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FURTHER NOTES ON THE AMPULLAE OF MILLEPORA

by

H. BOSCHMA

After a prolonged scrutiny of numerous colonies of *Millepora* in the collections of various museums I found, besides a number of colonies with open ampullae, ten specimens possessing ampullae with their coverings of a trabecular network. The chief details of these ampullae were described in a previous paper (Boschma, 1949 *a*). Afterwards I had the good fortune to obtain material of different species of *Millepora* from six localities showing ampullae in an undamaged state. These ampullae are figured and described in the present paper.

I am greatly indebted to Mr. Harold Gatty of Suva, who enabled me to visit coral reefs in the Fiji Islands during the time I stayed in this locality (March, 1949). I want to thank Dr. C. H. Edmondson, curator, Bernice P. Bishop Museum, Honolulu, for a specimen collected by him on Johnston Island. I am much obliged to Dr. R. W. Hiatt, University of Hawaii, for presenting to me specimens collected by him at Bikini Island and at Yap Island. To Dr. P. Wagenaar Hummelinck, Utrecht, I owe an interesting specimen collected by him at Bonaire. I further want to thank Professor H. Graham Cannon, University of Manchester, for a specimen from the collection of the late Prof. S. J. Hickson, obtained at Brandewijnsbaai by the late Prof. Max Weber. Finally my sincerest thanks are due to Mr. A. Salverda, Groningen, who with great skill performed the difficult task of photographing of each colony a part of the surface showing numerous ampullae.

As even in these excellent photographs in many cases the ampullae are not distinctly showing off against their surroundings, from each photograph

a diagrammatic copy of the upper or lower third part was made. These are shown in the text-figures 1 and 2.

The chief details of the material dealt with here are described below.

1. *Millepora alcicornis* L.. Bonaire, Lesser Antilles, roadstead of Kralendijk, September 21, 1948, depth 0-1½ m, Dr. P. Wagenaar Hummelinck (Pl. I; text-fig. 1 *a*).

The specimen is a small colony with a height of 8 cm and a breadth of 5 cm. The largely flattened branches have broadly united so that the tops only are freely projecting. In certain parts of the corallum there are fairly large numbers of ampullae, which, however, on account of their small size and inconspicuous appearance are rather hard to detect. The central part of each ampulla is slightly concave, just sunk below the surface, whilst the marginal part hardly or not at all protrudes above its surroundings. The coverings of the ampullae are rather compact plates in which there are numerous small openings irregularly distributed around a central opening of slightly larger size. The trabeculae forming the covering do not show a radial arrangement towards the centre.

The ampullae of this specimen have a diameter of 0.3-0.4 mm; they are strikingly similar to those of a specimen in the Leiden Museum previously described (Boschma, 1949 *a*, Pl. I figs. 3-5), whilst they are entirely different from those of a specimen in the Amsterdam Museum (l. c., Pl. I figs. 1-2). Undoubtedly the latter during life contained the female medusae, whilst the former were the cavities enclosing the male medusae. If this conclusion is correct in *Millepora alcicornis* the male ampullae are of much smaller size than the female.

2. *Millepora platyphylla* Hempr. & Ehr., Bikini, Marshall Islands, lagoon, July, 1947, Dr. R. W. Hiatt (Pl. II; text-fig. 1 *b*).

The specimen is the basal part taken off from a large upstanding plate, very compact and heavy in structure. The surface shows well developed longitudinal ridges, which in further development would have given the colony the typical honeycombed shape usually found in specimens living under favourable conditions. Moreover the surface in many parts is beset with distinct verrucae. The fragment has a height of 6½ cm, a breadth of 10 cm, and a thickness of 1½ to 2 cm. On the entire surface of the specimen there is a multitude of ampullae, nearly all of which are still in a closed condition. When viewed with a pocket lens the ampullae appear as shallow pits. As a rule their margin does not protrude over the surface of the corallum, but in some parts the margin of the ampullae is slightly raised so that they are surrounded by a low wall.

The ampullae of this specimen have a diameter of 0.4-0.5 mm. Their

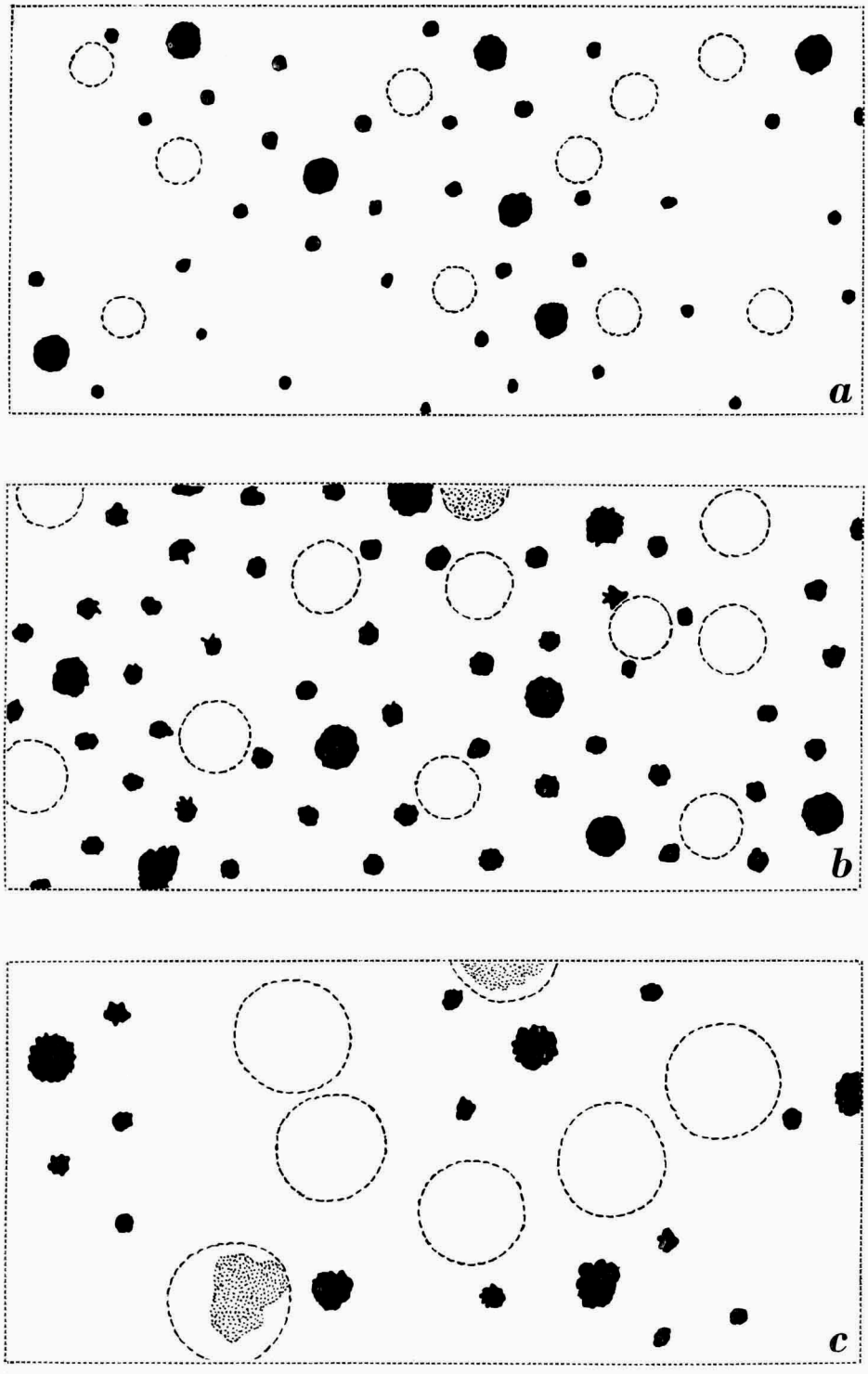

Fig. 1. Diagrams of the gastropores (large black dots), the dactylopores (smaller black dots), and the ampullae (circles in broken lines; open parts dotted). *a*, lower third part of *Millepora alcicornis* from Bonaire of Pl. I; *b*, upper third part of *M. platyphylla* from Bikini of Pl. II; *c*, lower third part of *M. murrayi* from Brandewijnsbaai of Pl. III. × 20.

covering is distinctly concave, so that the central region is pronouncedly below the surface of the corallum. The trabeculae composing the covering do not show a radial arrangement from the centre; between these trabeculae there are a number of openings of which the central is not larger than the others.

In shape and in structure the ampullae of the specimen from Bikini are like those of specimens from the Island Edam in the Bay of Batavia (l.c., Pl. II). Especially those of one of the latter specimens (l.c., Pl. II figs. 1-3) correspond in every detail with the ampullae of Pl. II in the present paper.

3. *Millepora murrayi* Quelch, Brandewijnsbaai, Padang, Sumatra, April 10-17, 1888, Prof. Max Weber (Pl. III; text-fig. 1 *c*).

The specimen is a small fragment, height 4 cm, breadth 4 cm, consisting of a part of a typically curved larger branch from which smaller vertical branchlets are growing out, all of which have fused into one common plate. The tops have largely broken off, the few remaining tips of the branches have the pointed shape characteristic of *M. murrayi*. The surface on both sides of the fragment shows numerous ampullae, most of which are open; in some parts, however, a fairly large number of ampullae still have their coverings.

The ampullae of this specimen are comparatively large, as their diameter amounts to 0.6-0.8 mm. Their covering consists of a reticulum of trabeculae in which not a radial arrangement from the centre is to be observed. As a rule there is a central opening that is slightly larger than most of the other openings in the covering.

The ampullae of the specimen from Brandewijnsbaai closely correspond with those of the specimen from Tongatabu (l. c., Pl. III figs. 1-3); in both specimens they have a flat surface (exceptionally the central part is slightly protruding above the surface of the corallum).

Besides the specimen of *Millepora murrayi* from Tongatabu, in the collection of the British Museum there is a specimen from Zamboanga, Philippine Islands, from the collections of the Challenger Expedition, that shows a great number of ampullae (Boschma, 1949 *b*). In size and in shape, and in the arrangement of the trabeculae these ampullae completely correspond with those of the specimen from Tongatabu and with those of that from Brandewijnsbaai. In the three specimens the ampullae are comparatively large and rather indistinctly separated from their surroundings.

No date of collecting was noted on the label accompanying the specimen from Brandewijnsbaai. It is, however, absolutely certain that the specimen was taken from the colony in the week from April 10 to 17. Mrs. W. S. S. van der Feen-van Benthem Jutting of the Amsterdam Museum kindly

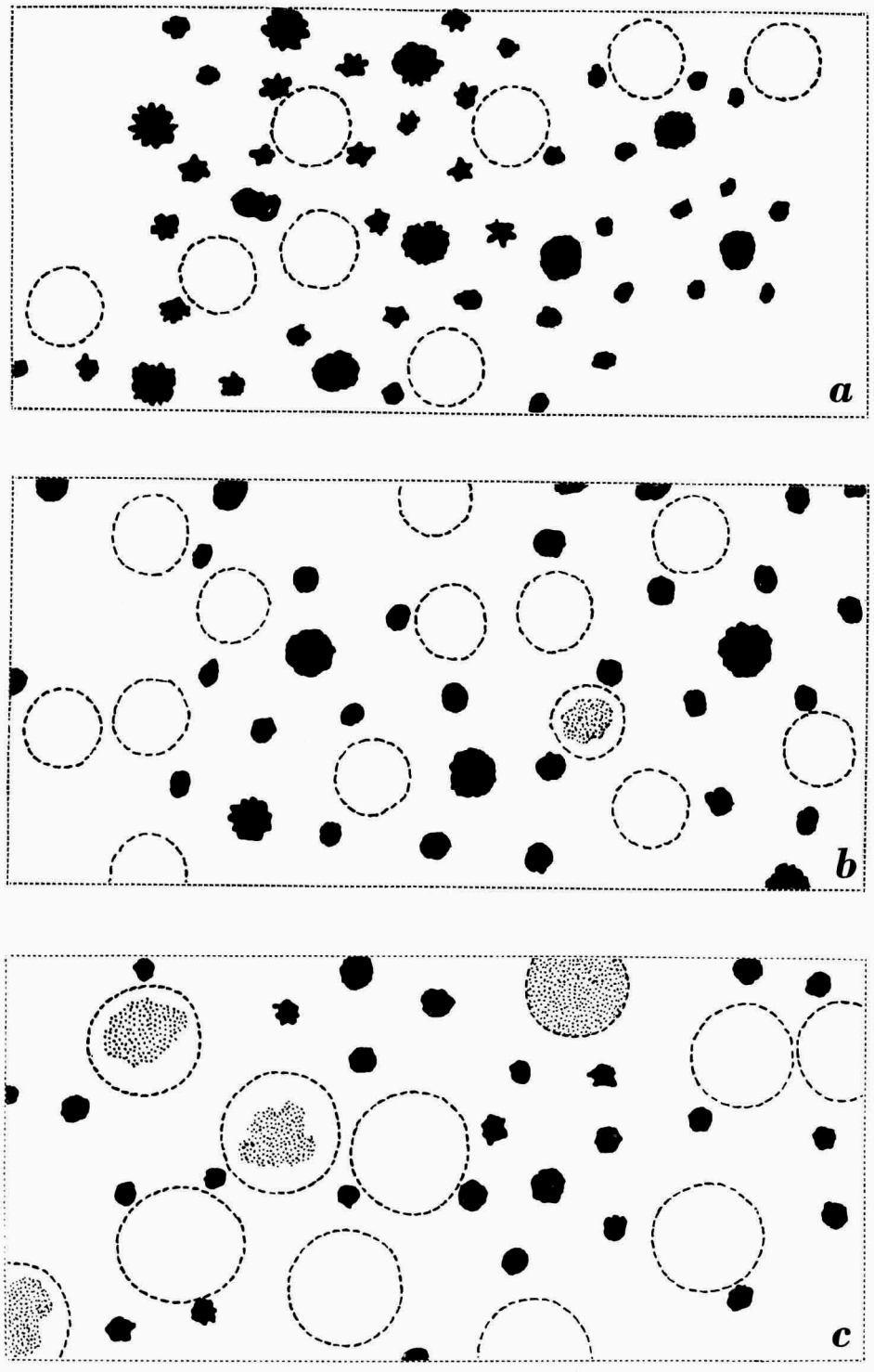

Fig. 2. Diagrams of the gastropores (large black dots), the dactylopores (smaller black dots), and the ampullae (circles in broken lines; open parts dotted). *a*, lower third part of *Millepora tenera* from the Suva reefs of Pl. IV; *b*, upper third part of *M. tenera* from Johnston Island of Pl. V; *c*, upper third part of *M. tenera* from Yap Island of Pl. VI. × 20.

informed me that according to notes made by the late Prof. Max Weber during his first voyage to the East Indies he stayed at Padang from April 10 to 17, 1888; in this week the visit to the Brandewijnsbaai must have taken place.

4. *Millepora tenera* Boschma, Suva reef, Fiji Islands, March 16, 1949, Dr. H. Boschma (Pl. IV; text-fig. 2 *a*).

The specimen is one of several collected on the reefs near Suva Harbour. In some colonies every branch showed a multitude of ampullae, in closed as well as in empty condition, whilst in other colonies of the same shape and size not a single ampulla was present. The colonies consisted of numerous upstanding more or less plate-like growths extending in all directions, each plate being more or less fan-shaped, its lower part being composed of the completely united lower portions of the branches, its upper part consisting of slender branches, free for 2 to 3 cm or partly anastomosing, the tops of the branches being broadened and showing an incipient dichotomical division. The shape and manner of branching of these colonies in every respect closely corresponds with the description of *Millepora tenella* given by Ortmann (1892).

The ampullae of this specimen have a diameter of 0.5-0.6 mm. Their covering consists of a mass of trabeculae that only exceptionally show a tendency for a radial arrangement from the centre. The central opening often is slightly larger than the other openings between the trabeculae. The central part of the coverings as a rule is somewhat below the surface of the corallum, whilst the margin may slightly rise above the surroundings.

The ampullae of the Suva reef specimens are strongly similar to those of the specimens from Halmahera described in a previous paper (Boschma, 1949 *a*, Pl. IV figs. 1-4), though in general the concave shape of their coverings is less pronounced.

5. *Millepora tenera* Boschma, Johnston Island, Dr. C. H. Edmondson (Pl. V; text-fig. 2 *b*).

The specimen has a height of 18 cm, a breadth of 10½ cm, and in its basal region a thickness of about 1 cm. It consists of a more or less compact lower part and a number of slender branches that vertically are growing upward from the lower part. These branches have a length of about 10 cm, they are of more or less even breadth for the whole of their length, and at their tips only are divided into a few very short smaller branchlets. Partly the branches have grown together sideways. Especially on the lower parts of the branches there are numerous ampullae, many of which still have their coverings.

The ampullae of this specimen have a diameter of 0.4-0.5 mm. Their

covering is more or less convex so that their central part slightly protrudes over the surface of the corallum. The covering consists of a reticulum of trabeculae with rather wide openings; as a rule there is not a central opening differing in shape or in size from the others. In the arrangement of the trabeculae there is not a tendency for a radial structure.

In the specimen from Johnston Island the ampullae are strikingly similar to those of a specimen from Rodriguez Island (l. c., Pl. IV figs. 5-7). In the two specimens the ampullae have a corresponding set of trabeculae and in both specimens they have rather indistinct borders.

6. *Millepora tenera* Boschma, Yap Island, lagoon, July, 1945, Dr. R. W. Hiatt (Pl. VI; text-fig. 2 *c*).

The specimen is a fragment of a larger colony, it consists of a rather compact lower part and a few branches of various sizes spreading more or less fan-like in one plane. The tops of the branches are rather blunt, they do not show a pronounced tendency for a dichotomous division. Almost the whole surface of the corallum shows numerous ampullae, most of which are in an open condition, but in various places still a fairly large number of ampullae have kept their coverings.

The ampullae of this specimen are fairly large as their diameter amounts to 0.6-0.8 mm. Their covering is slightly concave so that the central region is below the surface of the corallum. Their marginal parts often slightly project above the surroundings. The covering of the ampullae consists of a mass of trabeculae in which sometimes a tendency for a radial arrangement is to be observed. The openings between the trabeculae are rather small, as a rule the central opening is not distinctly larger than the others.

The ampullae of the specimen from Yap Island are similar to those of the specimens from the Suva reefs and to those of the specimen from Halmahera (l. c., Pl. IV figs. 1-4), though they are of a somewhat larger size.

The shape and the structure of the covering of the ampullae are known now in five species of the genus *Millepora*. In many cases they show characters that may be typical for the species, whilst in other cases the ampullae of specimens regarded as conspecific show marked differences. The data contained in previous papers (Boschma, 1949 *a, b*) and those of the present paper may be summarized as follows.

Millepora alcicornis. Closed ampullae known in three colonies, two from unknown localities, and one from Bonaire. In two specimens the ampullae are completely alike in shape and in size, in the third they are larger and have a distinct radial structure of the covering, entirely different from that found in the other specimens. It stands to reason that the two different structures represent the male and the female ampullae of one species.

Millepora platyphylla. Closed ampullae known in three specimens, two from the Island Edam in the Bay of Batavia, one from Bikini. All of these are strikingly similar in shape and in size. The pronounced concavity of the covering of the ampullae may be regarded as a specific character of constant value.

Millepora murrayi. Closed ampullae known in four specimens, one from Tongatabu, one from the Island Edam, one from Zamboanga in the Philippine Islands, and one from Brandewijnsbaai (Sumatra). In three of these the ampullae are exactly alike as far as concerns their shape and structure, though their size in the various specimens may be slightly different. In the fourth specimen, the colony from the Island Edam, the ampullae are more distinctly convex than those of the other specimens. In general the shape and the structure of the ampullae of *M. murrayi* may be regarded as characteristic of the species.

Millepora latifolia. Closed ampullae known in one specimen. On account of their comparatively large size and by the pronouncedly radial arrangement of the trabeculae these ampullae in all probability are characteristic of the species.

Millepora tenera. Closed ampullae known in specimens from six localities: one from Halmahera, one from Rodriguez Island, one from the East Indies (Siboga Expedition, exact locality unknown), some specimens from the Suva reefs, one from Yap Island, and one from Johnston Island. Now the ampullae in the specimens from Halmahera, from the Suva reefs and from Yap Island belong to one group, characterized by a more or less concave covering. The specimen from the Siboga Expedition has ampullae of a similar structure. On the other hand the specimens from Rodriguez and from Johnston Island have ampullae of a rather different structure, as these are not concave and have not a more or less circular contour as is typical in those of the former group.

Now it is by no means certain that all the specimens identified as *Millepora tenera* in reality are conspecific. The species, as defined by Ortmann (1892, *Millepora tenella*), is characterized by slender flattened branches, broadened at their tips and having a dichotomous manner of branching. The specimens from the Suva reefs (text-fig. 3 *a*) have branches as described above. In the specimen from Yap Island (text-fig. 3 *b*) the branches, though distinctly spreading fan-wise, do not show a definite dichotomous manner of division; the general appearance of this specimen, however, points to its identification as *M. tenera.* The ampullae of the specimens from the Suva reefs and of that from Yap Island correspond in every detail, and, moreover, they are strongly similar to those of the specimen from Halmahera described in a previous paper (Boschma, 1949 *a*).

The specimen from Johnston Island (text-fig. 3 *c*) differs from typical specimens of *M. tenera* by having numerous slender branches rising independently from a common basal part, and extending vertically. Here there is not a tendency for a fan-like spreading of the branches, and in a great number of the branches the tips are pointed, not flattened and broadened sideways. It is, therefore, by no means certain that the specimen from

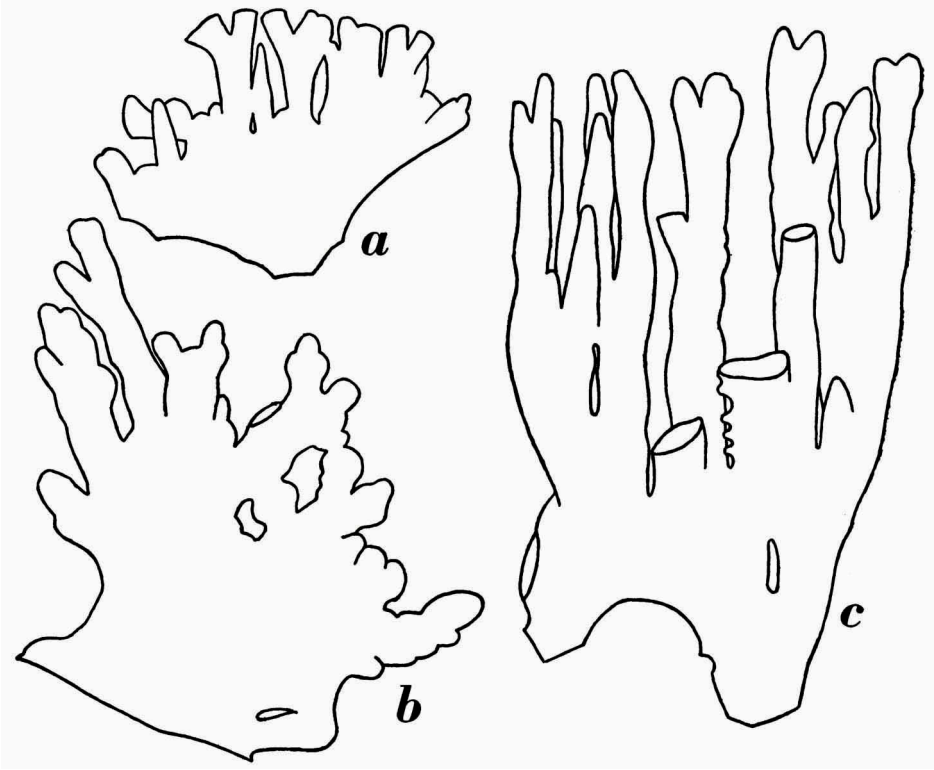

Fig. 3. *Millepora tenera. a,* specimen from the Suva reefs; *b,* specimen from Yap Island; *c,* specimen from Johnston Island. All figures one-half natural size.

Johnston Island belongs to *Millepora tenera.* In this specimen the ampullae are so strikingly different from those of typical specimens of *M. tenera* that this again may be an indication of the fact that the specimen from Johnston Island belongs to a separate species.

Now it is interesting that the ampullae of the specimen from Rodriguez Island previously described (l. c.) in all important details are entirely similar to those of the specimen from Johnston Island. This might indicate that the two belong to one species. But the growth form of the two specimens

is rather different. In the specimen from Rodriguez Island (l. c., text-fig. 4 *c*) the branches are short with rounded tops, spreading from the compact basal part in a more or less fan-like manner, not conspicuously different from the usual manner of growth in *M. tenera*. On the other hand the specimen from Johnston Island has vertically extending branches, giving the colony a highly different shape from that ordinarily found in *M. tenera*.

The structure of the corallum around the ampullae in the specimens from the Suva reefs and from Yap Island is different from that found in the specimen from Johnston Island, this structure in the latter being much coarser than in the former (Pls. IV-VI); but in this respect the colonies of *Millepora* that undoubtedly belong to one species often show a good deal of variation. Further it remains possible that the two kinds of ampullae occurring in different specimens that are regarded as belonging to *M. tenera* may represent the cavities for the medusae of the two sexes. At present this is just a supposition, definite proof is to be obtained only when a more extensive material becomes available.

It is interesting to note the time of the year in which colonies of *Millepora* with closed ampullae were collected. In a previous paper (Boschma, 1949 *a*) the following data were recorded: *Millepora platyphylla,* May 25; *M. murrayi,* July 5-8; *M. tenera,* May 28; *M. latifolia,* May 27; *M. murrayi,* October 24-November 12 or January 11-February 5.

The dates for the occurrence of ampullae, derived from the material dealt with in the present paper, are: *Millepora alcicornis,* September 21; *M. platyphylla,* July; *M. murrayi,* April 10-17; *M. tenera,* March 16; *M. tenera,* July.

With the exception of that concerning one specimen of *M. murrayi* the dates of collecting of all the specimens from the Pacific are in the months from March till July. This does not yet point to a definite time of breeding. Perhaps observations in one restricted locality during the whole of the year would show that in such a locality there is a definite period for the formation of ampullae.

Notes on some specimens of *Millepora*

During a short visit to Honolulu, March 22 to 27, 1949, I had the opportunity to study the collection of specimens of *Millepora* in the Bernice P. Bishop Museum, where Dr. C. H. Edmondson kindly placed this material at my disposal. As it has been collected in many localities from which up till now no specimens of the genus were reported a few notes on this material are given here.

Wake Island. A fairly large colony of about 20 cm height and 35 cm larger diameter, consisting of flattened branches extending vertically from a common basal part, spreading in various directions. Each larger branch is a more or less fan-like spreading broad lamella that on its free extremity is divided into a number of short rounded lobes. The colony is a *Millepora platyphylla* of a rather uncommon growth form, closely resembling the specimen from Lacépède Island, N. W. Australia, figured in a previous paper (Boschma, 1949 *b*, Pl. I). A number of smaller fragments from the same locality show a corresponding manner of growth.

Johnston Island. Several colonies consisting of vertically extending rather slender branches growing from a common basal part, as the specimen of text-fig. 3 *c* in the present paper. In some specimens the branches are rather thick, in others they are more slender, whilst in the various colonies they differ in their tendency to unite sideways. In all these colonies the younger branches have pointed tips, so that their identification as *Millepora tenera* Boschma is not altogether certain. Besides these there are other specimens from Johnston Island that more distinctly have the typical growth form of *M. tenera*. In the latter the branches in one plane are spreading more or less radially from the basal part, so that the larger branches have a fan-like appearance. Some specimens in their manner of growth are intermediate between the two forms, which gives a support for the opinion that all these specimens belong to *M. tenera*.

Howland Island. A large colony of *Millepora platyphylla*, consisting of a number of upstanding rather narrow plates united on a common basal part. The tops of the thick plates are roundish with some irregular knobs, whilst the entire surface is beset with numerous knobs and warts of various shapes and sizes.

Washington Island. A fairly large colony and some smaller fragments of *Millepora platyphylla*. The specimens consist of thick broadened large branches, in many cases showing a tendency for a honeycombed arrangement.

Palmyra Island. The colonies consist of broad upstanding plates that on their free upper margins are divided into numerous short knobs or branchlets with rounded tops. The specimens belong to *Millepora platyphylla*, the growth form in many respects is similar to that of the colonies from Wake Island dealt with above.

In Honolulu I further could examine a number of specimens from Bikini and from Yap Island in the collection of Dr. R. W. Hiatt, University of Hawaii.

Of the four specimens from Bikini one is a heavy upstanding plate of *Millepora platyphylla* with irregular longitudinal thick ridges. The height

is about 22 cm, the breadth about 13 cm, the thickness in the basal region 1½ to 2 cm. The basal third part was taken off for further examination; just as the remaining part this fragment shows a multitude of ampullae (Pl. II).

The second specimen from Bikini is a thick branch, the topmost part of which is divided into two smaller branches. The main branch has a breadth of about 6 cm and a thickness of 5 cm, the length of the specimen is about 26 cm. The colony shows numerous ampullae. Growth form and ampullae prove that it belongs to *Millepora platyphylla.*

The third specimen from Bikini is an upstanding thick plate with rather straight free margin. The height of this large fragment is 13 cm, its breadth 14½ cm. It is a *Millepora platyphylla* that in its topmost region shows a tendency for a honeycombed arrangement of the plates. In this colony again there are numerous ampullae.

The fourth specimen from Bikini is a fragment, high 17 cm, broad 8 cm, thick not much over ½ cm, forming an upstanding plate with numerous knobs and irregular outgrowths. It is a *Millepora platyphylla* growing under unfavourable conditions. The colony has numerous ampullae of the same shape and size as those of the figured specimen.

Plate-like growths of *Millepora platyphylla,* arranged in honeycombed masses, from the reefs of Bikini are figured by Tracey, Ladd, and Hoffmeister (1948, Pl. I fig. 2).

In the lagoon of Yap Island Dr. Hiatt collected a few specimens that had to be identified as *Millepora tenera.* One of these is a large plate, 25½ cm high, 15 cm broad, and about 1 cm thick, from which the upper and lateral parts are growing out as flabelliform broad branches that on their free margins are divided into numerous short branchlets; the latter often showing a marginal broadening and a dichotomous division. The colony has a great number of ampullae.

A second specimen from Yap Island is a *Millepora tenera* of the same general shape. It is much smaller than the former (height 10½, breadth 7½, thickness about 1 cm).

A third specimen of *Millepora tenera* from Yap Island is described and figured above (text-fig. 2 *c*); the ampullae of this specimen are shown in Pl. VI.

The specimens of *Millepora* referred to above all are from the northern half of the Pacific. With the exception of Johnston Island, from which Edmondson (1928) reported the occurrence of *Millepora,* and Bikini, where *Millepora platyphylla* is shown to occur by Tracey, Ladd, and Hoffmeister (1948), the localities noted above form new records of the distribution of

the species. Wake Island, at nearly 20° N., up till now is the northernmost locality for *Millepora* in the Pacific.

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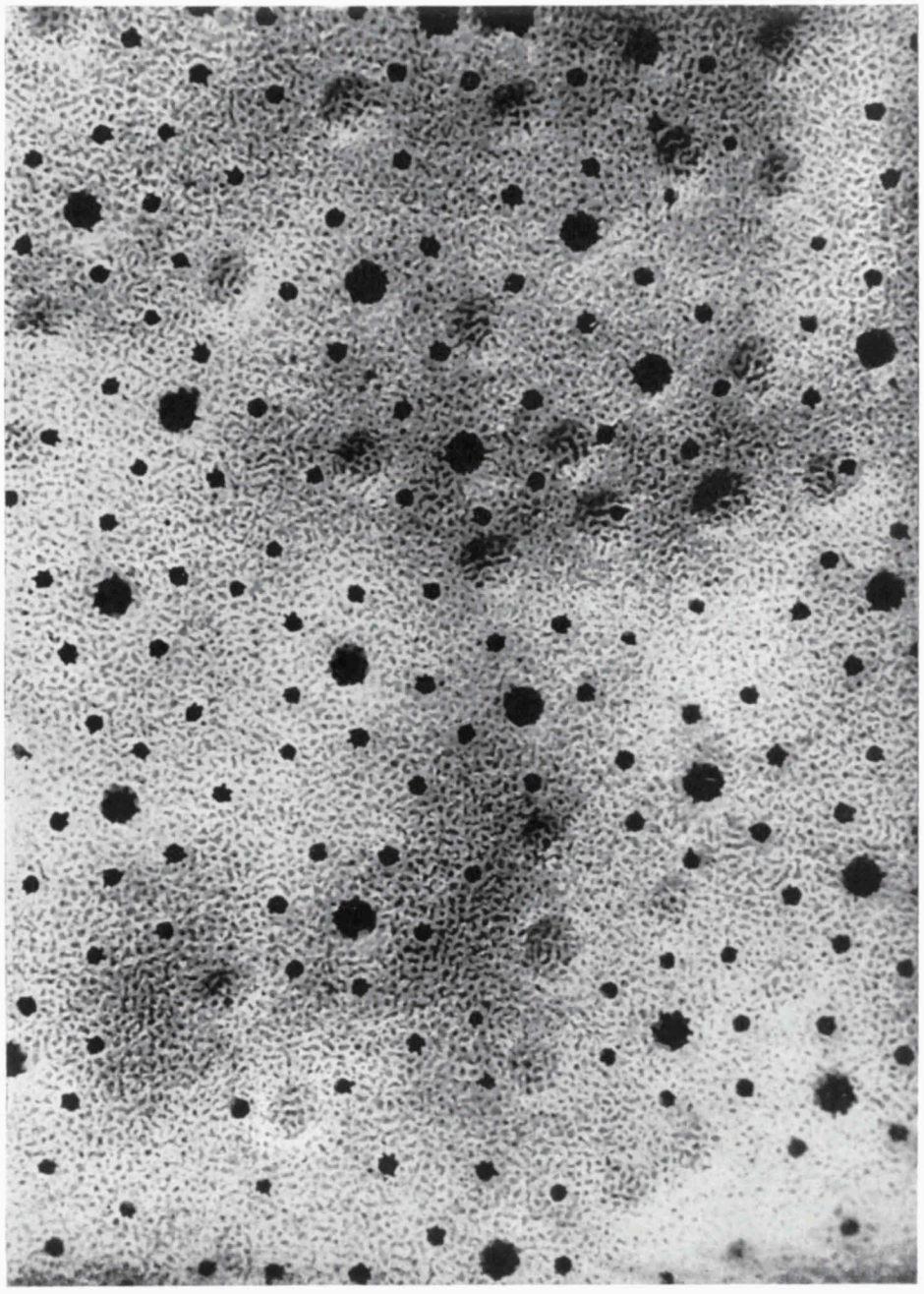
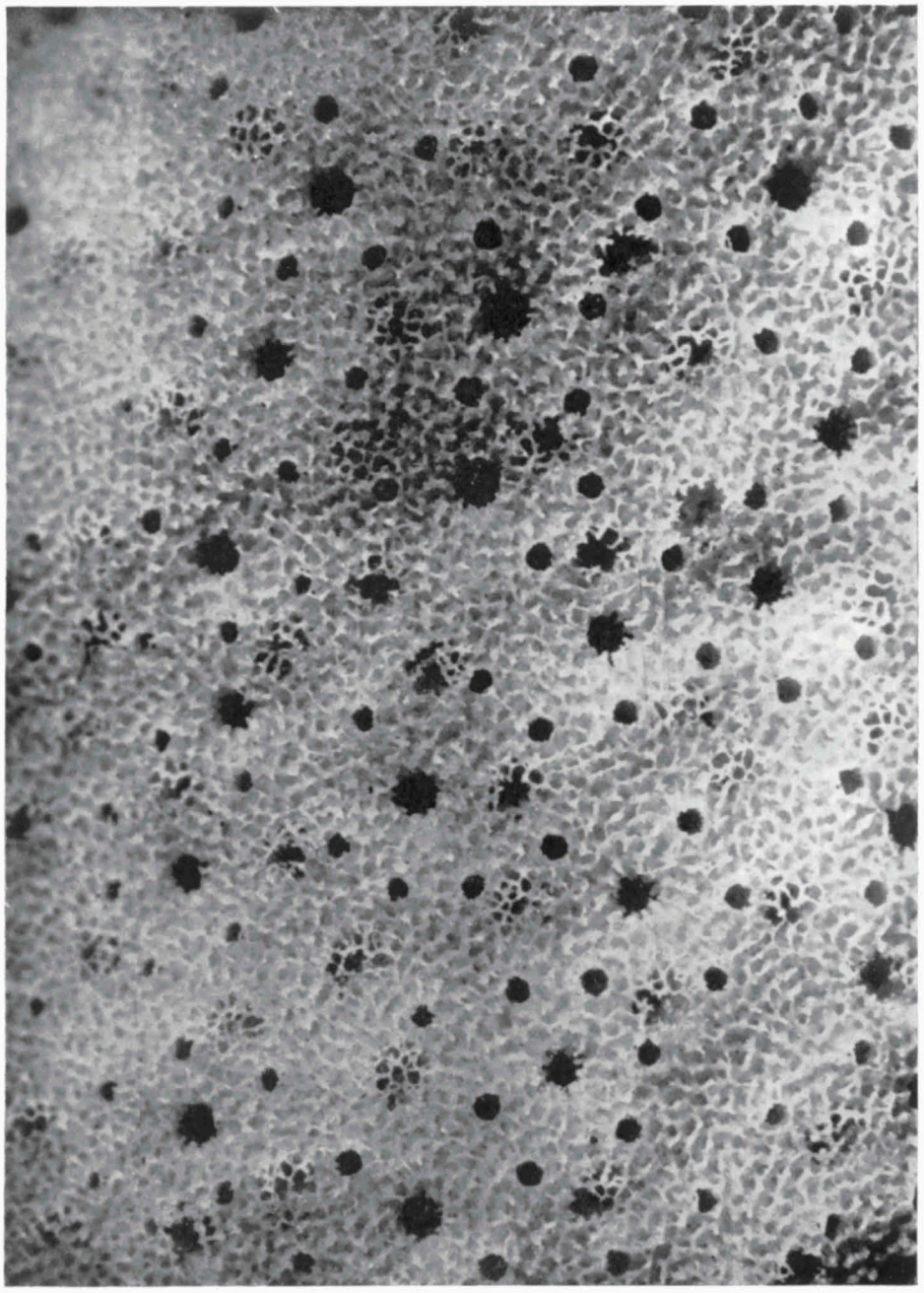
Millepora alcicornis L., Bonaire, ampullae. × 20.



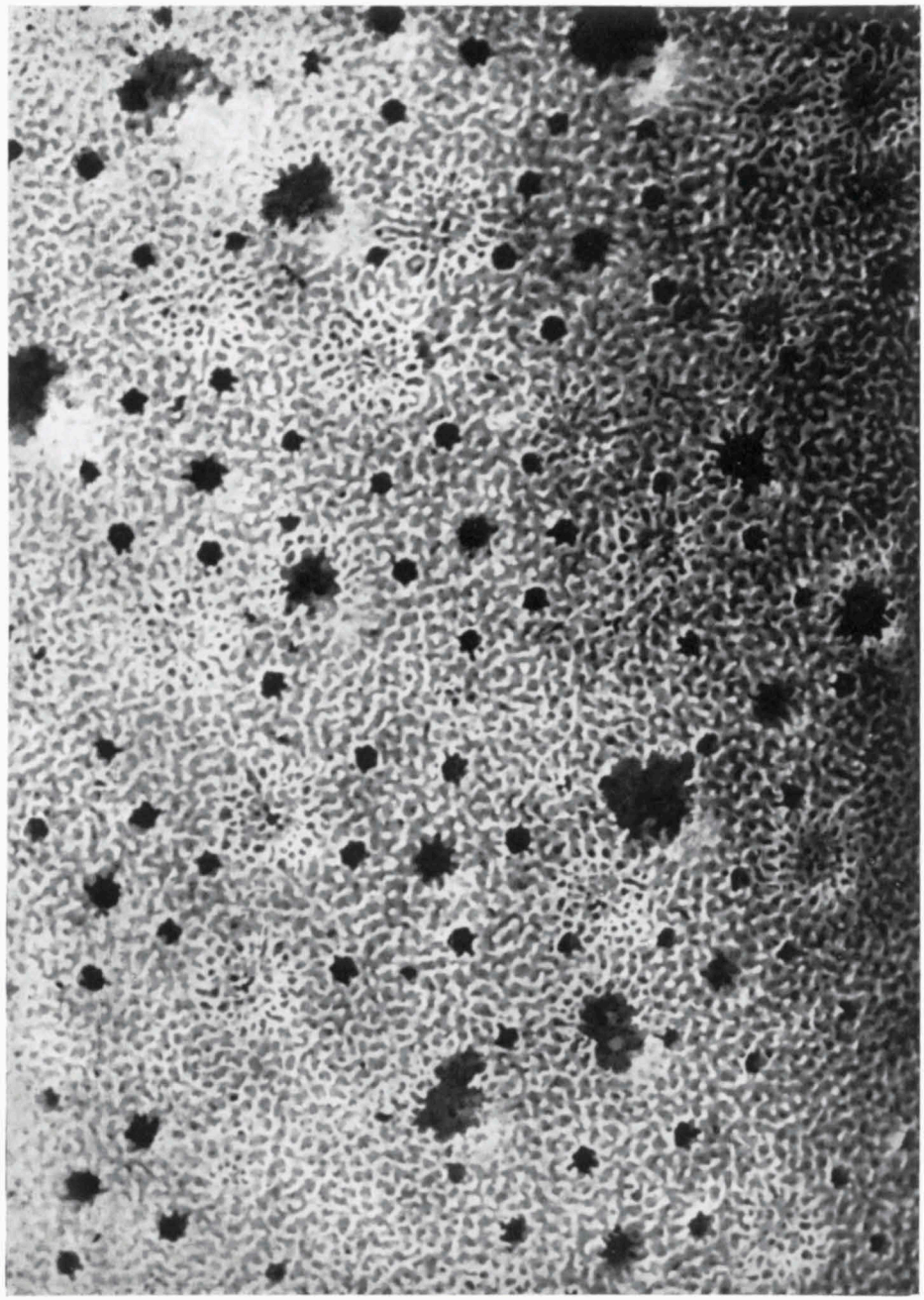
Millepora platyphylla Hempr. & Ehr., Bikini, ampullae. × 20.

Millepora murrayi Quelch, Brandewijnsbaai, ampullae. × 20.

Millepora tenera Boschma, Suva reef, ampullae. × 20.



Millepora tenera Boschma, Johnston Island, ampullae. × 20.



Millepora tenera Boschma, Yap Island, ampullae. × 20.