *Patellinella*, *Annulopatellina* and *Patellinoides*. Hofker (1951) has recently combined three of them (*Patellina*, *Patellinella* and *Patellinoides*) in a new genus *Discobolivina*, which is obviously invalid, since the only name available for a combination of these three genera is that of the first-described, *Patellina*. His reasons for this combination are based on the morphology of the aperture and associated structures and on the pore system, and he considers that the many records which refer to an undivided spiral commencement in these genera are erroneous (p. 422, loc. cit.). This contention can scarcely be upheld against the weight of contrary evidence, particularly the detailed researches of Myers (1935) in the case of *Patellina*.

In the present collections there are specimens of *Patellina corrugata* Williamson in which the earlier whorls are clearly undivided and spirilline. The author can, moreover, vouch for the occurrence of an undivided spiral commencement in the Tertiary species described as *Patellinella annectens* Parr and Collins, 1930. The genus *Patellinoides*, described from the Antarctic by Heron-Allen and Earland (1934), is characterized by undivided early whorls, as shown clearly in the figures and also described.

In contrast, the type species of the genus *Patellinella* (*P. inconspicua* Brady) which is common in the shore sands of the region from which it was described, Bass Strait, is either pseudobiserial from the beginning or in some specimens commences with a short trochospiral series of 2 or 3 chambers. In such specimens the early chambers may show a brown coloration similar to that found in *Discorbis* and other rotaline genera. The four species of "Discobolivina" illustrated by Hofker (loc. cit.) also start with a short trochospiral series.

The investigations of Wood (1948) on the structure of the foraminiferal test show that *Spirillina*, *Patellina* and *Patellinoides* tend to have the test made up of a single crystal of calcite, whereas *Patellinella* is shown to have a radial wall structure similar to that of most other Rotalidae.

These considerations suggest that two distinct lineages exist in this subfamily. *Patellina* and *Patellinoides* are characterized by having an undivided spiral commencement and single-crystal wall structure, suggesting that these genera have evolved from a spirilline ancestor, while *Patellinella* has a trochospiral early series and radial wall structure, suggesting discorbine ancestry.

It follows that the pseudobiserial growth-plan of the later chambers in the three patellinid genera, actually a trochospiral coil with the chambers added at 180° intervals, as shown by the alternating slant of the loop-shaped aperture, is a case of convergence, producing similar apertural structures in genera which are not closely related.

The tertiary species *Patellinella annectens* should probably be referred to the genus *Patellinoides* on account of its spirilline commencement. The position of this species and of the genus *Annulopatellina* Parr and Collins requires detailed examination of their wall structure, which is beyond the scope of this report.

In the light of the above considerations, the genera *Patellina* and *Patellinella* have been retained in this work, with *Discobolivina* placed in synonymy, and *Patellinella* transferred to the subfamily Discorbisinae. Parr (1950) appears to have arrived at the same conclusion by including *Patellinella* in the Discorbidae without comment.

Genus *Patellina* Williamson, 1858.

(286) *Patellina corrugata* Williamson.

Patellina corrugata Williamson, 1858, Rec. For. Gt. Britain, p. 46, pl. iii, figs. 86–89; Parr and Collins, 1930, p. 90, pl. iv, figs. 1–5.

The specimens found in this material are indistinguishable from the form found in British waters. Occasional specimens were found in samples of all groups.

(287) *Patellina altiformis* Cushman.

Patellina advena Cushman, var. *altiformis* Cushman, 1933a, Contrib. Cushman Lab. Foram. Res. 9, pt. 4, p. 87, pl. 9, figs. 8a, b.

P. altiformis Cushman. Parr, 1950, p. 352.

Two specimens of this high-spired form were found in sample 29, Jukes Reef. It is present in Raine Island material but, strangely enough, is not found in the deeper-water sample 45, where it is replaced by the wider-ranging *P. corrugata*. Parr records it from off Tasmania.

Family ROTALIDAE.

Subfamily DISCORBISINAE.

Genus *Discorbis* Lamarck, 1804.

(288) *Discorbis rugosus* (d'Orbigny).

Rosalina rugosa d'Orbigny, 1839, Foram. Amer. Merid., p. 42, pl. ii, figs. 12–14.

Discorbina rugosa (d'Orbigny). Brady, 1884, p. 652, pl. lxxxvii, figs. 3a–c; Millett, 1898 etc. (1903), p. 703; Chapman, 1901, p. 190; Heron-Allen and Earland, 1914 etc. (1915), p. 697.

The umbilical flaps developed on the ventral side of the test in this species, though simple in form, are apparently homologous with the more complex structures found in *D. vesicularis* and related forms. It is therefore considered as a species of *Discorbis* s. str. Common in sample 29, occasional in other samples of group 3.

(289) *Discorbis subvesicularis* n. sp.

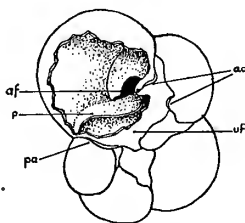
(Plate V, figs. 5a, b and c.)

Test trochoid, planoconvex, periphery broadly rounded and lobulate, 2–3 whorls, 6 chambers in the last whorl, wall thin and coarsely perforate. Dorsal side convex, chambers inflated, sutures depressed and recurved, in some specimens having a small triangular opening between the chambers at the junction of the suture with the previous whorl, passing between the chamber walls to the opposite side of the test. Ventral face slightly convex, sutures radial and slightly recurved, umbilicus masked by strongly-developed extensions of the chamber wall forming umbilical flaps. Commencing at the junction of the apertural face with the previous whorl, the edge of the flap is everted to form a broad lip covering a crescentic aperture extending radially toward the umbilicus. From the end of this primary aperture the edge of the flap turns at right angles and passes over and is attached to the surface of flaps formed by previous whorls. Where it meets the last suture, a short narrow crescentic lip is formed, covering an accessory aperture. From the end of this aperture the flap is attached to the wall of the preceding chamber, and then turns distally, parallel to the direction of coiling, and forms a longer, sigmoid lip covering a second accessory

aperture. This aperture is terminated by the incurving and merging of the edge of the flap with the chamber wall.

Each flap, therefore, forms 3 arched, lipped apertures, separated by attached parts of the margin. The primary aperture is covered by the flap of the next succeeding chamber, the others remaining open in close proximity to the accessory apertures of the previous and following chambers. The flaps are perforate, but the pores are smaller and more scattered than those of the chamber wall proper.

While the apertural flaps do not form separate chamberlets, partial separation is made by a fold or partition about one-third the height of the chamber, originating from the peripheral end of the primary aperture, attached to the dorsal interior surface of the chambers for about half its length, running in a sigmoid curve and in a roughly circumferential direction to terminate on the ventral wall of the chamber just below the second accessory aperture. Immediately below and behind this point of attachment is the septal foramen connecting to the penultimate chamber (Text-fig. 1).



TEXT-FIG. 1.—*Discorbis subvesicularis* n. sp. Specimen broken to show internal structures. *af* apertural foramen, *aa* accessory apertures, *p* partition, *pa* primary aperture, *uf* umbilical flap.

Earlier chambers have the same flap-like structure but simplified in form. The whole complex of cavities, baffles and passageways formed in the umbilical area by these flaps and the sigmoid partitions invites comparison with the canal systems of the more highly-developed rotalids.

No attempt has been made to apply the morphological nomenclature introduced by Hofker in describing these structures, as it is considered that the assumption of homologies which are not yet fully investigated is not advisable at this stage.

Holotype from sample 1.

Dimensions of holotype ; diameter 0.51 mm., thickness 0.22 mm.

A few specimens were found in most of the samples of groups 1, 2 and 3. This species is one of the *vesicularis-dimidiatus* group. It differs from *D. vesicularis* Lamarck from the Eocene of the Paris Basin in its rounded periphery (*D. vesicularis* being keeled, at least in the earlier chambers) and its more complex development of the umbilical region. It differs from the southern Australian 'recent' species, *D. dimidiatus* (Parker and Jones), in its consistently smaller size, rounded periphery and somewhat less complicated umbilical structures. Cushman (1918 etc. (1931), p. 34) refers to a species from the Australian coast "which is very close to the Eocene species of Lamarck", probably the form under consideration.

The closely allied species *D. dimidiatus* has been made the genotype of a new genus, *Lamellodiscorbis* Bermudez, 1952. After comparing it with specimens of *D. vesicularis* from the Eocene of Grignon, the author is of the opinion that the umbilical structures in the Australian species are no more than a larger and more complicated development of the alar projections seen in *D. vesicularis*, which are in some specimens widened at the

extremities and recurved to form rudimentary supplementary apertures of similar nature to those found in the present species and in *D. dimidiatus*, though less developed. The differences between the present species and *D. vesicularis* are considered to be of specific value only, and it is therefore retained in *Discorbis* s. str.

In describing this species I have had the privilege of consulting an unpublished MS. dealing with the morphology of *D. dimidiatus*, by Mr. A. N. Carter of the Department of Mines, Victoria, to whom my thanks are due for the assistance thus given in working out the somewhat similar structures in the present species.

Genus *Discopulvinulina* Hofker, 1951.

(290) *Discopulvinulina bertheloti* (d'Orbigny).

Rosalinabertheloti d'Orbigny, 1839, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, 2, pt. 2, "Foraminifères," p. 135, pl. 1, figs. 28, 30.

Discorbis bertheloti (d'Orbigny). Cushman, 1918 etc. (1931), p. 16, pl. iii, fig. 2.

Discopulvinulina bertheloti (d'Orbigny). Hofker, 1951, p. 449.

Rare in the samples of group 3.

(291) *Discopulvinulina mira* (Cushman).

Discorbis mira Cushman, 1922. Publ. 311, Carn. Instit. Washington, p. 39, pl. 6, figs. 10, 11; 1918 etc. (1931), p. 25, pl. 5, figs. 5, 6a-c; Parr, 1943, p. 16; Collins, 1953, p. 103.

Described from the West Indies, this species is evidently well distributed in Australian waters. It was recorded from Glenelg, S. Australia by Parr (1943), and from warm-water Pleistocene deposits in Victoria by the author (1953). Specimens are not uncommon in the samples of groups 1, 2 and 3, and compare well with West Indian examples.

(292) *Discopulvinulina lobatula* (Parr.)

Discorbina isabelleana Brady (not *Rosalina isabelleana* d'Orbigny) 1884, Rep. Voy. Chall., Zool. 9, p. 646, pl. lxxxviii, fig. 1.

Discorbis lobatulus Parr, 1950, p. 354, pl. xiii, figs. 23-25.

A few examples of this species were found in sample 45. It has a wide range in the Indo-Pacific and was recorded by Parr from off Tasmania.

(293) *Discopulvinulina subcomplanata* (Parr).

Discorbis subcomplanatus Parr, 1950, B.A.N.Z.A.R. Exped. Rept. V, pt. 6, p. 355, pl. xiv, figs. 1a, b, 2.

Rare in sample 1. This species was described from the Antarctic and is distinguished by its heavily limbate sutures on the dorsal side and its complanate form.

Genus *Rosalina* d'Orbigny, 1839.

(294) *Rosalina orbicularis* Terquem.

Rosalina orbicularis Terquem, 1876, Anim. sur la plage Dunkerque, p. 75, pl. ix, figs. 4a, b.

Discorbis orbicularis (Terquem). Berthelin, 1878, p. 39, no. 63; Cushman, 1918 etc. (1931), p. 27, pl. 6, figs. 3a-c (synonymy).

Rosalina orbicularis Terquem. Bermudez, 1952, p. 34.

Good examples are common in samples 44 and 45.

(295) *Rosalina orientalis* (Cushman).

Discorbis globularis Heron-Allen and Earland (not of d'Orbigny), 1914 etc. (1915), p. 694, pl. li, figs. 36-39.
D. orientalis Cushman, 1925, Bernice P. Bishop Mus., Bull. 27, p. 130.

Probably the commonest of the smaller rotalids in the samples of groups 1, 2 and 3, this species has a wide Indo-Pacific range. It was described as having "the umbilical end of each chamber ending in a tooth-like process, bluntly pointed". These processes originate in a flap-like extension of the chamber wall covering the umbilical extension of the aperture. As chambers are added, thickening of the shell wall at this point results in the formation of polished non-tubulate blebs on the inner margin of the chambers, varying from triangular tooth-shaped inwardly-pointing processes to groups of irregularly-rounded pustules.

As this form is related to *Rosalina globularis* d'Orbigny, it should be referred to that genus.

(296) *Rosalina frustata* (Cushman).

Discorbis frustata Cushman, 1933, Contrib. Cushman Lab. Foram. Res. 9, pt. 4, p. 88, pl. 9, figs. 2a-c.

Described by Cushman from off Fiji, this species is very distinctive with its tiers of upward-curved, flanged chambers. Two specimens were found in sample 29.

Genus *Mississippina* Howe, 1930.(297) *Mississippina pacifica* Parr.

Mississippina pacifica Parr, 1950, B.A.N.Z.A.R. Exped. Rept. V, pt. 6, p. 361, pl. xiv, figs. 17a-c.

Five specimens were found in sample 45. Parr records the species from Raine Island. The state of preservation of these specimens apparently differs from that of Parr's material from off Tasmania, the body of the test being white and opaque, while the peripheral areas are yellowish and translucent with a depressed margin.

Genus *Conorbella* Hofker, 1951.(298) *Conorbella patelliformis* (Brady).

Discorbina patelliformis Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 647, pl. lxxxviii, fig. 1; Millett, 1898 etc. (1903), p. 700; Heron-Allen and Earland, 1914 etc. (1915), p. 703, pl. lii, fig. 32; Sidebottom, 1918, p. 254.

Discorbis patelliformis (Brady). Cushman, 1924, p. 33.

Conorbella patelliformis (Brady). Bermudez, 1952, p. 37.

This well-known Indo-Pacific species was found occasionally in the samples of groups 1, 2 and 3.

(299) *Conorbella pulvinata* (Brady).

Discorbina pulvinata Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 650, pl. lxxxviii, figs. 10a, b; Heron-Allen and Earland 1914 etc. (1915), p. 702.

Conorbella pulvinata (Brady). Hofker, 1951, p. 470.

Rare, two specimens found in sample 26.

(300) *Conorbella pyramidalis* (Heron-Allen and Earland).

Discorbina pyramidalis Heron-Allen and Earland, 1924, Journ. Linn. Soc. Zool. **35**, p. 634, pl. 37, figs. 56-61.
Conorbella pyramidalis (Heron-Allen and Earland). Hofker, 1951, p. 470.

This species, described from Lord Howe Island and recorded by the authors from South and Western Australia, is represented by rare but typical specimens in the samples of groups 3 and 4.

(301) *Conorbella tabernacularis* (Brady).

Discorbina tabernacularis Brady, 1884, Rep. Voy. Chall., Zool. **9**, p. 648, pl. lxxxix, fig. 7 (not 5 and 6).
Conorbella tabernacularis (Brady). Hofker, 1951, p. 470.

Striate specimens similar to Brady's fig. 7 are not uncommon in all groups. It is doubtful, however, whether this form is conspecific with the large costate form of figs. 5 and 6, which was not found in the present material.

(302) *Conorbella corrugata* (Millett).

Discorbina corrugata Millett, 1898 etc. (1903), Journ. Roy. Micr. Soc., p. 700, pl. vii, fig. 5.

Rare in the samples of group 3, less frequent than *C. pyramidalis*, from which it differs in the greater number (5 to 6) and less regularity of the radial ridges on the dorsal side.

(303) *Conorbella opercularis* (d'Orbigny).

Rosalina opercularis d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 271, no. 7.
Discorbina opercularis (d'Orbigny). Brady, 1884, p. 650, pl. lxxxix, figs. 8, 9.
Conorbella opercularis (d'Orbigny). Bermudez, 1952, p. 37.

Four specimens from sample 45 are similar to those figured by Brady, which were from Queensland waters. Parr (1950) records the species from off Tasmania.

(304) *Conorbella earlandi* n. sp.

(Plate V, figs. 6a, b and c.)

Test minute, compressed, subhexagonal in outline, with slightly inflated chambers and a narrow keel. On the ventral side the sutures are straight and radial, slightly depressed, chambers triangular and somewhat inflated, with a depressed umbilicus. On the dorsal side all chambers are visible, subrectangular, 3 to 4 times as long as wide, arranged in a spiral hexagonal series, surface concave with the ends of the chambers curving up to form ridges which are continuous from the centre of the test to the periphery. Ventral side smooth, very finely perforate, dorsal side more coarsely perforate. Aperture is a narrow slit at the anterior margin of the last chamber on the ventral side, extending from the periphery to the umbilicus.

Holotype from sample 45.

Dimensions of holotype: Diameter 0.20 mm., thickness 0.07 mm.

Three specimens were found in sample 45, but a good series was available from Raine Island material. The geometric outline and ridged dorsal side suggest relationships with *C. pyramidalis* and *C. corrugata*, but in this case the ridges are caused by the upward-curved radial sutures, not by an angular form of the chamber itself. The species does not appear to be closely related to any described form.

This species was recognized as new by Mr. A. Earland in a slide mounted by him from Raine Island material and given to the late W. J. Parr for further study. I have great pleasure in associating it with his name, not only for this reason, but in inadequate acknowledgment of his helpful advice and encouragement over a period of many years.

Genus *Discorinopsis* Cole, 1941.

(305) *Discorinopsis tropica* n. sp.

(Plate V, figs. 7a, b and c.)

Test trochospiral in about 2 whorls, up to 10 chambers in last whorl; dorsal side rounded with all chambers visible, coarsely perforate, sutures depressed-limbate; ventral side flat or slightly concave, all but the last 2 chambers masked by irregular pustular shelly outgrowths. Periphery bluntly keeled, aperture a low slit on the ventral side of the periphery.

Holotype from sample 9.

Dimensions of holotype: Greater diameter 0.52 mm., thickness 0.17 mm.

One specimen was found in sample 9, and two others were available for study from the collection of the late W. J. Parr, their locality being Plum Beach, New Caledonia. The species differs from *D. aguayoi* Bermudez in its more regular form and bluntly keeled periphery.

Genus *Bronnimannia* Bermudez, 1952.

(306) *Bronnimannia haliotis* (Heron-Allen and Earland).

Discorbina haliotis Heron-Allen and Earland, 1924, Journ. Roy. Micr. Soc., pt. 2, p. 173, pl. xiii, figs. 99-101.

Discorbis haliotis (Heron-Allen and Earland). Parr, 1939, p. 68; Collins, 1953, p. 96.

Planulina haliotis (Heron-Allen and Earland). Chapman, 1941, p. 176.

This species was described from the Lower Miocene of Victoria and has since been recorded from the Lower Pliocene and Pleistocene. Parr records it from Geraldton Harbour, Western Australia, and mentions it as occurring at Barwon Heads, Victoria. Chapman records the species from 470 fathoms off the south-east coast of Australia. It occurs occasionally in the samples of groups 3 and 4.

Heron-Allen and Earland's figure (loc. cit.) does not show the full characteristics of the species. The sutures on the dorsal side are usually incurved, varying from a shallow indentation to a deep re-entrant, and leaving the umbilical margin of the chamber free of attachment. The author's figure shows a faint suggestion of this form, but gives a wrong impression of the suture as a simple curve. Specimens from the type locality show all stages, those with a deep re-entrant sinus being the more common. There is considerable variation in thickness of the test in the present material, some specimens being flat and compressed, others intermediate between these and the typical form.

This species is very close to the genotype, *B. palmerae* (Bermudez) which, however, is considerably thicker in proportion to diameter.

Genus *Poroeponides* Cushman, 1944.

(307) *Poroeponides lateralis* (Terquem).

Rosalina lateralis Terquem, 1878, Mem. Soc. Géol. France, ser. 5, 1, mem. III, p. 25, pl. ii, figs. 11a, b.

Poroeponides lateralis (Terquem). Cushman, 1944, p. 34 (synonymy).

This common Indo-Pacific species was met with in most of the samples, particularly those of group 3.

Genus *Patellinella* Cushman, 1928.

(308) *Patellinella jugosa* (Brady).

Textularia jugosa Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 358, pl. xlii, figs. 7a, b.

T. inconspicua Brady var. *jugosa* Brady. Millett, 1898 etc. (1899), p. 558, pl. vii, figs. 2a, b.

Discobolivina inconspicua (Brady). Hofker, (not of Brady) 1951, p. 431, text-fig. 296.

This well-marked species with ridged projecting sutures was rare in sample 45, one specimen only being found, which was closely comparable with specimens from Raine Island, the type locality. It is quite distinct from Brady's *Textularia inconspicua* which, as figured by Brady (1884) and by Parr and Collins (1930), has a smooth subconical outline with wide flush sutures of clear shell substance, the chamber walls being perforate with large closely-spaced pores. The latter species is common in Bass Strait, from which locality it was described. It has not been met with in the present samples, nor, in the author's experience, in any tropical material, though Brady records it from Nares Harbour, Admiralty Islands and from south of Japan, and Heron-Allen and Earland record it from the Kerimba Archipelago. The latter record does not appear to be correct, as the figured specimen has thin depressed sutures. Millett's figure of *Textularia inconspicua* (1898 etc., (1899), pl. vii, fig. 1). with its flared outline and markedly convex apertural face, is also distinct from the typical southern Australian form.

P. jugosa appears to be confined to tropical Australia and the regions to the north.

(309) *Patellinella nitida* (Hofker).

Discobolivina nitida Hofker, 1951, Siboga Exped., Part III, p. 498, text-figs. 293, 294.

This small depressed form, subcircular in end view, corresponds well with Hofker's description of specimens from south of Sumatra. Similar specimens were present in material from Challenger Stn. 185, Raine Island, mounted by Mr. A. Earland. Rare in sample 45.

(310) *Patellinella carinata* n. sp.

(Plate V, figs. 8a, b, c.)

Test minute, hyaline, commencing with a short trochoid spiral of 3 or 4 chambers, with later chambers added at 180° intervals (Text-fig. 2). Triangular in side view, with periphery slightly carinate, and set with fine apically-directed spines. Sutures distinct,



TEXT-FIG. 2.—*Patellinella carinata* n. sp. Specimen showing arrangement of early chambers.

arcuate, thin and almost flush, produced at the periphery as a larger spine. Chamber wall thin, transparent, finely perforate, with an irregular row of larger pores on the proximal side of each suture. In apertural view the test is ovoid with pointed ends, the distal chamber wall being thin, transparent and finely perforate, with a few larger pores scattered round the periphery and grouped near the outer ends. Aperture loop-shaped with a curved

toothplate, the aperture of the penultimate chamber being closed by what appears to be an extension of the toothplate.

Holotype from sample 45.

Dimensions of holotype: Length 0.18 mm., breadth 0.28 mm., thickness 0.16 mm.

This species is distinguished from others of the genus by its carinate and spinous periphery. It is fairly rare in the deeper-water sample 45, and is present in material from Challenger Stn. 185, Raine Island.

Subfamily VALVULINERIIINAE.

Genus *Globorotalia* Cushman, 1927.

(311) *Globorotalia tumida* (Brady).

Pulvinulina menardii var. *tumida* Brady, 1877, Geol. Mag., Dec. II, 4, p. 535; 1884, p. 692, pl. ciii, figs. 4-6. *Globorotalia tumida* (Brady). Cushman, 1927, p. 175.

Rare in sample 45 (one specimen).

(312) *Globorotalia canariensis* (d'Orbigny).

Rotalina canariensis d'Orbigny, 1839, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, II, "Foraminifères", p. 130, pl. 1, figs. 34-36.

Globorotalia canariensis (d'Orbigny). Galloway and Morrey, 1929, p. 25, pl. 3, fig. 11.

Frequent in sample 45.

(313) *Globorotalia menardii* (d'Orbigny).

Rotalina menardii d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 273, no. 26.

Globorotalia menardii (d'Orbigny). Cushman, 1927, p. 175.

Rare in sample 45 (1 specimen).

Genus *Cancris* Montfort, 1808.

(314) *Cancris auriculus* (Fichtel and Moll).

Nautilus auricula Fichtel and Moll, 1803, Test. Micr., var., α p. 108, pl. 20, figs. a-c.

Cancris auriculus (Fichtel and Moll). Cushman and Todd, 1942, p. 74, pl. 18, figs. 1-11, pl. 23, fig. 6 (synonymy).

Not uncommon in the samples of groups 1, 2 and 3.

Genus *Eponides* Montfort, 1808.

(315) *Eponides procerus* (Brady).

Pulvinulina procera Brady, 1879 etc., (1881), Quart. Journ. Micr. Sci. XXI, p. 66; 1884, p. 698, pl. cv, figs. 7a-c; Heron-Allen and Earland, 1914 etc. (1915), p. 717.

Rare in sample 45 (two specimens).

(316) *Eponides repandus* (Fichtel and Moll).

Nautilus repandus Fichtel and Moll, 1803, Test. Micr., p. 35, pl. 3, figs. a-d.

Eponides repandus (Fichtel and Moll). Montfort, 1808, 1, p. 127, 52e genre.

Rare in sample 10.

(317) *Eponides tubuliferus* (Heron-Allen and Earland).

Truncatulina tubulifera Heron-Allen and Earland, 1914 etc. (1915), Trans. Zool. Soc. London, XX, pt. 17, p. 710, pl. lii, figs. 37-40; Cushman, 1924, p. 38, pl. 11, fig. 8.

This small biconvex form with its peculiar development of tubules grouped within a crater-like tubercle on each dorsal chamber wall is rare in the samples of group 3. It has a wide Indo-Pacific distribution.

Genus *Gyroidinoides* Brotzen, 1948.

(318) *Gyroidinoides soldanii* (d'Orbigny).

Gyroidina soldani d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 278, no. 5.

Four specimens from sample 45 are small in size but otherwise typical of this wide-ranging species.

Subfamily GLOBOTRUNCANINAE.

Genus *Truncorotalia* Cushman and Bermudez, 1949.

(319) *Truncorotalia truncatulinoidea* (d'Orbigny).

Rotalina truncatulinoidea d'Orbigny, 1839, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, II, "Foraminifères," p. 132, pl. ii, figs. 25-27.

Globorotalia truncatulinoidea (d'Orbigny). Cushman, 1927, p. 176.

G. (Truncorotalia) truncatulinoidea (d'Orbigny). Cushman and Bermudez, 1949, p. 35.

Rare in sample 45 (one specimen).

Subfamily EPISTOMININAE.

Genus *Höglundina* Brotzen, 1948.

(320) *Höglundina elegans* (d'Orbigny).

Rotalia (Turbinulina) elegans d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 276, no. 54.

Epistomina elegans (d'Orbigny). Cushman, 1918 etc. (1931), p. 66, pl. 13, figs. 6a-c.

Höglundina elegans (d'Orbigny). Brotzen, 1948, p. 92.

This well-known and widely-distributed species was common in sample 45, but not found in the shallower-water samples.

Genus *Rolshausenia* Bermudez, 1952.

(321) *Rolshausenia inflata* (Millett).

Rotalia schroeteriana Parker and Jones, var. *inflata* Millett, 1898 etc. (1904), Journ. Roy. Micr. Soc., p. 504, pl. x, figs. 5a-c; Heron-Allen and Earland, 1914 etc. (1915), p. 719.

Specimens close to Millett's figure were not uncommon in the samples of groups 1, 2 and 3. Bermudez (1952) refers this form to his new genus *Rolshausenia*.

Genus *Torresina* Parr, 1947.

(322) *Torresina haddoni* Parr.

Torresina haddoni Parr, 1947a, Journ. Roy. Micr. Soc. LXIV, p. 133, pl. 1, figs. 4, 5a-c, 6a-c, text-fig. 3.

Three specimens of this recently-described species were found in sample 45. The largest, measuring 0.83 mm. in its greater diameter, showed on its ventral face the structure

described by Parr as a "lunate apertural chamberlet". As only one specimen showing this development was found, it was not examined by sectioning or breaking. However, examination in a liquid medium suggests that the "chamberlets" are in fact only curved inflated alar extensions of the ventral chamber wall with a deep sinus or re-entrant, basically similar to those seen in other discorbid genera.

The two smaller specimens measured 0.41 and 0.32 mm. in diameter respectively. The smaller was incomplete, the other showed only a simple, rather inflated alar flap extending over the preceding whorl. This specimen compared closely with a topotype specimen from Raine Island in Parr's collection, in which a similar structure was observed. The diameter of the proloculus of the two larger specimens was the same, *ca.* 0.08 mm. in diameter, that of the incomplete specimen being 0.03 mm., suggesting that it may be the microspheric form. There would appear to be little doubt that the large specimen figured by Parr (figs. 4 and 5*a-c*) represents the full development of the species, as suggested by its author.

Genus *Pseudoparrella* Cushman and Ten Dam, 1948.

(323) *Pseudoparrella pulchra* (Cushman).

Pulvinulinella pulchra Cushman, 1933*a*, Contrib. Cushman Lab. Foram. Research, 9, pt. 4, p. 92, pl. 9, figs. 10*a-c*.

This minute form is fairly common in the finer fractions of the samples of groups 1, 2 and 3. Cushman states that it has a wide Indo-Pacific distribution.

Genus *Epistomaroides* Uchio, 1952.

(324) *Epistomaroides polystomelloides* (Parker and Jones).

Discorbina polystomelloides Parker and Jones, 1865, Phil. Trans. CLV, p. 421, pl. xix, figs. 8*a-c*; Brady, 1884, p. 652, pl. xci, figs. 1*a-c*; Heron-Allen and Earland, 1914 etc. (1915), p. 698, pl. liii, figs. 19-23.

(?) *Epistomaria polystomelloides* (Parker and Jones). Howchin and Parr, 1938, p. 303, pl. xvii, figs. 5-7, 11, 13.

Epistomaroides polystomelloides (Parker and Jones). Uchio, 1952, p. 158.

This common Indo-Pacific tropical species occurs in most of the samples of groups 1, 2 and 3. Specimens are of normal size, averaging about 1 mm. in diameter, and have the early chambers obscured by exogenous shell-growth in the form of granules which spread in an irregular manner along the sutures and in later chambers merge into the clear glassy struts which bridge the deep sutural grooves characteristic of this species. The incidence of this exogenous growth is rather variable, specimens from the Australian region showing a good deal of granulation and up to 4 or 5 sutural struts on the dorsal side, whereas East African specimens show little granulation and in most cases have the sutural struts confined to the periphery, possibly representing a geographical subspecies.

Occasionally very large specimens are found, apparently referable to this species but having an extreme development of exogenous shell-growth. Howchin and Parr record such a specimen, *ca.* 4 mm. in diameter, from the Upper Pliocene of Adelaide. No such specimens have been found in the present material, but the author has one from Longreach Bay, Rottnest Island, Western Australia (collected by Mr. L. Glauert) which reaches 5 mm. in diameter. In this specimen most of the surface is covered by an anastomosing network of deep narrow ridges of clear shell substance, the coarsely perforate shell wall showing in

the interstices. These ridges, despite their apparent irregularity, are related to the sutural grooves, arising in a complex of radial and circumferential bars immediately over the grooves, and extending circumferentially over the chamber walls. In the earlier chambers the ridges anastomose, leaving small perforate areas between them. In the later chambers the circumferential extensions of the ridges do not meet over the chamber walls, and a large perforate area is exposed.

A specimen from Plum Beach, New Caledonia, in the author's possession from the collection of the late W. J. Parr, shows intermediate characteristics, being larger than the normal (1.68 mm. in larger diameter) and having the earlier chambers obscured by peculiar flat-topped vermiculate ridges which do not anastomose. This form, however, may be distinct from the present species.

The great disparity in size and comparative rarity of these larger specimens suggest that they may be the microspheric form of the species. Insufficient material is as yet available for sectioning to determine whether this is the case, or whether they are merely monstrous specimens showing gerontic characteristics.

Genus *Epistomariella* Kuwano, 1950.

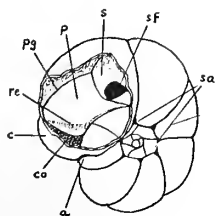
(325) *Epistomariella milletti*, n. sp.

(Plate V, figs. 9a, b, and c.)

Discorbina semimarginata Millett (not of d'Orbigny), 1898 etc. (1903), Journ. Roy. Micr. Soc., p. 703, pl. vii, figs. 8a-c.

Test trochoid and biconvex, dorsal side more convex than ventral, thin-walled, smooth, polished and finely perforate, periphery rounded and lobulate, sutures depressed. The ventral side shows inflated, roughly triangular chamberlets about two-thirds the radial height of the chamber proper, and tapering down to a deep umbilicus. The chamberlet walls are rather more densely perforate than the remainder of the test. At the peripheral junction of the chamberlet and the chamber, the wall of the test turns in to form a groove in which there is a slit-like supplementary aperture with a slight lip, connecting to the chamberlet. Attached to the underside of the groove is a partition wall which runs diagonally across the chamber and is attached to the septum of the preceding chamber and the periphery of the earlier whorl. It is not attached to the apertural face of the chamber, but has a rolled and thickened free edge, leaving a narrow space next to the apertural face which gives communication between chamber and chamberlet (Text-fig. 3).

On the dorsal side the chambers are inflated, and a supplementary slit-like aperture in the depressed suture communicates with the chamber. There is an indication of a narrow



TEXT-FIG. 3.—*Epistomariella milletti* n. sp. Specimen broken to show internal structures. *a* primary aperture, *co* communicating opening, *c* chamberlet, *re* rolled edge of partition, *pg* peripheral groove, *p* partition, *s* septum, *sf* septal foramen, *sa* supplementary apertures.

aperture at the base of the apertural face, on the periphery of the earlier whorl, but it is indistinct and does not appear to be open. The septal foramen between chambers is semi-circular and placed above the base of the septum.

Holotype from sample 23.

Dimensions of holotype: Greatest diameter 0.29 mm., thickness 0.13 mm.

Comparing the species with Millett's figures of the form which he referred to *Discorbina semimarginata* d'Orbigny, it would appear to be the same. Millett states that his form "bears a strong resemblance to *Discorbina rimosa* of Parker and Jones, but is devoid of the chinks between the chambers characteristic of that species". The present species does possess "chinks", but they are not at all obvious and are easily overlooked.

Hofker (1953) has studied specimens from the Lutetian of the Paris Basin which he refers to *D. semimarginata* (as *Epistomaria*), and places *D. rimosa* Parker and Jones, hitherto regarded as the genotype by original designation of Galloway's genus *Epistomaria*, in the synonymy of the former species. The original figures and descriptions of both these species are quite inadequate for the purpose of critical comparison, and it does not appear that the original material of either of the authors has been re-studied, leaving the question of the identity of *D. rimosa* with *D. semimarginata* somewhat doubtful.

With this reservation, *Epistomaria semimarginata* (d'Orbigny), as diagnosed by Hofker, has very different characteristics from the present species, in particular a granular, more or less opaque shell wall and a lobulate toothplate structure on the ventral side, rather than actual chamberlets.

The present species closely resembles the figures of *Discorbina rimosa* Parker and Jones, which is recorded by the authors from "Australian coral reefs" as well as from Grignon. Their description, however, mentions a thick shell wall and large pores, neither of which characteristics fit the present form. Considering the wide concept of species held by these authors, it is hard to say whether their figure or description referred to the Eocene or the Recent specimens studied by them, but it seems possible that their Australian specimens were actually the species now being dealt with, lumped with the Eocene form on the grounds of certain similarities such as the marginal apertures. If this were the case, it might explain the disparity between their figure with its smooth, apparently poreless surface and the description quoted above, if the figures were executed from recent specimens. This could only be decided by reference to the original material.

The generic position of this species presents some difficulties. *Epistomariella* Kuwano, 1950 was erected for the reception of forms with a smooth, finely perforate shell wall and rudimentary chamberlets. However, the distinctions between the granular wall of *Epistomaria* (fide Hofker), the coarsely perforate wall of *Epistomaroides* and the finely perforate and smooth wall of *Epistomariella* appear to be more fundamental than the degree of development of chamberlets, and the present specimens are therefore placed in *Epistomariella* on this basis.

Genus *Anomalinella* Cushman, 1927.

(326) *Anomalinella rostrata* (Brady).

Truncatulina rostrata Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, p. 65; 1884, p. 668, pl. xciv, figs. 6a-c.

Anomalinella rostrata (Brady). Cushman, 1927a, p. 93.

Rare in sample 40. This species has a generally Eastern Pacific distribution.

Genus *Siphonina* Reuss, 1856.(327) *Siphonina tubulosa* Cushman.

Siphonina tubulosa Cushman, 1924, Publ. 342, Carnegie Instit. Washington, p. 40, pl. 13, figs. 1, 2.

This species has a wide Indo-Pacific distribution and occurs also in southern Australian waters. Rare in samples of groups 1, 2 and 3.

Genus *Siphoninoides* Cushman, 1927.(328) *Siphoninoides echinatus* (Brady).

Planorbulina echinata Brady, 1879, Quart. Journ. Micr. Sci. XIX, p. 283, pl. viii, fig. 31.

Truncatulina echinata Brady, 1884, p. 670, pl. xcvi, figs. 9-14; Millett, 1898 etc. (1904), p. 490; Heron-Allen and Earland, 1914 etc. (1915), p. 711.

Siphoninoides echinata (Brady). Cushman, 1927, p. 77, pl. 16, fig. 12.

Rare in the samples of groups 1, 2 and 3.

(329) *Siphoninoides glabrus* (Heron-Allen and Earland).

Truncatulina glabra Heron-Allen and Earland, 1914 etc. (1915), Trans. Linn. Soc. London, Zool., XX, pt. 17, p. 711, pl. lii, figs. 41-47.

Siphoninoides glabra (Heron-Allen and Earland). Cushman, 1927b, p. 13.

This smooth form was rather more common than *S. echinatus* in the samples of group 1, 2 and 3.

Subfamily ROTALIINAE.

Genus *Rotalia* Lamarek, 1804.(330) *Rotalia erinacea* Heron-Allen and Earland.

Discorbina imperatoria (d'Orbigny), var. *globosa* Millett (not *Nonionina globosa* v. Hagenow), 1898 etc. (1903), Journ. Roy. Micr. Soc., p. 701, pl. vii, figs. 6a-c.

Rotalia erinacea Heron-Allen and Earland, 1914 etc. (1915), Trans. Linn. Soc. London, Zool. XX, pt. 17, p. 720, pl. liii, figs. 23-26.

This minute species with its globose chambers and long slender spines was rare but well distributed in the shallow-water samples of groups 1, 2 and 3. The apertural characteristics are obscure, but it does not appear to possess the angled extension of the aperture into the apertural face, regarded by Finlay (1939) as diagnostic of the spined genus *Calcarina*. It is therefore left in *Rotalia* as described, with some doubt.

(331) *Rotalia murrayi* Heron-Allen and Earland.

Rotalia murrayi Heron-Allen and Earland, 1914 etc. (1915), Trans. Linn. Soc. London, Zool. XX, pt. 17, p. 721, pl. liii, figs. 27-34.

This species has approximately the same distribution in these samples as *R. erinacea*. The aperture appears to open into the umbilical cavity, but is obscure, and the affinities of the species remain rather doubtful. It is therefore recorded as described.

Genus *Streblus* Fischer, 1817.

(332) *Streblus papillosus* (Brady).

Rotalia papillosa Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 708, pl. clv, figs. 9a, b, c.

This typical Indo-Pacific species was fairly common in the samples of group 3.

(333) *Streblus convexus* n. sp.

(Plate V, figs. 10a, b and c.)

Test subcircular in outline, dorsal side convex, ventral side flattened, periphery rounded and slightly lobulate. Chambers on dorsal side are in 2-3 whorls with up to 11 chambers in the last whorl, sutures oblique, clear and slightly limbate. Chambers on ventral side triangular, wall finely punctate, suture splitting near periphery and leaving a tapering groove which deepens toward the umbilicus, chambers edged with a thin imperforate limbate margin, rounded at the umbilical angle and forming an apical knob of clear shell material in the earlier chambers only. Umbilicus partly filled with a large flat-topped plug, subpolygonal in shape and sparsely perforate. Aperture consists of a low slit at the umbilical margin of the last chamber.

Holotype from sample 8. Occurs in the samples of groups 1, 2 and 3.

Dimensions of holotype: Diameter 0.56 mm., thickness 0.36 mm.

This species differs from *S. beccarii* (Linnaeus) in its smaller dimensions, greater convexity on dorsal side and less exogenous shell growth.

(334) *Streblus tepidus* (Cushman).

Rotalia beccarii (Linnaeus), var. *tepida* Cushman, 1926b, Publ. 344 Carnegie Instit., Washington, p. 79, pl. 1. *Streblus catesbyanus* (d'Orbigny), var. *tepida* (Cushman). Bermudez, 1952, p. 74, pl. xii, fig. 3.

Specimens have been compared with examples of Cushman's variety from the Dry Tortugas, Florida, and are found to be inseparable. This small and delicate form, which does not exceed 0.35 mm. in diameter, is very different from the large, heavy and decorated *S. beccarii* from the Adriatic. Bermudez has placed it as a variety of *S. catesbyanus* d'Orbigny, presumably on account of its lack of an umbilical plug. Its distinctive characters, together with its apparently wide tropical distribution, are here considered to justify its specific separation.

Family CERATOBULIMINIDAE.

Subfamily CERATOBULIMINAE.

Genus *Geminospira* Makiyama and Nakigawa, 1941.

(335) *Geminospira bradyi* Bermudez.

Bulimina convoluta Brady (not *B. pupoides* var. *convoluta* Williamson), 1884, Rep. Voy. Chall., Zool. 9, p. 409, pl. cxiii, figs. 6a, b; Millett, 1898 etc. (1900), p. 274, pl. ii, fig. 9.

Pseudobulimina convoluta Glaessner (not of Williamson), 1937, p. 23, pl. 2, figs. 26, 27; Cushman, 1947, p. 77; Hofker, 1950, p. 386, text-figs. 265, 267.

Geminospira bradyi Bermudez, 1952, pl. xiii, figs. 7a, b (no description or synonymy).

Four specimens of this rare form were found in sample 45. Hofker (loc. cit.) has studied the internal structures in detail, and the author has nothing to add, except to note that in well-preserved specimens there is a clear area surrounding the apertural fold and extending

for some distance dorsally, ventrally and toward the periphery, bordered by a densely perforated area which extends to the suture, as in the genus *Caneris*. This feature is suggested in Millett's figure of the species.

The nomenclature of this species has long been doubtful. The identity of Brady's and Millett's specimens from the tropical Indo-Pacific with Williamson's North Atlantic species has been seriously questioned, although the author is unaware of any actual comparisons being made between specimens representing the original material studied by these authors, or even specimens from the two localities concerned. With these reservations, the re-naming of Brady's form by Dr. Bermudez appears to be well justified.

The earlier relegation of this species to the genus *Pseudobulimina* Earland has little to justify it when comparison is made with the type species of that genus, *P. chapmani* Heron-Allen and Earland. The wall in *G. bradyi* is thin and transparent, and in *P. chapmani* thick and opaque, though it must be noted that Wood (1948) found that the shell wall in both species was radiate. The evolute development of the former contrasted with the tight helicoid spiral of the latter is also noteworthy, and in all the differences amount to quite as much as between some well-established genera of the Rotalidea.

Genus *Cushmanella* D. K. Palmer and Bermudez.

(336) *Cushmanella primitiva* Cushman and McCulloch.

Cushmanella primitiva Cushman and McCulloch, 1940, Allan Hancock Pacific expd. 6, pt. 3, p. 163, pl. 18, figs. 6-8, 10.

A few specimens referable to this species were found in most of the deeper-water dredgings of groups 3 and 4, and occasionally in shallow-water samples. Generally they agree well with the original description, but show a peculiar patterning in the wall caused by irregular lobulate areas of clear shell substance which contrast with the finely-perforate character of the wall in general. The supplementary aperture in the apertural face is small, rounded and obscure, usually marked by a depression in the wall. It can, however, be seen as a rounded opening in the septal face of the penultimate chamber, where it is presumably enlarged by resorption.

Genus *Lamarckina* Berthelin, 1881.

(337) *Lamarckina scabra* (Brady).

Pulvinulina oblonga Williamson, var. *scabra* Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 689, pl. cvi, fig. 8.
Lamarckina scabra (Brady). Cushman, 1926c, p. 13.

Rare, one specimen in sample 44.

Subfamily ROBERTININAE.

Genus *Robertina* d'Orbigny, 1846.

(338) *Robertina tasmanica* Parr.

Robertina tasmanica Parr, 1950, B.A.N.Z.A.R. Exped. Rept. V, pt. 6. Foraminifera, p. 369, pl. xv, figs. 10a, b, 11a, b.

Four specimens from sample 45 are referable to this species, described from off Tasmania.

(339) *Robertina australis* n. sp.

(Plate V, figs. 11a, b.)

Test irregularly fusiform with inflated chambers and lobulate outline, variable in proportions, the length/width ratio varying from 1.65 : 1 to 2.55 : 1. Chambers roughly equal in height and width, up to 6 in the last whorl. Initial end subacute, oral end broadly rounded. Chamber wall thin, fragile and transparent. Aperture loop-shaped, inclined to the axis of the test, in a shallow depression in the face of the last chamber. No secondary aperture was observed.

Holotype from sample 45, where it is not uncommon.

Dimensions of holotype: Length 0.39 mm., width 0.20 mm.

This species has the slender proportions of *R. subteres* (Brady), in some specimens at any rate, but differs in the inflation of the chambers and the lobulate outline.

Genus *Robertinoides* Höglund, 1947.(340) *Robertinoides oceanicus* (Cushman and Parker).

Robertina oceanica Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210-D, p. 75, pl. 18, fig. 18.

One specimen was found in sample 45. The presence of a second aperture in the sutural junction of the last and penultimate chambers is clearly shown in the type figure and is apparent in the specimen studied. As only one specimen was available, the internal features could not be effectively studied, but the external features place the species in the genus *Robertinoides*.

(341) *Robertinoides subcylindricus* (Brady).

Bulimina subcylindrica Brady, 1879 etc. (1881), Quart. Journ. Micr. Sci. XXI, p. 56; 1884, p. 404, pl. 1, figs. 16a, b.

Robertina subcylindrica (Brady) Cushman and Parker, 1947, p. 75, pl. 18, fig. 13 (synonymy).

One small specimen from sample 45 has the long embracing early chambers of this species. Brady's figures do not show the accessory aperture at the junction of the last 2 chambers. It is, however, clear in the present specimen and others in the author's possession. Cushman and Parker mention "supplementary apertures very inconspicuous" in their diagnosis. The presence of the accessory aperture in this well-marked species places it in the genus *Robertinoides*.

Family ANOMALINIDAE.

Subfamily ANOMALININAE.

Genus *Anomalina* d'Orbigny, 1826.(342) *Anomalina tasmanica* Parr.

Anomalina tasmanica Parr, 1950, B.A.N.Z.A.R. Exped. Rept. V, pt. 6, Foraminifera, p. 363, pl. xiv, figs. 4a-c.

Not uncommon in sample 45. This is another example of the general relationship of the deeper-water assemblage to that of south-east Australia.

(343) *Anomalina colligera* Chapman and Parr.

Anomalina ammonoides Brady (not *Rosalina ammonoides* Reuss), 1884, Rep. Voy. Chall., Zool. 9, p. 672, pl. xciv, figs. 2, 3.

A. colligera Chapman and Parr, 1937, Aust. Antarctic Exped. 1911-14, Sci. Repts., ser. C, 1, (2), p. 117, pl. ix, fig. 26; Parr, 1950, p. 362, pl. xv, figs. 3a-c.

This widely-distributed form is not uncommon in sample 45.

Subfamily CIBICIDINAE.

Genus *Cibicides* Montfort, 1808.

(344) *Cibicides praecinctus* (Karrer).

Rotalia praecincta Karrer, 1868, Sitzungsab. d. k. Ak. Wiss. Wien, lvii, p. 189, pl. v, fig. 7.

Truncatulina praecincta (Karrer). Brady, 1884, p. 667, pl. xciv, figs. 1-3.

Specimens agreeing very well with Brady's figures are not uncommon in the samples of group 3. The species has been placed in *Eponides*, but the present specimens show the aperture continuing along the dorsal inferior border of the chamber as in typical *Cibicides*.

(345) *Cibicides subhaidingeri* Parr.

Truncatulina haidingeri Brady (not *Rotalia haidingeri* d'Orbigny) 1884, Rep. Voy. Chall., Zool. 9, p. 663, pl. xciv, fig. 7.

Cibicides subhaidingeri Parr, 1950, p. 364, pl. xv, figs. 7a-c.

Common in sample 45.

(346) *Cibicides lobatulus* (Walker and Jacob).

Nautilus lobatulus Walker and Jacob, 1798, Adams Essays (Kanmacher's Edn.), p. 642, pl. xiv, fig. 36.

Cibicides lobatulus (Walker and Jacob). Cushman, 1918 etc. (1931), p. 118, pl. xxi, fig. 3.

Occasional in the samples of groups 1, 2 and 3, common in sample 26.

Family AMPHISTEGINIDAE.

Genus *Amphistegina* d'Orbigny, 1926.

(347) *Amphistegina radiata* (Fichtel and Moll).

Nautilus radiatus Fichtel and Moll, 1798, Test. Micr., p. 58, pl. 8, figs. a-d.

Amphistegina radiata (Fichtel and Moll). Hofker, 1927, p. 76, pls. xxix, xxx, figs. 2, 3, 4, 6 and 7 (synonymy).

One of the commonest larger foraminifera in the shallow-water samples of groups 1, 2 and 3.

Family CALCARINIDAE.

Genus *Calcarina* d'Orbigny, 1826.

The interpretation of this genus is still a matter of disagreement amongst systematists, as to whether it should apply to the "*Rotalia*" *calcar* and *R. venusta* group or to the more complex rotalids of the *spengleri* group. The author accepts the views of Finlay (1939)

based on Galloway's 1933 classification, that *Calcarina calcar* d'Orbigny is the genotype of this genus, and that the *spengleri* group is correctly placed in Montfort's genus *Tinoporos* with *T. baculatus* Montfort as its genotype.

(348) *Calcarina calcar* d'Orbigny.

Calcarina calcar d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 276, no. 1, Modèles no. 34.

Rotalia calcar (d'Orbigny). Brady, 1884, p. 709, pl. cviii, figs. 3, 4.

Calcarina calcar d'Orbigny. Finlay, 1939, p. 526.

Common in practically all the shallow-water samples of groups 1, 2 and 3.

(349) *Calcarina venusta* (Brady).

Rotalia venusta Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 708, pl. ciii, figs. 2a-c.

Calcarina venusta (Brady). Finlay, 1939, p. 524.

Frequent in the samples of group 3, but not so common or well-distributed as *C. calcar*. Some specimens develop short spines on the periphery, one to each chamber, confirming further the generic relationship to *C. calcar* as adduced by Finlay from apertural characteristics.

Genus *Tinoporos* Montfort, 1808.

(350) *Tinoporos baculatus* Montfort.

Tinoporos baculatus Montfort, 1808, Conchyl. Syst. 1, p. 46, 37e genre.

Calcarina baculatus (Montfort). Cushman, 1919a, pp. 363-368, pl. 1, fig. 3.

Specimens closely following Cushman's diagnosis of this species are not uncommon in the samples of groups 1, 2 and 3. Finlay (1939) has shown that *Tinoporos* Montfort is a valid genus, despite inadequacies and discrepancies in description and figuring, since it is based on the present species (Cushman 1919), giving it a clearly recognizable type species. The use of *Tinoporos* for the *spengleri-baculatus* group rather than the later *Calcarina* d'Orbigny has the practical advantage of allowing the latter to be retained for the *C. calcar* group of rotalids, which are distinct from both *Rotalia* and *Tinoporos*.

It may be noted that Brady's fig. 7, pl. cxiii of the "Challenger" Report appears to belong to this species, rather than *spengleri* to which Brady refers it.

(351) *Tinoporos hispidus* (Brady).

Calcarina hispida Brady, 1876, Proc. Roy. Irish Acad., ser. 2, 2, p. 590; 1884, p. 713, pl. cviii, figs. 8 and 9.

This well-known species occurs commonly in the samples of groups 1, 2 and 3, usually together with *T. baculatus*.

Genus *Baculogypsina* Sacco, 1893.

(352) *Baculogypsina sphaerulata* (Parker and Jones).

Orbitolina sphaerulata Parker and Jones, 1860, Ann. Mag. Nat. Hist., ser. 3, VI, p. 33, no. 8.

Tinoporos baculatus Carpenter (not of Montfort), 1860, p. 557, pls. xviii, xxi; Brady, 1884, p. 716, pl. ci, figs. 4-7.

Baculogypsina sphaerulata (Parker and Jones). Sacco, 1893, p. 206.

Tinoporos baculatus var. *florescens* Chapman, 1901, p. 386, pl. 36, fig. 4.

This species is found in great quantities in the coarser sediments of the littoral region and is rare or absent in deeper-water samples, whether mud or coral sand. It is one of the

few forms with tests able to withstand the pounding of surf, and is hence recognizable as a constituent of the coarser sediments from the surf zone where few other forms survive.

Wherever the species is found in abundance in these samples a small proportion of the tests are found to have flattened and furcate spines, similar to topotype specimens of Chapman's variety *florescens* from the collection of the late W. J. Parr. Variation ranges from specimens with 1 or 2 spines flattened at the tips to those with groups of short radiating spines which project from the surface of the test in 3 or 4 places. The occurrence of these forms in populations of the typical species suggests that they are individual abnormalities caused by factors such as the accidental coalescence of 2 or more spines, and as such not justifying nomenclatorial distinction.

Family CYMBALOPORIDAE.

Genus *Cymbaloporetta* Cushman, 1928.

(353) *Cymbaloporetta bradyi* (Cushman).

Cymbalopora poeyi (d'Orbigny) var., Brady, 1884, p. 637, pl. cii, fig. 14.

C. bradyi Cushman, 1924, Publ. 342, Carnegie Instit. Washington, p. 34, pl. 10, figs 2-4.

Common in all groups.

(354) *Cymbaloporetta squamosa* (d'Orbigny).

Rotalia squamosa d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 272, no. 8.

Cymbaloporetta squamosa (d'Orbigny). Cushman, 1928a, p. 7.

Common in all groups.

Genus *Cymbaloporella* Cushman, 1927.

(355) *Cymbaloporella tabellaeformis* (Brady).

Cymbalopora tabellaeformis Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 727, pl. cii, figs. 15-18.

Cymbaloporella tabellaeformis (Brady). Cushman, 1927a, p. 81, pl. 17, fig. 7.

Occasional in all groups.

Genus *Tretomphalus* Moebius, 1880.

(356) *Tretomphalus milletti* (Heron-Allen and Earland).

Cymbalopora bulloides Millett (not of d'Orbigny), 1898 etc. (1903), Journ. Roy. Micr. Soc., p. 697, pl. vii, fig. 4.

C. milletti Heron-Allen and Earland, 1914 etc. (1915), p. 689, pl. li, figs. 32-35.

Tretomphalus milletti (Heron-Allen and Earland). Cushman, 1934, p. 36, pl. 11, fig. 4.

Fairly common in sample 24, occasional in other samples.

(357) *Tretomphalus planus* Cushman.

Tretomphalus bulloides (d'Orbigny) var. *plana* Cushman, 1924, Publ. 342, Carnegie Instit. Washington, p. 36, pl. 10, fig. 8.

T. planus Cushman, 1934a, p. 94, pl. 11, figs. 11a-c, pl. 12, figs. 18-22.

Occasional specimens in all groups.

(358) *Tretomphalus clarus* Cushman.

Tretomphalus clarus Cushman, 1934a, Contrib. Cushman Lab. Foram. Research, **10**, pt. 4, p. 99, pl. 11, figs. 6a-c, pl. 12, figs. 16, 17.

The *Discorbis*-stage of this species was not uncommon. Some fine specimens with float-chambers intact were found in sample 27.

Family ELPHIDIIDAE.

In this report the genera *Nonion* and *Nonionella* have been treated as belonging to the family Chilostomellidae on the grounds of likeness in wall structure, following the work of Wood (1948). This requires a change in the family name Nonionidae as used in Bermudez' classification of the Rotalidea, which has otherwise been followed. It appears preferable to base any such changed family name on the oldest-established and most typical genus, *Elphidium*.

Genus *Elphidium* Montfort, 1808.(359) *Elphidium advenum* (Cushman).

Polystomella subnodosa Brady (not of Montfort), 1884, p. 734, pl. cx, figs. 1a, b; Chapman, 1901, p. 203; Millett, 1898 etc. (1904), p. 604; Heron-Allen and Earland, 1914 etc. (1915), p. 753.
P. advena Cushman, 1922, Publ. 311, Carnegie Instit. Washington, p. 56, pl. 9, figs. 11, 12.
Elphidium advenum (Cushman), 1918 etc. (1930), p. 25, pl. 10, figs. 1, 2.

This common Indo-Pacific species was found in most of the samples of groups 1, 2 and 3.

(360) *Elphidium craticulatum* (Fichtel and Moll).

Nautilus craticulatus Fichtel and Moll, 1798, Test. Micr., p. 51, pl. 5, figs. h-k.
Polystomella craticulata (Fichtel and Moll). d'Orbigny, 1826, p. 284, no. 3.
Elphidium craticulatum (Fichtel and Moll). Cushman, 1932 etc. (1933), p. 48, pl. 11, figs. 5a, b.

This large coral-reef species was common in the coarser fractions of the samples of groups 1, 2 and 3.

(361) *Elphidium crispum* (Linné).

Nautilus crispus Linné, 1758, Syst. Nat., ed. 10, p. 709.
Polystomella crispa (Linné). Lamarck, 1816 etc. (1822), p. 625.
Elphidium crispum (Linné). Cushman, 1939, p. 50, pl. 13, figs. 17-21 (synonymy).

Large well-developed specimens were common in the samples of groups 1, 2 and 3.

(362) *Elphidium hispidulum* Cushman.

Elphidium hispidulum Cushman, 1936a, Contr. Cushman Lab. Foram. Research, **12**, pt. 4, p. 83, pl. 14, figs. 13a, b.

Frequent in most of the samples of groups 1, 2 and 3. It was described from Western Australia, and appears to be confined to the warmer coastal waters of Australia.

(363) *Elphidium* sp. aff. *josephinum* (d'Orbigny).

(Plate V, fig. 12.)

aff. *Polystomella josephina* d'Orbigny, 1846, For. Foss. bassin Tert. Vienne, p. 130, pl. 6, figs. 25, 26.
Elphidium josephinum (d'Orbigny). Cushman, 1939, p. 43, pl. 11, fig. 15 (synonymy).

One specimen from sample 9 is very close to Cushman's figure of this species. Records are confined to the Miocene of central and southern Europe, but it is not unusual for species originating in this region or their close congeners to be found living in the Indo-Pacific.

(364) *Elphidium limbatum* (Chapman).

Polystomella macella (Fichtel and Moll) var. *limbata* Chapman, 1909, Journ. Quekett Micr. Club, ser. 2, 10, p. 142, pl. 10, figs. 9a, b.

Elphidium macellum (Fichtel and Moll) var. *limbata* (Chapman). Cushman, 1932 etc. (1933), p. 50, pl. 11, figs. 9a, b.

Specimens are closely similar to those from the type locality, Port Phillip Bay, Victoria. It occurs there together with *E. macellum* s. str., and therefore cannot be regarded as a geographical subspecies. The characters are well marked, and it has a wide Indo-Pacific range, being recorded by Cushman from Fiji. It is therefore treated as a distinct species in this report.

Specimens are not uncommon in the samples of groups 1, 2 and 3.

(365) *Elphidium oceanicum* Cushman.

Elphidium oceanicum Cushman, 1932 etc. (1933), U.S. Nat. Mus. Bull. 161, pt. 2, p. 52, pl. 12, figs. 7a, b.

This small species is fairly rare, 1 or 2 specimens per sample being found in many of the samples of groups 1, 2 and 3.

(366) *Elphidium pacificum* n. sp.

(Plate V, fig. 13.)

Elphidium milletti Cushman (not *Polystomella milletti* Heron-Allen and Earland), 1932 etc. (1933), U.S. Nat. Mus. Bull. 161, pt. 2, p. 49, pl. 11, figs. 8a, b.

Three specimens very close to Cushman's figure of a form from the Tonga Islands were found in sample 45. Compared with the original figures of *E. milletti* from the Kerimba Archipelago and with East African specimens which are clearly referable to this species, the present form is seen to differ widely. The outline is much more lobulate and irregular than in *E. milletti*, and the costae, instead of being low or broken and beaded, are high and ridged, tending to obscure the sutures. The rounded periphery and slightly angled form of the costae are the only real points of similarity between the two forms, and it is considered that they are specifically distinct.

Family GLOBIGERINIDAE.

Subfamily GLOBIGERININAE.

Genus *Globigerina* d'Orbigny, 1826.

(367) *Globigerina bulloides* d'Orbigny.

Globigerina bulloides d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 277, no. 1. Modèles no. 17 and no. 76.

Occasional specimens of this wide-ranging species were found in all groups.

(368) *Globigerina* sp. cf. *dubia* Egger.

cf. *Globigerina dubia* Egger, 1857, Neues Jahrb. für. Min. etc., p. 281, pl. ix, figs. 7.9; Brady, 1884, p. 595, pl. lxxix, figs. 17a-c.

Rare in sample 39. This form, which is low-spined, is referred doubtfully to *G. dubia*, rather than the Pacific species *G. eggeri* Rhumbler.

Genus *Globigerinella* Cushman, 1927.(369) *Globigerinella aequilateralis* (Brady).

Globigerina aequilateralis Brady, 1879, Quart. Journ. Micr. Sci. XIX, p. 71; 1884, p. 605, pl. lxxx, figs. 18-21.

Globigerinella aequilateralis (Brady). Cushman, 1927a, p. 87.

Rare in sample 45 (1 specimen).

Genus *Globigerinoides* Cushman, 1927.(370) *Globigerinoides sacculiferus* (Brady).

Globigerina sacculifera Brady, 1877, Geol. Mag., Dec., II, IV, p. 535; 1884, p. 604, pl. lxxx, figs. 11-17, pl. lxxxii, fig. 4.

Globigerinoides sacculifera (Brady). Cushman, 1927, p. 173.

Common in sample 45.

(371) *Globigerinoides conglobatus* (Brady).

Globigerina conglobata Brady, 1879, Quart. Journ. Micr. Sci. XIX, p. 72; 1884, p. 603, pl. lxxx, figs. 1-5, pl. lxxxii, fig. 5.

Globigerinoides conglobata (Brady). Cushman, 1927a, p. 173.

Occasional specimens were found in all groups.

Subfamily PULLENIATININAE.

Genus *Pulleniatina* Cushman, 1927.(372) *Pulleniatina obliquiloculata* (Parker and Jones).

Pullenia obliquiloculata Parker and Jones, 1865, Phil. Trans. CLV, pp. 368, 421, pl. xix, fig. 4.

Pulleniatina obliquiloculata (Parker and Jones). Cushman, 1927a, p. 90, pl. 19, fig. 5.

Rare in sample 45 (2 specimens).

Genus *Sphaeroidinella* Cushman, 1927.(373) *Sphaeroidinella dehiscens* (Parker and Jones).

Sphaeroidina dehiscens Parker and Jones, 1865, Phil. Trans. CLV, p. 369, pl. xix, figs. 5a, b.

Sphaeroidinella dehiscens (Parker and Jones). Cushman, 1927a, p. 90, pl. 19, fig. 2.

One typical specimen was found in sample 45.

Family PEGIDIIDAE.

Genus *Physalidia* Heron-Allen and Earland, 1928.(374) *Physalidia* ? *reniformis* (Heron-Allen and Earland).

Discorbina reniformis Heron-Allen and Earland, 1914 etc. (1915), Trans. Zool. Soc. London, XX, pt. 17, p. 696, pl. lii, figs. 7-14.

Two specimens were found in sample 29. The position of this rarely-recorded species is doubtful, though it definitely does not belong in *Discorbis* s. str., and is probably not closely related to that genus. It is here referred with some doubt to the genus *Physalidia* because of its ovoid shape, its thick, pitted and coarsely-perforate shell wall, and its obscure aperture. This genus was described as having opposed chambers, but the figures of some species (cf. *P. earlandi* Bermudez) could be interpreted as showing loose spiral growth. The present species is trochospiral, tending to open out in the last 1 or 2 chambers. Taking all the observed characters into account, its affinities are probably with the Pegidiidae.

Genus *Pegidia* Heron-Allen and Earland, 1928.(375) *Pegidia dubia* (d'Orbigny).

Rotalia dubia d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 274, no. 24.

Pegidia dubia (d'Orbigny). Heron-Allen and Earland, 1928, Journ. Roy. Micr. Soc., p. 294.

Two characteristic specimens of this rarely-recorded species were found, one each in samples 35 and 40.

Family PLANORBULINIDAE.

Subfamily PLANORBULININAE.

Genus *Planorbulina* d'Orbigny, 1826.(376) *Planorbulina rubra* d'Orbigny.

Planorbulina rubra d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 200, no. 4 (*nomen nudum*).

Gypsina rubra (d'Orbigny). Heron-Allen and Earland, 1914 etc. (1915), p. 725, pl. liii, figs. 35-37.

Planorbulina rubra d'Orbigny. Parr, 1932, p. 232, pl. xxii, figs. 51a-c; 1950, p. 368.

Parr has recorded this species from various localities on the Australian coast. Large incrusting specimens were found in some of the samples of groups 2 and 3, some with a faint pink tinge, but mostly white.

(377) *Planorbulina acervalis* Brady.

Planorbulina acervalis Brady, 1884, Rep. Voy. Chall., Zool. 9, p. 637, pl. xlii, fig. 4.

Occasional specimens were found in most of the samples of groups 1, 2 and 3.

Genus *Acervulina* Schultze, 1854.(378) *Acervulina inhaerens* Schultze.

Acervulina inhaerens Schultze, 1854, Organ. des Polythal., p. 68, pl. vi, fig. 12.

Gypsina inhaerens (Schultze). Brady, 1884, p. 718, pl. cii, figs. 1-6.

Acervulina inhaerens Schultze. Cushman, 1918 etc. (1931), p. 134, pl. xxv, fig. 2; Parr, 1950, p. 368.

Occasional specimens were found in most of the samples of groups 1, 2 and 3.

Subfamily GYPSININAE.

Genus *Gypsina* Carter, 1877.(379) *Gypsina vesicularis* (Parker and Jones).

Orbitolina vesicularis Parker and Jones, 1860, Ann. Mag. Nat. Hist., ser. 3, 6, p. 31, no. 5.
Gypsina vesicularis (Parker and Jones). Carter, 1877a, p. 173.

This common coral-reef species occurred in most of the samples of groups 1, 2 and 3. Particularly well-preserved specimens were found in sample 38.

(380) *Gypsina fimbriata* (Chapman).

(Plate V, figs. 14a, b.)

Planorbulina acervalis Brady var. *fimbriata* Chapman, 1900a, Journ. Linn. Soc., Zool. XXVIII, no. 181, p. 143, pl. 20, fig. 4.

Six specimens were found in sample 38. The test is circular, slightly concave below, campanulate above, with raised rounded centre and flattened periphery. The chambers of the body of the test are subpolygonal, bordered by a clear imperforate wall with papillose prominences at the junctions of polygons, and filled in with a thin perforate diaphragm, added alternately in adjacent chambers so that the surface of the test is on two levels. These chambers are slightly smaller than those of *G. vesicularis* which occurs in the same sample, but are otherwise clearly similar, and bear little resemblance to the inflated, coarsely perforate chambers of *Planorbulina acervalis*.

Fringing the periphery is an alternating series of elongate, subrectangular chambers, with imperforate wall and perforate diaphragm, differing only in size and shape from the other chambers. These fringing chambers occasionally anastomose or fork at the extremity, and are normally separated by a space which will be filled by the next-formed series. The upper surface of the test is brownish, the fringing chambers and the surface layer on the underside being glass-clear. Diameter *ca.* 1 mm.

From Chapman's figures and description, this is evidently the form he had from Funafuti. At first sight the fringing series of chambers suggests relationship with *Planorbulinella*, but there are no special apertures in these chambers, and in all other respects the species is a typical *Gypsina*. Chapman's illustrated specimen appears somewhat eroded, which may account for its reference to *Planorbulina*.

Genus *Sphaerogypsina* Galloway.(381) *Sphaerogypsina globulus* (Reuss).

Ceripora globulus Reuss, 1847, Haidinger's Naturw. Abhandl. II, p. 33, pl. v., fig. 7.
Gypsina globulus (Reuss). Brady, 1884, p. 717, pl. cl., fig. 8.
Sphaerogypsina globulus (Reuss). Galloway, 1933, p. 309, pl. 28, figs. 13, 14.

Occurs with *G. vesicularis* in the samples of groups 1, 2 and 3, with particularly good specimens in sample 38.

Genus *Planogypsina* Bermudez, 1952.(382) *Planogypsina squamiformis* (Chapman).

Gypsina vesicularis Parker and Jones var. *squamiformis* Chapman, 1901, Journ. Linn. Soc., Zool. XXVIII, p. 200, pl. 19, figs. 15a, b.

Planogypsina squamiformis (Chapman). Bermudez, 1952, p. 124, pl. xxiv, fig. 15.

One specimen from sample 38 agrees with Chapman's diagnosis. The chambers are acervuline, in one plane, with a thin wall and slightly inflated perforate diaphragm. On the underside the trochospiral early stage, coloured brown, is clearly visible. The specimen is 1.2 mm. in diameter, but the periphery is broken all round and it is evidently part of a larger specimen.

Genus *Carpenteria* Gray, 1858.(383) *Carpenteria monticularis* Carter.

Carpenteria monticularis Carter; 1877b, Ann. Mag. Nat. Hist. 4, p. 14, pl. xiii, figs. 9.12; Brady, 1884, p. 677, pl. xcix, figs. 1-5.

A few specimens, adherent to calcareous algae, were found in the samples of group 3, wherever bottom conditions favoured the growth of sessile forms, particularly in sample 29.

Genus *Homotrema* Hickson, 1911.(384) *Homotrema rubrum* (Lamarek).

Millepora rubra Lamarek, 1816, Hist. Nat. Anim. sans Vert., p. 202.

Homotrema rubrum (Lamarek). Hickson, 1911, Trans. Linn. Soc. London, Zool., ser. 2, 14, pp. 445-447, pls. 30-32; Emiliani, 1951, pp. 143-147, pls. 15, 16 (synonymy).

Occasional fragments were found in the coarser coral-sand residues of samples of groups 1, 2 and 3.

Genus *Miniacina* Galloway, 1933.(385) *Miniacina miniacea* (Pallas) subsp. *alba* (Carter).

Polytrema miniaceum (Pallas) var. *album* Carter, 1877b, Ann. Mag. Nat. Hist., ser. 4, XIX, p. 213, pl. xiii, fig. 14; Brady, 1884, p. 721, pl. cl, figs. 2, 3.

Occasional specimens were found in the coarser residues, particularly in sample 29.

Family NUMMULITIDAE.

Subfamily NUMMULITINAE.

Genus *Operculina* d'Orbigny, 1826.(386) *Operculina ammonoides* (Gronovius).

Nautilus ammonoides Gronovius, 1781, Zooph. Gron. exh. Anim. Quadr., Leyden, p. 282, pl. xix, figs. 5, 6.

Operculina ammonoides (Gronovius). Carpenter, Parker and Jones, 1862, p. 810; Chapman and Parr, 1938, p. 290, pl. xvii, figs. 12-16, text-fig. 5 (synonymy).

This is the commoner of the two species present in the samples, and is frequent in most of the samples of groups 1, 2 and 3.

(387) *Operculina bartschi* Cushman.

O. bartschi Cushman, 1921, U.S. Nat. Mus. Bull. 100, p. 376, text-fig. 13; Chapman and Parr, 1938, p. 292, pl. xvii, figs. 17-20, text-fig. 6.

Material dredged from Linden Bank (samples 31, 32 and 33) yielded a series of complanate and expanded specimens which are referred to the above species. No 31 contained three very large specimens averaging about 2 cm. in diameter and no. 33 had one broken specimen which had been in the same size range; in no. 32 the specimens did not exceed 6 mm. An example of each type was sectioned, with the following result:

	Small form.	Large form.
Diameter of proloculus	0.04 mm.	0.02 mm.
Maximum diameter of test	5.3 mm.	19.0 mm.
Number of whorls	4	6½
Number of chambers in last whorl	27	38
Total number of chambers	57	140

The specimens thus fall into the normal pattern of alternation of generation, with the microspheric form larger and having more chambers than the megalospheric form. Relative abundance could not be ascertained, as the specimens came from different samples, both of which had apparently been fractionated, no. 31 containing only very large forms, and no. 32 containing nothing larger than 5-6 mm., while no. 33 contained only one broken specimen of the larger form and two of the smaller.

The external characters are those of *O. bartschi* Cushman. In both forms the central portion is thickened, convex and beaded, while the later whorls are thin, complanate and comparatively smooth. Beading in the large specimens is confined to the earlier whorls, the last whorl being smooth. The smaller specimens are beaded throughout, some specimens having the more prominent beading along the sutures, others in a row along the middle of the chamber between the sutures. A strong rounded keel is present, and the larger specimens are somewhat warped out of plane.

Sutures are highly recurved and somewhat wavy and irregular in the later whorls. Some specimens of the smaller form show regular thickenings of the outer face of the septum, marked also by a local widening of the septal canal and suggesting incipient chamberlet growth. They do not, however, amount to partial septation as recorded by Chapman and Parr for *O. complanata* DeFrance.

Genus *Operculinella* Yabe, 1918.388. *Operculinella venosa* (Fichtel and Moll).

Nautilus venosus Fichtel and Moll, 1798, Test. Micr., p. 59, pl. 8, figs. e-h.

Operculinella venosa (Fichtel and Moll). Cushman, 1924, p. 50, pl. 17, fig. 7; Chapman and Parr, 1938, p. 293, pl. xlvii, figs. 21, 22, text-fig. 7 (synonymy).

Well-developed specimens including the evolute microspheric form were common in many of the samples of group 3. Said (1949) has identified "*Nautilus*" *venosus* Fichtel and Moll as a species of *Amphistegina*, rather than of *Operculinella* as considered by Cushman and later authors. Fichtel and Moll's fig. "f", pl. 8, which shows only one side of the test,

could be taken as representing either the dorsal view of *Amphistegina* or one side of the symmetrical *Operculinella*. In the present material there are specimens, considered to be the megalospheric form of *Amphistegina radiata*, which correspond as closely to fig. "f" as do other specimens to fig. "b", of "*Nautilus*" *radiatus* on the same plate, suggesting that *venosa* may be a junior synonym of *A. radiata*. While there is apparently some doubt of the status of "*Nautilus*" *venosus*, it appears to the author that there is as yet insufficient evidence to justify any re-naming of the present species.

Subfamily HETEROSTEGININAE.

Genus *Heterostegina* d'Orbigny, 1826.

389. *Heterostegina suborbicularis* d'Orbigny.

Heterostegina suborbicularis d'Orbigny, 1826, Ann. Sci. Nat. VII, p. 305; Hofker, 1927, p. 70, pls. xxxv, xxxvi, figs. 3, 6-12 (synonymy).

This widely-distributed species is well represented in most of the samples of group 3, but does not occur in the reef collections nor in the two deeper-water samples.

390. *Heterostegina operculinoides* Hofker.

Heterostegina operculinoides Hofker, 1927, Foram. Siboga Exped., pt. 1, p. 67, pls. xxxiv, xxxvi, figs. 1, 2, 4, 5.

Six specimens from sample 46 are referable to this species, the two largest being *ca.* 7 mm. in diameter. The tests are thin, complanate and evolute, only the first few chambers being thickened to form a small raised and beaded boss. The sutures of the early whorls are beaded and limbate, the beading becoming less prominent in the later whorls. The radial sutures of the chamberlets are also limbate, but not so strongly as the septal sutures, so that the surfaces of the chamberlets appear as depressed rectangular areas. The form of the chamberlets is characteristic, being long and narrow, this character being assumed in the earliest whorls. Only the form regarded by Hofker as megalospheric was found.

This sample apparently derives from a plankton net which bottomed at 205 metres. In this area, therefore, *H. operculinoides* appears to be confined to the deeper waters of the continental shelf, while *H. suborbicularis* represents the genus in shallower water.

Genus *Cycloclypeus* Carpenter, 1856.

(391) *Cycloclypeus carpenteri* Brady.

Cycloclypeus carpenteri Brady, 1881, Quart. Journ. Micr. Sci. XXI, p. 67; Chapman, 1900, p. 22, pl. 2, figs. 6, 7, pl. 3, figs. 1-5.

One specimen of the megalospheric form (= *C. guembelianus* Brady) was found in sample 46. The records show that this species is confined to the deeper off-shore waters, and it did not occur in any other sample.

PREVIOUS WORK IN THE REGION.

Up to the time of the voyage of the "Challenger", comparatively little intensive study was made of the Barrier Reef foraminiferal fauna. Parker and Jones had described

species from "Australian coral reefs", and the researches of Carpenter into the detailed morphology of the larger tropical foraminifera are of considerable importance. Unfortunately the "Challenger" collections were confined to the Torres Strait islands. Nevertheless the records then made have been very relevant to the present work, particularly those from Raine Island.

Since the "Challenger" report, only short papers giving faunal lists or dealing with particular species have been published. Jensen (1905) listed foraminifera from Palm and Lizard Islands and described new species. Jensen and Goddard (1907) listed species from Townsville. Chapman (1898) described *Haddonina* from Torres Straits, (1908) recorded dimorphism in *Alveolinella* from Cairns Reef, and (1931) reported on bore samples from Michaelmas Reef. Chapman and Parr (1938) studied the species of *Operculina* and *Operculinella* occurring in the region. Cushman has described new species from the area and (1942) reported on a boring at Heron Island. Cushman and McCulloch (1940, 1942 and 1950) have described new species from West Molle Island, collected by the Allan Hancock Pacific Expeditions.

Parr has from time to time and in the course of other work referred to and resolved many questions of nomenclature in the case of Barrier Reef species, and in his last work (1950) recorded many species as ranging from Tasmania to North Queensland. He erected the genus *Torresina* (1947) to receive a new species from Torres Straits. In general, the foraminifera of this region have been more closely studied than those of the subtropical waters of southern Queensland and New South Wales.

ZOOGEOGRAPHICAL RELATIONSHIPS.

The shallow-water assemblages of the Barrier Reef, as might be expected, show a close relationship with faunas recorded for other locations in the tropical Indo-Pacific, ranging from the east coast of Africa to the islands of the central Pacific and including the Malay Archipelago. There is also a relationship with the raised beaches and shallow-water deposits of the warm phases of the Quaternary in southern Australia, when *Marginopora complanata* flourished as far south as Yorke Peninsula, and other tropical forms penetrated as far as the south coast of Victoria. A further relationship is to be noticed in the tendency for shallow-water tropical species to be represented by a closely-related cool-water form in south-east Australian waters, as in the case of *Discorbis subvesicularis* n. sp. and the well-known *D. dimidiatus* Parker and Jones.

Deeper-water assemblages include many species recorded from Victorian and Tasmanian waters by Chapman, Parr and others, indicating the existence of an eastern Australian continental-shelf fauna which requires much more study before its composition and north-south distribution will be fully understood. This relationship is brought out to some extent by Parr (1950) in recording species from off Tasmania and from the Great Australian Bight and noting their occurrence in Queensland waters.

The present collections throw some light on the northward distribution of previously-known cool-water forms, but much more work in this direction is needed, particularly in the New South Wales and South Queensland coastal waters, from which foraminiferal records are scanty. Greater knowledge of the climatic and depth distribution of recent foraminifera in these areas is needed for the fuller understanding of such factors in relation to Quaternary palaeoecological and climatic studies in southern Australia.

DEPTH INDICATIONS IN RELATION TO REEF BORINGS.

The results of this work have been considered in regard to the light they may throw on problems of reef-building, such as those raised by the Great Barrier Reef bores, 1926 and 1937 (Reports of the Great Barrier Reef Committee, vol. v, 1942). Cushman (*ibid.*, p. 112) suggests that where mixed assemblages of worn larger shallow-water foraminifera and smaller well-preserved deeper-water species occur, greater weight is to be given to the deeper-water specimens in determining the living fauna and hence the probable depth during deposition.

Richards and Hill (*ibid.*, p. 68) draw the inference from Cushman's determinations that, if the above conclusions are correct, alternating shallow and deep-water conditions must have occurred in the area of these bores, and state further that no evidence has been found in favour of such a history, the evidence of the mollusca being definitely at variance with it. Later, the authors state their opinion that the deeper-water types of foraminifera recognized by Cushman have been washed into the shallow shore area and that their smaller size has protected them from wear.

The evidence of the present collections is decidedly in favour of the latter view. Wherever conditions of deposition on the reef-flat or mangrove-pool stations have allowed fine material to collect, such mixtures have been found. The smaller foraminifera include both pelagic and benthic species, the larger forms usually represented by worn specimens of *Baculogypsina*, *Calcarina*, *Marginopora* and *Amphistegina*, perhaps the most characteristic forms found in the coarse coral sands of the surf zone.

Larger foraminifera derived from dredgings a few fathoms deep in the immediate off-shore zone are usually well preserved, though eroded specimens are of course found occasionally. Where bottom sediments are coarse in nature, due to current-sorting, sessile organisms are found on the eroded tests of larger foraminifera. This is rare in littoral deposits, where wave-pounding wears down the tests before such organisms can get a hold. Erosion in the deeper-water specimens appears to have been caused by biological factors such as boring algae, since the tests tend to be rotten and fragmentary rather than smoothly worn down as in the surf zone.

A rough classification of depth indications connected with the state of erosion of tests is as follows :

Assemblage.	Indication.
(1) Larger tests only, <i>Baculogypsina</i> and <i>Marginopora</i> predominant, in various stages of surface wear and smoothing-off of detail	Surf zone.
(2) Mixture of larger tests as in (1) and smaller species in good condition, with some mud	Reef pools and areas of quiet deposition near shore.
(3) Larger tests only, <i>Operculina</i> , <i>Heterostegina</i> and <i>Operculinella</i> predominant, with a proportion rotten and fragmentary and serving as a base for sessile foraminifera and other organisms	Deeper waters off-shore, subject to current-scouring.
(4) Large assemblages of species of various sizes, including the more delicate calcareous and larger arenaceous forms, in fine-grained matrix.	Deeper off-shore waters, mud bottom.

The evidence of the present collections does not go much beyond this, but is sufficient to show that the conditions observed by Cushman in the Barrier Reef bores are more likely to indicate shallow-water or littoral deposition than deep-water deposits comparable

with the depth of boring. The variations in assemblage with depth of bore do not necessarily mean varying depths of deposition. In shallow-water and littoral conditions, where the foraminiferal assemblage is largely a thanatocoenosis, current- and wave-sorting result in the accumulation of coarse or fine sediments in localities perhaps separated by only a few yards. Changes in local topography can result in similar variations occurring in vertical succession, giving very different assemblages by purely mechanical and accidental causes having no depth significance. To interpret such changes correctly requires consideration of the condition of tests, the presence or absence of sessile organisms and the nature of the matrix.

LIST OF LITERATURE.

- BALKWILL, F. P. and MILLETT, F. W. 1884. The Foraminifera of Galway. Journ. Micr. 3, pp. 19-28, 78-90, pls. i-iv.
- BANDY, O. L. 1952. The genotype of *Siphogenerina*. Contr. Cushman Found. Foram. Res. 3, pt. 1, pp. 17-18.
- BATSCH, A. J. G. F. 1791. Sechs Kupfertafeln mit Conchylien des Seesandes. Jena.
- BERMUDEZ, P. J. 1952. Estudio sistematico de los Foraminiferos Rotaliformes. Ministerio de Minas e Hidrocarburos, Venezuela, Boletin de Geologia, 2, No. 4, pp. 1-230, pls. 1-35.
- BERTHELIN, G. 1878. Liste des Foraminifères recueillies dans la Baie de Bourgneuf et à Pornichet. 8vo. Nantes.
- BLAINVILLE, H. M. D. DE. 1834. Manuel d'Actinologie ou de Zoophytologie, pp. 1-644, pls. i-c (in Atlas). Paris. Levrault.
- BRADY, H. B. 1876. On some Foraminifera from the Loo Choo Islands. Proc. Roy. Irish Acad., ser. 2, 2, II, pp. 589-590.
- 1877. Supplementary Note on the Foraminifera of the Chalk (?) of the New Britain Group. Geol. Mag., Dec., II, LV, pp. 534-536.
- 1879 etc. Notes on some of the reticularian Rhizopoda of the "Challenger" Expedition. Quart. Journ. Micr. Sci., 1879, XIX, pp. 20-63, pls. iii-v; pp. 261-299, pl. viii; 1881, *ibid*, XXI, pp. 31-71.
- 1882. Report on the foraminifera. In Tizard and Murray, Exploration of the Faroe Channel during the summer of 1880, in H.M.S. "Knight Errant", with subsidiary reports. Proc. Roy. Soc., Edinburgh, II (1880-82), pp. 708-717, pl. vi.
- 1884. Report on the foraminifera dredged by H.M.S. "Challenger" during the years 1873-76. "Challenger" Exped. Repts., Zool. 9, 2 vols., text and pls.
- 1890. Note on a new type of foraminifera of the family Chilostomellidae. Journ. Roy. Micr. Soc., 1890, pp. 567-571, text-fig.
- PARKER, W. K. and JONES, T. R. 1870. A monograph of the genus *Polymorphina*. Trans. Linn. Soc., London, XXVII, (2), pp. 197-253, pls. xxxix-xlii.
- BROTZEN, F. 1948. The Swedish Paleocene and its Foraminiferal Fauna. Sver. geol. Unders., ser. C, No. 493, Arsbok 42, No. 2, pp. 1-140, pls. 1-19, text-figs. 1-41.
- BUCHNER, P. 1940. Die Lagenen des Golfes von Neapel und der marinen Ablagerungen auf Ischia. Nova Acta Leopoldina. Abh. K. Leopoldinisch-Carolinisch Deutschen Akad. der Naturf. N.F., Bd. 9, No. 62, pp. 363-560, Taf. i-xxix.
- BURROWS, H. W. and HOLLAND, R. 1895. In Jones, Parker and Brady (T. R. Jones). A monograph of the Foraminifera of the Crag, Part II. Pal. Soc. Mon., London, pp. 73-210, pls. 5-7.
- CARPENTER, W. B. 1861. Researches on the Foraminifera. Phil. Trans. 150, pp. 535-586, pls. xvii-xxii.
- PARKER, W. K. and JONES, T. R. 1862. Introduction to the Study of the Foraminifera. Ray Soc., London.
- CARTER, H. J. 1877. Description of a new species of Foraminifera (*Rotalia spiculotesta*). Ann. Mag. Nat. Hist., ser. 4, XX, pp. 470-473, pl. xvi.
- 1877a. On a Melobesian form of Foraminifera (*Gypsina melobesoides* mihi); and further observations on *Carpenteria monticularis*. Ann. Mag. Nat. Hist., ser. 4, XX, pp. 172-176.
- 1877b. On the locality of *Carpenteria balaniformis*, with Description of a new Species, and other Foraminifera found in and about *Tubipora musica*. Ann. Mag. Nat. Hist., ser. 4, XIX, pp. 209-219, pl. xii.

- CHAPMAN, F. 1898. On *Haddonina*, a new Genus of the Foraminifera from Torres Straits. Journ. Linn. Soc., Zool. XXVI, pp. 452-456, pl. 28.
- 1900. On some New and Interesting Foraminifera from the Funafuti Atoll, Ellice Islands. Journ. Linn. Soc., Zool., XXVIII, pp. 1-27, pls. 1-4.
- 1900a. Foraminifera from the Lagoon at Funafuti. Journ. Linn. Soc., Zool., XXVIII, pp. 161-210, pls. 19, 20.
- 1901. On the Foraminifera collected around the Funafuti Atoll from Shallow and Moderately Deep Water. Journ. Linn. Soc., Zool., XXVIII, pp. 379-417, pls. 35, 36.
- 1908. On Dimorphism in the Recent Foraminifer, *Alveolina boscii* DeFr. sp. Journ. Roy. Micr. Soc. for 1908, pp. 151-153, pls. ii, iii, text-fig.
- 1909. Recent Foraminifera of Victoria: Some Littoral Gatherings. Journ. Quekett Micr. Club, ser. 2, 10, pp. 117-146, pls. 9, 10.
- 1910. On the Foraminifera and Ostracoda from Soundings (Chiefly Deep-water) collected round Funafuti by H.M.S. "Penguin". Journ. Linn. Soc., Zool., XXX, pp. 387-444, pls. 54-57.
- 1915. Report on the Foraminifera and Ostracoda obtained by the F.I.S. "Endeavour" from the east coast of Tasmania and off Cape Wiles, South Australia. Australia, Dept. Trade and Customs, Fisheries, Zool. (Biol.) Results, 3 (1), pp. 3-51, pls. i-iii.
- 1931. A Report on Samples obtained by Boring into Michaelmas Reef, about 22 miles N.E. of Cairns, Queensland. Great Barrier Reef Committee, Repts. III, pp. 32-42, pls. ix, x.
- 1941. Report on Foraminiferal Soundings and Dredgings of the F.I.S. "Endeavour" along the Continental Shelf of the S.E. Coast of Australia. Trans. Roy. Soc. S. Aust., 65 (2), pp. 145-211, pls. vii-ix.
- and PARR, W. J. 1935. Foraminifera and ostracoda from soundings made by the trawler "Bonthorpe" in the Great Australian Bight. Journ. Roy. Soc. W. Aust. 21 (1934/35) pp. 1-6, pl. 1.
- — 1937. Aust. Antarctic Exped. 1911-14, Sci. Repts., Ser. C, Zool. and Bot. 1, part ii, Foraminifera, pp. 1-190, pls. viii-x.
- — 1938. Australian and New Zealand Species of the Foraminiferal Genera *Operculina* and *Operculinella*. Proc. Roy. Soc. Victoria, 50, part 1, pp. 279-299, pls. xvi, xvii.
- CHASTER, G. W. 1892. Report upon the Foraminifera of the Southport Society of Natural Science District. Southport Soc. Nat. Sci. 1, pp. 54-71, pl. 1.
- COLLINS, A. C. 1953. Pleistocene Foraminifera from Port Fairy, Western Victoria. Mem. Nat. Mus. Victoria., Melbourne, 18, pp. 93-105, pl. 1.
- COSTA, O. G. 1856. Paleontologia del Regno di Napoli, parti 2. Atti Accad. Pont. VII, pp. 145-378, pls. ix-xxvii.
- CUSHMAN, J. A. 1910 etc. A monograph of the foraminifera of the North Pacific Ocean. Smithsonian Inst., U.S. Nat. Mus. Bull. 71, pt. 1, 1910; pt. 2, 1911; pt. 3, 1913, pt. 4, 1914; pt. 5, 1915, pt. 6, 1917.
- 1910a. New Arenaceous Foraminifera from the Philippines. Proc. U.S. Nat. Mus. 38, No. 1759, pp. 437-442, text-figs. 1-19.
- 1913. New Textulariidae and other Arenaceous Foraminifera from the Philippine Islands and contiguous waters. Proc. U.S. Nat. Mus. 44, No. 1973, pp. 633-638, pls. 78-80.
- 1918 etc. The foraminifera of the Atlantic Ocean. Smithsonian Inst., U.S. Nat. Mus. Bull. 104, pt. 1, 1918; pt. 2, 1920; pt. 3, 1922; pt. 4, 1923, pt. 5, 1924; pt. 6, 1929, pt. 7, 1930, pt. 8, 1931.
- 1918a. Foraminifera from Murray Island, Australia. Publ. 213, Carnegie Instit. Washington, pp. 289, 290, pl. 96.
- 1919. Recent foraminifera from off New Zealand. Proc. U.S. Nat. Mus. 56, No. 2302, pp. 593-640, pls. lxxiv-lxxv.
- 1919a. The relationships of the genera *Calcarina*, *Tinoporos* and *Baculogypsina* as indicated by recent Philippine material. U.S. Nat. Mus. Bull. 100, 1, pt. 6, pp. 363-368, pls. 44, 45.
- 1921. Foraminifera of the Philippine and adjacent seas. U.S. Nat. Mus. Bull. 100, pt. 4, pp. 1-608, pls. 1-xcix.
- 1922. Shallow-water foraminifera of the Tortugas region. Publ. 311, Carnegie Instit. Washington, XVII, pp. 1-85, pls. 1-14.
- 1924. Samoan Foraminifera. Publ. 342, Carnegie Instit. Washington, pp. 3-75, pls. 1-25.
- 1925. Foraminifera of the Tropical Central Pacific. Bernice P. Bishop Mus. Bull. 27, pp. 121-144.
- 1926. Foraminifera of the genera *Siphogenerina* and *Pavonina*. Proc. U.S. Nat. Mus. 67, Art. 25, pp. 1-24, pls. 1-6.
- 1926a. The genus *Chilostomella* and Related Genera. Contr. Cushman Lab. Foramin. Res. 1, pt. 4, pp. 73-80, pl. 11.

- CUSHMAN, J. A. 1926*b*. Recent Foraminifera from Porto Rico. Publ. 344, Carnegie Instit. Washington, pp. 73-84, pl. 1.
- 1926*c*. The genus *Lamarckina* and its American species. Contr. Cushman Lab. Foram. Res. 2, pt. 1, pp. 7-14, pl. 1 (in part).
- 1927. Recent Foraminifera from off the West Coast of America. Bull. Scripps Instit. Oceanogr., Tech. Ser. 1, No. 10, pp. 114-188, pls. 1-6.
- 1927*a*. An outline of a reclassification of the Foraminifera. Contr. Cushman Lab. Foram. Res. 3, pt. 1, pp. 1-105, pls. 1-21.
- 1927*b*. Foraminifera of the genus *Siphonina* and related genera. Proc. U.S. Nat. Mus. 72, Art. 20, pp. 1-15, pls. 1-4.
- 1928. Fistulose species of *Gaudryina* and *Heterostomella*. Contr. Cushman Lab. Foram. Res. 4, pt. 4, pp. 107-112, pl. 16.
- 1928*a*. Additional genera of the foraminifera. Contr. Cushman Lab. Foram. Res. 4, pt. 1, pp. 1-8.
- 1929. The genus *Bolivina* and its species. Contr. Cushman Lab. Foram. Res. 5, pt. 2, pp. 28-34, pl. 5.
- 1931. *Parrina*, a new generic name. Contr. Cushman Lab. Foram. Res. 7, pt. 1, pp. 17, 18, pl. 3 (in part).
- 1931*a*. Two new foraminiferal genera from the South Pacific. Contr. Cushman Lab. Foram. Res. 7, pt. 4, pp. 78-82, pl. 10 (in part).
- 1932 etc. The foraminifera of the tropical Pacific collections of the "Albatross", 1899-1900: U.S. Nat. Mus. Bull. 161, pt. 1, 1932; pt. 2, 1933, pt. 3, 1942.
- 1933. Some new foraminiferal genera. Contr. Cushman Lab. Foram. Res., 9, pt. 1, pp. 21, 22.
- 1933*a*. Some new Recent Foraminifera from the Tropical Pacific. Contr. Cushman Lab. Foram. Res. 9, pt. 4, pp. 77-95, pls. 8-10.
- 1934. A Recent *Gumbelitra*? from the Pacific. Contr. Cushman Lab. Foram. Res. 10, pt. 4, p. 105, pl. 13 (in part).
- 1934*a*. Notes on the genus *Tretomphalus* with descriptions of some new species and a new genus *Pyropilus*. Contr. Cushman Lab. Foram. Res. 10, pt. 4, pp. 79-101, pls. 11, 12, 13 (in part).
- 1936. New genera and species of the families Verneuilinidae and Valvulinidae and of the subfamily Virguliniidae. Sp. Publ. No. 6, Cushman Lab. Foram. Res., pp. 1-71, pls. 1-8.
- 1936*a*. Some new species of *Elphidium* and related genera. Contr. Cushman Lab. Foram. Res. 12, pt. 4, pp. 77-89, pl. 13 (in part), 14, 15.
- 1937. A monograph of the foraminiferal family Verneuilinidae. Sp. Publ. No. 7, Cushman Lab. Foram. Res., pp. i-xiii, 1-157, pls. 1-20.
- 1937*a*. A monograph of the foraminiferal family Valvulinidae. Sp. Publ. No. 8, Cushman Lab. Foram. Res., pp. i-xiii, 1-210, pls. 1-24.
- 1937*b*. A monograph of the subfamily Virguliniinae of the foraminiferal family Buliminidae. Sp. Publ. No. 9, Cushman Lab. Foram. Res., pp. i-xv, 1-228, pls. 1-24.
- 1939. A monograph of the foraminiferal family Nonionidae. U.S. Geol. Survey Prof. Paper 191, pp. 1-100, pls. 1-20.
- 1942. A report on samples obtained by the boring on Heron Island, Great Barrier Reef, Australia. Reports of the Great Barrier Reef Committee, V, Appx. 1, pp. 112-119, pls. 11-12.
- 1944. The genus *Articulina* and its species. Sp. Publ. No. 10, Cushman Lab. Foram. Res., pp. 1-21, pls. 1-4.
- 1944*a*. Foraminifera from the shallow water of the New England coast. Sp. Publ. No. 3, Cushman Lab. Foram. Res., pp. 1-37, pls. 1-4.
- 1945. The species of the subfamily Réussellininae of the foraminiferal family Buliminidae: Contr. Cushman Lab. Foram. Res. 21, pt. 2, pp. 23-54.
- 1946. The genus *Sigmoilina* and its species. Contr. Cushman Lab. Foram. Res. 22, pt. 2, pp. 29-45, pls. 5, 6.
- 1946*a*. The genus *Hauerina* and its species. Contr. Cushman Lab. Foram. Res. 22, pt. 1, pp. 2-15, pls. 1 (in part), 2.
- 1946*b*. *Polysegmentina*, a new genus of the Ophalmidiidae. Contr. Cushman Lab. Foram. Res. 22, pt. 1, p. 1, pl. 1 (in part).
- CUSHMAN, J. A. and BERMUDEZ, P. J. 1949. Some Cuban species of *Globorotalia*. Contr. Cushman Lab. Foram. Res. 25, pt. 2, pp. 26-45, pls. 5-8.
- CUSHMAN, J. A. and GRAY, H. B. 1946. Some new species and varieties of Foraminifera from the Pliocene of Timms Point, California. Contr. Cushman Lab. Foram. Res. 22, pt. 2, pp. 65-69, pl. 12.

- CUSHMAN, J. A. and McCULLOCH, I. 1939. A Report on some Arenaceous Foraminifera. Allan Hancock Pacific Exped. 6, No. 1, pp. 1-113, pls. 1-12.
- — 1940. Some Nonionidae in the collections of the Allan Hancock Foundation. Allan Hancock Pacific Exped. 6, No. 3, pp. 145-178, pls. 17-20.
- — 1942. Some Virguliniinae in the collections of the Allan Hancock Foundation. Allan Hancock Pacific Exped. 6, No. 4, pp. 181-230, pls. 21-28.
- — 1948. The Species of *Bulimina* and related genera in the collections of the Allan Hancock Foundation. Allan Hancock Pacific Exped. 6, No. 5, pp. 231-294, pls. 29-36.
- — 1950. Some Lagenidae in the collections of the Allan Hancock Foundation. Allan Hancock Pacific Exped. 6, No. 6, pp. 295-364, pls. 37-48.
- CUSHMAN, J. A. and PARKER, F. L. 1931. Recent Foraminifera from the Atlantic Coast of South America. Proc. U.S. Nat. Mus. 80, Art. 3, pp. 1-24, pls. 1-4.
- — 1947. *Bulimina* and related foraminiferal genera. U.S. Geol. Survey Prof. Paper 210-D, pp. 55-176, pls. 15-30.
- CUSHMAN, J. A. and TODD, M. R. 1941. Notes on the species of *Uvigerina* and *Angulogerina* described from the Pliocene and Pleistocene. Contr. Cushman Lab. Foram. Res. 17, pt. 3, pp. 70-78, pls. 17-20.
- — 1942. The genus *Cancris* and its species. Contr. Cushman Lab. Foram. Res. 18, pt. 4, pp. 72-94, pls. 17-24.
- — 1943. The genus *Pullenia* and its species. Contr. Cushman Lab. Foram. Res. 19, pt. 1, pp. 1-23, pls. 1-4.
- — 1944. The genus *Spiroloculina* and its species. Sp. Publ. No. 11, Cushman Lab. Foram. Res., pp. 1-82, pls. 1-9.
- — 1944a. Species of the genera *Nodopthalmidium*, *Nodobaculariella* and *Vertebralina*. Contr. Cushman Lab. Foram. Res. 20, pt. 3, pp. 64-77, pls. 11-12.
- CUSHMAN, J. A. and OZAWA, Y. 1930. A Monograph of the Foraminiferal Family Polymorphinidae, Recent and Fossil. Proc. U.S. Nat. Mus. 77, Art. 6, pp. 1-185, pls. 1-40.
- DOUVILLÉ, H. 1906. Les calcaires à Fusulines de l'Indochine. Bull. Soc. Géol. France, ser. 4, 6, pp. 576-587, pls. xvii, xviii.
- EARLAND, A. 1933. Foraminifera; Part II, South Georgia. "Discovery" Repts., Cambridge, VII, pp. 27-133, pls. i-iv.
- 1934. Foraminifera; Part III, The Falklands Sector of the Antarctic (excluding South Georgia). "Discovery" Repts., Cambridge, X, pp. 1-208, pls. i-x.
- EGGER, J. G. 1857. Die Foraminiferen der Miocän-Schichten bei Ortenburg in Nieder-Bayern. Neues Jahrb. für Min., Jahrg. 1857, pp. 266-311, pls. 5-15.
- 1893. Foraminiferen aus Meersgrundproben, gelothet von 1874 bis 1876 von S. M. Sch. "Gazelle". Abhandl. kön. bay. Akad. Wiss., München, Cl. II, 18, Abt. 2, pp. 195-458, 21 pls., 1 map.
- EHRENBURG, C. G. 1843. Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika. K. Akad. Wiss., Berlin, Physik Abh., Jahrg., 1841, pp. 291-445, pls. i-iv.
- 1854. Mikrogeologie. Leipzig, 2 vols. folio, 40 pls.
- EIMER, G. H. T. and FICKERT, C. 1899. Die Artbildung und Verwandtschaft bei den Foraminiferen. Zeitschr. Wiss. Zool., Leipzig, 65, pp. 599-708, text-figs. i-xlv.
- EMILIANI, C. 1951. On the species *Homotrema rubrum* (Lamarck). Contr. Cushman Found. Foram. Res. II, pt. 4, pp. 143-147, pls. 15-16, fig. 1.
- FICHEL, L. v. and MOLL, J. P. C. v. 1798. Testacea microscopica aliaque minuta ex generibus Argonauta et Nautilus ad naturam delineata et descripta. Vienna.
- FINLAY, H. J. 1939 etc. New Zealand Foraminifera: Key Species in Stratigraphy. No. 1, Trans. Roy. Soc. New Zealand, 68, (1939), pp. 504-533, pls. 68, 69; No. 2, l. c., 69, (1939), pp. 89-128, pls. 11-14; No. 3, l. c., pp. 309-329, pls. 24-29; No. 4, l. c., 69, (1940), pp. 448-472, pls. 62-67.
- FLINT, J. M. 1899. Recent Foraminifera. A descriptive catalogue of specimens dredged by U.S. Fish Commission Steamer "Albatross". U.S. Nat. Mus., Ann. Rept., 1897, pt. 1, pp. 249-349, pls. i-lxxx.
- FORNASINI, C. 1900. Le Polymorphine e le Uvigerine fossili d'Italia. Boll. Soc. Geol. Ital. 19, pp. 132-172, 7 figs.
- 1902. Intorno a la nomenclatura di alcuni nodosaridi neogenici italiani. Mem. Accad. Sci. Istit. Bologna, 9 (1901), pp. 45-76, 27 text-figs.
- FORSKÅL, P. 1775. Descriptiones Animalium, etc. 4to, Copenhagen.
- FRIZZELL, D. L. and SCHWARTZ, E. 1950. A new Lituolid Foraminiferal Genus from the Cretaceous, with an emendation of *Cribrostomella* Cushman. Univ. Missouri, School of Mines and Metallurgy, Tech. Ser., Bull. 76, pp. 1-12, pl. 1, text-fig. 1.

- GALLOWAY, J. J. 1933. A Manual of Foraminifera. 4to, Bloomington, Indiana; pp. i-xii, 1-483, 42 pls.
- and MORREY, M. 1929. A Lower Tertiary Foraminiferal Fauna from Manti, Ecuador. Bull. Amer. Pal. XV, No 55, pp. 7-56, pls. i-vi.
- GLAESSNER, M. 1937. On a New Family of Foraminifera. Studies in Micropaleontology, 1, fasc. 3, pp. 19-29, pls. i, ii.
- 1947. Principles of Micropalaeontology. 4to, Melbourne, pp. i-xvi, 1-297, 14 pls., 7 tables, 64 text-figs.
- GODDARD, E. J. and JENSEN, H. I. 1907. Contributions to a knowledge of Australian foraminifera, Part II. Proc. Linn. Soc. New South Wales, 32, pp. 281-318, pl. vi.
- GRONOVIVS, L. T. 1781. Zoophylacium Gronovianum etc. Leyden.
- HADA, Y. 1931. Report of the Biological Survey of Mutsu Bay. 19. Notes on the Recent Foraminifera from Mutsu Bay. Sci. Repts. Tohoku Imp. Univ., 4th Ser., Biol. VI, No. 1, pp. 45-148, text-figs. 1-95.
- HERON-ALLEN, E. and EARLAND, A. 1913. On some Foraminifera from the North Sea, dredged by the Fisheries Cruiser "Goldseeker"; No. 3. Journ. Roy. Micr. Soc. for 1913, pp. 272-276, pl. xi.
- — 1913a. Clare Island Survey, pt. 64, Foraminifera. Proc. Roy. Irish Acad. XXXI, sect. 3 (1911-15), pp. 1-188, pls. i-xiii.
- — 1914 etc. The Foraminifera of the Kerimba Archipelago (Portuguese East Africa). Trans. Zool. Soc. London, 20, pt. 1, 1914, pp. 363-390, pls. xxxv-xxxvii; pt. 2, 1915, pp. 543-794, pls. xl-liii.
- — 1922. Protozoa, Part II, Foraminifera. Brit. Antarctic (Terra Nova) Exped., 1910, Nat. Hist. Repts., Zool. 6 (2), pp. 25-268, pls. i-viii.
- — 1924. The Foraminifera of Lord Howe Island, South Pacific. Journ. Linn. Soc., Zool. 35, pp. 599-647, pls. 35-37.
- — 1924a. The Miocene Foraminifera of the "Filter Quarry", Moorabool River, Victoria, Australia. Journ. Roy. Micr. Soc., 1924, pp. 121-186, pls. 7-14.
- — 1928. On the Pegididae, a New Family of Foraminifera. Journ. Roy. Micr. Soc. 48, pp. 283-299, 3 pls.
- — 1932. Foraminifera. Part 1. The ice-free area of the Falkland Islands and adjacent seas. "Discovery" Repts., Cambridge, 4, pp. 291-460, pls. vi-xvii.
- HICKSON, S. J. 1911. On *Polytrema* and some allied genera. Trans. Linn. Soc. London., Zool., ser. 2, 14, 442-62, pls. 30-32.
- HOFKER, J., 1927. The Foraminifera of the Siboga Expedition. Part I. Monograph IV, Siboga Exped., Pt. I, pp. 1-78, pls. i-xxxviii, text-figs. 1-11.
- 1951. The Foraminifera of the Siboga Expedition, Part III. Monograph IVa, Siboga Exped., pp. 1-508, text-figs. 1-348.
- 1953. The genus *Epistomaria* Galloway 1933, and the genus *Epistomaroides* Uchio 1952. Paläont. Zeitschr., 27, Nos. 3/4, pp. 129-142, text-figs. 1-14.
- HÖGLUND, H. 1947. Foraminifera in the Gullmar Fjord and the Skagerrak. Zool. Bidr. från Uppsala, Bd. 26, pp. 3-328, pls. 1-32, text-figs. 1-312.
- HOWCHIN, W. and PARR, W. J. 1938. Notes on the Geological Features and Foraminiferal Fauna of the Metropolitan Abattoirs Bore, Adelaide. Trans. Roy. Soc. South Australia, 62 (2), pp. 287-317, pls. xv-xix.
- JENSEN, H. I. 1905. Contributions to a knowledge of Australian foraminifera; Part I. Proc. Linn. Soc. New South Wales, 29 (1904), pt. 4, pp. 810-832, pl. xxiii.
- JONES, F. W. O. RYMER. 1872. On some Recent forms of Lagenae from Deep-sea Soundings in the Java Sea. Trans. Linn. Soc. London, XXX, p. 45, pl. xix.
- JONES, R. T. and PARKER, W. K. 1860. On the Rhizopodal fauna of the Mediterranean, compared with that of the Italian and some other Tertiary deposits. Quart. Journ. Geol. Soc., XVI, pp. 292-307.
- — and BRADY, H. B. 1866 etc. A Monograph of the foraminifera of the Crag. Palaeontogr. Soc., London, pt. 1, 1866, pp. 1-72; pt. 2, 1895, pp. 73-210, pt. 3, 1896, pp. 211-314; pt. 4, 1897, pp. 315-402.
- KARRER, F. 1868. Die Miocene Foraminiferen-Fauna von Kostež im Banat. Sitz. Akad. Wiss. Wien, VIII, pp. 111-193, pls. i-v.
- LAMARCK, J. P. B. A. DE. 1804 etc. Explication a des planches relatives aux coquilles fossiles des environs de Paris. Ann. du Mus. (Paris), 5, 1804, pp. 179-180, 237-245, 349-357. Continued in vol. 8, 1806, pp. 383-387, pl. lxii, and vol. 9, pp. 236-240, pl. xvi.
- 1816 etc. Histoire naturelle des Animaux sans Vertèbres. Paris, 2, 1816, pp. 193-197; 7, 1822, pp. 580-632.

- LACROIX, E. 1938. Révision des genre *Massilina*. Bull. l'Inst. Océanogr. (Monaco), No. 754, pp. 1-11, text-figs. 1-9.
- LALICKER, C. G. and McCULLOCH, I. 1940. Some Textulariidae of the Pacific Ocean. Allan Hancock Pacific Exped. 6, No. 2, pp. 115-143, pls. 13-16.
- LINNE, C. A. 1758. Systema Naturae, ed. 10. 8vo, Stockholm.
- LOEBLICH, A. R. jun. and TAPPAN, H. 1953. Studies of Arctic Foraminifera. Smithsonian Misc. Coll. 121, No. 7, pp. 1-143, pls. 1-24, 1 text-fig.
- ——— 1954. Emendation of the foraminiferal genera *Ammodiscus* Reuss, 862, and *Involutina* Terquem, 1862. Journ. Washington Acad. Sci. 44, No. 10, pp. 306-310, text-figs. 1, 2.
- MILLETT, F. W. 1898 etc. Report on the recent foraminifera of the Malay Archipelago contained in anchor-mud, collected by Mr. A. Durrand, F.R.M.S. Journ. Roy. Micr. Soc., 1898, pp. 258-269, 499-513, 607-614; 1899, pp. 249-255, 357-365, 557-564; 1900, pp. 6-13, 273-281, 539-549; 1901, pp. 1-11, 485-497, 619-628; 1902, pp. 509-528; 1903, pp. 253-275, 685-704; 1904, pp. 489-506, 597-609. 19 pls.
- MONTAGUE, G. 1803-8. Testacea Britannica, or natural history of British shells. 3 vols., London, 1803. Supplement (pls.) 1808.
- MONTFORT, D. DE. 1808. Conchyliologie Systematique et Classification Méthodique des Coquilles, etc. 2 vols. Paris. 1808-10.
- MYERS, E. H. 1935. The Life History of *Patellina corrugata* Williamson, a foraminifer. Bull. Scripps Instit. Oceanogr., Tech. Ser. 3, pp. 355-392, pls. 10-16, 1 text-fig.
- NORMAN, A. M. 1876. In Jeffries, Preliminary Report of the Biological Results of a Cruise in H.M.S. "Valorous" to Davis Strait in 1875. Proc. Roy. Soc. XXV, p. 202.
- 1878. On the Genus *Haliphysema*, with a description of several forms apparently allied to it. Ann. Mag. Nat. Hist., ser. 5, 1, p. 265, pl. xvi.
- D'ORBIGNY, A. D. 1826. Tableau méthodique de la classe des Céphalopodes. Ann. Sci. Nat., Paris., ser. 1, 7, pp. 96-314, pls. x-xvii (in Atlas).
- 1839. Voyage dans l'Amérique Méridional: Foraminifères. Strasbourg, P. Bertrand, 5, pt. 5, pp. 1-86, pls. i-ix.
- 1839a. Foraminifères. In Sagra, R. de la, Histoire physique, politique et naturelle de l'île de Cuba, pp. 1-224 (plates published separately), Paris, A. Bertrand.
- 1839b. Foraminifères des Iles Canaries. In Barker-Webb and Berthelot, Histoire Naturelle des Iles Canaries, Paris, Béthune, tome 2, pt. 2, Zool., pp. 119-146, pls. i-iii.
- 1846. Foraminifères fossiles du bassin tertiaire de Vienne (Autriche). Paris, Gide et Cie, pp. 1-303, pls. i-xxi.
- OVEY, C. D. 1947. Note on the taxonomy of *Spirillina limbata* var. *denticulata* Brady. Journ. Micr. Soc. 67, pp. 17, 18.
- PARKER, W. K. and JONES, T. R. 1860. On the nomenclature of the Foraminifera, IV, The Species enumerated by Lamarck. Ann. Mag. Nat. Hist. 6, pp. 29-40.
- ——— 1865. On some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay. Phil. Trans. Roy. Soc. 155, pp. 325-441, pls. xiii-xix.
- ——— and BRADY, H. B. 1865. On the nomenclature of the Foraminifera, XII. The Species enumerated by d'Orbigny in the Annales des Sciences Naturelles, vii, 1826, (3) The Species illustrated by Modèles. Ann. Mag. Nat. Hist. 16, pp. 15-41, pls. 1-3.
- PARR, W. J. 1932. Victorian and South Australian Shallow-water Foraminifera; Part I. Proc. Roy. Soc. Victoria, XLIV (n.s.), pt. 1, pp. 1-14, pl. i; Part II, *ibid.*, XLIV (n.s.), pt. 2, pp. 218-234, pls. xxi, xxii.
- 1939. Foraminifera of the Pliocene of South-Eastern Australia. Min. Geol. Journ., Victoria, 1, No. 4, pp. 65-71, 1 pl.
- 1941. A New Genus, *Planulinoides*, and some Species of Foraminifera from Southern Australia. Min. Geol. Journ., Victoria, 2, No. 5, p. 315, text-fig.
- 1943. In Cotton and Godfrey, 1943, A Systematic List of the Echinodermata, Foraminifera, Hydroida and Brachiopoda of Southern Australia. Publ. No. 3, Malac. Soc. South Australia, Adelaide.
- 1945. Recent Foraminifera from Barwon Heads, Victoria. Proc. Roy. Soc. Victoria, 56 (n.s.), pt. 2, pp. 189-218, pls. viii-xii.
- 1947. The Lagenid Foraminifera and their Relationships. Proc. Roy. Soc. Victoria, 58 (n.s.), pp. 116-130, pls. vi, vii.
- 1947a. On *Torresina*, a new genus of the Foraminifera from Eastern Australia. Journ. Roy. Micr. Soc. LXIV, pp. 129-135, pl. i, text-figs. 1-3.

- PARR, W. J. 1950. Foraminifera. B.A.N.Z. Antarctic Research Exped. 1929-31, Repts., Ser. B. (Zool. and Bot.) V, pt. 6, pp. 223-392, pls. iii-xv, text-figs. 1-8.
- and COLLINS, A. C. 1930. Notes on Australian and New Zealand Foraminifera; No. 1, The species of *Patellina* and *Patellinella*, with a description of a new genus *Annulopatellina*. Proc. Roy. Soc. Victoria, 43 (n.s.), pp. 89-95, pl. iv.
- REUSS, A. E. 1847. In Haidinger's Naturw. Abhandl. 2.
- 1850. Neue Foraminiferen aus dem Schichten des österreichischen Tertiärsbeckens. Denkschr. Akad. Wiss. Wien, 1, pp. 365-390, pls. 46-51.
- 1851. Ueber die fossilen Foraminiferen und Entomostraceen der Septarienthon der Umgegend von Berlin. Zeitschr. deutsch. geol. Gesel. 3, pp. 49-92, pls. iii-vii.
- 1863. Beiträge zur tertiären Foraminiferen-Fauna. Sitzungsber. d. k. Akad. Wiss. Wien, 48, pp. 36-69, pls. 1-8.
- 1865. Die Foraminiferen, Anthozoen and Bryozoen des Deutsches Septarienthones. Denkschr. d. k. Akad. Wiss. Wien, XXV, pp. 117-214, pls. i-xi.
- RHUMBLER, L. 1903. Systematische Zusammenstellung der recenten Reticulosa. Arch. Protist., Jena, III, pp. 181-294.
- 1906. Foraminiferen von Laysan und den Chatham Inseln. Zool. Jahrb., Abt. Syst., Jena, Bd. 24, pp. 21-80, taf. ii-v.
- SACCO, F. 1893. Sur quelques Tinoporinae du Miocène de Turin. Soc. Belge. Geol., Pal. Hydr. Bull., Bruxelles, 7, fasc. 3.
- SAID, R. 1949. Foraminifera of the Northern Red Sea. Sp. Publ. 26, Cushman Lab. Foramin. Res.
- SCHUBERT, R. 1907. Beiträge zu einer natürlichen Systematik der Foraminiferen. Neues Jahrb. für Min., 25, pp. 233-260, text-fig.
- SCHULTZE, M. S. 1854. Ueber den Organismus der Polythalamien (Foraminiferen), nebst Bemerkungen über die Rhizopoden im allgemein. Fol., 7 pls., Leipzig.
- SCHWAGER, C. 1866. Fossile Foraminiferen von Kar-Nicobar. Novara Exped. 1857-59. Wien, Bd. 2, Geol. Theil, pp. 187-268, taf. iv-vii.
- 1878. Nota su alcuni foraminiferi nuovi del tufo di Stretto presso Girgenti. Italy, Uff. Geol. (R. Comm. Geol. Ital.), Boll., col. 9, pp. 511-514, 519-529.
- SEGUENZA, G. 1862. Dei terreni terziari del distretto di Messina; Parti II—Descrizione dei foraminiferi monotalamica delle marne mioceniche del distretto di Messina. Messina, T. Capra, pp. 1-84, tav. i, ii.
- 1880. Le Formazione Terziarie nella Provincia di Reggio (Calabria). Atti Accad. Lincei, ser. 3, 6, pp. 1-446, pls. 1-17.
- SIDEBOTTOM, H. 1904, etc. Report on the Recent Foraminifera from the coast of the Island of Delos (Grecian Archipelago). Mem. Proc. Manchester Lit. Phil. Soc., Part I (1904), xlviii, pt. II, no. 5; Part II (1905), xlix, no. 5; Part III (1906), 1, no. 5; Part IV (1907) li, no. 9; Part V (1908), lii, no. 13; Part VI (1909), liii, no. 21.
- 1912 etc., Lagenae of the South-west Pacific Ocean, from soundings taken by H.M.S. "Waterwitch", 1895. Journ. Quekett Micr. Club, ser. 2, 11, 1912, No. 70. pp. 375-434, pls. xiv-xxi. Supplementary paper, 12, 1912, No. 73, pp. 161-210, pls. xv-xviii.
- 1918. Report on the Recent Foraminifera dredged off the East Coast of Australia. Journ. Roy. Micr. Soc., 1918, pp. 1-25, 121-153, 249-264, pls. 1-6.
- SILVESTRI, A. 1904. Ricerche strutturali su alcune forme dei trubi di Bonfornello (Palermo). Mem. Pont. Accad. Nuovi Lincei, 22, pp. 235-276, 14 text-figs.
- SILVESTRI, O. 1872. Le Nodosarie fossile nel Terreno subappennino Italiani e viventi nei Mari d'Italia. 11 pls., Catania.
- TERQUEM, O. 1875 etc. Essai sur le Classement des Animaux qui vivent sur la Plage et dans les Environs de Dunkerque. 8vo, Paris, fasc. 1, 1875, pp. 1-54, pls. i-vi; fasc. 2, 1876, pp. 55-100, pls. vii-xii; fasc. 3, 1881, pp. 101-152, pls. xiii-xvii.
- 1878. Les Foraminifères et les Entomostracés-Ostracodes du Pliocène supérieur de l'Île de Rhodes. Mem. Soc. Géol. France, ser. 3, 1, pp. 1-133, pls. 1-14.
- THALMANN, H. E. 1950. New names and homonyms in Foraminifera. Contr. Cushman Found. Foramin. Res. 1, pts. 3 and 4, pp. 41-45.
- UCHIO, T. 1950. Foraminiferal study of tertiary Formation near Otaki Gas Field, Chiba Prefecture (ser. 1), In Natural Gas in the Vicinity of Otaki, Chiba kin, by K. Kawai and others. Journ. Assoc. Petr. Techn. 15, No. 4, pp. 151-219, text-figs. 1-25.
- 1952. Foraminiferal assemblage from Hachigo Island, Tokyo Prefecture, with descriptions of some new genera and species. Japanese Journ. Geol. Geog. 22, pp. 145-159, pls. 6, 7, text-figs. A-C, table 1.

- WALKER, G. and JACOB, E. 1798. *In* Kanmacher, F., Adams' Essays on the Microscope, 2nd. Edn. 4to, London.
- WIESNER, H. 1912. Zur Systematik adriatischer Nubecularien, Spiroloculinen, Miliolinen und Biloculinen. *Arch. Protist.* 25, pp. 201-239. text-figs.
- 1931. Die Foraminiferen. *In* Drygalski, E. von, Deutsche Sud-polar Exped. 1901-3. Bd. 20 (Zool. Bd. 12), pp. 53-165, Taf. i-xxiv.
- WILLIAMSON, W. C. 1848. On the Recent British species of the genus *Lagena*. *Ann. Mag. Nat. Hist.*, ser. 2, 1, pp. 1-20, pls. i, ii.
- 1858. On the Recent Foraminifera of Great Britain. Ray Soc., London.
- WRIGHT, J. 1886. Report on the Marine Fauna of the South-west of Ireland—Foraminifera. *Proc. Roy. Irish. Acad.*, ser. 2, iv (1887) (Science), pp. 607-614.
- 1891. Report on the foraminifera obtained off the south-west coast of Ireland during the cruise of the "Flying Falcon". *Proc. Roy. Irish. Acad.*, ser. 3, 1 (1889-91), No. 4, pp. 460-502, pl. xx.
- 1911. *In* Heron-Allen and Earland, 1908-11, On the recent and fossil foraminifera of the shore sands of Selsey Bill, Sussex. *Journ. Roy. Micr. Soc.*, 1911, pp. 298-343.
- WOOD, A. 1948. The structure of the wall of the test in the Foraminifera; its value in classification. *Quart. Journ. Geol. Soc. CIV*, pt. 2, pp. 9-252, pls. xiii-xv.

PLATE I.

- FIG. 1.—*Discobotellina biperforata* n. sp. Holotype (Form 2). “a” side view, “b” edge view. × 2.
FIG. 2.—*D. biperforata* n. sp. Paratype (Form 1). “a” side view, “b” edge view. × 3.
FIG. 3.—*D. biperforata* n. sp., specimen broken in half and showing internal structure. × 4.
FIG. 4.—*Saccamina consociata* (Flint). × 28.
FIG. 5.—*Involutina* sp. × 45.
FIG. 6.—*Glomospira elongata* n. sp. Holotype. “a” side view, “b” end view. × 72.
FIG. 7.—*G. elongata* n. sp., immature test showing coiling of early whorls. “a” side view, “b” end view. × 72.
FIG. 8.—*Lituotuba minuta* n. sp. Holotype. × 72.
FIG. 9.—*Ammolagena clavata* (Parker and Jones), two-chambered specimen. × 45.
FIG. 10.—*Ammomarginulina australiensis* n. sp. Holotype. “a” side view, “b” apertural view. × 64.
FIG. 11.—*Nouria textulariformis* Hada, *armata* n. subsp. Holotype. “a” side view, “b” apertural view. × 45.
FIG. 12.—*Trochammmina chitinoso* n. sp. Holotype. “a” dorsal view, “b” ventral view, “c” edge view. × 120.
FIG. 13.—*Gaudryina* (*Siphogaudryina*) *wrightiana* Millett. “a” and “b” side views, “c” basal view. × 120.
FIG. 14.—*G. (Pseudogaudryina) concava* n. sp. Holotype. “a” side view, “b” apertural view, “c” basal view. × 45.

-1 OCT 1958

RECEIVED



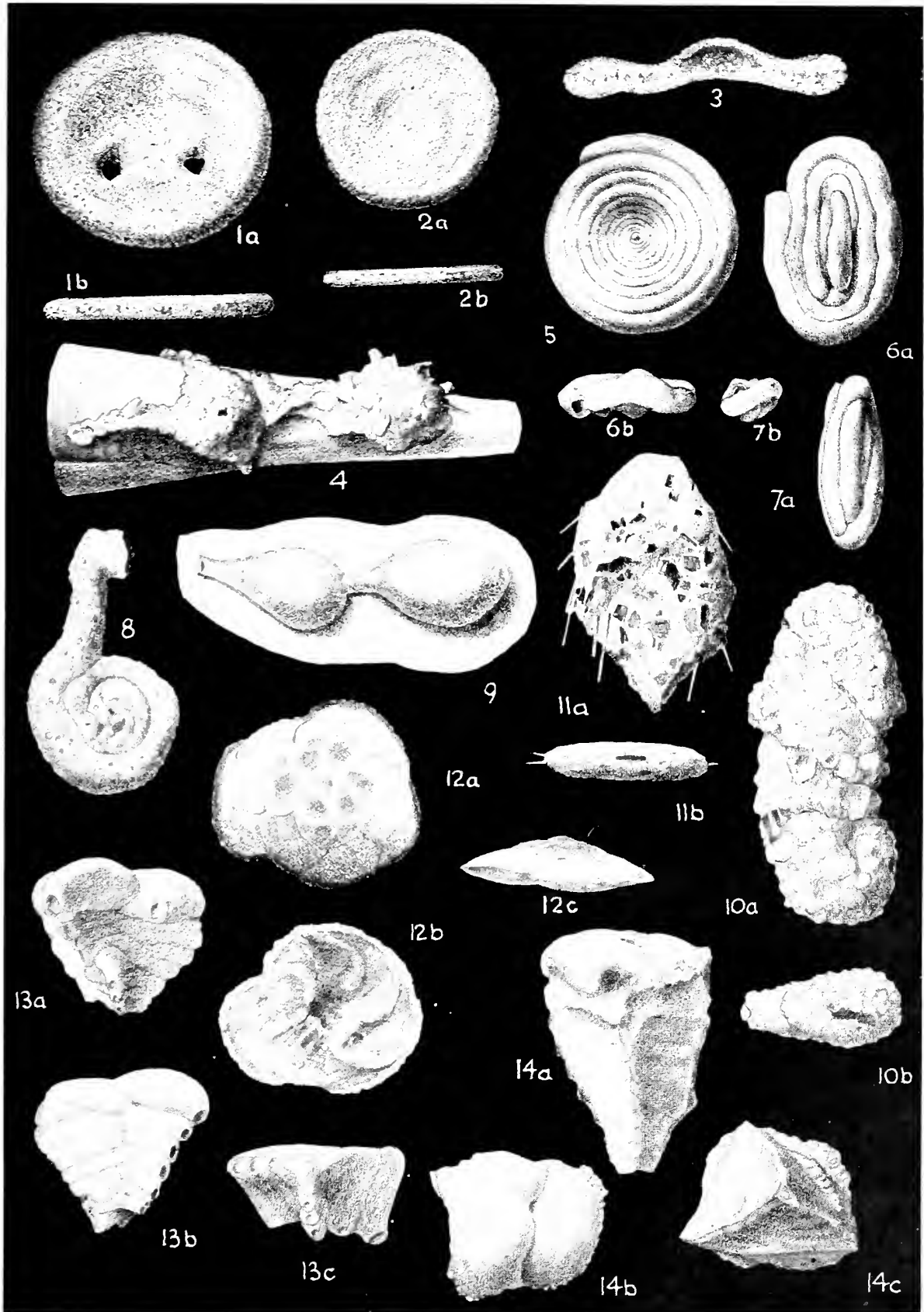


PLATE II.

- FIG. 1.—*Eggerella australis* n. sp. Holotype. “a” side view, “b” apertural view. $\times 120$.
FIG. 2.—*E. polita* n. sp. Holotype. “a” side view, “b” apertural view. $\times 120$.
FIG. 3.—*Dorothia inepta* n. sp. Holotype. Side view. $\times 30$.
FIG. 4.—*D. inepta*, early chambers of another specimen exposed by grinding. $\times 50$.
FIG. 5.—*Karrerrella (Karrerulina) attenuata* n. sp. Holotype. Side view. $\times 120$.
FIG. 6.—*Quinqueloculina crassicarinata* n. sp. Holotype. “a” and “b” side views, “c” apertural view. $\times 45$.
FIG. 7.—*Q. cuvieriana* d’Orbigny, *queenslandica* n. subsp. Holotype. “a” and “b” side views, “c” apertural view. $\times 66$.
FIG. 8.—*Q. quinquecarinata* n. sp. Holotype. “a” and “b” side views, “c” apertural view. $\times 110$.
FIG. 9.—*Massilina subrugosa* n. sp. Side view. $\times 22$.
FIG. 10.—*M. secans* d’Orbigny, *tropicalis* n. subsp. Holotype. “a” and “b” side views, “c” apertural view. $\times 36$.
FIG. 11.—*M. corrugata* n. sp. Holotype. “a” and “b” side views, “c” apertural view. $\times 36$.
FIG. 12.—*M. corrugata* n. sp. Paratype. “a” and “b”, side views, “c” apertural view. $\times 36$.



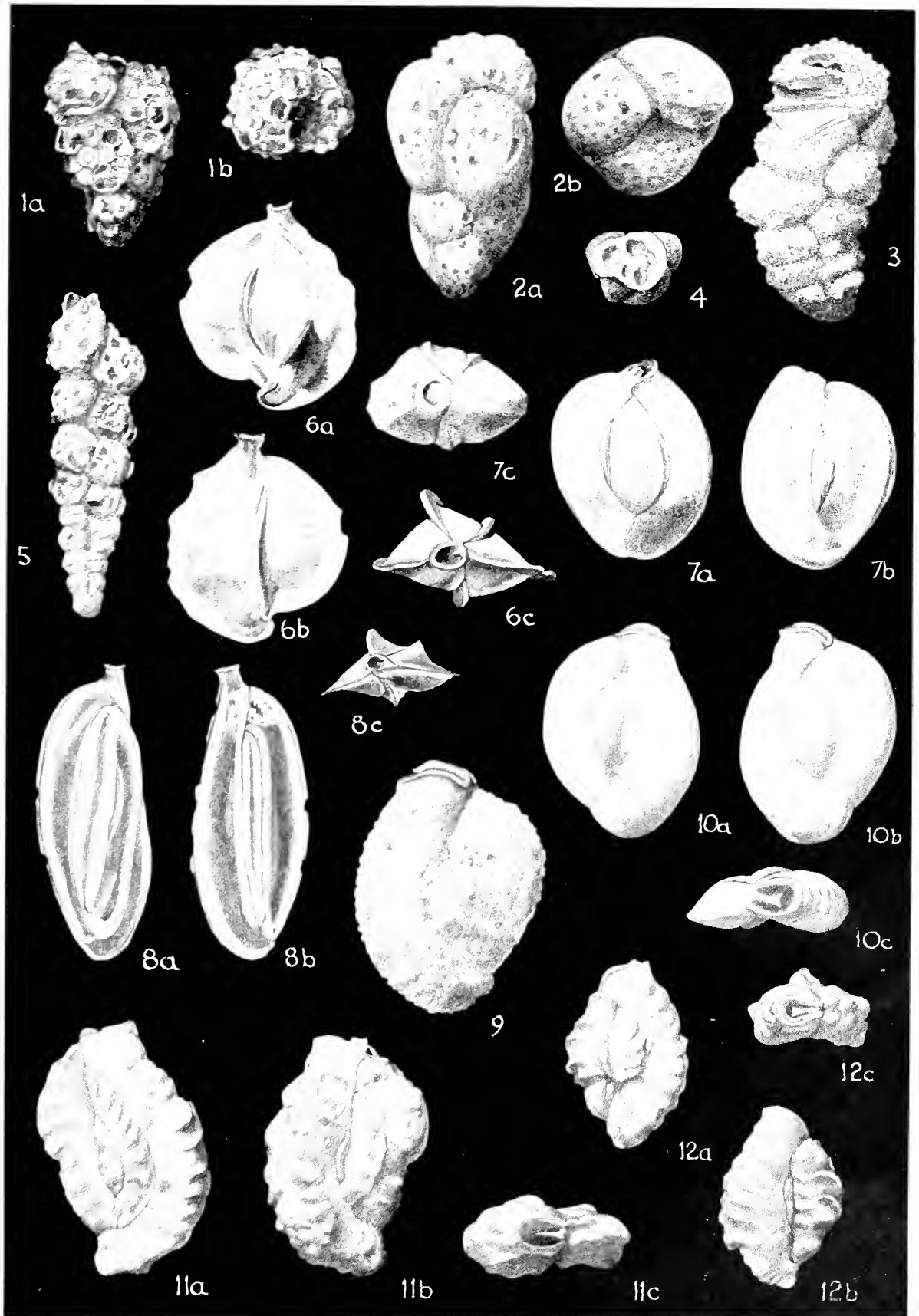


PLATE III.

- FIG. 1.—*Massilina minuta* n. sp. Holotype. “a” and “b” side view. × 120.
FIG. 2.—*M. minuta*, section through another specimen. × 120.
FIG. 3.—*Spirosigmoilina parri* n. sp. Holotype. “a” and “b” side views, “c” apertural view.
× 105.
FIG. 4.—*S. parri*, section through another specimen. × 210.
FIG. 5.—*Articulina tricarinata* n. sp. Holotype. “a” side view, “b” apertural view. × 210.
FIG. 6.—*A. tricarinata*, side view. × 210.
FIG. 7.—*A. sagra* d’Orbigny. Side view. × 72.
FIG. 8.—*A. queenslandica* n. sp. Holotype. Side view. × 120.
FIG. 9.—*A. queenslandica*. Side view. × 120.
FIG. 10.—*A. queenslandica*. Side view. × 120.
FIG. 11.—*Hauerina pacifica* Cushman, *rugosa* n. subsp. Holotype. “a” and “b” side views, “c”
apertural view. × 55.
FIG. 12.—*Triloculina littoralis* n. sp. Holotype. “a” and “b” side views, “c” apertural view.
× 85.
FIG. 13.—*T. quadrata* n. sp. Holotype. “a” and “b” side views, “c” apertural view. × 48.
FIG. 14.—*T. sublineata* (Brady)? “a” side view, “b” apertural view. × 48.
FIG. 15.—*Nodophthalmidium gracilis* n. sp. Holotype. Side view. × 115.
FIG. 16.—*Cornuspirella diffusa* (Heron-Allen and Earland). × 48.

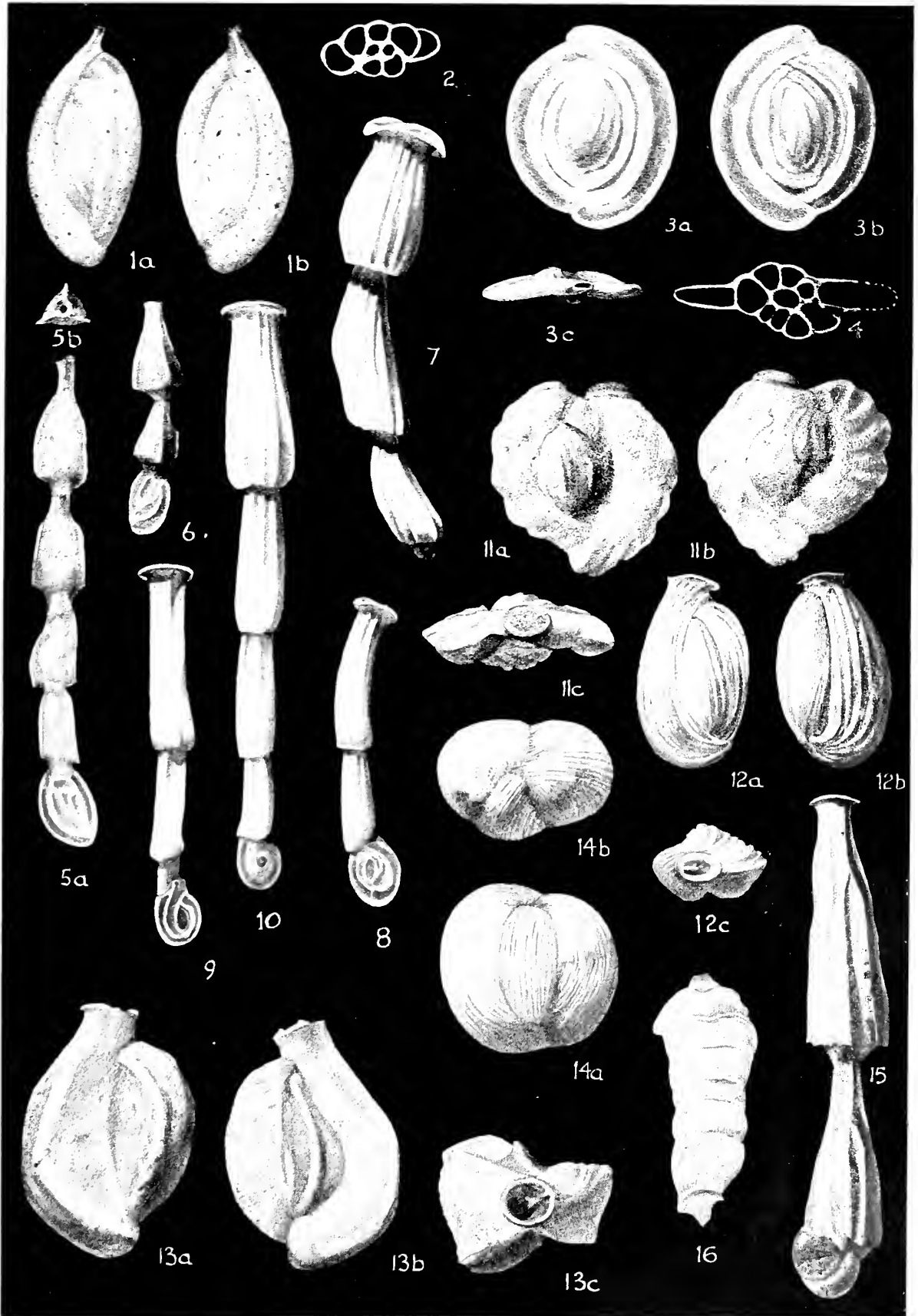


PLATE IV.

FIG. 1.—*Ophthalmidium circularis* (Chapman) *tropicalis* n. subsp. Holotype. “a” side view, “b” apertural view. $\times 120$.

FIG. 2.—*Planispirinella involuta* n. sp. Holotype. “a” side view. “b” apertural view. $\times 90$.

FIG. 3.—*Nubeculopsis queenslandica* n. gen., n. sp. Holotype. “a” ventral view, “b” dorsal view, “c” apertural view. $\times 70$.

FIG. 4.—*Fischerina pellucida* Millett. $\times 115$.

FIG. 5.—*Globulotuba entosoleniformis* n. gen., n. sp. Holotype. “a” side view, “b” aboral view. $\times 115$.

FIG. 6.—*Glandulina semistriata* n. sp. Holotype. “a” side view, “b” aboral view. $\times 115$.

FIG. 7.—*Buliminella latissima* n. sp. Holotype. “a” and “b” side views, “c” apertural view. $\times 160$.

FIG. 8.—*Ungulatella pacifica* Cushman. $\times 160$.

FIG. 9.—*Bulimina oblonga* n. sp. Holotype. “a” and “b” side views, “c” apertural view. $\times 115$.

FIG. 10.—*Globobulimina australiensis* n. sp. Holotype. “a” side view, “b” apertural view, “c” aboral view. $\times 55$.

FIG. 11.—*Mimosina rimosa* Heron-Allen and Earland. $\times 140$.

Fig. 12.—*Trimosina milletti* Cushman, *multispinata* n. subsp. Holotype. Side view. $\times 115$.

FIG. 13.—*Siphogenerina virgula* (Brady). “a” megalospheric specimen, “b” and “c” microspheric specimens. $\times 90$.

FIG. 14.—*Gümbelitra vivans* Cushman. $\times 215$.



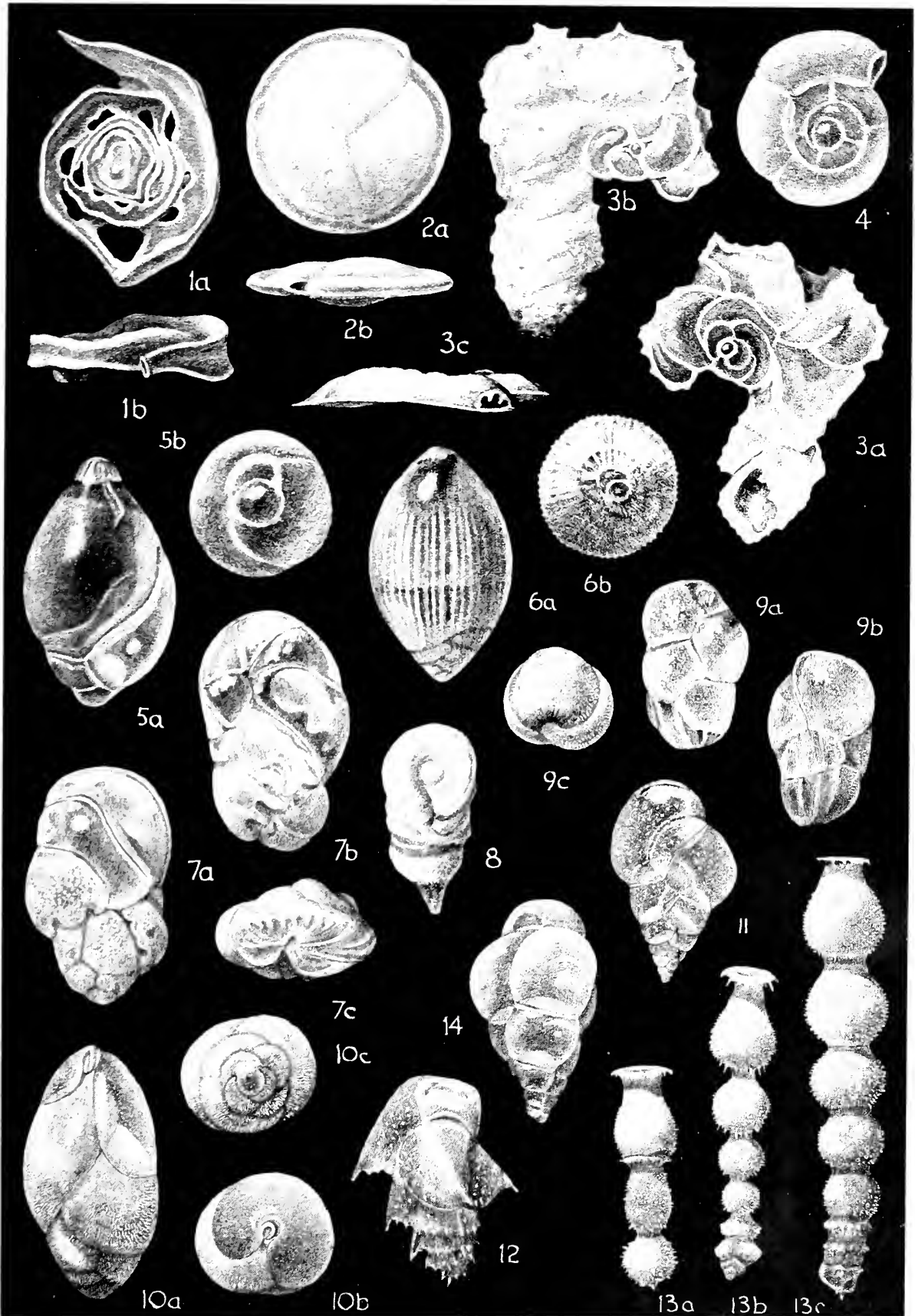


PLATE V.

- FIG. 1.—*Bolivina alata* Seguenza, *fimbriata*, n. subsp. Holotype. “a” side view, “b” apertural view. × 115.
- FIG. 2.—*Loxostomum convallarium* (Millett). × 115.
- FIG. 3.—*Bifarina elongata* Millett. × 115.
- FIG. 4.—*B. queenslandica* n. sp. Holotype. “a” side view, “b” apertural view. × 115.
- FIG. 5.—*Discorbis subvesicularis* n. sp. Holotype. “a” dorsal view, “b” ventral view, “c” apertural view. × 75.
- FIG. 6.—*Conorbella earlandi* n. sp. Holotype. “a” dorsal view, “b” ventral view, “c” apertural view. × 160.
- FIG. 7.—*Discorinopsis tropica* n. sp. Holotype. “a” dorsal view, “b” ventral view, “c” apertural view. × 70.
- FIG. 8.—*Patellinella carinata* n. sp. Holotype. “a” side view, “b” dorsal view, “c” ventral view. × 115.
- FIG. 9.—*Epistomariella milletti* n. sp. Holotype. “a” dorsal view, “b” ventral view, “c” apertural view. × 115.
- FIG. 10.—*Streblus convexus* n. sp. Holotype. “a” dorsal view, “b” ventral view, “c” apertural view. × 55.
- FIG. 11.—*Robertina australis* n. sp. Holotype. “a” side view, “b” apertural view. × 115.
- FIG. 12.—*Elphidium* sp. aff. *josephinum* (d’Orbigny). × 100.
- FIG. 13.—*E. pacificum* n. sp. Side view. × 100.
- FIG. 14.—*Gypsina fimbriata* (Chapman). “a” view from above, “b” edge view. × 22.

