NOTES ON HYDROCORALLIA

by

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1. Introduction.

When using here the name Hydrocorallia for a group of corals, it is not intended to regard this group as a recognized systematic unit. Since Moseley (1880) placed the Stylasteridae with the Milleporidae in the Hydrocorallinae, a separate sub-order of the Hydroids, it has been sufficiently pointed out that the families Milleporidae and Stylasteridae have little in common, and that their respective relations are with Hydroids of systematically different groups. Broch (1914) maintains that the family Milleporidae traces its origin to that of the Corynidae, whilst in his opinion the family Stylasteridae is a highly specialized group that has been derived from the Bougainvilliidae. Stechow (1923) came to the same conclusion, he also placed the Milleporidae next to the Corynidae, and regarded the Stylasteridae as related to the Hydractiniidae (classified by other investigators as the subfamily Hydractiniinae of the Bougainvilliidae). Broch (1924) divides the suborder Athecatae of the Hydroida into three sections, the Simplicia, the Capitata, and the Filifera; the Capitata embrace the Corynidae, the Milleporidae, and a number of other families, the Filifera are divided into the Bougainvilliidae, the Stylasteridae, and some other families. According to Hickson & England (1905, p. 1) the Milleporidae have very little in common with the Stylasteridae: "It appears to us that to express more accurately the relations of the old group Hydrocorallinae, *Millepora* should be placed in an order Milleporina situated in our system next to the Hydromedusae, whilst the family Stylasteridae should be placed in an order Stylasterina situated near the Trachymedusae". Some years before publication of the opinion quoted above, Hickson had already expressed his views in a similar manner (cf. Delage & Hérouard, 1901, p. 153, footnote). In his treatise on the Coelenterata and Ctenophora, Hickson (1906) again regards the two groups as widely separated, as here he divides the class Hydrozoa into the six orders Eleutheroblastea, Milleporina, Gymnoblastea-Anthomedusae, Calyptoblastea-Leptomedusae, Graptolitoidea, and Stylasterina. Accordingly Hickson regards the Milleporina as rather primitive Hydrozoa, whilst the Stylasterina are considered the most highly specialized group. Hyman (1940) too classifies the

Milleporidae and the Stylasteridae as separate orders, the Milleporina and the Stylasterina.

The distinction of the two groups is based on studies of the soft parts; when dealing with genera that are known in the fossil state only, their place in the zoological system must remain arbitrary. Kühn (1939) recognizes three families of Hydrocorallia and apparently related forms, viz., the Milleporidae, the Stylasteridae, and the Milleporidiidae. In this publication the Milleporidae embrace the genera *Millepora, Axopora, Milleaster,* and *Diamantopora*; the Stylasteridae contain four genera known in the fossil state only (*Congregopora, Cryptaxiella, Deontopora,* and *Palassopora*), and eight genera of which also recent species are known (*Stylaster, Astya, Conopora, Distichopora, Labiopora, Pliobothrus, Spinipora,* and *Sporadopora*); the Milleporidiidae comprise six genera, four of which (*Milleporidium, Myrioporina, Promillepora,* and *Stromaporidium*) in a previous work (Kühn, 1928) were included in the family Stromatoporinidae of the order Stromatoporoidea, whilst the two other genera (*Siphostroma* and *Tosastroma*) were not mentioned in the cited paper, one being of a later date. The evidence for regarding the Milleporidiidae as a group allied to the Milleporidae is far from conclusive. The genus *Milleporidium* has characters pointing to a relationship with the Stromatoporoidea, the type species of the genus, *Milleporidium remesi* Steinmann, was placed by Dehorne (1920) in the genus *Stromatopora*.

The four genera included by Kühn (1939) in the family Milleporidae form a heterogeneous group. *Milleaster* with its two kinds of pores, gastropores and dactylopores, without styles, may be allied to *Millepora,* though among the Stylasteridae there are species of the genus *Pliobothrus* to which *Milleaster* shows a certain similarity. On the other hand the genera *Axopora* and *Diamantopora,* together forming a group of closely allied forms, are principally different from *Millepora* by having pores of one kind only that possess distinct styles. These two genera ought to be separated from the Milleporidae as an independent family, the Axoporidae. As the Axoporidae are characterized by having well-developed styles, they in some respects appear to be more closely allied to the Stylasteridae than to the Milleporidae, though on account of their one set of pores they are widely separated from the two families.

Numerous papers have appeared dealing with Hydrocorallia, recent as well as fossil forms. As a rule authors publishing papers on recent material did not study the fossil representatives of the group, and investigators examining fossil material did not make a profound study of the literature concerning the recent forms. This procedure has resulted in a large amount

of confusion. Many species of fossils have been placed in the genus *Millepora* that on account of their characters belong to entirely different groups; some instances of this kind are dealt with in the following pages. Some fossils have been described as independent genera whilst their characters are not principally different from those of recent species. In another paper (Boschma, 1951) I pointed out that the genus *Deontopora* Hall, 1893, was based on characters that are of common occurrence among the species of the genus *Stylaster*; in the same paper I drew attention to the fact that the genus *Cryptaxiella* Kühn, 1939 (*Cryptaxis* Reuss, 1865) is a synonym of the subgenus *Allopora,* an opinion already brought forward by Moseley (1879, 1880). Unfortunately it is not always an easy task to determine the systematic position of a fossil described as belonging to the Hydrocorallia; if it can be demonstrated that the fossil is not related to the group it often is impossible to indicate its real position (cf. notes on *Palassopora* in the following pages).

There is also a great deal of confusion concerning the specific identification of recent Stylasteridae and the arrangement of the species in genera or subgenera. At least 88 species and subspecies have been described in the genus *Stylaster* sensu latiore, 25 in the genus *Distichopora,* 24 in the genus *Errina,* 14 in the genus *Crypthelia,* and smaller numbers in about a dozen other genera of the group. Many of these described species undoubtedly have to be placed in the synonymy of previously described species, but up till now comparatively little has been done leading to a clear understanding of the majority of the species described in the previous century. Moreover, the arrangement of the species in genera and subgenera in many cases is still unsettled. Broch (1942) divided the genus *Errina* in three subgenera, viz., *Eu-Errina, Labiata,* and *Spinipora*; in a recent paper (Broch, 1951) he came to the conclusion that the two last named subgenera had to be united; for this subgenus the name *Inferiolabiata* was introduced as the two names mentioned above proved to be preoccupied.

II. The fossils commonly regarded as species of the genus *Millepora.*

In "Fossilium Catalogus" Kühn (1928) lists the following fossils as species of *Millepora*: *M. cylindrica* Reuss, *M. dalmatina* Oppenheim, *M. Damesi* (Felix), *M. depauperata* Reuss, *M. parva* Nielsen, *M. ramea* Catullo, *M. Reussi* Kühn, *M. Samueli* (d'Archiac), and *Millepora* spec. of Vadász.

Millepora mammillosa d'Achiardi, 1867, in the cited work is placed in the genus *Axopora; Millepora parasitica* Catullo, 1856, is listed as a synonym of *Axopora pyriformis* (Michelin, 1840-1847). A number of other species that originally were described as representatives of the genus *Millepora* now

are regarded as Bryozoa. In a later publication Kühn (1939), obviously referring to the nine forms listed above, states that 9 fossil species of the genus *Millepora* are known.

The genus *Millepora* in its modern conception is based on the common characters of the living species: before any fossil form was placed in the genus already a fairly large number of recent corals were described as species of *Millepora,* namely *M. alcicornis* Linnaeus, 1758, *M. exaesa* Forskål, 1775, *M. dichotoma* Forskål, 1775, *M. squarrosa* Lamarck, 1816, *M. complanata* Lamarck, 1816, *M. platyphylla* Hemprich & Ehrenberg, 1834, and *M. tenera* Boschma (the present name for *M. tortuosa* Dana, 1848) (cf. Boschma, 1948, 1949). As far as concerns the pores, the common characters of the species of *Millepora* are: Pores of two kinds, gastropores and dactylopores, the latter as a rule of distinctly smaller size than the former; diameter of the gastropores generally 0.2 to 0.3 mm; pores without styles, with circular opening, exceptionally more or less star-shaped; margins of the pores not protruding over the surface of the corallum; pores arranged in cyclosystems each consisting of one gastropore surrounded by a circle of about six dactylopores (when the pores are crowded on the surface of the corallum the different cyclosystems often are not apparent). These characters prove that, with one exception or possibly two, all the fossil forms hitherto placed in the genus *Millepora* in reality do not belong to this genus.

Mr. R. Lagaaij, who recently has made studies on fossil Bryozoa, kindly informed me that, judging by the figures in Reuss's papers, a number of the species of *Millepora* described by this author bear some resemblance to Bryozoa. In this respect it is not altogether improbable that *Millepora cylindrica* (Reuss, 1870, Pl. IV fig. 4) belongs to the genus *Acroporana,* that *Millepora verrucosa* (Reuss, 1868, Pl. XV fig. 9) belongs to the genus *Entalophora,* and that *Millepora depauperata* (Reuss, 1864, Pl. IX fig. 5; later identified as *M. cylindrica*: Reuss, 1868, p. 164) belongs to the genus *Heteropora.* It stands to reason, however, that these conclusions are of a tentative character, a definite decision can be obtained only after an examination of the original specimens.

It is interesting to note that a similar case presented itself when Hall (1893) described the genus *Leptobothrus* as a coral of the family Stylasteridae; afterwards MacGillivray (1895) proved that the specimens were Bryozoa of the genus *Porina.*

The conclusion arrived at above, namely that nearly all the fossils described as species of the genus *Millepora* belong to other groups of animals, is not entirely new. Hickson (1898) already stated that in the literature there is

not a description or a figure proving that *Millepora* existed in Tertiary times, and remarks (l. c., pp. 70-71): "The conclusion I have arrived at then is that there is no evidence that *Millepora* existed further back in history than what may be called geologically recent times." Some years afterwards Hickson (1906, pp. 261-262) expressed his views concerning this question as follows: "The generic name *Millepora* has been applied to a great many fossils from different strata, but a critical examination of their structure fails to show any sufficient reason for including many of them in the genus or even in the order. Fossils that are undoubtedly *Millepora* occur in the raised coral reefs of relatively recent date, but do not extend back into Tertiary times. There seems to be no doubt, therefore, that the genus is of comparatively recent origin." In a later paper Hickson (1934) again observed that no evidence has come forward concerning the existence of *Millepora* in Tertiary or Pretertiary deposits. But as Hickson did not demonstrate that the fossils described as species of the genus *Millepora* on account of their characters appear to be excluded from this genus, his remarks did not meet with the success they deserved. In this connexion Kühn (1927, p. 551) writes: "Hickson hat 1899 bezweifelt, dass *Millepora* im Tertiär auftritt; leider ist seiner kurzen Mitteilung nicht zu entnehemen, warum er die systematische Stellung der zahlreichen aus dem Vicintin und dem Pariser Becken bekannten Arten anzweifelt und wohin er sie stellen will."

An example from a modern treatise may show that it is still regarded as an established fact that *Millepora* is known to occur in strata of rather old age. Though not explicitly stating this, Shimer & Shrock (1947, p. 58) obviously refer to this opinion when dealing with the order Hydrocorallinae: "Some forms, like *Millepora,* are very important reef builders, and fossils of this order are known from as early as the Triassic." A similar remark is found in Twenhofel & Shrock (1935, p. 83). On the other hand Woods (1950, p. 76) is less positive when he remarks concerning *Millepora*: "it has been recorded from Cainozoic deposits, but whether these examples really belong to that genus appears to be somewhat doubtful."

In the following pages an attempt has been made to prove that nearly all the fossils that up till now still find a place in the genus *Millepora* have a structure preventing them from remaining included in this genus. One fossil form only, indicated below with the new name *Millepora tornquisti,* appears to have the characters of the genus, whilst of some other forms the position in the genus *Millepora* remains at least doubtful.

1. *Millepora samueli* (d'Archiac, 1848).

When d'Archiac (1848, p. 413, pl. IX figs. 11, 12) described the species *Scyphia samueli,* he regarded it as a sponge. The two figured fragments show numerous circular pores arranged in regular rows, whilst between the pores the surface is profusely pitted by minute openings. Some of the larger pores are surrounded by an inconspicuous wall that slightly rises above the surface. The regular, more or less rectiliniar arrangement of the larger pores proves that these cannot be regarded as gastropores as they occur in *Millepora*; moreover, the regular distribution of the smaller openings and their minute size obviates their interpretation as dactylopores. In the same paper d'Archiac (1848, p. 413, pl. IX fig. 13) gave a description of *Scyphia quinquelobata,* an organism of less regular structure, regarded by the author as a sponge or an alcyonarian. Here again the surface is entirely beset with pores, some of larger size than the others. Especially the larger pores are surrounded by a distinct wall that slightly rises above the surface.

Oppenheim (1896, p. 39) published some notes on material identified by him as *Millepora samueli* (d'Archiac). His specimens correspond with d'Archiac's figures, especially with those showing an irregular structure of the corallum (*Scyphia quinquelobata* d'Archiac?). Moreover, Oppenheim stresses the fact of the similarity of his material with *Millepora verrucosa* Reuss, a form dealt with below under the name *Millepora reussi* Kühn. As, however, the openings in the surface of the corallum in the two species of d'Archiac cannot be regarded as gastropores and dactylopores as they occur in *Millepora,* and as, moreover, *M. reussi* is not a species belonging to the genus *Millepora* (cf. notes on a following page), it must be concluded that Oppenheim made a mistake when placing the species in this genus.

2. *Millepora ramea* Catullo, 1856.

The description of *Millepora ramea* by Catullo (1856, p. 79) in translation reads as follows: "A palmate *Millepora,* cylindrical, provided with slightly compressed, often dichotomous branches, and beset with minute round pores, irregularly distributed on both surfaces of the corallum." The figure (l.c., Pl. XVIII fig. 5) has been drawn in a perfunctory manner, so that it does not show any details besides those of the description. As the available data are altogether insufficient to determine the position of the species in the zoological system it must remain undecided whether or not the species belongs to the genus *Millepora.* Kühn (1928) already stated that it is questionable to regard *M. ramea* as a coral.

3. *Millepora depauperata* Reuss, 1864.

Reuss (1864, p. 29) describes the species as follows:

"*M. depauperata* m. (Taf. 9, Fig. 2-5). Die Äste sind kurz, selten drehrund, meistens etwas zusammengedrückt. An den Enden scheinen die Zacken selbst kurz, konisch zugespitzt gewesen zu sein. Die Zellenmündungen sind sehr klein, ungleich, rundlich, dem Anscheine nach schwach umrandet, ohne alle Ordnung zerstreut, ohne Spur von Radiallamellen. Das Gewebe des Polypenstockes ist ziemlich dicht, sehr fein-schwammig."

The figures do not lead to a better understanding of the characters of the species. Figs. 2-4 represent fragments in natural size so that no exact idea can be formed in regard to the finer structure of the surface and the shape of the pores; fig. 5 shows a fragment in natural size and a part of it enlarged. In a later paper (Reuss, 1868, p. 164) the author states that the specimen of his fig. 5 belongs to a species differing from *M. depauperata.* In the cited paper Reuss remarks that *M. depauperata* is characterized by compressed, usually digitiform fragments that bear scattered pores of varying size, surrounded by weakly raised margins; the pores are not crowded, but rather widely distributed over the surface of the corallum.

As in *Millepora depauperata* all the pores are of the same kind, though of somewhat varying size, and as the pores are surrounded by a distinct wall, the species does not possess the typical characters of the genus *Millepora,* and therefore does not belong to this genus.

4. *Millepora cylindrica* Reuss, 1868.

One of the specimens described by Reuss (1864, Pl. IX fig. 5) as *Millepora depauperata* in a later paper (Reuss, 1868, p. 164) was referred to another species, described as *Millepora cylindrica.* This description is accompanied by a figure showing an enlarged part of another branch(Reuss, 1868, Pl. XV fig. 10). According to Reuss, *Millepora cylindrica* differs from *M. depauperata* by the cylindrical shape of the branches, by pores of very variable but larger size, situated on small excrescences of the corallum. The pores are more crowded than those of *M. depauperata.* Reuss is not fully convinced that the two forms are separate species, in his opinion they might represent parts of one species of different age, but as long as no conclusive evidence is available in this respect he prefers to regard the two as separate. Later, Reuss (1870, p. 55, Pl. IV fig. 4) identified another fragment as *Millepora cylindrica*; he draws attention to the fact that in this specimen the surface of the corallum between the pores is pitted by small openings, and points again to the differences of this species from *M. depauperata.* Afterwards (Reuss, 1874, p. 18) the species *M. cylindrica* was mentioned once more.

The three figures of *Millepora cylindrica* referred to above have been

copied in fig. 1*a*, *d*, and *e* of the present paper. Among each other they show rather striking differences. In the 1864 specimen (cf. fig. 1*d*) the more or less circular pores have a thin wall that is distinctly raised above the surface of the corallum; in the 1868 specimen (cf. fig. 1 *e*) the pores have an oval shape whilst in the figure the wall does not project over the surface, though this is mentioned in the description; in the 1870 specimen (cf. fig. 1 *a*) the more or less circular pores are surrounded again by distinct,

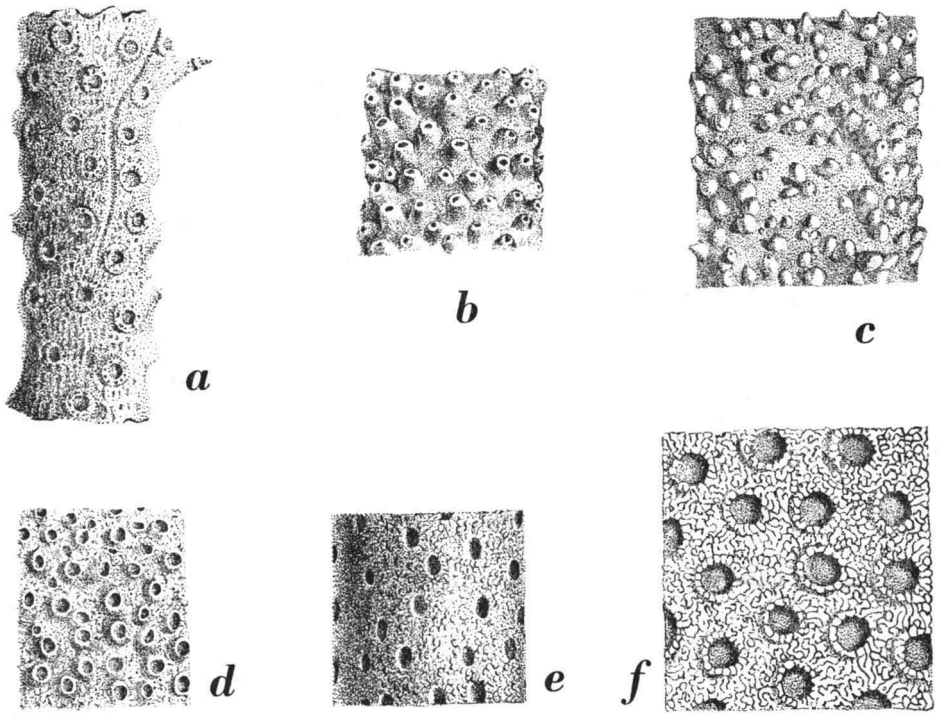

Fig. 1. *a, Millepora cylindrica* Reuss (1870, Pl. IV fig. 4 *b*, × about 3; named *Millepora dalmatina* by Oppenheim, 1901); *b, Millepora verrucosa* Reuss (1868, Pl. XV fig. 9 *b*, × about 4); *c, Millepora verrucosa* Reuss (1869, Pl. XXVII fig. 3 *b*); *d, Millepora depauperata* Reuss (1864, Pl. IX fig. 5 *b*; identified by Reuss, 1868, as *M. cylindrica*); *e, Millepora cylindrica* Reuss (1868, Pl. XV fig. 10 *b*, × about 4); *f, Millepora mamillaris* d'Achiardi (Reuss, 1869, Pl. XXVII fig. 5 *b*). Names as in the cited papers.

rather thick walls with minute openings, so that each pore is encircled by a complete row of these. Between the pores in all the specimens the surface of the corallum is profusely pitted with small openings, largest in the 1870 specimen.

As in the specimens of *Millepora cylindrica* described and figured by

Reuss in the papers cited above there is but one kind of pores (the smaller openings in the surface of the corallum cannot in any respect be regarded as dactylopores), and as, moreover, the margins of the pores extend above the surface of the corallum (when not evident in the figure this character is mentioned in the description), these specimens without any doubt do not belong to the genus *Millepora*.

As noted on a previous page, it is not improbable that the figure copied in fig. 1 *d* of the present paper represents a Bryozoan, possibly a species of the genus *Heteropora*.

Oppenheim (1901) described the species *Millepora dalmatina*; he regarded the specimens of Reuss (1870, pl. IV fig. 4) as belonging to this species, distinct from *M. cylindrica*. The latter name was used by Oppenheim (1906) for specimens from the Balkan Peninsula, no further description of which was given. Additional data concerning *M. dalmatina* will be dealt with on a following page.

Tornquist (1905, pp. 332-333) published the following notes on a fossil from the Eocene of Madagascar, identified by him as *Millepora cylindrica* Reuss:

"Der guterhaltene Ast einer *Millepora* stimmt vollständig mit der vom Mte. Grumo im Vicintin beschriebenen *M. cylindrica* überein. Die Kolonie bildet verhältnismässig schlanke Äste, welche etwas abgeflacht sind; die Endigungen sind plump und abgerundet. Die Oberfläche ist ziemlich eng mit Zooidkelchen bedeckt; diese sind kreisrund und haben keine Spur von Septen. Das Skelett besitzt die bekannte maschige Struktur. *M. cylindrica* gehört zu den Milleporiden, deren Kelchränder nicht verdickt oder erhöht sind. Bei der vicintinischen Form gibt Reuss an, dass die Mündungen der Zellen auf bläschenartigen Erhebungen stehen. Es sind diese nur bei sehr vollkommener Erhaltung an den vicintinischen Stücken zu sehen. Das madagassische Stück lässt diese Eigentümlichkeit nicht erkennen."

Judging by the description and the figure (Tornquist, 1905, Pl. XLVI fig. 8; cf. fig. 2 *e* in the present paper) this specimen is the only known fossil that without any reasonable doubt may be regarded as a representative of the genus *Millepora*. It certainly does not belong to *M. cylindrica* Reuss or to any of the other fossils described as species of the genus. Accordingly, though there are hardly any characters for a specific distinction, the species provisionally may be indicated as *Millepora tornquisti*, especially because in all probability the Eocene coral is specifically distinct from the recent species of the genus.

Millepora tornquisti nov. spec.

Millepora cylindrica Tornquist, 1905, p. 332, Pl. XLVI fig. 8; non *Millepora cylindrica* Reuss, 1868.

Corallum branched, branches slightly flattened, ends of the branches blunt and rounded.

It must be admitted that this description of the species is far from adequate. Tornquist's notes and figure do not show any other characters besides those given above and those pointing to the fact that the species really is a *Millepora*: the pores are circular, their walls not rising above the surface of the corallum; there are two kinds of pores, larger and smaller. In the figure a few of the larger pores (gastropores) are seen to be surrounded by a circular row of five or six smaller pores (dactylopores). Fig. 2 *e* of the present paper was drawn after an enlarged photograph (× 3) of Tornquist's original figure. The fragment is similar to a slightly beach worn part of one of the recent branching species of *Millepora;* on account of its shape and manner of branching it corresponds in nearly every respect with the recent species *Millepora tenera* Boschma (synonyms: *M. tortuosa* Dana, *M. tenella* Ortmann).

5. *Millepora reussi* Kühn, 1927.

Reuss (1868, p. 170, Pl. XV fig. 9) described skeletal fragments of a fossil organism as *Millepora verrucosa,* and stated that this species differs from *M. cylindrica* by its lesser thickness. The surface of the branches of this *M. verrucosa* is crowdedly covered by small slightly tapering verrucose excrescences that on their tops bear small circular openings. For the rest the surface of the corallum is finely granular. The cited figure has been copied in fig. 1 *b* of the present paper, this figure shows that the pores occur on the tops of distinctly higher papillae than those of *M. cylindrica.* In a following paper (Reuss, 1869, p. 251, Pl. XXVII fig. 3) another fragment, regarded as belonging to *M. verrucosa,* is described. Here again the surface of the corallum is beset with numerous well developed papillae. Pores were observed on the tops of a few of the papillae only, in the majority no pore was to be seen. The figure of this specimen, copied in fig. 1 *c* of the present paper, in many respects differs from that of the original specimens of *M. verrucosa*; in the former the papillae are more regularly distributed and they have rather wide openings, whilst in the latter the papillae are irregularly placed and the pores, when present, are very small.

Oppenheim (1906) used the name *Millepora verrucosa* for specimens from the Balkan Peninsula, without adding any particulars concerning his material.

Kühn (1927) drew attention to the fact that the name *Millepora verrucosa* Reuss, 1868, is preoccupied by the name *Millepora verrucosa* Milne Edwards, 1857 (a synonym of *M. platyphylla* Hemprich & Ehrenberg), and proposed the new name *Millepora reussi* for *M. verrucosa* Reuss. The name *M. reussi* was used again in a later paper by Kühn (1928).

The characters of *Millepora reussi* Kühn (*M. verrucosa* Reuss) prevent the species from being included in the genus *Millepora*. The specimens described and figured by Reuss have but one kind of pores; moreover, these pores are found on the tops of papillae. On a previous page it has been suggested that at least the specimen of fig. 1 *b* in the present paper may belong to the Bryozoa, possibly to the genus *Entalophora*.

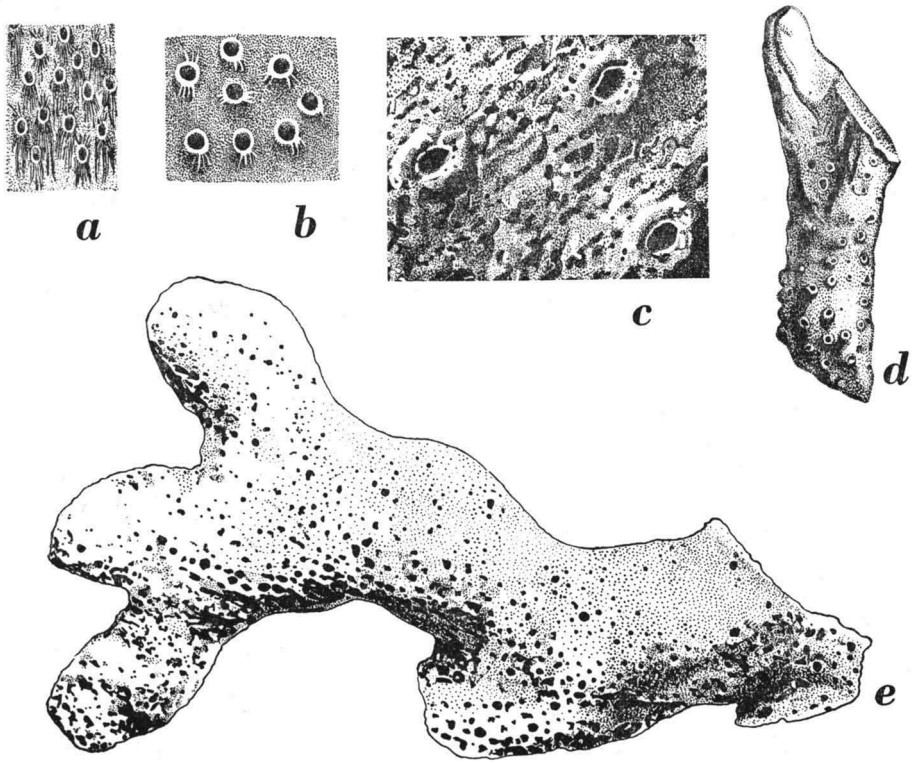

Fig. 2, *a, b, Stylophora Damesi* Felix (1884, Pl. IV figs. 1 *b*, 2 *b*); *c, Millepora dalmatina* Oppenheim (1922, Pl. II fig. 2 *a*; × about 8, part of original figure 3 times enlarged); *d, Millepora dalmatina* Oppenheim (1901, Pl. XVI fig. 10); *e, Millepora cylindrica* Reuss (Tornquist, 1905, Pl. XLVI fig. 8; original figure 3 times enlarged). Names as in the cited papers.

6. *Millepora dalmatina* Oppenheim, 1901.

Oppenheim (1901, pp. 197-198, Pl. XVI fig. 10) gives the following description of *Millepora dalmatina*:

"Die Colonie hat anscheinend die Gestalt eines Baumes, dessen drehrunde, breite Zweige vorliegen. Sie tragen die Grosszellen auf zitzenförmigen, am Rande schwach gezähnten Anschwellungen über die ganze Oberfläche vertheilt. Das Lumen dieser Gebilde beträgt 1 mm, von dem die Hälfte etwa auf die eigentliche, stets sichtbare, rund-

liche Zellöffnung fällt. Die Poren der Autozoidien stehen gedrängt und sind durch wurmförmig gewundene Canäle verbunden."

In the figure, copied in fig. 2 *d* of the present paper, the pores do not appear as crowdedly as one would expect according to the last sentence of the description.

Oppenheim (1901, pp. 164, 198) regards the specimens of *Millepora cylindrica* described by Reuss in 1870 (p. 55, Pl. IV fig. 4; copied in fig. 1 *a* of the present paper) as belonging to his *M. dalmatina*; the two forms indeed are rather similar.

A more elaborate description of *Millepora dalmatina,* partly based on additional material, from the Eocene of the Herzegowina, was given by Oppenheim (1922, pp. 17-18, Pl. II figs. 2, 2 *a*). The figured specimen is a fragment of a flattened branch, the larger diameter of which is about 66 mm. The structure of the circular pores, on the tops of small papillae, and their distribution on the surface of the corallum, is in complete accord with the corresponding particulars of the type specimen (cf. fig. 2 *d* in the present paper). Oppenheim points to the differences of his *Millepora dalmatina* from *M. verrucosa* Reuss and from *M. cylindrica* Reuss, he further states that in the basal region of the pores there is an adumbration of a style, constituting a similarity of the species to the genus *Axopora.* Moreover, according to Oppenheim some peculiarities of the structure of *M. dalmatina* point to a probable connexion with the Alcyonarian coral *Heliopora.* The latter speculations, however, do not appear so well founded that they deserve further consideration.

Oppenheim further states that in his *Millepora dalmatina* the skeletal elements surrounding the pores often are radially arranged. He remarks that this is also apparent in some calices of the figures of Reuss (cf. fig. 1 *a* of the present paper), and still more pronouncedly in the form described by Felix (1884) as *Stylophora Damesi,* a coral that according to Oppenheim belongs to the genus *Millepora.* For further data concerning the last mentioned species I refer to a following page.

In the same paper Oppenheim (1922, p. 18) quotes an interesting remark by Weissermel (1913), namely that the genus *Diamantopora* described by this author, as all the fossil Milleporidae, is distinct from the recent genus (i. e., *Millepora*) by having pores of one size, not to be divided into autopores (gastropores) and dactylopores. Oppenheim emphatically combats this view, he states that in his specimens of *Millepora dalmatina* as well as in the specimens described by Reuss (1870) as *M. cylindrica* (figure copied in fig. 1 *a* of the present paper) there are two kinds of pores, numerous small pores in the whole of the surface of the corallum (also occurring in

circular rows on the walls surrounding the large pores) and the large pores themselves. What Oppenheim means here is apparent from his figure of an enlarged part of the corallum (Oppenheim, 1922, Pl. II fig. *2 a*, part of which has been copied in fig. *2 c* of the present paper).

Oppenheim does not want to give a definite opinion concerning the function of the pores, although he is inclined to regard the large pores as gastropores. He admits the possibility that also the smaller pores contained individuals of the colony with a certain function. This appears, however, extremely improbable. If *Millepora dalmatina* is to be regarded as a species of the genus, it stands to reason that the small pores of this coral completely correspond with the inconspicuous openings found in the superficial skeleton of the recent species of the genus, namely the pores between the trabeculae. They contain parts of the canal system connecting the various individuals of the colony, but do not form pores for polyps comparable to the dactylozooids.

Oppenheim's figure *2 a* (cf. fig. *2 c* of the present paper), showing an enlarged part of his *Millepora dalmatina*, corresponds in every respect with the specimen figured by Reuss (1870, cf. fig. *1 a* in the present paper). Both figures show a row of openings in the walls surrounding the pores. On account of its having but one kind of cavities for polyps, indicating that these did not show dimorphism, the species cannot find a place in the genus *Millepora*. Moreover, this position is excluded by the fact that the walls of the pores protrude above the surface of the corallum. On a previous page it has been remarked that the form known as *Millepora dalmatina* (especially the specimen figured by Reuss, 1870), shows some resemblance to certain Bryozoa, it is not improbable that eventually the species will prove to belong to the genus *Acroporana*.

Among the fossil Stylasteridae described by Nielsen (1919) the species *Pliobothrus dispergens* (l. c., p. 18, Pl. I figs. 7-10) and *P. laevis* (l. c., p. 19, Pl. I figs. 11-13) show an at least superficial likeness to *Millepora dalmatina* and other described species of a similar character. There is not any direct indication for including *Millepora dalmatina* and similar forms among the Stylasteridae, but the possibility of a relation between these forms and the species described by Nielsen referred to above is not positively precluded.

7. Millepora damesi (Felix, 1884).

Fragments of a coral from Eocene deposits in Egypt were described by Felix (1884, Pl. IV figs. 1-4) as *Stylophora Damesi*. In the oval or circular calices that showed a great amount of variation in size, no septa were

found. The calices project above the surface of the corallum with a distinct wall possessing some ridges of more or less radial arrangement around the centre of the calice, thereby showing a similarity to the costae as they occur in many species of corals. The figures representing enlarged views of parts of the surface have been copied in fig. 2 *a, b* of the present paper. These figures show that the specimens are not principally different from most of the forms that have been described as fossil representatives of the genus *Millepora*. Oppenheim (1901) drew attention to the latter fact, and tentatively stated that the species described by Felix might be related to his *M. dalmatina*. In a later paper (Oppenheim, 1922) this author is even more positively convinced that *Stylophora Damesi* is a species of the genus *Millepora,* closely allied to *M. dalmatina*. It is not to be denied that the two species appear to be of a very similar structure, but on account of their lack of dimorphism of the pores and because of the raised margins of the pores they cannot find a place in the genus *Millepora*. For the present it must remain undecided where *Stylophora Damesi* really belongs in the zoological system.

8. *Millepora* spec., Vadász, 1906.

The fossils identified by Vadász (1906) as *Millepora* sp. occurred as massive forms and as incrustations. The author remarks that because of their characteristic structure they belong to the genus *Millepora*; but their manner of preservation prevented a specific identification. As, however, all the specimens from Central European localities described as fossil species of the genus *Millepora* do not belong to this genus, it is highly probable that the material dealt with by Vadász must find a place in the same category.

9. *Millepora parva* Nielsen, 1919.

The description of *Millepora parva* by Nielsen (1919, p. 17) in translation reads as follows:

"The species forms small nodular lobed colonies of a size of up to 10 mm length. They are adhering to other objects on the sea bottom, especially to coral colonies.

The surface of the coenosteum very distinctly shows the reticular structure. The pores clearly show the double function, as there are a few scattered large gastropores and numerous small dactylopores. The species is peculiar in that the dactylopores appear distributed without distinct order, whilst in the other species of the genus they occur in circular rows round the gastropores. For the rest the coenosteum is smooth, without indication of ampullae. Cross sections show that the pores penetrate for a short distance into the tissue. The internal part of the colonies forms a more or less compact mass."

This description does not contain any detail that prevents the species from a place in the genus *Millepora*. It is of very little importance that the dacty-

lopores are not arranged in circular rows around the gastropores, as this arrangement without distinct order is of common occurrence in recent species of the genus. In the specimen of *Millepora complanata* Lamarck of Pl. I fig. 1 in the present paper the pores are seen to be fairly regularly distributed over the surface of the corallum; the gastropores are distinct from the dactylopores by their larger size only but it is impossible to indicate the different cyclosystems.

If, however, Nielsen's figures (1919, Pl. I figs. 1-2) are examined in connexion with his description of *Millepora parva,* some details become apparent that give rise to doubt to its identification as a species of the genus *Millepora.* The size of the gastropores and their distribution on the surface of the corallum is not different from that found in many recent species of *Millepora.* Judging by the figures, however, the dactylopores are much more crowdedly distributed than in any recent species of the genus. In the latter the distance between two neighbouring dactylopores as a rule is far larger than the diameter of these pores, whilst in *Millepora parva* the dactylopores are in such a narrow mutual contact that but small ridges of the surface are not occupied by these pores. This arrangement of the dactylopores gives the coral an aspect entirely different from that of the recent species of the genus, so that it must remain doubtful whether or not the species really belongs to *Millepora.*

In the drawings (l. c., figs. 1-2) most of the gastropores show a light spot in the centre of the opening. This gives the impression as if on the bottom of the pores there occurs a slight conical excrescence that might represent a style as it is known to occur in the genus *Axopora.* Nielsen's figure 2 has been copied in a paper by Kühn (1939, fig. 30) in such a manner that the apparent occurrence of a style is still more distinct than in the original figure. If really there is a style in the gastropores of *Millepora parva* (which is improbable, for Nielsen certainly would not have overlooked the occurrence of styles, as he observed them in various Stylasteridae) the species possibly ought to be removed to the genus *Axopora,* though on the condition that the cavities regarded as dactylopores are no real pores for the lodging of polyps, but superficial openings between the trabeculae of the corallum. A solution of the questions brought forward here can be obtained only after an examination of the material. Provisionally the species *Millepora parva* may be regarded as a doubtful representative of the genus *Millepora.*

If really *M. parva* proves to be a species of the genus it is the oldest representative known. It occurs in the Danian, a geological layer between the Cretaceous and the Tertiary formations, preceding the Eocene, from

which the only fossil species (*M. tornquisti*) has been recorded that without reasonable doubt may be regarded as belonging to *Millepora*.

III. The genus *Milleaster* Ulrich, 1904.

The characters of the genus *Milleaster* are defined by Ulrich (1904, p. 435) as follows:

"Encrusting (? or subramose) polyparia, composed of one or more layers. Upper surface rough, exhibiting two sets of large, more or less irregularly distributed pores, the one (? dactylozooids) with elevated margins and stellate orifices, the other (? gastrozooids) fewer in number and occupying the depressed spaces between the elevated apertures, being a little larger, irregularly rounded in shape and the centers from which the astrorhizal grooves diverge. A third set of pores, in this case rounded in form and less than half the size of the other sets, occurs scattered among the granules of the interspaces. No columella nor tabulae observed. Septa of the elevated pores strong, not very regular, usually six in number, but varying from four to seven; sometimes joining laterally so as to leave but a minute central opening. Coenenchyma cancellate, granulose at the surface. Skeleton calcareous, apparently composed of a loose network of fibers. Astrorhizal grooves always present, but conspicuous only on such portions of the surface where the zooidal pores are either wanting or more widely separated than usual."

Ulrich further states that the genus has much in common with *Hydractinia*, but that it differs radically in the characters of its zooidal pores. He remarks that it differs from the Stylasteridae by not having a columella and by having three sets of pores, and writes (l. c., pp. 435-436): "Excepting the well-developed pseudo-septa of the elevated zooidal pores, *Milleaster* compares probably best with *Millepora*, and it is between this genus and the Stylasteridae that I believe the affinities of the new genus lie." Some relation to *Hydractinia* and possibly to the Poritidae is regarded as not excluded.

In the description of the species *Milleaster incrustans*, Ulrich (l. c., p. 436) notes the following particulars besides those already contained in the description of the genus: the elevated stellate pores are thick-lipped, greatest diameter of the elevated rim averaging about 0.25 mm; larger openings irregularly rounded and not septate, though they may appear to be irregularly septate because of the "astrorhizal grooves" that empty into them; the small rounded openings of the third set of pores are scattered in the coenenchyme between the two sets of larger pores.

A second species, *Milleaster* (?) *subramosus* Ulrich (1904, p. 437) has similar septate pores though with less elevated margins. In this species the larger of the two sets of non-septate pores has not been certainly observed, but the set of smaller non-septate pores is abundantly represented.

To the two species from the Miocene of Maryland a third, *Milleaster interglacialis*, was added by Richards (1933), based on material from the Pleistocene of New Jersey. The description of this species reads (Richards, 1933, p. 211):

"Polyparium encrusting on shells of gastropod mollusks; the incrustation is of one or more layers and is usually about 1 mm. or less in thickness. As far as can be observed the shell is not absorbed by the coral. On the surface at irregular intervals are distributed thick-lipped pores, the mouths of which are irregularly stellate; pseudosepta are well marked and are usually about six in number, although variations from four to seven have been noted. The pores are not elevated above the surface of the colony; the opening between the septa is often very narrow. The average diameter of these stellate pores is 0.2 mm."

The described stellate pores obviously correspond with the elevated pores in *M. incrustans*; in *M. interglacialis* no other sets of pores could be clearly observed, although faint indications of other pores, probably round and larger than the stellate pores, could be seen on a portion of the type specimen.

The excellent figure of *Milleaster incrustans* (Ulrich, 1904, Pl. CXXI fig. 10) distinctly shows two sets of pores, viz., the large wide pores not protruding over the surface, and the elevated stellate pores; moreover, there are numerous small openings in the coenenchyme between the two sets of pores. The structure of the fossil coral therefore in many respects corresponds with that of *Millepora*. The larger pores then are, as suggested by Ulrich, the gastropores, whilst the stellate elevated pores are, as already remarked by Ulrich, the dactylopores. The third set of pores, the very small circular ones, in all probability are nothing else but the openings between the trabeculae of the skeleton, containing canals belonging to the intricate system of tubes connecting the cavities of the various polyps. These small openings are visible in the skeleton of *Millepora* in the same manner as in that of *Milleaster,* it is very improbable that in *Milleaster* these minute pores ever contained polyps.

The difference between *Millepora* and *Milleaster* then amounts to the fact that in *Millepora* the gastropores and the dactylopores do not protrude above the surface of the corallum, whilst in *Milleaster* the dactylopores have a raised margin and the gastropores open at the level of the surface (in *Milleaster interglacialis* the pores are not elevated above the surface).

Ulrich stresses the point that the dactylopores of *Milleaster,* and to some extent the gastropores too, have a stellate structure by showing distinct pseudosepta. He regards this character as the chief peculiarity distinguishing the genus from *Millepora* with its pores of a circular kind without pseudosepta. As a rule indeed the pores of *Millepora* do not show pseudosepta, generally they are of a circular shape. Exceptionally, however, in *Millepora* pores may occur of a distinctly stellate character. Milne Edwards (1836-1849, Pl. 89 fig. 1 *b*) figures a part of the surface of a specimen of *Millepora alcicornis* Linnaeus, in which all the gastropores are more or less star-shaped and some of the dactylopores show the same peculiarity. In Hyman's (1940, fig. 137 B) figure of a specimen of *Millepora complanata* Lamarck

the gastropores as well as the dactylopores are drawn with distinct septa, so that they have a decidedly stellate shape. In a previous paper (Boschma, 1948) I repeatedly noted the occurrence of star-shaped pores in various species of the genus *Millepora*. On p. 95 of the cited paper I mentioned a colony of *Millepora complanata* Lamarck in the collection of the Leiden Museum, erroneously labelled as "*Millepora platyphylla* Ehrb., Junghuhn, Java", that in certain parts shows star-shaped pores. A photograph of a part of the surface of this coral is reproduced on Pl. I fig. 1 of the present paper. Here all the pores, gastropores as well as dactylopores, have pseudosepta, giving them a regularly stellate appearance. The number of pseudosepta varies with the size of the pores, so that in the gastropores there are 12 to 15 pseudosepta, in the dactylopores 6 to 9.

The figured specimen proves that the distinction between *Milleaster* with its stellate pores and *Millepora* with its round pores is not constant. Whilst, however, in *Milleaster* the stellate pores are found in all the known specimens, these are of rare occurrence in corals of the genus *Millepora*. Moreover, in *Milleaster* the stellate pores (the dactylopores) in two of the three species are raised above the surface, whilst in *Millepora* the dactylopores do not protrude above the surface. The two genera, *Milleaster* and *Millepora,* appear to be closely related, though constant characters for a generic distinction are not easily defined.

When discussing the probable affinities of *Milleaster,* attention must be drawn to the structure of the Stylasterid genus *Pliobothrus*. The type species of this genus, *P. symmetricus* (cf. de Pourtalès, 1871, p. 57, Pl. IV figs. 7, 8) has two kinds of pores, both without styles. The larger pores (the gastropores) occur in comparatively small numbers, their opening does not protrude above the surface. The smaller pores (the dactylopores) are more numerous, regularly scattered over the surface, they open on the tops of small tubes extending over the surface. Except for the fact that the openings of the two kinds of pores in *Pliobothrus* are round in contradistinction to the stellate dactylopores of *Milleaster,* the hard parts of the two genera have a similar structure. Provisionally, however, the genus *Milleaster* may remain in the family Milleporidae as long as no data become available proving a relation to some other group.

IV. Genera and species described as Milleporidae or regarded as closely allied forms.

1. The genus *Arachnopora* Tenison-Woods, 1878.

The recent genus *Arachnopora* was defined by Tenison-Woods (1878, p. 8) as follows: "Zoothome parasitic spreading like a small thin web over

other corals." The genus was regarded as belonging to the Milleporidae; the description of the species reads (l. c.):

"*Arachnopora argentea.* n. s.

Zoothome spreading in a small extremely thin web, silvery white, and in parts quite transparent, which are sparsely covered with small silvery granules. The calices are all small very slightly raised, rounded, on which septa protrude as three or six broadly triangular teeth; calices irregular, but with a tendency to a quincuncial arrangement. Length of zoothome 7, breadth 3 mil. Calices like minute dots, barely discernable to the unassisted eye.

In this species the substance of the zoothome seems a quite transparent membrance, on which there is generally a very close arrangement of small silvery granules. It occurs parasitic on corals, filling up half of the calice and spreading from opposite septa just like a spider's web. It also spreads over the sides of the costae, where it appears just like a snail's track on which some very fine white dust had been sparsely scattered. There are no calices on the outside."

The transparent membranous part of the corallum precludes an affinity with *Millepora*; this peculiarity might point to a possible relationship with Bryozoa. The tendency to a quincuncial arrangement of the calices and the occurrence of three or six broadly triangular teeth perhaps also might indicate a classification of the species among the Bryozoa.

Besides the just mentioned characters, the slightly raised calices form a peculiarity distinguishing the species from the genus *Millepora*; moreover, the general appearance of the coral is entirely different from that of the recognized species of the genus, even in their youngest stages. It seems therefore safe to conclude that the genus *Arachnopora* does not belong to the Milleporidae.

2. *Millepora undulosa* Tenison-Woods, 1879.

In Foveaux Strait in New Zealand specimens of a coral-like organism were obtained of which Tenison-Woods (1879, p. 345) noted the following peculiarities:

"On examining the surface with the microscope, it is seen to be covered with minute rounded pores, which have an exact, thickened, very slightly raised margin. These pores are very close to one another, but there are interstices which are occupied by much smaller pores, which are in fact nothing but the polygonal spaces left between the closely-crowded tubes. When a fragment is broken across, two different kinds of structure are observed. One is a kind of outer ring, on which a radiate arrangement of the tubes is preserved, that is to say radiating from the axis to the circumference; the other is a central cancellous tissue, made up of tubes exactly like the surface, but the walls more delicate. The outer radiate ring of tubes is about one-fifth of the diameter; the remaining four-fifths is occupied by the central tissue. The latter is of different colour, or blueish white, while the outer ring is a reddish-brown."

Tenison-Woods described this organism as *Millepora undulosa*. Several of the characters, however, point to the fact that the generic identification is incorrect. The smaller pores that are "nothing but the polygonal spaces

left between the closely-crowded tubes" certainly are not the equivalents of the dactylopores of *Millepora*. Morover, in all the known species of the genus *Millepora* the colour of the skeletal parts is white, not covered by a superficial layer of a darker colour.

The description of the species (l. c., pp. 346-347) reads:

"*Millepora undulosa,* n. s.

Corallum arborescent, very much branched, branches crowded cylindrical, spreading in all directions, generally somewhat flattened at the extremity and with a short bifurcation, often coalescent, either along the whole side of the branch or just at the point of contact, or by sending out a short small branchlet from one stem to another. The whole surface of the branches undulating with broad but not deep rugosities; cells exceedingly small, crowded, giving a spongy appearance; colour, dull reddish-brown. Altitude of specimen described 80; width at farthest extremity of branches 52; diameter of branches from 3½ to 6; diameter of extremity of branch at bifurcation, 7 millimetres.

It is nearest in shape, dimensions, etc., to *M. tortuosa* of Fiji, the only known Pacific form."

In this description the dull reddish-brown colour is the only indication showing that the species is not a *Millepora,* the characters mentioned above, however, are conclusive to remove the species from the genus. The data brought forward by Tenison-Woods are too vague to determine the place of the organism in the zoological system; judging by the peculiarities noted above it is not improbable that the coral belongs to the Bryozoa.

3. *Millepora* spec., Tenison-Woods, 1880.

When dealing with the families Milleporidae and Stylasteridae, Tenison-Woods (1880, p. 4) writes:

"There is one common form living on the New Zealand coast to which I formerly gave the name of *Millepora undulosa.* This I have removed to a new genus, of which there are two representatives among the fossils, which I distinguish as *Cylindropora.* There is also a true species of *Millepora,* which is very like certain tropical forms, showing that in Tertiary times the genus was not so restricted as it is now."

No description is given of this "true species of *Millepora*", and it would be premature to conclude from this statement that really the genus *Millepora* occurs in the Tertiary of New Zealand. Many of the Hydrocorals described by Tenison-Woods, viz., *Arachnopora argentea* (1878), *Millepora undulosa* (1879), *Heteropora ovalis* and *H. calycifera, Cylindropora areolata* and *C. spongiosa* (1880), in all probability are Bryozoa. It remains therefore highly uncertain whether the "true species of *Millepora*" really had the characters of the genus, and the data concerning this fossil for the present are best ignored.

4. The genus *Millestroma* Gregory, 1898.

Gregory (1898, p. 340) regards a fossil from the Cretaceous formation

(Turonian) of Egypt as "one of the missing links between the Palaeozoic Milleporoid Stromatoporoids and the Cainozoic Milleporidae" and therefore proposes for it the name *Millestroma*. The characters relating to the structure of the corallum and to the peculiarities of the pores are (l.c., pp. 340-341): "The coenosteum is composed of reticular tissue with abundant tabulae ..... The pores are mostly irregular in distribution, but some occur in small cyclo-systems and others in laminar series ..... Cyclo-systems widely scattered; the macropore (gastropore) is not much greater than the micropores (dactylopores), of which there are usually six or seven in a system."

The figure of an enlarged part of the surface of the corallum (Gregory, 1898, Pl. XIII fig. 1 *c*) in the upper half of the left side shows a group of pores regarded as a cyclosystem, in the lower half of the right side a weathered area of the corallum. The supposed cyclosystem then consists of a gastropore surrounded by seven dactylopores, the latter are of slightly smaller dimensions than the gastropore.

The characters of the fossil are too little distinct to allow of a well founded opinion as to its place in the system. Gregory at first was in doubt whether the fossil was a Hydrocoralline, an Alcyonarian, or a Bryozoan allied to *Heteropora,* but later came to the conclusion that the only available groups in which the species may be placed are the Milleporidae and the milleporoid section of the Stromatoporoidea. According to Gregory the affinity seems to be nearer with the Stromatoporoidea, but by the presence of occasional cyclosystems it agrees more closely with the Milleporidae.

If, however, the supposed cyclosystems really must be regarded as such, they differ from the corresponding groups of pores in *Millepora* by presenting a very small difference in width between the gastropores and the dactylopores. The figure gives the impression that there is but one kind of pores, fairly regularly distributed on the surface, and slightly varying in size. The width of the pores corresponds with that of the canals in the worn-off part of the skeleton. There is, at least, very little reason to regard the genus as a form allied to *Millepora,* and Dehorne (1920, p. 7 footnote) gave as her opinion: "Cet organisme me paraît plutôt référable aux Bryozoaires." In connexion with the lack of distinct characters this opinion appears to be as well founded as the one defended by Gregory; the affinity with the Milleporidae is at least highly problematic. Kühn (1928, 1939) classifies *Millestroma* among the genera incertae sedis.

5. The genus *Milleporidium* Steinmann, 1903.

When Steinmann (1903 *a*) described the genus *Milleporidium,* he pointed to the similarity of the skeleton to that of *Millepora.* In *Milleporidium,* how-

ever, there is but one kind of pores, comparable to the gastropores of *Millepora*; as in the latter they show distinct tabulae. The gastropores of *Milleporidium* seem to be restricted to certain layers of the corallum only, it appears as if they were of a more or less periodic occurrence. Steinmann regards *Milleporidium* as an ancestral form of the Hydrocorallia, and observes that the dimorphism of the zooids in the latter group is of comparatively recent date. On the other hand Steinmann points to the close relationship of *Milleporidium* to the Stromatoporoidea.

Dehorne (1920) includes the genus *Milleporidium* in the family Stromatoporidae, and even uses the name *Stromatopora remesi* for the species described by Steinmann as *Milleporidium remesi*, the type of the genus. Notwithstanding this classification Dehorne (1920, p. 82) remarks of the species: "La ressemblance de cet Hydrozoaire avec *Millepora*, d'une part, et *Stromotopora*, d'autre part, est vraiment frappante".

With some other genera, all of which are known in the fossil state only, Kühn (1939) places *Milleporidium* in the family Milleporidiidae next to the families Milleporidae and Stylasteridae, separate from the order Stromatoporoidea.

Milleporidium differs form the Milleporidae and the Stylasteridae by having pores of one kind only; the genus may belong to a group allied to the ancestral forms of the recent Hydrocorallia; it may represent a transitional form between the Stromatoporoidea and the recent Hydrocorallia, but in its organization it appears to be more closely allied to the Stromatoporoidea.

When describing the genus *Balatonia*, Vinassa de Regny (1911) drew attention to the similarity of this genus to *Milleporidium*; Dehorne (1920), who includes the latter genus in the Stromatoporidae, regards *Balatonia* as a form belonging in the neighbourhood of, but different from this family. Kühn (1939) does not include the genus *Balatonia* in the family Milleporidiidae.

6. The genus *Promillepora* Dehorne, 1920.

The following is the description by Dehorne (1920, pp. 97-98, Pl. VIII fig. 12) of *Promillepora pervinquierei* from the Upper Jurassic formation of Tunis:

"Hydrozoaires dendroïdes, aux rameaux dichotomiques.

Le détail de la surface est visible à l'oeil nu: il consiste en un réseau squelettique vermiculé à la façon des Millépores, au milieu duquel s'ouvrent des pores de deux sortes; les plus grands étant relativement moins nombreux que les autres et se trouvant distants les uns des autres de 5 à 8 mm, le long d'une ligne légèrement zigzagante. A ces pores plus grands, correspondent, dans les coupes, des tubes tabulés de plus grande taille. La forme les éléments squelettiques radiaux est absolument identique à celle des *Millepora*.

Le nombre des canaux de la région axiale est extrêmement réduit, comme aussi le nombre des tubes zooïdaux, mais les éléments du squelette sont beaucoup plus grands que ceux de *Millepora* et la section des plus grands rameaux ne mesure guère plus de 15 mm. de diamètre."

The fragment (Dehorne, 1920, Pl. VIII fig. 12) is a branch of coral not unlike parts of some of the living species of *Millepora*; the pores, however, are different. The larger pores are very wide, about as wide as the cyclosystems of the recent coral figured in the same paper (l. c., Pl. XVII fig. 6: *Millepora nodosa;* this coral may represent the species *M. exaesa* Forskål, of which the name *M. nodosa* is a synonym, but the general shape of the corallum suggests an identification as *M. platyphylla* Hemprich & Ehrenberg; the distinct cyclosystems and the verrucose surface of of the corallum give additional evidence for its identification as *M. platyphylla,* a variety of which because of an uneven surface was described as the separate species *M. verrucosa*). In the description of the coral the smaller pores are only casually mentioned; their distribution on the surface apparently is without distinct relation to the gastropores (Dehorne, 1920, p. 51):

"Avec *Promillepora Provinquierei* (pl. VIII, fig. 12) nous assistons à un premier stade de groupement; à des distances relativement égales et le long d'une ligne continue, on observe de larges pores arrondis, qui doivent être les gastropores, et autour d'eux se distribuent, d'une manière fort irrégulière, d'autres pores, plus petits et moins nettement circulaires."

As the gastropores occur in a single line only, running in a longitudinal direction over the surface of the corallum, it is not certain that *Promillepora* has any relation to *Millepora.* Dehorne (1920, p. 50) remarks that *Promillepora* undoubtedly is associated with the Stromatoporoidea, and Kühn (1928) lists the genus among this group of Hydrozoa. In a later publication (Kühn, 1939) the genus is placed in the family Milleporidiidae. Moret (1940), who remarks that *Promillepora* has the calcareous tissue of *Millepora* and the two kinds of pores, lists the genus among the fossils that show affinities with *Millepora.*

7. The genus *Thaumatostroma* Weissermel, 1926.

Weissermel (1926, pp. 100-105, Pl. 35 figs. 4-5, Pl. 37 figs. 1-5, Pl. 38 figs. 1-4) described *Thaumatostroma verrucosa* and its variety *elliptica,* fossils from the Eocene of South West Africa. The skeletal elements consist of thin parallel or concentric layers, arranged horizontally (laminae, as a rule occurring at some distance from each other) and vertically (ridges or pillars consisting of numerous closely arranged thin layers). In the superficial parts of the corallum the horizontal elements predominate, in deeper regions the vertical elements are more strongly developed. Between the vertical elements

there are open spaces divided into separate cavities by the thin horizontal elements, these open spaces have a diameter of 3 to 4 mm, so that they are much wider than the pores of the Milleporidae.

Weissermel states that an affinity of *Thaumatostroma* to the Hydrocorallia is out of the question, as the skeletal elements of the former are entirely different from the reticular, tubular and porous skeleton of the latter. He is inclined to place the genus in the order Stromatoporoidea, in the vicinity of the genus *Labechia,* but prefers, because of the striking differences, to regard *Thaumatostroma* as the representative of a separate family.

The genus *Thaumatostroma* is mentioned here because Kühn (1928, pp. 101, 105) lists this genus in the family Milleporidae. In a later paper (Kühn, 1939) the genus finds a place in an entirely different group, in the family Hydractiniidae. As already remarked by Weissermel (1929) the structure of the skeleton of *Thaumatostroma* proves that it does not belong to the Hydrocorallia.

V. Notes on Axoporidae.

The genus *Axopora,* known in the fossil state only, generally is placed in the family Milleporidae (Kühn, 1928, 1939). On the other hand Steinmann (1903 *a*) points to the fact that *Axopora,* though showing a coenenchyme of a typical milleporoid character, has a style of the same structure as the gastrostyles of the three recent genera *Sporadopora, Errina,* and *Spinipora,* belonging to the Stylasteridae; he regards *Axopora* as the ancestral form of these recent corals.

Axopora differs form the Stylasteridae as well as from the Milleporidae by having pores of one kind only, not differentiated into gastropores and dactylopores. On account of this character the genus must be placed in a separate family, the Axoporidae. In this family also the genus *Diamantopora* must find a place, as the characters of the only known species of this genus closely correspond with those of *Axopora.*

1. The genus *Axopora* Milne Edwards & Haime, 1850.

The genus *Axopora* was founded in 1850 by Milne Edwards & Haime (1850-1854, p. lix) with the following diagnosis:

"Corallum composite, incrusting, and forming thin expansions, which are often superposed. Coenenchyme abundant, and forming irregular ridges between the calices, which are small and deep. Septa rudimentary. Columella well developed, fasciculate, and expanding at its passage through each of the tabulae.

Typ. sp., *Axopora pyriformis,* nob.; *Geodia pyriformis,* Michelin, Icon., tab. xlvi, fig. 2."

Milne Edwards (1860, p. 243) defines the genus in about the same man-

ner as quoted above; here he adds that the coenenchyme has a finely reticulated structure. Three species of the genus are dealt with here:

1. *Axopora Solanderi* (synonyms: *Pocillopora Solanderi* Defrance, 1826; *Palmipora Solanderi* Michelin, 1840-1847; *Lobopsammia Solanderi* Milne Edwards & Haime, 1850; *Axopora Solanderi* Milne Edwards & Haime, 1851). Corallum consisting of angular lobes or of upstanding plates with ridges. Pores sunken below the surface of the corallum. Style very large and strongly grooved. Tabulae distinct, widely separated. No septa, no costae. — Defrance (1826, p. 48) obviously regarded the style as the homologon of the columella of *Pocillopora,* and accordingly placed the species in that genus.

2. *Axopora parisiensis* (synonyms: *Alveolites parisiensis* Michelin, 1840-1847; *Holaraea parisiensis* Milne Edwards & Haime, 1850; *Axopora parisiensis* Milne Edwards & Haime, 1851). Corallum encrusting. Pores deep, polygonal, surrounded by a raised margin, central opening small and circular. Style composed of a bundle of small rods, united at their tops and forming below a spongy tissue. No septa, no costae.

3. *Axopora pyriformis* (synonym: *Geodia pyriformis* Michelin, 1840-1847). Corallum encrusting. Pores small, sunken below the surface of the corallum. Known from Michelin's figure; Haime examined the specimen and determined its affinity with the other species of the genus.

Michelin (1840-1847) published figures of *Axopora solanderi* (Pl. 45 figs. 9, 9 *a*), *A. parisiensis* (Pl. 45 figs. 10, 10 *a*, 10 *b*), and *A. pyriformis* (Pl. 46 figs. 2, 2 *a*), using the names as these are cited in the synonyms mentioned above. In *A. solanderi* the colony consists of a strong stem divided into two robust branches, the pores are rather scattered over the surface. In *A. parisiensis* the colony is an encrusting cylindrical tube, whilst the pores mutually are in narrow contact, separated by upstanding ridges. In *A. pyriformis* the colony forms a thin layer over a shell of a gastropod, the pores are more widely distributed. The figures of the pores of *A. solanderi* and of *A. pyriformis* are similar, that of *A. parisiensis* differs from the other two especially by the crowded occurrence of the pores.

In the Atlas accompanying the Histoire naturelle des Coralliaires there are figures giving a clear idea of the structure of *Axopora solanderi* (Milne Edwards, 1857, Pl. F 3 fig. 2 *a, b, c*), one showing the corallum with its angular outgrowths and ridges (fig. 2 *a*), another representing a longitudinal section of a terminal knob (fig. 2 *c*; partly copied in twice the original size in fig. 3 *a* of the present paper), and a third exhibiting a surface view (fig. 2 *b*; partly copied in twice the original size in fig. 3 *b* of the present paper). The figures show that the styles are of a solid structure, longitudinal-

ly grooved but not spongy, the tops appearing as if composed of bundles of small rods. Besides the styles, that occupy most of the space, the pores show a fairly large number of tabulae. The coenosteum between the pores is of a reticular structure, similar to that found in the species of *Millepora*

Keferstein (1859) described two species of *Axopora,* viz., *A. arborea* and *A. paucipora.* In the description of *A. arborea* the characters noted are those of the genus *Axopora*; the species really belongs to this genus as the

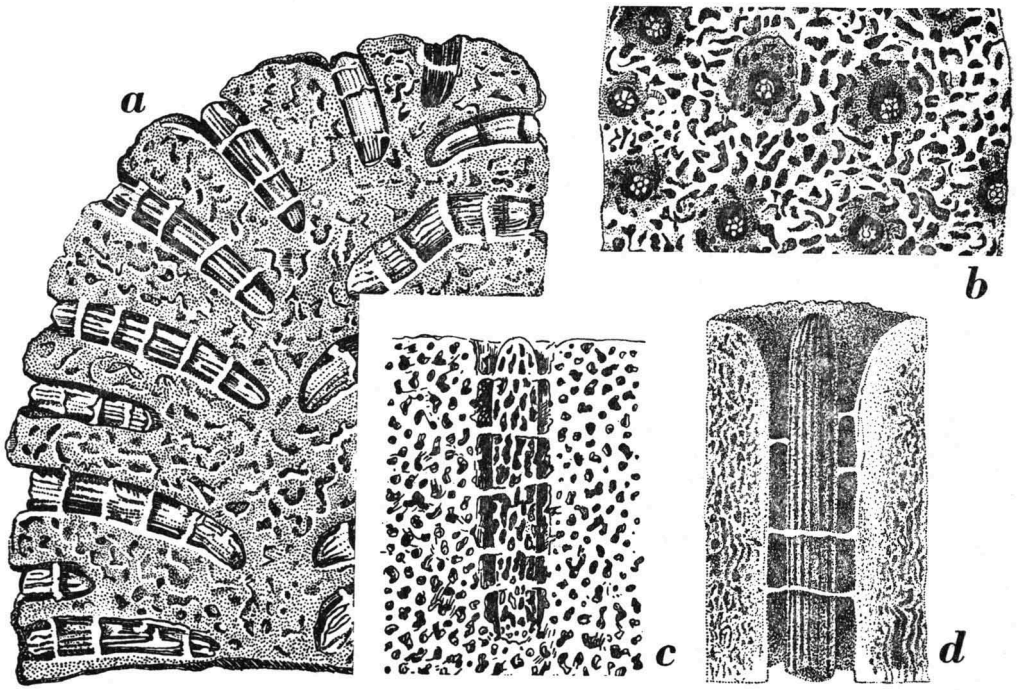

Fig. 3. *a, b, Axopora solanderi* (Defrance) (Milne Edwards, 1857, Pl. F 3 fig. 2 *b, c*; parts of original figures 2 times enlarged); *c, Axopora solanderi* (Defrance) (Steinmann, 1903 *b*, fig. 184 A; part of original figure 2 times enlarged); *d, Axopora michelini* Duncan (1866, Pl. VII fig. 14).

author (l. c., p. 381) writes: "Im Grunde der Zellen eine dicke, fast das ganze Lumen ausfüllende Spindel." This points to a similarity of the coral with *Axopora solanderi* (Defrance). The figures of *A. arborea* (l.c., Pl. XV figs. 9, 9*a*) are rather sketchy, they show a fragment in slightly larger than natural size, and a more strongly enlarged transverse section, the latter presenting a superficial likeness to the section of *A. solanderi* (cf. fig. 3 *a*); Keferstein (1859, p. 381), however, regards his *A. arborea* as similar to

A. parisiensis, though it does not have the raised margins of the pores. *Axopora paucipora* is even more perfunctorily described. As Keferstein remarks that in this species he could not dectect styles its identification as a species of the genus *Axopora* is highly questionable. The figure (l.c., Pl. XV fig. 10), a slightly enlarged view of one of the fragments, does not give any clue for a definite identification.

Two species of the genus *Axopora* were described by Duncan (1866). The description of the first, *A. michelini,* reads (l. c., p. 50):

"The corallum is large, very irregular in shape, and marked by inequalities of the surface. The coenenchyma is abundant, very finely reticulate, and is dotted by numerous and very small calices, which are not very deep, and often irregular in shape; they are not separated by ridges. The columella is formed by longitudinal fibres, and projects but slightly at the bottom of the calice; it is slender, very long, and often wavy. — There are no septa. — The tabulae are horizontal, not numerous, very small, and do not go through the columella, and divide the corallite off perfectly. — A variety of this species is in the form of a flat cake, and its corallites are very long and thin."

The second species, *Axopora fisheri,* is described as follows (l. c., p. 64):

"The corallum is large, it has an oval encrusting base, and a gibbous and tumid upper surface and sides. — The coenenchyma is coarsely reticulate even for an *Axopora,* and is very abundant. — The calices are larger than usual in the genus, are very distinct, rather distant, and are separated by irregular elevations of the coenenchyma. — The columella is large, is very simple and prominent, and is rounded and rather sharp. The tabulae are very wide apart. — The coarse coenenchyma and the size of the calices, with the nature of the encrusting base, distinguish this species from those already described."

The two forms seem to differ especially in the structure of the coenenchyme (finely or coarsely reticulate) and in the size of the pores, perhaps not altogether reliable characters for a specific distinction. In the two forms the margins of the pores do not project over the surface; the "irregular elevations of the coenenchyma" separating the pores are ridges dividing the surface of the corallum into strips each with long rows of pores (l.c., Pl. X fig. 20).

When defining the genus *Axopora,* Duncan (l.c., p. 50) remarks that the columella is fasciculate, in the description of *A. michelini* the columella is stated to be formed by longitudinal fibres. This is distinctly shown in one of the figures (l.c., Pl. VII fig. 14; copied in fig. 3 *d* of the present paper). The species described by Duncan bear a strong likeness to *Axopora solanderi* Defrance as described and figured by Milne Edwards (1857, 1860, cf. figs. 3 *a* and *b* in the present paper). The sections of the variety of *A. michelini* (Duncan, 1866, Pl. VII figs. 13 and 15) also in general show the same

peculiarities as those of *A. solanderi,* so that possibly the three described forms are conspecific.

Dollfus (1906), who examined a specimen of *Axopora solanderi,* expressed as his opinion that possibly this species is the same as that described by Duncan as *A. michelini.*

In the figure of *Axopora solanderi* in Steinmann's textbook (1903 *b,* fig. 184 A; partly copied in fig. 3 *c* of the present paper) the styles have a spongy structure, entirely different from that in the specimen of *A. solanderi* figured by Milne Edwards (cf. fig. 3 *a* in the present paper). Weissermel (1913, p. 111) too is of the opinion that in *Axopora* the style has a spongy structure, different from the solid style occurring in the genus *Diamantopora.* In *Axopora parisiensis* the lower part of the style is spongy, the upper part fasciculate; in all the other described forms of the genus the style is of a solid structure with longitudinal grooves.

I have not seen the description of *Axopora ramea* by d'Achiardi (1867), but quote here the notes concerning a specimen identified by Reuss (1874, p. 19) with that name:

"Es ist ästig mit an den Enden zusammengedrückten, fast abgestutzten Ästen. Die Oberfläche des reichlichen fein schwammigen Cönenchyms zeigt regellos stehende feine Poren. Die sehr kleinen, um mehr als ihren Durchmesser von einander abstehenden Sternzellen sind ebenfalls regellos gestellt und lassen nur hin und wieder Spuren von 6 Septis in Gestalt sehr kurzer Radialleistchen wahrnehmen. Die Axe bildet ein verhältnismässig dickes Bündel.

Die Species ähnelt, wie auch d'Achiardi bemerkt, im Äusseren sehr der *Millepora depauperata* Rss., bei welcher ich aber nie die geringste Andeutung einer Axe entdecken konnte."

The figure of the coral in natural size (Reuss, 1874, Pl. XLI fig. 7 *a*) represents a branched fragment crowdedly beset with small pores, the figure of an enlarged part of the coral (l.c., fig. 7 *b*) shows the reticular surface of the specimen, very similar to that of *Millepora,* and numerous round pores, each containing a style of fairly large size of solid appearance without distinct grooves. The general aspect of this figure is rather similar to that of the figures of the two species of the genus in Duncan (1866).

The various fossils described as species of the genus *Axopora* differ in their form of growth: this may be a more or less solid mass, a branching form, or an encrusting layer. This might already indicate that probably there are at least some different species in the genus. Most of the described species, however, are too little known to allow of a definite specific distinction. Judging by the available data, including the various figures, there are differences in the structure of the coenenchyme, in the size of the pores, and in the configuration of the styles, but as yet it is unknown in how far the various characters regarded as specific are subject to variation.

2. *Millepora mammillosa* d'Achiardi, 1867.

The species originally described as *Millepora mammillosa* apparently belongs to the genus *Axopora*. I have not seen the description of *Millepora mammillosa* by d'Archiardi (1867), but quote here the description by Reuss (1869, p. 252) of specimens identified as this species:

"Ich vereinige die von mir beobachteten Formen mit der von d'Achiardi aufgestellten Species, weil er die Formähnlichkeit derselben mit der lebenden *M. gonagra* M. Edw. und die Gleichheit der kleinen Sternkelche hervorhebt, — Charactere, welche sich an der Art von Crosara wieder finden. Andere Kennzeichen führt d'Achiardi in seinem Verzeichnisse nicht an."

As d'Achiardi apparently did not publish a figure of his *M. mammillosa* it is altogether uncertain whether or not his material is conspecific with that described by Reuss (1869) with the same name (in the explanation of the figure, l.c., Pl. XXVII fig. 5, the name *M. mammillaris* d'Ach. is used). The growth form of the specimen figured by Reuss (l.c., fig. 5 *a*) indeed is very similar to that of the recent species *Millepora exaesa* Forskål (*M. gonagra* Milne Edwards), but the calices as figured by Reuss (l.c., fig. 5 *b*; copied in fig. 1 *f* of the present paper) are entirely different from those of *Millepora*. The place of this coral in the system now, however, seems to be determined since Steinmann (1903 *a*, p. 5, footnote) found styles in the pores of material in the Freiburg collection, indicating that the species belongs to the genus *Axopora*.

The figure of an enlarged part of the surface of *Millepora mammillosa* (Reuss, 1869, Pl. XXVII fig. 5 *b*; fig. 1 *f* of the present paper) shows a certain resemblance to the Alcyonarian coral *Heliopora caerulea* (Pallas). A part of this coral with the remains of the soft parts still adhering is shown in fig. 2 of Plate I in the present paper, next to a cleaned part of the same colony (Pl. I fig. 3). The similarity of the two figures (text-figure 1 *f* and Pl. I fig. 2) is not conclusive, but the two figures on the whole show corresponding characters in the shape of the calices and of the skeletal elements between these.

It is interesting to note that the specimen of *Heliopora caerulea* of Pl. I figs. 2 and 3 is entirely free of Polychaet worms (*Leucodora* spec. or *Polydora* spec.). Vaughan (1919, Pl. 4 fig. 2) figures a specimen of the same coral showing numerous tubes of these worms.

The comparison of *Millepora mammillosa* with *Heliopora caerulea* is of interest as Reuss (1873, p. 18, Pl. LI figs. 2 and 3) identified a coral as *Heliopora Bellardii* (Haime) that in its growth form, and in the structure of the pores and the skeletal elements around and between the pores, is almost exactly alike to his figured specimen of *Millepora mammillosa*. As a

synonym of *Heliopora Bellardii,* Reuss lists *Millepora globularis* Catullo, a species that was indistinctly described and carelessly figured, but that in its growth form (Catullo, 1856, Pl. XVII fig. 9) bears some resemblance to the specimens dealt with by Reuss (1873).

Steinmann's discovery of styles in the specimens indentified by Reuss (1869) as *Millepora mammillosa* indicates that in all probability the specimens identified by Reuss (1873) as *Heliopora Bellardii* eventually will prove to belong to the genus *Axopora.*

3. The genus *Diamantopora* Weissermel, 1913.

A coral from the Eocene of South West Africa was described by Weissermel (1913, pp. 108-111, Pl. 14 figs. 1-2) as *Diamantopora Lotzi* n. g. n. sp., and placed by him in the family Milleporidae. Weissermel remarks that the coral is very similar to the recent genus *Millepora,* but differs from the latter by not having dactylopores and by the presence of styles. Examination of cross sections showed that there are several more or less circular tubes in a coenenchyme consisting of vermiculate, rather thick calcareous trabeculae. The walls of the tubes of the zooids (the autopores) consist of the same calcareous elements as the coenenchyme, these walls consequently are highly porous, and the contour of the tubes often is very irregular. The tubes of the zooids occur at distances about equal to their diameter, locally these distances may be shorter or longer. Longitudinal sections show that the tubes have a more or less straight course. The tubes of the zooids are all of approximately equal size, they do not show a distinction in autopores and dactylopores (siphonopores). In the centre of each pore there is a distinct style. Tabulae are of rare occurrence in the tubes of the zooids.

Weissermel concludes his account of *Diamantopora lotzi* by pointing out that the coral is very similar to *Millepora* because of the structure and the arrangement of its calcareous elements. He adds that the coral, as all fossil Milleporids, differs from the living genus *Millepora* by having pores of one size only, not to be distinguished in autopores and dactylopores, and by having a style. Weissermel remarks that the occurrence of a style is a character that *Diamantopora* has in common with *Axopora,* but that in the latter the style has a spongy structure and a comparatively larger size. The presence of a style, moreover, distinguishes the coral from *Balatonia* Vinassa de Regny.

Diamantopora lotzi has been mentioned again in a later paper (Weissermel, 1926, p. 105); here no further data are given on the structure of the corallum besides noting that the pores seem to be restricted to the younger parts of the colonies only.

With some reason Weissermel states that his *Diamantopora lotzi* corresponds with the fossils described as representatives of the genus *Millepora* by having pores of one kind only. In a previous chapter it has been demonstrated that nearly all these fossils erroneously have been placed in the genus *Millepora,* so that a comparison with the species of this genus has to be restricted to the living representatives. As these invariably have the two kinds of pores (gastropores and dactylopores) it is evident that *Diamantopora* is principally different from *Millepora.*

Fig. 4 in the present paper was made after a photograph of a part of

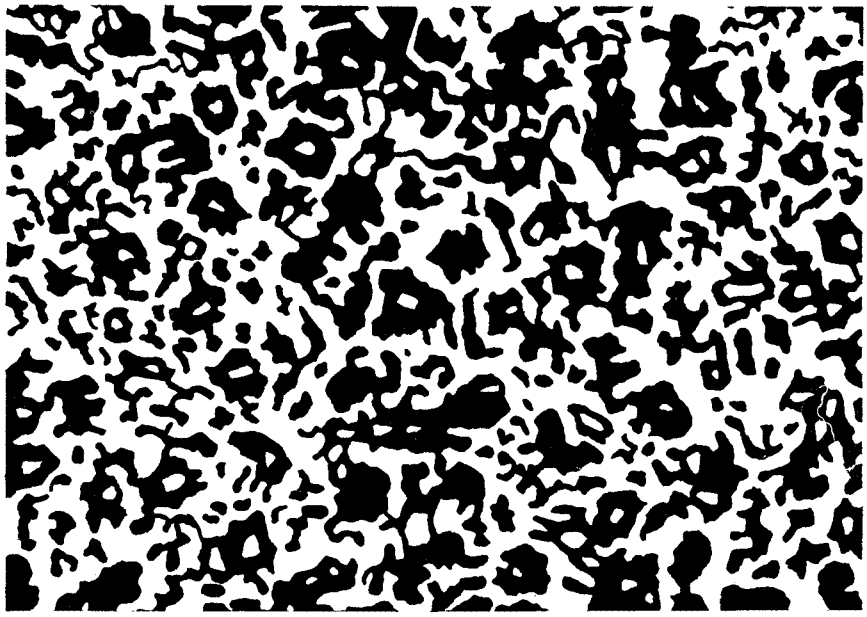

Fig. 4. *Diamantopora lotzi* Weissermel (1913, Pl. 14 fig. 1; × 30, part of original figure 2 times enlarged). Thin section of the corallum; pores and canals black, skeletal parts white.

Weissermel's figure (1913, Pl. 14 fig. 1), enlarged to twice the original size. The pores and the other cavities in the skeleton are drawn here in black. The figure shows that the pores are of an approximately equal size, and that in most of these there is a distinct style. According to Weissermel the style of *Diamantopora* by its solid structure is different from that of *Axopora,* the latter being of a spongy structure. This opinion may be based on the figure of *Axopora solanderi* (Defrance) as represented by Steinmann (1903*b*, fig. 184 A; copied in fig. 3 *c* of the present paper); in this figure

the style indeed has a spongy structure. Milne Edwards (1857, Pl. F 3 fig. 2 *b, c*; cf. fig. 3 *a, b* in the present paper) draws the styles of *Axopora solanderi* as longitudinally grooved, the tips appearing as being composed of a bundle of united rods, entirely different from the irregularly porous styles as figured by Steinmann. Duncan's (1866, Pl. VII fig. 14; cf. fig. 3 *d* in the present paper) figure of *Axopora michelini* shows a style of a rather regular structure, on the whole corresponding with that in Milne Edwards's figures. It appears therefore safe to conclude that *Axopora* generally has styles of a solid character, and in this respect *Diamantopora* does not show a pronouncedly different aspect from *Axopora*. The two forms indeed seem to be closely allied; the generic difference between *Axopora* and *Diamantopora* is not easily to determine. As a rule the style in *Axopora* is not as slender as that in *Diamantopora*, but there are differences of a similar kind when various species of *Axopora* are mutually compared; in the specimen of fig. 3 *d* there is a much wider cavity around the style than in those of fig. 3 *a*. For the present *Diamantopora* may be regarded as a separate genus that is closely allied to *Axopora*.

VI. Some genera erroneously placed in the Stylasteridae.

1. The genus *Aphyllacis* Reuss, 1872.

Fossils from the Miocene of Transylvania were described by Reuss (1872, p. 260, Pl. XIX fig. 3) as *Aphyllacis ramulosa* n. g. n. sp., in the explanation of the plate the name *Aphyllacis Neugeboreni* is used. In the generic description the fossil is characterized as branching, with longitudinally striated surface, in which there are scattered pores, more or less in longitudinal rows. These pores are small, deep, without style, and with completely rudimentary septal lamellae. Reuss places the fossil among the perforate corals, in the neighbourhood of *Turbinaria*, whilst further there seems to be an affinity with *Dendracis*, though it differs from the latter by its non-granular surface and by the lack of septa. The description of the species, *Aphyllacis ramulosa*, reads (l. c., p. 260):

"Die beiläufig 1 Millim. grossen Sterne stehen entfernt, in unregelmässige Längsreihen geordnet, und zwar sind sie in der Umgebung der Ursprungsstellen der cylindrischen Äste weiter von einander entfernt als anderwärts. Sie ragen in Gestalt kleiner, gerade nach auswärts gerichteter Warzen hervor, so dass ihre Axen auf der Längsaxe des Stämmchens senkrecht stehen. Nur wenige erheben sich in Gestalt eines gestutzten Kegels etwas mehr über die Umgebung. Bei diesen erscheint der Aussenrand mit 12-16, bisweilen gabelförmig gespaltenen kurzen Längsrippchen bedeckt.

Im Innern der tiefen Sterne beobachtet man sechs sehr wenig vorragende Längsleistchen — die Rudimente der Septa, zwischen welchen eben so viele Längsreihen von Poren eingesenkt sind, die aussen in den Zwischenfurchen der Längsrippchen münden."

Vaughan & Wells (1943, p. 346) note that *Aphyllacis* Reuss is not a scleractinian, but possibly a stylasterid. The fossil indeed shows some resemblance to other forms that have been classified among the Hydrocorallia. The figure of an enlarged part of *Aphyllacis* (Reuss, 1872, Pl. XIX fig. 3 *b*) shows a general structure similar to that of the fossil described by Hall (1893) as *Leptobothrus spenceri,* as in the two specimens the large pores are surrounded by a ring of smaller pores, leading to a superficial likeness to the cyclosystems as they are to be seen in species of the subgenus *Allopora* of the genus *Stylaster.* MacGillivray (1895) demonstrated that *Leptobothrus* is a Bryozoan, to be classified in the genus *Porina.*

The structure of *Aphyllacis ramulosa,* moreover, is very similar to that of the fossil described by Reuss (1870) as *Millepora cylindrica* (cf. fig. 1 *a* in the present paper), afterwards included by Oppenheim (1901) in the species *Millepora dalmatina.* Here again the larger pores are surrounded by a ring of smaller pores. Further there is a striking similarity between the figure of *Millepora dalmatina* of Oppenheim (1901, Pl. XVI fig. 10; cf. fig. 2 *d* in the present paper) and that of *Aphyllacis ramulosa* in natural size (Reuss, 1872, Pl. XIX fig. 3 *a*), except for the fact that the latter is longitudinally striated and the former is not; the shape and the size of the pores, and their distribution on the surface of the corallum in the two figures is strikingly similar. On a previous page it has been remarked that the forms referred to above show some resemblance to Bryozoa, and possibly may prove to belong to the genus *Anacropora.*

On account of the similarities dealt with above I am convinced that the affinities of *Aphyllacis* are with the Bryozoa, not with the Hydrocorallia. The question cannot be definitely settled without an examination of the original material.

2. The genus *Cylindropora* Tenison-Woods, 1880.

Fossils from the Upper Miocene of New Zealand were described by Tenison-Woods (1880) as *Heteropora ovalis, H. calycifera* (in the explanation of the figures indicated as *Cylindropora calycifera*), *Cylindropora areolata,* and *C. spongiosa.* The author remarks that these species together with *Millepora undulosa,* described in a previous paper (Tenison-Woods, 1879) form a transitional group between the Stylasteridae and the Milleporidae. The pores of *M. undulosa* are described by Tenison-Woods (1879, p. 345) as follows: "These pores are very close to one another, but there are interstices which are occupied by much smaller pores, which are in fact nothing but the polygonal spaces left between the closely-crowded tubes." This excludes the species from the genus *Millepora*; moreover, it differs

from this genus by the colour of the skeleton that is bluish white covered by an outer layer of reddish brown.

Of the new species described in the 1880 paper two are placed in the genus *Heteropora,* of which the pores are characterized as "of two kinds, devoid of styles, and scattered irregularly without tabulae." (l.c., p. 20). The species *H. ovalis* has the "Surface covered with small gasteropores and minute dactylopores, the latter more numerous, and both disposed irregularly." (l.c., p. 20), whilst *H. calycifera* has "Gasteropores with an irregular quincuncial arrangement, a circular aperture, and a raised margin. About two small dactylopores to one gasteropore, the latter prolonged inwards and downwards." (l.c., p. 21). This proves that the latter form is strongly different from *Millepora.* Judging by the characters noted by Tenison-Woods, the form described as *H. ovalis* might find a place in the genus *Millepora,* but as it was placed in the same genus with *H. calycifera,* the two forms must have been of a similar structure.

The genus *Cylindropora* is defined as follows: "Hydroid corals, in which the pores are all equal, and disposed on radiating descending tubes round the solid axis of a branched corallum." (Tenison-Woods, 1880, p. 21). The author remarks that these corals might easily be mistaken for Bryozoa, but that they are very much alike to *Millepora undulosa.* On a previous page (l.c., p. 4) he even remarks that he has removed the species *M. undulosa* to a new genus, distinguished as *Cylindropora.* The species *C. areolata* has "Cells or gasteropores deeply immersed, sloping from an acute raised hexagonal margin to a deep, pyriform, nearly central pore, from which the cell curves deeply inwards and downwards to the centre of the axis, making the central tissue spongy in appearance, but hard and compact." (l.c., p. 21); of *C. spongiosa* the author remarks: "It is evident that this coral belongs to the hydroids described above, and is closely allied to the species just described." (l.c., pp. 21-22). The quotations prove that the structure of the species of the genus *Cylindropora* is entirely different from that of any recognized representative of the Hydrocorallia.

Tenison-Woods draws attention to the similarity of the structure of *Cylindropora areolata* to that of certain Bryozoa. The figures (Tenison-Woods, 1880, Pl. (III) figs. 21 A-D), though executed in a rather perfunctory manner, are almost decisive for placing the species among the Bryozoa.

It remains at least highly improbable that any of the species dealt with above is even remotely connected with the Hydrocorallia.

3. The genus *Palassopora* Gregory, 1930.

A coral from the Lower Eocene of the Samana Range in the North-West Frontier Province of Pakistan was described by Gregory (1930) as *Palassopora eocenica*. Gregory regarded the coral as belonging to the order Stylasterina of the Hydrocorallia, and placed the genus in the family Sporadoporidae, a group usually regarded as a subfamily (cf. Broch, 1936, who lists the Stylasterinae, the Distichoporinae, and the Sporadoporinae as subfamilies of the family Stylasteridae). The generic and specific characters of the coral read as follows (Gregory, 1930, pp. 126-127):

"Genus: *Palassopora,* gen. nov.

Diagnosis. — Coenosteum in an encrusting sheet. Dactylopores relatively few; about a quarter or a fifth of the diameter of the gastropores. The dactylopores are mostly scattered irregularly, though sometimes in short curved series. No tabulae and no style.

Palassopora eocenica sp. nov.

Diagnosis. — Coenosteum forming a somewhat limpet shaped sheet; about 5 to about 9 mm. thick. The gastropores are elliptical to circular or sometimes irregular. They are widely scattered over the whole surface. Some are separated only by a narrow wall without dactylopores, which are mostly irregularly arranged though some occur in short curved or linear series where the interspace between the gastropores is relatively wide."

The dimensions of the gastropores are from 0.75 to 1.5 mm, those of the dactylopores from 0.2 to 0.4 mm.

From the discussion on the affinities of *Palassopora* the following may be quoted (Gregory, 1930, pp. 127-128):

"The fossil has somewhat the aspect of an *Astreopora,* owing to the presence of the large circular apertures; but a section shows that it is fundamentally distinct in structure, and is one of the Hydrocorallina ..... It appears to be one of the Stylasterina but to differ from the living members of that order by having a laminar encrusting instead of an erect, branching coenosteum ... Among the Stylasterina it agrees with *Sporadopora* by its irregularly scattered apertures; but it differs from that genus by the absence of a style and tabulae and by its laminar form ... In this respect *Palassopora* agrees with *Pliobothrus,* Pourtalès, but that genus has a branched coenosteum, with a tendency to be flabelliform and the dactylopores open at the end of small projections ... The vertical section through the coenosteum has a double layer of large spaces in an apparently compact calcareous tissue; this appearance is rather that of *Hydractinia* than that of the Hydrocorallina with their complex of canals and tubes; but a microscopic section through the coenosteum shows trace of an elaborate canal system now largely obliterated during fossilization."

Gregory further points out that on account of various characters the coral is different from *Millepora,* and that none of the Eocene species of this genus resemble *Palassopora.*

The type specimen of *Palassopora eocenica* is a conical colony of fairly large size, the surface of which is crowdedly beset with shallow pits that are so close to each other that the distances between the cavities as a rule are shorter than their diameter (Gregory, 1930, Pl. XV figs. 6*a,* 6*b*). The figure of an enlarged part (l.c., fig. 6*c*) shows a number of these pits

and numerous smaller pits between and around them. Judging by the figures the larger pits undoubtedly represent the calices or the gastropores of some kind of coral. The smaller pits, however, do not necessarily represent pores in which there must have occurred polyps of a certain kind, e.g., dactylozooids; these smaller pits may just as well represent parts of the canal system connecting the coral polyps. It seems at least fairly uncertain that the living coral possessed more than one kind of polyps, those contained in the larger cavities only.

Is is extremely doubtful that *Palassopora* belongs to the Stylasteridae. In the genera of this group the gastropores are much more widely distributed over the surface of the corallum than the supposed gastropores of *Palassopora*. As far as the description quoted above and the figures referred to can give an idea of the structure of the fossil, it is more likely that the specimen represents a madreporarian coral in a strongly worn-off state. The comparatively regular arrangement of the pits (calices or pores) over the surface of the corallum gives an indication for this supposition. To say the least, the position of *Palassopora* among the Hydrocorallia is open to severe doubt.

VII. Notes on Stylasteridae.

1. Fossil corals of the genus *Stylaster*.

A. *Stylaster antiquus* Sismonda, 1871.

Sismonda's description of this species from the Lower Miocene of Piedmont reads (l.c., p. 333):

"*Stylaster antiquus* Michtti.

Cette espèce a beaucoup de rapport avec le *St. roseus;* elle s'en distingue par ses rameaux qui sont plus gros et couverts par des tubercules vésiculeux très-gros et très-nombreux."

Michelotti, who edited Sismonda's paper, gives his own name as author of the species, but this species is not described in the two publications by Michelotti (1847, 1861) dealing with the fossils of Northern Italy.

If really the species is similar to *Stylaster roseus* it must be different from the form described by Reuss (1872) as *Stylaster priscus*; as the characters of Sismonda's species are practically unknown it is not possible to come to a definite conclusion.

B. *Stylaster priscus* Reuss, 1872.

From the Miocene of Moravia Reuss (1872, pp. 249-250, Pl. XIX figs. 4-5) described fragments of coral, parts of an apparently branched colony, as *Stylaster priscus*. The structure of the surface, the cyclosystems, and the ampullae are described as follows (l.c., p. 250):

"Die kleinen Sterne stehen in zwei alternirenden Längsreihen, sind rundlich oder etwas in die Quere verlängert, tief, und ragen mit ihrem gekerbten Rande ziemlich stark hervor. Man zählt darin 12-14 kurze dicke, wenig regelmässige Septalfalten, die nicht weit in die Tiefe reichen. Die Oberfläche des Cönenchyms ist mit feinen, in kurze regellose und vielfach anastomosirende, wurmförmig gekrümmte Reihen zusammenfliessenden Körnchen bedeckt und gewinnt dadurch ein feinrunzeliges Ansehen. Auf den Endzweigen erheben sich hin und wieder verhältnismässig grosse, kugelige, blasige Tuberkel, die grob radial gefurcht sind mit wechselnder Zahl der Furchen. An einem der vorliegenden Bruchstücke stehen diese Höcker dicht an einander gereiht in unregelmässigen

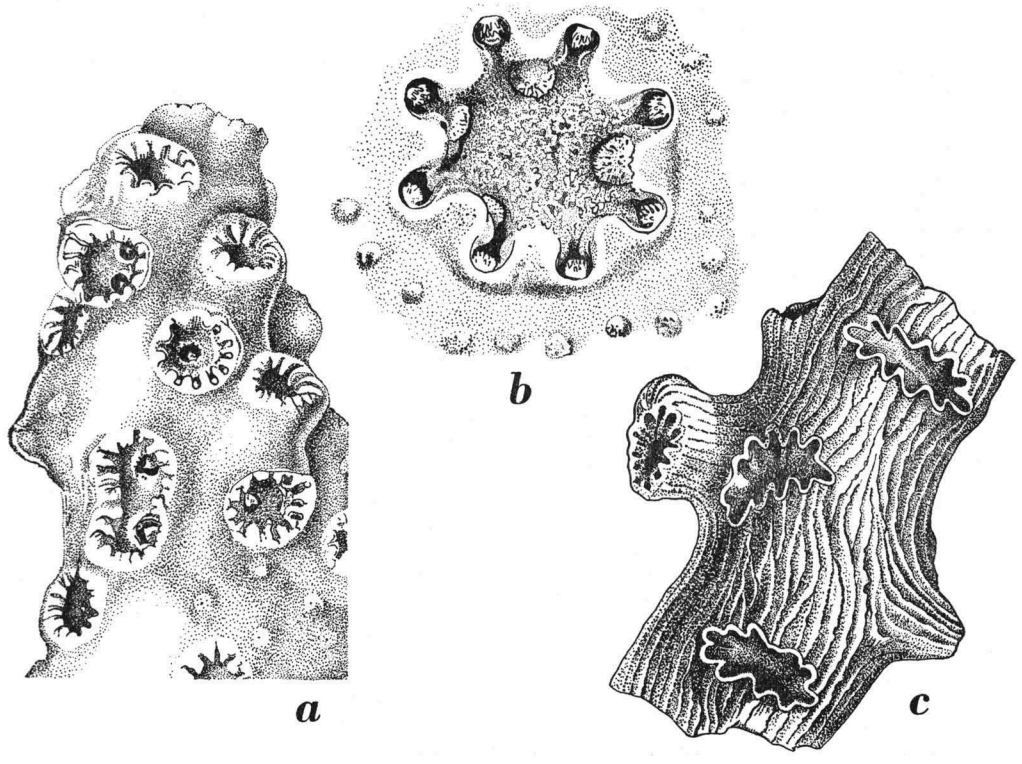

Fig. 5. *a, Stylaster stellulatus* Stewart (1878, part of Pl. 3 fig. 1); *b, Stylantheca porphyra* Fisher (1931, Pl. XV fig. 1: a typical cyclosystem with four gastrostyles viewed from above, × 30); *c, Stylaster priscus* Reuss (1872, Pl. XIX fig. 5, × about 10).

Spirallinien, während sie an dem anderen mehr zerstreut auftreten. Auf den älteren Theilen der Stämmchen scheinen sie allmälig zu verschwinden, wenigstens hat das dritte mir vorliegende Bruchstück keine mehr aufzuweisen."

The coral undoubtedly belongs to the genus *Stylaster,* for Reuss mentions as one of the characters of the genus: "Die Sterne mit sehr tiefliegender griffelförmiger Axe". Judging by the available data, the species *Stylaster priscus* seems to differ from *Stylaster antiquus* Sismonda. If the latter

species really is allied to *S. roseus* it is distinct from *S. priscus* by having the cyclosystems on the two sides of the branches and by possessing ampullae with a smooth surface. The last mentioned character was already noted by Esper (1794) as typical of the species; a beautiful figure showing this peculiarity is that on Plate 38 of the Dictionnaire des Sciences Naturelles, illustrating the article Zoophytes by de Blainville (1830). Here numerous ampullae are drawn, of a globular shape and with a smooth surface.

In *Stylaster priscus* the cyclosystems are not confined to the two sides of the branches only, but they appear to occur all over the branches (Reuss, 1872, Pl. XIX fig. 5; copied in fig. 5 *c* of the present paper). Moreover, the cyclosystems have a somewhat compressed shape, they are not so distinctly circular as those of *S. roseus*. The ampullae of *S. priscus* are described and figured as spherical tubercles that possess a variable number of radial grooves. A further character separating the two species is that of the structure of the surface of the corallum that in *S. roseus* has a smooth, even appearance, whilst *S. priscus* shows a system of grooves, chiefly running in a longitudinal direction.

C. *Stylaster* spec., Tornquist, 1905.

A coral from the Eocene of Madagascar was mentioned as *Stylaster* spec. by Tornquist (1905, p. 332, Pl. XLVI fig. 10), The specimen is a small fragment of a branch with three or four cyclosystems, showing insufficient characters for a definite identification.

D. *Stylaster milleri* Durham, 1942.

Durham (1942, p. 102, Pl. 15 figs. 8, 18; Pl. 16 fig. 4; Pl. 17 fig. 20) gives the following description of *Stylaster milleri* from the Lower Oligocene of Washington:

"Polyparia massive, irregular, with or without short, stubby, ill-defined branches. Gastropores generally distributed over the polyparia, from 0.5 mm. to 1.0 mm. apart and about 0.3 mm. in diameter. They are surrounded by a ring of 6 to 10 dactylopores, the ring being slightly raised. Style not quite flush with the surface and occupying from one-half to two-thirds of the calycular space. Ten to fourteen pseudosepta surround the style, apparently these pseudosepta are not always present. Dactylopores always regularly arranged around the gastropores and distant from it about their own diameter, which ranges from 0.1 mm. to 0.2 mm. in large specimens. The dactylopores are occasionally provided with three or four septalike processes.

The polyparia is usually about 2 cm. in height, but may range up to 4 cm. or more."

The species belongs to the subgenus *Allopora* of the genus *Stylaster,* for the cyclosystems are not restricted to the sides of the branches. The figure of an enlarged cyclosystem (l. c., Pl. 17 fig. 20) shows a large gastropore surrounded by a circular row of dactylopores that are more or less separated from the gastropore, in a similar manner as in other species belonging to the subgenus *Allopora*.

2. The subgenus *Stylantheca* Fisher, 1931.

Fisher (1931, p. 395) founded the genus *Stylantheca* with the following characters:

"Resembles *Allopora,* but a cyclosystem may contain upward of seven gastrozooids, each with its own gastrostyle; a variable number of cyclosystems with one gastrozooid only; gastrozooid tentacles 5 to 8, short; dactylozooids as in *Allopora,* provided with a well-developed spiculate style.
Type, *Stylantheca porphyra.*"

The paper contains figures of a cyclosystem with four gastrostyles (l. c., Pl. XV fig. 1; copied in fig. 5 *b* of the present paper) and of a cyclosystem with three gastrostyles (l. c., Pl. XVI fig. 1).

In a later paper (Fisher, 1938) the species is named *Allopora porphyra*; here the author remarks (l.c., pp. 529-530):

"This species stands apart from all Alloporas and Stylasters by reason of the peculiar organization of the cyclosystem, which typically houses a small aggregation of gastrozooids, although exceptionally in less vigorous colonies cyclosystems with only one gastrozooid (and hence one gastrostyle) are found. Whether this condition is of generic or even subgeneric value only more knowledge of the Stylasterina will determine."

Broch (1936) and Fisher (1938) commented upon the difficulties of separating *Stylaster* and *Allopora* as groups of generic or subgeneric rank. The same applies to *Stenohelia.* It is, however, convenient to keep these groups at least as subgenera of the genus *Stylaster.* The occurrence of a number of gastrostyles in one cyclosystem is a character that, though not entirely constant, furnishes such a marked difference between *Stylantheca porphyra* and the species of the genus (or subgenus) *Allopora* that it seems advisable to regard the species as the type of a separate group of at least subgeneric value, so that it may be named *Stylaster* (*Stylantheca*) *porphyra* (Fisher).

Whilst here cyclosystems with a single gastrostyle form an exception to the rule, there is a species of the subgenus *Allopora,* described by Stewart (1878) as *Stylaster stellulatus,* collected in the vicinity of Tahiti, that exceptionally shows cyclosystems with two gastrostyles. A part of Stewart's figure (1878, Pl. 3 fig. 1) has been copied in fig. 5 *a* of the present paper; in two of the cyclosystems two gastrostyles are to be seen; the shape of one of these cyclosystems is not different from the normal, whilst the other is elongatedly oval, indicating that here two cyclosystems are largely united.

3. The genus *Congregopora* Nielsen, 1919.

The following is a translation of Nielsen's description of the genus

Congregopora and its type species *C. nasiformis* (1919, pp. 21-22, Pl. 2 figs. 24-27, textfigs. 3 and 10):

"*Congregopora* gen. nov.

The genus differs from all others known up till now by the arrangement of the pores. The gastropores are deeply sunk in; near their opening there is a single dactylopore or a pair of dactylopores that are elongate cavities surrounded by a slightly elevated wall, so that the gastropores and the adjoining dactylopores have a common two- or three-cornered mouth. Besides these there are smaller, scattered dactylopores that have no connexion with gastropores. The gastropores have a tendency to occur in long rows.

Congregopora nasiformis n. sp.

The species has arboriform, branched colonies, with a tendency to a fan-like expansion of the branches. By means of flat, broadened parts of branches they are attached to coral colonies of *Dendrophyllia candelabrum* or other species.

The gastropores are rather deep, circular, without central style. The dactylopores are scattered without distinct regularity among the gastropores, or are found as rather broad cavities at the sides of the gastropores. As a rule the margins of the dactylopores form a sharp nasiform excrescence in the centre of which the dactylopore itself is found as a kind of crevice. There is no style in the dactylopores. As often the gastropores have a tendency to occur in rows along the branches, a condition arises approaching that of the recent species of *Distichopora,* in which the gastropores are arranged in a furrow in one row, and the slit-like dactylopores are found in parallel rows, one at each side of the row of gastropores.

The genital products are formed in ampullae, that often occur in groups on certain parts of the branches. Each ampulla is flat, cup-shaped, sometimes with a beautifully toothed margin."

Nielsen's material of the genus *Congregopora* was found at Faxe in Denmark, in the Danian, a geological formation of the border between the Cretaceous and the Eocene.

Copies of two of Nielsen's figures of *Congregopora nasiformis,* in twice the original size, are shown in fig. 6 *a, b* of the present paper. In one of these (fig. 6 *a*) the cyclosystems as a rule are three-cornered, they are arranged in more or less distinct rows. In the other figure (fig. 6 *b*) the cyclosystems are less distinctly three-cornered. The latter figure shows the "cup-like" ampullae with their neatly toothed margins. It stands to reason that the upper part of all these ampullae has broken off, so that the figure shows the inner surface of the cavities.

Nielsen (1919, p. 22) emphatically states that *Congregopora* does not possess gastrostyles and dactylostyles. This points to an affinity of the genus with *Astya* [1]) and *Conopora,* perhaps chiefly with the latter as the cyclosystems are not restricted to one face of the colony. In this connexion it is interesting that the species of *Conopora* that have a large number of dactylopores have cyclosystems of a more or less radially symmetrical shape,

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1) Stechow (1921) pointed out that the generic name *Astylus* Moseley was preoccupied, and established the new generic name *Astya.*

whilst the cyclosystems of the species with small numbers of dactylopores have a strong tendency to a bilateral symmetry.

In *Conopora tenuis* Moseley, the type species of the genus, the gastropore is surrounded by a fairly large number of dactylopores arranged in a circular row (cf. Moseley, 1880, Pl. XII fig. 5 *b*, showing a cyclosystem with fourteen dactylopores). In Broch's (1936) specimen of *C. tenuis* the cyclosystems have 12 to 19 dactylopores, most frequently 15 or 16. In the three figured cyclosystems of the type specimen of *Conopora major* Hickson & England (1905, Pl. III fig. 34) there are 9, 11, and 10 dactylopores respectively. The specimens of *C. major* figured by Broch (1936, fig. 30)

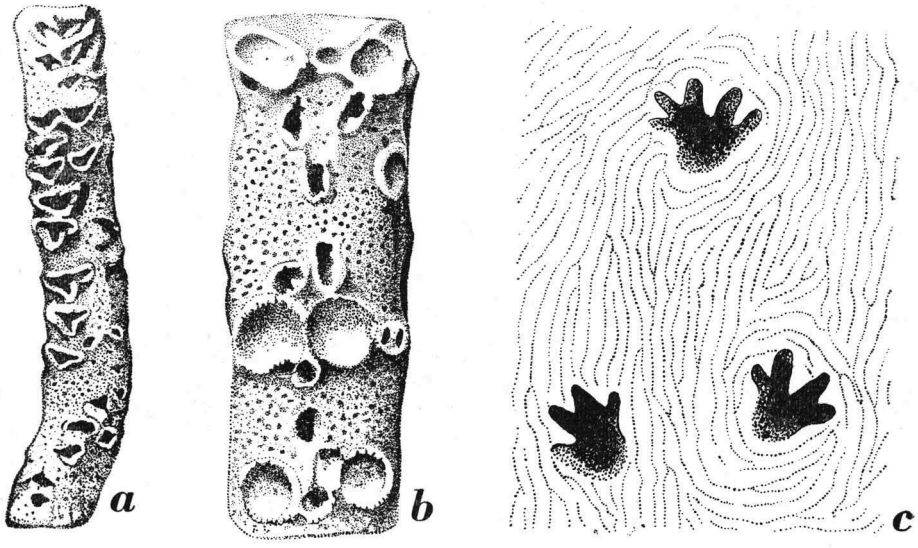

Fig. 6. *a, Congregopora nasiformis* Nielsen (1919, Pl. 2 fig. 24; × 6, original figure 2 times enlarged); *b, Congregopora nasiformis* Nielsen (1919, Pl. 2 fig. 27; × 8, original figure 2 times enlarged); *c, Conopora pauciseptata* Broch (1950, fig. 8, part of the anterior side of the stem with two cyclosystems of the median row and one 'displaced' (lower left) at the basis of a branch, × 20).

have cyclosystems with 12 to 16 dactylopores. In the fossil species *Conopora arborescens* Nielsen the cyclosystems have 8 to 10 dactylopores, radially arranged around the gastropore (Nielsen, 1919, p. 24).

Though there is some variation in the number of the dactylopores in the cyclosystems, the latter in the species mentioned above are more or less radially symmetrical. On the other hand in the species *Conopora dura* Hickson & England (1909, p. 351) the cyclosystems are characterized as follows: "There are about twelve septa of different sizes, the larger and

thicker being usually directed towards the base of the branch." Here, therefore, the cyclosystems show a beginning of a bilateral symmetry, as also appears from the figure (l. c., Pl. 44 fig. 10).

Recently Broch (1950) described the species *Conopora pauciseptata,* in which the dactylopores in the (incomplete) cyclosystems of stem and branches number from 3 to 11 (average about 7.07). Broch's figure (l. c., fig. 8; copied in fig. 6 *c* of the present paper) shows that in *C. pauciseptata* the cyclosystems may have a pronounced bilateral symmetry as well as a tendency to a strong reduction of the number of dactylopores. A further reduction of the number of dactylopores in a bilaterally symmetrical cyclosystem of *Conopora* might lead to a condition as it is characteristic of the genus *Congregopora.*

As remarked above, the genera *Congregopora* and *Conopora* on account of their lack of gastrostyles already show an important common character; to a certain extent the cyclosystems of *Conopora pauciseptata* have a shape that is more or less intermediate between that in the species of the genus with radially symmetrical cyclosystems and that in *Congregopora.*

Totton (1924) made a slight error when indicating *Congregropora* as a genus of the family Milleporidae; a second error was made by Kühn (1939), who remarks that in the cited paper *Congregopora* is regarded as a sponge.

4. *Crypthelia japonica* (Milne Edwards & Haime, 1849).

Milne Edwards & Haime (1849, p. 69) gave a short description of the genus *Endhelia* and its type species *E. japonica*; in a later publication (Milne Edwards & Haime, 1850, p. 94) they gave a more elaborate account of the characters:

"Polypier dendroïde et flabelliforme, à surface lisse. Calices alternant sur les branches, mais tournés d'un même côté, à cavité profonde, à bords non saillants, et armés d'une petite languette dressée au-devant de leur ouverture. Cloisons égales, non débordantes. Pas de palis, ni de columelle distincte.

Polypier ayant la forme d'un arbre en espalier; tous les rameaux situés dans un même plan vertical, un peu épais et coalescents, à surface lisse ou ne présentant que des granulations microscopiques. Tous les calices dirigés d'un même côté, alternant sur les branches, à bords peu ou point saillants et présentant au-devant de leur ouverture une petite languette dressée et aiguë. Fossette calicinale grande et profonde. Columelle nulle. Dix-huit cloisons égales, non débordantes, étroites, un peu épaisses et assez serrées. L'échantillon que nous avons observé n'a guère plus de 3 centimètres de hauteur; la plus grosse branche a 3 millimètres de diamètre, et les calices sont larges d'un peu plus de 1 millimètre.

Habite la mer du Japon. — Musée de Leyde."

In a later work (Milne Edwards & Haime, 1857, p. 128) the essential characters of the genus and the species are mentioned in a more concise

manner; here the spelling of the generic name is changed into *Endohelia*.

In his list of the species of Stylasteridae, Moseley (1879) records *Endhelia japonica*, with some doubt, as a synonym of *Crypthelia pudica*. Hickson & England (1905, p. 20) list the coral as a separate species under the name *Cryptohelia japonica*. Broch (1936) again records *Endhelia japonica* as a doubtful synonym of *Crypthelia pudica* [1]).

Fisher (1938) examined specimens obtained on Stations 4890 and 4924 of the "Albatross" expedition (North East region of the Eastern Sea, in the vicinity of the island Kyushu), and writes (1938, p. 535):

"A species I have provisionally identified as *C. japonica* (Milne Edwards and Haime) (pl. 64, figs. 2-4) can be distinguished from both *pudica* and *trophostega* by the size of cyclosystems and surface texture of coenosteum and by the small lids, which do not contain ampullae. Some cyclosystems have no lid. In others the lid begins as a lobelike outgrowth of a wider septum between two dactylotomes. The male ampullae are imbedded in the coenosteum between the cyclosystems and are evident superficially only as slight irregularities of surface. Diameter of cyclosystem 1.5 to 1.8 mm; dactylopores 10 to 20. Surface of coenosteum coarsely vermiculated but not longitudinally striated."

In the collection of the Leiden Museum there is a coral labelled "*Endohelia japonica* Edw. & H.", locality and collector indicated as unknown. This specimen undoubtedly is the type of the species, though it is not marked as such and the origin is not noted.

The colony (Pl. II fig. 1) consists of a broad stem and a few thick branches that have a tendency to become coalescent, rising from a thin broad basal part that is firmly attached to the substratum, a piece of rock. The stem and branches are spreading, more or less fan-wise, in one plane. The surface of the corallum is smooth to the naked eye, when enlarged it is seen to be minutely granulated or vermiculated and having numerous very small shallow circular pores. The cyclosystems occur rather crowdedly on the stem and the branches, on one surface of the colony only. In the cyclosystems the number of dactylopores varies from 14 to 19, average of 18 cyclosystems: 15.9. The cyclosystems as a rule have a distinct tongue-like excrescence (lid), nearly constantly in the proximal region; these lids are more strongly developed in the older cyclosystems, whilst in the younger, on the tops of

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1) *Crypthelia* is the original spelling of the generic name, it occurs as such in the cited papers of Milne Edwards & Haime of 1849 and 1850. In the Histoire Naturelle des Coralliaires (1857) the authors changed the names *Crypthelia* and *Endhelia* into *Cryptohelia* and *Endohelia*. Broch (1936, p. 94), when commenting upon the change of *Crypthelia* into *Cryptohelia*, remarks that the latter spelling since 1857 has been in general use, and is "sprachlich korrekter" than the former, though the spelling *Crypthelia* must be used according to the rules of nomenclature. Etymologically, however, *Crypthelia* is the better spelling of the two; the "emendation" is of the same kind as if the proper name Philippus were to be corrected to "Philohippus" (cf. Gill, 1898, p. 473).

the branches, they are often much smaller. The diameter of the cyclosystems varies from 1.2 to 1.6 mm; the older cyclosystems protrude very little over the surface of the corallum, the younger are the terminal broadenings of slender stalks.

The basal part of the colony has a diameter of $2^3/_4$ cm, the greater diameter (the spreading) of the colony is $4^1/_2$ cm, the height including the basal part $3^1/_2$ cm, the height except the basal part $2^1/_2$ cm; the thickest branch at its base measures about $4^1/_2$ mm. In the stem and in the larger branches there are wide central cavities, so that the living specimen may have been inhabited by worms.

The figures of the more strongly enlarged parts of the corallum (Pl. II figs. 2-4) show the variation in size of the lids of the cyclosystems. In one cyclosystem (Pl. II fig. 3, upper half of the branch at the left side) the lid is prolonged into a band that joins the opposite side, in all the others the lid is short and does not reach noticeably over one half of the cyclosystem. Often the lid remains much shorter (right lower corner of fig. 2, lowermost cyclosystem of fig. 3, etc.).

The cyclosystems as a rule are separated, but in one part of the colony there are three pairs of cyclosystems, the two of each pair divided by a narrow partition only (fig. 4).

The colony undoubtedly is the type of the species *Endhelia japonica*. The rather thick, coalescing branches, a character mentioned in the description, is a striking feature of the specimen. Most of the other characters specified in the description are exactly those of the specimen; the data concerning the measurements fairly accurately correspond with those of the specimen; there are several cyclosystems with 18 dactylopores as noted in the description, though many cyclosystems have a smaller number. Unfortunately the data concerning the locality and the collector are not (no more?) available, but it seems safe to conclude from the original description that the specimen came from Japan.

In the type specimen of *Crypthelia japonica* there are no distinct indications of ampullae. Of several branches the tops have broken off, and here the section of the branches does not show cavities that might represent ampullae; moreover, there are no superficial swellings of the surface indicating the presence of ampullae.

It is interesting that the description and the figures of Japanese specimens, identified as *Crypthelia japonica* by Fisher (1938, p. 535, Pl. 64 figs. 2-4) in all important details correspond with the type specimen. The size of the branches, the manner of branching, and the rather crowded distribution of the cyclosystems on the branches is entirely similar; especially the coral of

Fisher's Pl. 64 fig. 3 in its growth form closely corresponds with the type, the two other specimens (l.c., Pl. 64 figs. 2, 4) are more spreadingly branched. An important character, also noted by Fisher, is that of the surface not being longitudinally striated.

Among the species of *Crypthelia* described by Hickson & England (1905) there are two, *C. balia* and *C. stenopoma,* that have a lid of a similar shape as that of *C. japonica.* In *C. balia* the lid is small, thick, triangular, as in the older cyclosystems of *C. japonica*; in *C. stenopoma* the lid is small, thin and narrow, as in the younger cyclosystems of *C. japonica.* The two species differ from *C. japonica* in their manner of growth, the colonies consisting of slender, widely spreading branches (Hickson & England, 1905, Pl. III figs. 29 and 30). A more striking character distinguishing the two species from *C. japonica* is that of the structure of the surface. In *C. balia* the surface is "longitudinally striated and granulated" (l.c., p. 23), in *C. stenopoma* the surface is "marked by pronounced longitudinal and fine transverse striations" (l.c., p. 22), whilst in *C. japonica* the surface is not striated.

The West Indian species *Crypthelia peircei* also has lids of a similar shape as those of *C. japonica* (cf. de Pourtalès, 1871, p. 37, Pl. II figs. 18, 19). The figured colony of *C. peircei* is very slender, the terminal cyclosystems occurring on long stalks. In the description the corallum is defined as "finely striated", the figure shows distinct longitudinal grooves, a character separating the species from *C. japonica.*

The species *Cryptohelia virginis,* described by Lindström (1876) from the West Indian region, is characterized by structures that might be regarded as adumbrations of lids as these are found in recognized species of the genus. As Lindström stated that there is a columella (meaning a gastrostyle), the species does not belong in the genus *Crypthelia.* Moseley (1880, p. 87) placed it with doubt in the genus *Stylaster.*

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EXPLANATION OF THE PLATES

Plate I

Fig. 1. *Millepora complanata* Lamarck, from the West Indian region, exact locality unknown (erroneously labelled: *Millepora platyphylla* Ehrb., Junghuhn, Java). Surface view of fragment with stellate pores.

Fig. 2. *Heliopora caerulea* (Pallas), Pulu Weh, North Sumatra, P. Bui-

tendijk leg., September, 1927. Surface view of part of the corallum with remains of soft parts.

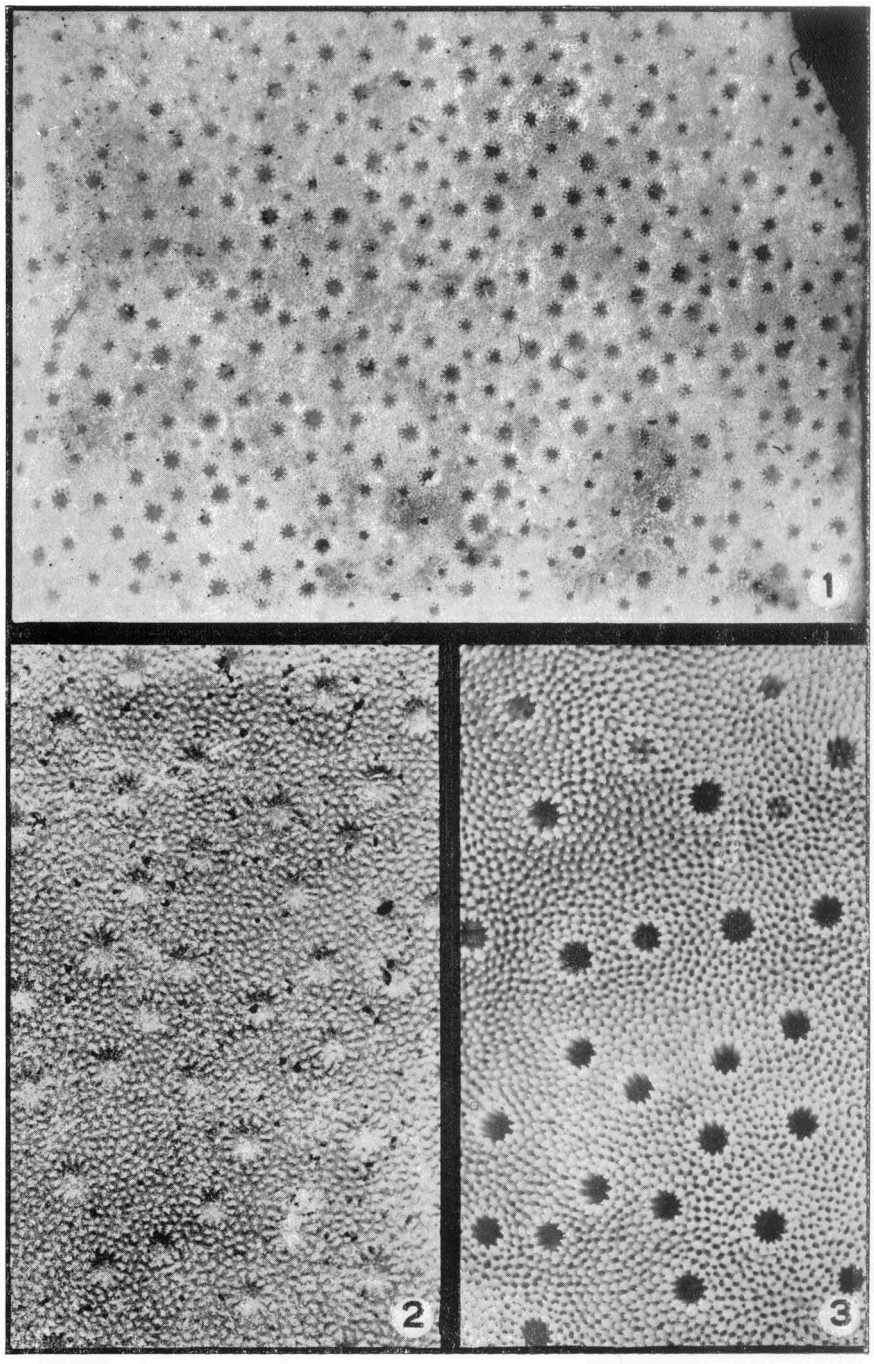
Fig. 3. *Heliopora caerulea* (Pallas), same specimen. Surface view of cleaned part of the corallum.

All figures × 7.

Plate II

Fig. 1. *Crypthelia japonica* (Milne Edwards & Haime), type specimen, anterior surface, × 2.

Figs. 2-4. *Crypthelia japonica* (Milne Edwards & Haime), type specimen, anterior surface, parts of the colony, × 5.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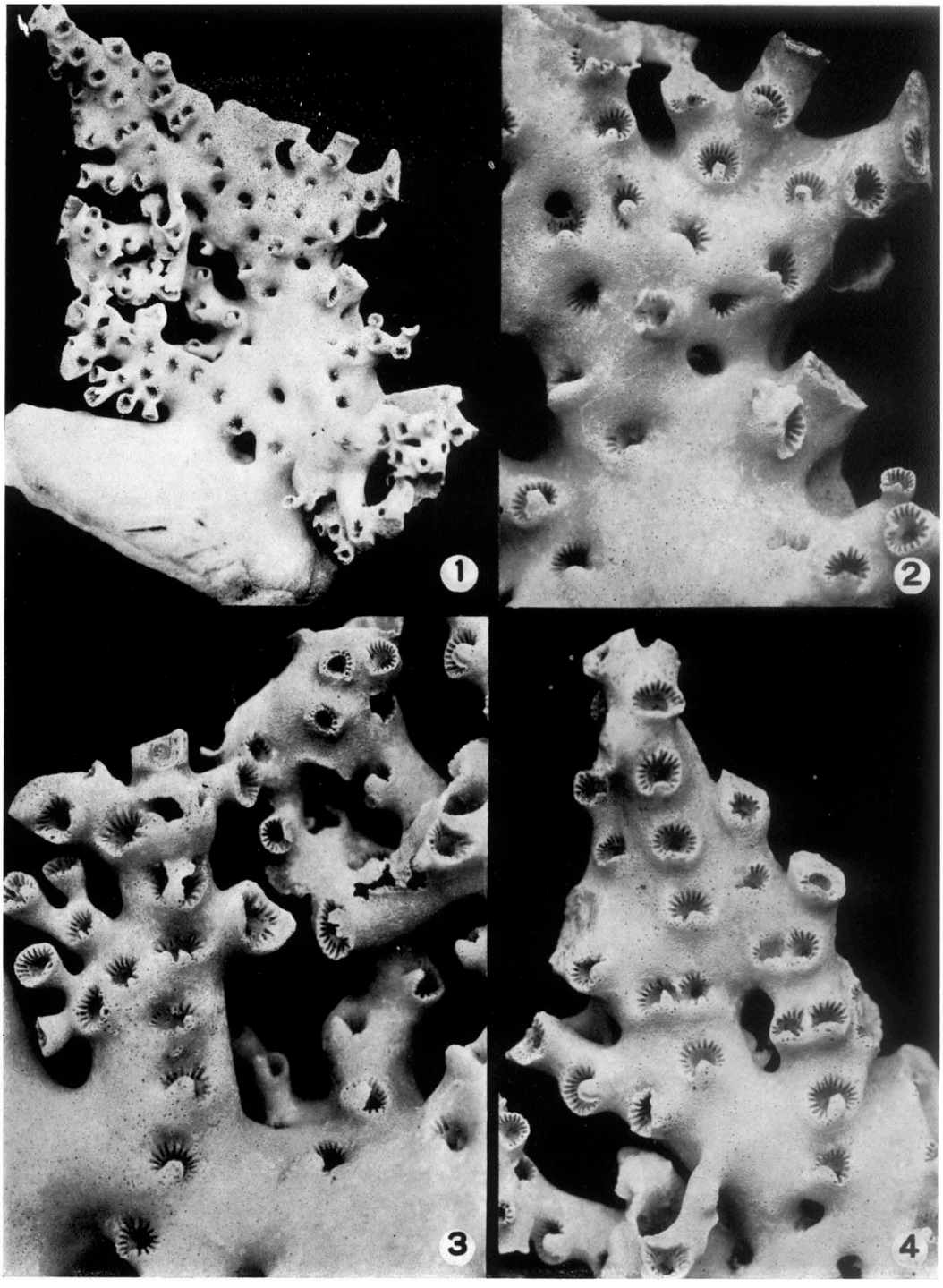
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