THE SPECIES PROBLEM IN MILLEPORA

by

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I. INTRODUCTION

As a result of his studies on the growth forms of *Millepora* Hickson (1898 *a*, *b*, 1899) came to the conclusion that these various forms entirely are caused by different environmental factors, and that they are nothing else but manifestations of the extreme variability of the one species *Millepora alcicornis* L. Previously Hickson (1889) had seen more or less extreme growth forms on the reefs of North Celebes, and at that time he distinguished a more or less delicately branched growth form named by him *Millepora alcicornis* from a plate-like growth form named by him *Millepora plicata*. Now these growth forms are so strongly different that it seems a matter of fact that they are specifically distinct. Later, however, Hickson made an extensive study of material from expeditions and of museum specimens; this material apparently was not accompanied by notes on the conditions of the environmental circumstances of the colonies on the reefs. In his comprehensive researches Hickson tried to find specific characters in representatives of the genus, especially in regard to the more or less minute structure of the corallum. He altogether failed to find specific peculiarities of constant character to warrant an arrangement of his material in specific entities, and consequently reached the conclusion mentioned above. Hickson overlooked, however, that perhaps the growth form might give an indication for the existence of real species in the genus.

In the years 1920 to 1922 I repeatedly visited the coral reefs of the Bay of Batavia, especially those of the island Edam. I had read Hickson's papers, and was convinced that his conclusions were right. The conditions on the reefs, however, soon showed me that Hickson's ideas of the modifiability of the corallum of *Millepora* as a result of external circumstances were not such a matter of fact as assumed by him. In the region of the strongest surf, on the extreme edges of the reefs, there were to be found, side by side, colonies of so different growth forms as *M. platyphylla* and *M. murrayi,* the one constituting a compact plate-like, honeycombed solid mass, and the other consisting of a multitude of delicate branches. And these were growing on exactly the same spot, under completely corresponding external influences. If anything were needed to show that Hickson's line of reasoning lacked the necessary background of a corroboration of his conclusions with the natural facts on the coral reefs, it was these observations.

Moreover sometimes two colonies of strongly different growth form were found living side by side and in close contact. When these colonies united they did not fuse into a single mass as one would expect when the two were to be regarded as specifically the same, but invariably the colony of the more slender form of growth was overgrown by the more robust colony. This again points to a specific difference of the two growth forms.

In the course of time so many forms of *Millepora* had been described as separate species that it was not an easy task to assign a colony of the genus to one of the described forms. In this respect it was a relief that Hickson with a large amount of likelihood demonstrated that all these described forms were nothing else but the outcome of influences of the environment on the so highly variable material. But when one studies the corals of this genus on the reefs and tries to show that environmental factors bring about the so highly different growth forms, one is soon convinced that Hickson's conclusions were, to say the least, premature.

It is not to be denied that in its growth form *Millepora* is highly susceptible to environmental influences, but the modifications on account of these influences substantiate themselves to a far lesser degree than Hickson thought possible. The genus *Millepora* may be divided into a number of species, each of which has its own characters, differing from those of the other species. As the minute structure of the corallum does not yield easily definable characters of specific value (in this respect Hickson was entirely right) the specific characters must be those of the growth form of the corallum. To obtain an idea of the species and their variation it is of great help to study these on the reefs and to observe how they change under the influence of the external conditions. If one knows his corals on the reefs one can usually state in regard to museum specimens under what conditions they attained a certain growth form, thereby discerning between conditions brought about by external factors and peculiarities of innate specific value.

In the present paper I have attempted to demonstrate that the various forms of *Millepora,* which in the course of time have been described as separate species or varieties, may be arranged in ten distinct species, each of which can be characterized with sufficient accuracy to warrant its being specifically distinct from the others. It is, however, not altogether certain that the ten distinct groups really represent all the species of the genus. Some of the species, as they are defined in the present paper, in reality may consist of a complex of two (or perhaps more) species. But for the present the arrangement in ten species seems to fit in nicely with the facts of the literature, the observations on the coral reefs, and the investigations on museum material.

I have tried to consult the whole of the literature of 1758 and later years dealing with recent forms of the Hydrocoralline genus *Millepora,* and I am convinced that hardly any papers of great importance have escaped my notice. As far as concerns the literature of the years before the publication of the 10th edition of Linnaeus's Systema Naturae a few works only were used, especially those which might elucidate Linnaeus's views. The papers dealing with fossil representatives of the genus have not been taken into account.

It was of great advantage to me that in September 1947 I had the opportunity to examine the extensive collection of *Millepora* in the Muséum National d'Histoire Naturelle in Paris, so that I could study a considerable number of type specimens of described species and several other specimens of interesting growth forms. I want to express my sincerest thanks to Dr. G. Ranson and to Mr. G. Cherbonnier of the Paris Museum, who kindly placed the material at my disposal. Moreover Dr. Ranson at my request sent me an excellent photograph of the type specimen of *Millepora squarrosa* Lamk. I am further indebted to him for the identification of specimens of *Ostrea spreta* d'Orb., taken from a coral colony without indication of the locality, so that proof could be obtained of its West Indian origin.

I am much obliged to Prof. A. C. Hardy, F. R. S., who took the trouble to make a thorough search in the Oxford University Museum for certain specimens of coral figured by Morison (1715); it is not to be wondered

that after more than two centuries these were not to be found. Further I want to express my thanks to Captain A. Knyvett Totton of the British Museum (Natural History) for sending me notes from literature which was not to be obtained in this country.

I am greatly indebted to Prof. L. F. de Beaufort and Dr. H. Engel of the Amsterdam Zoological Museum for placing the specimens of *Millepora* in this museum at my disposal. Moreover I want to thank Dr. Ch. Bayer, Miss A. M. Buitendijk, and Mr. P. P. de Koning of the Leiden Museum for identifications of various mollusks and of a crab, in this way enabling me to fix the locality of specimens of unusual growth forms.

II. HISTORICAL NOTES, INCLUDING THE SUCCESSIVE VIEWS CONCERNING THE SPECIFIC VALUE OF THE GROWTH FORMS

In the genus *Millepora* of Linnaeus (1758) there is but one species, *Millepora Alcicornis,* which may belong to the genus as it is understood in the present time, all the other species now are regarded as belonging to various genera of Madreporaria or to the calcareous algae. Linnaeus (1758, p. 791) characterizes the species as follows:

"10. M. ramosa compressa, poris sparsis obsoletis.

Moris. hist. 3, *s.* 15. *t.* 10. *f.* 26. Corallium albidum latum & compressum ad extrema tantum ramosum.

Habitat..

Caulis *pedalis, albus, compressus, varie ramosus, obtusus, fragilis.*

Pori *sparsi, minimi, vix conspicui, remoti.*"

These notes do not give any clue for the identity of Linnaeus's *Millepora Alcicornis* with one or more of the forms described in later years as separate species or varieties. The only useful indication is the reference to Morison's coral. Now Morison's *Corallium albidum latum & compressum ad extrema tantum ramosum* (see Pl. I fig. 3 in the present paper) may represent a *Millepora* (which is highly improbable), or it may represent a *Montipora* (there are species of this genus which have the same form of growth), or it may represent a *Porites* (which is the most probable interpretation as the calices are drawn in such a manner that the general appearance of the surface strongly reminds of that in *Porites*). In all probability, therefore, Linnaeus's *Millepora Alcicornis* does not even belong to the genus [1]).

1) It would have been extremely interesting to obtain more particulars concerning Morison's corals. As there might be a slight chance that after more than two centuries these still were in the Oxford University Museum, I asked Prof. A. C. Hardy, F.R.S. to ascertain whether they still existed. Though a thorough search was made among the old collections at Oxford the specimens could not be traced.

There is, however, another argument which points to the probability that Linnaeus really had in mind the branched West Indian species when publishing his data on *Millepora Alcicornis*. The meaning of the trivial name "*alcicornis*" is so evident that it characterizes the form referred to as the species with the elk-horn shaped branches. Crossland (1941, p. 61) writes: "I cannot resist the remark that the one thing quite certain about the many forms of *Millepora* is that none of them have any resemblance to an elk's horn, except perhaps that from the West Indies." Now the West Indian *Millepora alcicornis* is extremely variable in its mode of growth and in the shape of its branches. In some specimens, however, the branches have a remarkable resemblance to minute elk's horns, e.g., in the one figured by Dana (1872).

The genus *Millepora* in Linnaeus (1767) still contains the same heterogeneous group of organisms, among which the species *Millepora alcicornis* now is sufficiently defined as a species of *Millepora* in the modern sense. From Morison's publication no more the specimen of his figure 26 is cited, but the specimens of his figures 24 (*Corallium albidum fragile polyschides*, see Pl. I fig. 2 in the present paper) and 27 (*Corallium albidum digitatum*, see Pl. I fig. 4 in the present paper). Morison's figures 24 and 27 undoubtedly were made after specimens of *Millepora*, which probably came from the West Indies, so that they represent the species *Millepora alcicornis*, as it is defined in the present paper. Linnaeus (1767) moreover refers to the *Corallium asperum candicans adulterinum* of Bauhinus c.s. (1651) as a synonym. This form (see Pl. I fig. 1 in the present paper) probably is a *Millepora*. Morison with some doubt places it in the synonymy of the form of his fig. 27. Specimens indicated with the name *Corallium asperum candicans adulterinum* by Sloane (1707) without any doubt belong to *Millepora alcicornis* in the modern sense.

Pallas (1766) also includes, besides *Millepora alcicornis*, in the genus a number of Madreporaria and Nullipores. In *Millepora alcicornis* he distinguishes 5 varieties, indicated with the symbols α 1, α 2, β, γ and δ.

Knorr (1771) gives a figure of the form which in later years was described as the variety *crustacea* and one of the form which in later years was named *plicata* (see fig. 2 *a* in the present paper).

Forskål (1775) places six species from the Red Sea in his genus *Millepora;* four of these (including the *Millepora alcicornis* of Forskål which, according to Crossland (1941), belongs to the genus *Stylophora*) are species of various genera of Madreporaria; the remaining two, *Millepora exaesa* and *Millepora dichotoma*, are well defined forms of specific rank.

Gmelin's (1789) conception of the genus *Millepora* and of the species *M. alcicornis* does not differ noticeably from that of Linnaeus (1767).

Esper (1790) gives names to the varieties indicated by Pallas with Greek symbols, so that now these various forms are indicated as: *α digitata, α 2 corniculata, β ramosa, γ plicata* (see fig. 2 *b* in the present paper), and δ *crustacea*. Moreover Esper described a new variety *nodosa* (see fig. 2 *c* in the present paper). All these forms, which Esper lists as varieties of *Millepora alcicornis*, are figured in such a manner that the growth form is typically represented. With the exception of *corniculata* and *crustacea* all the names of Esper's varieties in later years were used to indicate forms which were considered to be of specific value. Esper's genus *Millepora* still includes numerous species belonging to the Nullipores and the Foraminifera (*Polytrema*).

Oken (1815) mentions from the genus *Millepora* besides a number of Nullipores, etc., the species *M. alcicornis* only, without giving characters indicating which of the previously described forms was meant.

In Lamarck's (1816) genus *Millepora* the 14 species are arranged in two groups. In one of these the species have distinct pores (comprising the new species *M. squarrosa* and *M. complanata*, and *M. alcicornis*, besides four Mediterranean coralline algae or Bryozoa and a *Polytrema*). In the other group (the Nullipores) Lamarck places 9 species with not or hardly apparent pores. In the present paper Lamarck's *M. squarrosa* and *M. complanata* are regarded as well defined distinct species.

Ehrenberg (1834) includes in his genus *Millepora* six species from the Red Sea: the species at present known as *Heliopora caerulea*, and *Millepora complanata* Lmk., *platyphylla* Hemprich & Ehrenberg, *porulosa* Ehrb., *clavaria* Ehrb., and *cancellata* Ehrb. The name *cancellata* is a synonym of *dichotoma* Forsk., the name *porulosa* is a synonym of *platyphylla* or of *dichotoma*, the other "species" belong to *platyphylla*, which is well characterized as a distinct species. Moreover, Ehrenberg mentions *Millepora alcicornis*, which he has not obtained from the Red Sea, and distinguishes 4 varieties of this species (without giving distinctive characters).

Blainville divides the genus *Millepora* (as it was understood by Lamarck, 1816) into two parts. For one of these divisions, involving the species *Millepora alcicornis, M. squarrosa*, and *M. complanata*, Blainville erects the new genus *Palmipora*. He retains the name *Millepora* for the majority of Lamark's species, the Nullipores.

Dana (1848) gives descriptions or notes of 11 species and 2 varieties of the genus *Millepora*; 3 of the species and the 2 varieties are described as new. His new species *M. moniliformis* and *M. pumila* may be regarded as forms of *M. alcicornis,* his new species *M. tortuosa* (a preoccupied name) in all probability is the same as *M. tenella* Ortm. Dana's variety *incrassata* was arranged by him under the species *M. squarrosa*; in reality it is a form of *M. platyphylla.* Dana's variety *truncata* (a preoccupied name) was correctly regarded by him as a form of the species *M. platyphylla.*

Duchassaing (1850) describes three "new species" from the West Indies, and mentions the three forms from this region which were already regarded as different species by Lamarck (1816).

Milne Edwards (1860) arranges the available data in connection with the species of the genus *Millepora* in an excellent manner; he gives diagnoses of 16 species and notes on 4 other described forms. His new species are: *M. folliata* (misprint for *foliata*), *M. ehrenbergi, M. verrucosa* (a preoccupied name), *M. forskali, M. reticularis, M. intricata,* and *M. gonagra* (named *M. tuberculosa* by Milne Edwards, 1857, in the explanation of the plates). Of these *Millepora intricata* in the present paper is regarded as a distinct species, the others are placed in the synonymy of other species. Milne Edwards's descriptions are concise, generally much better than those of previous authors. But still far too many forms are regarded by him as distinct species.

Duchassaing & Michelotti (1860) give a list of the 7 described West Indian "species" of the genus *Millepora,* and describe one more "new species" from the region. In another paper (Duchassaing & Michelotti, 1864) they discern not less than 22 (or 24) West Indian "species", 12 of which are "new to science". The distinctions are based on slight modifications of growth form. Many of these are figured, which shows, as the short diagnoses, that the procedure is highly arbitrary.

Verrill (1864) describes the new species *Millepora insignis,* which has the salient characters of *M. platyphylla* Hempr. & Ehrb. In a later paper (Verrill, 1868) some new "species" and "varieties" of *Millepora* are described, based on material from the Abrolhos Reefs off Brazil. The same names are mentioned in another paper by the same author (Verrill, 1901).

Pourtalès (1871) distinguishes two West Indian species of the genus *Millepora*: *M. plicata* Esper and *M. alcicornis* Lmk. With some doubt he regards *M. ramosa* Dana as a different species. Pourtalès places numerous species of previous authors in the synonymy of *M. plicata* and *M. alcicornis.* The paper therefore constitutes an important progress as far as concerns the conception of the species in the genus.

Moseley (1876) describes some particulars of *Millepora alcicornis* from Bermuda and of another species (not indicated with a specific name) from Zamboangan, Mindanao. In a later paper (Moseley, 1877) he mentions again these two species, and moreover deals largely with the particulars of a species occurring at Tahiti, identified as *Millepora nodosa*.

Klunzinger (1879) obtains excellent results in his studies on the material of *Millepora* from the Red Sea. His conception of the species is altogether modern. He designates the species with their right names and places exactly those names in the synonymy of the real species which ought to occupy this place. This was a marvellous achievement for his time. Klunzinger discerns: 1, *Millepora platyphylla* Ehrenberg with the synonyms *platyphylla* Ehrb., ?*platyphylla* Dana, *verrucosa* M. Edw., *complanata* Ehrb. (?non *complanata* Lmk.), and *ehrenbergi* M. Edw. (of these *complanata* Lmk. only does not belong to *M. platyphylla*); 2, *Millepora exaesa* Forskål with the synonyms *exaesa* Forsk., *clavaria* Ehrb., and *gonagra* M. Edw.; 3, *Millepora dichotoma* Forskål, with the synonyms *dichotoma* Forsk., and *reticularis* M. Edw. Klunzinger gives the new name var. *glabrior* to indicate the form of *M. platyphylla* described as *M. complanata* Ehrb. and as *M. ehrenbergi* M. Edw. In *M. exaesa* he discerns the three varieties *incrustans* (a new name), *gonagra*, and *clavaria* (the latter including *M. exaesa* Forsk. and *M. clavaria* Ehrb.). Finally Klunzinger retains the name *reticularis* for a variety of *M. dichotoma* Forsk., quite the right procedure. Klunzinger's work forms an example, even for modern times, of how an intricate problem of specific relations in a group of highly variable forms should be tackled.

Quelch (1884) describes the new species *Millepora murrayi* and gives a short account of the ampullae, which up to this time had not yet been found in the genus. In his extensive publication on the reef corals of the Challenger Expedition (Quelch, 1886) he describes the particulars of specimens which he arranges in 8 species of *Millepora*, among which *M. murrayi* and the new species *M. confertissima*. In the present paper the latter is regarded as a synonym of *M. murrayi*.

Ortmann (1892) gives a description of his new species *Millepora tenella*, in which the important characters are well defined. He regards *verrucosa* as a variety of *platyphylla*.

Saville-Kent (1893) gives an account of two forms of *Millepora*, in which the salient characters are so distinctly noted that the forms may be identified, although they are recorded by Saville-Kent under the wrong names. His excellent plates help to come to the correct identification.

Three papers by Hickson (1898 *a*, 1898 *b*, 1899) are of extreme importance, as they have had an enormous influence on the ideas in connection with the species concept in the genus *Millepora*. In previous papers this author (Hickson, 1888, 1889) used different specific names for specimens of the genus which were characterized by a certain manner of form. In his papers of 1898 and 1899 Hickson gives an analysis of the specific characters in *Millepora*, and concludes that all the described species are nothing else but growth forms of the one extremely variable species *Millepora alcicornis*. His conclusions are (Hickson, 1808 *a*, p. 249): "The form assumed by the coral must depend upon many circumstances connected with the exact spot on which it grows. If a *Millepora* embryo happens to become fixed on a large piece of dead coral, it will form a large incrusting base, and such a base nearly always gives rise to a lamellate form of growth; if, on the other hand, the embryo settles on a small stone or other object, lamellate growth is impossible, and the corallum will be ramified." Hickson further remarks that in various parts of the reefs the available food-supply, the set of tide and currents, the chemical composition of the sea-water, particularly the amount of calcium carbonate, varies. Such variations then must affect the rate of growth of Millepores, and in Hickson's opinion it is reasonable to believe that they affect the mode of growth also. Hickson tried to find specific characters in: 1, the size of the pores, 2, the degree of isolation of the cycles, 3, the presence or absence of ampullae, 4, the texture of the surface of the corallum, 5, the relative number of dactylopores and gastropores, and 6, the anatomy of the soft parts, but as these researches did not lead to any reliable specific distinctions, he concluded that all his investigations pointed to the fact that there is but one species of the genus, *Millepora alcicornis*.

In his next paper Hickson (1898 *b*, p. 828) remarks concerning the genus *Millepora*: "... there is no reason to suppose that there is more than one species of this genus, but there are nevertheless several characters of interest presented by specimens from different coral-reefs which are deserving of record. I propose to use the term "Facies" for the general form of growth of the specimens described, and to retain as far as possible under this term the names previously used for species." Hickson in this paper gives particulars of the facies named by him "*ramosa*", "*esperi*", "*complanata*", and "*plicata*" (material from Funafuti and Rotuma).

In a similar manner Hickson (1899) describes specimens from Willey's expedition to New Britain, New Guinea, the Loyalty Islands, and "elsewhere" as facies *dichotoma, complanata, nodosa,* and *verrucosa*. Among the excellently figured specimens there is one consisting of three different facies, thereby giving proof of the variability of the corallum.

It is not astonishing that Hickson's views, which were based on the results of extensive studies, were eagerly accepted as the real solution of the species problem in *Millepora*. Only gradually, and hesitatingly, later authors ventured to characterize the various growth forms of *Millepora* by special names, arguing: "Hickson probably is right, but it is convenient to use a special name to indicate the particulars of a certain form."

Curiously enough Hickson's identifications of the previously described "species" in the genus *Millepora* in numerous cases were entirely wrong. In his paper of 1898 *a* he gives the name *M. intricata* to a specimen which had obtained a peculiar shape by growing over a small piece of wood; the complicated growth form of the real *intricata* never could be brought about in this manner. In his next paper (Hickson, 1898 *b*) he states that a certain specimen has the characters of *Millepora esperi* Duch. & Mich., but from his description clearly results that the specimen belonged to the entirely different *M. exaesa*. In the same publication specimens from Funafuti are referred to as the facies "*complanata*" and specimens from Rotuma as the facies "*plicata*". Now these two names undoubtedly are synonyms; Hickson himself was convinced of this, as in his paper of 1898 *a* he uses the name *plicata* for a certain part of a specimen collected by Willey, whilst the same part is referred to in Hickson's paper of 1899 as the facies *complanata*. When describing the specimen of his fig. 7, Hickson (1899) names the different parts of this corallum, each of which are of a rather different growth form, from left to right: *complanata, verrucosa,* and *gonagra*. These names ought to have been (in Hickson's terminology): *complanata, gonagra,* and *verrucosa* respectively. But notwithstanding the fact that his arguments lacked the necessary systematic background, Hickson's conclusion seemed so well founded that for a long time it was generally accepted that he had definitely solved the species problem in the genus *Millepora*.

Vaughan (1902) states that in *Millepora alcicornis* from Porto Rican waters there are two distinct forms, a digitiform variety and a variety with flabellate fronds.

Gardiner (1907, p. 133) remarks that *Millepora* "... is particularly interesting on account of the extraordinary different facies which it assumes, incrusting, branching, massive, spreading, close-set leaves, &c. Any facies may be found at any depth and all belong, as Prof. S. J. Hickson has shown, to a single species."

Wood-Jones (1907, 1910) remarks that in the Cocos Keeling Islands *Millepora* occurs in the well-marked forms *M. alcicornis, M. complanata,* and *M. verrucosa,* and adds: "But these well-marked forms are all linked up by intermediate stages, and I have no doubt that all are variants of one species." (Wood-Jones, 1910, p. 133).

Gravier (1911) gives a clear and vivid description of a *Millepora* occurring in the Gulf of Aden, and correctly identifies his material as *M. dichotoma* Forsk.

Vaughan (1918) on Hickson's authority names his material *Millepora alcicornis*, but remarks (l.c., p. 206): "But it is at least convenient, if not systematically sound, to recognize by distinctive names the different aspects presented by colonies." Vaughan then identifies his specimens as *Millepora dichotoma* Forsk., *M. platyphylla* Ehrb., and *M. truncata* Dana.

Mayor (1924) denotes a coral of more or less plate-like growth as *Millepora truncata* Dana.

Hickson (1924) again comments upon the varieties of form in the genus *Millepora*, and concludes: "These differences in form seem to be associated with differences in the conditions of the immediate environment and cannot be used as characters for specific distinctions." (l.c., p. 145).

Barker (1925), uses the specific names *Millepora dichotoma* Forsk. and *M. truncata* Dana.

Hoffmeister (1925) identifies a specimen as *Millepora alcicornis* L. and remarks that it is very similar to *M. confertissima* Quelch. For another specimen he uses the name *M. truncata* Dana and adds that it is very much like *M. incrassata* Dana. In a later paper (Hoffmeister, 1929) the name *Millepora truncata* is used.

Faustino (1927) remarks that according to Hickson there is but one species of *Millepora*, and states (l.c., p. 300): "He may be correct; but, as the present paper aims to give an account of all the forms occurring in Philippine waters, it is thought best to record the forms as they were recognized by the different workers."

Crossland (1927) was able to discern different facies in material of *Millepora*, but concludes (l.c., p. 545): "All, as HICKSON suggested, belong to the same species in spite of these apparently wide differences." In a following paper Crossland (1928) states that *Millepora alcicornis* in Tahiti occurs in five facies, and remarks that the growth forms of *Millepora* directly correspond to external conditions, corroborating Hickson's prolonged investigations.

Umbgrove (1928) is convinced that there are no different species in the genus *Millepora*, but for convenience's sake he indicates the various growth forms with separate names. He points to the fact that each of these growth forms in its distribution is more or less restricted to an area of the reef with certain ecological conditions.

Russell & Yonge (1928, p. 163), when pointing to the strong variation in corals in connection with external influences, write: "The most striking example is that of the hydroid coral, Millepora, of which there are all manner of different forms but apparently the one species in the world."

Thiel (1933) identifies a coral from the Philippine Islands as *Millepora intricata* M. Edw. & Haime. He remarks that according to Hickson all the forms of *Millepora* belong to the one species *M. alcicornis*, but expresses his doubts if not a growth form as that of his specimen is to be regarded as a specific character. In his opinion it is difficult to understand how a network as in his specimen could be a result of external circumstances. Thiel then states that the formation of a network as in his specimen easily might be due to specific reasons, not dependent on external conditions. He is inclined to regard such specimens as specifically distinct, or at least to consider them as a separate form.

Yabe & Sugiyama (1933, 1935 *a, b,* 1937) use various specific names to indicate representatives of the genus *Millepora.*

Sewell (1936) uses the name *Millepora complanata* for a corallum of apparently a plate-like growth.

Boschma (1936) discriminates specimens of the genus with different growth forms as *Millepora alcicornis* forma *dichotoma* and *M. alcicornis* forma *platyphylla.*

Dollfus (1937) identifies his material as *Millepora alcicornis,* and indicates various "formes" with the names *plicata, fasciculata* and *gothica* of previous authors.

Eguchi (1938) states that according to Hickson all the hitherto described species of *Millepora* probably belong to *M. alcicornis,* but records three species of the genus for the Palao Islands.

Hiro (1938) mentions four species of *Millepora* as hosts of the cirriped *Pyrgoma milleporae* Darwin.

Butsch (1939) states that *Millepora alcicornis* occurs in several different forms which are quite unlike in appearance, namely a digitate form, a palmate form, and a flabellate form.

Crossland, who in previous papers showed himself a strong supporter of Hickson's conclusion of the specific unity of all the forms of *Millepora,* in a later paper (Crossland, 1941) emphatically states that the Millepores from the Red Sea may be distinctly arranged in three well characterized species. He writes (l.c., p. 61): "In my opinion there is more than convenience in distinguishing by name such well marked forms as the three of the Red Sea. Young specimens of them naturally may, and do, resemble each other, and modification by environment may cause convergence, real or apparent; other variation, such as that illustrated by *M. exaesa* on Plate XII, may lead one to think anything possible, and to overlook limits that do hold good, but, when it is found that the vast majority, if not indeed all, well grown adult colonies in the Red Sea fall distinctly into the three species here dealt with it seems likely that there is a genetic distinction."

Summarizing the data given above it may be observed that there are the following salient features in the historical development of the ideas in connection with the species problem in the genus *Millepora*.

In all probability *Millepora Alcicornis* Linnaeus, 1758, represents a species which not even belongs to the genus, although the trivial name *alcicornis* gives some evidence that Linnaeus knew the West Indian branched species, and had this species in mind when he published his description. On the other hand *Millepora alcicornis* Linnaeus, 1767, really is the species as it is understood nowadays when using the same name.

Pallas (1766), Esper (1790), Forskål (1775), Lamarck (1816), Ehrenberg (1834), Dana (1848), and Duchassaing (1850) describe a number of species and varieties, for a large part based on differences of minor importance.

Milne Edwards (1860) arranges and describes the species of the genus known till that time and adds the description of seven new species. Though his descriptions clearly show the characters of the various forms he still regards too many of these as distinct species.

Duchassaing & Michelotti (1860, 1864), and to some extent also Verrill (1864, 1868) regarded every growth form of West Indian *Millepora* which had a slightly different shape from that of previously described forms as a new species. In this way almost every individual colony could be regarded as a distinct species.

Pourtalès (1871) was the first to realize that a great number of previously described West Indian "species" are nothing else but various growth forms of a very small number of real species. He lists as specifically distinct forms of the West Indies *Millepora plicata* and *M. alcicornis*, and remarks that possibly *M. ramosa* is different.

Most important results were obtained by Klunzinger (1879) in his studies on the forms of *Millepora* of the Red Sea. His publication is an example of a modern conception of the species question. He distinguishes, rightly, three Red Sea species of the genus, *Millepora platyphylla, M. exaesa,* and *M. dichotoma,* and places the other described species, as far as they were from the Red Sea, in the synonymy of these three, just where they belong. Hickson (1898 *a, b,* 1899) probably had no knowledge of Klunzinger's results, otherwise he would not have propagated his idea of the unity of all the Millepores as representatives of one species as emphatically as he did in the cited publications. Klunzinger's statements form a real progress, his conclusions are completely sound.

Quelch's (1886) publication does not form an important improvement in the modern sense. Ortmann (1892) gives a rather distinct description of a new species.

It is interesting to state that up to this time the following trivial names had been published to indicate recent species or varieties of the Hydrocoralline genus *Millepora*:

alcicornis Linnaeus, 1758; *exaesa* Forskål, 1775; *dichotoma* Forskål, 1775; var. *digitata* Esper, 1790; var. *corniculata* Esper, 1790; var. *ramosa* Esper, 1790; var. *plicata* Esper, 1790; var. *nodosa* Esper, 1790; var. *crustacea* Esper, 1790; *squarrosa* Lamarck, 1816; *complanata* Lamarck, 1816; *platyphylla* Hemprich & Ehrenberg in Ehrenberg, 1834; *porulosa* Ehrenberg, 1834; *clavaria* Ehrenberg, 1834; *cancellata* Ehrenberg, 1834; var. *cristata* Ehrenberg, 1834; var. *effusa* Ehrenberg, 1834; *moniliformis* Dana, 1848; *pumila* Dana, 1848; *tortuosa* Dana, 1848; var. *incrassata* Dana, 1848; var. *truncata* Dana, 1848; *fasciculata* Duchassaing, 1850; *parasitica* Duchassaing, 1850; *tuberculata* Duchassaing, 1850; *verrucosa* Milne Edwards, 1857; *intricata* Milne Edwards, 1857; *tuberculosa* Milne Edwards, 1857; *folliata* Milne Edwards, 1860 (misprint for *foliata*); *ehrenbergi* Milne Edwards, 1860; *forskali* Milne Edwards, 1860; *reticularis* Milne Edwards, 1860; *gonagra* Milne Edwards, 1860; *gothica* Duchassaing & Michelotti, 1860; the following names by Duchassaing & Michelotti, 1864: *schrammi, esperi, crista-galli, delicatula, candida, rugosa, carthaginiensis, trinitatis, fenestrata, sancta, faveolata,* and *striata*; *insignis* Verrill, 1864; *nitida* Verrill, 1868; *braziliensis* Verrill, 1868; var. *cellulosa* Verrill, 1868; var. *glabrior* Klunzinger, 1879; var. *incrustans* Klunzinger, 1879; *undulosa* Tenison-Woods, 1879; *murrayi* Quelch, 1884; *confertissima* Quelch, 1886; *tenella* Ortmann, 1892.

Many of these names were, when they came in use for a form of the Hydrocoralline genus *Millepora*, preoccupied, as they previously had been given to nullipores which had been arranged in the genus *Millepora*. Numerous names of varieties have been used by later authors to indicate forms which they regarded as distinct species. These particulars are more fully noted in the part of the present paper dealing with the specific arrangement of the various forms.

The excessive number of names which in the course of time had been proposed for forms of the Hydrocoralline genus *Millepora* considered as distinct species of the genus made it a bewildering task to identify a specimen as belonging to one of the described species. Hickson (1898 *a*, *b*, 1899) tried to find a solution of the species problem in the genus, and it is not to be astonished that he came to the conclusion that all the described species are nothing else but manifestations of the susceptibility of the corallum to environmental influences, and that all these different growth forms ought to be regarded as modifications of one highly variable species, *Millepora alcicornis*. Hickson tried to find specific differences in characters of the pores and their distribution, the texture of the surface, the anatomy of the soft parts, etc., and concluded that there are not to be found any constant differences of specific value. He overlooked, however, that the type of growth may furnish characters of specific value, though it is difficult to sufficiently define these in a concise manner.

Hickson's views have had an enormous influence on the work of later authors. If these were inclined to make a distinction between various forms of the genus, they hesitatingly stated that though Hickson probably was right, it nevertheless might be useful to discern the various growth forms with different names. Only gradually the authors who had to deal with specimens of *Millepora* ventured to designate their material with specific names other than *Millepora alcicornis*. As a reaction to the fabrication of specific names, as shown in the list given above, Hickson's work was extremely useful, but his conclusions were, to say the least, exaggerated.

The conclusions of Wood-Jones (1907, 1910) were arrived at independently from Hickson's views. Wood-Jones is convinced that far too many forms of Madreporaria in the course of time have been described as separate species, and that the majority of these are nothing else but varieties caused by factors of the environment. As far as concerns *Millepora* he reasons along the same lines: in his opinion the various growth forms as they manifest themselves in the genus are solely modifications caused by environmental circumstances.

Numerous authors of publications in which material of *Millepora* was mentioned or described evidently were under the influence of Hickson's statements (Vaughan, 1918; Hoffmeister, 1925; Faustino, 1927; Crossland, 1927, 1928; Umbgrove, 1928; Russell & Yonge, 1928; Boschma, 1936). On the other hand Gravier (1911) uses the name *Millepora dichotoma* without referring to Hickson's opinion concerning the described species of the genus.

Though still somewhat hesitatingly, Thiel (1933) expresses as his views that in all probability the growth form of *Millepora* may represent a specific character. He identifies his material as *Millepora intricata* and argues that the peculiar network of the colony hardly can be explained as a result of external influences only, there must be some innate peculiarity of the species to produce exactly this complicated system of branches.

Undoubtedly influenced by Hickson's results Crossland (1927, 1928) at first is convinced of the specific unity of all the forms of *Millepora*. In a later paper (Crossland, 1931), though still referring to the "monospecific genus *Millepora*" this author observes that there are three separate forms of the genus in the Red Sea, without intermediates, whereas between the five forms in Tahiti easily intermediates are found. More emphatically Crossland's (1941) statements are pronounced. He now is convinced that all the Red Sea corals of the genus *Millepora* easily can be arranged in the three well defined species *M. exaesa, M. dichotoma,* and *M. platyphylla,* thereby largely confirming Klunzinger's ideas on the species conception of these corals.

In the present paper it is attempted to demonstrate that the described forms of the genus *Millepora* can be arranged in ten species, defined by distinct characters based on peculiarities of their growth forms. Most of the names given by previous authors to forms of the genus *Millepora* with sufficient accuracy in each case can be placed in the synonymy of one of these species.

III. THE SPECIES OF THE GENUS MILLEPORA

In this chapter the characters of the species of *Millepora* are given, though the data on which the distinction of the various species is based are contained in the following chapters. As in these later chapters specific names are used it is necessary that the characters of these species are defined here to indicate what is meant when a certain name has been used.

Millepora alcicornis Linnaeus, 1758
(Pl. XIV fig. 3; textfig. 6)

Corallum of extremely variable shape, at the growing edge divided into branches which as a rule are laterally compressed, but may be more or less finger-like. In the older parts the branches generally are largely united into plate-like growths or thicker compounds. Some colonies are decidedly delicately branched, others are of a very compact growth form. The surface of the corallum is even or shows shallow depressions in the centres of which the gastropores are found.

The shape of the corallum of *M. alcicornis* sometimes may be entirely that of various Indopacific species of the genus. *M. alcicornis* is so highly variable in shape that it is impossible to characterize the species in this respect. If of a branched specimen the locality is known as the Atlantic region it undoubtedly belongs to *M. alcicornis,* as the two other species of this region present well-defined specific characters which distinguish them at once from *M. alcicornis.* If of a branched specimen the locality is unknown it is sometimes extremely difficult or impossible to decide whether it belongs to *M. alcicornis* or to one of the branched species from the Indopacific region. The presence of slight depressions in which the gastropores occur then decidedly points to *M. alcicornis.* But when these depressions do not occur a correct identification in many cases may remain impossible.

Millepora exaesa Forskål, 1775
(Pl. V fig. 1; textfig. 2 *c*)

Corallum forming irregular lumps with numerous fairly large sized, roundish tubercles, or presenting robust branches which are divided into smaller branches of thickly tubercular appearance. The corallum has a pronouncedly knobbed shape. Surface even. Pores as a rule distinct.

Millepora dichotoma Forskål, 1775
(Pl. VI figs. 1, 2; Pl. VII fig. 1; textfigs. 7-9)

Corallum forming plate-like growths which on their growing edges show numerous branches. As a rule these branches have rounded tops. They may unite to form plates full of openings or to form nearly compact plates. Generally the colonies originate as a regular network with equal meshes which in the older parts gradually become filled. The surface of the corallum is even, the pores as a rule are distinct.

In the Leiden Museum there is a large specimen which in its growth form is entirely different from the usual shape in the species (Pl. VII fig. 1). It is surprisingly similar to certain specimens of *Millepora alcicornis.* As it undoubtedly is from the Red Sea it cannot be anything else but a specimen of *Millepora dichotoma.*

Millepora squarrosa Lamarck, 1816
(Pl. VIII; Pl. IX)

Corallum forming upstanding thin plates with numerous lateral expansions which among each other are united to form a more or less honeycombed complex. The surface of the corallum besides the larger lateral outgrowths presents numerous crests and tubercles, giving the corallum a frilled appearance. Between the ridges and tubercles the surface of the corallum is even or showing shallow depressions each with a central gastropore.

Millepora complanata Lamarck, 1816
(Pl. VII fig. 2; textfigs. 2 *a*, *b*, 11)

Corallum consisting of thin upstanding plates growing out from a common basal part. The plates are of various breadth and height, as a rule they have a truncated free edge. Surface of the corallum very smooth and even. The minute structure of the surface may be flat or may present insignificant depressions in the centres of which there are the gastropores.

Millepora platyphylla Hemprich & Ehrenberg, 1834
(Pl. II figs. 1, 2; Pl. IV fig. 2; Pl. V figs. 2, 3; Pl. XV figs. 4, 5; textfig. 19)

Corallum forming compact and thick upstanding plates which among each other have a tendency to unite as a honeycombed mass. The surface of the corallum may be smooth and even, or may be covered with warts which originally each bear a central gastropore. Pores very distinct.

Millepora intricata Milne Edwards, 1857
(Pl. III figs. 1-3; Pl. X)

Corallum forming rather loosely arranged but compact masses of thin and slender branches which mutually are repeatedly united to form a complicated mass of branches in all directions. Surface of the corallum very smooth and even. Pores very small and indistinct.

Millepora murrayi Quelch, 1884
(Pl. II figs. 1, 2; Pl. XI figs. 1, 2; Pl. XV figs. 1, 3)

Corallum forming rather compact masses of branches in chiefly two directions. The erect stems have lateral branches which in the shape of ogives project sideways. Both parts of the corallum bear smaller branches which grow out vertically and have rather acutely pointed tips. Surface of the corallum smooth and even. Pores as a rule rather small.

Millepora tenella Ortmann, 1892
(Pl. XII figs. 1, 2; Pl. XIII figs. 1-3; Pl. XIV figs. 1, 2; Pl. XV fig. 2; textfigs. 3-5, 12, 13)

Corallum forming more or less plate-like growths consisting of fan-like spreading branches which at their extremities as a rule are more or less truncated. The plate-like growths may expand chiefly in one direction, or they may occur in various planes. The individual branches may remain more or less distinct, or they may largely unite to broad expansions of the corallum. Surface of the corallum even, pores as a rule distinct.

Millepora latifolia nov. spec.
(Pl. III figs. 1-3; Pl. IV fig. 1; textfig. 1)

Corallum consisting of plate-like growths arisen from the fusion of erect branches with pointed tips. The corallum may form expansions in the shape of ogives, which again possess numerous erect smaller branches. The majority of the branches are in one plane, the plates may have some lateral branches more or less perpendicular to the chief plane. Surface of the corallum comparatively smooth and even. Pores distinct and fairly large.

Type specimen: a plate-like growth with a height of 18 cm, a breadth of $14^1/_2$ cm, and a thickness (in its basal region) of about 1 cm, in Rijksmuseum van Natuurlijke Historie, Leiden (fig. 1).

Type locality: Island Noordwachter, Java Sea.

A few specimens collected on the reefs of the islands Noordwachter and Edam belong to this new species. They may be described here in some more detail.

In the type specimen (fig. 1) nearly all the branches have united to form a rather compact plate, there is only one opening of fairly large size left in the middle region of the marginal part. Some branches have broken off. The colony in one part has an expansion in the shape of an ogive. In the upper region of the side which is not represented in the figure there are a few small branches which are more or less perpendicular to the chief plane of the colony.

The specimen of Pl. III fig. 1 is the topmost part of another plate-like growth of the same colony. It shows the manner of branching in the growing edge and the way in which the branches become united in the older parts of the colony. The other side of the same specimen is, somewhat foreshortened, represented on Pl. III fig. 2. The enlarged figure (Pl. III fig. 3) shows the comparatively large pores.

The specimen of Pl. IV fig. 1 is from the reef of the island Edam. It is figured on a reduced scale, its dimensions are: height 21 cm, breadth $12^1/_2$ cm, and thickness about 1 cm (in its basal region). The growth form is similar to that of the type specimen. Here again there are in the marginal region a great number of parallel erect branches with more or less pointed tips, which in the older parts of the colony are largely united. In one part

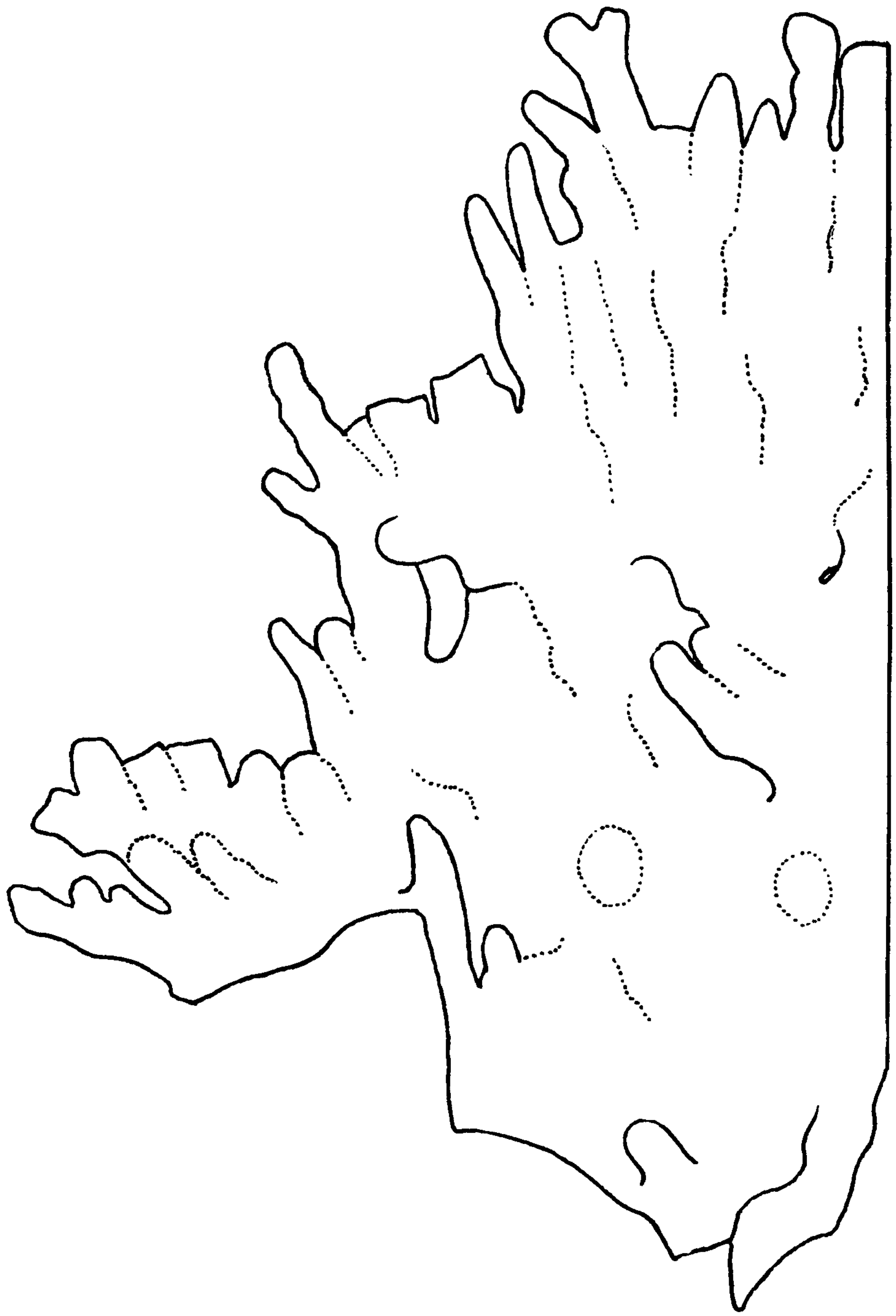

Fig. 1. Outline of the type specimen of *Millepora latifolia* nov. spec. from the Island Noordwachter. Natural size.

there is a branch in the shape of an ogive which again bears numerous smaller branchlets. The surface of this specimen is rather uneven on account of the great number of barnacles which have given rise to as many warts.

In its manner of growth *Millepora latifolia* bears some resemblance to *M. dichotoma*. The young branches, however, have quite a different mode of growth in the two species, and the extremities of the branches are very unlike: pointed in *M. latifolia* and rounded in *M. dichotoma*.

Moreover *Millepora latifolia* in many respects is resembling *M. murrayi*. In both species the corallum consists of erect stems or plate-like growths which have a tendency to spread by branches in the shape of ogives, whilst on all parts of the corallum there are numerous smaller vertical branchlets with pointed tips. The two species, however, are entirely different in their general manner of growth, as the colonies of *M. latifolia* consist of a number of more or less isolated plate-like growths, and colonies of *M. murrayi* form more compact masses in which the various parts mutually are rather narrowly united.

IV. SYNONYMY AND GEOGRAPHICAL DISTRIBUTION

Millepora alcicornis Linnaeus, 1758

? *Corallium asperum candicans adulterinum* Bauhinus, Cherlerus, Chabraeus & a Graffenried, 1651 [1].

Corallium asperum candicans adulterinum Sloane, 1707 [2].

? *Corallium album fragile polyschides ramusculis aequalibus contiguis dumosum* Morison, 1715 [3]

? *Corallium albidum latum & compressum ad extrema tantum ramosum, sive Corallium spurium ex variis quasi tegumentis sibi invicem incumbentibus conflatum* Morison, 1715 [4].

? *Corallium albidum digitatum, ramis hinc inde contiguis ad latitudinem dispositis* Morison, 1715 [5].

? *Millepora Alcicornis* Linnaeus, 1758 [6].

? *Millepora alcicornis* α 1, α 2 Pallas, 1766 [7].

Millepora alcicornis β Pallas, 1766 [8].

Millepora alcicornis δ Pallas, 1766 [9].

? *Millepora alcicornis* Linnaeus, 1767 [10].

Tab. A VI fig. 3 Knorr, 1771 [11].

? *Millepora alcicornis* Gmelin, 1789 [12].

Millepora alcicornis var. α *digitata* Esper, 1790 [13].

Millepora alcicornis var. α 2 *corniculata* Esper, 1790 [14].

Millepora alcicornis var. β *ramosa* Esper, 1790 [15].

? *Millepora alcicornis* var. δ *crustacea* Esper, 1790 [16].

Millepora alcicornis var. Esper, 1796 [17].

Millepora alcicornis Lamarck, 1816 [18].

Millepora alcicornis Guérin-Méneville, 1829-1843 [19].

Palmipora alcicornis Blainville, 1834 [20].

Millepora alcicornis Deshayes & Milne Edwards, 1836.

Millepora alcicornis Milne Edwards, 1836-1849 [21].
Millepora alcicornis Dana, 1848 [22].
Millepora moniliformis Dana, 1848 [23].
Millepora ramosa Dana, 1848 [24].
Millepora pumila Dana, 1848, 1849 [25].
Palmipora alcicornis Duchassaing, 1850.
Palmipora fasciculata Duchassaing, 1850 [26].
Palmipora parasitica Duchassaing, 1850 [27].
Millepora alcicornis Dana, 1859.
Millepora moniliformis Dana, 1859.
Millepora ramosa Dana, 1859.
Millepora pumila Dana, 1859.
Millepora alcicornis Milne Edwards, 1860.
Millepora Forskali Milne Edwards, 1860.
Millepora pumila Milne Edwards, 1860.
Millepora fasciculata Milne Edwards, 1860.
Millepora ramosa Milne Edwards, 1860.
Millepora moniliformis Milne Edwards, 1860.
Millepora alcicornis Duchassaing & Michelotti, 1860, 1864.
Millepora ramosa Duchassaing & Michelotti, 1860, 1864.
Millepora fasciculata Duchassaing & Michelotti, 1860, 1864 [26].
Millepora pumila Duchassaing & Michelotti, 1860, 1864.
Millepora moniliformis Duchassaing & Michelotti, 1860, 1864.
Millepora gothica Duchassaing & Michelotti, 1860, 1864.
Millepora Schrammi Duchassaing & Michelotti, 1864.
Millepora Esperi Duchassaing & Michelotti, 1864.
Millepora crista-galli Duchassaing & Michelotti, 1864 [28]
Millepora delicatula Duchassaing & Michelotti, 1864.
Millepora candida Duchassaing & Michelotti, 1864.
Millepora digitata Duchassaing & Michelotti, 1864.
Millepora carthaginiensis Duchassaing & Michelotti, 1864.
Millepora Trinitatis Duchassaing & Michelotti, 1864.
Millepora fenestrata Duchassaing & Michelotti, 1864.
Palmipora parasitica Duchassaing & Michelotti, 1864.
Millepora alcicornis Verrill, 1864.
Millepora moniliformis Verrill, 1864 [29].
Millepora pumila Verrill, 1864.
Millepora nitida Verrill, 1868 [30].
Millepora alcicornis var. *cellulosa* Verrill, 1868.
Millepora alcicornis var. *digitata* Verrill, 1868.
Millepora alcicornis var. *fenestrata* Verrill, 1868.
Millepora Schrammi Duchassaing, 1870.
Millepora Esperi Duchassaing, 1870.
Millepora Ramosa Duchassaing, 1870.
Millepora Pumila Duchassaing, 1870.
Millepora Crista-galli Duchassaing, 1870.
Millepora Delicatula Duchassaing, 1870.
Millepora Candida Duchassaing, 1870.
Millepora Fasciculata Duchassaing, 1870.
Millepora Alcicornis Duchassaing, 1870.
Millepora Digitata Duchassaing, 1870.
Millepora Carthaginiensis Duchassaing, 1870.
Millepora Trinitatis Duchassaing, 1870.

Millepora Fenestrata Duchassaing, 1870.
Millepora Gothica Duchassaing, 1870.
Millepora alcicornis Pourtalès, 1871 [31].
Millepora ramosa Pourtalès, 1871 [32].
Millepora alcicornis Dana, 1872 [33].
Millepora alcicornis Verrill, 1872.
Millepora moniliformis Verrill, 1872 [29].
Millepora ramosa Verrill, 1872.
Millepora pumila Verrill, 1872.
Millepora alcicornis Moseley, 1876 [34].
Millepora ramosa, Moseley, 1879 [34].
Millepora alcicornis Agassiz, 1880 [35].
Millepora alcicornis Quelch, 1886 [36].
Millepora carthaginiensis Quelch, 1886 [37].
Millepora ramosa Quelch, 1886 [38].
Millepora alcicornis Hickson, 1898 *a* [39].
Millepora alcicornis Verrill, 1901.
Millepora nitida Verrill, 1901.
Millepora alcicornis var. *cellulosa* Verrill, 1901.
Millepora alcicornis var. *digitata* Verrill, 1901.
Millepora alcicornis var. *fenestrata* Verrill, 1901.
Millepora alcicornis digitiform variety Vaughan, 1902.
Millepora alcicornis Gardiner, 1912 [40].
Millepora alcicornis Gardiner, 1931 [41].
"*Palmipora fasciculata*" Dollfus, 1936.
Montipora gothica Dollfus, 1936.
Millepora alcicornis digitate form Butsch, 1939.
Millepora sp. Wolcott, 1940 [42].

NOTES

1. Locality unknown. The specimen described by Bauhinus c.s. certainly is a coral, as they remark: "Substantia interna minutissimis poris pertusa est, & quam externa facies albicantior." and "Omnium maxime lapideum hoc Corallium esse videtur." (l.c., p. 806). The figure (cf. the present paper, Pl. I fig 1) probably represents a *Millepora,* the growth form may be that of the highly variable *alcicornis* or of *intricata.*

2. From Jamaica. Three specimens are figured. Tab. 17 fig. 1 shows a fragment of a corallum with comparatively thick, strongly united branches, Tab. 18 fig. 1 shows the form which in later years was described as *crustacea, moniliformis,* and *parasitica,* Tab. 19 shows two figures of a bottle overgrown by *Millepora* with short divided branches.

3. Locality unknown. The figure in the present paper (Pl. I fig. 2) is a copy of Tab. 10 fig. 24 of sectio 15 in Morison (1715). The figure probably is of one of the delicately branched forms of *alcicornis,* but it is not impossible that the specimen belonged to *intricata.*

4. Locality unknown. The figure in the present paper (Pl. I fig. 3) is copied from Tab. 10 fig. 26 of sectio 15 in Morison (1715). If it represents a *Millepora* it is the form of *alcicornis* described as *gothica,* or it belongs to *murrayi.* But it is far more probable that the specimen was not at all a *Millepora.* Instead of the minute pores as they occur in *Millepora* the specimen shows pores of a fairly large size so that the figure in this respect strongly reminds of a branched species of *Porites.* The growth form is very similar to that of certain species of *Montipora,* though in this genus the calices are not so large that they would have been represented as in the figure. As Morison's other figures (24 and 27) undoubtedly were made after specimens

of *Millepora* the aberrant structure of his figure 26 is not accidental, it proves that this figure represents quite another coral, in all probability a *Porites*.

5. Locality unknown. The figure in the present paper (Pl. I fig. 4) is a copy of Tab. 10 fig. 27 of sectio 15 in Morison (1715). The figure probably represents one of the strongly branched forms of *alcicornis*, but it is not altogether impossible that it was made after a specimen of *intricata*, as it also shows characters of that species.

6. Linnaeus's diagnosis is too vague to give any certainty concerning the identity of his species. He gives one reference only, namely Morison's *Corallium albidum latum & compressum ad extrema tantum ramosum*. As shown above this in all probability represents a *Porites*, so that Linnaeus's *Millepora Alcicornis* would be an entirely different species from the *M. alcicornis* of the various authors after Linnaeus (1758), including Linnaeus (1767). On the other hand the trivial name *"alcicornis"* must have a meaning. If this name only is regarded as a characteristic designation of the species meant by Linnaeus, it undoubtedly represents the West Indian form for which in the present paper the specific name *Millepora alcicornis* is restricted. Corals of the genus with branches reminding in shape of minute elk's horns are found in the West Indies only, a typical example of such a coral was figured by Dana (1872). Linnaeus in all probability must have had specimens in mind with branches of this form, inducing him to select the name *alcicornis* for the species.

7. No locality given.

8. According to Pallas "ex M. Americano".

9. According to Pallas "in Mari Antillarum frequentissima".

10. As synonyms Linnaeus lists here the *Corallium asperum candicans adulterinum* of Bauhinus c.s., and the *Corallium album fragile polyschides* of Morison; of the latter Linnaeus cites the figures 24 and 27, which undoubtedly represent specimens of *Millepora*. Fig. 26 of Morison on which Linnaeus's diagnosis of 1758 was based, is not cited here. Whilst therefore Linnaeus's *Millepora Alcicornis* of 1758 in reality is not a *Millepora* (unless the choice of the trivial name proves that the West Indian branched form was meant), his *Millepora alcicornis* of 1767 undoubtedly belongs to the genus, and probably is the West Indian digitiform species.

11. The copy of this work which was at my disposal contains the plates only. The specimen represents the form which later was described as *crustacea*, or *moniliformis*, or *parasitica*, on a branch of a Gorgonian.

12. The concept of the species is largely the same as that of Linnaeus (1767). As in the latter publication the figures 24 and 27 only are cited from Morison's work.

13. According to Esper from the southern American islands, and especially from Curaçao and St. Eustatius. Duchassaing & Michelotti were the first to list this form as a species, *Millepora digitata*.

14. Esper remarks that this variety comes from the same localities as his variety *digitata*.

15. Esper states that this variety came from the American coasts. Dana (1848) was the first to regard this form as a species. The name *Millepora ramosa* Dana, 1848, however, is preoccupied by *Millepora ramosa* Fleming, 1828 (fide Sherborn, 1930, p. 5425).

16. According to Esper this variety is from the East Indian coasts. The specimen is, however, growing on *Rhipidogorgia flabellum* (L.), a West Indian species. Moreover Esper identifies his var. *crustacea* as the form indicated with δ by Pallas, of which Pallas remarks: "in Mari Antillarum frequentissima". The form has not been recorded as a species. The name *crustacea* Esper, 1790, is preoccupied by *Millepora crustacea* Linnaeus, 1758, from the Mediterranean (probably belonging to the algae).

17. From the West Indies. Esper's Tab. XXVI: a stone overgrown with a layer of *Millepora* from which divided branches take their origin.

18. Locality: "l'océan des Antilles".

19. With a figure (Pl. 3 fig. 11) of the specimen represented by Blainville (1834).
20. The figure (Pl. LVIII fig. 2) represents the branched West Indian form.
21. With a very good figure (Pl. 89 fig. 1). The explanation of this figure reads: "Fig. 1. Millépore corne d'élan, *Millepora alcicornis,* Lin. De grandeur naturelle, d'après l'échantillon décrit par Lamarck et appartenant à la collection du Muséum". The specimen forms an upstanding plate which in its marginal region shows a great number of short branches. The size of the branches indicates, in connection with the general form of growth, that it can be nothing else but the West Indian *Millepora alcicornis.* It is interesting to note that in the figure of the strongly enlarged part of the surface (l.c., fig. 1 b) the gastropores and some of the dactylopores are distinctly stellate. Milne Edwards (1860, p. 228), in the synonymy of his species *Millepora forskali,* cites the figures of *M. alcicornis* in the Atlas of the Règne Animal as representing *M. forskali,* but gives as locality the Red Sea.
22. From the West Indies.
23. From the West Indies, "incrusting Gorgoniae". The name *moniliformis* Dana, 1848, is preoccupied by *Millepora moniliformis* Rafinesque, 1820 (fide Sherborn, 1928, p. 4138).
24. Probably from the West Indies.
25. From the harbour of Carthagena, East coast of South America. The name *pumila* Dana, 1848, is preoccupied by *Millepora pumila* Pallas, 1766, form the Mediterranean (probably belonging to the algae).
26. From the Antilles. *Palmipora fasciculata* Duchassaing was later mentioned by Duchassaing & Michelotti (1860, 1864) as *Millepora fasciculata.* The latter name is preoccupied by *Millepora fasciculata* Lamarck, 1816, placed by its author among the Nullipores.
27. From the Antilles, "Gorgonias incrustans".
28. The name *crista-galli* Duchassaing & Michelotti, 1864, is preoccupied by *Millepora crista galli* Morren, 1828 (fide Sherborn, 1925, p. 1636).
29. Verrill regards *moniliformis* as a form of *alcicornis.*
30. From the Abrolhos Reefs.
31. Pourtalès regards as synonyms: *alcicornis* Pallas α 1 and α 2, *alcicornis* Esper α and α 2, *alcicornis* Dana, *alcicornis* Duch. & Mich., *crista-galli* Duch. & Mich., *delicatula* Duch. & Mich., and *schrammi* Duch. & Mich.
32. According to Pourtalès this may be a distinct species, differing from *alcicornis.*
33. The figure on p. 103 shows a specimen with more or less elk -horn shaped branches.
34. From Bermuda.
35. A very good figure on Pl. 20.
36. Specimens from St. Thomas and from Bermuda.
37. From St. Thomas.
38. From Bermuda.
39. Specimens from the West Indies.
40. With a reproduction of the figure of Agassiz (1880).
41. The figure (Pl. XII fig. 1) in some respects reminds of typical Red Sea specimens of *Millepora dichotoma,* as the corallum consists of vertical plates showing the network as commonly found in that species. The plates, however, are not parallel, so that probably the colony is one of the several growth forms of the so highly variable *M. alcicornis.*
42. Fig. 71 A shows the West Indian branched form: "the pepper coral (*Millepora* sp.), often called the stag-horn coral".

Geographical distribution. American seas or American coasts (Pallas, 1766; Esper, 1790); West Indies (Esper, 1790; Dana, 1848; Hickson, 1898 *a*); Antilles (Pallas, 1766; Lamarck, 1816; Duchassaing, 1850; material in Paris Museum and in Amsterdam Museum); Carthagena, Colombia (Dana, 1848; Duchassaing & Michelotti, 1864); Florida (Verrill, 1868; Agassiz, 1880); Jamaica (Sloane, 1707); Haiti (material in Leiden Museum); Porto Rico (Vaughan, 1902); St. Thomas (Duchassaing & Michelotti, 1864; Quelch, 1886); St. Eustatius (Esper, 1790); Guadeloupe (Duchassaing & Michelotti, 1864; Dollfus, 1937; material in Paris Museum); Barbados (Butsch, 1939); Trinidad (Duchassaing & Michelotti, 1864); Curaçao (Esper, 1790; material in Leiden Museum and in Amsterdam Museum); Bermuda (Moseley, 1876, 1879; Quelch, 1886); Pernambuco, Bahia, and Abrolhos Reefs (Verrill, 1868).

Millepora exaesa Forskål, 1775

Millepora exaesa Forskål, 1775 [1].
Millepora alcicornis var. *nodosa* Esper, 1790 [2].
Millepora Clavaria Ehrenberg, 1834 [3].
Millepora clavaria Dana, 1848, 1849.
Millepora tuberculosa Milne Edwards, 1857 [4].
Millepora gonagra Milne Edwards, 1860 [5].
Millepora alicornis var. *nodosa* Milne Edwards, 1860.
Millepora clavaria Milne Edwards, 1860.
Millepora exaesa Klunzinger, 1879 [6].
Millepora exaesa var. *incrustans* Klunzinger, 1879.
Millepora exaesa var. *gonagra* Klunzinger, 1879.
Millepora exaesa var. *clavaria* Klunzinger, 1879.
Millepora nodosa Moseley, 1877 [7].
Millepora nodosa Moseley, 1879 [8].
Millepora nodosa Moseley, 1880 [7].
Millepora nodosa Quelch, 1886 [9].
Millepora gonagra Quelch, 1886 [10].
Millepora exaesa Hickson, 1898 *a* [11].
Millepora alcicornis facies "*esperi*" Hickson, 1898 *b* [12].
Millepora gonagra Hickson, 1899.
Millepora exaesa Faustino, 1927 [13].
Millepora gonagra Faustino, 1927.
Millepora gonagra Eguchi, 1938 [14].
Millepora gonagra Hiro, 1938 [15].
Millepora exaesa Crossland, 1941 [16].

NOTES

1. Red Sea. Types in Copenhagen Museum, reexamined by Crossland (1941).
2. According to Esper locality unknown, but probably from the East Indian seas. Fig. 2 *c* in the present paper shows an outline of the corallum figured by Esper.
3. Red Sea. Belongs undoubtedly here. Ehrenberg notes that it is allied to Esper's *M. alcicornis nodosa*.
4. Described as *gonagra* in 1860.

5. From the Red Sea. Figured as *tuberculosa* in 1857.

6. Red Sea. With excellent, concise description. Synonyms: *exaesa* Forsk., *clavaria* Ehr., *gonagra* M. E. & H.

7. Moseley (1877, p. 117/118) remarks: "The Tahitian species, of which the structure

a

b

c

Fig. 2. Outlines of figures of *Millepora* in 18th century publications. *a*, Knorr, 1771, Tab. A XI fig. 4; *b*, Esper, 1790, Millep. Tab. VIII (*Millepora alcicornis* var. γ *plicata*); *c*, Esper, 1790, Millep. Tab. IX (*Millepora alcicornis* var. *nodosa*). All figures reproduced in half the original size.

is here described, resembles closely in form *M. tuberculosa* (*M. gonagra*) figured by MM. EDWARDS and HAIME. Like this species it never forms foliaceous expansions, but is tuberculate and irregular in shape, and often encrusting, commonly overgrowing the dead fronds of *Lophoseris cactus,* which is a principal component of the Tahitian reefs. The present species seems, however, to differ from *M. tuberculosa* in that its calicles are disposed over the surface of the corallum in well-marked and separated systems, and in this respect is more closely allied to *M. plicata, M. foliata,* and *M. Ehrenbergi* as described by MM. EDWARDS and HAIME." In a note Moseley adds that material of this Tahitian *Millepora* has been identified by Brüggemann as *M. nodosa.*

The passage quoted above occurs in almost the same words in a later publication (Moseley, 1880, p. 13/14).

8. Very common on Tahitian reefs. The figure shows that the form belongs to *exaesa.*

9. From Tahiti.

10. From the Philippine Islands and from Tahiti.

11. From the Red Sea, Dr. von Marenzeller.

12. A specimen from Funafuti, of which Hickson (1898 *b,* p. 829) first remarks: "... agrees most closely with the description given of *Millepora esperi* by Duchassaing and Michelotti". (This is a strongly branched "species" with delicate branches). Hickson adds, however: "The form of the corallum is not unlike that assumed by large specimens of *Alcyonium digitatum,* being thickly palmate with short obtuse and warty branches" (l.c., p. 829/30). Hickson further comments upon the thickness of the corallum, so that the form dealt with here undoubtedly belongs to *exaesa,* it corresponds with Esper's *nodosa.* Possibly Hickson really meant the latter form.

13. Faustino mentions, beside the Philippine Islands, the Red Sea and Tahiti, as locality Kandavu (Fiji Islands).

14. From the Palao Islands.

15. From the Palao Islands. Unless the *Millepora* is an incrustation on a dead piece of another coral, Hiro's figure (Pl. I fig. 3) certainly represents *Millepora exaesa.*

16. Comments upon Forskål's specimens from the Red Sea and description of the species with notes on variation. Figures of three different growth forms on Pl. XII. Crossland regards *Millepora tuberculosa* M. Edw. (*M. gonagra* M. Edw.) as a synonym of *M. exaesa.*

Geographical distribution. Red Sea (Forskål, 1775; Ehrenberg, 1834; Milne Edwards, 1860; Klunzinger, 1879; Hickson, 1898 *a*; Crossland, 1941; material in Paris Museum, in Leiden Museum and in Amsterdam Museum); probably East Indian seas (Esper, 1790); "South Sea" (material in Amsterdam Museum); Philippine Islands (Quelch, 1886; Faustino, 1927); Palao Islands (Eguchi, 1938; Hiro, 1938); Karakalong Islands (Siboga Expedition, Sta. 129); Soela Besi (Siboga Expedition, Sta. 193); Taam (Siboga Expedition, Sta. 252); Funafuti (Hickson, 1898 *b*); Fiji Islands (Faustino, 1927); Tahiti (Moseley, 1877, 1879, 1880; Quelch, 1886); Paumotu Islands (Agassiz, 1903).

There is a specimen of *Millepora exaesa* in the Paris Museum which on its label bears the locality "Iles Sandwich". As Edmondson (1928) remarks that *Millepora* does not occur in the Hawaiian Islands it is improbable that the specimen really is from this locality. Previously also Moseley (1877,

p. 117) remarked that *Millepora* "apparently does not occur at the Sandwich Islands, the water being too cold for it."

Moseley (1877, 1879, 1880) stated that "*Millepora nodosa*" (the name is a synonym of *M. exaesa*) is a very common coral on the Tahitian reefs. It is not mentioned from Tahiti by Crossland (1928), who commented upon the various forms of *Millepora* found on the reefs of this island.

Millepora dichotoma Forskål, 1775

Millepora dichotoma Forskål, 1775 [1].
Millepora cancellata Ehrenberg, 1834 [2].
Millepora reticularis Milne Edwards, 1860 [3].
Millepora cancellata Milne Edwards, 1860.
Millepora dichotoma Klunzinger, 1879 [4].
Millepora dichotoma var. *reticularis* Klunzinger, 1879.
Millepora dichotoma Hickson, 1898 *a* [5].
? *Millepora alcicornis* facies "*ramosa*" Hickson, 1898 *b* [6].
? *Millepora dichotoma* Hickson, 1898 *b* [7].
? *Millepora alcicornis* Hickson, 1898 *b* [8].
Millepora alcicornis facies *dichotoma* Hickson, 1899 [9].
Millepora dichotoma Gravier, 1911 [10].
? *Millepora dichotoma* Barker, 1925 [11].
Millepora dichotoma Crossland, 1941 [12].

NOTES

1. Red Sea. Types in Copenhagen Museum, reexamined by Crossland (1941).
2. Red Sea. Ehrenberg's statement "cancellato-ramosa" proves that the form belongs here.
3. From the Red Sea. The specimens in the Paris Museum show the characters of *dichotoma.*
4. Red Sea. With excellent, concise description. Klunzinger was the first to realize that *reticularis* M. Edw. is a synonym of *dichotoma* Forsk.
5. From the Red Sea, Dr. von Marenzeller. Without any remarks on the form of the specimen, but the locality proves the identity.
6. Specimen from Funafuti. "The stem divides into branches in a vertical plane, which freely anastomose, forming a wide-meshed network 10 inches in height". (Hickson, 1898 *b*, p. 828). This points to *M. dichotoma,* but it is not impossible that the material belonged to *M. tenella.*
7. Hickson states that *M. dichotoma* is regarded as a synonym of *M. ramosa* by some authors.
8. Specimen from Rotuma. "The branches are disposed in a single plane and freely anastomose, their average thickness being about 5 mm" (Hickson, 1898 *b*, p. 831). This points to *M. dichotoma,* but may more or less apply to *M. tenella* too.
9. Hickson, 1899, Pl. XII fig. 1. From New Britain, New Guinea, Loyalty Islands, or "elsewhere". The growth form of the figured specimen reminds strongly of that of many colonies from the Red Sea. The tips of the branches only, which are less rounded than generally in *M. dichotoma,* remind in some way of those of *M. tenella.* The cancellated growth form of the colony, however, excludes the identity with *M. tenella.*
10. From the Gulf of Aden. Gravier (1911, p. 91) gives a very clear and distinct description: "... ils sont formés essentiellement de plaques faisant entre elles un angle

très aigu et soudées par leur base... La partie supérieure, plus mince, est formée par les ramifications dichotomes présentant entre elles de nombreuses soudures qui dessinent des mailles très irrégulières dans la plaque elle-même. Les branches sont généralement un peu aplaties et disposées sensiblement dans un même plan. Quelques rares ramifications sont plus ou moins inclinées sur l'ensemble, parfois presque normales.'

11. From the New Hebrides. Name only. It is quite uncertain whether the specimen belonged to *M. dichotoma* or to *M. tenella.*

12. Comments upon the description and the specimens of Forskål from the Red Sea. With critical regards concerning Vaughan's specimen of "*M. dichotoma*", which in the present paper is regarded as a representative of the species *Millepora tenella* Ortm.

Geographical distribution. Red Sea (Forskål, 1775; Ehrenberg, 1834; Milne Edwards, 1860; Klunzinger, 1879; Hickson, 1898 *a*; Crossland, 1941; material in Paris Museum, in Leiden Museum and in Amsterdam Museum); Gulf of Aden (Gravier, 1911; material in Paris Museum); New Britain group (Hickson, 1899); ?New Hebrides (Barker, 1925); ?Funafuti and ? Rotuma (Hickson, 1898 *b*).

Millepora squarrosa Lamarck, 1816

Millepora squarrosa Lamarck, 1816 [1].
Palmipora squarrosa Blainville, 1834.
Millepora squarrosa Deshayes & Milne Edwards, 1836.
Millepora squarrosa Dana, 1848.
Palmipora squarrosa Duchassaing, 1850.
Palmipora tuberculata Duchassaing, 1850 [2].
Millepora squarrosa Dana, 1859.
? *Millepora folliata* Milne Edwards, 1860 [3].
Millepora squarrosa Milne Edwards, 1860 [4].
Millepora squammosa Milne Edwards, 1860 [5].
? *Millepora foliata* Duchassaing & Michelotti, 1864.
Millepora tuberculata Duchassaing & Michelotti, 1864.
Millepora faveolata Duchassaing & Michelotti, 1864 [6].
Millepora striata Duchassaing & Michelotti, 1864 [7].
? *Millepora Braziliensis* Verrill, 1868 [8].
? *Millepora Foliata* Duchassaing, 1870.
Millepora Tuberculata Duchassaing, 1870.
Millepora Taveolata Duchassaing, 1870.
Millepora Striata Duchassaing, 1870.
Millepora squarrosa Verrill, 1872.
Millepora tuberculata Hickson, 1898 *a*.
Millepora striata Hickson, 1898 *a*.
? *Millepora Braziliensis* Verrill, 1901.
? *Millepora alcicornis* palmate form Butsch, 1939 [9].

NOTES

1. Concerning the locality Lamarck states: "Je le crois des mers de l'Amérique". The growth form is characterized as having "expansions aplaties et subfoliacées". Type

specimen in the Paris Museum (cf. Pl. VIII in the present paper). A specimen in the Leiden Museum, without indication of locality, and with the same characters as the type specimen, is from the West Indies, as it contained a few shells of mollusks peculiar to that region.

2. The "species" *Millepora tuberculata* is figured by Duchassaing & Michelotti (1864, Pl. XI fig. 4). This figure represents a young colony with crowded parallel vertical plates. The edges of the plates are divided into numerous small tips which may be the beginnings of branches. The latter character points to *Millepora alcicornis*, but the growth form in general corresponds more closely with that of *M. squarrosa*.

3. Locality unknown. Milne Edwards (1860, p. 226) gives the following description of the type specimen: "Polypier en touffe composé de grandes feuilles subplanes et dressées, qui sont remarquablement minces près des bords et se divisent en beaucoup de lobes disposés irrégulièrement". The type specimen seems no more to be present in the collections of the Paris Museum, so that I cannot prove its identity with *M. squarrosa*, though the numerous irregularly disposed lobes strongly point in this direction. The name "*folliata*" is a misprint for for "*foliata*", in the index of Milne Edwards's work the latter spelling is given.

4. Locality unknown. The description undoubtedly was made after the large colony in the Paris Museum: "Polypier en touffe composée de feuilles dressées, contournées vers le bord, et donnant naissance à une multitude de crêtes ou de lames verticales, tuberculifères, dont les principales sont coalescentes, de façon à réunir entre elles les feuilles voisines; parfois ces crêtes sont remplacées par des séries de tubercules". (Milne Edwards, 1860, p. 227). A part of this large colony, which certainly may be regarded as Lamarck's type specimen, is represented on Pl. VIII of the present paper.

5. Misprint for *squarrosa*.

6. In the short description the form is characterized as being of a plate-like growth with ridges. It is placed by Duchassaing & Michelotti (1864) in the same group as their *M. striata*. These data point to the identity of *M. faveolata* with *M. squarrosa*.

7. This form undoubtedly belongs to *M. squarrosa*. The figure (Duchassaing & Michelotti, 1864, Pl. XI fig. 8) represents a small fragment of a colony with more or less longitudinal ridges.

8. Verrill's description is rather dubious: "Corallum forming large, irregularly lobed and branched masses, the branches erect, angular or flattened, or forming broad, convoluted and folded, rough plates, with acute edges and summits, the sides covered with sharp, irregular, angular, crest-shaped and conical prominences varying much in size and elevation, often becoming continuous ridges, usually standing at right-angles to the sides of the branches; ..." (l.c., p. 363). Most characters point to the identity with *M. squarrosa*, but it is not impossible that the description refers to a plate-like growth of *M. alcicornis*, as that of Pl. XIV fig. 3 in the present paper.

9. Probably this form belongs to *M. squarrosa*, whilst then Butsch's flabellate form may belong to *M. complanata*. From his notes and figures, however, no definite conclusion can be made.

Geographical distribution. American seas (Lamarck, 1816); Antilles (Duchassaing, 1850); Belize, Honduras (material in Paris Museum); ? Barbados (Butsch, 1939); Curaçao (Duchassaing & Michelotti, 1864); Venezuela (material in Amsterdam Museum); ? Pernambuco and ? Abrolhos Reefs (Verrill, 1868).

Millepora complanata Lamarck, 1816

Millepora alcicornis γ Pallas, 1766 [1].
Tab. A XI fig. 4 Knorr, 1771 [2].
Millepora alcicornis var. γ *plicata* Esper, 1790 [3].
Millepora complanata Lamarck, 1816 [4].
Palmipora complanata Blainville, 1834.
Millepora complanata Deshayes & Milne Edwards, 1836.
Millepora plicata Dana, 1848 [5].
Millepora complanata Dana, 1848.
Palmipora complanata Duchassaing, 1850.
Millepora plicata Dana, 1859.
Millepora complanata Dana, 1859.
Millepora complanata Milne Edwards, 1860.
Millepora plicata Milne Edwards, 1860.
Millepora complanata Duchassaing & Michelotti, 1860, 1864.
Millepora plicata Duchassaing & Michelotti, 1860, 1864.
Millepora rugosa Duchassaing & Michelotti, 1864 [6].
Millepora sancta Duchassaing & Michelotti, 1864 [7].
Millepora Rugosa Duchassaing, 1870.
Millepora Complanata Duchassaing, 1870.
Millepora Plicata Duchassaing, 1870.
Millepora Sancta Duchassaing, 1870.
Millepora plicata Pourtalès, 1871 [8].
Millepora plicata Verrill, 1872.
Millepora complanata Verrill, 1872 [9].
Millepora complanata Hickson, 1898 *a* [10].
Millepora alcicornis variety with flabellate fronds Vaughan, 1902.
Millepora alcicornis forme *plicata* Dollfus, 1936.
? *Millepora alcicornis* flabellate form Butsch, 1939 [11].
Millepora Hyman, 1940 [12].

NOTES

1. No locality given.

2. The copy of this work which was at my disposal contains the plates only. Fig. 2 *a* in the present paper shows an outline of the corallum figured by Knorr.

3. Esper mentions a specimen from Surinam. Esper's figure is represented in outline in fig. 2 *b* of the present paper. Dana (1848) was the first to regard this form as a species, *Millepora plicata*.

4. Lamarck gives as locality: "les mers de l'Amérique". As synonyms Lamarck mentions Morison's fig. 26, adding "non bene" (which is entirely different from Lamarck's *complanata*), Sloane's Pl. 17 fig. 1 (which again is different from Lamarck's *complanata*), Knorr's Pl. A XI fig. 4, and Esper's Pl. 8. The latter two in every respect correspond with Lamarck's *complanata*.

5. Locality not given. Dana's specimen "is a clump of erect folia, some of which are fifteen inches high and six or eight wide, and remarkable for being quite thin, and for two inches from the margin more or less translucent". (Dana, 1848, p. 546). The thinness proves the identity with *M. complanata* or with *M. squarrosa*. Apparently the plate-like growths had a smooth surface, not possessing ridges or tubercles, otherwise the term "translucent" would not have been appropriate. The specimen consequently must have been a *Millepora complanata*.

6. Section C of Duchassaing & Michelotti (1864) embraces the "species ramis

coalescentibus fenestratae vel cancellatae": *M. digitata, M. rugosa, M. carthaginiensis, M. trinitatis,* and *M. fenestrata.* Most of these are forms of *Millepora alcicornis,* but the figure of *M. rugosa* (l.c. Pl. XI fig. 3) shows all the salient characters of *M. complanata.*

7. Duchassaing & Michelotti's note "feuille large et continue" decidedly points to the identity with *M. complanata.*

8. Pourtalès regards as synonyms: *alcicornis* var. γ *plicata* Esper, ? *complanata* of Lamarck, Dana, Milne Edwards and Duchassaing & Michelotti, ? *foliata* of Milne Edwards and Duchassaing & Michelotti, ? *faveolata* Duch. & Mich., *striata* Duch. & Mich., and ? *tuberculata* Duch.

9. Verrill adds: "A variety of plicata. (?)".

10. Specimens from the West Indies.

11. This may be *M. complanata,* and Butsch's palmate form may be *M. squarrosa.* The data are not sufficient to reach a definite decision.

12. The figure (Hyman, 1940, fig. 137) shows the "typical flabellate shape".

Geographical distribution. American seas (Lamarck, 1816); West Indies (Hickson, 1898 *a*); Antilles (Duchassaing, 1850; material in Paris Museum and in Amsterdam Museum); Haiti (material in Leiden Museum); Porto Rico (Vaughan, 1902); Guadeloupe (Dollfus, 1937); Iles des Saintes, off Guadeloupe (Duchassaing & Michelotti, 1864); Barbados (Butsch, 1939); Curaçao (Duchassaing & Michelotti, 1864; material in Amsterdam Museum); Surinam (Esper, 1790).

Millepora platyphylla Hemprich & Ehrenberg, 1834

Millepora complanata Ehrenberg, 1834 [1].
Millepora platyphylla Hemprich & Ehrenberg in Ehrenberg, 1834 [2].
? *Millepora porulosa* Ehrenberg, 1834 [3].
Millepora complanata Darwin, 1842 [4].
Millepora squarrosa β incrassata Dana, 1848, 1849 [5].
Millepora platyphylla Dana, 1848, 1849 [6].
Millepora platyphylla β truncata Dana, 1848, 1849 [7].
? *Millepora porulosa* Dana, 1848.
Millepora verrucosa Milne Edwards, 1857.
Millepora squarrosa var. *incrassata* Dana, 1859.
Millepora platyphylla Dana, 1859.
Millepora Ehrenbergi Milne Edwards, 1860 [8].
Millepora verrucosa Milne Edwards, 1860 [9].
Millepora platyphylla Milne Edwards, 1860.
Millepora Incrassata Milne Edwards, 1860.
Millepora insignis Verrill, 1864 [10].
Millepora platyphylla Verrill, 1872.
Millepora platyphylla Klunzinger, 1879 [11].
Millepora platyphylla var. *glabrior* Klunzinger, 1879 [12].
Millepora verrucosa Forbes, 1885 [13].
Millepora plicata Hickson, 1888 [14].
Millepora plicata Hickson, 1889 [15].
Millepora platyphylla Ortmann, 1892 [16].
Millepora platyphylla var. *verrucosa* Ortmann, 1892 [16].

Millepora plicata Hickson, 1898 *a*.
Millepora verrucosa Hickson, 1898 *a*.
Millepora alcicornis facies "*complanata*" Hickson, 1898 *b* [17].
Millepora alcicornis facies "*plicata*" Hickson, 1898 *b* [18].
Millepora alcicornis facies *complanata* Hickson, 1899 [19].
Millepora alcicornis facies *verrucosa* Hickson, 1899 [20].
Millepora alcicornis facies *nodosa* Hickson, 1899 [21].
Millepora verrucosa Kirkpatrick, 1902.
Millepora complanata Wood-Jones, 1907, 1910 [22].
? *Millepora verrucosa* Wood-Jones, 1907, 1910 [23].
Millepora platyphylla Vaughan, 1918 [24].
Millepora truncata Vaughan, 1918, 1919 [25].
Millepora truncata Mayor, 1924 [26].
Millepora truncata Barker, 1925.
Millepora truncata Hoffmeister, 1925 [27].
Millepora platyphyllia Hoffmeister, 1925 [27].
Millepora incrassata Hoffmeister, 1925 [27].
Millepora of the facies *truncata* Crossland, 1927 [28].
Millepora of the honeycomb facies Crossland, 1927 [28].
Millepora alcicornis facies *truncata* Crossland, 1928 [29].
Millepora "*platyphylla*" Umbgrove, 1928 [30].
Millepora "*truncata*" Umbgrove, 1928 [31].
Millepora truncata Hoffmeister, 1929 [32].
Millepora alcicornis Crossland, 1931 [29].
Millepora platyphylla Yabe & Sugiyama, 1933 [33].
Millepora truncata Yabe & Sugiyama, 1933, 1935 *a, b* [34].
Millepora cfr. *platyphyllia* Yabe & Sugiyama, 1935 *a, b* [35].
Millepora sp. Sewell, 1935 [36].
Millepora complanata Sewell, 1936 [37].
Millepora alcicornis forma *platyphylla* Boschma, 1936 [38].
Millepora cf. *platyphylla* Yabe & Sugiyama, 1937 [39].
Millepora truncata Yabe & Sugiyama, 1937 [39].
Millepora truncata Hiro, 1938 [40].
Millepora platyphylla Crossland, 1941 [41].
Millepora form *truncata* Crossland, 1948.

NOTES

1. From the Red Sea. The description proves that *platyphylla* is meant.
2. From the Red Sea. Is not strongly different from Ehrenberg's *complanata,* for he remarks (l.c., p. 125): "An rectius *complanatae* varietas β?".
3. From the Red Sea. Ehrenberg remarks: "an rectius *M. complanata* γ?", which points to the identity with *platyphylla.* The word "subreticulatis" in the diagnosis, however, might be an indication that *porulosa* is a synonym of *dichotoma* Forsk.
4. From the Cocos Keeling Islands and from the Maldives. Darwin states that it grows in thick vertical plates, intersecting each other at various angles, forming an exceedingly strong honey-combed mass.
5. From the Paumotu Archipelago. In 1859 Dana lists this form still as "var. *incrassata*". It was given the rank of species, *Millepora incrassata,* by Milne Edwards (1860).
6. Dana's specimens came from the Fiji Islands.
7. From the Fiji Islands. The first record of *Millepora truncata* as a species is by Vaughan (1918). *Millepora truncata* Vaughan, 1918, as well as Dana's name of

the variety *truncata*, are preoccupied by *Millepora truncata* Pallas, 1766, from the Mediterranean (probably belonging to the algae).

8. Red Sea. Has the characters of "*verrucosa*": "... une multitude de petites bosselures mammillaires qui sont souvent diposées en séries rameuses et qui portent chacune un calice principal entouré d'un cercle de cinq ou six calices plus petits; ..." (Milne Edwards, 1860, p. 226).

9. From the Seychelles and from the Red Sea. The name was already given in 1857 in the explanation of the figure. The name *verrucosa* Milne Edwards, 1857, is preoccupied by *Millepora verrucosa* Meuschen, 1787 (fide Sherborn, 1902, p. 1038).

10. From the Kingsmill Islands. Description of the corallum: "Corallum forming large, meandering plates, giving off smaller plates at right angles to their surface; the edges are thick, obtuse, often lobed, and sometimes divided into short, irregular branches, obtuse at the ends; surface irregular, covered with small verrucae". (Verrill, 1864, p. 59).

11. With excellent, concise description. Synonyms: *platyphylla* Ehr., ? *platyphylla* Dana, *verrucosa* M. E. & H., *complanata* Ehr. (? non Lamk.), *Ehrenbergi* M. E. & H.

12. Synonyms: *ehrenbergi* M. E. & H., *complanata* Ehr.

13. From the Cocos Keeling Islands, identified by Ridley and Quelch.

14. From Talisse Island, North Celebes. "... seems to correspond very closely with the *M. plicata* of Milne Edwards". (Hickson, 1888, p. 193).

15. From North Celebes. "... in the form of four leaves or plates with their upper edges slightly turned over towards the deeper water". (Hickson, 1889, p. 128).

16. From Dar es Salaam. Ortmann remarks that the Strasbourg Museum has a specimen of the var. *verrucosa* from Mauritius.

17. From Funafuti.

18. From Rotuma.

19. Hickson, 1899, Pl. XII fig. 2, Pl. XIII fig. 3, Pl. XIII fig. 4. The latter is a typical *platyphylla*, the former two are somewhat divided at their free margins. From New Britain, New Guinea, Loyalty Islands, or "elsewhere".

20. Hickson, 1899, Pl. XV fig. 8. From New Britain, New Guinea, Loyalty Islands, or "elsewhere".

21. Hickson, 1899, Pl. XIV fig. 6, Pl. XV fig. 7. A specimen according to Hickson consisting partly of *complanata*, of *verrucosa*, and of *nodosa*. The part named by Hickson "*verrucosa*" has the appearance of *nodosa* M. Edw., but is an incrustation over another coral. The part named "*nodosa*" is similar to the specimen of *verrucosa* of Hickson's Pl. XV fig. 8. From New Britain, New Guinea, Loyalty Islands, or "elsewhere".

22. From the Cocos Keeling Islands. "*Millepora* Colony of the Type named *complanata*." (Wood-Jones, 1910, fig. 34).

23. From the Cocos Keeling Islands. Perhaps Wood-Jones used the name *verrucosa* for *M. nodosa*, a synonym of *M. exaesa* (as Hickson, 1899), as he distinguishes the growth form *verrucosa* from *complanata*.

24. Wood-Jones's specimen of "*complanata*" from the Cocos Keeling Islands.

25. From Murray Island (Australia).

26. From Samoa. Specimen with more or less lobate free margin.

27. From Samoa. Hoffmeister remarks that *truncata* Dana is the same as "*platyphyllia*" Dana, the latter being different from "*platyphyllia*" Ehrenberg. As far as concerns *truncata* it is stated: "The species is similar to *M. incrassata* Dana, but differs from it by its smaller gastropores". (Hoffmeister, 1925, p. 82).

28. From the Marquesas Islands.

29. Crossland writes that in Tahiti *Millepora alcicornis* grows in five facies: (1) simple incrustations, (2) incrustations with upright spatulate branches, the facies named *truncata*, (3) foliose branches, (4) plates forming a honeycomb facies, (5)

amorphous masses of small size. Facies (4) indicates favourable conditions. Probably all these facies mentioned by Crossland belong to *M. platyphylla,* of which then facies (4) is the typical growth form. The specimens present considerable variety in shape, as Crossland's figures show. The explanation of the figures in Crossland's 1928 paper contains a number of errors; a corrected explanation of these figures is given in a later paper (Crossland, 1931). Of the two specimens of Crossland's fig. 10, corals from the surf-swept reef-edge, the left was partially sheltered in a cranny and began to send up plates; this specimen has already the typical growth form of *M. platyphylla.* The right specimen of fig. 10 is an amorphous crust. Fig. 11 represents the leafy form from the lagoon. Its base is an incrustation over a dead *Acropora,* the free ends are growing out in the typical manner of *M. platyphylla.* At first sight the colony reminds somewhat of *M. dichotoma,* but the branching form clearly is the result of the uncommon substratum. The explanation of fig. 12 (in 1931) reads: "A second lagoon form, growing in the form of upright plates. This specimen has been partly killed by the accumulation of sand, and the edge is changing to a leafy form." The reduction in size of the specimen of fig. 12 is not indicated. In all probability it is again a *M. platyphylla.* Fig. 14, which shows a specimen reduced to a scale somewhat more than one third of the original size, on account of this reduction again appears to present some likeness to *M. dichotoma.* In the left half of the figure the branching mode of growth prevails, in the right half there is a strong tendency for the formation of broader plates. In all probability this leafy form from the lagoon too is a specimen of *M. platyphylla.* It has developed in much quieter water than the typical form of this species (which is found especially on the edge of the reef in the strong surf).

In the text of the later paper an important note is given concerning the comparison of the Millepores in Tahiti with those of the Red Sea (Crossland, 1931, p. 353): "It seems, too, that variability is specially great in Tahiti — compare the monospecific genus *Millepora.* In the Red Sea I found only three forms: (1) thin parallel netted plates, of a yellow-brown colour, and (2) solid irregular plates, resembling the *M. platyphyllia* from Cocos Keeling Atoll figured by Vaughan (1918, pl. 93), but never attaining the size given by Wood-Jones, and always of a light greenish-grey colour; (3) honeycomb facies, with no intermediates. Here in Tahiti the genus is far more variable, comprising the four distinct forms I have already described, and a fifth, massive form, while intermediates between all five are easily found." As far as concerns the Red Sea forms of *Millepora,* Crossland (1941) distinguishes the three species *M. dichotoma* (the parallel netted plates), *M. exaesa* (a nodose form not mentioned above), and *M. platyphylla* (the form with solid plate-like growth). The "honeycomb facies" here is no more mentioned separately, Crossland (1941) remarks that the vertical plates when fully grown may form a sort of gigantic irregular honeycomb.

30. Bay of Batavia. Name given to the larger colonies of plate-like growth.

31. Bay of Batavia. Name given to the smaller colonies of plate-like growth.

32. From Tahiti.

33. From the Borodino, Bonin, and Ryukyu Islands, and Formosa.

35. From the Bonin and the Ryukyu Islands.

36. From the Nicobar Islands. The colonies are described as "a branching plate-like growth" (Sewell, 1935, p. 493).

37. From Horsburgh or Goifurfehendu Atoll, Maldive Islands.

38. From the Bay of Batavia.

39. From the Japanese region.

40. From the Palao Islands.

41. From the Red Sea.

Geographical distribution. Red Sea (Ehrenberg, 1834; Milne Edwards, 1860; Klunzinger, 1879; Crossland, 1941; material in Paris Museum and in Leiden Museum); Dar es Salaam (Ortmann, 1892); Seychelles (Milne Edwards, 1860); Maldive Islands (Darwin, 1842; Sewell, 1936); Nicobar Islands (Sewell, 1935); Cocos Keeling Islands (Darwin, 1842; Forbes, 1885; Wood-Jones, 1907, 1910; Vaughan, 1918); Bay of Batavia (Umbgrove, 1928; Boschma, 1936; material in Leiden Museum); Soela Besi (Siboga Expedition, Sta. 193); Saleyer (Siboga Expedition, Sta. 213); Binongka (Siboga Expedition, Sta. 219); Soembawa (Siboga Expedition, Sta. 313); North Celebes (Hickson, 1888, 1889); Moluccas (material in Leiden Museum); Palao Islands (Hiro, 1938); Murray Island, Australia (Vaughan, 1918, 1919); New Britain group (Hickson, 1899); New Hebrides (Barker, 1925); Funafuti (Gardiner, 1898; Hickson, 1898 *b*); Rotuma (Hickson, 1898 *b*); Fiji Islands (Dana, 1848); Samoa (Mayor, 1924; Hoffmeister, 1925); Kingsmill Islands (Verrill, 1864); Solomon Atoll, Chagos Islands (Gardiner, 1936); Tahiti (Crossland, 1928; Hoffmeister, 1929); Paumotu Islands (Dana, 1848); Marquesas Islands (Crossland, 1927, 1948); Borodino Isands, Bonin Islands, Ryukyu Islands, Japanese region (Yabe & Sugiyama, 1933, 1935 *a*, 1935 *b*, 1937).

Millepora intricata Milne Edwards, 1857

Millepora intricata Milne Edwards, 1857, 1860 [1].
Millepora intricata Verrill, 1864 [2].
Millepora intricata Quelch, 1886 [3].
Millepora ramosa Saville-Kent, 1893 [4].
Millepora intricata Faustino, 1927.
Millepora intricata Thiel, 1933 [5].

NOTES

1. Locality unknown. The type specimen, a fairly large colony in the Paris Museum, was excellently described by Milne Edwards (1860, p. 229/30): "Polypier très-rameux, en touffes irrégulières. Les branches subcylindriques, divergentes dans tous les sens et se confondant aux points de rencontre, de façon à former un assemblage inextricable de réticulations; et à ne pas donner naissance à des lames frondiformes. Calices très-petits. Branches ayant généralement environ 5 millimètres de large sur 4 d'épaisseur."
2. From the Philippine Islands.
3. From Amboina.
4. From the Great Barrier Reef of Australia. "This species may be readily distinguished by the more slender, cylindrical, contour of its closely-crowned ramifications, and by its thick, bush-like habit of growth, as compared with the compressed palmate growth-plan of *Millepora alcicornis.*" (Saville-Kent, 1893, p. 19). Cf. l.c., pl. X no. 1. (Saville-Kent's *M. alcicornis* is *M. tenella*).
5. From the Philippine Islands.

Geographical distribution. Sumatra (material in Leiden Museum); Brandewijnsbaai, Sumatra (material in Amsterdam Museum); Noordwachter, Java Sea (material in Leiden Museum); Philippine Islands (Verrill, 1864; Faustino, 1927; Thiel, 1933); Moluccas (material in Leiden Museum); Amboina (Quelch, 1886; material in Leiden Museum); Saleyer (Siboga Expedition, Sta. 213); Koer (Siboga Expedition, Sta. 250); Great Barrier Reef, Australia (Saville-Kent, 1893); Caroline Islands (material in Leiden Museum).

Millepora murrayi Quelch, 1884

Millepora murrayi Quelch, 1884 [1].
Millepora murrayi Quelch, 1886 [2].
Millepora confertissima Quelch, 1886 [3].
Millepora murrayi Hickson, 1898 *a* [4].
? *Millepora alcicornis* Hoffmeister, 1925 [5].
Millepora murrayi Faustino, 1927.
Millepora cfr. *confertissima* Yabe & Sugiyama, 1935 *b* [6].
Millepora alcicornis forma *dichotoma* Boschma, 1936 [7].
Millepora confertissima Yabe & Sugiyama, 1937 [6].
Millepora confertissima Eguchi, 1938 [8].
Millepora confertissima Hiro, 1938 [8].

NOTES

1. First description of the ampullae of *Millepora*.
2. From the Philippine Islands. According to Quelch the species is closely allied to *M. tortuosa* from the Fiji Islands, but can be easily distinguished from it.
3. From Ternate.
4. From Torres Strait.
5. From Samoa. Hoffmeister states that his specimen of *M. alcicornis* is very similar to *M. confertissima* Quelch. He adds that *M. dichotoma* Forsk. is very like *M. alcicornis*. When referring to the latter statement Crossland (1941, p. 62) writes: "They are as unlike as possible".
6. From the Ryukyu Islands. Mentioned by name only, but it seems safe to assume that the identification is correct.
7. From the Bay of Batavia. Two specimens are dealt with, used for experiments on growth. One became lost, the other specimen is the one of Pl. XI fig. 1 in the present paper.
8. From the Palao Islands. Mentioned by name only.

Geographical distribution. Bay of Batavia (Boschma, 1936; material in Leiden Museum); Philippine Islands (Quelch, 1886); Ryukyu Islands (Yabe & Sugiyama, 1935 *b*, 1937); Palao Islands (Eguchi, 1938; Hiro, 1938); Ternate (Quelch, 1886); Rotti (Siboga Expedition, Sta. 299); Torres Strait (Hickson, 1898 *a*); Samoa (Hoffmeister, 1925).

Millepora tenella Ortmann, 1892

Millepora tortuosa Dana, 1848, 1849 [1].
Millepora tortuosa Dana, 1859.
Millepora tortuosa Milne Edwards, 1860.
Millepora tortuosa Verrill, 1872.
Millepora dichotoma Ridley, 1883 [2].
Millepora tenella Ortmann, 1892 [3].
Millepora alcicornis Saville-Kent, 1893 [4].
Millepora alcicornis Wood-Jones, 1907, 1910 [5].
Millepora dichotoma Vaughan, 1918 [6].
Millepora Krempf, 1927 [7].
Millepora "dichotoma" Umbgrove, 1928 [8].
Millepora "complanata" Umbgrove, 1928 [9].
? *Millepora tortuosa* Yabe & Sugiyama, 1933, 1935 *a, b,* 1937 [10].
? *Millepora tortuosa* Abe, Eguchi & Hiro, 1937 [11].
Millepora alcicornis Abe, 1937 [12].
? *Millepora tortuosa* Eguchi, 1938 [11].
? *Millepora tortuosa* Hiro, 1938 [11].

NOTES

1. From the Fiji Islands. The description of the growth form (Dana, 1848, p. 546) is: "The clumps are tortuously branched, the branches sometimes widening and giving out a cluster of finger-like branchlets nearly in the same plane, and in the other parts subdividing irregularly". There are two figures in Dana's report. The specimen of Pl. 52 fig. 3 in some way reminds of *M. intricata,* but the central branch shows the characteristic flabelliform arrangement of the tips as found in *M. tenella.* The specimen of Pl. 53 fig. 3 *a* in many respects is similar to certain colonies of *M. dichotoma.* The manner of division of the young branches, however, is far more like that found in *M. tenella.* It is almost certain that *M. tortuosa* Dana is the same species as *M. tenella* Ortm., as in parts of colonies of the latter species exactly the same mode of growth may be observed as represented in Dana's figures. The name *tortuosa* Dana, 1848, is preoccupied by *Millepora tortuosa* Esper, 1796, which belongs to the calcareous algae, so that the species has to be named *M. tenella* Ortm.

2. From Ceylon. Ridley characterizes a large specimen as having the branches subparallel and almost wholly fused into laminar vertical expansions. In a younger specimen the ends of some of the branches are cuneiform and the branches themselves are more distinct than in the older specimen. The term "cuneiform" points to *tenella,* it characterizes the tips of the branches which are broadened before during further growth they divide into two.

3. From Dar es Salaam. The description of the corallum is: "Aus incrustirender Basis erheben sich zahlreiche, dichotom verzweigte, schlanke Aeste von ca. 5 mm Dicke. Dieselben sind cylindrisch, verwachsen häufig und unregelmässig mit einander und sind an den Gabelungsstellen oft etwas verbreitert. Sie verlaufen theils parallel, ab und zu ist der Verzweigungswinkel stumpf, meist spitz. Die Aeste erheben sich von der Basis der Kolonie bis zu 4 und 5 cm, die Endverzweigungen sind fingerförmig, 1-2 cm lang, an den Spitzen abgestutzt oder gerundet." (Ortmann, 1892, p. 668).

4. Great Barrier Reef, Australia. "In one of these species, *Millepora alcicornis,* the corallum takes the form of a thick, bush-like aggregation of flattened palmate, or frondose, expansions, all of which are disposed in the same vertical plane." (Saville-Kent, 1893, p. 202). Cf. Saville-Kent's Pl. VII, showing a corallum of the characteristic shape of *M. tenella.*

5. From the Cocos Keeling Islands. The figure (Wood-Jones, 1910, fig. 35) shows a colony with largely united branches, all practically in one vertical plane. The flabelliform arrangement of the tips of the branches shows that the specimen belongs to *Millepora tenella* and not to *Millepora dichotoma* with its retiform arrangement of the colony.

6. Wood-Jones's specimen from the Cocos Keeling Islands. Crossland (1941, p. 62) has the following comments: "1918. Vaughan figures a form from Cocos Keeling (Pl. 93, fig. 1) under the name *M. dichotoma* Forsk. It is quite different, and, as far as I know, is not found in the Red Sea." See note 5.

7. From Indochina. The plates (Krempf, 1927, Pls. II and III) show colonies consisting of a more or less reticular mass of branches, not distinctly arranged in separate vertical plates. Especially the specimen on the foreground in Pl. III shows the flabelliform arrangement of the tips of the branches in the marginal region of the colony. The specimen strongly reminds of that of Pl. XIII fig. 2 of the present paper.

8. Bay of Batavia. The figures (Umbgrove, 1928, Pl. 26 fig. 48 and Pl. 30 fig. 54) show dichotomously branched specimens of the typical growth form of *M. tenella*.

9. Bay of Batavia. Name given to colonies of "*dichotoma*" in which the branches have largely united into a meshy plate. Umbgrove remarks that Darwin probably named *complanata* this type of growth. Darwin's *complanata*, however, is a typical *platyphylla*. In all probability Umbgrove's remarks refer to *M. tenella*, though it remains possible that colonies of *M. dichotoma*, which may develop into more or less plate-like growths, are meant with the name "*complanata*".

10. From the Borodino and the Ryukyu Islands, and from Formosa. Mentioned by name only.

11. From the Palao Islands. Mentioned by name only.

12. From the Palao Islands. The figure (Abe, 1937, fig. 2) shows a colony of plates arranged in more or less parallel vertical planes. The marginal parts of these plates are divided into numerous small branches, the manner of branching is typically that of *Millepora tenella*.

Geographical distribution. Dar es Salaam (Ortmann, 1892); Ceylon (Ridley, 1883); Indochina (Krempf, 1927); Sabang (material in Amsterdam Museum); Bay of Batavia (Umbgrove, 1928; material in Leiden Museum); "Java" (material in Leiden Museum); Cocos Keeling Islands (Wood-Jones, 1907, 1910; Vaughan, 1918); Palao Islands (Abe, 1937; Abe, Eguchi & Hiro, 1937; Eguchi, 1938; Hiro, 1938); Moluccas, Amboina and Timor (material in Leiden Museum); Haingsisi (Siboga Expedition, Sta. 60); Saleyer (Siboga Expedition, Sta. 213); Great Barrier Reef, Australia (Saville-Kent, 1893); Fiji Islands (Dana, 1848; material in Paris Museum); ? Borodino Islands and ? Ryukyu Islands (Yabe & Sugiyama, 1933, 1935 *a*, 1935 *b*, 1937).

Millepora latifolia nov. spec.

Geographical distribution. At present known only from the reefs of the islands Noordwachter and Edam in the Java Sea.

Incertae sedis

Millepora alcicornis Oken, 1815 [1].
Millepora alcicornis Ehrenberg, 1834 [2].
Millepora alcicornis var. α *cristata* Ehrenberg, 1834.
Millepora alcicornis var. β *digitata* Ehrenberg, 1834.
Millepora alcicornis var. γ *effusa* Ehrenberg, 1834.
Millepora alcicornis var. δ *nodosa* Ehrenberg, 1834.
Millepora alcicornis Darwin, 1842 [3].
Millepora undulata Tenison-Woods, 1879 [4].
Millepora forskäli Forbes, 1885 [5].
Millepora alcicornis Hickson, 1889 [6].
Millepora intricata Hickson, 1898 *a* [7].
Millepora alcicornis Hickson, 1898 *a* [8].
Millepora alcicornis facies *nodosa* Hickson, 1899 [9].
Millepora alcicornis Kirkpatrick, 1902 [10].
Millepora complanata Kirkpatrick, 1902 [11].
Millepora "incrustans" Umbgrove, 1928 [12].
Millepora alcicornis Abe, 1938 [13].

NOTES

1. In Oken's treatise the species is not sufficiently defined for identification as one of the species recognized in the present paper.

2. Ehrenberg did not find *Millepora alcicornis* in the Red Sea, but with some doubt he regards *M. dichotoma* Forsk. as a synonym of the former. Ehrenberg's notes on *M.alcicornis* are based upon material in the Berlin Museum. He lists as varieties *cristata, digitata* Esper, *effusa,* and *nodosa* Esper. No description is given of his new varieties *cristata* and *effusa.*

3. From the Cocos Keeling Islands, so that it may have been one of the branched species of the Indopacific region, viz., *M. dichotoma, M. intricata, M. murrayi* or *M. tenella.* Of these the last named is known to occur on the Cocos Keeling Islands.

4. The description of the species (Tenison-Woods, 1879, p. 347/348) runs as follows: "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 a 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 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."

Concerning the pores the author remarks (l.c., p. 345): "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."

Tenison-Woods further states that when a fragment is broken across it is observed that the outer one-fifth part is of a reddish-brown colour, whilst the inner four-fifths are bluish white.

The peculiar smaller pores and the aberrant colour make it highly probable that the form described by Tenison-Woods does not belong to the genus *Millepora.*

5. From the Cocos Keeling Islands, identified by Ridley and Quelch. Mentioned by name only; it must have been one of the four branched Indopacific species.

6. From North Celebes. Mentioned by name only, form not described.

7. Specimen having obtained the shape of "*M. intricata*" by growing over a piece of wood. This proves that it certainly was not *M. intricata.*

8. Specimen from Tonga. Apparently belonging to one of the branched species.

9. Hickson, 1899, Pl. XIV fig. 5. Hickson remarks that the specimen reminds of *M. gonagra (M. tuberculosa)* of Milne Edwards; it is, however, very unlike that species *(M. exaesa).* It may represent a narrow plate of *M. platyphylla.* From New Britain, New Guinea, Loyalty Islands, or "elsewhere".

10. Form not described. Probably *M. alcicornis,* but it may have been any other branched species.

11. May have been *M. complanata* or *M. platyphylla,* as Kirkpatrick was largely influenced by Hickson's views, and Hickson often used the name *M. complanata* to indicate *M. platyphylla.*

12. From the Bay of Batavia. All the species of *Millepora* may occur as incrusting growth forms. The locality (on the lithothamnion-ridge) indicates that the incrustations probably belonged to *M. platyphylla* or to *M. exaesa.*

13. From the Palao Islands. No particulars of the form of the corallum

V. DISCUSSION OF THE VARIOUS CHARACTERS FOR SPECIFIC DISTINCTION

Though systematically belonging to quite a different group, biologically *Millepora* entirely corresponds with the reef corals. This manifests itself primarily in its extreme variability as a response to external circumstances. Just as in reef corals the development of a colony of *Millepora* is dependent upon the conditions of depth, the abundance or lack of available space for a normal development, and numerous other factors. If an investigator with a thorough training in systematics could have an opportunity to study the various forms of *Millepora* on the reefs he would have come to an altogether acceptable conclusion concerning the division of the genus in distinct species. Now the species question in *Millepora* has become such an intricate problem chiefly on account of the fact that data on the specific value of the various forms largely were arrived at after the examination of museum specimens. It is well known that collectors of material for systematic research as a rule try to obtain from a certain locality an amount of material in which the various species are typically represented. They therefore especially select those specimens which seem to belong to different species, and choose colonies which among each other present as much as possible a different aspect. Moreover there is a general tendency to select specimens of perfect form and luxurious development, whilst deformed or stunted colonies, which biologically often are far more interesting than those of systematically "typical" appearance, are not considered worth while for collecting. In this manner as a rule the collections of corals in museums do not give a complete idea of the variability of the species. But the study of the variation is necessary to come to a reliable conclusion concerning the specific distinctions.

As far as concerns my own results, as these are laid down in the present paper, I never could have become as decisive in my conviction that there are different species in the genus *Millepora* if I had not had the opportunity to make some observations on corals of the genus in their natural habitat on the reefs. Being convinced of the fact that there must be real specific distinctions in *Millepora*, the attempt to show how the various described forms of the genus could be arranged in a systematically justified manner already at the beginning seemed to have the necessary sound background.

The characters of the species of the genus *Millepora*, as these are defined in the present paper, are almost exclusively those of the macroscopical peculiarities of the growth form, and, owing to the pronounced effect of variation, these characters not always are easily to be defined. As Hickson (1898 *a*, *b*, 1899) already demonstrated, the characters of the minute structure of the corallum and of the polyps do not furnish sufficiently constant data for specific distinctions. In my own investigations no serious efforts have been made to find specific characters in these minute structures, but it is interesting to record here some statements in the literature which show that the data concerning these characters in many cases are even more unstable than results from Hickson's conclusions. These data are arranged here under the same, or similar, headings as in Hickson's (1898 *a*) paper; they are not given in the same sequence as in the cited paper. It was thought useful to add some notes on the distribution of the various forms on the reefs, based on data from the literature, as these data in some cases may point to specific differences in regard to choice of habitat.

The Form of the Corallum.

As Hickson (1898 *a*) commented upon the difficulties in finding distinct specific characters based on the form of the corallum in *Millepora*, a few statements from the literature concerning these difficulties may be dealt with here.

Dana (1848, p. 543) writes: "There is much difficulty in characterizing the Millepores, on account of the variations of form a species undergoes, and the absence of any good distinctions in the cells. The branched species are often lamellate at base, owing to the coalescence of branches, and the lamellate species, as well as the branched, sometimes occur as simple incrustations." It is not to be denied that these remarks remain entirely valid.

Duchassaing & Michelotti (1860) maintain that the peculiar incrustations on Gorgonians, named by Dana (1848) *Millepora moniliformis*, are nothing else but growth forms of *M. alcicornis* which owing to the process of drying have become broken into small fragments. This tentative explanation probably is not correct.

In a later paper the same authors (Duchassaing & Michelotti, 1864) remark that species of *Millepora* growing in very shallow water may develop in a totally different manner from those in deeper water, and remark that care should be taken not to describe such specimens as separate species. This remark is altogether correct, it only is quite unexpected from authors who described so many forms as separate species, based on slight differences in growth form.

Hickson (1898 *a*) gives some instances of modification of growth of Millepores as a result of external influences. He mentions that a specimen of *Millepora intricata* had obtained its peculiar mode of growth by covering a small piece of wood (which proves, however, that the identification as *M. intricata* was not correct). Hickson (1898 *a*, 1899) further describes a specimen of plate-like growth which partially had assumed knob-like protuberances by growing over a dead piece of coral of another species. He remarks that in the collection of Dr. Willey there is a series of varieties of growth leading from a massive lamellate form to a complicated branching and anastomosing form.

In his description of the facies "*ramosa*" from Funafuti Hickson (1898 *b*, p. 829) writes: "There is another piece of corallum in Mr. Gardiner's collection which must be included in this facies, which is of interest as being found in shallow water and showing a flattening and expansion of the branches, which if it were carried a little further would lead to the formation of plates. Millepores living in very shallow water cannot grow to more than a certain height, and their growth upwards is checked and stopped by the low tides. It is probable that a lateral expansion of the branches follows any check to the growth given to the distal extremities, and that ultimately the broadened branches fuse together to form lamellae or plates."

The influence of currents on the form of *Millepora dichotoma* is described by Gravier (1911, p. 91): "Il se présente sous forme de palissades verticales disposées parallèlement les unes aux autres, très régulièrement, dont la direction paraît orientee normalement à la direction des courants dominants."

Crossland's (1927, 1928) researches on the variation of *Millepora* in connection with external influences were the results of actual observations on the reefs. He describes incrusting, upright branching, leafy, and plate-like honeycombed forms as typically represented in various parts of the reefs, and concludes that these different forms are modifications of one species. Crossland's paper of 1928 contains a striking instance of modification of the form of a *Millepora* by external influences, viz., the specimen of his fig. 11, which shows, especially in its basal region, some resemblance with *M. dichotoma*. In the correction of the explanation of the plates, in a later paper (Crossland, 1931), it is stated that the basal part of the specimen is encrusting dead branches of an *Acropora*. The topmost parts, free of the substratum, already are of the characteristic growth form of young colonies of *M. platyphylla*.

The effect of currents on the form of corals is noted by Abe (1937, p. 322): "Current force influences the growth direction of the branches of some corals, and the branch develops vertical to the current direction. Such influence is seen in *Millepora alcicornis*, ..." (the figure shows that the coral belongs to *Millepora tenella*).

Undoubtedly external influences may have a considerable effect on the shape of colonies of *Millepora*. Crossland (1927, 1928), who studied his specimens on the reefs, obtained very reliable data on the variability of *M. platyphylla*. He was the first to collect and to figure unsightly specimens, but the ones he selected to illustrate his views are very convincing.

In he present paper too a few instances are described of striking modifications of colonies of *Millepora*. A part of one of the specimens of *M. tenella* from Timor is entirely similar to *M. intricata* on account of its having encrusted the branches of a colony of *Seriatopora*. Still more surprising at first sight is the difference between two parts of a colony of *M. platyphylla* of which one has the typical shape, the other consists of numerous small knobs as a result of its having covered a colony of *Pocillopora* (Pl. IV fig. 2). A similar change of form is occurring in the colony of *M. latifolia* which has partially overgrown the neighbouring colony of *M. intricata* (Pl. III).

Hickson is right when he states that in *Millepora* the form of the corallum is dependent upon many circumstances connected with the exact spot on which it grows. It is quite true that the propinquity of other corals is one of these factors: "Its form must be adapted to the space left between its neighbours on the crowded reef." (Hickson, 1898 *a*, p. 249). Undoubtedly the specimen of *M. tenella* represented on Pl. XII fig. 1 with its luxuriant growth occupied an isolated position on the reef. On the other hand the specimen of *M. murrayi* of Pl. II with its crowded system of small branches was wedged in between other colonies of corals. This specimen moreover shows the influence of reaching its maximum height. Further growth would have exposed the topmost branches too much to the air during low tide, so that further development of branches was possible only next to the already existing ones. This resulted in a crowded mass of small branches forming together a more or less flat surface. Moreover it is not to be denied that currents may have an influence in modifying the shape of colonies, as has been demonstrated by Gravier (1911) for *M. dichotoma* and by Abe (1937) for *M. tenella.* Finally the influence of parasites in bringing about changes in the form of colonies often is of great importance. *Pyrgoma milleporae* may, when it occurs in large masses, completely alter the surface of colonies of *Millepora,* as, e.g., in the specimen of *M. exaesa* of Hiro (1938, Pl. I fig. 3) and in that of *M. latifolia* (Pl. IV fig. 1 in the present paper). According to Crossland (1931) the polychaete worm *Phyllochaetopterus* spec. may cause similar changes, so that the surface is raised into little cones, about 5 mm across the base and 3 mm high, from the tops of which the worm-tube projects a millimetre or so.

But these changes in form, as they are caused by external influences, manifest themselves within certain limits. Every species of *Millepora* has its range of variation, but notwithstanding that it keeps certain characters of its growth form which as a rule are sufficiently distinct to warrant a reliable specific identification.

Hickson certainly exaggerates in his statement concerning Willey's collection of a continuous series from a massive lamellate form to a complicated branching and anastomosing form. The various species of *Millepora* are extremely variable, but each of them always keeps certain characters of form which allow of a specific identification. The only exception is that of the encrusting forms which obtain the shape of their substratum.

The Texture of the Corallum and of its Surface.

In the description of his variety *plicata* Esper (1790) remarks that the surface is rough with small pits, in the latter there are larger pores than in the higher parts of the surface. This corresponds with Milne Edwards's (1860) remark concerning *Millepora foliata,* namely that in this species the principal individual of a cycle of pores occupies the centre of a slight depression. Duchassaing & Michelotti (1864) describe the same peculiarity for the form named by them *Millepora rugosa.* A similar statement is made by Verrill (1868), who writes that in his *M. alcicornis* var. *cellulosa* "the cells are sunken in a distinct depression". Quelch (1886) observes that in his specimen of *Millepora carthaginiensis* the gastropores are "sunk in small, shallow depressions".

Dana (1848) describes the surface of his *Millepora plicata* as minutely rugose and vertically carinate.

The surface of *Millepora platyphylla* according to Ehrenberg (1834) is provided with "tuberculis hemisphaericis aequalioribus". Milne Edwards (1860) mentions for his *M. ehrenbergi* (which is a synonym of *M. platyphylla*) a multitude of "bosselures mammillaires", each of which bears a principal calicle surrounded by five or six smaller ones. Verrill's (1864) *M. insignis*, which belongs to the same species, has the "cells at the summit of slight prominences". In his description of *M. platyphylla* Klunzinger (1879) states that the surface is covered with minute warts, and that on the top of each of these a gastropore is found. Hickson (1898 *a*, 1899) remarks that by various authors these small excrescences were regarded as a specific character of the form described as *M. verrucosa* (which is a synonym of *M. platyphylla*), but that these verrucae are caused by young barnacles (*Pyrgoma milleporae* Darwin) which have become overgrown by the corallum. In one specimen Hickson (1899) could prove, by filing down to a level with the surface of the corallum or deeper or by fracturing with a bone forceps, that at least half of the verrucae contained an irregular cavity with the remains of cirripede shells. Hickson (1898 *a*) further states that not unfrequently one side of a lamella is tuberculate and the other is not, thereby proving that as a specific character the presence or absence of verrucae is of no distinct value. Crossland (1941) also gives as his opinion that the wartiness of *M. platyphylla* is perhaps entirely due to cirrepede and worm parasites.

In the literature there are a few remarks concerning differences in texture of the corallum taken as a whole. Verrill (1868) observes that in his *M. nitida* "The tissue is, for the genus, very firm and compact". In the same paper a similar statement is made in regard to *M. braziliensis* Verr., whilst *M. alcicornis* var. *celluosa* Verr. is described as having the texture rather open and coarsely porous, and *M. alcicornis* var. *digitata* as differing from other West Indian specimens by a somewhat more porous texture.

Quelch (1886) describes the surface of the coenosteum of his *M. murrayi* as "nearly smooth, being finely and evenly reticulated". In *M. confertissima* according to Quelch (1886) the surface is very smooth and even.

Hickson (1898 *b*) gives a few more examples of these differences. The texture of the corallum of a specimen from Funafuti, identified as *M. alcicornis* facies "*esperi*" (but according to the description belonging to *M. exaesa*) was remarkably light and brittle, its specific gravity was found to be 2.3. Hickson states that compared with other Millepores this is decidedly low, as of a fragment of the facies "*ramosa*" it was 2.9, of a complanate form from Funafuti also 2.9, and of a complanate form in the Manchester Museum 3.17. In the same paper Hickson refers to the remarkable hardness of the corallum of a specimen from Rotuma, named by him facies "*plicata*" (apparently belonging to *M. platyphylla*).

According to Hickson not any character of specific value is to be found in the texture of the surface of the corallum of *Millepora*. There is, however, one character of the surface which is peculiar to West Indian species only, viz., the occurrence of slight depressions in the centre of which there is found a gastropore. This peculiarity is described as occurring in *M. alcicornis* (in the var. *cellulosa* and in the form *carthaginiensis*), in *M. complanata* (under the name *plicata*), and in *M. squarrosa* (in *M. foliosa,* which name in all probability is a synonym of *M. squarrosa*). In the collection of the Leiden Museum and of the Amsterdam Museum several specimens of *M. alcicornis* and of *M. complanata* show the slight depressions as referred to above.

Depressions in the surface of the corallum never seem to occur in Indopacific species of the genus. Among the latter, however, there is one, *M. platyphylla,* in which quite commonly the reverse is to be seen, namely that the surface is covered with small round knobs on the tops of which there is a well developed gastropore. In the literature the opinion is given that these excrescences of the surface are caused by parasites. It is true that in some cases similar verrucae may be brought about by the action of parasites, but in the majority of cases the verrucae of *M. platyphylla* develop without any influence of external conditions, in many cases they occur in a too distinct order to admit the possibility of external factors (see, e.g., Pl. V fig. 2).

Among the species of *Millepora* which have a tendency to a plate-like growth the West Indian species, *M. squarrosa* and *M. complanata,* develop into plates of a remarkable thinness, especially in their marginal parts. The Indopacific species of a plate-like growth, *M. platyphylla,* forms much thicker laminae. In connection with these differences the corallum of the West Indian species is much more compact and much harder than that of *M. platyphylla.*

In the Indopacific species the hardness and compactness of the corallum largely depends upon the manner of branching. As a rule the most strongly and finely branched colonies have the most compact structure and in connection with this a very smooth surface. The extreme in this direction is that of *M. intricata* with its exceedingly thin branches. The other extreme is that of the lamellar species *M. platyphylla* in which the corallum consists of a rather loose structure in comparison to that of the strongly branched species.

As far as concerns *Millepora alcicornis,* which may occur as finely branched forms and as heavy compact masses which only at the growing margins show branches, the structure may differ from "rather open and coarsely porous" to "very firm and compact". Also in this respect therefore the species is extremely variable.

Hickson was convinced that the texture of the corallum could not furnish data for a specific distinction. As shown above there are a few indications for specific characters to be derived from the texture. The peculiarities of the texture, however, are not sufficiently pronounced to be regarded as constant specific characters. The pitted surface is a feature of certain specimens of the West Indian species only, others have an even surface. In *M. platyphylla* some specimens do not show any verrucae, whilst in the majority these are found at least in parts of the colony.

The Size of the Pores.

The data in the literature concerning the size of the pores generally are far from precise, measurements given in exact numbers are noted by Ehrenberg (1834), Dana (1848), Klunzinger (1879), Moseley (1880), Quelch (1884, 1886), and especially by Hickson (1898 *a, b,* 1889). Not all of these are sufficiently reliable.

Forskål (1775) remarks that the pores of his *Millepora dichotoma* are minute. They indeed generally are smaller than those of the other Red Sea species, *M. exaesa* and *M. platyphylla.* Esper (1790) states that in his var. *ramosa* the pores are small, whilst in his var. *crustacea* they are large. Later (Esper, 1796) he observes that in an unnamed variety of *alcicornis* from the West Indies the pores are larger than those in any variety he had previously studied. Lamarck (1816) characterizes the pores of *M. alcicornis* as small.

In Ehrenberg's (1834) paper we find the first data on the size of the pores based on measurements. For his *M. complanata* (a form of *M. platyphylla* with apparently a rather smooth surface) he notes: "stellis maioribus sparsis, $^1/_6{}'''$ latis". Now one sixth of a Prussian line of 2.18 mm is approximately 0.36 mm. Hickson (1898 *a*) found as greatest average diameter of the gastropores in *Millepora* 0.37 mm, so that these measurements certainly were correct, especially as *M. platyphylla* indeed has comparatively large pores. For his *M. platyphylla* Ehrenberg gives the statement "stellulis subtilioribus, $1^1/_8{}'''$ latis", which would result in a diameter of 2.5 mm. At first sight it appears as if Ehrenberg had made a mistake here. It is, however, quite possible that he refers to the small verrucae with their central gastropore, which have a similar appearance as the true calices in many species of Madreporaria. The measurement of 2.5 mm is quite in accordance with the size of these verrucae, which are of common occurrence in *M. platyphylla* (cf., e.g., the specimen of Pl. V fig. 2 in the present paper, in which the greater part of the verrucae have approximately this size).

According to Dana (1848) the gastropores of *Millepora alcicornis* are rather large, those of *M. ramosa* quite minute, those of *M. tortuosa* very minute. For some other forms Dana gives measurements. The variety *incrassata* has pores of a large size, measuring $^1/_5$ of a line, which is, taking an English line as 2.11 mm, a diameter of 0.42 mm, indeed a rather high value. For *platyphylla* and the variety *truncata* the size of the pores is given as $^1/_8$ of a line, which is 0.26 mm, quite a reasonable result in comparison to Hickson's data.

Duchassaing (1850) defines the pores of his *M. tuberculata* as "perparvi", and states that his *M. parasitica* has much larger pores than *M. alcicornis* which may occur in the same form of growth.

When Milne Edwards (1860) in the diagnosis of the genus *Millepora* states: "Calices de dimensions très-différentes dans le même polypier." he undoubtedly refers to the difference in size of the gastropores and the dactylopores. In the description of the species the pores are mentioned as large (in *reticularis*), as of medium size (in *verrucosa*), or as very small (in *squarrosa, alcicornis, tortuosa,* and *intricata*). Duchassaing & Michelotti (1864) remark that their species *M. rugosa* is similar to *M. foliata* on account of its large calices. Verrill (1864) mentions that *M. insignis* has cells large for the genus, whilst in a later paper (Verrill, 1868) the gastropores of *M. nitida* and *M. braziliensis* are stated to be small, whilst those of *M. alcicornis* var. *cellulosa* are described as rather large. Pourtalès (1871) mentions that *M. alcicornis* has "very small calicles".

Klunzinger (1879) points out that whereas in *Millepora dichotoma* the gastropores and the dactylopores differ very little in size, the size of the gastropores is much larger than that of the dactylopores in *M. exaesa* and in *M. platyphylla*. The pores of *M. dichotoma* are described as small, and concerning *M. platyphylla* Klunzinger remarks that on the top of each verruca there is a gastroporus with a diameter of circa $^1/_4$ mm. This is a quite reasonable measurement, though it is less than one would expect after the statement that the pores of *M. dichotoma* are small.

Moseley (1880) writes that in his *Millepora nodosa* from Tahiti (the name is a synonym of *M. exaesa*) the larger gastropores of the systems measure about 1.5 mm in diameter. To say the least this is strongly exaggerated, and certainly it is not based on actual measurements.

Ridley (1883) observes that in the specimen indentified by him as *Millepora dichotoma* there is a well marked distinction in dactylopores and gastropores, quite different from what Klunzinger found in his specimens of *M. dichotoma*. Now it is highly probable that Ridley's coral belonged to a different species, *M. tenella*.

Quelch (1884) characterizes the gastropores of *M. murrayi* as "minute" and gives as their diameter 0.25 mm. In his more extensive paper Quelch (1886) mentions a specimen of *Millepora alcicornis* which has the pores very large, a *M. carthaginiensis* with rather large pores, whilst the pores of *M. murrayi* and *M. ramosa* are described as small, and those of *M. intricata* and *M. confertissima* as very small.

Before dealing with Hickson's results it may be remarked that Hoffmeister (1925) writes that *M. truncata* is similar to *M. incrassata,* but that the gastropores of the former are much smaller than those of the latter.

Among the data given above there are a few which are based on exact measurements, but the most reliable and most accurate data concerning the size of the pores are those in Hickson's papers. Hickson in his measurements took the average value of the size of a number of pores of in each case the same specimen. As greatest average diameter of the gastropores Hickson (1898 *a*) found a value of 0.37 mm, as smallest average diameter a value of 0.13 mm. The usual range of variation in size was found to be between 0.2 and 0.3 mm. In the same paper Hickson remarks (l.c., p. 250): "The large pores are very constantly found in specimens with thick lamellae or branches, while the small pores are found on those of a more slender habit". In a specimen labelled *Millepora complanata* Hickson found an average diameter of the gastropores at the base (the oldest part) of 0.185 mm, on a middle branch of 0.17 mm, and on the growing edge (the youngest part) of 0.13 mm. Hickson further remarks that the average size of the pores on one side of a colony may differ 0.03 mm from the average size of the pores on the other side. In his next paper Hickson (1898 *b*) gives as average size of the pores of *M. alcicornis* facies *"ramosa"* 0.276 mm, of a specimen of the facies *"plicata"* on one side of the colony 0.27 mm, on the other side less than 0.2 mm. Finally Hickson (1899) mentions that the gastropores in a specimen of the facies *dichotoma* have an average diameter of 0.28 mm.

The only important result of all the statements in the literature concerning the size of the pores is Hickson's remark that large pores are found in specimens with thick lamellae or branches, and small pores in more slender specimens.

It is interesting that *Millepora alcicornis,* which is so highly variable in its growth form, presents a similar variability in the size of the pores.

As the size of the pores in different parts of many colonies is highly different it was not thought worth while to demonstrate this with exact measurements. In handling a certain amount of material one cannot escape the conclusion that taken as a whole Hickson's remarks are altogether right. There are some striking differences which point to the fact that the size of the pores may constitute a specific character, at least in some cases. In colonies of *M. intricata* the pores are so small that they are difficult to find, whilst in colonies of *M. platyphylla* they are so large that they are evident to the naked eye.

In other species the size of the pores is highly different in the various colonies. In many colonies of *Millepora tenella* the pores are sufficiently distinct (cf. Pl. XII figs. 1 and 2), whilst in other specimens they are far less distinct (e.g., in the specimen of Pl. XIII fig. 3) or even very difficult to find (e.g., in the specimens of Pl. XIV figs. 1 and 2). When we compare the extreme forms it appears that the specimens of Pl. XII are much larger and consist of much thicker and broader branches than those of Pl. XIV which are colonies of a more dwarfed appearance.

The few specimens known of *Millepora latifolia* have very distinct pores (cf. Pl. III fig. 3).

In *Millepora dichotoma* the pores not always are as small as some data in the literature tend to show. The specimen of Pl. VI fig. 2, e.g., has very distinct pores.

In complete colonies of *Millepora platyphylla,* the species with the largest pores, always regions may be found in which the pores are much smaller. These are especially the basal parts of the colony and other parts which did not receive the full light. The same pecularity is to be observed in many large colonies of *M. alcicornis* in which hardly any pores may be found in the basal parts, whilst they are easily to be seen in the upper regions.

It seems safe to conclude that as a specific character the size of the pores may be of some help in exceptional cases only, e.g., in *M. platyphylla* and in *M. intricata.* But other species within certain limits in this respect may present the appearance of each of these two.

The Shape of the Pores.

Milne Edwards (1836-1849, Pl. 89 fig. 1 *b*) gives an enlarged figure of part of the surface of *Millepora alcicornis,* in which the gastropores all are more or less star-shaped and some of the dactylopores too are distinctly stellate.

In the literature there are very few remarks on the shape of the pores. Dana (1848, p. 542) observes that "the cells of the coralla are ... extremely small, looking like pin-holes, and without distinct rays". Milne Edwards (1860, p. 225) gives as characters of the pores: "Pas de cloisons distinctes, ni de columelle".

Hyman (1940) figures a *Millepora*, "showing typical flabellate shape", apparently a specimen of *M. complanata* from the West Indies. In the figure of a magnified part (l.c., fig. 137 B) the gastropores as well as the dactylopores are represented with distinct septa, so that they appear entirely different from the usual aspect, being distinctly star-shaped instead of forming simple round openings.

Milne Edwards's and Hyman's drawings undoubtedly were made from specimens which actually had star-shaped pores, as this shape of the pores also occurs, though very exceptionally, in other specimens. In a small specimen of *M. complanata* in the Paris Museum (apparently a marginal fragment of a large colony) the pores are distinctly star-shaped, whilst also in some other colonies of the same species in the Paris Museum, in the Leiden Museum, and in the Amsterdam Museum there are often pores to be found of stellate shape. Moreover, the colony of *M. latifolia* represented on Pl. IV fig. 1 shows some pores of stellate form. These are found in those parts of the colony which form a thin covering of specimens of *Pyrgoma milleporae*. When this layer on the shells of the parasites becomes thicker the pores have their usual more or less circular shape, just as in the parts of the colony which are not occupied by the parasites. In the Leiden Museum there is a specimen of *Millepora alcicornis* which in certain parts of the corallum has distinctly star-shaped gastropores.

When pores of stellate shape occur they form an exceptional case restricted to individual colonies. The shape of the pores therefore does not furnish a character for specific distinctions.

The Degree of Isolation of the Cycles.

Linnaeus (1758, 1767) and Gmelin (1789) characterize *Millepora alcicornis* as being provided with "poris sparsis obsoletis", so that they did not observe an arrangement of the pores in systems.

In the description of his varieties of *Millepora alcicornis* Esper (1790) repeatedly remarks that the pores are distributed without distinct order. In his figure of *M. alcicornis* var. *nodosa*, however, Esper (1790, Millep.

Tab. IX) represents the pores as distinct systems, in which a gastropore is surrounded by a number of dactylopores (as a rule 5 or 6).

Ehrenberg (1834) states that in his *Millepora complanata* the large pores are surrounded by 4 to 6 smaller ones, which points to distinct cyclosystems. His species *M. clavaria* is characterized by "poris crebris, parum regularibus", and according to Ehrenberg in this respect differs from Esper's *nodosa* with its pores arranged in groups.

From Dana's (1848) statements only that regarding the var. *truncata* seems to indicate the presence of more or less isolated cycles.

Milne Edwards's (1860) remarks concerning the degree of isolation of the cycles in the various species of *Millepora* are interesting. In *complanata* the systems are not well recognizable, in *plicata* they are sufficiently distinct (the two forms belong to the same species). In *foliata* the pores form small systems, in *squarrosa* there are no distinct systems (the two forms probably again belong to one species). *M. alcicornis* is stated to have no distinct systems of pores, and in *ehrenbergi* the verrucae bear a central principal pore which is surrounded by 5 or 6 smaller pores.

In his species *Millepora insignis* Verrill (1864) recognizes groups of pores: principal cells at the summit of slight prominences surrounded by a circle of six smaller ones. Verrill (1868) describes the dactylopores of *M. nitida* as having a tendency for an arrangement around the gastropores in circles of 6 or 8. Klunzinger (1879) remarks that in those parts of the corallum of the typical *M. platyphylla* where there are no verrucae the dactylopores often are arranged in circles around the gastropores, and also records more or less distinct cycles for the variety *glabrior* of this species. Moseley (1880) remarks that his *M. nodosa* from Tahiti has well-marked and separated systems (the name is a synonym of *M. exaesa*). Ridley (1883) states that the dactylopores of the species named by him *M. dichotoma* are scattered irregularly between the gastropores. Ridley's *M. dichotoma* in the present paper is regarded as belonging to *M. tenella*, and it is interesting that Ortmann (1892) in his description of *M. tenella* remarks that the dactylopores are scattered among the gastropores and do not form groups.

Hickson (1898 *a*) observed that in some parts of the corallum the cycles are more distinct than in other parts. He remarks that slow growing parts have distinct cycles, and that in fast growing parts the cycles are confused. In a later paper Hickson (1899, p. 124) again gives some examples: "An examination of Fig. 5 with a magnifying glass shows that in the lower half of the specimen the systems are very well marked, whereas in the upper half and at the edge the pores seem to be distributed indiscriminately. A better example of the variability of this feature in Millepora may be seen in Fig. 3 where the systems are perfectly distinct on the flat surface of the corallum but completely fused on the tubercles and at the edges". In a more recent publication (Hickson, 1924, fig. 66) a specimen is represented (enlarged) with pores arranged in regular cyclosystems.

Hyman (1940) remarks that in *Millepora* the pores usually are irregularly scattered, but that they may occur in cyclosystems with several dactylopores encircling a central gastropore.

From his researches on the degree of isolation of the cycles Hickson draws the correct conclusion that slow growing parts have distinct cycles and that in fast growing parts the cycles are confused .This at least as a general rule is entirely true. In many cases also in slow growing parts there are no distinct cycles, and in fast growing parts the cycles may be rather distinct. In all the species of *Millepora* colonies may be found with generally distinct cycles and others in which the cycles are not to be distinguished as separate groups. As a specific character the degree of isolation of the cycles is without any value.

The Relative Number of Dactylopores and Gastropores.

The scanty data in the literature before 1898 concerning the number of dactylopores surrounding a gastropore in a cyclosystem are the following:

Esper (1790), *M. alcicornis* var. *nodosa:* 5, 6 or more.
Ehrenberg (1834), *M. complanata*: 4-6; *M. alcicornis*: about 6.
Dana (1848), *M. platyphylla β truncata*: 5 or 6.
Milne Edwards (1860), *M. ehrenbergi:* 5 or 6.
Verrill (1864), *M. insignis:* about 6.
Verrill (1868), *M. nitida*: 6 or 8.
Moseley (1880), *M. nodosa*: 5-8.

Hickson (1898 *a*) in several species of *Millepora* calculated the number of dactylopores belonging with one gastropore to the same system. In order not to be misled he used only those cycles which were clearly defined from their neighbours. The average amounts of a number of countings were given, as shown in the accompanying table (see p. 58).

Concerning the results of these countings Hickson observes that there is not much variation in the average proportion of dactylopores to gastropores. The extreme averages (5.08 and 7.08) do not show so great a range as may be seen on different parts of a single colony: 9 and 4, and 8 and 3. Hickson's conclusions are that the number of dactylopores is very variable, as it may be any number up to 8 or 9, that widely different forms of growth apparently have the same average number, that the average number of dactylopores for specimens of all kinds of growth forms is about 6, and that the relative number of dactylopores and gastropores cannot be used as a specific character.

It was not considered worth while to try and add more data to those of Hickson. As his results in every respect seem to be conclusive it is

"Accepted specific names"	Number of cycles counted	Average number of dactylopores in each cycle	Highest number	Lowest number	
M. murrayi (Torres Str.)	6	5.15	8	5	
M. alcicornis (W. Indies)	8	6.45	8	5	
M. alcicornis (Bermudas)	6	5.6	7	5	
M. alcicornis (Tonga)	12	6.7	8	6	(one side)
	12	5.08	8	3	(other side)
M. plicata (Celebes)	12	7.08	9	6	
M. complanata (W. Indies)	7	6.28	7	5	(one side)
	100	5.82	7	4	(other side)
M. alcicornis (W. Indies)	7	6.14	7	5	
M. alcicornis (Bahamas)	13	5.5	9	4	

certainly right to state that the relative number of dactylopores and gastropores does not give an indication for specific distinction. In every colony the variation of this number is so evidently a result of different conditions influencing the various parts that this character is entirely valueless in regard to the species problem.

The Distribution of the Pores in various Parts of the Corallum.

According to Pallas (1766) the pores in *Millepora alcicornis* occur "in iunioribus extremitatibus crebriores". Esper (1790) too remarks that the pores in the tips of the branches are more close together than in the other parts of the colony. Lamarck (1816) states that in *Millepora* the pores in the tips of the colony are scattered.

Ehrenberg (1834) noticed in his species *M. porulosa* that in the basal part of the colony there was a more distinct difference in the size between the gastropores and the dactylopores than in the higher parts.

In *M. ehrenbergi* according to Milne Edwards (1860) there are often distinct systems of 5 or 6 smaller pores around one larger, but in some parts of the colony this difference in size between the gastropores and the dactylopores is little pronounced.

Klunzinger (1879) remarks that in the basal region of *M. exaesa* the pores are smaller in number and less distinct than in other parts of the colony.

Hickson (1898 *a*) observes that in many large specimens the cycles are much more distant in one part than in another. In slow growing parts of the corallum there usually are distinct cycles, in fast growing parts the cycles as a rule are confused. In his description of the facies *nodosa* Hickson (1899) mentions that in some parts of the colony there are regular systems of pores, whilst in other parts the arrangement is irregular.

It seems, indeed, to be a general rule that the pores are more numerous in fast growing parts of colonies than in slow growing parts. In connection with this the pores usually are more conspicuous in the upper parts of the colonies than in the basal regions. Probably in the first place this is due to the amount of light penetrating to the various parts of the colonies, as in parts of the colonies which do not receive sufficient light the pores have a tendency to disappear. This has, e.g., occurred in the specimen of Pl. V figs. 3 and 4 in the part of the colony which formed the under side when it remained attached to a brick during some time. Not only are the pores here as a rule smaller than those of the upper side, but in many parts they have a tendency to disappear altogether.

As a specific character the mode of distribution of the pores in various parts of the corallum is of no value.

The Presence or Absence of Ampullae.

Quelch (1884) described the ampullae in his new species *Millepora murrayi*, and gave a further account of these structures in a following paper (Quelch, 1886). Hickson (1898 *a*) remarks that ampullae may be found in plicate, ramose, and digitate specimens, and that the presence or absence of ampullae cannot be used as a specific character. This stands to reason, as the ampullae form a regular feature in the life-history of *Millepora*. In a later publication (Hickson, 1924, fig. 68) a figure is given of a part of a colony of *Millepora*, showing the surface profusely pitted with ampullae.

It stands to reason that the ampullae, which form a regular feature in the sexual development of *Millepora*, from time to time occur in all the species. It would be altogether absurd to presume that the presence or absence of ampullae might form a specific character.

I found open ampullae in numerous specimens of *Millepora alcicornis*, and ampullae which still possess their covering of radiating calcareous bars in one colony of *M. murrayi*, in one of *M. latifolia*, and in one of *M. platyphylla*. As yet no characteristic structures could be observed in these ampullae pointing to specific differences. There only seems to be a difference in size as those of *M. latifolia* are somewhat larger than those of *M. murrayi*, whilst those of *M. platyphylla* are the smallest of the three. But as of each species only one colony showing ampullae is available it is not certain that this difference in size may be due to specific peculiarities. It is remarkable that of the three species *M. platyphylla*, which has the largest gastropores and dactylopores, has ampullae of smaller size than those of the other species.

It is not impossible that the closed ampullae may be different in the various species, so that the structure of these parts might yield specific characters. The material at hand as yet is too scanty to allow of a definite conclusion.

The Anatomy of the Soft Parts.

Moseley (1880) gave a detailed account of the soft parts of *Millepora*, based on studies of *M. exaesa* (named by Moseley *M. nodosa*). Hickson (1898 *a*, *b*, 1899) studied material of various growth forms of the genus, especially to find specific characters, without succeeding in obtaining results of this kind. Hickson states that the structure of the gastrozooids and the dactylozooids is essentially the same in all the described species of the genus, though their size varies somewhat. Moreover the canal system is the same in all specimens. Further zooxanthellae of exactly the same size are always present in the superficial canals. There are two different kinds of nematocysts in each specimen (already described by Moseley, 1880). Notes on the nematocysts, confirming Moseley's and Hickson's results, are moreover given by Abe (1938).

It is not impossible that a more detailed study of the nematocysts of the various species of *Millepora* might yield characters confirming the diversity of the species. The data which at present are available, however, as yet do not point in this direction. Instead of concluding with Hickson that the study of the soft parts again gives evidence of the specific unity of all forms of *Millepora* it must be remarked that as yet the soft parts do not furnish any character of specific value.

The Stinging Properties.

Several authors have commented upon the stinging properties of *Millepora.* Ehrenberg (1834) adds to his description of *M. complanata* "viva pruriens", and to that of *M. platyphylla* "viva prurit". Darwin (1842) also has some remarks on the stinging property of *Millepora,* and Klunzinger (1879) mentions that *Millepora* is called "fire coral" by the Arabs.

The following quotation from Hickson (1898 *a,* p. 254) is interesting as it points to the possibility of a specific distinction based on this peculiarity: "Many of the Millepores are known to sting badly, and have received popular names in various languages expressive of this feature, but Mr. Gardiner informs me that one form in Funafuti did not sting. "It was at its base rather overgrown with weed, and above, curiously enough, it did not sting, and was the only one in Funafuti that did not" ". Unfortunately Hickson gives no particulars of the growth form of this specimen.

There is another statement which points to differences of a similar kind. Wood-Jones (1910, p. 133) remarks: "It is curious that of the three forms, *M. alcicornis* has the power of stinging more severely than the other two, but this fact does not necessitate their taking specific rank, and I do not doubt that there is but one species of *Millepora*".

Now Wood-Jones's *M. alcicornis* is the more delicately branched form of the Cocos Keeling Islands, whereas the two other forms, named by him *M. complanata* and *M. verrucosa,* are of a more compact manner of growth. Yonge (1930) mentions a "finely branched Millepora which stung like nettles at the touch...". In the latter publication it is not especially noted that branched specimens of *Millepora* have a stronger stinging power than more massive ones, but in connection with Wood-Jones's observations it is interesting that Yonge's specimens were finely branched.

The data concerning the differences in the stinging effect of the various forms of *Millepora* as yet do not furnish sufficient evidence for specific characters. Moreover, if really there is a difference in the stinging power of the various species of the genus it will be exceedingly difficult to find a means of expressing this feature in distinct terms. Anyhow it is interesting that the available data seem to point to a physiological difference which may be of specific value.

The Distribution of the various Forms in different Parts of the Reefs.

Forskål (1775) remarks that *Millepora dichotoma* inhabits deeper water.

Darwin (1842) observes that in the Cocos Keeling Islands *Porites* and *Millepora* alone seem able to resist the fury of the breakers on the upper and outer edge of the reef (the *Millepora* is named *M. complanata*, its correct name is *M. platyphylla*). Here "*M. alcicornis*" (obviously one of the branched species of another name) is found in the hollows of the reef. In the Maldives again "*M. complanata*" is one of the commonest kinds on the outer margin. It grows to a large size, only where it is washed by a heavy sea. At greater depths, a strong *Madrepora* and "*Millepora alcicornis*" are the commonest kinds. The latter lives in from 0 to 12 fathoms.

Duchassaing & Michelotti (1864, p. 105) publish an interesting note: "Un autre fait peut encore se présenter qui peut induire le naturaliste en erreur; il y a souvent des millépores qui prennent naissance dans des endroits où la mer est très-peu profonde, par example dans les creux de rochers, où il n'y a pas plus de deux ou trois pouces d'eau; dans ce cas le Polypier ne pouvant se développer en hauteur, s'étale en une large croûte à la surface des corps marins, qui forment le fond. On doit éviter d'établir des espèces sur de pareils spécimens, à moins d'avoir à invoquer d'autres caractères plus positifs". This is the more interesting as Duchassaing & Michelotti gave a separate specific name to specimens which differed among each other in slight modifications of growth form only.

Moseley (1879) mentions when dealing with the corals of Bermuda that *Millepora ramosa* seems to thrive best in the shade.

Forbes (1885) records *M. verrucosa* from outside the reef, and *M. forskäli* from inside the reef of the Cocos Keeling Islands.

Hickson (1889) states that "*Millepora alcicornis*" occurs on the outer edge of the reef (in North Celebes). Apparently a branched form is meant, for in the same publication Hickson refers to "*M. plicata*" as a different form.

Ortmann (1892) found his *Millepora tenella* at Dar er Salaam during ebb-tide (spring-tide) in the surf, in clefts of the reef.

Saville-Kent (1893) remarks that "*Millepora ramosa*" (the correct name probably is *M. intricata)* is rarely uncovered at ebb-tide.

Gardiner (1898, p. 428) in describing conditions on the reefs of Funafuti writes: "*Millepora,* which is generally supposed to grow where the break of the waves is strongest, I only obtained in this area in a well-protected situation on the leeward side of the atoll". Another remark concerning the reefs of Funafuti is (l.c., p. 434): "two varieties of *Millepora* flourish, one near the openings of the reef, and the other, a massive brown lamellar variety, on nearly all the shoals of the lagoon". On Rotuma *Millepora* is very common in the boat channel. In the atoll Nukulailai *Millepora* is everywhere very common. On p. 479 of the cited paper Gardiner mentions that from a greater depth than 30 fathoms small pieces of *Millepora* were obtained, and he further remarks: "*Millepora* was, however, very common in all the hauls up to 7 fathoms, and evidently grows extremely luxuriantly at about this depth".

Hickson (1898 *b*) describes a specimen of *Millepora alcicornis* facies "*ramosa*" obtained by Gardiner in Funafuti at a depth of 7 fathoms, and writes (l.c., p. 828): "Tenison-Woods says that *Millepora undulosa* occurs in 20 fathoms in Foveaux Straits, Moore and Smith found living *M. ramosa* in 15 fathoms, ..." [1]). In a footnote Hickson remarks that Gardiner believes to have obtained pieces of *Millepora* from 20 and 30 fathoms, but does not wish to consider this evidence as conclusive. In the same paper Hickson points to the interesting fact that in both cases (Moore & Smith, and Gardiner; Hickson expresses his doubts to Tenison-Woods's statement) in which Millepores have been dredged at a depth well below low-water mark, i.e., in places where the growth in height cannot be limited by exposure to the air, the facies is "*ramosa*". Hickson's facies "*esperi*" (according to the description it is *Millepora exaesa*) in Funafuti occurred "most abundantly in the lagoon on each side of the passages to windward, and never where it would be directly exposed to the rush of the tide. In this situation it forms large clumps, commonly as much as 7 or 8 feet in diameter, rising out of 5-10 feet of water to a foot from the surface at ordinary low tide" (l.c., p. 830). The facies "*complanata*" (the correct name is *M. platyphylla*) occurred in Funafuti in shallow water.

In the region of the Maldive and Laccadive Islands Gardiner (1902) obtained the branching form of *Millepora* 3 times from 21-25 fms., twice from 26-30 fms., 3 times from 36-40 fms., and once from 41-50 fms. It was not found in more shallow water, nor did it occur on the reefs.

Agassiz (1903) ascertains that in the Paumotu Islands a yellowish green nodular species of *Millepora* is very common between the surface and three fathoms; apparently *M. exaesa* is meant here (it is interesting that Forskål (1775) also indicates the colour of *M. exaesa* as greenish). At Niau, in the same group of islands, Millepores and other corals "... grow in abundance from the edge of the reef platform, taking their greater development in from three to seven fathoms". (l.c., p. 65). In the Tonga Archipelago *Millepora*

1) Tenison-Woods remarks that his specimen of *Millepora undulosa* was found in Foveaux Strait, but the depth at which it occurred was not stated. In a note to Tenison-Wood's paper Hutton observes that *Millepora undulosa* is obtained not uncommonly in from 14 to 20 fathoms of water.

(and other corals) occur on reef flats in great profusion, and to a depth of five to six fathoms in the sounds. In the Gilbert Islands (and in some other groups too) an immense flat of Millepores was observed in which the corals had been killed as they approached the surface. Next to this flat of dead corals Millepores were seen growing in great profusion in a deep and wide secondary lagoon. Agassiz further observes that Millepores are the most abundant of the corals in the lagoons of the Marshall Islands. At Kusaie in the Caroline Islands Millepores were found "... growing luxuriantly on all the flats and shoals and ledges of the lagoon to the west of Port Lottin" (l.c., p. 339). At Ponapi in the same group of islands gigantic masses of Millepores and other corals were met with on the outer slope of the reef.

Gardiner (1907) mentions *Millepora* which he procured from a depth of 29 fathoms. He further remarks that this coral may assume extraordinarily different facies, and adds (l.c., p. 133): "Any facies may be found at any depth and all belong, as Prof. S. J. Hickson has shown, to a single species".

Crossland (1927) in discussing the effect of sand on coral growth, mentions that *Millepora* is the last survivor when the reef corals are destroyed. On the reefs of Tahuata Island in the Marquesas "large colonies of *Millepora* decorate the edge, especially of the channel on the west side, growing in rounded masses made of thin plates, ..." (l.c., p. 550).

Crossland (1928) describes various growth forms (facies) of *Millepora* from the reefs of Tahiti and remarks: "These growth forms of *Millepora* thus directly respond to external conditions, corroborating Professor Hickson's prolonged investigations, and afford an index marking stages in the changes of reefs as conditions alter". (l.c., p. 727). Simple incrustations form the first stage of every form of growth, but in bad conditions *Millepora* remains at this stage.On the surf-swept barrier edge of the reef plate-like masses occur which may show branching in their upper margins. In quiet water an upright branching form is found, and in the lagoon a leafy form. (The explanation of the plates in Crossland's paper of 1928 contains some errors, which are corrected in a later paper by Crossland, which appeared in 1931). It is quite possible that Cossland is right when he regards all these growth forms from Tahiti, including the form described by him as plates forming a honeycomb facies, as belonging to one species, *Millepora platyphylla* (Crossland indicates a certain facies with the name *truncata*, which is a synonym of *platyphylla*).

Umbgrove (1928) points to the fact that on the reefs of the Bay of Batavia the various growth forms of *Millepora* are more or less restricted to certain areas each with its own ecological conditions. Of the various forms "*dichotoma*" is very common on the outer slope of the shingle wall, "*platyphylla*" occurs on the rich reef in deeper water, and "*incrustans*" on the shingle walls (the lithothamnion-ridge).

Yonge (1930) remarks that in the Great Barrier Reef *Millepora* occurs in sheltered waters as a finely branching coral, and on the surface of the reefs as an encrusting growth.

Stephenson, Stephenson, Tandy & Spender (1931) mention *Millepora* as one of the animals characteristic of seaward slopes and anchorage.

Gardiner (1931, p. 85) writes: "On the reef the corallum of *Millepora* is incrusting and growing outwards from the base, while its surface is covered with flattened stems, which may vary from quite small and anastomosing branches to great upgrowing plates several inches in breadth at the base; at depths of 15 to 25 fathoms their branching is often that of delicate twigs".

Yabe & Sugiyama (1935 *a*, p. 211) observe that "*Millepora* and *Porites* like more agitated water and are common along the outer margin of the belt of growing corals".

Sewell (1935) states that the outer zone of Nankauri Island (Nicobar Islands) is composed completely of a branching plate-like growth apparently of *Millepora* sp.

Sewell (1936) mentions the same for Horsburgh Atoll (Maldive Islands), but here *Millepora* is one of a great number of corals. The species is referred to as *M. complanata*, so that undoubtedly *M. platyphylla* is meant.

Gardiner (1936) points out that under unfavourable conditions the incrusting colonies of *Millepora* are the last to survive as living corals. He remarks that in the Solomon Atoll, Chagos Archipelago, *Millepora* occurs as thick flattened plates.

Abe (1937) remarks that the distribution of "*Millepora alcicornis*" in Iwayama Bay (Palao Islands) is mainly near the mouth of the bay where the current is comparatively swift. The growth of the coral is influenced by the current so as to cause a system of branches "vertical to the current direction". The figured specimen of "*M. alcicornis*" belongs to *M. tenella*.

Abe (1938) states that "*M. alcicornis*" is widely distributed on the reef margin of the outer part of Iwayama Bay.

Crossland (1938) when discussing the conditions of the reefs at Ghardaqa between the Biological Station and the edge of the reef remarks that *Millepora*, common on the outer reefs, is here small and rare.

Butsch (1939) observes that in the Bahamas *Millepora alcicornis* occurs commonly in depths of from two feet to six fathoms.

Yonge (1940, p. 369) remarks: "Referring to the Hydrocorallinae, Hickson (1924) points out that the Stylasterina, which have no zooxanthellae, extend from shallow water to great depths. *Millepora*, on the other hand, which does possess zooxanthellae, has never been found below about 40 fathoms and does not flourish except near the surface".

Of the data given above the most important and most precise particulars concerning the distribution of the forms of *Millepora* on the reefs are the following.

The greatest depth at which species of the genus *Millepora* may occur seems to be well established as about 40 fathoms. This undoubtedly is, as Yonge (1940) remarks, dependent upon the conditions for existence of the symbiotic algae. The data in the literature point to the fact that in more or less deep water only branching forms occur. Gardiner's (1907) assertion "any facies may be found at any depth" apparently is a slip of the pen, as it contradicts his own statements in other papers.

Millepora exaesa has been recorded from 5-10 feet to 1 foot depth in Funafuti (Hickson, 1898 *b*) and from between the surface and 3 fathoms in the Paumotu Islands (Agassiz, 1903). "*M. ramosa*" (evidently *M. dichotoma* or *M. tenella)* was obtained in Funafuti from a depth of 7 fathoms (Hickson, 1898 *b*).

Millepora platyphylla is repeatedly mentioned as common on the surf-swept edge of the reef (Darwin, 1842; Forbes, 1885; Crossland, 1927, 1928; Sewell, 1935, 1936), in this region it seems to find ideal conditions as it develops here into strong colonies of large size. But also species of a more or less delicately branched form may occur on the outer edge of the reef. Hickson (1889) remarks that "*M. alcicornis*" occurs here, Ortmann (1892) found his *M. tenella* in the surf, and Abe (1938) states that "*M. alcicornis*" (probably *M. tenella*, cf. Abe, 1937) is widely distributed on the reef margin. On the other hand Saville-Kent (1893) observes that *M. intricata* (named by him "*M. ramosa*") is rarely uncovered at ebb-tide.

Crossland (1927, 1928), and Umbgrove (1928) published valuable data concerning the occurrence of the various forms in ecologically different parts of the reefs.

On the reefs in the Bay of Batavia I found the species *Millepora platyphylla, M. murrayi*, and *M. tenella* in luxurious development on the extreme edge, in the full surf. Under entirely similar conditions the species *Millepora latifolia* and *M. intricata* were found on the edge of the reef of the island Noordwachter in the Java Sea.

In strongly agitated water *Millepora tenella* develops into strong plate-like growths with rather numerous thick and broad branches (figs. 3 and

4). In more quiet water the form of the corallum becomes widely spreading. If then it is growing under favourable conditions the branches become rather

Fig. 3. Outline of a plate-like growth of *Millepora tenella* Ortm. with more or less separate branches from the Island Edam. Natural size.

thick and broad (fig. 5). If on the other hand it is growing in the region of the reef at the inner part of the patches of luxuriant coral growth, where the conditions are less favourable for development, the branches remain much thinner and the whole corallum has a much more delicate appearance (Pl. XIV figs. 1 and 2).

In rather shallow water *Millepora murrayi* is of a robust structure and has rather short vertical branchlets (Pl. XI fig. 2). The specimen of Pl. XI

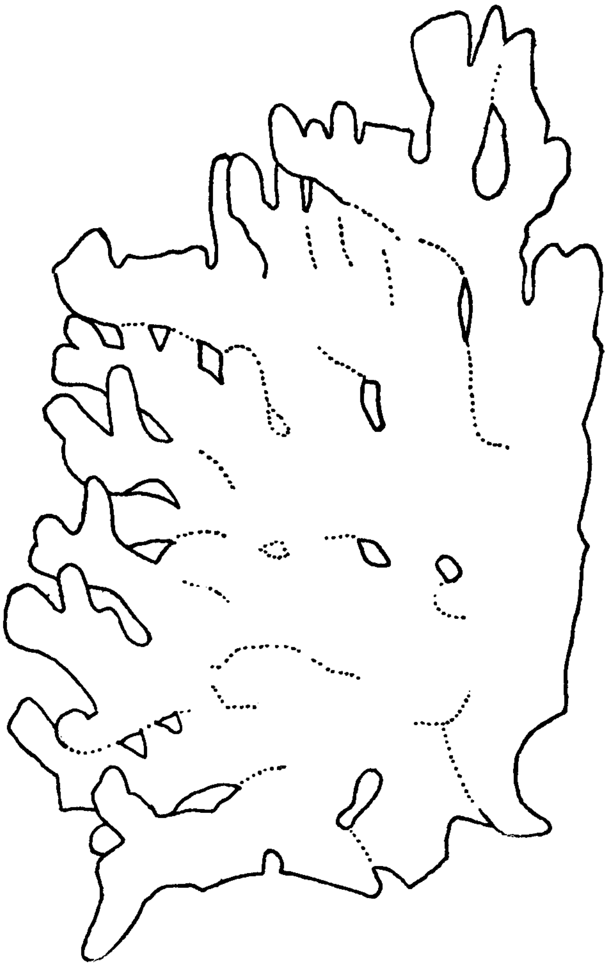

Fig. 4. Outline of a plate-like growth of *Millepora tenella* Ortm. with strongly united branches from the Island Edam. Natural size.

fig. 1 for a long time remained in somewhat deeper water. Here the corallum obtained a rather loose structure, with comparatively thin principal branches and very long vertical branchlets. The two colonies principally have the same manner of growth, but the one is much stronger than the other.

Colonies of *Millepora intricata* of the typical shape, as that of Pl. X (which in every respect reminds of the type specimen in the Paris Museum) in all probability grow in more or less sheltered water, somewhat below the low-tide level. Of the specimens of *M. intricata* in the Paris and the Leiden Museums it is unknown whether they really are from deeper water, but of the specimens of *M. intricata* referred to by Saville-Kent (1893) under the name *M. ramosa* this author remarks that the species is rarely uncovered

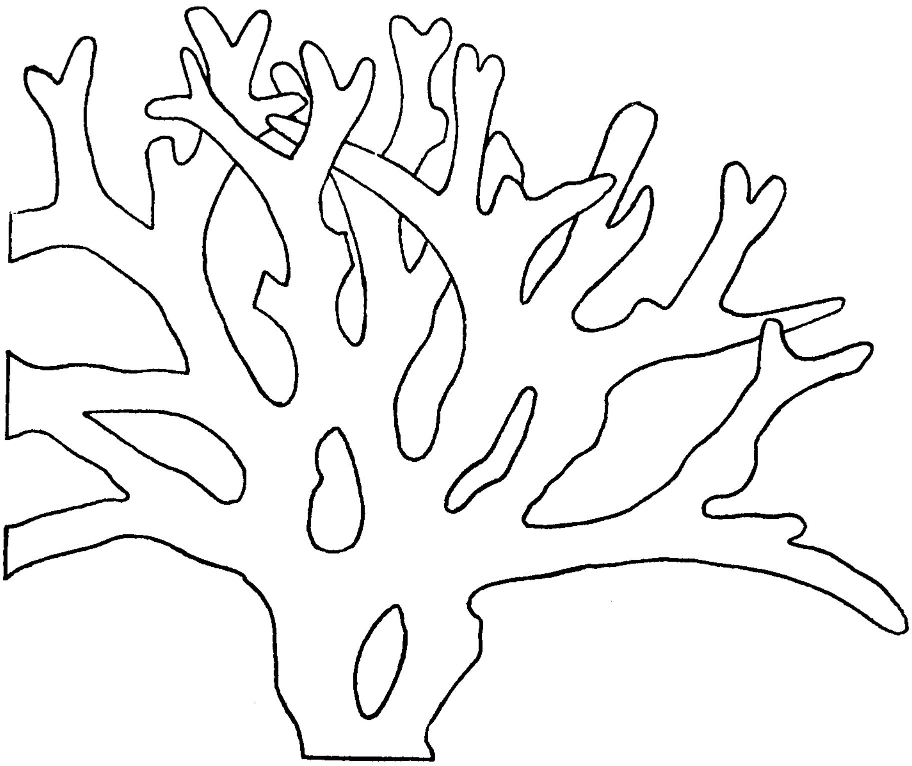

Fig. 5. Outline of a colony of *Millepora tenella* Ortm. with widely spreading branches from the Island Edam. Natural size.

at ebb-tide. Now it is interesting that the strongly branched part of the compound of Pl. III is from the surf-swept edge of the reef of the island Noordwachter. In all probability this coral belongs to *M. intricata,* as it has the typical manner of branching and of anastomosing of the branches of this species. The branches themselves, however, are much stronger and broader than in the typical specimens (figs. 1 and 2 of Pl. III are on $^7/_{10}$ of the natural size). If really the species prefers somewhat deeper water for its typical development it is astonishing that this colony from the edge of the reef has such a vigorous manner of growth.

Summary and General Conclusions.

(1). The form of the corallum, regarded by Hickson as entirely dependent upon external conditions, is the most important character for the distinction of the species. Each species of *Millepora* is highly variable, but the variation is limited to a certain degree.

(2). The texture of the corallum and of its surface in some cases may give an indication for the specific identification. It cannot be used as a specific character of constant value.

(3). The size of the pores as a rule is variable. Some species generally have large pores, others generally small. As a specific character the size of the pores is not sufficiently constant.

(4). The shape of the pores on the whole is circular. Exceptionally pores of a stellate kind may occur, but this character has individual value only.

(5). The degree of isolation of the cycles varies in the different parts of each colony. It cannot be used as a specific character.

(6). The relative number of dactylopores and gastropores again varies in the different pars of colonies. It is of no value as a specific character.

(7). The distribution of the pores in various parts of the corallum is different in each individual colony. It cannot give any indication for a specific distinction.

(8). The presence or absence of ampullae cannot constitute a specific character, as every now and then ampullae must develop in each full grown colony. It is not impossible that the structure of the ampullae may show distinct particulars in each of the species of the genus. Until now too little is known in this respect.

(9). The anatomy of the soft parts did not yield characters of specific value. As far as known at present the nematocysts of the various species do not show differences in structure.

(10). The stinging properties may be different in the various species. Too little is known at present to form a decision.

(11). The distribution of the various forms in different parts of the reefs points to a preference of each species for a certain habitat with optimal ecological conditions. Each species has a considerable power of adjustment to more or less unfavourable conditions, resulting into a change of growth form of the colony.

Hickson (1898 *a*, *b*, 1899) examined an extensive material of *Millepora* of various growth forms and applied the criteria indicated above with (1), (2), (3), (5), (6), (8), and (9) to detect constant specific distinctions. He failed to find these and therefore concluded that all the different forms belong to the one species *Millepora alcicornis*. Hickson (1898 *a*, p. 249) writes: "The form assumed by the coral must depend upon many circumstances connected with the exact spot on which it grows", and continues: "If a *Millepora* embryo happens to become fixed on a large piece of dead coral, it will form a large incrusting base, and such a base nearly always gives rise to a lamellate form of growth; if, on the other hand, the embryo settles on a small stone or other object, lamellate growth is impossible, and the corallum will be ramified". That the latter statement is incorrect is proven by Crossland's (1928, fig. 11) specimen, a *M. platyphylla* starting growth on branches of *Acropora* and continuing as a lamellate form.

Hickson's conclusions that all the described species of *Millepora* are various growth forms of *M. alcicornis* cannot be upheld. Instead of the quotation given above the following explanation of the diversity of forms may be given.

There are a number of species of *Millepora*, each of which is so strongly variable that under the influence of external conditions it may assume a form which is more or less typical for another species. If a *Millepora* larva happens to become fixed on a spot where the conditions of existence are ideal for the species, it grows out to a colony of the typical form. If it happens to become fixed on a spot where the conditions of existence for this particular species are unfavourable it may grow out to a colony with a growth form quite different from that of the typical form. If it happens to become fixed on a spot where the conditions of existence are altogether unsuitable for this particular species (although other species of *Millepora* may find here ideal conditions for a luxuriant development) the young colony dies. It is not to be denied that certain species which have a pronounced preference for distinct parts of the reefs in these parts only develop into colonies of the typical shape. A good example forms *M. platyphylla* that attains its most vigorous growth (the "honeycomb facies") on the surf-swept edge of the reefs only, and changes into a leafy form when living in the quieter water of the lagoon.

VI. NOTES ON SPECIMENS OF MILLEPORA FROM THE ISLANDS EDAM AND NOORDWACHTER IN THE JAVA SEA

In the years 1920 to 1922 I had the opportunity to study corals on the reef of the island Edam in the Bay of Batavia. Moreover in September

1921 I stayed for about a week at the island Noordwachter in the Java Sea, farther north from Batavia. After having read Hickson's (1898 *a*, *b*, 1899) papers I paid special attention to the variation of *Millepora* in connection with external circumstances, and collected a number of colonies showing the result of these external influences. It soon became evident that not all the variation in form of *Millepora* can be ascribed to external factors. Quite commonly side by side on the surf-swept edge of the coral reefs colonies of *Millepora* are found of a compact plate-like growth next to colonies with a delicately branched manner of growth. As in these cases the external circumstances are exactly the same the differences of the growth form must be due to internal influences, or in other words, must be specific. On the other hand colonies of a similar initial growth may later present striking differences in connection with their living under different conditions, e.g., in quiet or in more agitated water. Further the nature of the substratum may be decisive in determining the shape of colonies of *Millepora,* especially of young layers of the corallum in the incrusting stage. Moreover the shape of the colonies may be altered by parasitic growths. Finally the shape of the colonies may become peculiar as a result of reaching their limit of height in connection with the surface of the water. A few instances illustrating these various phenomena are described here in some detail.

Influence of neighbouring colonies of *Millepora.*

The figures on Pl. II are photographs of a clump of *Millepora* consisting of the united parts of two neighbouring colonies growing on the extreme edge of the reef of the island Edam. Both colonies in the same manner were exposed to the full action of the waves. One half of the compound is a plate-like growth of *M. platyphylla,* developed as the typical honeycombed facies. The other half belongs to the species *M. murrayi.* It consists of a crowded mass of delicate branches which only at the sides of the colony had sufficient room to grow out as lateral ogives with parallel erect smaller branchlets. The colony had reached the level in which further growth in height was made impossible on account of its having reached the surface of the water. Expansion of the colony therefore had taken place in a lateral direction so that almost all the available space has become filled with the small branches (Pl. II fig. 2).

The compound has a larger diameter of $18\frac{1}{2}$ cm, the part belonging to *M. murrayi* has a smaller diameter of about 13 cm, the part belonging to *M. platyphylla* has a height of 17 cm. The colony of *M. murrayi* has comparatively small pores, that of *M. platyphylla* has rather large and distinct pores.

The basal half of the corallum of *M. murrayi* is covered by a thin layer of the neighbouring colony of *M. platyphylla*; at its growing edge this layer forms a distinct ridge. In the competition for space therefore the more robust colony has used the more delicate one as a substratum for further development.

A similar compound of two united colonies of *Millepora* belonging to different growth forms is that represented on Pl. III. This specimen was collected on the surf-swept edge of the reef of the island Noordwachter, so that here again the two united colonies were living under the same conditions of existence. The compound consists of a fragment of a plate-like growth of *Millepora latifolia* with a height of 11 cm, a breadth of 9 cm, and a thickness of about 1 cm in its basal region, united with a strongly branched, more delicate colony of *Millepora intricata*. The latter, as far as is was taken off, has a diameter of 7 by 8 cm and a height of about 16 cm. The branches of this colony are very broad and robust for the species, but especially when seen from above the colony has the typical intricate composition of the species. The pores are very insignificant and in many parts of the colony difficult to find, another character which points to the identity with *M. intricata*. On the other hand the pores of the plate-like growth of *M. latifolia* are very distinct and comparatively large.

The two colonies were growing next to each other and have become united. In this process the colony of stronger composition has used the more delicate corallum as a substratum, so that a large part of the branches of *M. intricata* have become covered by a thin layer of *M. latifolia*. This is clearly shown in Pl. III fig. 3, an enlarged photograph of the tips of two united branches of *M. intricata* covered with a thin layer of *M. latifolia*. A part of this thin layer has been broken off, so that the corallum of *M. intricata* is visible. By its lack of pores the surface of the latter is conspicuously different from that of the surrounding *M. latifolia*.

In both cases dealt with above the weaker of the two colonies is treated by the stronger as a foreign object and it is enveloped by its growing edges. Quite similar phenomena occur when neighbouring objects of a colony of *Millepora* are living Madreporaria or algae, as in the instances described below concerning the coral *Pocillopora* and the algae *Laurencia* and *Amphiroa*. When on the other hand different branches of one colony of *Millepora* come into contact they unite without the one part growing over the other. Therefore it strongly points to a specific difference when of two uniting colonies of *Millepora* the one becomes overgrown by the other.

In Madreporaria a few examples are known of the fusion of colonies which originally arose from different larvae. In one case the author even assumed that the component parts were representatives of different genera. In the Bahama Islands Whitfield (1901) found a colony of *Maeandra cerebrum* (Ell. & Sol.) of which the central part showed much broader and more pronounced valleys and ridges than the surrounding parts. He identified the central part as a species of *Ctenophyllia*, possibly *Ct. quadrata* Dana, and the surrounding parts as *Maeandra labyrinthica* (Gmel.) (which name is a synonym of *M. cerebrum*). The curious fact is that the valleys of "*Ctenophyllia*" are directly connected with those of *Maeandra*. This already indicates that the various parts of the colony have taken their origin from one larva, and that the differences must be due to individual variation. Soon after Whitfield's paper appeared Vaughan (1901) already emphatically disputed the author's explanation and showed that the coral only presented a case of striking variation within a single colony.

In his studies on the development and the formation of colonies in *Pocillopora bulbosa* Ehrb. and *Porites haddoni* Vaughan, Stephenson (1931) observed that often in reared colonies formed by the fusion of a number of primary polyps calcareous rims were developing separating the parts of different origin. These rims were of erratic occurrence, they might be present in one part and absent in another. In *Pocillopora* the rimless condition is the rule in normal and healthy young colonies.

Moreover partitions consisting of calcareous rims or ridges are common in corals of *Maeandra areolata* (L.) which have taken their origin from two or more planulae fixing themselves in the immediate neighbourhood. A figure of such a colony is already given by Wilson (1888, Pl. I fig. A); here the lower part is distinctly separated from the larger upper part by a distinct ridge. Yonge (1935) examined the phenomenon of compound colonies in *Maeandra areolata* in more detail, and stated that the colony has grown out from one larva if the valleys are all in communication. If on the other hand the corallum is divided into self-contained series it has grown out from as many larvae. Yonge's figure (l. c., Pl. 3 fig. 15) shows a specimen arisen from three fused polyps. Pl. IV fig. 3 in the present paper shows a specimen of *Maeandra areolata* which has taken its origin from two larvae, the calcareous ridge separating the two constituents is clearly visible.

As far as concerns the Madreporaria dealt with above the constituents of the compound colonies in each case are belonging to one species. They behave in a different manner from that in the complex colonies of *Millepora*, the parts of which are representing different species.

Influence of quiet or agitated water.

The two specimens of *Millepora murrayi* figured on Pl. XI show the effects of differences in environmental conditions. The specimen of Pl. XI fig. 2 is a part of a colony growing not far from the edge of the reef, so that it occurred in more or less agitated water. The larger branches, which are spreading as neatly curved ogives, are rather strong and robust, they bear numerous short parallel vertical branchlets.

The specimen of Pl. XI fig. 1 was used for experiments on growth (Boschma, 1936, under the name *Millepora alcicornis* forma *dichotoma*). It remained for about 16 months in the deeper water directly at the inner side of the ridge with luxuriant coral growth which forms the seaward border of the reef of the island Edam. It lived therefore for a long time in sheltered surroundings in more or less quiet water. The part of the corallum shown in Pl. XI fig. 1 almost entirely has developed in this quiet environment. As compared with the specimen of Pl. XI fig. 2 the branches are much more slender, those which are spreading laterally as ogives as well as the parallel smaller branchlets extending vertically. The latter are extremely long for the species. The whole colony is much more fragile and delicate than the other specimen.

Millepora tenella seems to attain its most vigorous development in the most strongly agitated water. The colonies of this species often occur on the extreme edge of the reef, so that they are exposed to the full surf. Here they generally form plate-like growths extending perpendicularly from the edge of the reef. The outline of the lower part of one of these plate-like growths is given in fig. 3. The more or less dichotomously divided branches are rather broad and thick, they are largely united, but especially in the marginal region the individual branches are still distinct.

Another specimen of *M. tenella* from the outermost edge of the reef is that represented in outline in fig. 4. It is again a fragment of a plate-like growth extending in a direction perpendicular to the edge of the reef. It is much more compact than the former specimen, as the branches have almost completely united, leaving only a few small openings. In the marginal region the growing branches still remain separated.

The specimen of *M. tenella* drawn in outline in fig. 5 is from the outer part of the reef, where it was found growing among various Madreporaria. It is from a less exposed area of the reef, and its growth form is much less compact than that of the former specimens. The branches are freely spreading, all practically in the same plane. They are comparatively broad and thick, but much longer and mutually very little united. The specimen represents the growth form of the species in more or less sheltered surroundings, but occurring under favourable conditions of life.

The colonies of *M. tenella* of Pl. XIV fig. 1 and Pl. XIV fig. 2 were collected from the inner region of the flourishing reef of the island Edam. They lived in a more or less sheltered locality, but the external conditions were not favourable for a vigorous development of the colonies. They are widely spreading, but the branches are narrow and thin. Though they are in a sufficiently healthy condition the colonies have a somewhat dwarfed aspect in comparison to those of the figures 3, 4, and 5.

As a matter of fact the colony of *M. tenella* of Pl. XV fig. 2 too was living on a part of the reef where the conditions of life were of a character not favourable for a strong development of the corallum.

Millepora platyphylla thrives especially in the exposed edge of the reef, here it develops into large colonies consisting of strong plates arranged in a more or less honeycombed manner. Towards the more inner regions of the reefs it often occurs as an incrusting mass over dead pieces of other corals. In my experiments on growth of various corals (Boschma, 1936) I transplanted a plate-like growth and an incrusting mass to a more or less sheltered place in comparatively quiet water. The plate-like growth here apparently came in altogether unfavourable conditions, so that it soon died. For the incrusting corallum, however, the external conditions in this new environment proved to be suitable, as in the course of 263 days it developed into a corallum showing the first traces of plate-like growths. The specimen is represented on Pl. V figs. 3 and 4. Originally it consisted of an incrustation of a lump of corallum of very little peculiar shape. This object was fastened with metal wire to a brick and left to itself in somewhat deeper water. After 263 days the lower surface (Pl. V fig. 4) had not appreciably altered its shape, but on the upper surface (Pl. V fig. 3) several ridges had developed which at their upper margins terminated in more or less truncated outgrowths which evidently are the beginnings of typical plates as they occur in *M. platyphylla*. In this case the new surroundings therefore gave the corallum a chance to develop into a more typical growth form than in its former place of living.

Influence of the substratum.

An interesting case showing the influence of the substratum in modifying the growth form of a specimen of *Millepora* is that of the compound of Pl. IV fig. 2. This consists of the fused parts of a colony of *Millepora platyphylla* and one of *Pocillopora* spec. The *Millepora* has taken the *Pocillopora* as a substratum, so that a fairly large number of the branches of the *Pocillopora* are covered by a thin layer of *Millepora*. In the left hand upper corner of the figure the plate-like growth of the *Millepora* is seen in its typical shape (somewhat foreshortened, as the photograph is taken obliquely from above), in the lower region of the figure four uncovered thick branches of the *Pocillopora* are visible, whilst the rest of the figure shows a corallum of rather warty appearance, consisting of the remaining part of the *Pocillopora* covered with a thin layer of *Millepora*. Each of the warts contains one of the minute branchlets of the *Pocillopora*. The compound forms a striking example of the ability of a coral of so typical a growth form as *Millepora platyphylla* for a complete change of form as a result of incrusting foreign objects.

As the figure is reduced the measurements of the compound may be given here. The larger diameter is 14½ cm, the smaller diameter 10 cm, and the height 15 cm.

Influence of parasitic growths.

Foreign objects attaching themselves to colonies of *Millepora* may bring about considerable changes in the form of the colonies. The most common of these are the barnacles *Pyrgoma milleporae* Darwin, which seem invariably to be associated with species of *Millepora*. When these occur in small numbers they give rise to some warty excrescences on the surface. When they are present in abundance they give the colonies an altogether different aspect from the normal shape.

The specimen of *Millepora latifolia,* figured on a reduced scale on Pl. IV fig. 1, has a height of 21 cm, a breadth of 12½ cm, and in its lower region a thickness of about 1 cm. It is largely covered with specimens of *Pyrgoma*. Especially the older barnacles (in the central part of the corallum) protrude above the surface as distinct warts, so that this part of the corallum has become decidedly uneven. When the parasites are younger they do not cause a so striking unevenness of the surface (in the marginal parts of the colony). A comparison of a fragment of *M. latifolia* without parasites (Pl. III fig. 1) with the specimen of Pl. IV fig. 1 at once shows the difference in appearance of the two colonies.

The surface of the corallum of Pl. XV fig. 4, an incrustation of a dead piece of coral, in many parts is entirely beset with barnacles. As yet these are young specimens, but in further growth they might have developed as pronounced warts, so that the corallum might have obtained the appearance of *Millepora exaesa,* whilst in all probability it belongs to *M. platyphylla*.

Peculiar deformations of the corallum by *Pyrgoma milleporae* are visible in the specimen of *Millepora murrayi* of Pl. XV fig. 1. In some parts of the colony the slender branches show well developed warts, each caused by a single large specimen of *Pyrgoma*. In other parts of the corallum there are larger warts, each resulting from a whole bunch of the parasites.

Other foreign objects settling on colonies of *Millepora* or growing in their immediate vicinity also may give rise to deformations. This occurs, e.g., when specimens of algae belonging to the genus *Laurencia* attach themselves to corals of *Millepora*. As a rule these algae then soon become overgrown by a layer of the corallum, as in the specimen of *Millepora tenella* of Pl. XV fig. 2. These parts then obtain a quite different appearance from that of the normal parts of the corallum. Besides *Laurencia* also *Amphiroa* spec. was found on the reef of the island Edam overgrown with a layer of *Millepora*.

Influence of the surface of the water.

It is well known that various Madreporaria obtain a peculiarly stunted shape when growing to a height which causes them to be exposed to the air during low tide. As growth in height then is strongly impeded the available space becomes occupied by a large number of small branches. The same changes in form may be observed in colonies of *Millepora*. The crowded arrangement of the branches of the corallum of *M. murrayi* of Pl. II is due to this lack of opportunity of growing in height.

The peculiar growth form of the fragment of *M. murrayi* of Pl. XV fig. 3 apparently is due to the same reason. Here the branches have irregularly thickened and have coalesced into masses of unusual shape. At the top of this colony there are a few short normal branches, these undoubtedly have developed as the conditions for some time again became more favourable. Undoubtedly later these young branches would have died as soon as the former unfavourable conditions were to represent themselves again. The colony is in a rather stunted condition, so that it is not absolutely certain that it belongs to *M. murrayi*. It may be a specimen of *M. tenella*, but then also it represents a form of growth entirely different from the common form.

Finally mention must be made of a specimen of *Millepora platyphylla* from the island Edam, which has a decidedly verrucose appearance (Pl. XV fig. 5). It is interesting that in the figured part of this corallum the warts on the whole are arranged in horizontal rows, as if the rows of warts represented growth lines on the surface of the corallum. The comparatively regular arrangement of these warts points again to the fact that they cannot be caused by parasites. Moreover not a single specimen of *Pyrgoma* is visible here.

VII. NOTES ON SPECIMENS OF MILLEPORA IN THE PARIS MUSEUM

In the end of September 1947 I had the opportunity to examine the extensive material of specimens of *Millepora* in the Muséum National d'Histoire Naturelle at Paris. During the comparatively short time ($2^1/_2$ days) I could stay in Paris I made notes of those specimens which seemed to be of the greatest importance. It was especially interesting to examine the type specimen of *M. squarrosa,* the characters of which are difficult to understand from the description only. The numerous specimens of *M. complanata* present in Paris are of great help to obtain an insight into the variation of this species. Further it was important to study the types of *M. intricata,* of *M. verrucosa,* and of *M. gonagra.* Moreover, the various specimens of *M. dichotoma* and of *M. reticularis* (the latter name certainly is a synonym of the former) were of great help for understanding the variation in growth form in this species.

During my visit to Paris I could not study the whole collection as completely as I might have wished. Therefore the notes as they are given in the following pages are far from complete. In many cases they are, however, sufficient to come to a decision concerning questions of characterization of species and of the synonymy of various names.

The notes on the various specimens are arranged here according to the system adopted in the present paper (if an arrangement based on the dates of description of the species really may be called a system).

Millepora alcicornis L.

Remarks are given here on a few specimens only of the extensive collection of *Millepora alcicornis* in the Paris Museum.

1. A specimen labelled "*Millepora ramosa* Dana, Guadeloupe, Mr. Duchassaing, 1870". It is a part of a colony with a height of $10^1/_2$ cm and a breadth of 10 cm. It is an interesting specimen as it has almost exactly the same manner of growth as *Millepora alcicornis* var. *β ramosa* of Esper (1790, Millep. Tab. VII).

2. A specimen from the Antilles, from Mr. Duchassaing, 1870, indentified as *Millepora esperi* Duch. & Mich. It has a height of 15 cm and a breadth of 18 by 15 cm. The specimen consists of a number of flat broad branches which at their tops and in their lateral margins are divided into numerous

smaller branchlets. This proves that the "species" *Millepora esperi* is one of the finely branched forms, quite different from the specimen identified by Hickson (1898 *b*) as *Millepora alcicornis* facies *"ramosa"*.

3. A colony labelled *"Millepora Forskalii"*, with a greater diameter of $15^1/_2$ cm, a lesser diameter of 11 cm, and a height of 7 cm. This colony in all probability is the type specimen of Milne Edwards's *Millepora Forskali*. The colony consists of a dense cluster of delicate branches which are flattened sideways and often form anastomoses. In their topmost parts they show the palmate arrangement of branchlets which is peculiar for many specimens of *Millepora alcicornis*. The branches are much slenderer than usual in the species. In many parts of the colony there are slight depressions of the surface in the centres of which the gastropores are found. This proves without any doubt that the specimen is from the Atlantic region of America. If really the specimen is the type (and there is no reason to doubt this) the locality as given by Milne Edwards (Red Sea) is due to a mistake.

Milne Edwards (1860, p. 228) gives the following definition of his *Millepora Forskali*: "Espèce très-voisine du *M. alicornis*, mais ayant les branches terminales beaucoup plus comprimées et sublobiformes" and lists as synonyms: *"Millepora alicornis*, Forskal; *M. compressa* (pars), Esper, pl. 10; *M. compressa* var. *β*, Lamarck; *M. alicornis*, Ehrenberg; *M. alicornis* Milne Edwards, Atlas du Règne anim. de Cuvier, Zooph., pl. 89, fig. 1, 1a, 1b".

Now *Millepora alcicornis* Forsk. in reality is a species of the genus *Stylophora*, as shown by Crossland (1941). Esper's *Millepora compressa* does not belong to the Hydrocoralline genus *Millepora*. It may be a Madreporarian coral, as Esper states that the calices have six septa, but the locality (the Mediterranean) makes this improbable. With *"M. compressa* var. *β* Lamarck" Milne Edwards undoubtedly means *M. complanata*, which is characterized by Lamarck (1816) as *"M. compressa, latissima, laevis; ..."*. It is, however, altogether out of the question that the specimen labelled *"Millepora Forskalii"* belongs to *M. complanata*. The *Millepora* figured in the Atlas of the Règne animal (Milne Edwards, 1836-1849, Pl. 89 fig. 1, 1*a*) undoubtedly is the real *M. alcicornis* of the West Indies, though the form of the colony somewhat reminds of that of *M. dichotoma*. It certainly belongs to the same species as the specimen labelled *"Millepora Forskalii"*, though the latter colony is much more delicate.

In numerous specimens of *M. alcicornis* in the collection of the Paris Museum there are open ampullae, e.g., in a specimen named *Millepora carthaginiensis*, evidently the type of this "species", as the colony corresponds with the figure of this form in Duchassaing & Michelotti's (1864) paper.

Millepora exaesa Forsk.

1. The type specimen of *Millepora tuberculosa* M. Edw., 1857, also the type specimen of *Millepora gonagra* M. Edw., 1860. It is the colony figured by Milne Edwards (1857, Pl. F 3 fig. 1*a*). The specimen has a height of about 9 cm, a thickness of about 7 by about $5^1/_2$ cm. It undoubtedly belongs to *M. exaesa*. Locality: Red Sea.

2. A very large colony labelled: "*Millepora squarrosa* Lmk." The colony in every respect has the characters of *M. exaesa*.

3. A specimen labelled "*Millepora gonagra* Edw. H., Iles Sandwich, Mr. Bailleu, 1878". A colony of 14 by 11 by 9 cm, not attached to its substratum, showing numerous nodose short marginal branches, so that the identity with *M. exaesa* is certain. It is improbable that the locality is correct, as Edmondson (1928, p. 6) remarks: "On Hawaiian reefs few alcyonarians are to be found and no hydroid corals such as *Millepora* and *Stylaster* have been reported although they exist at Johnston Island". (Johnston Island lies at about 17° N, 170° W, in a southwesterly direction from the Hawaiian Islands). Crossland (1948) also comments upon the remarkable absence of *Millepora* in the Hawaiian Islands.

Millepora dichotoma Forsk.

The specimens numbered 1, 2 and 3 form a continuous series from a comparatively widely meshed plate to a nearly solid plate with a few openings only in its upper region.

1. A specimen labelled "*Millepora reticularis*", a netted plate of 14 cm height, 14 cm breadth, and a thickness of about 1 cm(in the basal region). The whole plate is rather wide-meshed, so that everywhere the separate branches are still distinctly visible. The meshes occupy approximately as much space as the branches. The colony perhaps is the type specimen of *M. reticularis* M. Edw., as the description (Milne Edwards, 1860, p. 229) reads: "Polypier rameux, dont les branches subcylindriques s'étalent et se réunissent d'espace en espace, de façon à former de grandes feuilles réticulées. Calices grands et subégaux". In the specimen the gastropores indeed are more distinct than in numerous other specimens of *M. dichotoma*. Locality: Red Sea.

2. A second specimen labelled "*Millepora reticularis*", a plate of 18 cm height, $15^1/_2$ cm breadth, and a thickness of the basal region of about 1 cm. The specimen shows a network on the whole of its extent with rather wide

meshes and extremely narrow ones. Wide as well as narrow meshes occur in the upper part as well as in the lower (basal) part of the colony. In many parts the branches are broadened and largely united so as to leave just a few small openings. Locality: Red Sea.

3. A third specimen labelled "*Millepora reticularis*". It has a height of 23 cm, a breadth of 24 cm, and in its basal part a thickness of about 2 cm. The broadening and coalescence of the branches has resulted here in the formation of an almost solid upstanding plate. Only in the upper region there are a few openings left of the original network, the larger part of the colony consists of a continuous plate. The specimen is much heavier than the two former. Its surface shows a number of large specimens of *Pyrgoma milleporae*, especially in the lower part. Locality: Red Sea.

4. A specimen labelled "*Millepora reticularis*", a plate-like growth of a height of 12 cm, a breadth of 7 cm, and a thickness (in the basal region) of about 1 cm. It is distinctly reticular, the meshes being somewhat narrower than the branches. Locality: Red Sea.

5. A specimen labelled "*Millepora reticularis*", a plate-like growth of a height of $17^1/_2$ cm, a breadth of 12 cm, and a thickness (in the basal part) of about 1 cm. It is a robust, reticular plate, very much similar in growth form to the former specimen. Locality: Red Sea.

6. A specimen labelled "*Millepora dichotoma*, Mer Rouge, Mr. Lefebvre, 1827", consisting of some more or less parallel netted plates. It is distinctly reticular, the marginal branches are not so profusely united as usual in the species.

7. A specimen labelled "*Millepora dichotoma* Forsk., Djibouti, Mr. Gravier", a netted plate of a height of 27 cm and a breadth of 19 cm. Especially in its marginal part the plate is distinctly reticular, towards the base the branches become broader and the openings between the coalesced branches narrower.

8. A specimen labelled: "*Millepora dichotoma* Forsk., Djibouti, Gravier dét., Mission Gravier 1904". This specimen is somewhat larger than the former, and in every respect quite similar. The marginal region forms a system of divided branches, which towards the lower parts of the colony fuse into a network. In the basal part the colony is more compact, so that here only a few openings remain.

Millepora squarrosa Lamk.

1. The large colony of *Millepora squarrosa* in the Paris Museum has all the characters as enumerated by Milne Edwards (1860). The colony has a height of about 21 cm and a breadth of 18 by 16 cm. It consists of a number

of large plates which are covered with numerous more or less longitudinal ridges or rows of tubercles. Many of these ridges grow out to laminae which stand more or less perpendicularly to the surface of the larger plates. Often two of the larger plates are united by means of a number of these smaller laminae, or the smaller laminae themselves are more or less cylindrically contorted, so that the colony partially obtains a strongly honeycombed appearance. The whole colony has a decidedly crisped surface, quite the reverse of that found in *M. complanata*. A part of the large colony, which in all probability is the type of the species, is figured on Pl. VIII of the present paper. It distinctly shows some of the larger plates and a great number of the smaller laminae in various stages of development and contortion. The locality of the specimen is unknown. Lamarck (1816) thinks that his specimen of *M. squarrosa* came from the American seas. It is interesting that it was possible to prove that the specimen of *M. squarrosa* in the Leiden Museum without doubt came from the Atlantic region of America.

2. A specimen labelled "*Millepora plicata* Dana. Belize, Mr. Bocourt, 1875" may belong to *M. squarrosa*. The specimen consists of a colony with a large number of short and broad upstanding plates which in their marginal parts are irregularly divided into numerous short branches or papillae. It is a comparatively young colony, and it is by no means certain that it belongs to *M. squarrosa*. It is not impossible that in further growth it would have developed into the typical growth form of *M. complanata*. In many respects the growth form of this colony reminds of the specimen of *Millepora tuberculata* figured by Duchassaing & Michelotti (1864, Pl. XI fig. 4). In the specimen from Belize, however, the tubercular aspect of the surface is not as pronounced as stated by Duchassaing & Michelotti for their species.

3. A specimen with the same data and of a corresponding growth form.

Millepora complanata Lamk.

1. A colony of the growth form of the specimen represented on Pl. VII fig 2 and in fig 2 *a* and *b* of the present paper. It is the growth form named by Esper "*plicata*". It consists of two more or less parallel laminae which are united in their basal region and on one of the sides. Each of these laminae is divided into four or five narrower strips which among each other are more or less united. The height of the colony is 21 cm, the breadth 17 cm. The corallum is thin, its surface is comparatively smooth.

2. A fragment of a height of 7 cm, a breadth of $9^1/_2$ cm, and a thickness (in its basal region) of 3 mm. It is a part of the marginal region of apparently a large colony. The specimen is extremely interesting in sc

far as the gastropores as well as the dactylopores are distinctly star-shaped.

3. A large specimen from the collection of the Collège de France, with numerous narrow upstanding plates. In this specimen the pores have a tendency to remain more or less stellate.

4. A specimen labelled "*Millepora complanata* Lmk., Antilles, Mr. Schramm, 1869". It consists of comparatively broad upstanding plates which are very thin. In many parts of the colony the calices are more or less star-shaped.

5. A specimen labelled "*Millepora alcicornis* Lin., Antilles". The colony has a height of 31 cm and has a broad base on which numerous short and broad papillae (length about 3 or 4 cm, thickness about 1 cm) have developed. One part of the colony has grown out to a plate-like growth with a length of more than 20 cm and a breadth of 13 cm. In its basal part this plate has a thickness of about 1 cm, towards its upper region it gradually becomes thinner, its free margin has a thickness of a few millimetres only. A number of the dactylopores of this colony are distinctly star-shaped, the gastropores are round holes.

In the Paris Museum there are a number of other colonies labelled "*Millepora complanata*" or "*Millepora plicata*", all of which belong to *M. complanata*. Some of these are of extremely large size. Many of these colonies largely consist of narrow upstanding laminae with a breadth of 3 to 4 cm, in others the plates are much broader (often 15 to 20 cm). They have in common that the plate-like growths are thin, especially in their marginal regions, and that their surface is rather smooth and even.

Millepora platyphylla Hempr. & Ehrb.

1. The type specimen of *M. verrucosa* M. Edw., a part of a plate-like growth with a greater diameter of 27 cm and a height of 23 cm; in its basal part it has a thickness of about 2 cm. The description by Milne Edwards (1860, p. 227) reads: "Polypier en touffe composée de larges feuilles dressées, à bords presque entiers, se réunissant de loin en loin par des expansions latérales et couvertes de gros tubercules très-irréguliers. Calices très-inégaux, les principaux de grandeur médiocre; les autres extrêmement petits et répartis irrégulièrement". The specimen consists of one plate-like growth only, in all other respects the description may refer to this colony. The figured part (Milne Edwards, 1857, Pl. F 2 fig. 1 *a*), is the central portion of the marginal region of this colony. In many parts the verrucae are rather neatly arranged in longitudinal or in transverse rows, but in other parts they are irregularly disposed over the surface.

2. A specimen labelled "*Millepora Ehrenbergii*", which may represent a

fragment of the specimen described by Milne Edwards (1860, p. 226): "Polypier en touffe composée de grandes feuilles minces, peu ou point lobées sur les bords, et offrant latéralement une multitude de petites bosselures mammillaires qui sont souvent disposées en séries rameuses et qui portent chacun un calice principal entouré d'un cercle de cinq ou six calices plus petits; d'autres petits calices dans les vallées. Dans quelques parties, la distinction est peu marquée entre ces divers calices, mais en général elle est très-prononcée". The small verrucae are present in great numbers over the larger part of the surface. The fragment has a larger diameter of $15^1/_2$ cm and a height of $10^1/_2$ cm, its thin free margin is almost straight; the basal part has a thicknes of about 12 mm.

3. A part of a plate-like growth with a height of 23 cm and a breadth of $13^1/_2$ cm; in its basal region it has a thickness of 2 to $2^1/_2$ cm. Its free margin is divided into a few lobes of various breadth. The surface is rather regularly covered with verrucae, which gradually become larger towards the basal region. In the upper half each of the verrucae bears a central gastropore, the larger warts, towards the basal part of the specimen, often show a greater number of gastropores. There are a few specimens of *Pyrgoma* imbedded in the surface, but the protuberances caused by these parasites are distinctly different from the ordinary verrucae. Locality: Red Sea.

4. A part of a plate-like growth curved along a vertical axis, height about 21 cm, breadth about 10 cm. It reminds in many respects of the former specimen. The surface is rather densely covered with verrucae, which have a tendency for an arrangement in vertical rows. Locality: Red Sea.

5. A more or less amorphous mass on which small branches are beginning to develop, the latter have the typical broadened shape of young plates of *M. platyphylla*. The surface shows a fairly large number of verrucae. Locality: Red Sea.

Millepora intricata M. Edw.

1. The type specimen, a colony of a larger diameter of 19 cm, a lesser diameter of $6^1/_2$ cm, and a height of 10 cm. In general appearance, in thickness of the branches, and in the peculiar manner of coalescence of the branches it is very similar to the colony figured on Pl. X. The figure in Milne Edwards (1857, Pl. F 2 fig. 2 *a*) is very exact, it represents a small part of this colony from one of the narrow sides. The part represented in the figure is without any difficulty to be found in the specimen, it has precisely the same manner of branching and of anastomosing, and the small slightly swollen branch of the figure is present in its exact place in the specimen. Locality unknown, as already remarked by Milne Edwards (1860).

2. A large colony with the same manner of growth and similar arrangement of the branches as the type. Greater diameter 28 cm, lesser diameter 23 cm, height 17 cm. Locality unknown.

Millepora tenella Ortm.

1. A fragment of a colony labelled: "*Millepora tortuosa* Dana, Iles Fidji, Mr. Agassiz, 1862". It has a height of 7 cm and a breadth of $3^1/_2$ cm, it consists of two united branches with short side branches, the greater part of which are broken off at their bases. The specimen is too small and too incomplete to allow of an indubitable identification. It is probable that the fragment really belongs to *M. tortuosa,* so that it has to be named *M. tenella.*

VIII. NOTES ON SPECIMENS OF MILLEPORA IN THE LEIDEN MUSEUM

A number of specimens in the Leiden Museum bear unpublished museum names, provisionally given by Dr. J. G. de Man, who from 1872 to 1883 was a curator in the division of invertebrates. To avoid future confusion these names are not given here, unless they are names of varieties.

As far as concerns the localities the collection contains a fairly large number of mistakes. Some specimens of the West Indian *Millepora alcicornis* are labelled "Java", some specimens of the West Indian *M. complanata* are labelled "Java" or "Red Sea". This uncertainty of the value of the labels, especially of the older specimens, made it doubtful whether a colony of *M. dichotoma,* stated to be from the Red Sea, but differing in shape from other specimens of this locality, really was from this region. The find of a crab peculiar to the Red Sea gave evidence for the reliability of the label. In other cases the locality of specimens could be determined as the Atlantic region of America by molluscs found in the crevices of the colonies.

Millepora alcicornis L.

1. A specimen labelled "*Millepora alcicornis* Lam., Naturh. Inst. Linnaea (Berlin), 1849, Haiti". The specimen consists of two large plate-like growths in parallel planes, breadth 31 cm, height 45 cm. The plates are formed by the fusion of flattened thin branches, in the upper parts of the colony (Pl. XIV fig. 3) there are still a number of openings indicating that the plates originally consisted of separate branches. In many parts of this colony the surface shows shallow depressions, in the centres of which the gastropores are found.

2. A specimen labelled with an unpublished museum name and the indication "Junghuhn, Java". It has a larger diameter of 22 cm, a smaller diameter

of 11 cm, and a height of 27 cm.The branches are thin and flattened, they have a strong tendency to unite into plate-like expansions. In some regions the corallum shows distinct depressions of the surface, in the centre of which there are the gastropores. On the basal part of the colony there is a small colony of *Siderastrea radians* (Pall.), which proves that the specimen is not from the Indopacific region.

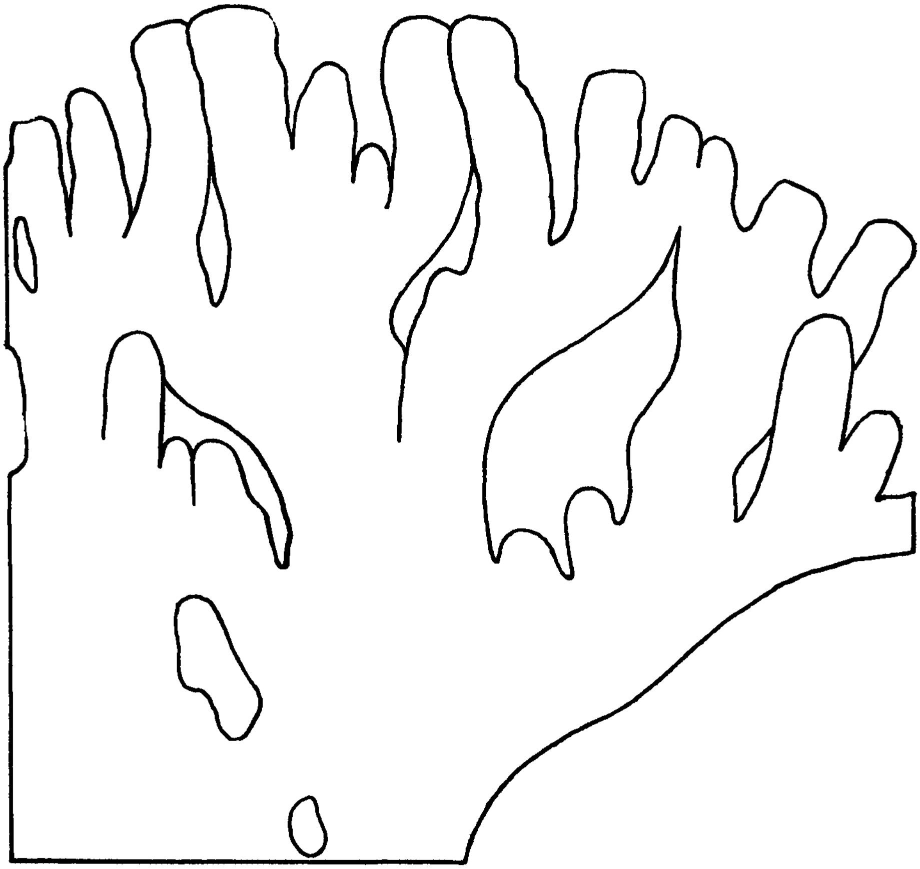

Fig. 6. Outline of a part of a colony of *Millepora alcicornis* L. of unknown locality. Leiden Museum. Natural size.

3. Another specimen labelled with an unpublished museum name with the addition "var. *javanica* de Man" and the indication "Junghuhn, Java". It has a larger diameter of 31 cm, a smaller diameter of $12^1/_2$ cm, and a height of 28 cm. It consists of a number of plate-like growths in more or less parallel planes. The growth form corresponds closely with that of the former specimen, as the branches are thin and flattened and are largely

fused into flat plates. In many parts of the corallum the surface shows shallow depressions, in the centres of which the gastropores are found. Moreover there are a great number of open ampullae.

4. A specimen with an unpublished museum name, without indication of the locality. Larger diameter 40 cm, smaller diameter 21 cm, height 28 cm. The specimen differs from the other forms of *Millepora alcicornis* by its freely extending long and thick branches. The branches often have a breadth of 8 mm and a thickness of 5 mm, quite different from the usual thin and flattened branches in the species (fig. 6). The growth form of the corallum strongly reminds of that of robust specimens of *M. tenella,* though the spreading, fan-like manner of branching is not so pronounced. The surface of the corallum does not possess the slight depressions which occur in many specimens of *M. alcicornis.* In certain parts of the corallum the pores are distinctly star-shaped. The surface is profusely pitted with open ampullae.

This specimen is rather different from the other branched West Indian forms. It is therefore interesting that proof could be obtained of its West Indian origin. A "date-stone" mussel was seen partly to protrude from a cavity in the bottom part of the coral colony. By carefully cutting away the coral material the specimen could be obtained in an undamaged state. It proved to be a fine specimen of *Lithophaga straminea* Dunker (identification by Dr. Ch. Bayer, curator of Molluscs of the Leiden Museum). This species in its distribution is restricted to the West Indian region, so that the coral undoubtedly belongs to *Millepora alcicornis.*

5. A specimen collected at Curaçao in 1880 by A. van Koolwijk, belonging to the form described as *Millepora moniliformis.* It consists of a great number of small patches covering the stems of a small specimen of *Rhipidogorgia flabellum* (L.). The corallum shows numerous open ampullae.

Millepora exaesa Forsk.

1. A specimen labelled "*Millepora gonagra* Edw. & H., Ruyssenaers, Mer Rouge". A free colony, not attached to the substratum, evidently a part of another colony which became detached and developed branches on all its sides. The larger dimension is 9 cm, in other directions the size is 7 or $7^1/_2$ cm. From the central part there are thick, slightly divided branches in all directions (Pl. V fig. 1). The pores, which are rather large and distinct, are more or less circular.

2. Another specimen with the same data. It has a similar shape, its larger diameter is $5^1/_2$ cm, in other directions the size is about 5 cm. It is interesting that in this specimen many of the pores are more or less star-

shaped. This especially holds for the dactylopores, but there are too a great number of gastropores which are more or less stellate.

3. A specimen labelled "*Millepora gonagra* Edw. & H., Clot-Bey, 1846, Mer Rouge". The corallum has a larger diameter of 15 cm, a smaller diameter of 6 cm, and a height of 7 cm. It forms an incrustation of another coral. From this incrusting part a great number of short branches (1-2 cm) are growing out, so that already the corallum has the typical growth form of *M. exaesa.*

4. A specimen with the same data, and of similar shape. It is an incrustation covered with tubercles, larger diameter 11 cm, smaller diameter 8 mm, height about 5 cm. The tubercles are too small for the young branches of typical *exaesa,* and too large for the verrucae of typical *platyphylla.* The specimen looks like an intermediate form between the two species, and is only provisionally brought to *M. exaesa.*

Millepora dichotoma Forsk.

1. Three fragments labelled "*Millepora reticularis* Rüpp., Mer Rouge". The larger fragment (Pl. VI fig. 2) has a breadth of 13 cm and a height of 15 cm. The upper half consists of a reticulated system of branches in which the openings are somewhat smaller than the thickness of the branches. The lower half is much more compact. A smaller plate of similar appearance forms a more or less parallel outgrowth. The second fragment has a breadth of 12 cm and a height of $12^1/_2$ cm, it is of the same form of growth (fig. 7). The third fragment has a breadth of 8 mm and a height of 12 cm. The latter is slightly less reticular as most of the openings between the branches have become closed. The specimens have distinct pores which in many parts of the colonies are neatly arranged in cyclosystems.

2. A specimen labelled "*Millepora reticularis* Rüpp., Clot-Bey, 1846, Mer Rouge". It consists of a few more or less parallel plates (Pl. VI fig. 1) which in their marginal region show a few openings but towards the older parts of the colony have a more solid appearance. On the edges there are very short knob-like branches. The colony has a breadth of 17 cm, its "thickness" is 8 cm, and its height is 22 cm. The pores as a rule are larger than those of the former specimens, here they are not distinctly arranged in cyclosystems.

3. A specimen labelled "*Millepora dichotoma* Forsk., Naturh. Inst. Linnaea, Berlin, Mer Rouge". It consists of a plate-like growth with a breadth of 20 cm and a height of $18^1/_2$ cm. Its marginal part is strongly reticulated, its basal part almost entirely solid. The branches on the upper margin are comparatively long and slender and distinctly dichotomously divided (fig. 8).

The growth form, therefore, is somewhat different from that of the former specimen, on the whole it is much more slender and more delicate.

4. A specimen labelled "*Millepora reticularis* Rüpp., Clot-Bey, 1846, Mer Rouge". A slightly curved plate, upper part distinctly reticular, lower

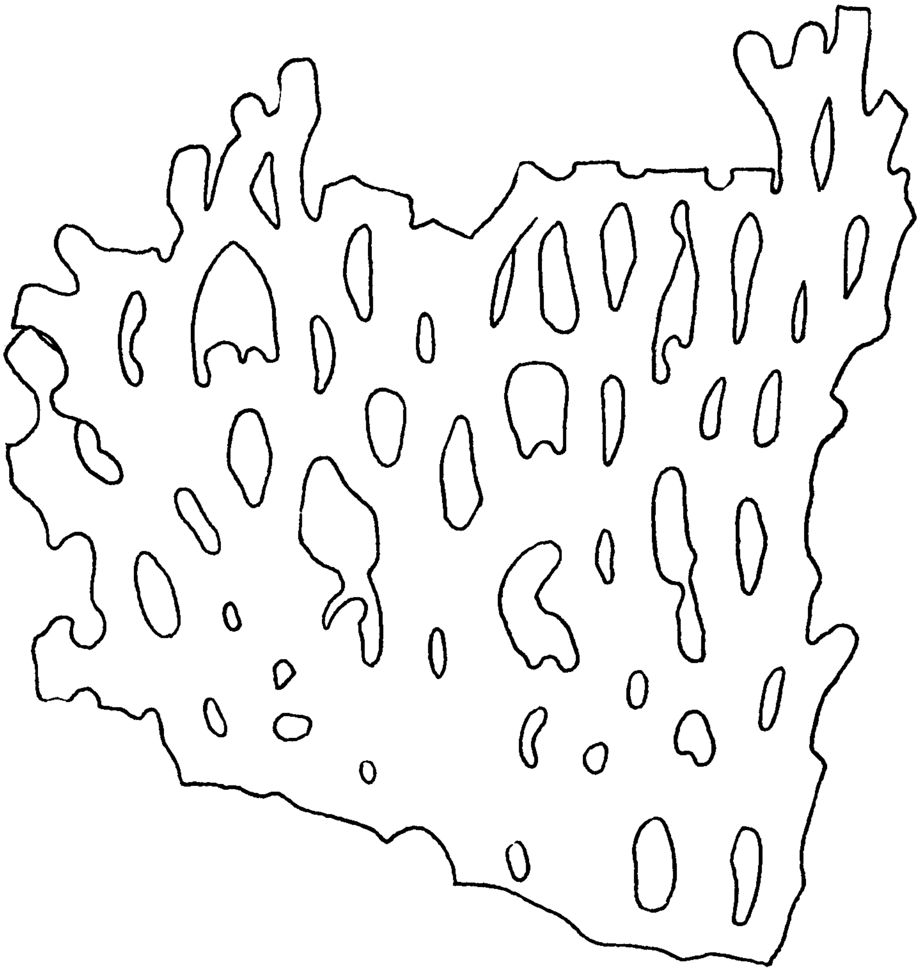

Fig. 7. Outline of a fragment of a plate-like growth of *Millepora dichotoma* Forsk. of reticulate appearance. Red Sea, Leiden Museum. Natural size.

part more or less solid on account of the openings between the branches being filled up (fig. 9). Breadth 17 cm, height 18 cm.

5. A specimen labelled "*Millepora forskalii* Edw. & H., Clot-Bey, 1846, Mer Rouge". It is a fairly large colony with a larger diameter of 38 cm, a smaller diameter of 21 cm, and a height of 21 cm, consisting of a number

of more or less parallel plate-like growths united on a comparatively solid common basal part. The basal part is so heavy and compact that here the

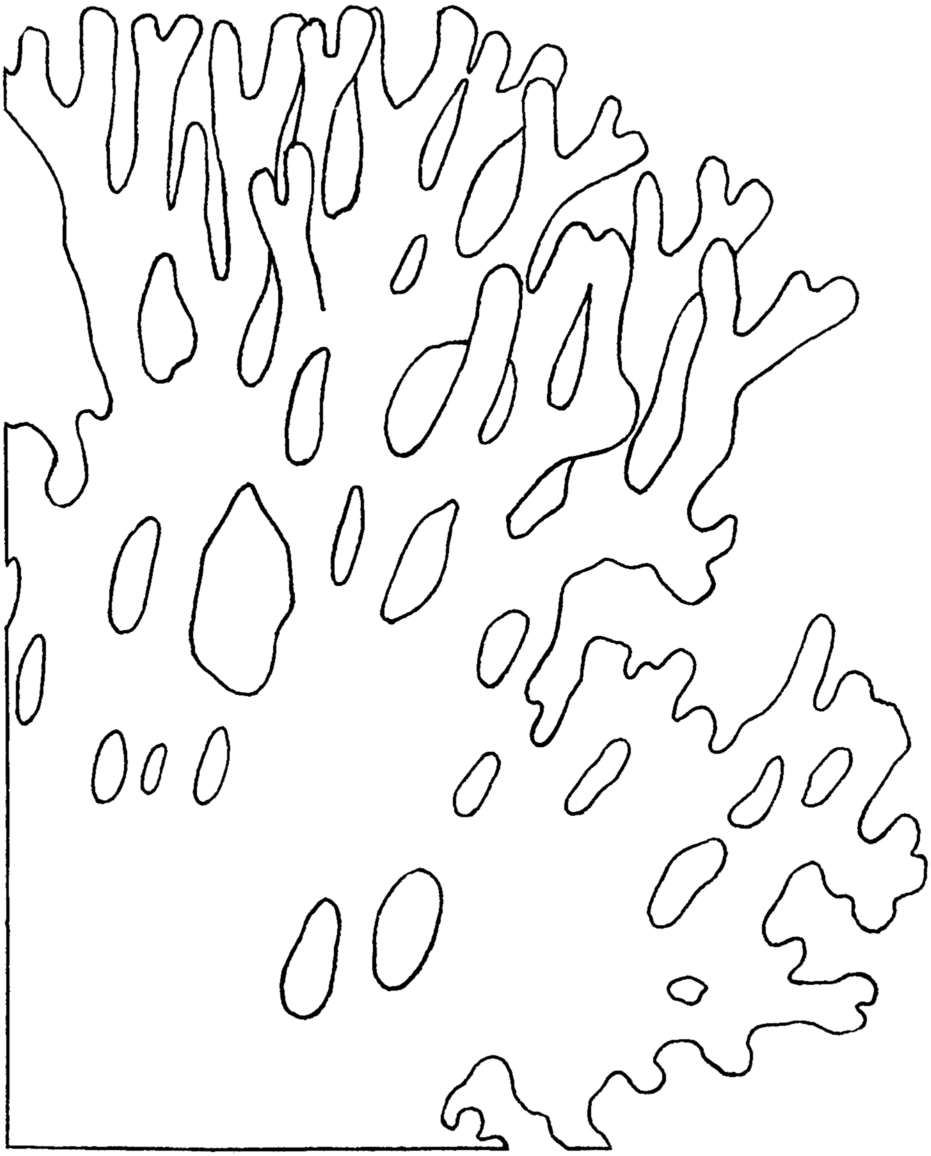

Fig. 8. Outline of a fragment of a plate-like growth of *Millepora dichotoma* Forsk. with distinct dichotomous branches. Red Sea, Leiden Museum. Natural size.

separate plates are no more visible. In the upper part of the colony (Pl. VII fig. 1) the plate-like growths are not as distinctly parallel as in typical

Fig. 9. Outline of a fragment of a plate-like growth of *Millepora dichotoma* Forsk. of rather compact appearance. Red Sea, Leiden Museum. Natural size.

colonies of the species, here there are a number of small outgrowths from a central mass, the planes of these outgrowths forming an acute angle with the neighbouring masses. In the marginal parts of the colony there are regions with a typically reticular arrangement of the branches. On the whole, however, the young branches have a tendency to form upright slender prolongations of the colony. Especially in the marginal regions there are parts with well developed pores.

The specimen in its growth form is quite different from the usual aspect of colonies of *Millepora dichotoma,* it strongly reminds of certain specimens of the West Indian *M. alcicornis,* e.g., the one figured by Agassiz (1880, Pl. 20). As the labels of museum specimens, especially those of old specimens, not always are fully reliable, a search was made for foreign objects in the cavities of the colony, with a quite satisfactory result. In a cavity bordered by the basal parts of two united plates a crab of fairly large size (breadth of the carapace $21^1/_2$ mm) was found, which after having remained in a dried state during a century was still sufficiently preserved for identification with definite result. I owe the following data to Miss A. M. Buitendijk, curator of Crustacea in the Leiden Museum. The crab undoubtedly belongs to the genus *Phymodius* and in all probability is a *Ph. granulatus* (Targ.-Torz.). In the dried specimen the hairs on the pereiopods are no more visible, whilst the pleopods are missing. Therefore certain important specific characters can no more be examined. On the other hand the last abdominal segment is broader than long, which undeniably points to *Ph. granulatus.* Now *Ph. granulatus* is a typical Red Sea crab, though Heller mentions it from Tahiti, and Balss from the Gilbert and Fiji Islands, from Madagascar and the Seychelles. In the Indopacific region exclusive of the Red Sea *Phymodius ungulatus* (H. M. Edw.) is the common species of the genus. It is therefore certain that the colony of *Millepora* is from the Indopacific region, and highly probably that it is from the Red Sea. As in some parts in the margin of the colony the branches have the growth form of typical specimens of *M. dichotoma* the specimen must be identified with that name. Moreover, there is no more reason to doubt the correctness of the label.

Millepora squarrosa Lamk.

The only specimen in the Leiden Museum is a large colony labelled with an unpublished museum name by De Man, locality unknown, received from the Paris Museum (evidently in 1815). The colony has a larger diameter of 36 cm, a smaller diameter of 30 cm, and a height of 25 cm. It consists of a mass of thin upstanding plates which by lateral expansions are repeatedly united and thereby form, at least in the greater part of the colony, a strongly honeycombed meshwork (Pl. IX). The plates have the same frilled appearance as those of the type specimen (Pl. VIII), their surface showing longitudinal ridges or rows of tubercles. Especially in the marginal parts of the plates the calices are rather distinct. The gastropores are not surrounded by depressions as in other West Indian species of the genus.

In its growth form the colony of the Leiden Museum so closely corresponds with the type specimen that there is not any doubt concerning their specific identity.

In its numerous cavities between the lamellae the colony proved to contain a number of shells of bivalve molluscs. These were two specimens of *Ostrea spreta* d'Orb. (identified by Dr. G. Ranson of the Paris Museum), three specimens of *Arca imbricata* Brug., one of *Pecten* (*Chlamys*) *antillarum* Recl., and one of *Lima scabra* Born (identifications by Mr. P. P. de Koning of the Leiden Museum). With the exception of *Arca imbricata* all these molluscs in their distribution are restricted to the West Indian region, so that the locality of the coral colony also can be fixed as the West Indies.

Lamarck (1816) remarked concerning his *Millepora squarrosa*: "Je le crois des mers de l'Amérique". The identification of the shells proves that the specimen from the Leiden Museum really came from the American Atlantic region so that this region may be definitely accepted as the type locality.

Millepora complanata Lamk.

1. A specimen labelled "*Millepora plicata* Esper, Naturh. Inst. Linnaea, 1889, Haiti". The colony has a larger diameter of 38 cm, a smaller diameter of 21 cm, and a height of 21 cm. From a common basal part ten upstanding plates take their origin. They are arranged in a crescentic row, they vary in breadth from about 4 to 8 cm and have a more or less truncated free margin. A part of this colony is figured on half the natural size on Pl. VII fig. 2. The individual plates may remain separate, but in many cases they have mutually united. The plates are of a rather firm structure, their free marginal parts are thin. The surface of the corallum is smooth and even, in many parts there are distinct, though shallow and insignificant, slight depressions, in the centres of which the gastropores occur.

2. A specimen labelled with an unpublished museum name, locality unknown, received from the Paris Museum (evidently in 1815). The colony has a larger diameter of 46 cm, a smaller diameter of 20 cm, and a height of 28 cm. It consists of a large number of upstanding plates which are extremely broad in comparison to those of other colonies of the same species.

The plates have a tendency to fuse in their lateral marginal regions, so that the colony in some respects becomes more or less honeycombed. Accordingly in its growth form the colony shows some resemblance to *Millepora squarrosa*. The surface of the plates, however, is rather smooth and even, which points to the identity with *M. complanata*. It does not show the slight depressions as they occur in many other colonies of the species.

In the Paris Museum there is at least one colony, of much larger size, which has a completely similar growth form.

3. A colony labelled "*Millepora platyphylla* Ehrb., Junghuhn, Java". Larger diameter 16 cm, smaller diameter 9 cm, height $17^1/_2$ cm. The surface of the corallum is flat and even, in some parts there are very shallow depressions, in the centres of which the gastropores are found. In certain parts of the corallum the pores are distinctly star-shaped. The specimen shows numerous pits of open ampullae.

4. A second specimen with the same label. Here the gastropores are not found in depressions.

5. A specimen labelled "*Millepora platyphylla* Ehrb., Mus. de Paris, Mer Rouge". Larger diameter 23 cm, smaller diameter 19 cm, height 17 cm. Surface flat and even, in some places slight depressions in the centres of which there are the gastropores.

6. A specimen labelled "*Millepora porulosa* Ehrb., Mus. de Paris". The surface in some parts of the corallum has distinct shallow depressions with gastropores in their centres.

7. A specimen labelled "*Millepora plicata* Esper, Curaçao, F. F. Steenberghe, Mei 1864". It has distinct shallow depressions in the centres of which there are the gastropores.

Millepora platyphylla Hempr. & Ehrb.

1. A specimen labelled "*Millepora verrucosa* Edw. & H., Ruyssenaers, Mer Rouge". It is a marginal fragment of a large colony, broad 14 cm and high 11 cm. The free margin is divided into a number of irregular lobes (Pl. V fig. 2). In its marginal part the surface of the corallum is rather flat and even, but in the older parts of the colony the surface is crowdedly covered with small verrucae, each of which on its top bears a gastropore. The regular distribution of the verrucae proves that these are not caused by barnacles. There are a few specimens of *Pyrgoma milleporae* imbedded in the surface of the corallum, but these have not given rise to warts. Even the young barnacle in the left hand corner of the figure, near the margin, does not protrude appreciably above the surface of the corallum.

2. A specimen labelled "*Millepora verrucosa* Edw. & H., Clot-Bey, 1846,

Mer Rouge". It is a marginal fragment of a large colony with a breadth of 13 cm and a height of 12 cm. The free margin is strongly divided into lobes of various height, so that this part of the colony was still in full growth. The surface of the corallum is densely covered with small verrucae, each of which in its topmost part bears a distinct gastropore.

3. A specimen labelled "*Millepora verrucosa* Edw. & H., Ruyssenaers, Mer Rouge". It consists of the marginal part of a large colony, a strongly bent plate with truncated edge, 13 cm high and 7 cm broad. The surface of the corallum is densely covered with small verrucae, each showing a central gastropore.

4. A specimen labelled "*Millepora ehrenbergi* Edw. & H., Clot-Bey, 1846, Mer Rouge". A fragment of a large colony with truncated edge, dimensions: 15 cm broad, 14 cm high. In its lower part it has a thickness of about 2 cm. The specimen is of a plate-like growth and has a comparatively smooth and even surface.

5. A specimen labelled "*Millepora verrucosa* Edw. & H. var.? *moluccensis* de Man, Reinwardt, Moluques". It consists of three small fragments, the largest of which has a larger transverse diameter of 7 cm, a smaller diameter of $5^1/_2$ cm, and a height of about 8 cm. The specimens represent marginal parts of a large colony, each of them consists of some united plates which show a number of ridges and tubercles, but on the whole have a comparatively smooth surface. The specimens bear a striking resemblance to the specimen of "*Millepora complanata*" of Wood-Jones (1910, fig. 34), which later was identified as *M. platyphylla* by Vaughan (1918).

As names of varieties have no standing in nomenclature there is no harm in mentioning the name on the label of this specimen.

6. A fragment labelled "Bikini, 1946, De Bruin leg., De Graag don.". The specimen is broken off from the upper part of a colony which apparently was living under unfavourable conditions. It consists of two broad, flattened branches and the remnants of a third (fig. 10). The colony from which the fragment formed a part was composed of branches which were rather strongly united but which left openings between them. The colony therefore is of a highly aberrant form for the species. In its growth form it reminds strongly of one of the specimens from Tahiti figured by Crossland (1928, Pl. IV fig. 11). The fragment has a height of 10 cm, a breadth of 9 cm, its thickness does not notably exceed 1 cm. The surface of the corallum is more or less uneven on account of warty excrescences of very slight height. The cyclosystems, however, are distributed without regard to these elevations of the surface, the gastropores may be found on the tops of the excrescences,

but in many cases they occur in the sunken parts of the surface as well. The pores are of fairly large size, as usual in *Millepora platyphylla.*

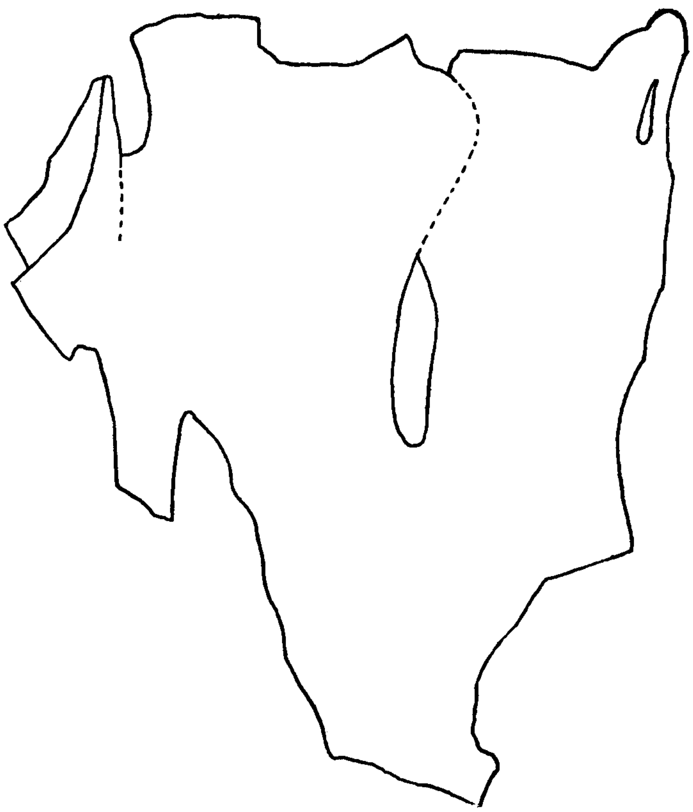

Fig. 10. Outline of a fragment of branched growth of *Millepora platyphylla* Hempr. & Ehrb. Bikini, Leiden Museum. Natural size.

Millepora intricata M. Edw.

1. A specimen labelled "*Millepora,* Dr. Serrurier, 12 Mei 1891, Carolinen". The colony has a larger diameter of 34 cm, a smaller diameter of 25 cm, and a height of $15^1/_2$ cm. It consists of a complicated system of small branches growing in all directions and largely anastomosing with neighbouring branches, thereby forming a complicated tangle of growth (Pl. X). The colony in every respect corresponds with the type specimen in the Paris Museum.

2. A specimen labelled "*Millepora,* Molukken". Larger diameter 24 cm, smaller diameter 20 cm, height 14 cm. The branches are slightly narrower and

thinner than those of the former specimen, in all other respects it is quite similar.

3. A specimen labelled "*Millepora intricata* Edw. & H., Hoedt, Amboina". Larger diameter $11^1/_2$ cm, smaller diameter $7^1/_2$ cm, height 8 cm. It is a part of a larger colony, it has narrow and thin branches, as those of the former specimen.

4. A specimen labelled "*Millepora intricata* Edw. & H., Ludeking, 1863, Amboina". Larger diameter 16 cm, smaller diameter 12 cm, height about 10 cm. Corresponds in growth form and shape of the branches with the former specimens.

5. A specimen labelled "*Millepora intricata* Edw. & H., Müller, Sumatra". Larger diameter 14 cm, smaller diameter 12 cm, height about 8 cm. The branches are extremely thin and narrow. In its growth form the colony corresponds completely with the former specimens.

Millepora tenella Ortm.

1. A specimen labelled "*Millepora digitata* de Man, Reinwardt, Molukken". The colony has a larger diameter of 32 cm, a smaller diameter of 22 cm, and a height of 21 cm. It consists of branches which in a fan-shaped manner are more or less arranged as plate-like growths. The different plates are partly more or less parallel and partly in planes perpendicular to the former (Pl. XIII figs. 1 and 2). The branches are distinctly flattened, their tops are gradually broadening and beginning to divide in their broadest parts.

2. A specimen with the same data on its label. Larger diameter 26 cm, smaller diameter 21 cm, height 22 cm. In its growth form this colony completely corresponds with the former specimen. The branches are more or less arranged in a fan-shaped manner, thereby forming more or less plate-like growths, which partly have parallel planes (Pl. XIII fig. 3). The figure shows the broadening of the topmost parts of the branches and their beginning to divide into more or less dichotomous systems.

3. A specimen labelled "*Millepora digitata* de Man, Junghuhn, Java". Larger diameter 31 cm, smaller diameter 28 cm, height $16^1/_2$ cm. In the growth form of the colony and in the shape of the branches and their arrangement the colony corresponds closely with the former specimens.

4. A specimen with the same data. Larger diameter 26 cm, smaller diameter 14 cm, height 19 cm. Corresponds in general aspect and in the shape of the branches with the former specimen.

5. A specimen labelled "*Millepora? truncata* de Man, Ludeking, 1863, Amboina". The colony has a larger diameter of 28 cm, a smaller diameter of 18 cm, and a height of $12^1/_2$ cm. It consists principally of four plate-like

growths, in two pairs extending in opposite directions, the individual plates of each pair in planes forming an angle of about 35 degrees. Towards their distal parts two of the four plates are again divided into smaller plates which have an angle of about 35 degrees with the larger plates. The plates are of comparatively loose structure. Their very broad base is divided into a few broad branches which give rise to numerous smaller branches arranged in a fan-shaped manner. As a rule the distal parts of the colony consist of rather long and slender branches, usually widening towards their extremities. In many parts of the colony the pores are arranged in distinct cyclosystems, which often are situated on insignificant verrucae, the gastropores in the centres of these minute mounds.

6. A specimen with the same data, a plate-like part of a colony with a breadth of 10 cm and a height of 9 cm. It is of the same loose manner of growth as the former specimen.

7. Another specimen with the same data, a plate-like growth with a breadth of $12^1/_2$ and a height of 10 cm. The distal parts of the branches are more fully united than those of the former specimen, in other respects it is quite similar.

8. A specimen labelled "*Millepora forskalii* Edw. & H., Wienecke, 1863, Timor". The colony consists of a plate-like growth of 28 cm breadth and 18 cm height, of a much more compact growth form than the former specimens (Pl. XII fig. 2). The branches still have a more or less fan-shaped arrangement, but they are largely united, so that only the tips of the branches remain free. The colony therefore appears quite different from the one of Pl. XII fig. 1. In many parts of the colony there are distinct cyclosystems, often on the top of minute elevations, the gastropores occupying the centres of these insignificant verrucae.

9. A specimen with the same data. Larger diameter 18 cm, smaller diameter 7 cm, height about 12 cm. It is a somewhat curved plate-like growth, very similar to the former specimen in its manner of branching and fusion of the branches.

The name *digitata* was first used by Esper (1790) for a variety of *Millepora alcicornis,* it was used as a species name by Duchassaing & Michelotti. The name *Millepora truncata* was first used by Esper (1790) for a form belonging to the Nullipores. Dana's name *truncata* for a variety of his *Millepora squarrosa* (correctly *M. platyphylla*) therefore was preoccupied. The specimens labelled "*M. truncata*" show a slight resemblance to Esper's species of this name, especially as far as concerns the broadened tips of the branches. The name *Millepora forskali* M. Edw. is a synonym of *M. alcicornis* L.

IX. NOTES ON SPECIMENS OF MILLEPORA IN THE AMSTERDAM MUSEUM

The following notes comprise the chief particulars of the larger part of the material of *Millepora* present in the collections of the Zoological Museum at Amsterdam. Not all the specimens are dealt with here, the notes are referring chiefly to specimens which for one or other reason seemed to be of importance. The material of the Siboga expedition, which forms a part of the collections of the Amsterdam Museum, is mentioned here for the data concerning the geographical distribution only. The particulars of the specimens from the Siboga expedition will be given in a later paper.

Millepora alcicornis L.

1. A specimen labelled "Antillen, mus. Van Heukelom". It is a pronouncedly branched colony reminding in every respect of the form described by Esper (1790) as var. *ramosa*. The height of the colony is 14 cm, its larger lateral dimension 15 cm, its smaller lateral dimension 13 cm.

2. A specimen labelled "Antillen, mus. Van Heukelom". It consists of small patches covering the surface of a Gorgonid, representing the form described as *moniliformis* by Dana (1848).

3. A specimen labelled "Antillen, mus. Van Heukelom". It has a knobbed appearance, and the form consequently at first sight strongly reminds of that of *M. exaesa*. The colony forms, however, a thin incrustation over a dead colony of a species of *Porites*, which explains its aberrant shape. On the topmost regions there are a few delicately branched parts. The surface shows depressions in the centres of which there are the gastropores.

4. A specimen labelled "Curaçao, Den Dekker". It is a rather flat colony of strongly branched structure. It has a height of 37 cm and a breadth of 42 cm. The surface of the corallum shows slight depressions in the centres of which there are the gastropores.

5. A number of delicately branched small colonies labelled "St. Anna Baai, Curaçao, don. Hoedemaker".

6. A specimen labelled "Curaçao, Molengraaff leg., 1923". It is a delicately branched colony, in its growth form more or less reminding of that of *M. tenella*. The surface of the corallum shows distinct depressions in the centres of which there are the gastropores. The colony has a height of 10$^1/_2$ cm, its lateral dimensions are 12 by 6 cm.

7. A specimen labelled "Caracas Baai, Curaçao, C. J. van der Horst leg., 19 V 1920". In its form of growth the colony reminds more or less of that of *M. tenella*. It has a height of 18 cm, the lateral dimensions are 27 by 18 cm.

8. A specimen labelled "Westpunt Curaçao, C. J. van der Horst leg., 14 V 1920". It is a strongly branched colony with a height of 12 cm, and with lateral dimensions of 15 by 8 cm.

In the collection of the Amsterdam Museum there are several other specimens from Dr. Van der Horst's voyage to Curaçao. They are of various forms, strongly branched or of a more or less knobbed appearance.

9. A colony labelled "*Seriatopora caliëndrum*, Roode Zee, Heinr. Platow, Hamburg, Naturalienhandlung". Undoubtedly the locality as well as the identification are entirely wrong. The colony is a delicately branched specimen of *M. alcicornis* from the West Indies. Its surface shows distinctly enough the slight depressions surrounding the gastropores, a peculiarity which is known to occur in West Indian species of the genus only.

10. A large colony from unknown locality extending chiefly in one flat plane, consisting of rather delicate branches forming a network. The height of the colony is about 50 cm, its breadth about 59 cm. The colony shows a multitude of open ampullae.

11. A specimen of a strongly branched shape from unknown locality, which especially in its distal parts reminds of *M. dichotoma,* though the branches are more slender than generally in the latter species. The colony has a height of 24 cm, the larger lateral dimension is 29 cm, the smaller lateral dimension 16 cm. Many parts of the surface distinctly show slight depressions in the centres of which the gastropores are found. Many parts of the surface are profusely pitted with open ampullae.

Millepora exaesa Forsk.

1. A specimen labelled "Roode Zee, don. Van Lennep". When being collected the colony was not attached to its substratum. It consists of a central mass beset with short thick knobbed branches of a diameter of 1 cm approximately. The colony has a height of 11 cm, its lateral dimensions are 12 by 11 cm.

2. A specimen labelled "Zuidzee, don. F. M. Cowan". The manner of growth is that of *M. exaesa,* but the branches are rather thin, their thickness as a rule not exceeding $^1/_2$ cm. The colony has a height of 13 cm, the larger lateral dimension is 8 cm, the smaller lateral dimension $4^1/_2$ cm.

Millepora dichotoma Forsk.

A specimen labelled "Roode Zee, don. Van Lennep". It is a fragment of a larger colony, most of the branches of which have broken off. It is of a rather compact growth form as most of the fenestrae between the original branches have become closed. The height of the fragment is $11^1/_2$ cm, its breadth 8 cm, its thickness (in the lower part) about $1^1/_2$ cm.

Millepora squarrosa Lamk.

1. A specimen labelled "Venezuela, don. Smissaert" consisting of a large part of a colony which had become detached and has continued its growth in a direction different from the original manner. The larger dimension of the specimen is 26 cm, the smaller dimensions are 22 by 13 cm. It consists of narrow plate-like strips of coral which have a more or less parallel course and show numerous smaller lamellae and ridges. There are distinct depressions around the gastropores. In its characters the specimen in many respects is intermediate between *M. squarrosa* and *M. complanata*. As the plate-like growths present numerous ridges and have a more or less twisted manner of growth the colony seems to have the chief characters of *M. squarrosa*. It may, however, represent an aberrant specimen of *M. complanata*.

2. Another specimen labelled "Venezuela, don. Smissaert". It consists of a lump of dead coral with a larger diameter of 60 cm, on which there are a number of young colonies, which in their manner of growth closely correspond with that of the former specimen, so that in many respects they represent a form intermediate between *M. squarrosa* and *M. complanata*. The surface of the corallum shows distinct shallow depressions surrounding the gastropores.

3. A specimen bearing a label reading "*Galaxea cuspidata,* Singapore, Heinr. Platow, Hamburg, Naturalienhandlung" and another label reading "Collectie Van Son, 1904". It undoubtedly represents a West Indian form of *Millepora,* as the gastropores are surrounded by distinct depressions of the surface. The colony has a height of 35 cm, a larger lateral diameter of 31 cm, and a smaller lateral diameter of 30 cm. It consists of numerous upstanding narrow lamellae which are covered with ridges in longitudinal and transverse directions. When seen from above the colony shows a more or less honeycombed arrangement of the lamellae, but in general these lamellae remain isolated. The growth form shows some resemblance to that of *M. complanata,* but most of the characters of the colony point to its identity with *M. squarrosa.*

4. A specimen bearing a label reading "*Millepora alcicornis* L., mus. Van Heukelom". The specimen consists of a conglomerate of thick branches which at their margins give rise to small clusters of young colonies. These young colonies are composed of numerous small lamellae which are crowdedly arranged. As yet they do not distinctly show the specific characters of *M. squarrosa,* but in the course of growth they undoubtedly would have given rise to the more or less twisted masses peculiar to the species. The whole mass has a size of 27 by 20 by 20 cm.

Millepora complanata Lamk.

1. A specimen with an old label reading "*Millepora foliata* Milne Edwards & Haime, ex museo Van Lidth de Jeude". The colony has a height of 52 cm, a larger lateral dimension of 71 cm, and a smaller lateral dimension of 29 cm. It consists of a large number of upstanding plates which broaden towards their upper parts and may attain a height of 30 cm and a maximum breadth of 19 cm. The plates have a rather thick base but gradually become narrower, their free extremity having a rather sharp edge. The colony in many respects reminds of that figured by Knorr (see fig. 2 *a* in the present paper).

2. A specimen with an old label "*Millepora foliata* Milne Edwards & Haime, mus. Van Heukelom". It is a rather robust colony of *M. complanata* with a height of 30 cm, and lateral dimensions of 35 by 21 cm. The surface of the corallum shows depressions surrounding the gastropores.

3. A specimen labelled "*Millepora alcicornis* L., Antillen". The colony consists of a number of broad flat plates, height of the colony 16 cm, larger lateral diameter 25 cm, smaller lateral diameter 13 cm. The specimen is interesting in so far as the greater part of the calicles are of a distinctly stellate shape.

4. A specimen labelled "Curaçao, Den Dekker". It consists of a large flat plate with a height of 27 cm and a breadth of 21 cm. The surface of the corallum has slight depressions surrounding the gastropores.

5. A specimen labelled "Caracas Baai, Curaçao, C. J. van der Horst leg., 10 IV 1920". The colony consists of rather thick plates which have a thin upper edge. The height of the colony is 36 cm, its lateral dimensions are 21 by 20 cm. Its surface shows slight depressions surrounding the gastropores.

6. A specimen labelled "Spaansch Water, Curaçao, C. J. van der Horst leg., 19 IV 1920". It consists of a rather thin plate divided into a few lobes (fig. 11 in the present paper); on its surface there are a few worm tubes. Its height is 17 cm, its breadth has approximately the same dimension. The thinness of the plate-like growth and the uneven surface of its growing edge indicate that the specimen was living under more or less unfavourable conditions.

7. A specimen from unknown locality consisting of a comparatively small number of broad upstanding plates with a thin growing edge, the largest of which has a breadth of 22 cm. The whole colony has a height of 35 cm and lateral dimensions of 33 by 19 cm. The surface of the corallum shows distinct shallow depressions in the centres of which there occur the gastropores.

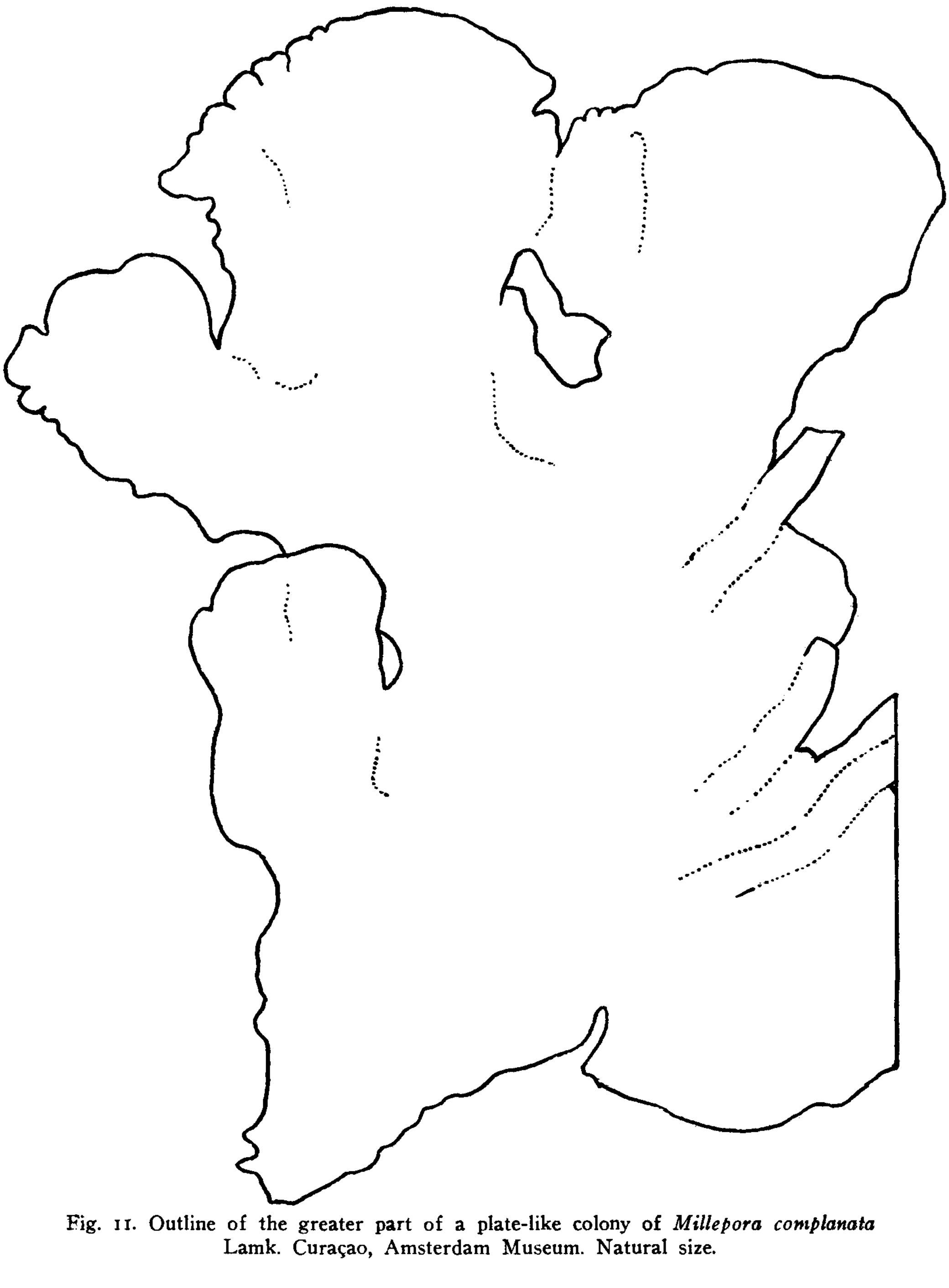

Fig. 11. Outline of the greater part of a plate-like colony of *Millepora complanata* Lamk. Curaçao, Amsterdam Museum. Natural size.

Millepora intricata M. Edw.

1. A specimen labelled "*Millepora alcicornis* L., Brandewijnsbaai, Sumatra". It has the typical characters of *M. intricata,* it consists of thin but comparatively strong branches which are loosely connected to form an intricate network. The height of the colony is 17 cm, its lateral dimensions are 21 by 15 cm.

2. A specimen with an old label "*Millepora intricata* Milne Edwards & Haime" of unknown locality. It has the typical characters of the species. The colony has a height of 20 cm, its lateral dimensions are 29 by 19 cm.

Millepora murrayi Quelch

A specimen labelled "*Millepora alcicornis* L., don. F. van Heukelom" of unknown locality. The colony is rather finely branched, its principal branches have grown in the shape of ogives, on the latter there are a great number of more or less parallel thin vertical branchlets. The colony has a height of 18 cm, a larger lateral dimension of 26 cm, and a smaller lateral dimension of 23 cm. It has become detached from its base, so that there are two directions of growth. When it became detached it was turned upside down, and therefore the new branches developed in an opposite direction from the older ones.

Millepora tenella Ortm.

A specimen labelled "Sabang, don. G. Herman, 1920". It forms a more or less plate-like growth chiefly extending in one vertical plane, consisting of a network of mutually united branches (figs. 12 and 13 in the present paper). The colony has a height of 33 cm and a larger lateral diameter of 45 cm. In its basal and central regions the corallum forms an almost continuous mass in which very few openings between the original branches have remained open. Towards the margin there are still numerous branches which are not united with others or to a slight degree only. The colony is rather robust for the species but especially in its peripheral regions it shows the typical characters, notably the broadening of the branches before they start to divide. The part of the colony represented in natural size (fig. 13) reminds in every respect of specimens of *M. tenella* from the reef of the island Edam.

The following list contains the data of the localities and the identifications (as far as possible) of the material collected by the Siboga expedition.

Sta. 60. Haingsisi, Samaoe Island, west of Timor, April 27-28, 1899, 1 *Millepora tenella.*

Sta. 129. Anchorage off Kawio and Kamboling Islands, Karakalong group, west of the Talaud Islands, July 22-23, 1899, 1 *Millepora exaesa.*

Sta. 193. Sanana Bay, east coast of Soela Besi, September 13-14, 1899, 1 *Millepora exaesa*, 1 *M. platyphylla*.

Sta. 213. Island Saleyer, south of Celebes, September 26 - October 26, 1899, 1 *Millepora platyphylla*, 1 *M. intricata*, 3 *M. tenella*.

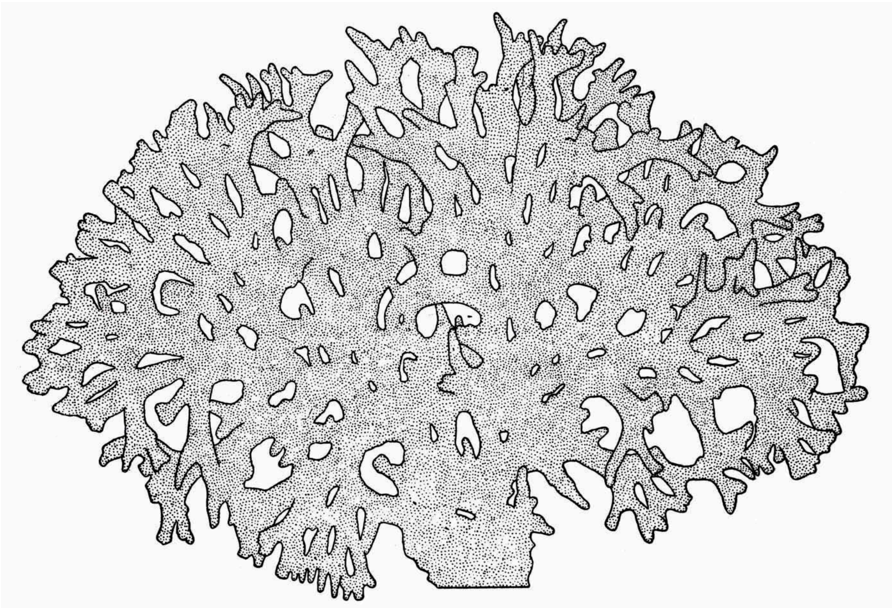

Fig. 12. Plate-like colony of *Millepora tenella* Ortm. Sabang, Amsterdam Museum. ¼ natural size.

Sta. 219. About 5 miles south west of Binongka Island (± 6° S, 124° E), November 1, 1899, 1 *Millepora platyphylla*. As for this station depths are recorded of 292-153 m, it is probable that the material of *Millepora* indicated as from Sta. 219 in reality is from Sta. 220, Binongka Island).

Sta. 220. Anchorage off Pasir Pandjang, west coast of Binongka Island (± 6° S, 124° E), November 1-3, 1899, 1 incrusting specimen of *Millepora*.

Sta. 250. Island Koer, west of the Kei Islands, December 6-7, 1899, 4 *Millepora intricata*.

Sta. 252. West side of Island Taam, west of the Kei Islands, December 8-9, 1899, 2 *Millepora exaesa*.

Sta. 282. Anchorage between Noesa Besi and the north east point of Timor, January 15-17, 1900, 3 incrusting specimens of *Millepora*.

Sta. 296. Anchorage off Noimini, south coast of Timor, January 24-26, 1900, 1 incrusting specimen of *Millepora*.

Sta. 299. Boeka or Cyrus Bay, south coast of Rotti, January 27-29, 1900, 1 *Millepora murrayi*.

Sta. 301. Papela Bay, east coast of Rotti, January 30 - February 1, 1900, 1 incrusting specimen of *Millepora*.

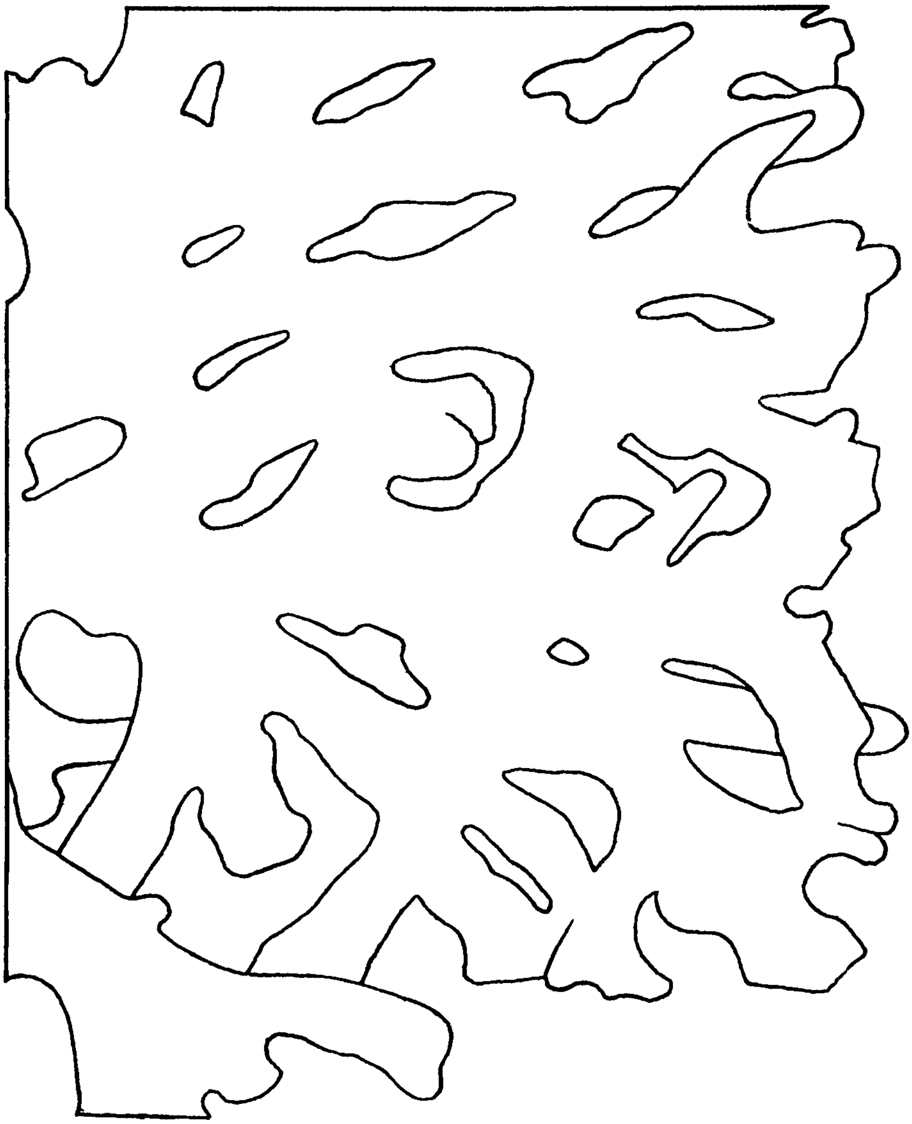

Fig. 13. Outline of a part of the colony of *Millepora tenella* Ortm. of fig. 11 (reverse side). Natural size.

Sta. 313. Anchorage east of Dangar Besar, Saleh Bay, north coast of Soembawa, February 14-16, 1900, 1 *Millepora platyphylla*.

Sta. ?. 1 *Millepora tenella*.

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EXPLANATION OF THE PLATES

Plate I

Fig. 1. The figure of *Corallium asperum candicans adulterinum* on page 806 of Tomus III Liber XXXIX of Bauhinus, Cherlerus, Chabraeus & a Graffenried (1651). Original size.

Fig. 2. The figure of *Corallium album fragile polyschides ramusculis aequalibus contiguis dumosum* on Tab. 10 of Tomus III Sectio XV of Morison (1715). Upper and lower part omitted. Original size.

Fig. 3. The figure of *Corallium albidum latum & compressum ad extrema tantum ramosum, sive Corallium spurium ex variis quasi tegumentis sibi invicem incumbentibus conflatum* on the same plate of Morison (1715). Original size.

Fig. 4. The figure of *Corallium albidum digitatum, ramis hinc inde contiguis ad latitudinem dispositis* on the same plate of Morison (1715). Original size.

Plate II

Fig. 1. The united part of colonies of *Millepora platyphylla* Hempr. & Ehrb. (left) and *M. murrayi* Quelch (right) from the edge of the reef of the Island Edam (Bay of Batavia), July 1921. Side view. $^3/_5$ natural size.

Fig. 2. The same, upper view. $^3/_5$ natural size.

Plate III

Fig. 1. The united part of colonies of *Millepora latifolia* nov. spec. (upper part) and *M. intricata* M. Edw. (lower part) from the edge of the reef of the Island Noordwachter (Java Sea), September 1921. Side view. $^7/_{10}$ natural size.

Fig. 2. The same from another angle. To the left *M. latifolia,* to the right *M. intricata.* Side view. $^7/_{10}$ natural size.

Fig. 3. Part of the same compound, enlarged. Branches of *M. intricata* covered with a thin layer of *M. latifolia.* A part of this thin layer is broken so that the surface of *M. intricata* becomes visible. In fig. 2 the branches of fig. 3 are to be seen from a slightly different angle. About 5 times natural size.

Plate IV

Fig. 1. *Millepora latifolia* nov. spec. from the outer region of the reef

of the Island Edam (Bay of Batavia), May 1921. Specimen largely infested with *Pyrgoma*. Side view. $^{7}/_{10}$ natural size.

Fig. 2. *Millepora platyphylla* Hempr. & Ehrb. from the outer region of the reef of the Island Edam (Bay of Batavia), May 1921. Specimen growing next to a *Pocillopora*, which it has partially overgrown. Obliquely from above. $^{5}/_{8}$ natural size.

Fig. 3. *Macandra areolata* (L.) from Tortugas, Florida, July 1925. Colony consisting of two parts, each derived from a separate larva. Obliquely from above. Natural size.

Plate V

Fig. 1. *Millepora exaesa* Forsk. Specimen from the Red Sea in the Leiden Museum, collected by Ruyssenaers. Natural size.

Fig. 2. *Millepora platyphylla* Hempr. & Ehrb. Specimen from the Red Sea in the Leiden Museum, collected by Ruyssenaers. Natural size.

Fig. 3. *Millepora platyphylla*. Hempr. & Ehrb. Part of an originally amorphous mass which for 263 days has been attached to a brick in quiet water and has developed young plate-like outgrowths. Island Edam (Bay of Batavia), September 1922. Obliquely from above. $^{2}/_{3}$ natural size.

Fig. 4. Same colony, under side. $^{2}/_{3}$ natural size.

Plate VI

Fig. 1. *Millepora dichotoma* Forsk. Red Sea, Clot-Bey, 1846. Leiden Museum. Natural size.

Fig. 2. *Millepora dichotoma* Forsk. Red Sea. Leiden Museum. Natural size.

Plate VII

Fig. 1. *Millepora dichotoma* Forsk. Red Sea, Clot-Bey, 1846. Leiden Museum. $^{1}/_{2}$ natural size.

Fig. 2. *Millepora complanata* Lamk. Haiti, from Naturhist. Inst. Linnaea, Berlin, 1889. Leiden Museum. $^{1}/_{2}$ natural size.

Plate VIII

Millepora squarrosa Lamk., part of the type specimen in side view. Paris Museum. Natural size.

Plate IX

Millepora squarrosa Lamk., part of a large colony, obliquely from above. Leiden Museum. Natural size.

Plate X

Millepora intricata M. Edw., the larger part of a colony in side view. Caroline Islands, Serrurier, 1891. Leiden Museum. Natural size.

Plate XI

Fig. 1. *Millepora murrayi* Quelch, colony from quiet water. Island Edam (Bay of Batavia), September 1922. Side view. Natural size.
Fig. 2. *Millepora murrayi* Quelch, colony from the neighbourhood of the edge of the reef. Island Edam (Bay of Batavia), July 1921. Side view. Natural size.

Plate XII

Fig. 1. *Millepora tenella* Ortm., specimen with comparatively long branches. Amboina, Ludeking, 1863. Leiden Museum. Side view. Natural size.
Fig. 2. *Millepora tenella* Ortm., specimen with comparatively short branches. Timor, Wienecke, 1863. Leiden Museum. Side view. Natural size.

Plate XIII

Fig. 1. *Millepora tenella* Ortm. Moluccas, Reinwardt. Leiden Museum. Side view. $^1/_3$ natural size.
Fig. 2. Same specimen. Upper view. $^1/_3$ natural size.
Fig. 3. *Millepora tenella* Ortm., another specimen of approximately the same growth form. Moluccas, Reinwardt. Leiden Museum. Side view. Natural size.

Plate XIV

Fig. 1. *Millepora tenella* Ortm., young colony from quiet water. Island Edam (Bay of Batavia), 1921. Side view. Natural size.
Fig. 2. *Millepora tenella* Ortm., more fully developed colony from quiet water. Island Edam (Bay of Batavia), 1921. Side view. Natural size.
Fig. 3. *Millepora alcicornis* L., colony which by fusion of its branches changes into a more or less plate-like growth. Haiti, from Naturhist. Inst. Linnaea, Berlin, 1849. Leiden Museum. Natural size.

Plate XV

Fig. 1. *Millepora murrayi* Quelch, colony with *Pyrgoma*, partly in rather crowded masses.

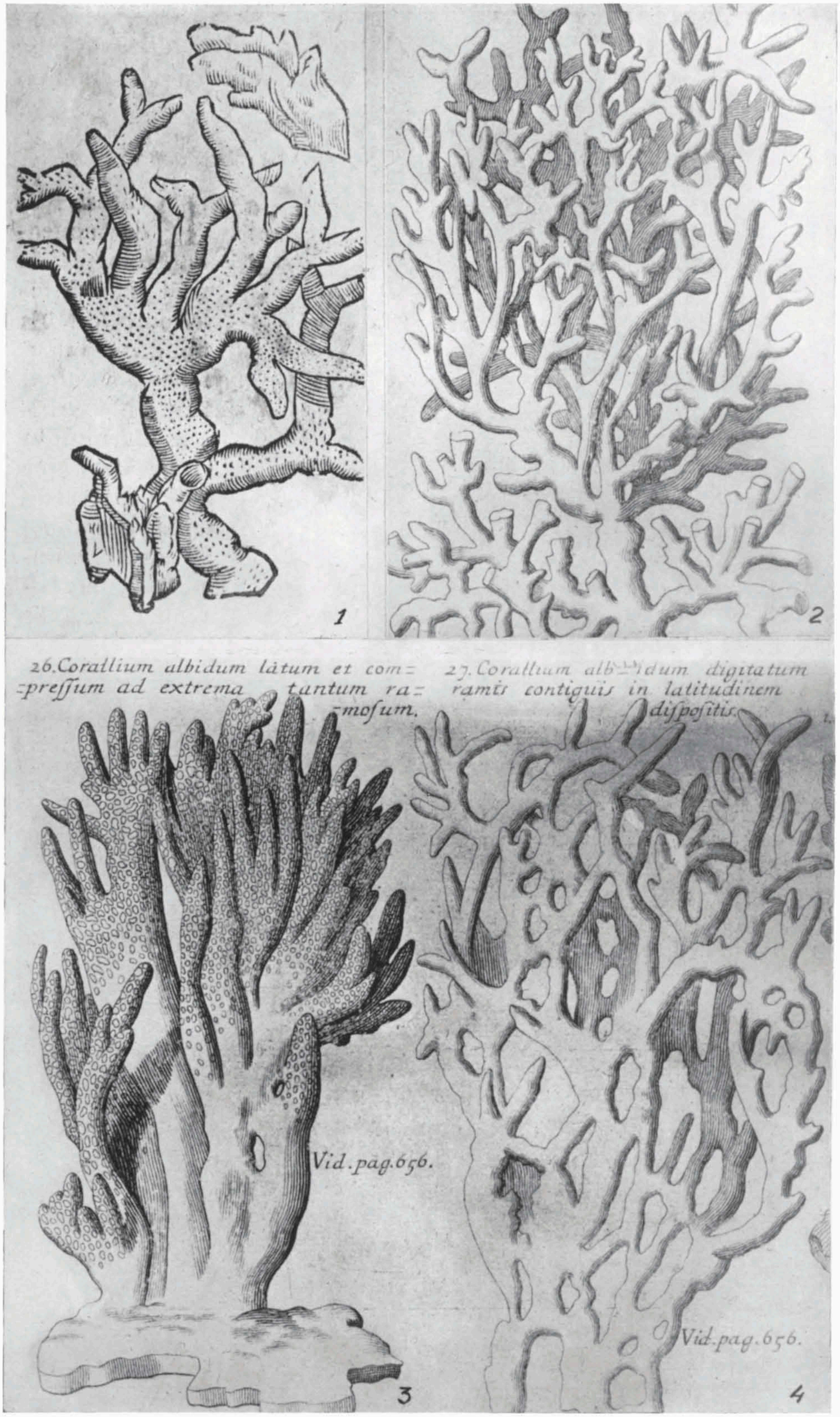
Fig. 2. *Millepora tenella* Ortm. with *Laurencia* spec., covered by the corallum.

Fig. 3. *Millepora murrayi* Quelch, colony of abnormal growth on account of having reached its maximum height.

Fig. 4. *Millepora* (*platyphylla* Hempr. & Ehrb.?), incrusting growth over a dead piece of coral, with numerous specimens of *Pyrgoma*.

Fig. 5. *Millepora platyphylla* Hempr. & Ehrb., part of a plate-like growth with horizontal lines of verrucae.

The specimens of figs. 1-5 are from the Island Edam (Bay of Batavia), 1921. Side view. Natural size.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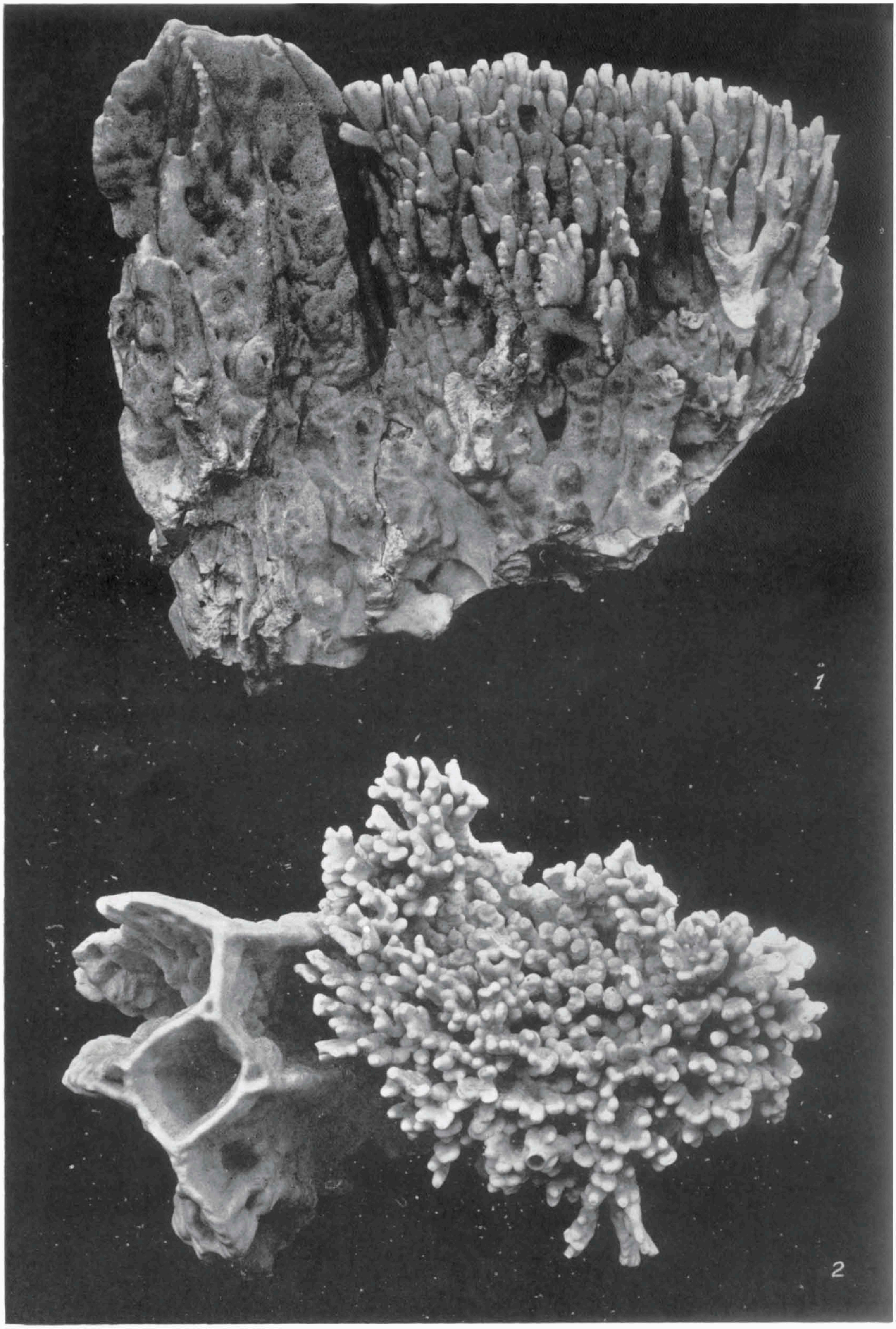
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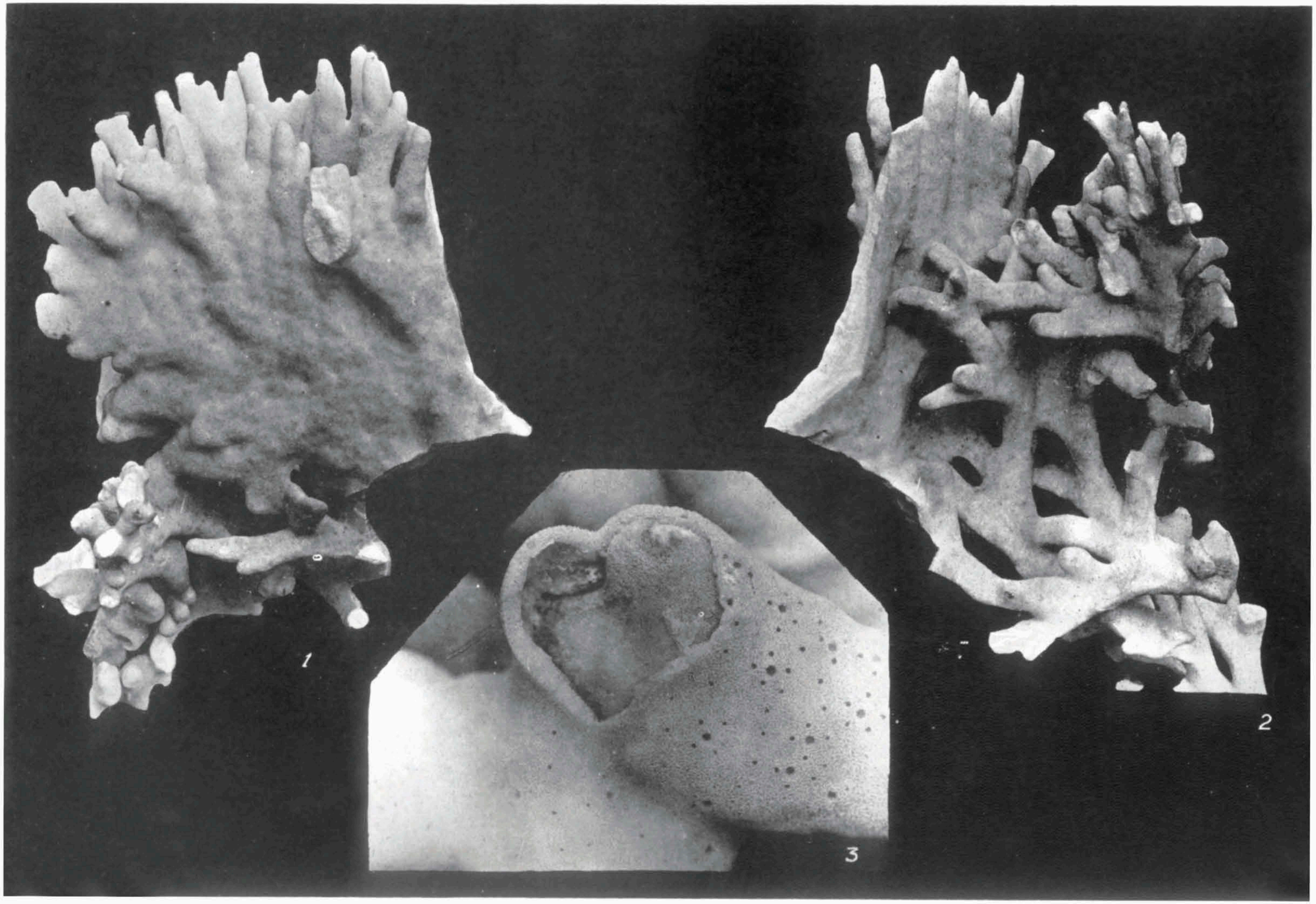
PLATE III



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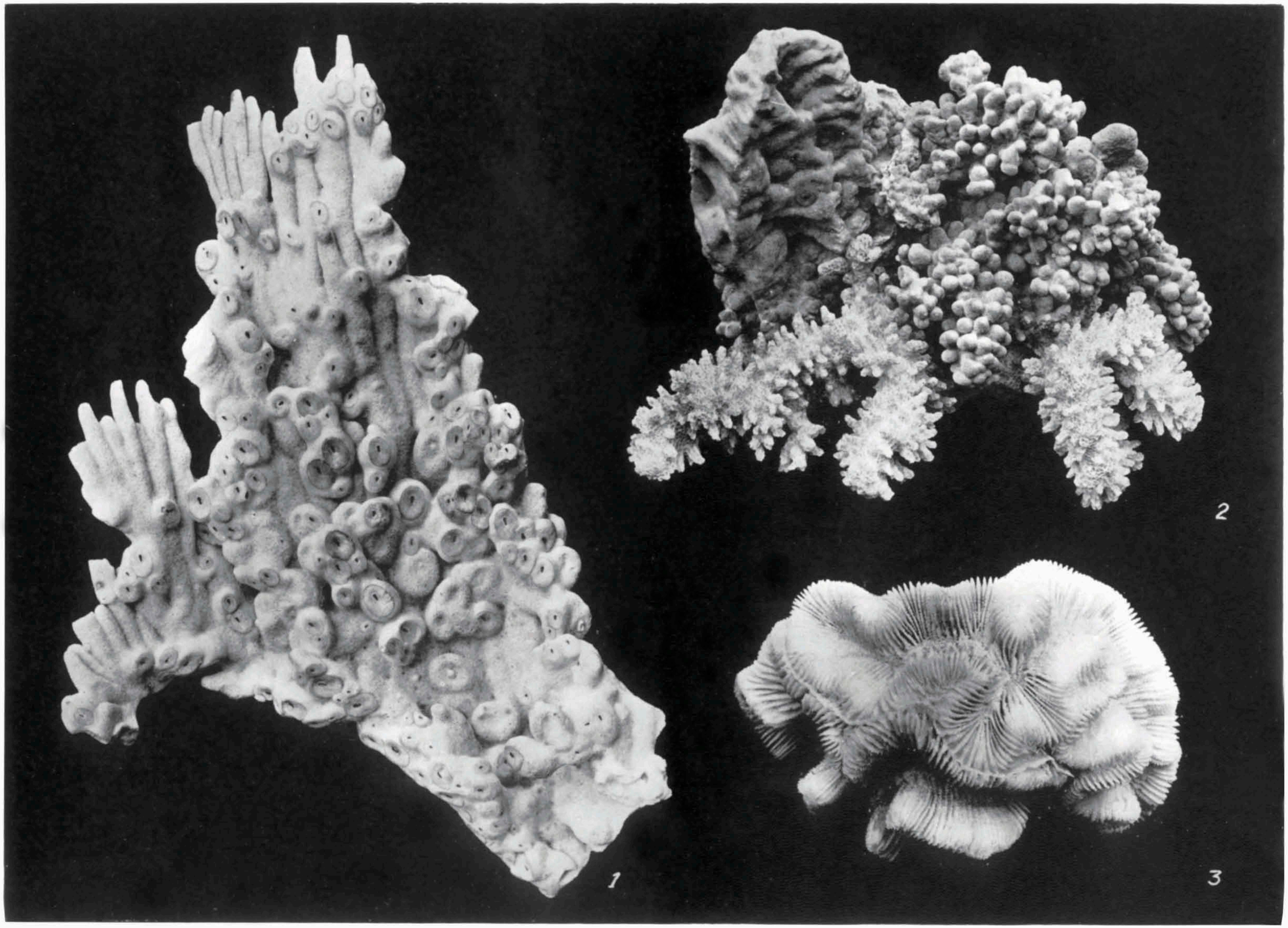

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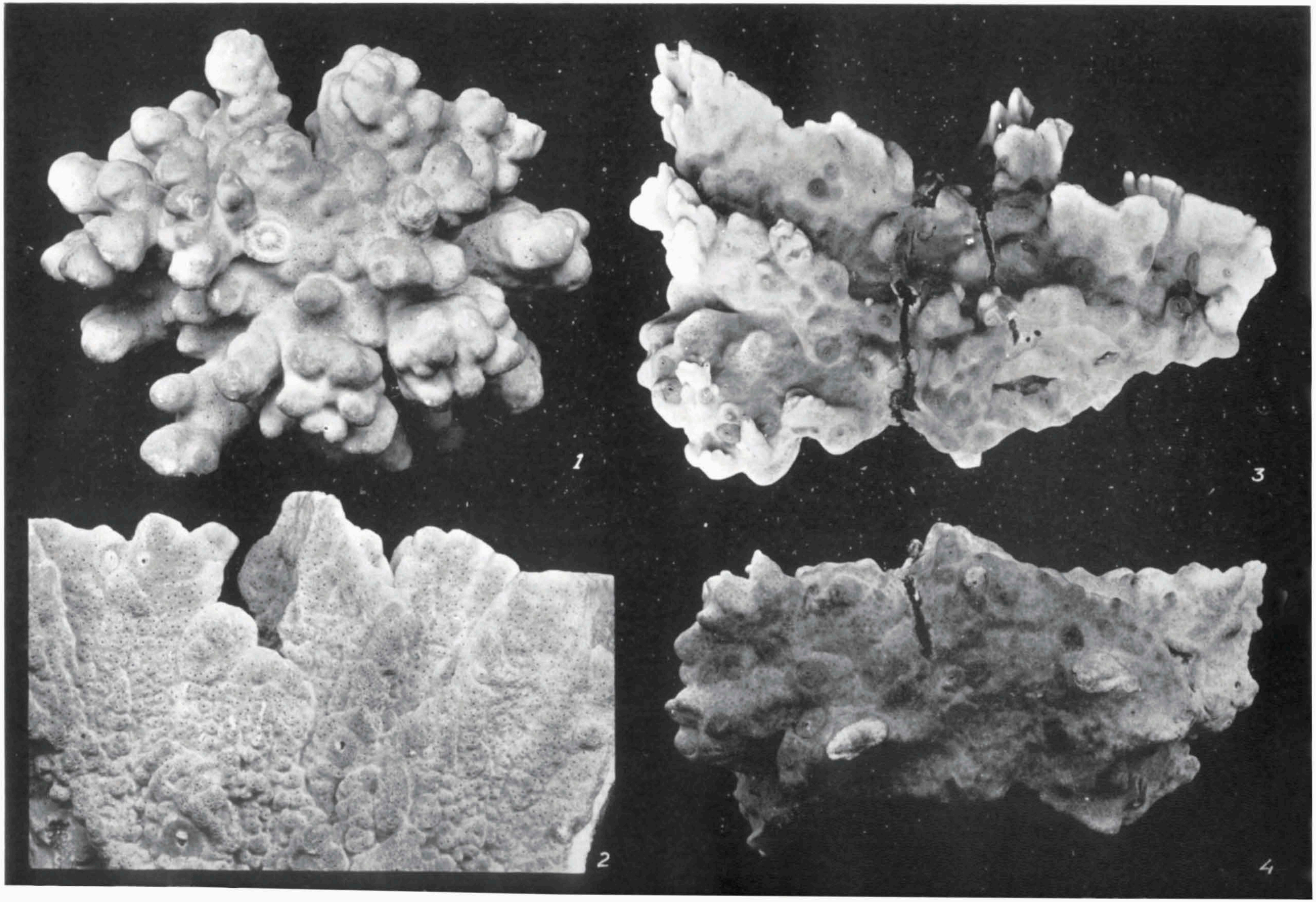

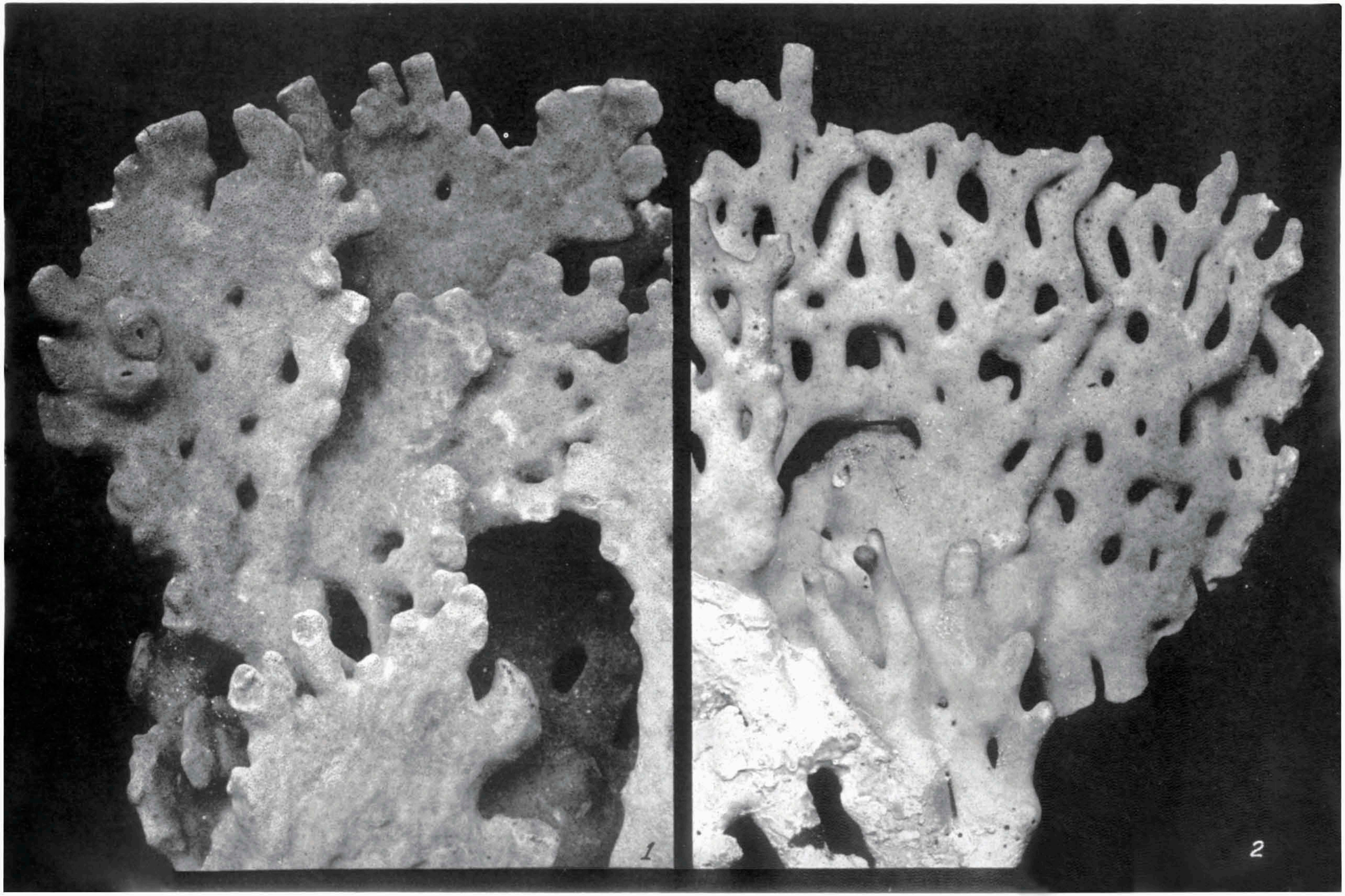
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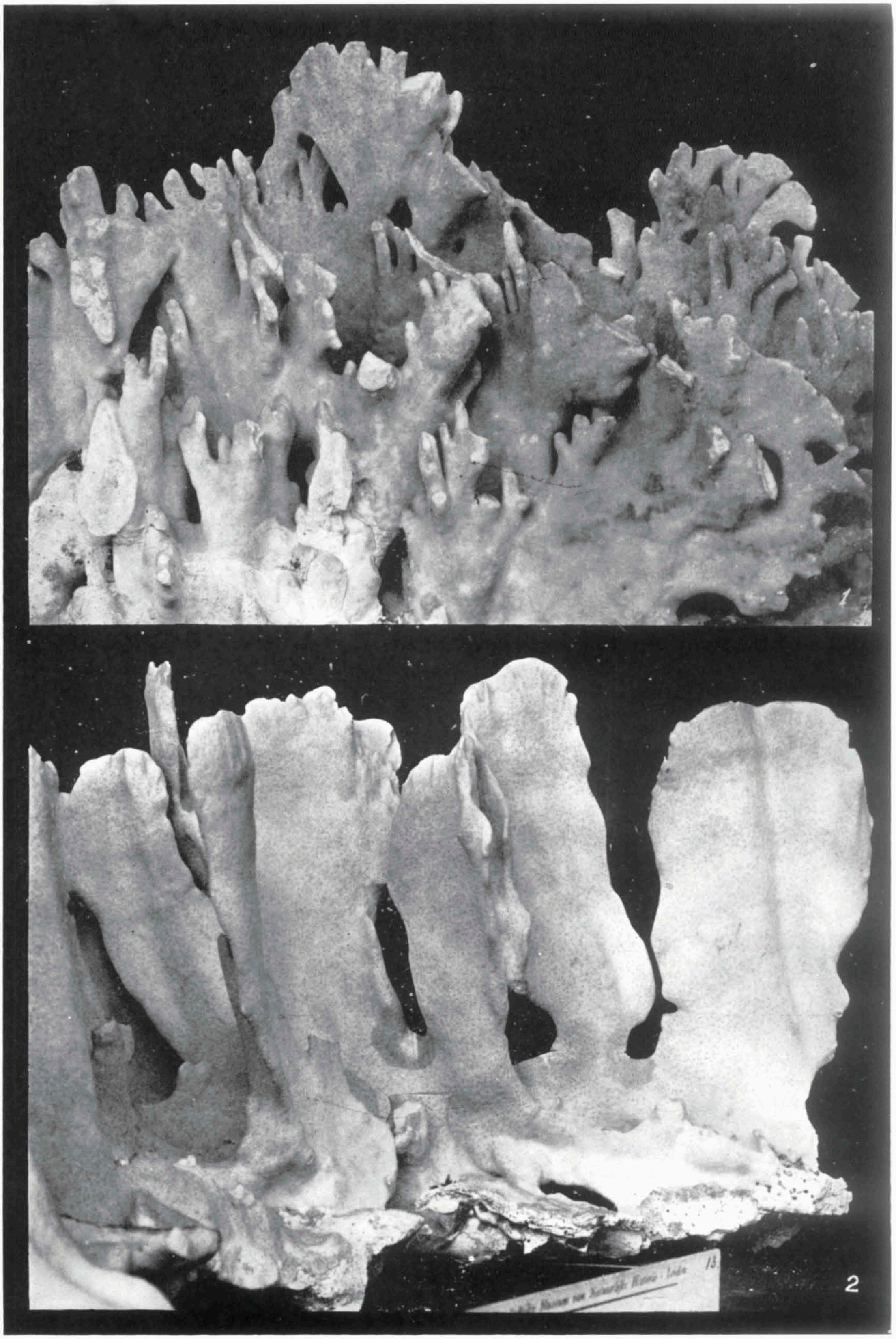
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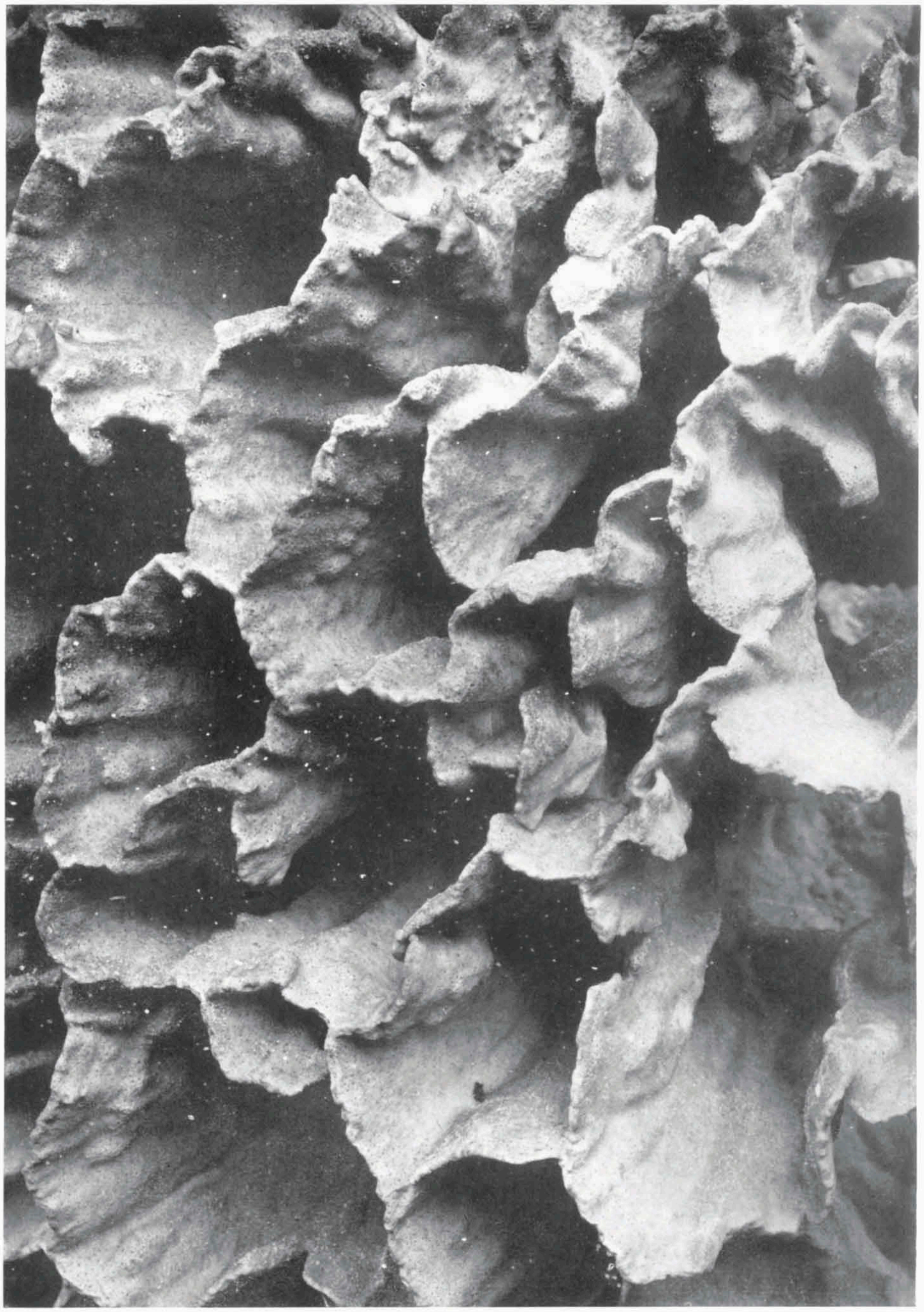

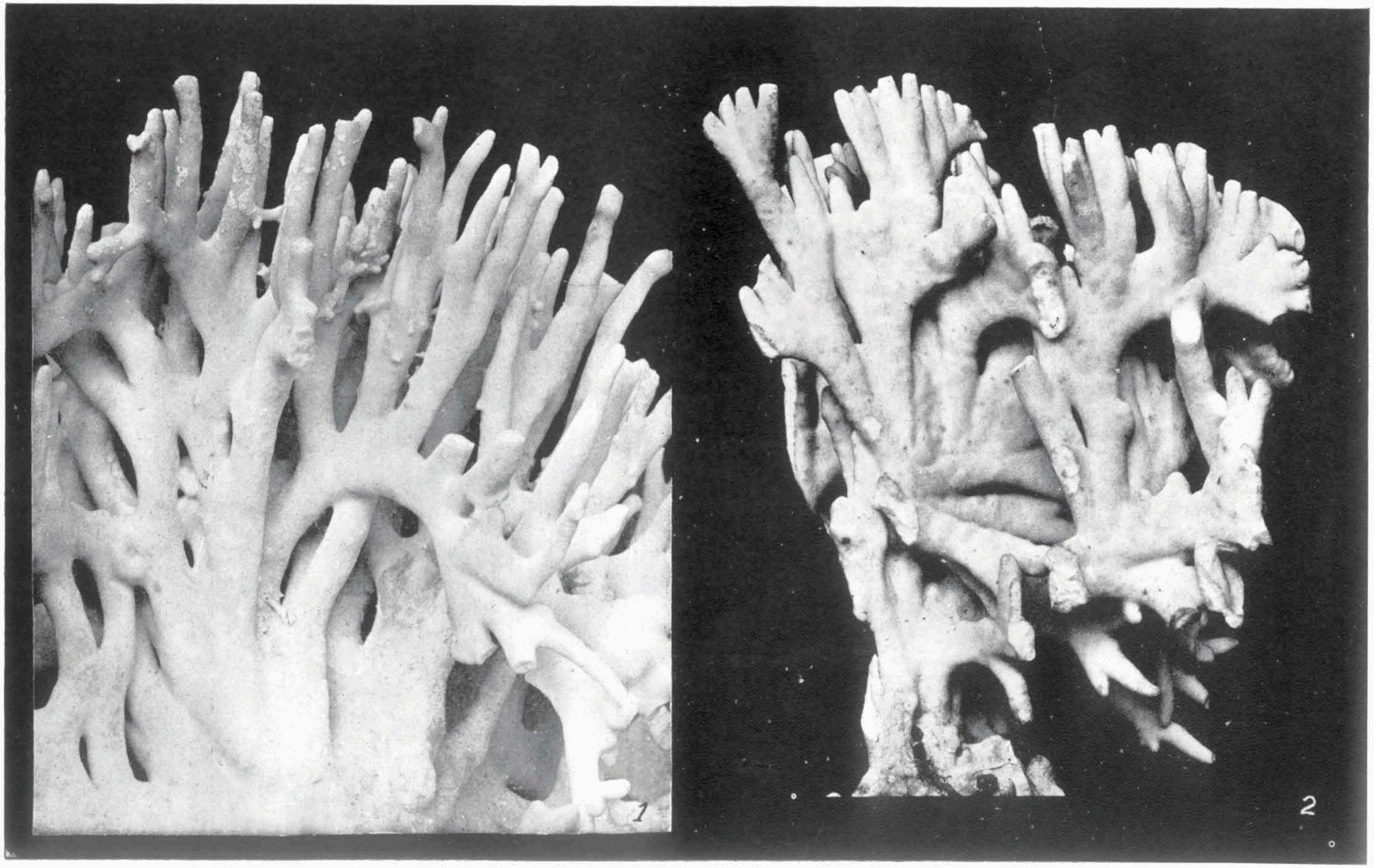
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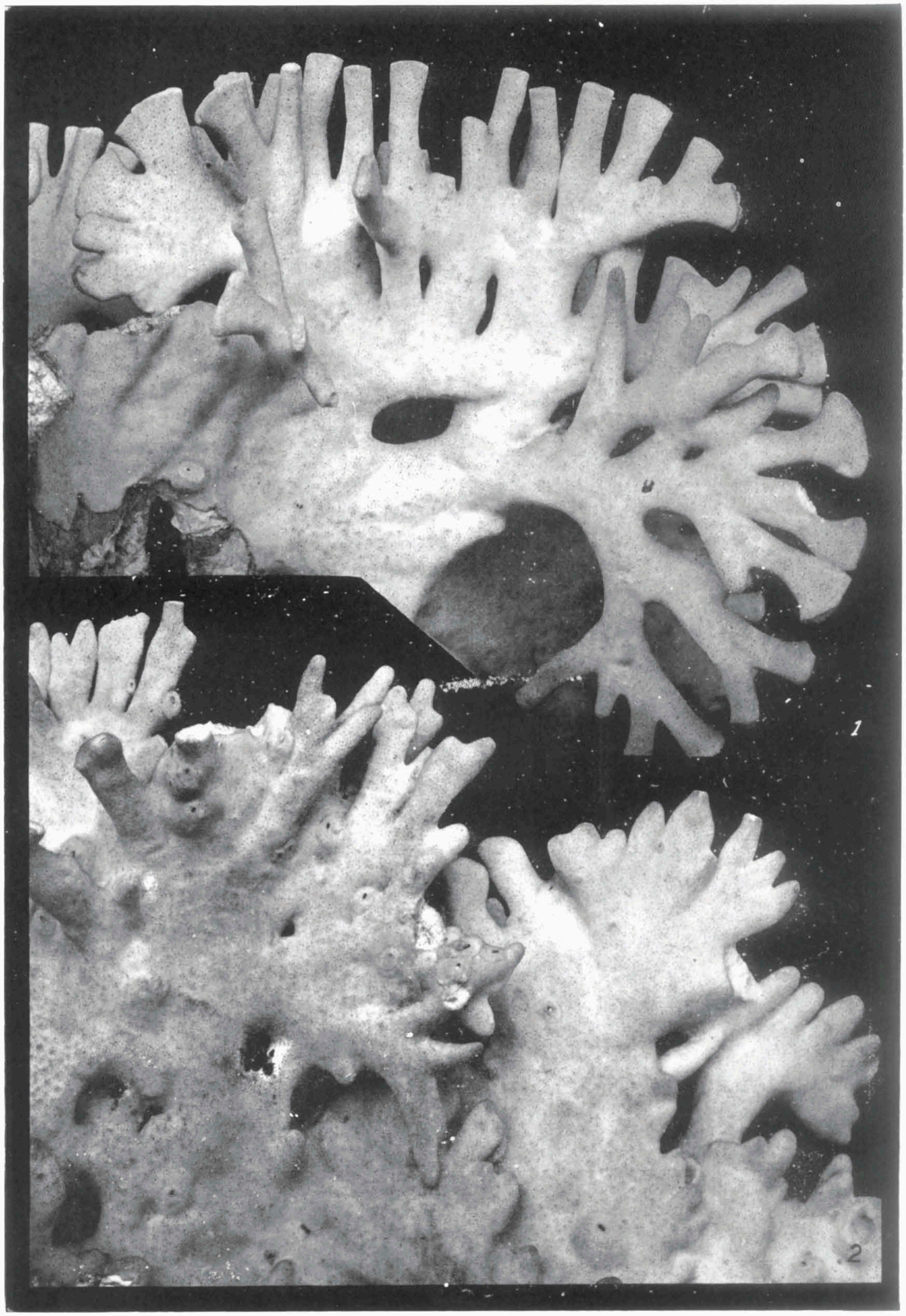
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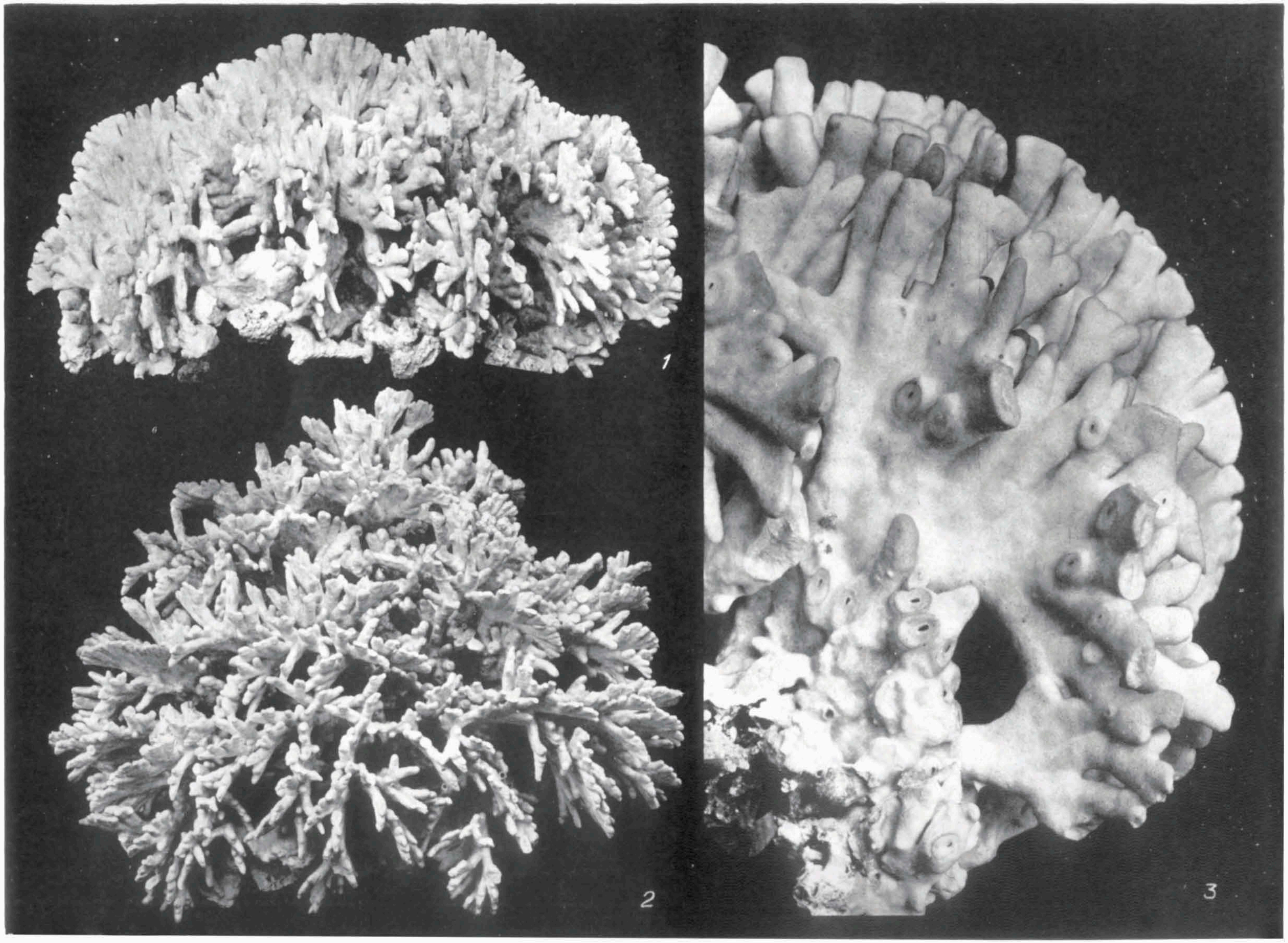
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PLATE XIV

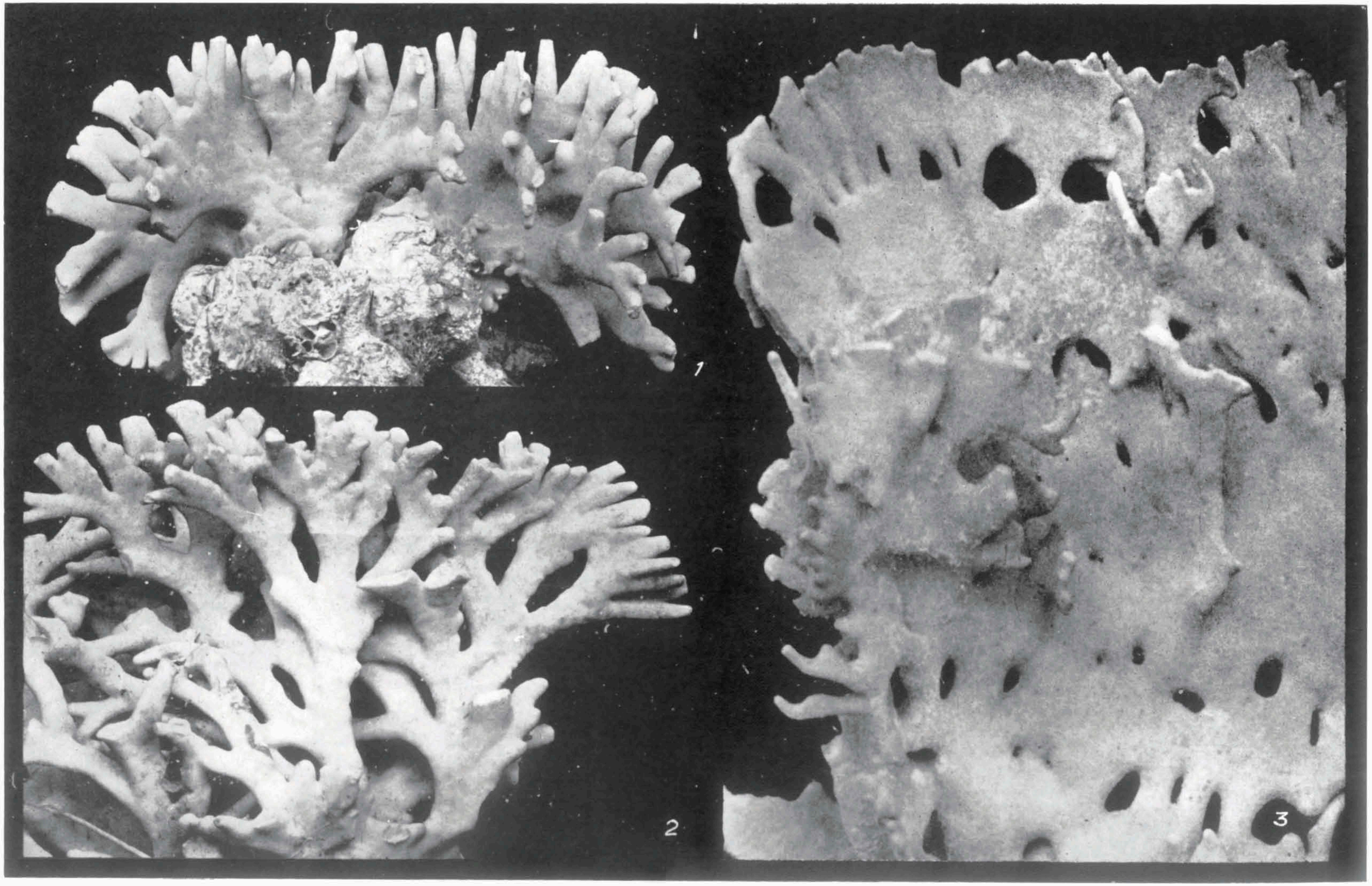

PLATE XV