

Zoology. — *The Ampullae of Millepora*. By H. BOSCHMA.

(Communicated at the meeting of December 18, 1948.)

In 1884 QUELCH described the ampullae of *Millepora murrayi* Quelch as "receptacles covered by a very thin and porous layer, which is often broken away" (l.c., p. 539). In his report on the reef corals of the Challenger Expedition he described them as follows: "Ampullae developing as special cavities in the superficial meshwork of the coenenchyma; often crowded, about 0.75 mm. in diameter within, scarcely raised above the general surface, on which they are seen as small white spots or vesicles, which are about 0.5 mm. in diameter, the centre being generally pierced by a small pore" (QUELCH, 1886, p. 192).

HICKSON (1891 a) reported upon medusae found in the ampullae of *Millepora murrayi*, and in another paper (HICKSON, 1891 b) gave a detailed description of the male medusae present in the ampullae of this species. In a later paper HICKSON (1897) stated that he noticed several ampulla-bearing specimens other than those belonging to the species *Millepora murrayi*; of these he mentioned *M. schrammi* Duch. and Mich., *M. alcornis* L., and *M. complanata* Lamk. In his next paper dealing with *Millepora* HICKSON (1898 a) remarked that ampullae may be found in plicate, ramose, and digitate specimens, and that the presence or absence of ampullae cannot be used as a specific character. In the same year HICKSON (1898 b) found male medusae in a specimen of the facies "*complanata*" (undoubtedly a specimen of *M. platyphylla* Hempr. and Ehr.) of the same size as those found previously in *M. murrayi*. According to HICKSON (1899) a brief account of medusae of a West Indian form of *Millepora* was given by DUERDEN (1899). In the cited paper HICKSON published a detailed description of the structure of various stages of the female medusae of this West Indian *Millepora*. Here HICKSON moreover stated that the medusae of *Millepora* "*complanata*" mentioned in his 1898 b paper were identical in size and form with those of *M. murrayi*, so that "no specific distinction could be drawn between the two forms based on characters of the medusa before it is set free" (HICKSON, 1899, p. 4). Finally mention must be made of figure 68 in HICKSON (1924), representing a part of a colony of *Millepora* (probably *M. alcornis*), the surface of which is profusely pitted with open ampullae.

During my previous investigations on *Millepora* (BOSCHMA, 1948 a, b) I found open ampullae in *M. alcornis*, and ampullae still in possession of their covering in *M. murrayi*, *M. latifolia*, and *M. platyphylla*. I noted a difference in size of the ampullae in the various specimens, but concluded that as yet the available data were too scanty to allow of a conclusion concerning specific differences.

Since I wrote my previous papers dealing with *Millepora* a continued examination of numerous colonies of the genus resulted in ten specimens with closed ampullae, some of which possessed a few only among a multitude of open ampullae, whilst in others most of the ampullae were still in a closed condition. Although this material is still far from being sufficiently complete it seemed worth while to try whether the ampullae might furnish peculiarities to be regarded as characteristic of the species. HICKSON (1897, p. 3) wrote: "The most important problems that have still to be solved are these: Are the medusae of the different species of *Millepora* alike, or do they present specific differences? Are the medusae confined to the male sex, or do medusae occur bearing the ova?" Soon afterwards the second question could be answered in the affirmative (HICKSON, 1899), but the first question still remains open. Moreover the question whether the

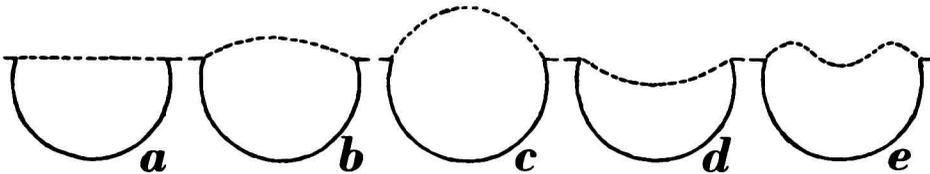


Fig. 1. Diagrams of sections of ampullae of various forms. Cavities of ampullae with full lines, coverings with broken lines.

ampullae of the different species of *Millepora* are alike or are presenting specific differences remains still unanswered. The new data contained in the present paper do show that the ampullae of different specimens of *Millepora* among each other may present striking differences, but it remains uncertain whether in all cases these data can be used for specific distinction.

For a comparison of the shape and size of the various ampullae it was necessary to obtain microphotographs of parts of the coralla, and I am strongly indebted to Professor S. T. BOK for placing his photographic apparatus at my disposal. As the surface of the corallum often is decidedly uneven in many cases it is difficult to obtain satisfactory results, but the photographs at least show the most important details of the ampullae.

In textfig. 1 diagrammatic sections of ampullae are represented showing the various forms of covering. Textfigs. 2 and 3 are more or less diagrammatic figures of some of the photographs of the plates, they may serve as an additional explanation of these photographs.

A short description of the ampullae of the various specimens follows here.

1. *Millepora alcicornis* L., Zoölogisch Museum Amsterdam (cf. BOSCHMA, 1948 b, p. 101, no. 10). Locality unknown. Textfig. 4 b of the present paper is an outline of a fragment of this colony.

Ampullae: Pl. I figs. 1—2, textfig. 2 a.

The colony shows a multitude of open ampullae, in certain parts only there are some ampullae which are still closed.

The ampullae have a diameter of 0.5—0.7 mm. They have a rather flat upper surface so that their shape approximately corresponds with the diagrammatic figure 1 a. The covering of the ampullae consists of trabeculae which have a strong tendency to a radial arrangement from the small central opening.

2. *Millepora alcornis* L., Rijksmuseum van Natuurlijke Historie, Leiden (cf. BOSCHMA, 1948 b, p. 87, no. 3). Locality unknown. Textfig. 4 a of the present paper is an outline of a fragment of this colony.

Ampullae: Pl. I figs. 3—5, textfig. 2 c.

The colony shows numerous ampullae, the greater part of which are still closed.

The ampullae have a diameter of 0.3—0.45 mm. Their central part is slightly sunk beneath the surface of the corallum, so that their shape more or less corresponds with the diagrammatic figure 1 d. The covering of the ampullae is a calcareous plate irregularly pierced by small openings surrounding the somewhat larger central opening.

3. *Millepora platyphylla* Hempr. and Ehr., Island Edam, Bay of Batavia, May 25, 1921. Colony of a plate-like growth.

Ampullae: Pl. II figs. 1—3, textfig. 2 b.

In certain regions the colony shows a large number of ampullae which for the greater part are still closed.

The ampullae have a diameter of 0.4—0.55 mm. Their covering as a rule is decidedly concave so that the central part is pronouncedly below the surface of the corallum (Pl. II figs. 1 and 3). In some parts of the colony the ampullae are less strongly concave (Pl. II fig. 2). Generally the shape of the ampullae corresponds with the diagrammatic figure 1 d, the concavity even may be still more pronounced. The covering of the ampullae consists of a calcareous plate which is more or less irregularly pierced by holes, the central of which usually is slightly larger than the others.

4. *Millepora platyphylla* Hempr. and Ehr., Island Edam, Bay of Batavia, date unknown. Colony of a plate-like growth (cf. BOSCHMA, 1948 b, Pl. XV fig. 5).

Ampullae: Pl. II figs. 4—7, textfig. 2 d.

In a part of the colony there are numerous ampullae, usually in a closed condition.

The ampullae have a diameter of 0.4—0.5 mm. They are slightly or pronouncedly concave, so that their general shape corresponds with the diagrammatic figure 1 d. The covering of the ampullae consists of a mass of trabeculae which are not distinctly arranged in a radial manner (Pl. II fig. 6), often the trabeculae are rather broadened, so that the covering consists of a calcareous plate pierced by irregular holes (Pl. II figs. 4, 5, 7). As a rule the central opening is somewhat larger than the other holes.

5. *Millepora murrayi* Quelch, British Museum (Natural History), reg. no. 94. 6. 19. 1, Tongatabu, J. J. LISTER. Colony of the same shape and

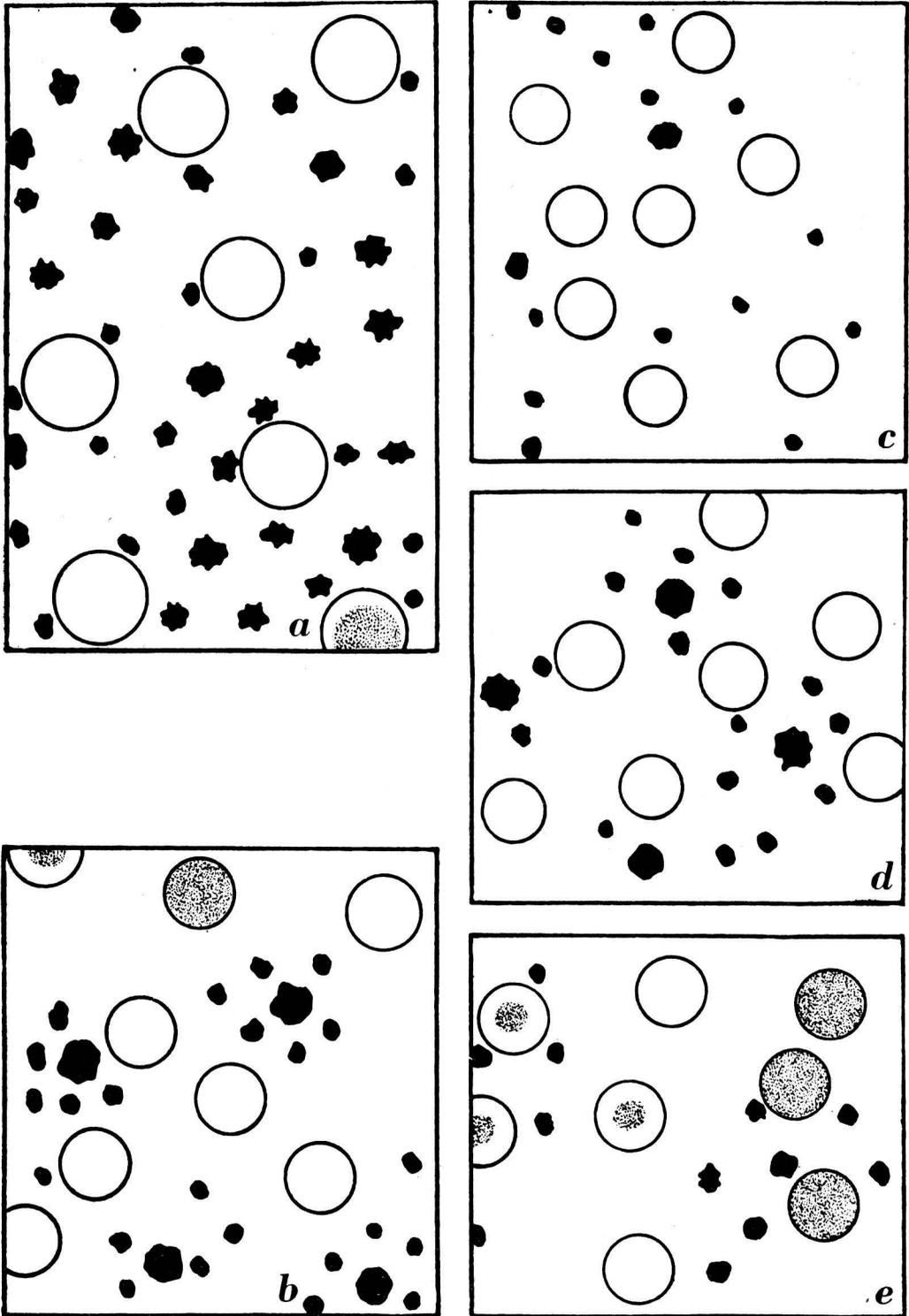


Fig. 2. Diagrams of some figures of the plates, indicating the place of the ampullae. *a*, *M. alcicornis* of Pl. I fig. 1; *b*, *M. platyphylla* of Pl. II fig. 2; *c*, *M. alcicornis* of Pl. I fig. 4; *d*, *M. platyphylla* of Pl. II fig. 7; *e*, *M. tenella* of Pl. V fig. 3. Open circles, closed ampullae; dotted parts, partly or wholly open ampullae; black, gastropores and dactylopores. $\times 20$.

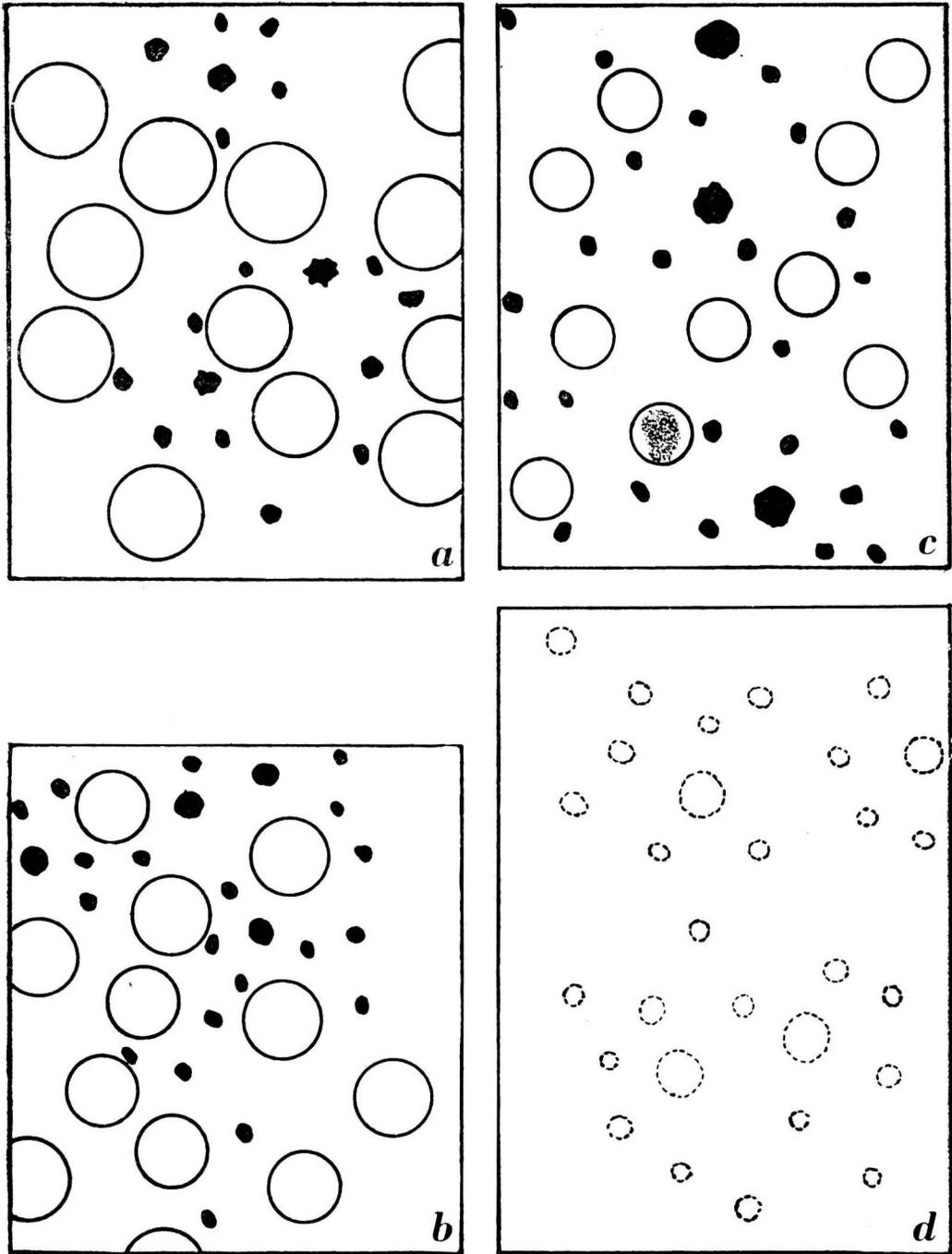


Fig. 3. Diagrams of some figures of the plates, indicating the place of the ampullae or (d) the partly closed pores. *a*, *M. murrayi* of Pl. III fig. 3; *b*, *M. murrayi* of Pl. III fig. 4; *c*, *M. tenella* of Pl. IV fig. 7; *d*, *M. platyphylla* of Pl. V fig. 3. For further explanation see fig. 2. $\times 20$.

manner of branching as the type specimen from Zamboanga, Philippine Islands (cf. QUELCH, 1886, Pl. VII figs. 5—5 a).

Ampullae: Pl. III figs. 1—3, textfig. 3 a.

The colony shows a great number of ampullae which for the greater part are still closed.

The ampullae have a diameter of 0.4—0.7 mm. As a rule their covering is flat so that in general appearance the ampullae correspond with the diagrammatic figure 1 a. In the greater part of the colony the ampullae are fairly large (Pl. III figs. 1, 3), in other parts they are decidedly smaller (Pl. III fig. 2). The covering of the ampullae consists of a mass of trabeculae with comparatively wide openings. The trabeculae are not arranged in a radial manner. As a rule the central opening is slightly larger than the other openings of the covering.

6. *Millepora murrayi* Quelch, Island Edam, Bay of Batavia, July 5—8, 1921. Colony very similar to that described in a previous paper (BOSCHMA, 1948 b, Pl. XI fig. 2).

Ampullae: Pl. III figs. 4—6, textfig. 3 b.

The colony shows a multitude of ampullae, in closed as well as in open condition.

The ampullae have a diameter of 0.4—0.6 mm. Their covering projects noticeably above the surface of the corallum, so that in general appearance the ampullae correspond with the diagrammatic figure 1 c. The trabeculae which form the covering of the ampullae are rather thick, and between themselves they leave but small openings. The central opening as a rule is slightly larger than the other openings of the covering.

7. *Millepora tenella* Ortm., Snellius Expedition, Ake Selaka, Kaoe Bay, Halmahera, May 28, 1930. Rather widely branched colony, textfig. 4 d of the present paper is an outline of the topmost part.

Ampullae: Pl. IV figs. 1—4.

The surface of the colony is largely covered with ampullae, nearly all of which are still in a closed condition.

The ampullae have a diameter of 0.5—0.6 mm. Their marginal part is raised above the surface of the corallum, whilst their central part shows a slight depression. In general appearance the shape of the ampullae corresponds with the diagrammatic figure 1 e. The covering of the ampullae consists of a mass of largely fused trabeculae forming a calcareous plate. The latter is pierced by numerous openings of comparatively large size, of which not always the central opening is larger than the others. There is no distinct radial arrangement of the trabeculae.

8. *Millepora tenella* Ortm., British Museum (Natural History), reg. no. 76. 5. 5. 110, Rodriguez Island, SLATER. Colony of plate-like growth with short marginal branches, textfig. 4 c of the present paper is an outline of a fragment of this colony.

Ampullae: Pl. IV figs. 5—7, textfig. 3 c.

The colony shows a great number of ampullae, many of which still are in a closed condition.

The ampullae have a diameter of 0.3—0.5 mm. They have a flat surface or are slightly convex, so that their shape corresponds with the diagrammatic figure 1 *a* or *b*. The covering of the ampullae consists of a mass of rather thick trabeculae, leaving between themselves some small openings. There is no distinct radial arrangement of the trabeculae.

9. *Millepora tenella* Ortm., Siboga Expedition, station unknown. Rather delicate, widely spreading colony, textfig. 4 *e* of the present paper is an outline of some top branches of this colony.

Ampullae: Pl. V figs. 3—4, textfig. 2 *e*.

Many branches of the colony show a multitude of ampullae which for the greater part are in open condition; on a few branches there are some ampullae which have remained closed.

The ampullae have a diameter of 0.5—0.6 mm. They are slightly convex so that their general appearance corresponds with the diagrammatic figure 1 *b*. The covering of the ampullae consists of an irregular mass of thin trabeculae. The central opening is larger than the other openings between the trabeculae. There is no indication of a radial arrangement of the trabeculae.

10. *Millepora latifolia* Boschma, Island Edam, Bay of Batavia, May 27, 1921. Colony figured in a previous paper (BOSCHMA, 1948 *b*, Pl. IV fig. 1).

Ampullae: Pl. V figs. 1—2.

The colony shows a very great number of ampullae, in closed as well as in open condition.

The ampullae have a diameter of 0.6—0.8 mm. As a rule they are slightly convex (corresponding with the diagrammatic figure 1 *b*), some ampullae have a flat surface, and some are slightly concave. The covering consists of a system of trabeculae which more or less distinctly show an arrangement radiating from the centre. This holds at least for the peripheral region of the ampullae, the central part of the covering is a calcareous plate with small openings irregularly surrounding the somewhat larger central opening.

The data given above show that the ampullae in many cases possess peculiarities which undoubtedly are characteristic of the species.

It is a curious fact that the ampullae of *Millepora platyphylla* are of comparatively small size, whilst the gastropores in this species are decidedly larger than those of the other species of the genus. In one of the specimens of *M. platyphylla* the ampullae as a rule are pronouncedly concave (Pl. II figs. 1 and 3), though in the same colony there are regions in which the covering of the ampullae is hardly below the surface of the corallum (Pl. II fig. 2). Here they are of a quite similar appearance as the ampullae of the second specimen of *M. platyphylla* (Pl. II figs. 4—7). In the two

specimens the covering of the ampullae consists of a similar mass of trabeculae in which a distinct radial arrangement cannot be observed. As far as definite conclusions may be drawn from the examination of the ampullae of the two colonies we may conclude that the ampullae of *M. platyphylla* differ from those of the other species of the genus by their strong tendency for a concave covering.

As compared with those of *M. platyphylla* the ampullae of *M. latifolia* (Pl. V figs. 1—2) have quite a different appearance. They are comparatively large (diameter 0.6—0.8 mm), they may be flat or slightly concave, but as a rule are more or less convex, and their covering consists of trabeculae which show a distinct tendency to a radial arrangement. In the two species the ampullae have such a pronouncedly different aspect that undoubtedly these differences point to specific distinction between *M. latifolia* and *M. platyphylla*.

Another specimen with ampullae of fairly large size is the colony of *M. murrayi* from Tongatabu. As a rule in this specimen the ampullae have a diameter of 0.5—0.7 mm (Pl. III figs. 1 and 3), in some parts of the colony they are somewhat smaller (0.4—0.5 mm, Pl. III fig. 2). The covering of the ampullae does not project above the surface of the corallum, it consists of a network of fine trabeculae in which a distinct radial arrangement cannot be observed. I could compare the ampullae of this specimen with those of the type specimen from the Philippine Islands, in the collection of the British Museum (Natural History). In the two specimens the ampullae are exactly alike in size and shape and structure, so that the ampullae of *M. murrayi* of Pl. III figs. 1—3 are of the typical shape. As far as concerns the two colonies taken as a whole the specimen from Tongatabu in every detail of shape and size of the branches and manner of branching corresponds with the type specimen from the Philippines.

In the specimen of *M. murrayi* from the Island Edam the ampullae have a diameter of 0.4—0.6 mm, and their covering consists of trabeculae which do not present a radial arrangement. They differ, however, from the other specimens examined by their pronouncedly convex shape of the covering (Pl. III figs. 4—6). This difference in shape of the ampullae might be an indication for a specific difference between the specimen from Tongatabu and that from the Island Edam. It must be admitted that it is not quite certain that the specimen from the Island Edam identified as *M. murrayi* really belongs to this species. The colony undoubtedly is a representative of the same species as the one figured in a previous paper (BOSCHMA, 1948 *b*, Pl. XI fig. 2), but this colony has not exactly the same manner of branching and shape and size of its component parts as typical specimens of *M. murrayi*. In the cited paper I came to the conclusion that there are ten distinct species of the genus *Millepora*. If this conclusion is right the specimen dealt with here undoubtedly belongs to *M. murrayi*. If on the other hand the two specimens of which the ampullae are shown on Pl. III

are specifically distinct the specimen from the Island Edam is a representative of an undescribed species which closely resembles *M. murrayi*.

The differences in the ampullae of the two specimens, however, not necessarily point to a specific distinction. It remains possible that one of the colonies is of the male sex, the other of the female. It is unknown whether there are differences in shape and size between the medusae of either sex in one species of *Millepora* (male medusae only are known of two forms of Indopacific, and female medusae of one form of West Indian *Millepora*), but if these occur they might easily develop in ampullae of different shapes.

The ampullae of the two specimens of *M. alcicornis* again show striking differences. In the one colony (Pl. I figs. 1 and 2) the ampullae have a diameter of 0.5—0.7 mm, they have a rather flat surface and their covering shows a pronouncedly radial arrangement of trabeculae. In the other colony (Pl. I figs. 3—5) the ampullae are much smaller (diameter 0.3—



Fig. 4. Outlines of parts of colonies of *Millepora*. a, *M. alcicornis* from Leiden Museum; b, *M. alcicornis* from Amsterdam Museum; c, *M. tenella* from Rodriguez; d, *M. tenella* from Halmahera; e, *M. tenella* from Siboga Expedition. 5/6 natural size.

0.45 mm), they are slightly concave and their covering is composed of trabeculae which do not show a radial arrangement. These differences might point to a specific distinction of the two colonies, but it is highly improbable that we have to find a solution of the problem in this way. In their general appearance and in their manner of branching the two colonies are strongly similar. The fragment from which the photographs of Pl. I figs. 1 and 2 were taken is represented in outline in textfig. 4 *b*, a fragment of the colony from which the photographs of Pl. I figs. 3—5 were taken is shown in the same manner in textfig. 4 *a*. Both colonies are of the highly branched form of *Millepora alcicornis*, in both the branches have a strong tendency to unite into more or less plate-like forms. The differences in shape and in manner of branching of the two fragments are less striking than those often found in parts of the same colony.

Here the only possible explanation of the differences between the two sets of ampullae seems to be that one set represents the ampullae of the female colonies, the other set the ampullae of the male colonies.

When we compare the ampullae of the specimen of *M. tenella* from Rodriguez (Pl. IV figs. 5—7) to those of *M. tenella* from the Siboga Expedition (Pl. V figs. 3—4) we do not find striking differences. In the Rodriguez specimen the ampullae are rather small (diameter 0.3—0.5 mm), in the Siboga specimen they are slightly larger (diameter 0.5—0.6 mm), but in both specimens they are rather flat and do not show a pronouncedly radial arrangement of the trabeculae. The ampullae of the specimen of *M. tenella* from Halmahera have a diameter of 0.5—0.6 mm, they have no distinct radial arrangement of the trabeculae, but they differ in shape from those of the two other specimens as they do not possess a flat surface but have a convex marginal part and a concave central part. As a result they appear much more distinct than those of the two other specimens.

The difference in the shape of the ampullae in the three specimens of *M. tenella* remind of the differences found in the two specimens of *M. platyphylla*. In two specimens of *M. tenella* the ampullae have a more or less flat surface, in the third specimen they distinctly protrude over the surface of the corallum. These differences may be due to variation, possibly as a result of different circumstances of the localities in which the specimens were growing. On the other hand here again the differences in the shape of the ampullae may be the result of sexual differences of the colonies.

The three colonies of *M. tenella* in which closed ampullae were observed do not show important differences in shape and in manner of branching. The colony from Rodriguez (cf. textfig. 4 *c*) is of a more or less plate-like growth with short and blunt small branches in its marginal part, that from the Siboga Expedition (cf. textfig. 4 *e*) is of a slender growth form with spreading branches, whilst that from Halmahera (cf. textfig. 4 *d*) in its growth form is more or less intermediate between the two others, it is

spreadingly branched with slightly more robust branches than the Siboga specimen. Among each other the three specimens do not present more striking differences than those commonly found in different parts of one fairly large colony of *M. tenella*.

It is highly probable that ampullae develop in the colonies of *Millepora* in certain times of the year only. Unfortunately only a small part of the material dealt with here has the dates of collecting. One specimen of *M. platyphylla* was collected on May 25, the specimen of *M. murrayi* from the Island Edam on July 5—8, the specimen of *M. tenella* from Halmahera on May 28, the specimen of *M. latifolia* on May 27, the specimen of *M. murrayi* from Zamboanga (Philippine Islands) between October 24 and November 12 or between January 11 and February 5 (cf. MOSELEY, 1879). The time of development of the ampullae may be different in the various species. The dates given above do not point to a distinct season for all the species of the genus.

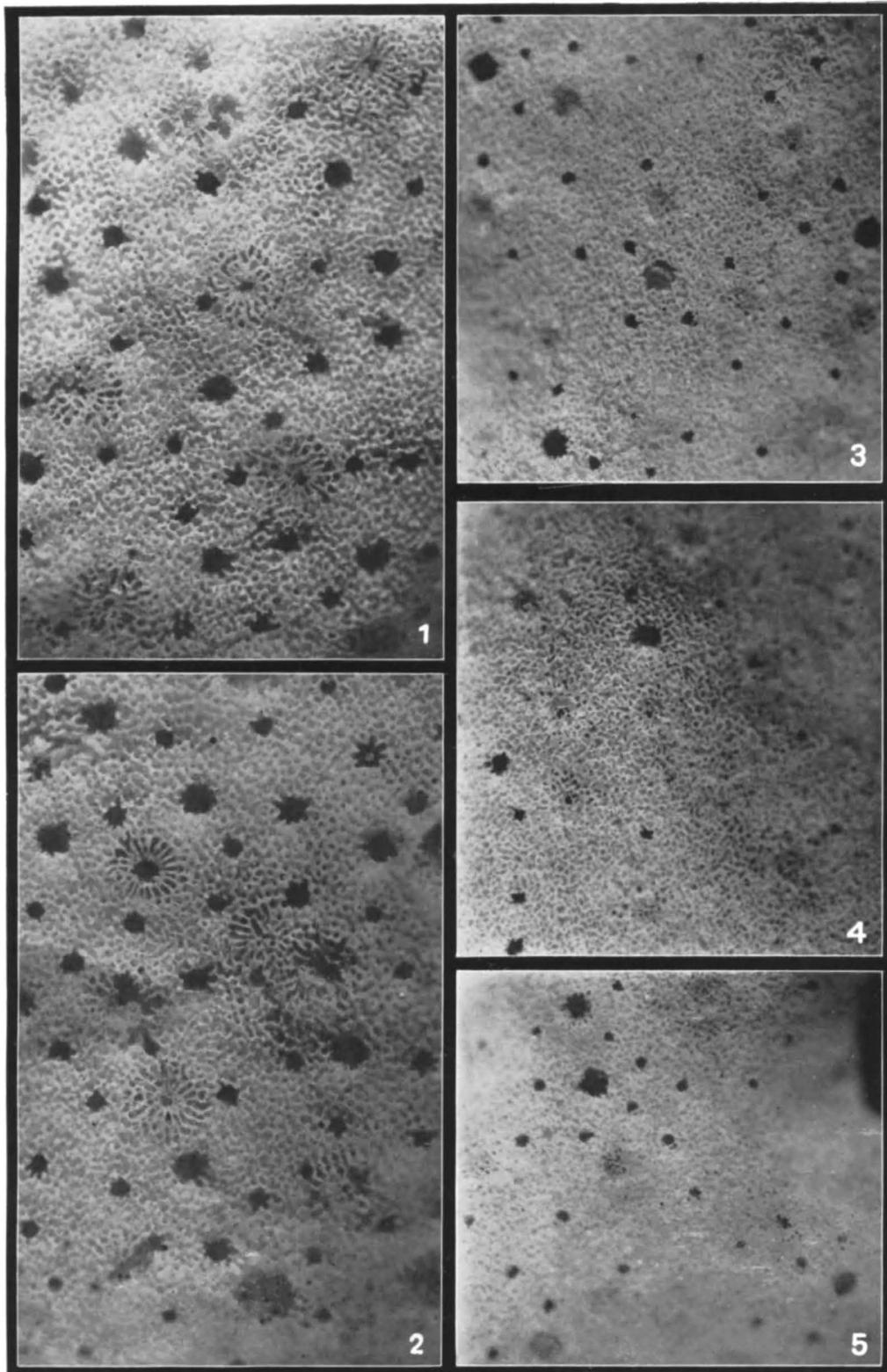
The peculiarities of one more colony of *Millepora* need to be described here, as it presents trabecular plates which easily might be mistaken for the coverings of ampullae. The colony is from Station 193 of the Siboga Expedition (Sanana Bay, Soela Besi, September 13—14, 1899), it is the topmost part of a plate-like growth of *Millepora platyphylla* (breadth of the fragment 14 cm, height 12 cm) which has broken off from the colony and apparently was collected in living condition after having been lying for some months on one of the flat sides of the colony on the reef. A large part of the new lower surface of the colony now was almost completely shut off from light, and on this surface it is to be observed that the size of the pores is gradually diminishing as their openings become covered by a thin plate consisting of trabeculae growing inwards from the margin of the pores. The figures (Pl. V fig. 5 and textfig. 3 d) show the surface of a part of this colony that remained in darkness for some time, here the gastropores and the dactylopores have become almost completely closed by the trabecular plates. Especially the almost closed gastropores show a marked resemblance to the ampullae of a number of specimens dealt with here.

Summarizing we may observe that the closed ampullae of the various specimens examined present striking differences which may be characteristic of the species. As long as it remains unknown whether or not the ampullae of a male colony of a certain species are different from those of a female colony of the same species no definite facts concerning the value of the ampullae as indicators of specific characters can be established.

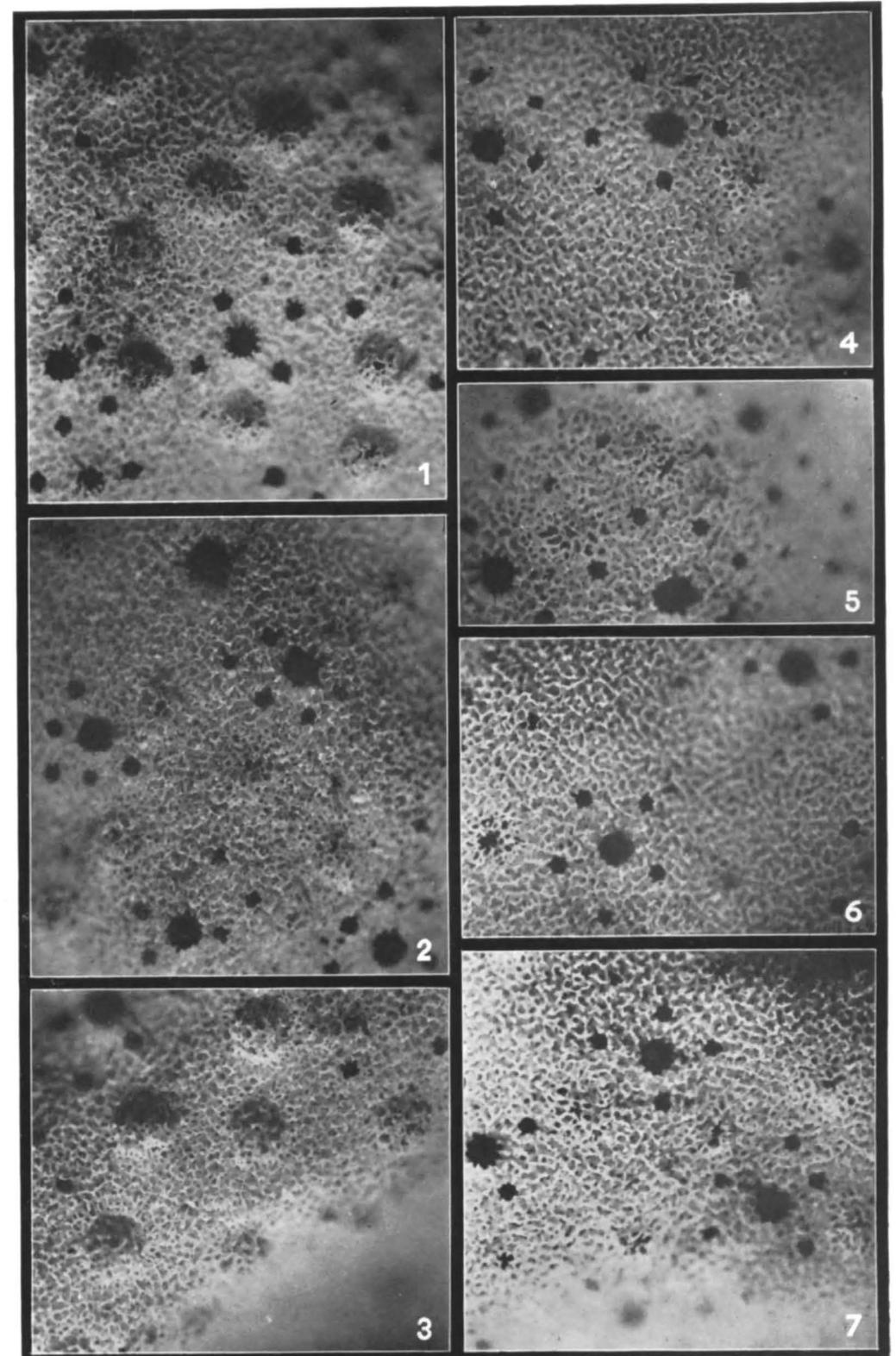
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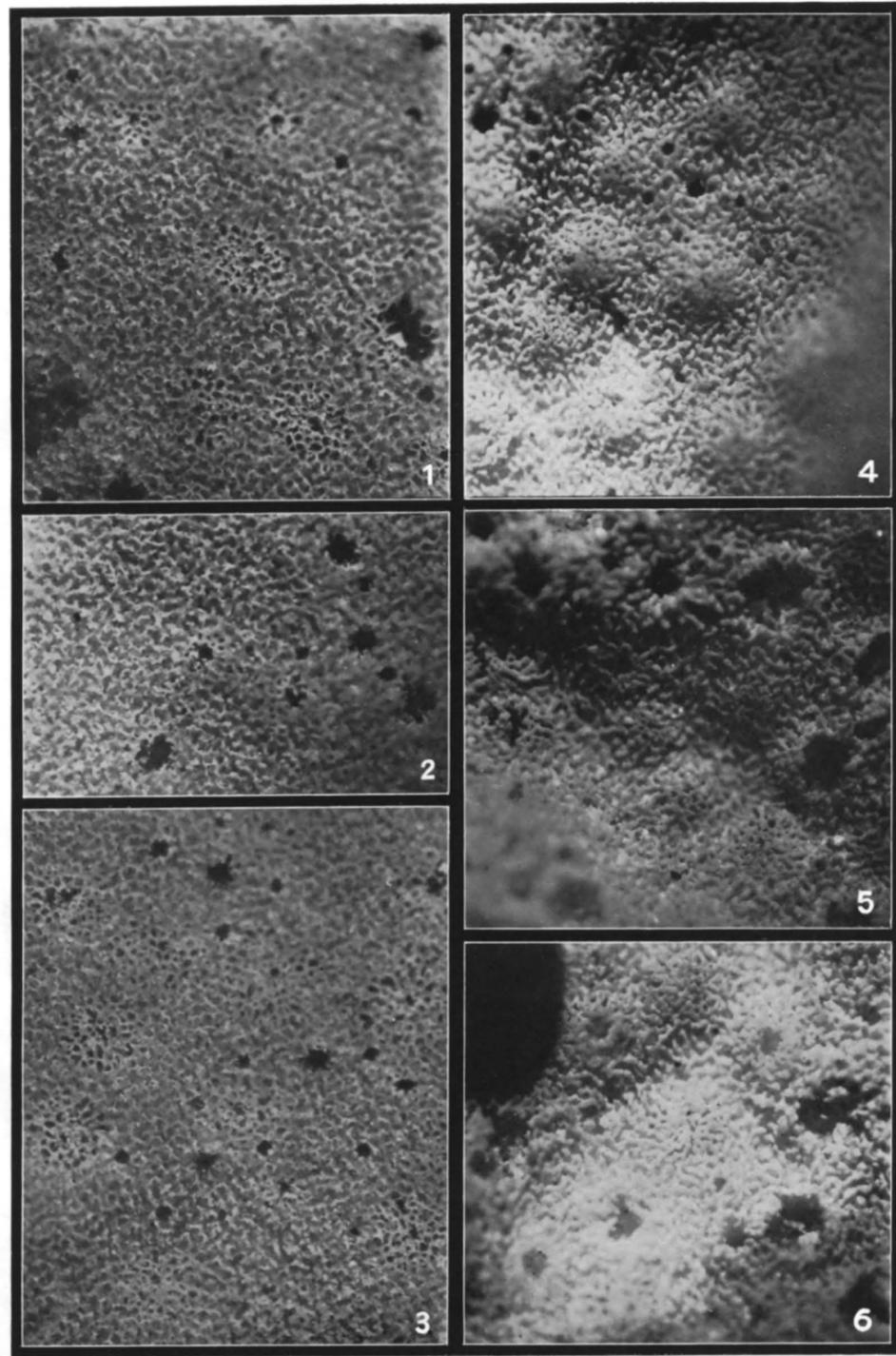
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Figs. 1 and 2. *Millepora alcicornis* L., Amsterdam Museum, ampullae.
Figs. 3—5. *Millepora alcicornis* L., Leiden Museum, ampullae.
All figures $\times 20$.

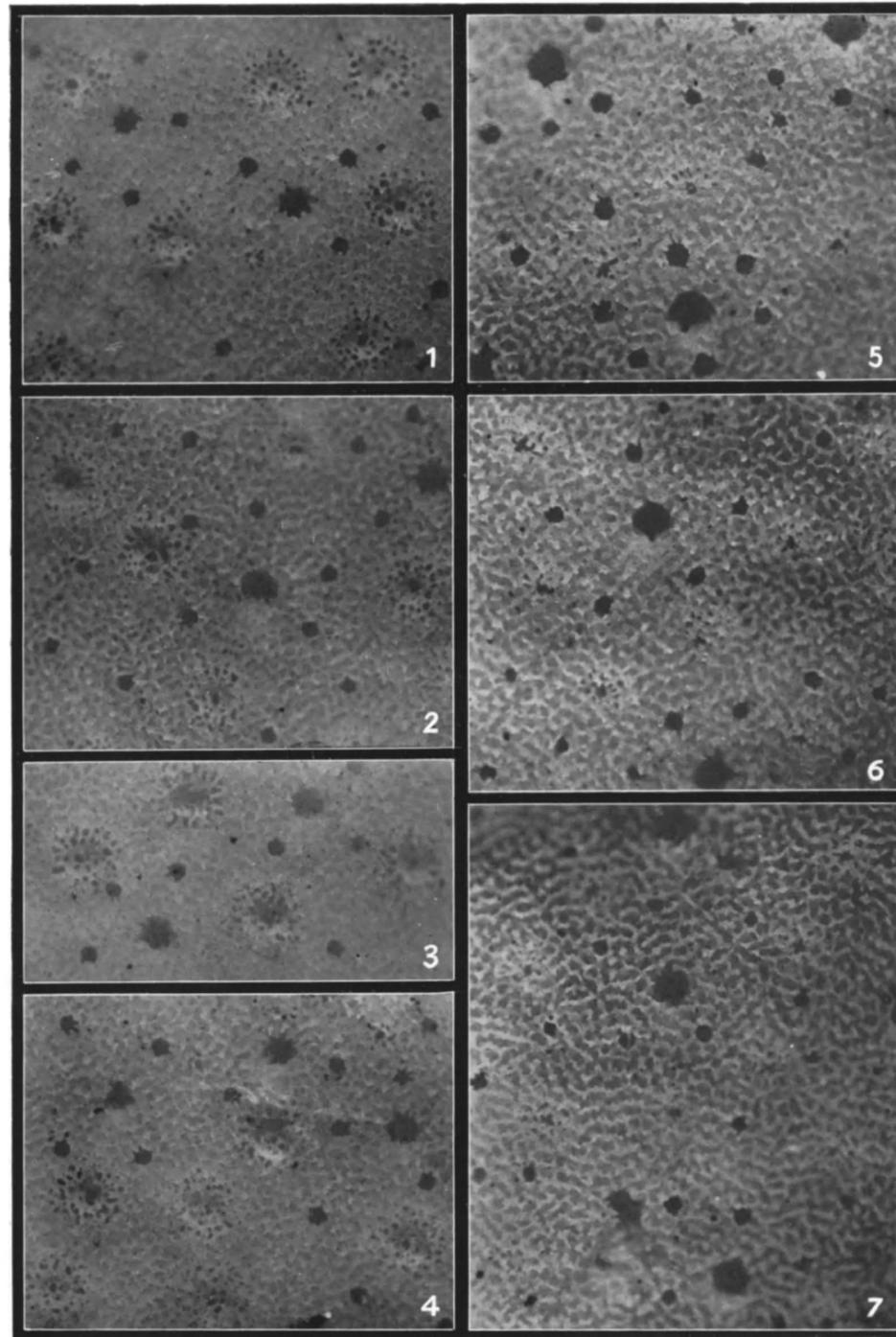


Figs. 1—3. *Millepora platyphylla* Hempr. & Ehr., Island Edam, May 25, 1921, ampullae.
Figs. 4—7. *Millepora platyphylla* Hempr. & Ehr., Island Edam, date unknown, ampullae.
All figures $\times 20$.



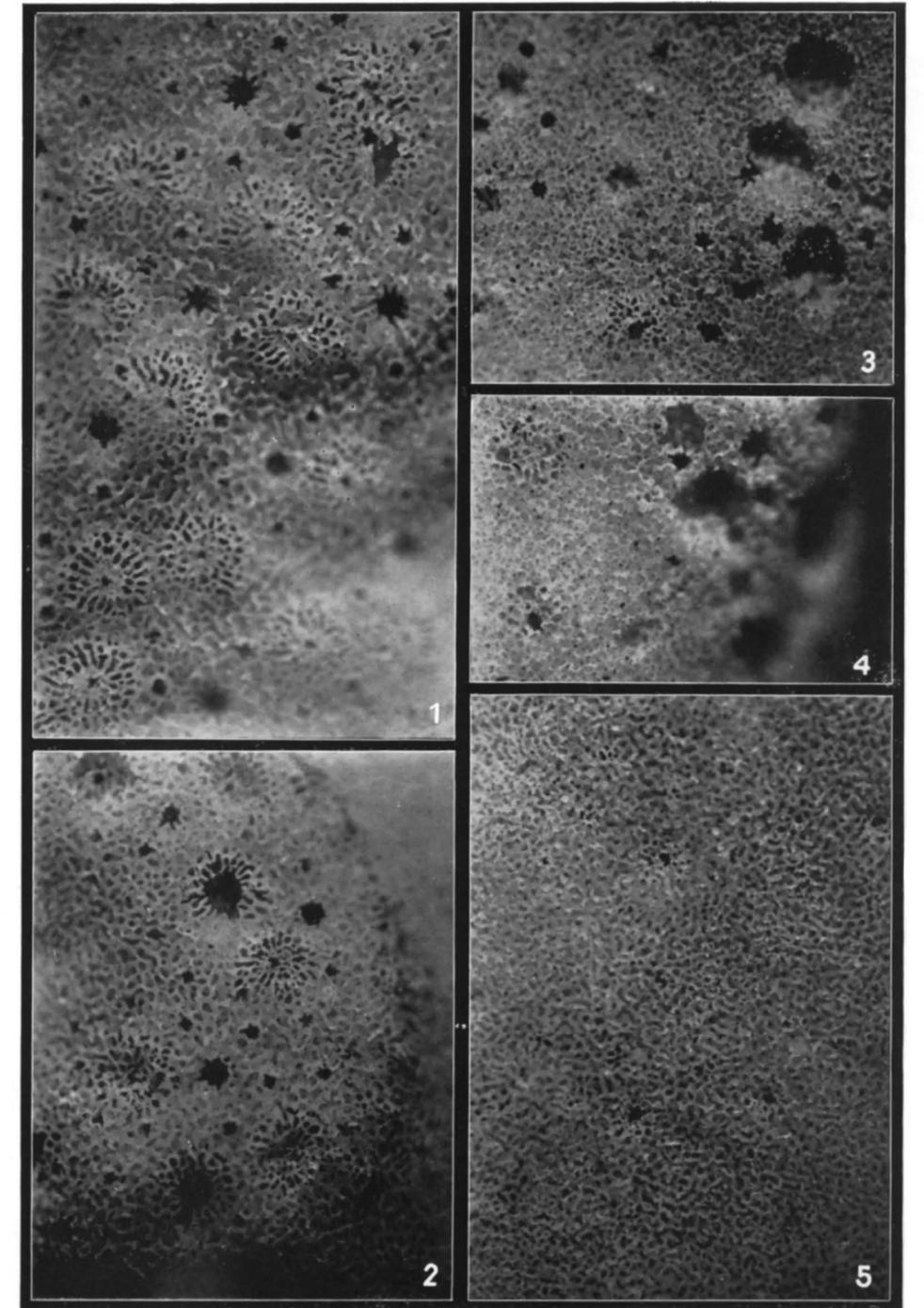
Figs. 1—3. *Millepora murrayi* Quelch, Tongatabu, ampullae.
 Figs. 4—6. *Millepora murrayi* Quelch, Island Edam, ampullae.

All figures $\times 20$.



Figs. 1—4. *Millepora tenella* Ortm., Halmahera, ampullae.
 Figs. 5—7. *Millepora tenella* Ortm., Rodriguez, ampullae.

All figures $\times 20$.



Figs. 1—2. *Millepora latifolia* Boschma, Island Edam, ampullae.
 Figs. 3—4. *Millepora tenella* Ortm., Siboga Expedition, station unknown, ampullae.
 Fig. 5. *Millepora platyphylla* Hempr. & Ehr., Siboga Expedition, Station 193, partially closed gastropores and dactylopores. All figures $\times 20$.