III.—Variations and Nomenclature of Bermudian, West Indian and Brazilian Reef Corals, with notes on various Indo-Pacific Corals.

By A. E. Verrill.

The following observations on a few of the common reef corals of the West Indian fauna are some of the results of my studies of the reef corals continued during the past forty years. During this period I have examined nearly all of the important collections of corals in the United States, including the types of Dana and others.* I have also had opportunities to study, in life, and to collect large series of several of the species here discussed.

The nomenclature of many of the corals is still unsettled. This is due largely to the natural difficulties of the subject. Perhaps there is no other group in which it is more difficult to determine the true characters of the genera and species and the actual limits of their variations. These difficulties cannot be overcome except by long and careful studies of large series of specimens of all ages and forms, grown under many diverse conditions. Good series of but few species can be found in most museums, even at the present time. Formerly, when most of the species were first described, series of specimens were generally unknown, and most of the species were described from a single specimen, or from very few, and these were often so beach-worn as to be nearly worthless for such a purpose.

In addition to these natural difficulties, the early literature is very unsatisfactory, for numerous species were often confounded under a single name, and a genus was often equivalent to one or several families, or even to the whole order.

In subdividing the old groups, later writers did not always take sufficient pains to follow the ordinary rules of zoölogical nomenclature, even in some cases when there could have been no reasonable doubt of the identity of the species and genera of the early writers.

* Among the collections studied by me are those of the Museum of Comparative Zoölogy, which I labelled and catalogued many years ago; those of the U. S. Nat. Museum, including most of Dana's types; those of the Museum of Yale University, also including many types of Dana and others; those of the American Museum, New York City; those of Professor Ward of Rochester, N. Y., now in the Field Columbian Museum of Chicago; of the Peabody Acad. Science, Salem, Mass.; of the Boston Society of Natural History, and many others.

The diagnoses of the Linnæan species are very poor and imperfect, and have led to much confusion. The longer descriptions of Pallas (1766) are excellent for that period.

In this article I have treated many of those genera and species that are among the most confused, but have not attempted to discuss all such cases, even among West Indian corals.

Mr. Vaughan (op. cit., 1901) has referred to the very poor character of the works of Duchassaing and Michelotti on the West Indian corals, which have led to much confusion and have very much retarded the elucidation of the synonymy. My own opinion of their works are entirely harmonious with Mr. Vaughan's. Fortunately Mr. Vaughan has been able to study the types of these authors that are in the Museum of Turin, and therefore he has been able to rectify many of their mistakes. In such cases I can but follow his determinations of their species, for I have not seen the types. I have, however, formerly studied a collection of corals sent to the Museum of Comparative Zoölogy by Duchassaing, as examples of their species. But I found that in very many cases the specimens sent did not at all resemble the species described under the same names, and concluded that Mr. Duchassaing himself was unable to identify their species.

Mr. Vaughan has also recently studied some of the types of Ehrenberg and of Edwards and Haime, and has thus been able to correct several errors.

That the nomenclature adopted by Dana, Edwards and Haime, and other standard authors is not in accordance with the strict rules of priority in zoölogical nomenclature, has been well known to me and others for many years.* Personally, however, I should have preferred to have left the current names undisturbed, considering that long usage gives sanction to many slight irregularities of this kind, in the earlier writings, and I have hitherto avoided making many changes in current names for such strictly technical reasons.

---

* I do not share the opinion expressed by Mr. Vaughan (op. cit., p. 4) that M.-Edw. and Haime were influenced by unworthy motives, or autocratic ideas. Nor would I accuse them of changing names "arbitrarily" or "through ignorance." They did not hold precisely the same views of the rules of nomenclature that Mr. Vaughan follows, but they were in accord with the best usage of their period and country. Their great works are monuments of long, laborious, and faithful study, continued for over twelve years, and embracing all known corals. That they made a few mistakes is natural. We are all liable to do that. No one is infallible. I find it necessary to change 12 out of the 28 names of corals in Mr. Vaughan's revised list, p. 8.

But several recent writers, especially Mr. Gregory and Mr. Vaughan, have seen fit to make several radical innovations of this kind, changing the long current names of various genera and species to make them comply with more rigid modern rules of priority.

In a number of cases, however, they have been unfortunate in choosing or adopting the new names, so that their nomenclature has, in such instances, no more permanent foundations than the older ones they displaced, as will be shown later.

Therefore, I have thought it desirable to look more deeply into this subject, and to go as nearly as possible to the root of the matter, and so have made several necessary changes that otherwise I should have chosen to have left untouched.

The changes in the application of the names *Mœandrina*, *Mœandra*, *Manicina*, *Madrepora*, *Acropora*, *Favites*, etc., are among the more notable instances of this kind. However, if they *must* be made, the sooner the better.

MADREPORARIA.

Family **Mæandridæ** Ver., nom. nov.

Mœandrinidæ Verrill, Comm. Essex Inst., v, p. 32, 1866.

This family is intended to include all those meandriniform genera in which the zoöids remain more or less united in series, and when living do not in expansion raise the disk above the calicinal walls or collines, and the astreiform corals that increase by fission.

The coral may have the calicinal centers scarcely distinct, along the bottom of more or less elongated calicinal grooves, and the tentacles not in circles around the mouths (subfamily *Mœandrinæ*). Or they may be perfectly distinct and marked by the radiating arrangement of the septa, as well as by the aggregations of the columella, and the tentacles forming circles, (*Trachyphyllinæ*, *Favitinæ*).

The septa are rather finely dentate or serrulate and have a paliform lobe, with an emargination above it which marks the situation of the tentacles and border of the disk. The increase is chiefly by continuous incomplete fission, but in many cases exothecal budding also occurs (see pp. 68, 71). Most of the corals in this family are massive and some grow to great size. Nearly all are tropical reef-builders. The new name of the family is due to the necessary transfer of the name *Mœandrina* to the family *Eusmillidæ*, (see p. 66, note).

Subfamily **Mæandrinæ** Ver., nom. nov.

Mæandriform corals with indistinct calicinal centers and confluent zoöids. Tentacles mostly in parallel rows.

Mæandra Oken (emended.) Type, *M. labyrinthiformis* (L.). "Brain Corals."

Mycedium (*pars*) Browne, Civil and Nat. Hist. Jamaica, 1756; ed. 2, 1789, (*non* Oken).

Mœandra (*pars*) Oken, Lehrb. Naturg., p. 70, 1815.

Meandrina (*pars*) Lam., ii, p. 244, 1816, (not of 1801.)

Mœandra (*pars*) + *Manicina* (*pars*) Ehrenberg, Corall. Roth. Meeres, pp. 99, 101, 1834.

Meandrina + *Manicina* (*pars*) Dana, Zoöph. Expl. Exp., 1846.

Mœandrina + *Cœloria* + *Manicina* + *Diploria* + *Leptoria* (*pars*) Edw. and Haime, Hist. Nat. Corall., ii, pp. 388–401, 1857.

Platygyra + *Diploria* + *Manicina* Vaughan, Fossil Corals of Curacao, etc., Samml. Geol. Reichs-Mus., Leiden, Ser. 2, ii, i, pp. 45, 48, 1901.

A study of large series of various species of the above so-called genera, during many years, has convinced me that they should all be reunited into one genus, which would thus correspond more nearly with the genus *Meandrina* Lam. (1816) and to *Meandrina* of Dana + *Manicina*, *pars*.

If it be necessary to restrict *Meandrina** (Lam., 1801) to the type *meandrites* (L.)=*pectinata* Lam., as claimed by Vaughan and others, the next generic name, in order of publication, would be *Mœandra* of Oken, 1815, in which the first species (*areola*=*Manicina areolata*, authors), as well as the second and fourth, belongs to this group. Ehrenberg, also, definitely adopted this name nearly in the sense used here. Vaughan arbitrarily chooses to assume that *M. meandrites* should be considered the type of *Mœandra*, and therefore places that name as a synonym of *Meandrina*. This is not logical and is contrary to his method of reasoning in other similar cases (e. g. *Favites* Link, on p. 22).

* In establishing the genus *Meandrina* in 1801 (Syst. An., p. 372) Lamarck named but one species, *M. pectinata*=*Madrepora meandrites* L.; Ellis and Sol., which may properly be the type, though he added many other species in 1816. M.-Edw. and Haime referred to these facts (Corall., ii, p. 389), but preferred to take for the type *M. filograna*, on the ground that *denticulated septa* was given by Lamarck (1801) as a character of the genus.

It is certainly a legitimate question for doubt, whether the characters given to a genus are not of more importance than the particular species cited as an example by the older writers, who did not usually give them as "types" in the modern sense.

As a matter of fact, one of the *meandrites*-group was included by Oken in this genus by mere accident, it being erroneously referred to as a variety of a true *Mœandra* (*M. labyrinthiformis* (L.)= *Diploria*), while the four other species are of the *Diploria* and *Cœloria* groups. Moreover, he founded, in the same work, a new genus (*Pectinia*) for the *meandrites*-group. This of itself would show that he did not intend to include *meandrites* in *Mœandra*. The fact that a copied figure of *meandrites* was given, as an example, has no special significance in this case, for the publisher of such general works, rather than the author, is in many cases responsible for the selection of the illustrations, which, as is well known, are often misleading.

It would be far more consistent and correct to take either the first species (*M. areola=areolata*), or else the second species mentioned, for the type of *Mœandra*. *Meandrites* had already been eliminated by Lamarck, as Vaughan himself admits, when he named it as the type of *Meandrina*, in 1801. But Ehrenberg (1834), in adopting the genus *Mœandra*, used it in nearly the sense now proposed, though he eliminated Oken's first species, referring it erroneously to his new genus *Manicina*, which, as understood by him, included *Plerogyra* and also *Colpophyllia* E. and H. (See note, p. 85.) *Platygyra* was used by Ehrenberg as a subgenus of *Mœandra*. It included *Cœloria*, *Diploria*, and *Leptoria* E. and H., or the whole of his *Mœandra* except *Dendrogyra*. Therefore it is a synonym of *Mœandra* proper.

These eliminations of two of Oken's species clearly leave, as the real available type, *M. labyrinthiformis* (Linné)=*Diploria cerebriformis* E. and H., which is *var. a.* of Oken's second species. Therefore, should others still prefer to consider the latter the type of a special genus, on account of its usually double ridges, it should be called *Mœandra labyrinthiformis* (L.) Oken, but for those who do not thus restrict the Linnæan name it should be *Mœandra implicata* (Ellis and Sol.), or else *M. cerebriformis*. The forms *Stokesi* (E. and H.) and *geographica* Whitf., are mere growth-variations in the forms of the ridges and grooves.

The characters that have been used by authors to separate *Mœandrina* E. and H., *Diploria*, *Cœloria*, and *Manicina* are due only to slightly different modes of growth. These several forms do not show any structural differences, such as should characterize genera. Young examples of *Diploria* can scarcely be distinguished from *Manicina*, of similar age, even by the forms of the grooves

and ridges. Many large specimens of typical *Diploria* have both single and double ridges on their different parts, or even side by side, and the same is true of *Manicina*. The calicles may form long series, more or less winding, or they may be short, or even circumscribed, equally in *Diploria*, *Cœloria*, and *Mœandrina* E. and H., and these variations are often seen on a single specimen of either group. They all form radial infoldings or collines at the margins, when young. Resorption of parts of the collines is frequent.

In *Diploria* and *Manicina* E. and H, and probably in the other groups, the ends or other parts of the growing ridges often expand and give rise to new zoöids, and thus form new actinal grooves by extracalicinal budding. Therefore the intervening ridges in such cases are necessarily simple for a time. See pl. x, figs. 1–3.

The genus *Mœandra*, as restricted above, would include the following four common West Indian species, two of which are found at the Bermudas.*

Besides these there are two or three other rare West Indian species that are not well known. One of these (*M. varia*), which was described by Dana as *Astræa varia*, is remarkable for having a large part of its surface covered with circumscribed polygonal calicles like those of *Goniastræa*, to which genus it has usually been referred.

But simple or multiple circumscribed calicles also occur, more or less frequently, in all the other species, and they are often due to extracalicinal budding and subsequent division. There is a large specimen of *M. clivosa* in the Museum of Yale University which has a large part of its surface covered with simple angular calicles, while in other parts they are long and meandriniform, as usual. The same is true of some of the East Indian species of the *Cœloria*-group.

In the Indo-Pacific region, including the Red Sea,† there are a considerable number of nominal species of *Mœandra*, most of which have been referred to *Cœloria* and *Leptoria*.

---

* Nelson (Trans. Geol. Soc. London, v, p. 112) records the occurrence of *M. areolata* as a fossil in the older beach rock. Probably his specimens are the same that Mr. Vaughan has recently identified as *Mycetophyllia Lamarckana* (in coll. Geol. Soc.). Neither of these species has been found living at the Bermudas, but the older "beach rock" there contains also several West Indian shells that no longer exist in the Bermudas, indicating a period of warmer climate than at present. This rock may be post-glacial in age. It is overlaid by several forest or red-clay beds with much æolian limestone interstratified.

† See Klunzinger, C. B., Die Korallthiere des Rothen Meeres. Madreporaria. Berlin, 1879. In this excellent work there are good descriptions and photographic figures of five species and four varieties of *Cœloria* and of one species of *Leptoria*.

Among those of the section *Cœloria* are the following:

M. dædalea (Ellis). E. Indies.

M. dædalina (D.).=*Astræa deformis, pars*, Dana, (*non* Lam.) Fiji Is.

M. spongiosa (Dana). West Indies (?). Pl. xii, fig. 3.

M. pachychila Ehr.= *C. labyrinthiformis* E. & H., *non* Linné.

M. lamellina (Ehr., p. 99) + *M. leptochila*, Ehr.,= *C. Bottai* and *C. Forskælana* E. and H. = *C. Arabica* Klz. Red Sea.

M. laticollis E. and H., (Corall., ii, p. 415, pl. D4, fig. 4, as *Cœloria*).

M. Sinensis (E. and H., Corall., ii, p. 416, as *Cœloria*). China.

M. stricta (E. and H., op. cit., p. 417). E. Indies.

M. astræiformis (E. and H, op. cit., p. 417). Red Sea.

M. Esperi (E. and H., op. cit., p. 417). Red Sea.

M. leptoticha (Klz., as *Cœloria*). Red Sea.

M. laxa Ver., sp. nov. This has broad, distant, and very thin septa, with the edges sparingly and very irregularly toothed, and with the summits broad and rounded or subtruncate. Walls very thin. Valleys deep, mostly sinuous. Columella but little developed. Depth of calicinal valleys, about 7^{mm}; width about 5 to 8^{mm}. Kingsmills Islands.

M. elegans, *M. deltoides*, *M. Australiensis* (all Rehb.), Australia.

The following have been referred to *Leptoria* by Edw. and Haime, on account of the somewhat lamellose columella:*

M. gracilis (Dana). Fiji Is.; *M. tenuis* (Dana). Tonga Is.

The following are, apparently, more closely related to the typical West Indian species:

M. rustica (Dana). Wakes Island.

M. valida (Dana). Locality unknown.

M. rudis Verrill = *M. phrygia* Dana, *non* Ellis and Sol.

M. delicatula (Ortman, 1888). Samoa.

The following species were referred to *Diploria*:—

M. crassior (E. and H., Corall., ii, p. 403). China Sea.

M. spinulosa (E. and H., op. cit., p. 404). China Sea.

He proposes *C. Arabica* Klz. to include *M. leptochila* and *M. lamellina* Ehr., + *C. Forskælana*, *C. Bottai*, and *C. subdentata* Edw. and Haime, as varieties.

This shows that the Red Sea species are quite as variable as the West Indian. However, it seems to me undesirable to give a new name (*Arabica*) to this revised and extended species. It would be better to extend the sense of *M. lamellina* (Ehr.) so as to include all these forms.

* The structure of the columella is not essentially different in the two following species (types examined) from that of typical *Mœandra*, especially that of *labyrinthiformis* when the latter is poorly developed. It is not a continuous plate, but consists of small, irregular, interrupted laminæ.

Mæandra labyrinthiformis (L.) V. Brain Stone. Brain Coral.

Madrepora labyrinthiformis (*pars*) Linné, Syst. Nat., ed. x, p. 794, 1758.

Madrepora meandrites, var. γ, Pallas, Elench. Zoöph., p. 292, 293, 1766.

Madrepora implicata Ellis and Solander, p. 164, 1786. Gmelin, op. cit., p. 3763.

Madrepora labyrinthiformis Esper, Pflanzenth., p. 74, pl. iii, 1789.

Mœandra meandrites (*pars*), including as var. *a*, *labyrinthiformis* (Linné), Oken, Lehrb. Naturg. Zoöl., i, p. 70, 1815.

Meandrina cerebriformis Lamarck, Hist. Nat. Anim. s. Vert., p. 246, 1816.

Mœandra (*Platygyra*) *cerebriformis*, vars. *a* and *b*, Ehrenberg, Corall. Rothen Meeres, Abhandl. Kgl. Akad. Wiss. Berl., p. 324 [100], 1834.

Meandrina cerebriformis, p. 263, pl. xiv, fig. 2; + *Meandrina truncata*, p. 264, pl. xiv, figs. 1, 1*a*, Dana, Zoöph. U. States Expl. Exped., 1846.

Diploria cerebriformis Milne-Edwards and Haime, Compt.-rend., xxvii, p. 493, 1848.

Diploria cerebriformis; + *Diploria Stokesi*, pl. D4, fig. 3; + *Diploria truncata* Milne-Edwards and Haime, Hist. Nat. Corall., ii, pp. 402, 403, 405, 1857.

? *Mœandrina labyrinthiformis* Pourtalès, Florida Reefs, Corals, pl. ix, figs. 10–12, 1880.

Diploria cerebriformis Pourtalès, Ill. Cat. Mus. Comp. Zoöl., No. iv, Mem. ii, p. 75; 1871; Verrill, these Trans., x, p. 552, 1900.

Diploria geographica Whitfield, Bull. Amer. Mus., N. York, xiv, p. 223, pl. xxxiii, xxxiv, 1901. (Types examined.)

Diploria labyrinthiformis Vaughan, Samml. Geol. Reichs-Mus., ii, p. 45, 1901 (*non Cœloria labyrinthiformis* Edw. and Haime).

Plate X. Figures 1–3.

This species can usually be distinguished from the allied forms by the generally double ridges between the actinal grooves and by the presence on these ridges of a more or less wide intermural furrow, but the furrow may be lacking or obsolete, and the wall may be simple and solid on parts of many specimens.

While living, the color of the soft parts is usually dull orange-yellow, but it varies from light ocher-yellow to brownish orange. The structure and appearance of the tentacles, mouth, and disk are like those of *M. cerebrum* and *M. clivosa*.

This is the most abundant of the reef-corals at the Bermudas. When it grows under very favorable conditions it forms large, evenly hemispherical or dome-shaped masses, which are sometimes 5 or 6 feet in diameter, and nearly as high. Perfect specimens of this form, from 8 inches to 2 feet in diameter, are much sought after by collectors, and are, therefore, common in museums. Much larger numbers of specimens on the reefs take on irregular, broad, thick encrusting forms, due to less favorable conditions, injuries, and especially to crowding and coalescence.

A very extensive series of this species was collected, in 1898 and 1901, in order to study its variations. Over 300 specimens of all sizes from less than half an inch up to over five feet in diameter were studied by me.

The variations are very great in several directions:—as in the modes of growth; breadth and depth of the actinal grooves; and especially in the breadth of the intervening ridges and of the intermural or exothecal groove at their summits. The length, direction, and arrangement of the grooves and ridges vary in every possible way, often presenting the most diverse arrangements on different parts of a single large specimen, especially if it has grown in a more or less crowded or restricted position.

These common variations include those forms that have been named *Diploria Stokesi* Edw. and Haime, but which differ in no way from the typical forms, except in having unusually wide ridges, surmounted by a deep intermural groove, which often expands, especially at the end of a ridge, to the breadth of 10 to 15^{mm}.

Extracalicinal budding frequently occurs in these wide intermural grooves. In life, many of these grooves show a distinct mouth, or a series of mouths, with rows of tentacles, before any marked changes occur in the underlying coral. But soon the bottom of the groove receives deposits of columellar tissues, and then paliform lobes and septa rapidly appear. Thus after a short period of growth, these grooves become true actinal grooves formed over the exothecal tissues of the walls, by true budding. They often become as deep and well formed as the other furrows before they break through, at one or more places, and thus become connected with the older grooves. Some of them, both long series and single calicles, may remain isolated for a long time in some specimens.

As a matter of course, actinal grooves formed in this way must be separated for some time by simple walls only. This accounts for many of the cases where simple ridges are found mixed with double ones on the same specimen (pl. x, fig. 1). A single ridge may also, on this account, be double for a part of its length and single in other parts, or it may divide into two simple ones, in certain places.*

* Probably some of the confusion in respect to the synonymy of this species is due to the fact that this mode of growth has not been recognized by authors, and therefore specimens of this species with simple ridges have been referred to different species and to a different genus (*Mœandrina*), for such specimens have all the characters of *Mœandrina*, as contrasted with *Diploria*. (See p. 67.)

It is not improbable that the figures of *M. labyrinthiformis* Pourtalès (op. cit., Florida Reefs, pl. ix, figs. 10–12, 1880) were drawn from a specimen of this kind

This mode of increase, by exothecal budding, seems to occur most freely in young specimens 2 to 3 inches in diameter, though not exclusively so. In such specimens the ridges are often all or nearly all broad and deeply grooved, or just ready to divide (plate x, figure 3). Others, scarcely larger, may be found in which all or nearly all the ridges are narrow and single, without grooves, the divisions having already taken place (pl. x, fig. 2). Specimens in both these stages, and in various intermediate conditions, were collected by me in Bermuda, both in 1898 and 1901.

The stage in which broad and deeply grooved ridges occur has been named as a distinct species (*Diploria Stokesi*) by Edwards and Haime. Some later writers have called it a "young stage"; others have called it a *variety*. It appears, from the facts just stated, that is is only a phase of growth, which may occur at various stages of development. *M. truncata* Dana seems to have been based on a phase following the division of the ridges and before the new grooves had developed on their summits. Such specimens are not rare. See pl. x, fig. 2.

Large specimens occur in which one part will show the *Stokesi* arrangement, while another part will be of the typical form ; and still other parts will present simple or nearly simple solid ridges of the *truncata* phase. See pl. x, fig. 1.

Many oblong specimens show, especially on the sides, many long and nearly parallel, subradial, or nearly transverse ridges and grooves, while on other parts they present the ordinary convoluted arrangement.

The gyri are often in places more or less angular or zigzag, especially on the median or more crowded portions, thus showing that the form recently described and figured by Whitfield as *D. geographica** is only a form of growth, not of varietal value.

Many of the larger hemispherical and oblong examples consist of two, three, or more originally separate masses that have come in contact by growth and crowding, and have then grafted themselves together completely. The planes of union are usually shown only by a thin line of epithecal tissue. Some of these double specimens are as evenly and regularly hemispherical as the simple ones.

---

and not from *M. cerebrum*, as Vaughan supposed. The types from which the original plates of that Report were drawn were not separately preserved nor in any way indicated by labels. While I had charge of the coral-collections of the Mus. of Comp. Zoölogy (1860–1864), I tried in vain to identify the specimens that had previously been figured on those plates, which were then unpublished. Therefore any question of synonymy must be settled by the plates themselves. Fortunately they are very accurate.

* Bull. Amer. Mus., xiv, p. 223, 1901.

The characters of the septa and costæ are also variable, though more reliable than the form of the ridges. The septa are not very crowded, though more so than in *M. cerebrum*. Smaller, thin ones alternate with the larger and usually extend down below the paliform lobe. The larger septa are rather broad, generally with the inner edge perpendicular, and often sometimes broader above, usually with the summit broadly rounded and continued into prominent costæ which have rather regular conical or spiniform serrations on their edges. The paliform lobe is generally well developed and roughly serrulate; the inner edge of the septa bears numerous, small, close, irregular, elongated teeth, many of which are rough or forked at the tip; those toward the summit are longer, directed strongly obliquely upward and frequently incurved; those on the rounded summit are usually more regular and divergent. The sides of the larger septa are covered with rather few and scattered conical grains,—much fewer and smaller than in *M. cerebrum*.

The columella is variable, but usually well developed, composed of curled lamellose processes, and thickened at the centers. Sometimes it is larger and nearly solid or subvesicular.

In transverse section the walls vary in breadth, but are usually thick and solid. In those specimens that have thin and simple walls at the surface, a section made an inch or so from the surface usually shows most of the walls as thick as usual (about 3 to 5^{mm}). The septa in section are thin and sparingly spinulose laterally, quite unlike those of *M. cerebrum* in similar sections.

The actinal grooves vary considerably in breadth and depth, but they are always decidedly narrower and shallower than those of typical *M. cerebrum*, and have a more square-cut appearance. The breadth from wall to wall, at top, is generally 5 to 10^{mm}; of the open valley, septal edge to septal edge, 4 to 6^{mm}; depth, mostly 4 to 6^{mm}. Number of septa to a centimeter, usually 14 to 16. One variety (*compacta*) has unusually shallow and narrow valleys (3–5^{mm} wide), with crowded septa.

This species is the largest and most important of the Bermudian reef corals. It occurs abundantly on the inner reefs of Great Sound, Castle Harbor, etc., often close to the shores and in water only two feet deep at low-tide, and mostly in less than twenty feet. It is still more abundant on the outer reefs. It does not occur in Harrington Sound, probably owing to a slightly diminished salinity of the water, due to its nearly land-locked condition. It may form masses 6 to 8 feet in diameter and height.

It is found on the Florida reefs and throughout the West Indies.

Mæandra cerebrum (Ellis and Sol.) V. Brain Coral. Brain Stone.

Madrepora cerebrum Ellis and Sol., Nat. Hist. Zoöph., p. 163, 1786. Gmelin, in Linné, Syst. Nat., ed. xiii, vi, p. 3763, 1798.

Madrepora labyrinthica Ellis and Solander, Nat. Hist. Zoöph., p. 160, pl. xlvi, figs. 3, 4, 1786 (not of Pallas, which is *M. meandrites* Linné, ed. x.)

Meandrina labyrinthica (*pars*) Lamarck, Hist. Nat. Anim. sans Vert., ii, p. 246, 1816 (non *Mad. labyrinthica* Pallas).

Meandrina sinuosa LeSueur, Mem. Mus. d'Hist. Nat. Paris, vi, p. 278, pl. xv, fig. 4, and ? varieties *viridis*, p. 279, pl. xv, fig. 5; ? *appressa*, p. 280, pl. xv, fig. 6; ? *rubra*, p. 280, pl. xv, fig. 7; ? *vineola*, p. 280, pl. xv, fig. 8, 1820 (*non Madrepora sinuosa* Ell. and Sol. = *Mussa* or *Isophyllia; nec Meandrina sinuosa* Quoy and Gaimard).

?? *Meandrina dedalea* Les., op. cit., p. 281, pl. xvi, fig. 9, 1820.

M. labyrinthica Les., op. cit., pl. xvi, fig. 10, 1820.

Meandrina labyrinthica Lamouroux, Exp. Meth. Gen. Polyp , p. 54, pl. xlvi, figs. 3, 4 (reprint from plate of Ellis and Solander), 1821 (*non* Pallas).

Mæandra (*Platygyra*) *labyrinthica* (*pars*) Ehrenberg, Cor. Rothen Meeres, Abh. k. Akad. Wiss. Berl. for 1832, p. 323 [99], 1834. (Includes 5 species. mostly of *Cœloria*, t. Vaughan, from types.)

Meandrina labyrinthica, p. 256, pl. xiv, fig. 1; + *M. strigosa*, p. 257, pl. xiv, fig. 4*a*, Dana, Zoöph. U. States Expl. Exp., 1840.

Mœandrina heterogyra, p. 392; + *M. sinuosissima*; + *M. serrata*, p. 393; + *M. crassa*, p. 394, + *Cœloria strigosa*, p. 418, Milne-Edwards and Haime, Hist. Nat. Corall., t. ii, 1857 (teste Vaughan, from types). See also *M. sinuosa* Les. and varieties, described on p. 389, foot note.

Leptoria fragilis Duchassaing and Michelotti, Mem. Corall. Ant., p. 351, 1861 (teste Vaughan, from type).

Mœandrina strigosa Pourtalès, Flor. Reefs, Corals, Mem. Mus. Comp. Zoöl., vii, pl. ix, figs. 6–9, 1880.

Mœandrina strigosa, pp. 10, 92; + *M. sinuosissima*, pp. 10, 91; + *M. labyrinthica*, pp. 10, 12, 91; + ? *M. sinuosa*, p. 12, Quelch, Reef Corals, Chall. Exp., vol. xvi, 1886.

Mœandrina filograna (*pars*) Gregory, op. cit., p. 265 (*non* Esper).

Platygyra viridis Vaughan, Samml. Geol. Reichs-Mus., ii, p. 51, 1901 (after var. *viridis* Les.)

Platygyra sinuosa Vaughan, op. cit., p. 56, 1901.

Mœandrina labyrinthica Whitfield, Bull. Amer. Mus. Nat. Hist., N. York, xiv, p. 221, pl. xxxi, xxxii, 1901. (Abnormal, type studied.)

Plate X. Figure 4. Plate XII. Figure 4. Plate XIV. Figures 4, 5.

This species usually forms evenly convex, thick, encrusting masses, or when well grown, large even hemispheres, sometimes a yard or more in diameter, with intricately convoluted gyri. Its actinal grooves are usually wider and more open than in the preceding species, while the mural ridges are generally high, narrow, solid, and rather thin in sections, and they usually appear acute at the crest, owing partly to the fact that the septa are generally narrowed

toward the summit; but also because the wall itself is generally (but not always) reduced to a thin solid lamina, which, as seen from above, runs as a zigzag line from septum to septum. The larger septa usually alternate with small very thin ones, most of which do not extend half way to the paliform lobes, thus leaving wide interseptal spaces below. The large septa are usually thin and rather narrow, with the inner edge rapidly sloping or nearly perpendicular to the well marked paliform lobe, so that the actinal grooves are generally deep and often more than twice as wide as the ridges, the width decreasing gradually to the level of the paliform lobes. The summits of the septa are only slightly prominent above the thin wall, and may be evenly but obtusely rounded, or they may have a gothic form, narrowing rather abruptly, giving a rather acute form to the ridges. Their inner edges are strongly and usually rather regularly serrulate, the teeth are often angular and sharp like sawteeth, but are frequently more elongated and uneven, some of them having minutely forked or lacerate tips; the teeth are directed obliquely upward, but are seldom incurved, as is so often the case in the preceding species. The paliform lobes are a little thickened and roughly serrulate on the sides and edges. The sides of the septa are almost always very roughly spinulose or hispid, being thickly covered with small, acute, spiniform grains, much more numerous and conspicuous than in the allied species. This is usually a good diagnostic character, and is available even in worn specimens, for these lateral septal spinules are conspicuous on the thin septa in transverse sections. The columella varies considerably; it is usually well developed and composed of numerous, small, thin, contorted laminæ, sharply spinulose laterally, and united into a nearly continuous but uneven series, with thickenings at irregular intervals. In some cases the columella is much less developed and composed of few laminæ. The gyri in large specimens are long and intricately convoluted in every direction, but in smaller examples they may be more or less radial, or parallel for long distances, especially on the sides. In some specimens, though rarely, short gyri occur, and in some instances isolated, round or elliptical, *Astræa*-like calicles may be found, due to intermural budding, but these are much less common than in *labyrinthiformis* and *clivosa*. Pl. xiv, fig. 4. Double mural ridges are rarely seen, but they sometimes occur, especially near the margins of the smaller specimens.

In sections the coral is rather cellular; the walls are relative thin and nearly solid, being seldom more than 1·5 to 2^{mm} thick, while the

septa are alternately thicker and thinner, and show numerous lateral spinules, as mentioned above. See pl. x, fig. 4.

This species can usually be easily recognized by its evenly convex surface and the long convoluted simple, often gothic ridges, with the crest of the wall, thin, solid, and often in a zigzag line; by its rather open grooves, generally wider than the ridges, and usually showing rather open interseptal spaces and thin unequal septa ; and especially by the strongly spinulose lateral surfaces of the septa.

The width and depth of the actinal grooves varies considerably, but is almost always greater than in *labyrinthiformis*. The breadth from wall to wall is generally 8 to 14^{mm}, rarely as little as 6^{mm} ; open space between septal edges, near summit, mostly 6 to 10^{mm} ; depth of grooves mostly 6 to 10^{mm}, usually about 8^{mm}. Number of septa to a centimeter, usually about 24 to 28, when the smaller ones are developed.

The color of this species, in life, so far as observed by me at the Bermudas, is dull yellow, ocher-yellow, or brownish yellow. It appears not to have the orange-yellow color, so general in *labyrinthiformis*. In the Bahamas it is more variable in color.

I think it very improbable that all the various color-varieties, named by Lesueur from the color alone, pertain to this species. But in any case they cannot be determined from color alone, for the color of such corals is variable and uncertain. Therefore *M. viridis* of Lesueur rests on no valid characters.

This species is not abundant in the Bermudas. It is sometimes, though rather rarely, found on the inner reefs, associated with the preceding species, but it occurs more commonly on the extreme outer reefs. Most of the larger specimens that I have seen were from the vicinity of the North Rocks, where it becomes one to two feet or more in diameter. It is common in the West Indies and on the Florida Reefs, where it grows to a large size. I have seen specimens over a yard across.

At least two forms of simple ridged *Mæandræ* occur on the outer reefs of the Bermudas. Whether they represent more than varieties of the above species may be doubtful, for no one has yet obtained a sufficiently large series of them for study. Those that I have seen appear to me to belong to two species, for they differ decidedly as to the form and denticulation of the septa and in other ways. The more common form seems to be the abundant West Indian and Florida species, named above.

I am not prepared to admit that all the described West Indian

forms, referred to this species by Vaughan, really belong to one species. It is certain that too many species of this group have been admitted by Edw. and Haime; Duch. and Michel.; and others. But Gregory has gone to the opposite extreme in uniting *M. clivosa* =*filograna*, etc., to this species, from which it differs very plainly. The latter does not occur at the Bermudas.

Much diversity of opinion has prevailed as to the correct name for this species, as shown by the above synonymy. Apparently none of the names in use for members of this genus in works previous to Lesueur's memoir are available, except *M. cerebrum* Ellis and Solander, which was evidently based on the most common form of this species. Their description, though brief, is characteristic, and they also give the vernacular name, "Brainstone," which is still in use in the Bahamas and the Bermudas. But it was also undoubtedly included by Linné, Pallas, Ellis and Solander, Esper, and other writers of the 18th century under several other names that now apply more strictly to different species.

It appears to me that *M. sinuosa* of Lesueur could be retained for this species, were it the first available name that clearly applies to it. Vaughan rejects it because Lesueur referred *doubtfully* to the *Madrepora sinuosa* of Ellis and Solander (probably from memory alone). But the latter belongs to a widely different genus, and has no particular resemblance to this species, so that there can be no danger of confusion in this case. Lesueur described his species under a different genus, as if it were new. His erroneous and useless synonym, given with doubt, should not invalidate his name.

Moreover, Vaughan adopts *viridis*, the name of one of the color-varieties described by Lesueur, for the species. There can be no certainty that this variety pertains to *M. sinuosa*, for Lesueur gave to it no characters except the green color. It is well known that the green color, so frequent in coral animals, is generally due to a parasitic, unicellular, vegetable organism and it may occur in almost any species of reef corals, so that one could never be certain of the difference or identity of two allied corals having this color, even in the same locality, without studying the hard parts. On this account also, the name *viridis* should not be adopted for this species. In this case the name *viridis* is not connected directly with any specific characters and therefore has no claims for recognition. The same remark would apply to the other "varieties" of Lesueur. They are not recognizably characterized. The next distinctive name, not based on color, appears to be *strigosa* Dana, 1846.

I have seen the type of Dana's *strigosa* and consider it this species from personal study of it. The figures published by Pourtalès (op. cit., 1880) are excellent.

Whitfield (op. cit., 1901*) has described and figured an interesting abnormal specimen of this species from the Bahamas, which he thought a case of union between a *Ctenophyllia* and *Mœandrina*. But the central part, which he called *Ctenophyllia*, is not that genus. It has serrate septa and is only a variation of this *Mœandra*, in which the ridges and valleys have become unusually wide, the latter varying from about 12 to 15^{mm}. Similar cases are not rare.

Mæandra clivosa (Ellis and Sol.) Ver.

Madrepora clivosa Ellis and Solander, Nat. Hist. Zoöph., p. 163, 1786.

Madrepora filograna Esper, Pflanzenth., p. 139, pl. xxii, figs. 1, 2, 1789.

Madrepora clivosa Gmelin, Linné, Syst. Nat., ed. xiii, p. 3763, 1790.

Meandrina filograna Lamarck, Hist. Nat. An. s. Vert., t. ii, p. 248, 1816.

Meandrina interrupta, p. 258, pl. xiv, fig. 18; *M. filograna*, p. 262; *M. mammosa*, pl. xiv, figs. 10, 10a; Dana, Zoöph. U. States Expl. Exp., 1846.

Meandrina filograna; M. grandilobata; M. superficialis Milne-Edwards and Haime, Ann. Sci. Nat., ser. iii, xi, pp. 280, 281, 283, 1849, (t. Vaughan).

Mœandrina filograna; M. grandilobata; M. superficialis and *M. ? mammosa*, p. 396, Milne-Edwards and Haime, Hist. Nat. Corall., ii, pp. 390, 391, 396, 1857, (t. Vaughan from types).

Mœandrina clivosa Verrill, Bull. Mus. Comp. Zoöl., i, No. 3, p. 48, 1864; Proceed. Bost. Soc. Nat. Hist., x, p. 323, 1865.

Mœandrina superficialis; M. interrupta; M. grandiloba; and *M. filograna* Duchassaing and Michelotti, Mem. Corall. Ant., p. 74, 1860, (t. Vaughan, from types).

Mœandrina clivosa Pourtalès, Ill. Cat. No. iv, Mem. Mus. Comp. Zoöl., ii, p. 74, 1871.

Mœandrina clivosa Pourtalès, Florida Reefs, Corals, Mem. Mus. Comp. Zoöl., vii, No. 1, pl. ix, figs. 1–5, 1880.

Mœandrina filograna (*pars*) Gregory, Quart. Jour. Geol. Soc. Lond., vol. li, p. 265, 1895.

Platygyra clivosa Vaughan, op. cit., p. 57, 1901.

This species is easily distinguished by its narrow actinal grooves and generally simple, solid ridges; by the crowded septa, alternately larger and smaller, and not rising much above the wall; by the number of septa to a centimeter, which is 28 to 36, usually about 30; by the narrow, interrupted columella; and by the nodose, gibbous, or lobulated character of the coral, except when young.

* Notice of a Remarkable Case of Combination between two different Genera of Living Corals, Bull. Amer. Mus., xiv, p. 221. I have recently examined this specimen, with Mr. Whitfield.

Gregory (op. cit., 1895, p. 265) erroneously united this and the preceding species. They are certainly clearly distinct. The name *clivosa* has unquestionable claims to priority.

This coral does not occur at the Bermudas, but it is very abundant and large on the Florida reefs and at the Bahamas, as well as farther south, throughout the West Indies, and at Colon.

This species varies extensively in the length and form of the calicinal grooves. Usually they are long and very sinuous, but in many specimens part of them are, in certain parts, shorter and circumscribed, with some oval or angular astreiform calicles, especially on the flat or depressed portions, between the nodules.

Var. *dispar* V. nov.

I have already alluded (p. 68) to a Florida specimen in the Yale Museum that has a large part of the flat basal mass covered with more or less short and circumscribed angular calicles, much like those of *M. Agassizii*. But on the nodules they are long and sinuous, as usual. Florida Reefs, coll. E. B. Hunt.

Var. *explanata* V. nov. Plate xiv, figure 2.

When young this may form rather thin encrusting plates, often with their spreading, or even free and foliaceous edges somewhat resembling a *Merulina*. In this condition the septa are more loosely arranged and obliquely inclined ; the collines become small, narrow, and sharply triangular, close to the edge, and the valleys become shallow and flat, most of them having short, rudimentary collines dividing them into two. Detached fragments of this form might easily be mistaken for a distinct species.

Colon, Yale Museum, coll. F. H. Bradley.

Mæandra varia (Dana) Ver.

Astræa (*Fissicella*) *varia* Dana, Zoöph. U. States Expl. Exp., p. 236, pl. xii, figs. 13*a*, 13*b*, 1846.

Prionastræa ? varia Edw. and Haime, Hist. Nat. Corall., ii, p. 524, 1857.

Goniastræa varia Verrill, Bull. Mus. Comp. Zoöl., i, p. 48, 1864.

Of this rare species, supposed to be West Indian, I have seen only few specimens and have none at hand for figuring. Dana's type I have not seen. He does not state where it was placed. However, Dana's description and figures indicate that this is a *Mæandra* with mostly circumscribed, *Goniastræa*-like calicles, much as in the next, but with a more cellular structure.

Meandrina spongiosa Dana is entirely unlike this species, to which Dana thought it might be united as a variety.

The type of the former is in the Museum of Yale University. It is one of the *Cœloria*-group, with larger, open, mostly polygonal calicles, rather few septa, and with a very cellular texture, as seen in sections. Its origin is very uncertain. I do not think it probable that it came from the West Indies, as Dana supposed. No recent collector has found it in American waters, so far as I know. See pl. xiv, fig. 3.

Mæandra Agassizii (Edw. and Haime).

Astræa reticularis Dana, Zoöph., p. 237, pl. xii, figs. 9-9*c* (*non* Lam.)=*Prionastræa? Agassizii* Edw. and Haime, Hist. Corall., ii, p. 524, 1857.

Plate XIV. Figures 1, 1*a*.

This rare species when well grown forms compact, even, hemispherical masses, a foot or more in diameter. Such a mass, from the Bahamas, in the Museum of Yale University, is ten inches across and about six thick. A large part of the calicles are simple, astræiform, angular, often hexagonal or pentagonal, like those of a *Goniastræa*, separated by narrow rather acute walls. But in many places, especially toward the borders, they form more or less elongated, mæandriniform grooves, which often become branched and convoluted, as in typical *Mœandra*. Some of these actinal grooves become one to two inches long (25 to 50^{mm}); 2.5 to 4^{mm} wide; they are separated by regular ridges, similar to those of *M. clivosa*, but smaller and more regular. The mændriniform grooves are often mixed with astræiform calicles, and all intermediate forms may occur on one specimen. The ridges are rather high, rounded or with a gothic profile, and have a simple, solid wall; they are about 2 to 3^{mm} wide. The septa are numerous, very thin, close, pretty regular, about 25–30 to a centimeter, and they project but little above the wall. The edge is finely serrulate and there is a small but distinct paliform lobe. The columella is well developed, spongy, composed of small convoluted laminæ, as in most other species of the genus.

On those parts where most of the calicles are simple and regular, they are mostly from 4 to 7^{mm} in diameter; double ones are from 12–14^{mm} long.

This species has not been found at the Bermudas and probably not on the Florida Reefs. Most specimens that I have seen have been from the Bahamas, where it seems to be rare. It is generally mistaken for a *Goniastræa*, which it often closely resembles, but it is closely related to *M. clivosa*.

Mæandra areolata (Linné).

Madrepora areolata (*pars*) Linné, Syst., ed. x, p. 795, 1758. Pallas, Elench. Zoöph., p. 295, 1766; ? Ellis and Sol., Nat. Hist. Zoöphytes, p. 161, pl. xlvii, figs. 4, 5, 1786.

Madrepora areola (*pars*) Linné, Sys. Nat. ed. xii, p. 1274, 1767. Esper. Pflanz., i, pp. 76, 84, pl. v, figs. 1-4, young, worn; and *Madrepora meandrites* (*pars*), pl. iv, figs. 1, 2, adult, 1788.

Mæandra areola Oken, Lehr. Naturg., i, p. 70, 1815.

Meandrina areolata Lam., Hist. Anim., ed. i, vol. ii, p. 247, 1816 (*non* Linné, ed. x). ? Lamouroux, Expos. Method., p. 55, pl. xlvii, fig. 5, 1821 (reprint of plate of Ellis and Sol.).

Manicina hispida + *Manicina prærupta* + *? Manicina manica* Ehrenberg, Corall. Rothen Meeres, p. 336, 337 [102, 103] 1834 (*non M. areolata*, p. 103).

Manicina areolata Dana, Zoöph. U. S. Expl. Exp., p. 191, pl. ix, fig. 3, 1846. Edw. and Haime, Corall., ii, p. 397, 1857. Verrill, Bull Mus. Comp. Zoöl., i, p. 48, 1864. Pourtalès, Florida Reefs, Corals, Mem. Mus. Comp. Zoöl., vii, pl. v, figs. 1-22, pl. vi, figs. 1-7, 1880.

Manicina ? dilatata + *M. prærupta* + *M. hispida* Dana, Zoöph. Expl. Exped., pp. 191-193, pl. ix, fig. 3, 1846.

Manicina strigilis + *M. hispida* + *M. Danai* + *M. Valenciennesi* Edw. and Haime, Hist. Corall., ii, pp. 399-401, 1857.

PLATE XI. FIGURES 1, 2. · PLATE XII. FIGURES 1, 2, 3.

This very common Florida and West Indian species does not occur at the Bermudas.*

It varies greatly in form and in the height, breadth, and form of the actinal grooves and intervening ridges. These are generally more or less regular infoldings while the coral is young, but in large specimens they become forked and more or less convoluted, finally assuming, in old specimens, the meandriniform arrangement. The actinal grooves are, however, always much wider, deeper, and more open than in either of the three preceding species. The septa are generally strongly granulated or subhispid on the sides and roughly denticulated on the edges, with a broad basal paliform lobe. It is pedicellate when young, but usually becomes free when old.

Some of the nominal species, quoted in the synonymy, were based on beach-worn specimens, which look very unlike fresh ones.

The name *Madrepora areolata* was first applied by Linné (Syst., ed. x, p. 795, 1758) chiefly to the East Indian coral now generally known as *Trachyphyllia amarantum* Edw. and Haime. Ehrenberg's *Manicina areolata* was probably the same or a related species (*T.*

* The fossils mentioned by Nelson as belonging to this species were probably *Mycetophyllia* (see p. 68, note).

Geoffroyi E. and H.). The former should be called *Trachyphyllia amaranthus** (Müll.).

Linné evidently had the East Indian species in view when he established the species *M. areolata*, for he quoted a recognizable figure of it (Rumphius, Amb., 6, p. 244, pl. 87, fig. 1), and gave "O. Asiatico" as its habitat. His diagnosis is so indefinite that it would apply to either species. This name should properly have been restricted to the East Indian coral, but in view of the whole history of the name, and especially in consequence of the early application of the name, *amaranthus*, by Müller, 1775, to the oriental species, the name *areolata* should continue to be used for the American coral.

Linné, however, quoted Petiver, Pterigraphia Americana, pl. xx, fig. 16, 1712, which undoubtedly refers to the American species. In the ed. xii, p. 1274, he arbitrarily changed the name to *areola*, keeping the same diagnosis, with slight changes.

Pallas (1766, p. 275) added the American species to that of Linné, and quoted references to both in earlier books, though his diagnosis applies best to the East Indian species.

Esper's name (*areola*) was applied mainly to the West Indian species, which he figured. His additional figure on pl. iv, figs. 1, 2, erroneously referred by him to *meandrites*, represents an old specimen with more or less convoluted grooves, such as are of frequent occurrence in favorable situations. It is represented with wide grooves; serrulate septa; and narrow subacute ridges, double in some places.

Dana's *M. dilatata* was based on a figure in Ellis and Solander, pl. xlvii, fig. 4. He apparently had no specimen. The figure is not determinable with certainty. It looks like a young *Trachyphyllia amaranthus*. But it might have been made from a poor drawing of a beach-worn, young *M. areolata*. Hence I place *M. dilatata* here as a doubtful synonym. In either case the name is useless.

The most important variations in this species are those that are due to the number and closeness of the septa; the amount of

* According to Bruggmann (Abhand. naturwiss. Vereins, Bremen, 1878, 549) the name *Madrepora amaranthus* was given to this coral by Ph. L. S. Müller in 1775 (German ed. Linné, Syst. Nat., vi, ii, p. 682, which I have not seen), and he proposed to call it *Trachyphyllia amarantus*. But it seems more desirable to follow Müller's spelling and call it *T. amaranthus* (Müll.). "Sea amaranth" was its ancient vernacular name. The specific name *amarantum*, as it was given by Dana, was based on a mistake in spelling. Rumphius called it *Amaranthus saxeus*.

columella ; and the solidity or vesicular character of the collines. Some of these forms are, perhaps, worthy of varietal names :

Var. *hispida* (Ehr.)=*M. prærupta* Dana (*non* Ehr.).

The type of Dana's *M. prærupta* is in the Yale Museum. It is a variety of *M. areolata*, with the collines mostly solid, narrower than usual, and partly sinuous. Septa rather narrow, thickened at base, emarginate, hispid laterally, roughly serrulate ; columella largely developed, finely lamellose. The collines are thin and simple in some places, but double in others. The valleys are mostly broad and open, 12 to 20^{mm} wide, usually about 15^{mm} ; collines mostly 4 to 6^{mm} wide. Pl. xii, fig. 2, type of Dana.

Florida Reefs.

Var. *confertifolia* V., nov.

Plate XI. Figure 2.

Form as usual. Collines generally wide, double, truncate or sulcate, sometimes simple, rather compact. Septa numerous and crowded, alternately wider and narrower, about 11 to 12 wider ones to a centimeter, not very hispid laterally, finely and pretty regularly serrulate, usually wide and rounded distally, and with a broad basal paliform lobe. External costæ numerous, pretty evenly spinulose. Columella usually well developed, spongy or finely lamellose. Calicinal valleys wide and open, mostly about 20^{mm} wide, sometimes 25^{mm} ; collines mostly 10 to 12^{mm} broad.

Florida Reefs. Yale Museum.

Var. *laxifolia* V., nov.

Plate XII. Figure 1.

Form as usual, but generally with lobulate margins. Valleys usually narrower than in the preceding variety, rather deep, often with perpendicular walls. Collines short at first, but branched and sinuous when older, mostly narrow, generally double, often becoming simple when older, usually with very cellular exotheca. Septa fewer than usual, and less crowded, about eight or nine wider ones to a centimeter, with small ones alternating, so openly placed that the interseptal spaces appear unusually wide and conspicuous, rather wide and rounded distally, moderately hispid laterally, pretty evenly and sharply serrulate, but the large, rounded paliform lobe is often lacerate-toothed. Columella well developed, finely lamellose. Exterior costæ prominent, sublamellar, sharply serrulate. Valleys mostly 10 to 13^{mm} wide ; collines 5 to 12^{mm} wide.

Florida Reefs and St. Thomas. Yale Museum.

Var. *columellaris* V., nov.

Form as usual. Septa numerous, crowded, much thickened toward the base and very strongly hispid laterally, edges roughly serrulate and lacerate. Columella highly developed, broad, trabecular or finely lamellose, the lamellæ often largely coalescent and rough on the surface. Valleys usually wide and open. Collines either single or double, often sulcate. This is near var. *hispida* (Ehr.), in the hispid character of the septa.

Florida Reefs. Yale Museum.

Var. *angusta* of Dana, p. 196, I have not seen. It may have been based on a young example of *M. labyrinthiformis.*

Mæandra conferta Ver.

Favia conferta Verrill, these Trans., vol. i, p. 355, 1868.
Favia conferta (*pars*) Vaughan, op. cit., pp. 39, 40, 1901.

Plate XIII. Figure 6.

Although this species has the aspect of a *Favia*, near *F. fragum*, when the calicles are mostly simple and elliptical, other specimens, and often even different parts of the same specimen, have more or less elongated, narrow cells or valleys, with several indistinct actinal centers, nearly as in *M. Agassizii* and parts of *M. clivosa.* These short valleys are often curved, or bent a little in sigmoid shape, but are not sinuous. They are then separated by small, narrow, solid collines.

It is evidently closely related to *M. varia*, but has much narrower calicles and valleys, and still more of the valleys are circumscribed. The septa are thinner and more numerous, rather regularly serrulate.

Brazil, at Pernambuco, Bahia, the Abrolhos Reefs, etc. Yale Mus., coll. Hartt; Rathbun.

Vaughan (op. cit., 1901) thinks that this species is not distinct from *Favia gravida* Ver. It seems that they must be referred to distinct genera. (See p. 91.) I have figured one of the types.

Subfamily **Trachyphyllinæ** Ver., nov.

Mæandriform corals that have distinct calicinal centers and radiating septa. (See p. 65.)

Manicina versus **Colpophyllia.** Type *M. gyrosa* Ehr.

Podasteria (provisional name) Ehr., p. 101, 1834.

If we consider *M. areolata* (L.) as congeneric with *Mæandra*, as above explained (p. 67), the name *Manicina* must either be dropped altogether for a genus, or else applied to some other type. By the

process of elimination, the last subdivision of *Manicina* Ehr. to receive a name was the group named *Gyrosmilia* in 1851. This was based on *M. interrupta*, the second species under *Manicina* in Ehrenberg's list,* pp. 101–103.

But *Gyrosmilia* is generally regarded as inseparable from *Plerogyra* E. and H., 1848 (*Euphyllia, pars*, Dana, 1846). It is doubtful whether *Plerogyra* can be kept as a genus distinct from *Euphyllia*, from which it differs chiefly in the loose union of the walls.

On p. 102, under *M. gyrosa*, Ehrenberg states that *gyrosa* does not agree with the generic characters, and proposes for it a provisional generic name (*Podasteria*). This might take the place of *Colpophyllia*† according to strict rules of priority, but he gives no definition of the generic characters, nor does he refer to it his *fissa* (sp. 6) and *mæandrites* (sp. 7), though they are probably all forms of the same species (*gyrosa*).

It seems best, therefore, to restrict the name *Manicina*, if it is to be retained for a genus, to the group named *Colpophyllia* E. and H., with *M. gyrosa* as the type. *Podasteria* and *Colpophyllia* would thus become strict synonyms of it. It is doubtful whether more than one species is known, most, if not all, of the several named species being mere forms of *gyrosa*.

This would surely produce the least disturbance in the current nomenclature. The only alternative would be to restore it to the second and third species = *Plerogyra* + *Gyrosmilia* E. and H. But in case these should be united to *Euphyllia* D. (1846), as is likely, the name would again lapse or else come back to *Colpophyllia*.

Another view may, possibly, be reasonably held. *Manicina* (E. and H.) by some may be thought worthy of recognition as a section or subgenus of *Mæandra*, with *M.* (*Manicina*) *areolata* as the type. But I know of no structural characters by which such a group can be distinguished.

---

* The 1st species is a *Mussa* (E. and H.); the 2d is type of *Gyrosmilia*, 1851 = *Plerogyra* E. and H., 1848; 3d is *Plerogyra*; 4, 6, 7 are *Colpophyllia* E. and H., 1848 = *Podasteria* Ehr., 1834; 5th is *Mæandrina* (revis.) = *Pectinia* Oken; 8, 9, 10 are *Mæandra*, restr., Oken; 12 is *Tridacophyllia* Blainv., 1830. The 11th, *M. areolata* Ehr. (*non* L.), is doubtful. Edw. and H. refer it to *Trachyphyllia Geoffroyi*, but the description in Ehr. does not apply to a *Trachyphyllia*, for it implies true sulcated collines, "*truncatis, passim fissis.*" It is indeterminable from the description.

† Ehrenberg's three species, Nos. 4, 6, 7, all belong to *Manicina* (*Podasteria*) *gyrosa* (or *Colpophyllia gyrosa* E. and H.), according to Vaughan, who has recently examined the types of Ehrenberg, in Berlin.

The principal distinctions between *areolata* and *Colpophyllia* is the presence of well defined calicinal centers and radial septa in the latter, while in the former they are indistinct, as in *Mæandra;* and the absence of a columella in *Colpophyllia.*

Callogyra V., gen. nov.

Coral pedicelled; calicles large and with very distinct centers in deep valleys, mostly united in short series. Collines large, with simple or double walls united by exotheca. Septa with paliform lobes; edges finely serrulate. Columella trabecular. Outer surface naked, covered with spinulose costæ. Endotheca not abundant, deep within the interseptal spaces.

This genus is like a *Trachyphyllia* with coalesced walls, and might, indeed, be considered a section of that genus if intermediate conditions were known. It bears about the same relations to that genus that *Symphyllia* does to *Mussa*, or *Plerogyra* to *Euphyllia.*

In form, the type resembles the *Manicina areolata* of authors, but differs widely from it in its large, distinct calicles, and finely and evenly serrulate septa. It also has a general resemblance to *Meandrina* (*Pectinia*) *Braziliensis*, but the latter has entire septa and the calicinal centers are not distinct.

It is also nearly allied to *Manicina*, emended = *Colpophyllia* E. and H., but the latter forms more massive and cellular corals, without a columella, and has different exterior costæ, and less distinct calicles.

Callogyra formosa V., sp. nov.

PLATE XXIV. FIGURES 1, 2.

The coral is narrowly pedicelled, glomerate, elliptical, with lobed margins and with high radial collines, more or less forked and curved, much as in *Isophylliæ* and young *Mæandræ.* Between the collines are large marginal calicles, which render the margin lobulate; two large calicles occupy the central valley. The valleys are deep and rather wide, the central ones with perpendicular walls. The calicinal centers are very distinct and occupied by a loose trabecular columella. The collines are simple in some places, with a thin wall, but in most places they are double with two thin walls near together; their summits are obtusely rounded.

The septa are thin with wide interspaces; their breadth is moderate; lengths very different, corresponding to the five cycles to which

they generally belong, the smallest being quite short. The larger ones have wide but slightly marked paliform lobes and are broadly rounded at the summits; their surfaces are finely granulate, and costulate close to the border; their edges are very finely and regularly denticulated.

The under side is covered with elevated, lamellate, radial costæ, which are sharply and closely dentate on their edges, the teeth being small and spiniform.

Length of the coral, 75^{mm}; breadth, 60^{mm}; width of the valleys mostly 13 to 25^{mm}; depth, 10–18^{mm}.

The type is from an unknown locality, but was supposed to be West Indian. It belongs to the American Museum, New York.

From its affinities with *Trachyphyllia*, I think its origin is more likely Indo-Pacific.

There is a smaller worn specimen in the Museum of Yale University, locality unknown.

Subfamily **Favitinæ** Ver., nom. nov.

This subfamily is intended to include all the astreiform corals that normally or chiefly increase by fission or by intracalicinal budding, for these two methods intergrade completely and often coexist on the same coral. It is thus nearly equivalent to *Fissicella* of Dana. Paliform lobes or teeth are generally present.

This group is very closely related to *Mæandrinæ*. The principal difference consists in the more complete fission of the zoöids and the rapid and usually complete isolation of the calicles, which may be either circular or angular.

Perhaps it would have been thought better by many to have considered the group a distinct family near *Mæandridæ*, under the name *Favitidæ*. But the study of such species as *Favia gravida* and *F. fragum*, in comparison with *Mæandra conferta*, *M. Agassizii*, and *M. clivosa*, var. *dispar*, shows that the two groups nearly intergrade.

The occasionally isolated calicles of *Mæandra* are structurally identical with those of *Favia*. Perhaps the two groups are not even of subfamily rank.

I have used *Favites* as the typical genus from which to form the family name, because the ultimate fate of *Astrea* and *Favia* is still uncertain. (See p. 89.)

Favia Oken, 1815, restricted by Edw. and Haime, 1857. Star Corals.

Astrea (1st section) Lamarck, Syst. Anim. s. Vert., p. 371, 1801 ; (*pars*) Hist. Anim., ii, p. 60, 1816.

Favites (*pars*) Link, Beschr. Nat.-Samml., Univ. Rostock, iii, p. 162, 1807.

Favia (*pars*) Oken, Lehrb. Naturg., i, p. 67, 1815.

Astrea, subgenus *Fissicella* (*pars*) Dana, Zoöph., p. 220, 1846.

Parastrea Edw. and Haime, Compt.-rendus, xxvii, p. 495, 1848 ; Ann. Sci. Nat., xii, 1850.

Favia Edw. and Haime, Hist. Nat. Corall., ii, p. 426, 1857 ; Verrill, these Trans., i, pp. 353–355, 1868.

Astrea Verrill, Comm. Essex Inst., v, p. 33, 1865; Verrill, in Dana, Coral Islands, pp. 380, 388, 1874.

Astræa Quelch, Reef Corals, Chall. Exped., xvi, 1886.

The name of this large genus has been much in question for a long time. This is due to several reasons. When *Astrea* was first proposed by Lamarck (1801) he gave it two sections with a single species as an example of each. His first section had *A. rotulosa* as its type. The second section had *A. galaxea* (=*radians*) as the type. Properly the name should have been retained for the former, as the more typical and first named.

But Oken, 1815, made two divisions similar to, but not the same as those of Lamarck, and applied the name *Favia* to the group more like the first of Lamarck's sections, and *Astrea* to the second. Blainville, in 1830, named the latter *Siderastræa*.

But under *Favia* Oken named three species, which belong to three modern genera, viz : 1. *F. ananas*=*F. fragum* ; 2. *F. cavernosa*=*Orbicella cavernosa* ; 3. *F. favites* or *favosa*=? *Prionastræa abdita* E. and H.=*Favites* Link.

The true relations of *A. rotulosa* Ellis and Sol., Lamarck's first type of *Astrea*, are still doubtful. It was referred to *Favia* by Edw. and Haime, perhaps erroneously. Their species, thus named, may very likely be different. It has much larger calicles, more numerous septa, and they place it in the section with feeble pali. The general appearance of the original figure is more like an *Orbicella* or *Plesiastræa*. It has a circle of very distinct, prominent pali, in which it agrees with *Plesiastræa*. The calicles are regular and circular and the septa are few and very prominent. I have never seen a perfect specimen of it. A few beach-worn West Indian corals that I have seen may belong to it, but they are not positively determinable.

It may be an East Indian coral of the *Plesiastræa*-group. In that case *Astrea*, if retained, should be restricted to this, as the original type, and thus it would be distinct from *Favia*.

The name *Favites* was given by Link, 1807, to a genus nearly equivalent to *Astrea* Lam. and *Favia* Oken, of which it could be considered a synonym. It included four genera. Vaughan (op. cit., 1901, p. 21) proposed to restore the name for a part (the *favosa*-group) of Link's genus, and thus use it in place of *Prionastræa*. It might have been substituted, equally as well, for *Favia* (in the usual sense) for the latter was practically synonymous. But Vaughan is justifiable in considering *favosa=abdita* as the proper type.*

There is an additional reason why *Astrea* is rejected by some writers, as by Vaughan (op. cit., 1901, pp. 60, 61).

Bolten used the name *Astræa* for a group of gastropod shells in 1798. His genus was not properly defined and has never come into use. It included species usually referred to *Turbo* (L.) and *Xenophora*. Whether it should be restored for any of these shells is very doubtful. Bolten's work was a mere catalogue, not a scientific work in any legitimate sense, and it is extremely rare. Still his names are recognized by many malacologists.

The difference in the original spelling of the two names would, perhaps, be a sufficient reason for retaining both, if not otherwise invalid.

It seems to me necessary to wait for the re-examination of the true *Astrea rotulosa* before the status of *Astrea* can be settled.

However, it would evidently lead to less confusion to reject *Astrea* altogether, on the ground of its prior use by Bolten, than to use it for *Siderastræa*, as some have done, for the latter does not belong to the group *Astræidæ*, but is a fungian coral.

Astrea is said to have been used by Gmelin, 1789 (see L. Agassiz, Nomencl. Zoöl., and Gregory, op. cit., p. 278). The latter cites it as on p. 3767, under *M. astroites*. But the name is used there only as a part of a polynomial name quoted from Browne (Hist. Jamaica, 1756, p. 392), with other descriptive quotations, and in no sense as a generic term. Browne gave several species of *Astrea*, but he used the term only as a part of his *polynomial* descriptive names.

---

* *Favites* Link (*pars*)=*Fissicella* (*pars*) Dana=*Prionastræa* Edw. and H. + *Metastræa* E. and H. For a review of the principal species see p. 92.

Favia fragum (Esper) Edw. and Haime.

Madrepora ananas (*pars*) Pallas, Elench. Zoöph., p. 321, 1766 (not of Linné, Syst. Nat., ed. x, 1758, p. 797, which was a palæozoic fossil (*Acervularia*), from Gothland.

Madrepora ananas (*pars*) Linné, Syst. Nat., ed. xii, i, p. 1275, (not of ed. x,) 1767.

Madrepora ananas Ellis and Solander, Nat. Hist. Zoöph., p. 168, pl. xlvii, fig. 6, 1786.

Madrepora fragum Esper, Pflanzenth., Fortsetz., i, p. 79, pl. lxiv, figs. 1, 2, 1797 (*non Madrepora ananas* Esper, Pflanzenth., pp. 128–131, pl. xix, which is a *Dichocœnia*.)

Favia ananas (*pars*) Oken, Lehrbuch Naturgesch., Zoöl., i, p. 67, 1815.

Astrea ananas Lamarck, Hist. Nat. Anim. s. Vert., ii, p. 260, 1816.

Astrea ananas LeSueur, Mem. Mus. Hist. Nat. Paris, vi, p. 285, pl. xvi, fig. 12, 1820.

Astrea ananas Lamouroux, Exp. Meth. Gen. Polyp., p. 59, pl. xlvii, fig. 6, (after Ellis and Sol.)

Favia ananas and *Favia fragum* Milne-Edwards and Haime, Hist. Nat. Corall., ii, pp. 435–439, 1857.

Favia incerta, p. 351 [75], pl. x, figs. 13, 14; +*Favia coarctata*, p. 352 [76], pl. x, figs. 17, 18; +*Favia ananas*, p. 352, Duchassaing and Michelotti, Mem. Corall. Ant., 1861 (t. Vaughan, from types).

Favia ananas Verrill, Bull. Mus. Comp. Zoöl., i, p. 48, 1864.

Favia fragum Verrill, these Trans., i, p. 355, 1868.

Astræa ananas and *A. coarctata* Quelch, Narrative Chall. Exp. Zoöl., i, pt. i, foot-note, p. 146, 1885.

Astræa coarctata, pp. 9, 12, 98; +*Astræa incerta*; +*Astræa ananas*, p. 12, 98; +*Astræa fragum*, pp. 13, 98, 99, Quelch, Reef Corals, Chall. Exp. Zoöl., xvi, 1886.

Favis ananas Gregory, Quart. Jour. Geol. Soc. London, li, p. 260, 1895.

Favia fragum Vaughan, Samml. Geol. Reichs-Mus., Leiden, ii, p. 24, 1901.

Plate XIII. Figures 1, 2.

The name *ananas*, as applied to this species, dates from Pallas, 1766, who described it very well indeed. But the name, as used previously by Linné (Syst., ed. x, p. 797) was particularly applied to a Gothland fossil coral of the genus *Acervularia*. So it should, without doubt, be dropped for this living species, to which it has been so long applied. However, this name has also been applied, by the earlier writers, to other existing species, so that its synonymy is complex. Fortunately the early name *fragum* is available and has, apparently, not often been applied to other species, so that its use for this one can hardly lead to any confusion. My own experience, based on a study of large numbers of specimens, living and dead, is in accord with that of Mr. Vaughan, as to the necessity of uniting the several forms described by Duch. and Mich. and by Quelch as

distinct species. The differences noticed are due to slight variations in growth, and especially to the greater or lesser crowding of the calicles. Sometimes the intervening spaces are very narrow; in other specimens, and more commonly, they are rather wide. The calicles may be circular, angular, or elliptical. The extreme forms occur associated together in tide-pools at the Bermudas, but intermediate specimens also occur in the same places. In life, the soft parts agree in color and structure.

My figures (pl. xiii, figs. 1, 2) are from photographs of two Bermuda specimens, found together. They show nearly the extreme forms of variation. The color of the soft parts, in life, is light yellow.

This coral is common on the Florida Reefs, and throughout the West Indies in shallow water. It is also abundant at the Azores. (t. Quelch.) It never becomes large.

Favia gravida Ver.

Favia gravida Verrill, these Trans., i, p. 354, 1868.
Favia conferta (*pars*) Vaughan, op. cit., pp. 39, 40, 1901 (*non* Verrill).

Plate XIII. Figure 3.

This Brazilian species is nearly allied to *F. fragum* of the West Indies. I do not think it is so closely related to *M. conferta* as Vaughan supposes, for he has united the two forms under the latter. (See p. 84.) I have never found mæandriniform calicles or valleys as in the latter, and the septa, columella, and sections of the walls are different.

I have here figured one of the types.

Abrolhos Reefs, Bahia and Pernambuco, coll. C. F. Hartt; R. Rathbun.

Favia leptophylla Ver.

Favia leptophylla Verrill, these Trans., i, p. 353, 1868.

Plate XIII. Figures 4, 5.

This species is very unlike any of those forms related to *F. fragum*. It has double walls and vesicular exotheca between the calicles. The proper walls are thin, continuous; those of adjacent calicles are separated by a loose, vesicular structure, with thin dissepiments. The septa are rather few, very thin with rather prominent summits. This species produces some intermural buds, but it increases mainly by fission.

The photographs here reproduced are from the original type, now in the Museum of Yale University.

Abrolhos Reefs, Brazil, coll. C. F. Hartt.

Favites Link, 1807, restricted.

Favites Link (*pars*), op. cit., p. 162, 1807.
Favia (*pars*) Oken, Lehrb. Naturg., i, p. 67, 1815.
Fissicella (*pars*) Dana, Zoöph., p. 220, 1846.
Prionastræa Edw. and Haime, Comptes-rend., xxvii, p. 495, 1848.
Prionastræa and *Metastræa* Edw. and Haime, Hist. Corall., ii, pp. 513 and 525, 1857.

Calicles usually angular or polygonal, separated by nearly solid walls, which often contain a single series of cellules, more distinct toward the base. The division of the calicles is generally excentric, or near the margin, by unequal fission or intracalicinal budding, but it may also be by median fission, where the calicles become crowded, or in the central parts. Septa rather numerous, denticulated, the larger teeth usually proximal. Columella developed more or less, spongy or trabecular. Pali usually distinctly developed.

The history of the name of this genus has been discussed on page 89.

This large genus appears to be absent from the West Indian fauna. The American species, hitherto referred to it, belong in other groups, so far as I have seen them. Among the better known Indo-Pacific species are the following, most of which I have studied personally :—

Favites favites (Pallas, *not M. favosa* L., ed. x, which was a fossil) = *P. abdita* (Lam.) E. and H. East Indies ; Singapore.

F. profundicella (E. and H.).

F. crassior (E. and H.).

F. magnifica (Bv. ; E. and H.) (*non* Dana). Batavia.

F. magnistellata (E. and H.).

F. obtusata (Lam.; E. and H.). Tongatabou; Fiji.

F. sulfurea (E. and H.). Vanikoro.

F. Quoyi (E. and H.). New Ireland; Fiji.

F. Ellisiana V. (nom. nov.) = *M. favosa* Ellis and Sol., Hist., p. 167, pl. l, fig. 1, 1786, *non* Linné = *Prionastræa favosa* E. and H., *non* Linné.

F. fusco-viridis (Q. and G.; Dana). Tongatabou; Fiji.

F. virens (Dana). Fiji.

F. flexuosa (Dana). Fiji.

F. spectabilis (Ver.) = *Astræa magnifica* Dana, *non* Blainv. = *P. spectabilis* Ver. East Indies.

F. sinuosa (Dana). Fiji.

F. favulus (Dana). Fiji.

F. coronata (Studer, 1881) Singapore.

F. robusta (Dana). Fiji; Amboina.

F. valida (Ver.)=*Astræa heliopora* (*pars*) Dana, p. 246, pl. xiii, figs. 11*a*, 11*b*. Wakes I.

F. tessellata Ver., nom. nov.=*A. tesserifera* Dana (*non* Ehr.).

F. Chinensis (Ver.)=*Prionastræa Chinensis* Ver., Comm. Essex Inst., v, p. 35, 1866. Hong Kong.

F. armata (Ver.)=*Astræa intersepta* Dana, Zoöph., p. 246, pl. xiii, figs. 12*a* to 12*d* (*non* Esper,=*Stephanocœnia*)=*Plesiastræa armata* Ver. in Dana, Coral Is., ed. ii, p. 381.

F. coronella Ver., sp. nov. = *Astræa parvistella* (*pars*) Dana, Zoöph., p. 244, but not the figures. One of Dana's specimens differs from the type. Calicles small, (2·5 to 3·5^{mm},) angular, separated by narrow, nearly solid walls. Septa unequal, in three cycles or more, usually 24 to 30, those of the 3d cycle very narrow, the larger ones roughly serrate and strongly granulated ; six prominent pali before the primary septa ; columella nearly solid. Endothecal dissepiments regular, nearly horizontal, not crowded. This and the next preceding might be referred to *Goniastræa* about as well as to *Favites*. Fiji.

The following are from the Red Sea :

F. gibbosa (Klunz., p. 40, pl. iv, fig. 10, as *Prionastræa*.

T. pentagona (Esp.; Klz., *non* Ehr.,=*P. melicerum* E. and H.

F. spinosa (Klunz., p. 39, pl. iv, f. 7, pl. x, f. 5).

F. vasta (Klunz., p. 38, pl. iv, f. 8, 12, pl. x, f. 4*a*, 4*b*, as *Prionastræa*).

F. tesserifera (Ehr.; Klz.; E. and H.).

F. Ægyptorum (Edw. and H.)=*Metastræa Ægyptorum* E. and H. Recent and fossil.

Family **Orbicellidæ** Ver. Star Corals.

This family will include the astreiform corals that have circular or nearly circular calicles, and increase by mural or exothecal budding. The polyps, when expanded, are exsert.

Orbicella (Dana), restricted.

Astræa, subgenus *Orbicella* (*pars*), Dana, Zoöph. Expl. Exped., p. 206, 1846.
Heliastræa Edw. and Haime, Hist. Corall., ii, p. 456, 1857.
Orbicella Verrill, Bull. Mus. Comp. Zoöl., i, p. 47, 1864. Verrill, in Dana's Corals and Coral Islands, ed. 1, p. 380, 1872 ; ed. 2, pp. 380, 388, 1874 ; ed. 3, pp. 421, 429, 1890.

Corallites cylindrical or nearly so. Costæ well developed and serving, with more or less cellular intercostal exotheca, to unite the corallites. Septa exsert ; paliform teeth and columella are present.

Orbicella annularis (Ellis and Sol.) Dana. Star Corals.

Madrepora astroites Pallas, Elench. Zoöph., p. 320, 1766 (not of Linné, ed. x, p. 796, which was a palæozoic fossil, nor of ed. xii).

?? Madrepora acropora Linné, Syst. Nat., ed. xii, p. 1276, 1766. (Probably not this species, perhaps a *Solenastræa*, but indeterminable.)

Madrepora annularis Ellis and Solander, Nat. Hist. Zoöph., p. 169, pl. liii, fig. 1, 2, and *Madrepora faveolata*, p. 166, pl. liii, figs. 5, 6, 1786.

?? Madrepora acropora Esper, Pflanzenth., Fortsetz., i, p. 21, pl. xxxviii, 1797, (*non* Linné, Syst., ed., xii, p, 1276.)

Astrea annularis Lamarck, Hist. Nat. Anim. s. Vert., ii, p. 259, 1816.

Astrea annularis Lamouroux, Exp. Meth. Genres de Polyp., p. 58, pl. liii, figs. 1, 2, and *Astrea faveolata*, p. 58, pl. liii, figs. 5, 6, 1821.

Astrea (*Orbicella*) *annularis* Dana, Zoöphytes U. S. Expl. Exp., p. 214, pl. x, fig. 6, and *? A.* (*O*) *stellulata*, p. 215, pl. x, fig. 7, (variety,) 1846.

Heliastræa annularis Milne-Edwards and Haime, Hist. Nat. Corall., ii, p. 473; and *? Heliastræa acropora*, p. 477, 1857.

Heliastrea annularis ;+ H. acropora ;+ H. Lamarcki Duchassaing and Michelotti, Mem. Corall. Antilles, p. 352, [76], 1861 (t. Vaughan from types, *non H. Lamarckana* E. and H.).

Orbicella annularis Verrill, Proc. Boston Soc. Nat. Hist., ix, p. 33, 1862, rate of growth.

Phyllocœnia sculpta + P. limbata + Cyphastræa costata (*pars*) *+ Astræa Barbadensis* Duncan, Quart. Journ. Geol. Soc. London, xix, pp. 432–444, pl. xv, figs. 6, 6*a*, 1863, all fossils, (t. Vaughan from types).

Plesiastræa ramea Duncan (fossil), op. cit., xx, p. 39, 1864 (t. Vaughan).

Orbicella annularis Verrill, Bull. Mus. Comp. Zoöl., i, p. 48, 1864; Pourtalès, Flor. Reefs, Cor., Mem. Mus. Comp. Zoöl., vii, No. 1, pl. iv, figs. 1–10, 1880.

Orbicella annularis A. Agassiz, Bull. Mus. Comp. Zoöl., xx, No. 2, p. 61, pls. i, ii, 1890, rate of growth. Verrill, these Trans., x, p. 553, 1900.

Orbicella acropora (*pars*) Gregory, Quart. Jour. Geol. Soc. Lond., li, p. 272 (*non* Linné,) ;+ *Cyphastræa costata*, p. 274 ;+ *Echinopora Franski*, p. 274, pl. xi, figs. 2*a*, 2*b*, 1895, (teste Vaughan from types).

Orbicella acropora Vaughan, Bull. Mus. Comp. Zoöl., xxviii, No. 5, p. 275, 1899; Samml. Geol. Reichs-Mus., ii, p. 22, 1901, (not of Gardiner, 1899).

Plate XV. Figure 1.

This common and well known species was admirably figured by Professor L. Agassiz in the plates of Florida Reefs, published by Pourtalès, 1880.

It shows considerable variations in the size of the calicles; in the extent to which they are crowded together ; in the prominence of their borders above the intervening exotheca ; in the prominence of the septa above the walls ; and in the extent to which the small septa of the third cycle are developed. But yet these variations, so far as I have seen, never go so far as to render difficult the recognition of the species, unless the specimens are badly worn.

The specimens from which the figures of *annularis*, *faveolata*, *stellulata*, and *pleiades* were made, in the work of Ellis and Solander, were all badly worn. Hence there has always been much uncertainty as to their identification. However, there seems to be no doubt but that their *annularis* was really this species, and their *faveolata* was probably the same species, more eroded. There is more doubt about *stellulata*. It may be the same thing, but it might be a *Solenastræa*. (See p. 97.)

It seems best, however, to let Dana's determination of the latter stand, for it is as likely to be correct as any other, and is based on types still preserved.

The *M. acropora* of Linné is utterly indeterminable. The locality is unknown, and the diagnosis is so brief and vague that it applies equally well to any one of a dozen or more species of small astrean corals, both Pacific and Atlantic. Nor does the author refer to any figure in earlier works. It is useless and unfortunate to try to apply the name to the present species and to displace a valid and long established name by one of extreme uncertainty, as has been done recently by both Gregory and Vaughan. I do not know any good reason for such a course, in this case. The name *acropora* (L.) should be discarded as indeterminable, both generically and specifically. If used at all it should only date from *H. acropora* E. and H.

There is no certainty nor probability that the Linnæan species was the same as *annularis*, nor is there any good reason to believe that the *acropora* of Esper, or of Edw. and Haime was the same as the *acropora* of Linné. Even if the *acropora* of Edw. and Haime should prove to be only a variation of *annularis* (which may still be doubted), it does not follow that the name should be adopted as from Linné (ed. xii), for Edw. and Haime applied this name arbitrarily to the particular form that they had in view. They could have had no more knowledge of this Linnæan species than Esper, Lamarck, Dana, and others, for there is nothing definite on which to base any such knowledge. It is certain that the contemporaries of Linné, like Pallas and Ellis, did not thus identify this species, for they described the *annularis* under other names. The *acropora* of Esper may or may not be the same as *annularis*, but in either case the latter has several years priority. Had this species been what Linné had before him, he would undoubtedly have referred to Pallas, who had already well described it as *M. astroites*, for he referred to the other species described by Pallas. That Pallas had the *annularis* particularly in view, instead of *cavernosa*, in his description of *astroites*, is evident

from what he there says of the size of the calicles, and also when, on p. 326, he compares the stars of *M. porites* with those of his *astroites*, and says they are subequal.

This species occasionally shows certain calicles larger than usual, and with more septa. Such calicles may subdivide by regular fission, as is the case with the similar unusually large cells in some species of *Porites*, *Madrepora*, *Pocillopora*, etc., in which fission is elsewhere very unusual. One of our Bermuda specimens shows such a cell in the very process of subdivision, (pl. xv, fig. 1, a).

This coral occurs on the outer reefs of the Bermudas, but it is not common there. It is very common and grows to a large size on the Florida Reefs, in the Bahamas,* and throughout the West Indies.

When well grown it forms hemispherical or spheroidal masses, up to five feet or more in diameter. But it also grows in irregular incrusting plates, and sometimes in nodose or lobulate masses, or even in branched forms.

Mr. A. Agassiz in the work quoted, 1890, has given some interesting data as to its rate of growth. Other data were given by me in Proc. Boston Soc., x, p. 862, and in Dana's Coral Islands, p. 125.

Variety, **stellulata** (Dana, ex. Ellis and Sol.).

Heliastræa stellulata Edw. and Haime, Hist. Corall., ii, p. 473, 1857.
? Cyphastræa oblita Duch. and Mich., Corall. Ant., p. 77, 1860.

Plate XV. Figure 2.

The two types of Dana's *stellulata* are in the Museum of Yale University. They are beach-worn specimens of a true *Orbicella*, more or less infiltrated with calcium carbonate, to which the unusual solidity of the walls and exotheca, in some parts, as seen in sections figured by Dana, seems to be partly due. In other parts the structure is nearly as in *O. annularis*, to which it probably belongs, though there are differences in the sections not due to infiltration. Its septal arrangement is the same as in ordinary specimens of the latter, those of the third cycle being distinct, but narrow and thin. The borders of the calicles seem to have been but little raised, and the septa rather thinner than usual, and not much exsert, but the poor condition of the specimens renders these characters rather uncertain.

The calicles are rather smaller (2 to 2·5^{mm} in diameter) than is usual in *O. annularis*. The thin septa are in three regular cycles; those of the third cycle are very thin and reach only one-fourth or one-

* There is a fine Bahama specimen, about four feet in diameter and three in height, in the Amer. Mus., New York (coll. R. P. Whitfield).

third to the columella, which is well developed. The septa are a little thickened at the wall; their faces are only slightly granulated. There are a few irregular small teeth on their inner edges where best preserved; upper ends are all worn off; some have a paliform tooth at the base. The costæ are well developed, inosculating, with irregular exothecal dissepiments between them, as in *O. annularis.* But in some vertical sections the walls appear as narrow, solid structures, (where unaltered); in the sections the columella region is loosely filled with stout ascending trabeculæ; the endotheca consists of small, very thin, nearly horizontal dissepiments, inclining downward a little, and often in two series. No. 4266.

Their origin is uncertain, but it appears to be West Indian. They are in the same beach-worn state as several other types of West Indian corals studied by Professor Dana. Apparently most West Indian corals, in good condition, were scarce in American museums at the time when he wrote his great work.

It appears to be a small or somewhat dwarfed variety of *O. annularis.* I have seen fresh specimens of a similar variety from the Florida Reefs.

This may well be identical with *M. stellulata* Ellis and Sol., but the latter cannot be determined with any certainty from the figure, which represents a badly worn specimen. Its calicles, as figured, are mostly even smaller than in Dana's type, and somewhat unequal in size; the walls appear to be as solid as in the latter; the calicles project slightly as in *annularis;* 12 to 15 septa are figured, all perfect; columella is as in *annularis.* There is much more reason for calling this a variety of *O. annularis* than there is for identifying it with *Solenastræa hyades,* as Gregory has done. There is no evidence that it is a *Solenastræa.**

* Gregory (op. cit., p. 273, 1895) adopts the name *Solenastræa stellulata* (ex. Ellis and Sol.) for *S. hyades* (Dana), and refers *O. stellulata* Dana and *Heliastræa stellulata* Edw. and Haime to it as synonymous. It is probable that Edw. and Haime knew their own genera and that their *stellulata* was not a *Solenastræa.* To me it seems perfectly identical with Dana's form, and only a variety of *annularis.*

It seems strange that Gregory should have tried to restore such indeterminable and badly described species as the *stellulata* Ellis and Sol. and *acropora* Linné, in new senses, while he rejected others, much better described, like *M. cavernosa* Linné, *M. clivosa* Ellis and Sol., because insufficiently characterized. He says of *cavernosa* that the diagnosis "is so imperfect and inadequate that it is absolutely useless." This remark, if true, would apply much better to the diagnoses of *acropora* (see p. 95) and *stellulata,* which he adopts, though in doing so he discards well established later names, based on good descriptions.

Orbicella excelsa Dana. Star Coral.

Astræa (*Orbicella*) *excelsa* Dana, Zoöph., p. 212, pl. x, fig. 16, 1846.
Heliastræa ? excelsa Edw. and Haime, Hist. Corall., ii, p. 478, 1857.
Solenastræa excelsa Verrill, in Dana, Coral Is., ed. 1, p. 380, 1872; ed. 3, p. 421, 1890.
Solenastræa excelsa (*pars*) Pourtalès, Deep Sea Corals, p. 77, 1871.

Plate XV. Figure 4.

Dana's type of this species, in the Boston Society of Natural History, was carefully studied by me a number of years ago, and descriptions were made at that time. The type is apparently slightly beach-worn, but so little that the natural surface of the cœnenchyma and costæ and the summits of the septa are well preserved in most parts, and there is no evidence of post-mortem alteration by infiltration to account for the solidity of the cœnenchyma, referred to by Dana, and which is, indeed, quite remarkable in most parts. The coral is very solid and heavy as contrasted with *O. annularis* or *Solenastræa hyades*.

A fragment, apparently of the same specimen, and which appears to have been used by Dana in describing the details, is preserved in the Museum of Yale University. From this the accompanying photograph has been made. (Pl. xv, fig. 4.) The coral grows in irregular, often upright, lobed or gibbous masses, up to 100 to 150^{mm} or more high, but when young it must be encrusting. No. 1729.

The type specimen is so strongly lobed that the lobules in some places look like incipient branches. But these may possibly be due to the coral growing over the tubes of invading bivalves or annelids, though none can be seen without sections. The calicles are more closely crowded on the lobules, especially at the obtuse summits, where they become angular and are separated by thin walls and cellular exotheca. Elsewhere the calicles are nearly circular, scarcely elevated, and separated by exothecal spaces usually about equal to the radii of the calicles, but toward the base often equal to their diameters. The exotheca and walls are very solid in most parts.

The 24 costæ are subequal, thickened, only slightly raised, faintly or almost microscopically granulated; those of adjacent calicles are

So under *Cyphastræa costata* Duncan = *C. oblita* D. and M. (p. 274, op. cit.) he says: "it was named by Duchass. and Mich. two years previously; but they gave so inadequate a diagnosis that their name has no claim to precedence." Yet the latter diagnosis consists of six lines, giving details of the septa, costæ, columella, pali, granulations, etc., that were never mentioned by Linné, Ellis and Sol., and other early writers on whose briefer diagnoses he bases radical changes in accepted nomenclature.

usually separated at the surface by a slight intermediate groove, forming polygonal areas around the calicles. The exotheca is nearly level with the edges of the walls and costæ, flat or slightly concave, minutely granulated or nearly smooth, sometimes slightly vesicular at the surface, but usually almost solid and blended with the costæ and walls; near the tips costæ unite and exotheca is cellular.

In a transverse section, near the surface, the entire partition between the calicles may be perfectly solid, whether thick or thin, but in many cases one or two rows of small rounded or crescent-shaped vesicles can be seen, and sometimes, close to the surface, vesicular dissepiments are visible between the small costæ, while close to the basal margin of the coral the exotheca may be decidedly vesicular, appearing almost like miniature honey-comb in transverse sections. But this basal portion is formed by the thin, down-growing margin, where the new calicles are very short, oblique, and far apart, as in many other corals that have a thin, proliferous margin.

The septa are generally 24, subequal, in three regular cycles; those of the first two cycles are nearly equal in height and thickness; those of the third cycle are thinner and narrower, and generally bend to the right and left in pairs to join the straight septa of the second cycle, usually at a point more than half-way to the columella, and often very near it. The summits of all the septa are narrow and only slightly raised above the walls. The edges are irregularly serrulate, two to four of the basal teeth being the larger. The sides are distinctly granulated. The septa are all thin, but slightly thickened toward the wall, and all are narrowed above the base, so as to leave a cup-like calicular cavity. The columella is small, trabecular, papillose, and often nearly wanting. In transverse sections of some calicles it is solid, and formed by the union of the inner edges of the septa, but in most it is small, porous, trabecular.

Diameter of the calicles 2·5 to 3^{mm}; breadth of intercalicinal spaces, usually 1 to 2^{mm}, sometimes 3 to 4^{mm} or more, near the base.

Origin uncertain, supposed to be West Indies. Several irregular gibbous masses of this species, 3 to 5 inches in thickness, in the Amer. Mus., New York, were found near Osprey, West Florida, cast on the beach after a storm, by R. P. Whitfield (No. 485). I have also seen specimens from Key West.

This species, in the form and structure of its calicles and septa, resembles *Solenastræa hyades*, but the latter has cellular exotheca and rudimentary costæ, characteristic of *Solenastræa*, while this has the costæ and exotheca of *Orbicella*, though the exotheca and walls

become more solid and heavy than usual in that genus, but not more so than in *O. hirtella* and some other species. In both this and *hyades* the septa of the third cycle are well developed and bend toward and join those of the second cycles; in both the septa are thin and but little prominent above the wall; and the columella is usually well developed in both. But *hyades* lacks the radial costal ridges on the exotheca and the bounding polygonal grooves between the calicles. The differences in sections are very marked. However, there are places, near the base, where the exotheca becomes more cellular in this species, and in sections of the under side it is composed of angular exothecal cells separated by thin dissepiments only.

In some respects this species is intermediate between *Solenastræa* and *Orbicella*, and raises the doubt whether a larger series might not compel us to unite the two genera.

I have seen no specimens truly intermediate between this and *hyades*, and as they can be distinguished by structural characters generally held to be generic, it is necessary to keep them separate here, but they may eventually prove to be one species. In that case *Solenastræa* cannot be maintained as a distinct genus.

From *O. annularis* and var. *stellulata* it can at once be distinguished by the thinner and much less projecting septa, and by the wider septa of the third cycle, which do not bend toward and join the septa of the second cycle in those forms.

Orbicella hispidula V., sp. nov.

PLATE XV. FIGURES 3, 3*a*, 3*b*.

Coral an encrusting mass over 125^{mm} across, and from 5 to 20^{mm} thick. The texture is rather solid and heavy, there being much solid exotheca between the calicles, which are rather far apart, the interspaces being mostly equal to, and often exceeding, their diameter.

The calicles are round, regularly stellate, a little prominent, with swollen, sloping, costate rims, much as in those of *O. annularis*, which they resemble in size, though distinctly larger. The septa are in three very regular cycles: the twelve principal ones are wide, nearly equal, all reaching the rather large columella; their edges are perpendicular and finely, sharply serrate, with slender rough teeth, which extend also over their prominent, obtuse or subtruncate summits, giving them a rough appearance under a lens; their surfaces are also rough or hispid with numerous conical grains. The septa of the third cycle are narrow, straight, and usually reach about halfway to the columella.

The costæ are thick, not very high, meeting or inosculating between the calicles, and covered with a single row of small, slender, rough spinules. The columella is well developed, formed of contorted trabecular processes, and often having a small pit in the center and a few erect spinules, similar to the slender, rough, paliform teeth that often (but not regularly) stand at the base of some of the 12 larger septa.

In sections the walls are very thick and nearly solid. The endothecal dissepiments are small, thin, irregularly convex or flat above. The calicles are not filled up below, or only slightly encroached upon, by a deposit between some of the septa. Diameter of the calicles 3 to 3.5^{mm} ; distance between them mostly 2 to 4^{mm}, often more.

Florida Reefs (Maj. E. B. Hunt), Yale Museum, No. 98. Near Nassau, N. P. (coll. R. P. Whitfield), Amer. Mus., New York.

This has the general appearance of *O. annularis*, but with calicles larger than usual and decidedly farther apart. The walls and exotheca are much thicker and more solid, and the endothecal cells are fewer and less regular. The sharply spinulose and hispid septa and costæ are also characteristic. The exothecal deposits are nearly as solid as in *Oculina*.

A Nassau specimen, in the American Museum, is an irregular rounded mass, about five inches in diameter and three to four thick, with a lobulated surface. The coral is heavy and solid ; the surface of the cœnenchyma is spinulose ; the costæ well developed. The calicles are more variable in size than in the type, in some places being one-half smaller and closely crowded. Coll. R. P. Whitfield.

Orbicella Braziliana Ver., nom. nov.

Orbicella cavernosa Quelch, Voy. Chall., xvi, p. 106, 1886 (*non* Lam.).

I propose this name for the form taken by the Challenger, off Barra Grande, Brazil, in 30 fathoms.

According to Quelch it forms rounded masses two feet in diameter. Its exotheca is so vesicular as to partly hide the costæ ; the septa are uniformly thickened. As he refers it to *cavernosa*, it should have large calicles with four cycles of septa. Since nearly all the other Brazilian corals are distinct from the West Indian, the locality and depth where this was found, as well as the characters mentioned, indicate a species distinct from the common West Indian reef species.

Orbicella cavernosa (Linné) Ver.

Madrepora cavernosa Linné, Syst., ed. xii, p. 1276, 1766. Esper, Fortsetz, i, p. 18, pl. xxxvii, 1797.

Madrepora radiata Ellis and Sol., Zoöph., p. 169, pl. xlvii, fig. 8, 1786.

Favia cavernosa Oken, Lehr. Naturg., p. 67, 1815.

Astrea radiata and *A. argus* Lam., Hist. Anim. sans Vert., ii, pp. 258, 259, 1816; ed. 2, p. 404. Lamouroux, Encyl. Meth., pp. 57, 131, pl. xlvii, fig. 8, 1824. (Reprint of plate of Ellis and Sol.)

Astrea cavernosa Schweig., Naturg., p. 419, 1820. Edw. and Haime, Brit. Fossil Corals, p. xxxix, 1850.

Astrea (*Orbicella*) *argus* and *A.* (*O.*) *radiata* Dana, Zoöph., pp. 206, 207, pl. x, figs. 1*a*, 1*b*, 1846.

Astrea cavernosa, *A. radiata*, and *A. conferta* Edw. and Haime, Ann. Sci. Nat., vol. x, pl. ix, figs. 1, 1*a*, vol. xii, pp. 97, 101, 102, 1850.

Heliastræa conferta, *H. cavernosa*, and *H. radiata* Edw. and Haime, Hist. Corall., ii, pp. 460, 463, 470, 1857.

Orbicella cavernosa Verrill, Bull. Mus. Comp. Zoöl., i, p. 47, 1864. Proc. Boston Soc. Nat. Hist., x, p. 323, 1865. These Trans., x, p. 553, 1900. Pourtalès, Florida Reefs, p. 76, 1871. Quelch, Reef Corals, Chall. Exp., xvi, pp. 12, 106, 1886.

Orbicella radiata (*pars*), Gregory, Quart. Jour. Geol. Soc., li, p. 270, 1895.

Orbicella cavernosa Vaughan, op. cit., p. 27, 1901 (Syn. and description).

Vaughan adds to the synonyms the following fossil forms described by Duncan: *A. endothecata*, *A. cylindrica*, A. *antiguensis?*, *A. intermedia*, *A. antillarum?*, *A. brevis.*

Much of the confusion in regard to the name of this species is due to the fact that it was generally described and figured from badly beach-worn specimens by the earlier writers. Such specimens have the septa and calicles worn away and the hard exotheca thus becomes prominent around the excavate calicles, so as to greatly change the appearance of the coral. Another cause is the rather wide variations in the size of the calicles.

The normal or average specimens have the calicles about 6 to 8^{mm} in diameter, but occasionally a specimen occurs in which part or all of them may be $9–10^{mm}$, or rarely, even 11^{mm} in diameter. Sometimes, on crowded parts of large specimens, the diameter may be only 4 to 5^{mm}. The degree of elevation of the calicles is also more or less variable on a single specimen.

The calicles may be pretty close together, where crowded, but in other cases they are separated by spaces of 4 to 6^{mm} or more. The costæ are usually well developed as denticulated, rounded, radial ribs, usually 48 in number.

The septa are generally about 48, arranged in four regular cycles, but several of those of the last cycle are often rudimentary or lacking, reducing the number to 40–44. They differ in breadth and

thickness according to the cycles; those of the last cycle are very thin and often bend toward and join those of the third cycle. The principal septa are exsert, denticulated, and thickened at the wall. The columella is usually well developed and broad. The paliform teeth are distinct, but not very prominent. It sometimes forms hemispherical masses four to five feet or more in diameter.

This species appears to be rare at the Bermudas, and probably occurs only on the outermost reefs. The only specimen seen by me from there was from near the North Rocks. (Centennial collection.) It is a hemisphere about 11 inches in diameter, of the typical form. It is common on the Florida reefs and throughout the West Indies. Bahia, Brazil; (Yale Mus.); = var. *hirta*, nov., with elevated corallites; roughly serrate, thin costæ and septa; calicles deep, 5-6^{mm} broad; septa narrow, perpendicular within, usually 40–44. Pl. xxxiii, figs. 2, 2*a*.

Orbicella aperta Verrill.

Heliastræa aperta Verrill, these Trans., vol. i, part 2, p. 356, 1868.

Plate XXXIII. Figures 1, 1*a*.

This species is remarkable, not only for its thin, lacerately toothed, and strongly exsert septa, but also for its very thin walls and abundant and very cellular exotheca, so that the coral is very light, as compared with *O. cavernosa* and *O. annularis*. There are usually four cycles of septa, those of the third being very narrow.

The costæ are rather feeble and those of the fourth cycle are rudimentary or lacking.

The calicles average somewhat smaller than in *O. cavernosa*, but decidedly larger than in *O. annularis*. They are about 6 to 8^{mm} in diameter. The interseptal loculi are deep and wide. The columella is rather wide, but is loosely trabecular and lamellar.

Having recently reëxamined the original type of this species, in comparison with large series of *O. cavernosa*, I must adhere to my original opinion that it is a distinct species.

Mr. Gregory (op. cit., p. 271) thinks it is only a form of *O. cavernosa*. Mr. Vaughan (op. cit., p. 31) thinks it a strongly marked variety, if not a distinct species.

Both species occur on the coast of Brazil, in shallow water, and apparently in the same region, but perhaps not in the same stations.

The type was from the Abrolhos Reefs, Brazil, in three to four feet of water. According to Mr. R. Rathbun, it is abundant in the Bay of Bahia, as at the Island of Itaparica, where it is collected to be burned into quicklime, with other corals. No. 1518.

Solenastræa hyades (Dana) D. and Mich.

Astrea (*Orbicella*) *hyades* Dana, Zoöph. U. States Expl. Exp., p. 212, pl. x, fig. 15, 1846.

Heliastræa? hyades Edw. and Haime, Hist. Nat. Corall., ii, p. 478, 1857.

Solenastræa Bournoni Edw. and Haime, Ann. Sci. Nat., xii, p. 121, 1850; Hist. Corall., ii, p. 497, 1857.

Solenastrea hyades + *? S. micans* + *? Heliastræa abdita* Duch. and Mich., Corall. Antill., pp. 76, 77, pl. ix, figs. 9, 10 (not 10 and 11, as in text), 1860. (On pl. ix there are two figures numbered 9, one by error for 10.)

Solenastræa hyades Verrill, in Dana, Coral Islands, ed. 1, p. 280; ed. 3, p. 421, 1890.

Solenastræa excelsa (*pars*) Pourt., Deep Sea Corals, p. 77, 1871.

?? Solenastræa stellulata (*pars*) Gregory, Quart. J. Linn. Soc., li, p. 273, pl. x, figs, 4*a*, 4*b*, 1895 (*non* Ellis and Sol.).

Plate XV. Figures 5, 5*a*.

The types of *Orbicella hyades* Dana and *O. excelsa* Dana are in the Boston Society of Natural History, where I carefully studied them several years ago.

Very similar specimens of *hyades*, from St. Thomas, attached to stones, are in the Yale Museum. These form convex masses, encrusting and thin at the margins, where the newly formed calicles are very oblique. (Pl. xv, fig. 5.) No. 1586*b*.

Calicles circular, or nearly so, mostly 3 to 3.5^{mm} in diameter; borders generally distinctly elevated above the exotheca, often to the height of .5 to 1^{mm}. Younger and smaller calicles, 1.5 to 2.5^{mm} in diameter, are scattered between the full grown ones. In the middle of the convex summit the calicles are so crowded that the walls are in contact, and here they often become angular by crowding, and when not in contact their edges may not be elevated. On other parts they may be separated by intervals of 2 to 3^{mm} or more. The walls are very thin. The costæ are thickened and roughly minutely serrulate; they are very narrow and mostly confined to the wall, never extending across the exothecal spaces, when these occur. The surface of the exotheca is smooth or vesicular; in sections the exotheca is openly vesicular.

Septa 20 to 24, mostly 24 in mature calicles; 12 extend to the columella; those of the third cycle are also wide, but thinner, and most of them bend toward and join the larger ones about midway between the wall and columella. The septa all become thin and curved toward the columella, but thickened at the wall; the summits are narrowed and rather prominent above the walls; inner edge irregularly and roughly serrulate, especially distally; sides

roughly granulated. Paliform lobes small and thin. Columella usually rather small and loose ; formed of small twisted processes from the inner edges of the septa, but variable in size.

Thickness of the larger mass from St. Thomas, about 50^{mm} ; diameter, 125^{mm} ; diameter of calicles mostly 3 to 3.5^{mm} ; rarely 4^{mm}.

This species is found on the Florida Reefs and throughout the West Indies. It has not been found at the Bermudas. St. Thomas (coll. C. F. Hartt, Yale Mus.). In the Amer. Museum, New York, there is a large turbinate mass, 12 to 14 inches in diameter and about 10 inches high, from Jamaica.

Mr. Pourtalès put *Madrepora pleiades* Ellis and Sol. and *M. stellulata* E. and H., as doubtful synonyms of this species. The original descriptions and figures of both those species are too imperfect for definite determination, having been based on badly beach-worn specimens, superficially examined, and rudely figured.

Mr. Gregory adopted *stellulata* as the name of this or an allied fossil species, and put *hyades* under *Orbicella acropora*. Yet Dana's description and figures are vastly better than those of Ellis and Solander. It seems incredible that such an error should have been made in so recent a work. The *stellulata* of Dana (ex. Ellis and Sol.) is an *Orbicella*, and is quite likely to be the same species named *stellulata* by Ellis and Sol. Surely Dana had as good reasons for his opinion as Gregory had. Therefore, it seems best to follow Dana's determination of that name, as being the prior one, and also because it eliminates a very doubtful and useless name. See p. 97.

As for *pleiades* (Ellis and Sol.), that is so doubtful a form that it has been interpreted in many different ways. According to Edw. and Haime it is the same as their *Heliastræa acropora*, and this seems to be the prevailing opinion. But the description and figure would apply just as well or better to certain East Indian species of *Solenastræa*. Hence it is best to eliminate the name by considering it the same as *Solenastræa pleiades* (Dana). There is no reason for thinking that it was a West Indian coral.

The fossil *Solenastræa stellulata* of Gregory may not be this species, for it has larger costæ, and much thicker and more solid exotheca and walls, while the septa of the third cycle are represented as narrow and straight. The figured sections resemble more nearly some of those seen in *Orbicella excelsa*, to which I am inclined to believe that his figured specimens belong.

The *Madrepora hyades* Ellis and Sol. was a *Siderastræa*, and has no relation to Dana's species.

Plesiastræa Goodei Verrill.

These Trans., x, p. 553, pl. lxvii, fig. 1, 1900.

In addition to the type, I have seen another fine Bermudian specimen of this species, in the American Museum, New York, collected on a reef in Bailey Bay, at the depth of about 20 feet, by Mr. R. P.

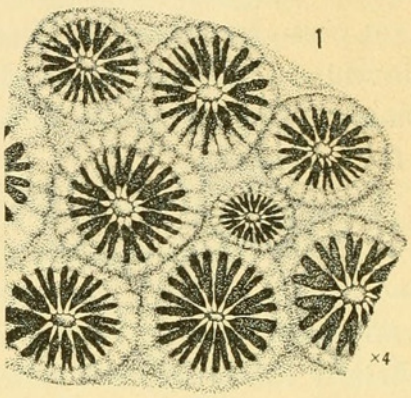


Figure 1.—*Plesiastræa Goodei* Ver. Part of type. ×4.

Whitfield, in 1897. It is about 10 inches in diameter, in the form of a somewhat irregular and lobulated hemisphere.

The same museum has two smaller specimens, in the form of subconical masses, 3 to 4 inches in diameter, obtained in the Bahamas by Mr. R. P. Whitfield. These also agree very closely with the type in all essential points, but some of them have the calicles more crowded, smaller, and subangular in some areas.

Stephanocœnia intersepta (Esper.) Edw. and H.

Madrepora intersepta Esper, Pflanz., Forts., I, p. 99, pl. lxxix, 1797.

Astrea intersepta Lam., Hist. Anim. s. Vert., ii, p. 266, 1816; ed. ii, p. 417, (*non* Dana).

Stephanocœnia intersepta and S. Michelini Edw. and Haime, Ann. Sci. Nat., x, pp. 300, 301, pl. 7, fig. 1–1*b*, 1849; Hist. Corall., ii, pp. 265, 266, 1857. Gregory, Quart. Jour. Geol. Soc. London, li, p. 276, pl. xi, figs. 5*a*, 5*b*, 6, 1895. Vaughan, op. cit., p. 20, 1901.

Antillastræa spongiformis Duncan, Revision Mad., p. 108, 1884, (t. Gregory from type).

The recent specimens that I have seen from the West Indies agree better with *S. Michelini*, which is, perhaps, only a massive variety of *S. intersepta*.

The American Museum, New York, has a large lobulated mass, over a foot in diameter, from Jamaica. This has six large rounded lobes, the largest about 6 inches in diameter, rising from a common basal mass.

The septa are much exsert, narrow, entire, and with the inner edge perpendicular, leaving a narrow central cup. The columella is

small, lamellose, sometimes with a minute central tubercle. The calicles vary considerably in size, being smaller and more crowded, sometimes angular, at the bases of the lobes. The distance between them is also variable. The diameter of the calicles varies from 1.75 to 2.5^{mm}, but most of them are about 2 to 2.5^{mm}.

Throughout the West Indies, but not recorded from Florida nor from the Bermudas. Fossil in the elevated reefs of many of the West Indies.

Cyphastræa nodulosa Ver., sp. nov.

Plate XXXI. Figures 2, 2*a*, 2*b*.

The coral forms small nodular masses, about 55 to 65^{mm} in diameter and 35 to 45^{mm} high, consisting of numerous small, rounded or short, subclavate nodules, rising like incipient branches from a common thick, irregular base. It is compact and heavy, with small circular calicles.

The corallites, where not much crowded, project distinctly above the cœnenchyma and have a rather thin rim and feebly costate wall. In other parts they are not at all raised and the calicles may be immersed in the cœnenchyma, which is very compact, with the surface sometimes covered with low rounded granules, in radial costal lines, but in other parts it is often nearly smooth.

The calicles are small, but rather open and deep, owing to the narrow septa. They are mostly from 1.25 to 1.50^{mm} in diameter, and are often separated by spaces of 1 to 2^{mm}.

The septa are in three cycles, consisting of 12 narrow, subequal ones, of the two first cycles, alternating with 12 very narrow or rudimentary ones of the third cycle. These last are often lacking, or invisible without a lens, in some of the systems.

The larger septa are narrow, usually much exsert, with an obtuse, serrulate apex, and a perpendicular inner edge, which is finely serrulate or subentire; their proximal portion is very thin and denticulate. The paliform tooth is very small, but distinct, papilliform. The columella is small, minutely trabecular with one or more minute papillæ on the surface.

In sections the walls and exotheca are often entirely compact, especially near the surface, but in other parts there may be exothecal cellules; the septa are thin and divided into numerous fine trabeculæ; the dissepiments are numerous, very thin, nearly horizontal, often subtabular; columella loosely trabecular.

Bahamas,—R. P. Whitfield; three specimens, No. 542, Amer. Mus.

Family **Stylophoridæ** Ver.

Stylophorinæ Edw. and Haime, Hist., ii, p. 132, 1857.
Stylophoridæ Verrill, these Trans., i, p. 514, 1867.

Corals mostly branched, often encrusting when young; sometimes lobulate or massive, increasing by budding. Calicles small, stellate, inmersed, usually separated by rather abundant exothecal cœnenchyma, not entirely solid, and often granulated or striated on the surface. Septa generally either 10 or 12. Loculi between the septa not filled up below by stereoplasm. Columella various. Polyps exsert in expansion, usually with 12, 20, or 24 tentacles.

This family is chiefly Indo-Pacific, where it is represented by numerous species of *Stylophora.*

Madracis decactis (Lym.) Ver.

Astrea decactis Lyman, Proc. Boston Soc. Nat. Hist., vi, p. 260, 1859.
Madracis decactis Verrill, Bull. Mus. Comp. Zoöl., i, p. 45, 1864. Pourtalès, Deep Sea Corals, pp. 28, 67, pl. vii, figs. 1–4, 1871. Quelch, op. cit., p. 53, 1886. Gregory, op. cit., p. 258, fig. 1, 1895. Verrill, these Trans., x, p. 554, pl. lxvii, figs. 8, 10, 1900.
Reussia lamellosa Duch. and Mich., Corall. Antill., p. 339 [62], pl. ix, figs. 7, 8 (as numbered on plate, not 8, 9 as in text), 1860 (*non Stylophora mirabilis*, p. 61, pl. ix, figs. 6, 9, as numbered, not 6, 7, as in text).
Stephanocœnia dendroidea Duncan, Quart. J. Linn. Soc., xix, p. 432, 1863, *non* Edw. and H. (t. Gregory).
Axhelia decactis Vaughan, op. cit., p. 8, 1901.
? Madracis asperula Moseley, Voy. Chall., ii, p. 182, 1880, from S. W. Bank, off Bermuda, 30 fath. (*? non* E. and Haime).

This species occurs in thin crusts, irregularly massive, nodose or lobulated, and also both in slender, and in short, stout, branched

2. 2*a*.

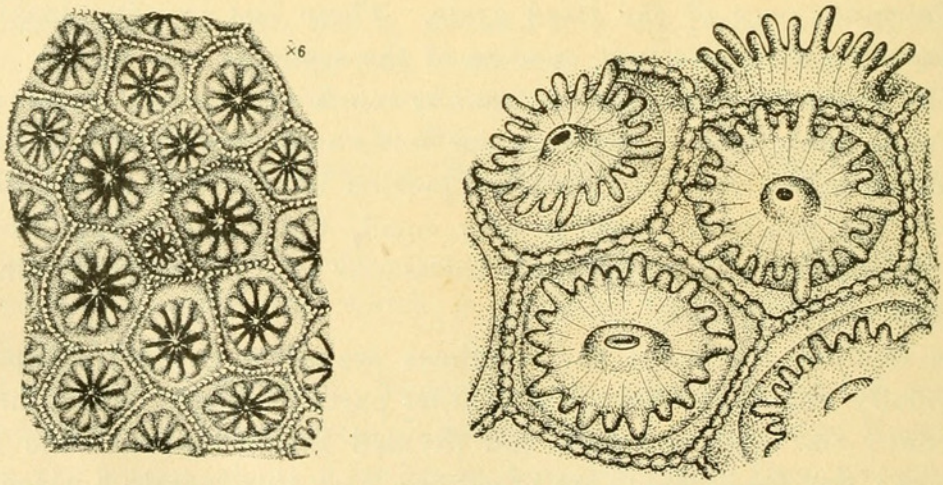


Figure 2.—*Madracis decactis* (Ly.) Ver. Part of the dry coral. ×6.
Figure 2*a*.—The same, with the polyps expanded. ×12.

forms. The animals have been described both by Pourtalès and myself and were figured by me. (These Trans., x, pl. lxvii, fig. 10.)

The general color of the coral, in life, is yellow, yellowish brown, or purplish brown ; disk often purplish, with white radii, forming a star around the mouth ; lips and tips of tentacles white.

As stated by Pourtalès, and figured by me in 1900, there are three pentamerous cycles of tentacles (5, 5, 10) and two equal cycles of septa (5, 5). Sometimes a few rudimentary septa of the third cycle appear. One Bermuda specimen has several very large calicles, with 20 to 30 regular septa. Pl. xiv, fig. 6.

Duncan (Revision, p. 45, 1884) united *Axohelia* E. and H. with this genus, under the name of *Madracis*. Several others have done the same. Vaughan, however (op. cit., pp. 5, 8), proposes to unite them under the name *Axhelia*. Both names are of the same date. Therefore, if they are to be united, Duncan's choice of names has precedence and should be upheld. Kent gave it the name *Pentalophora*, as a substitute for *Reussia* (preoccupied).

However, these genera seem to me sufficiently distinct. *Axohelia* lacks the definite bounding ridges of the calicles and the granulated exotheca. Its exothecal surfaces are smooth or striated, and show no partitions between the calicles.

Perhaps the *Madracis* taken by the Challenger, on the S. W. Bank, in 30 fathoms, and recorded by Moseley as *M. asperula*, was *M. decactis*, which is not uncommon on the reefs in shallow water.*

Some of the lobulated or branched clumps are 6 inches or more high and broad, but they are very brittle and not often obtained entire. Several large and fine specimens of this kind are preserved in the American Museum, New York, as well as a slender, dichotomously branched variety. Both forms occur at the Bermudas.

It is found on the Bermuda Reefs and throughout the West Indies. It also occurs as a fossil in the raised reefs of many of the islands. Gregory (op. cit.) records it as a Pleistocene fossil from Bermuda, (probably from Nelson's collection in Geol. Soc., London). The age of such Bermuda fossils, from the "beach rock," is however very uncertain, but they are probably postpliocene, or post glacial.

Pourtalès was evidently wrong in referring to this species the *Stylophora mirabilis* Duch. and Mich. Probably he was misled by errors in the numbering of the plate (ix). On that plate there are two figs. 9. One of these is a misprint for 7, and represents the enlarged calicles of the *mirabilis* (fig. 6), and shows 18 to 24 equal septa. The other fig. 9 is a *Solenastræa* and should have been 10. Other errors in numbering occur on this plate.

* Pourtalès (Deep Sea Corals, p. 27, pl. vii, fig. 4, and in later papers) records *M. asperula* Edw. and Haime, from the West Indian region, in 36–280 fathoms.

Axohelia Schrammii ? Pourt., Mem. Mus. Comp. Zoöl., iv, p. 41, pl. viii, fig, 2, 1874.

PLATE XVIII. FIGURES 3, 4.

Coral small, arborescently branched, the terminal branches slender, tapered, acute ; the larger stems are about 12–15^{mm} in diameter. The coral is hard; the cœnenchyma is abundant in the larger branches, and its surface is covered with long, curved septocostal striæ, between which it is microscopically granulated, but there are no lines of granules bounding the calicinal areas, as in *Madracis*. Septa 10, equal, narrow, slightly prominent. Columella small, solid, tubercular.

Several specimens are in the Museum of Yale Univ. They are attached to pieces of a cable. (Coll. H. A. Ward.) Guadaloupe (Pourt.).

Its calicles agree better with *A. myriaster* (?) Pourt., pl. viii, fig. 3, which may not be distinct. No. 5662.

Family **Oculinidæ** Edw. and Haime, restr.

Oculinidæ Verrill, these Trans., i, p. 514, 1867.

Corals generally branched, increasing by budding. Calicles round, stellate. Septa 12 to 48 or rarely more, unequal, usually entire or subentire ; pali often present. Interseptal loculi become filled up and obliterated below by a solid endothecal deposit, or stereoplasm. Usually a solid cœnenchyma, with curved costal striations on its surface, separates the calicles, especially in the older parts of the coral, where it is often abundant.

Madrepora (Linné) Oken, restr. (*non* Lam.). Type, *M. oculata* Linné.

Madrepora (*pars*) Linné, and of all writers before 1801 (not of Lamarck, 1801, nor of 1816 ; not of Ehrenberg, 1834).

Matrepora, restricted (altered spelling), Oken, Lehrb. Naturg., p. 72, 1815.

Oculina (*pars*) Lamarck, Hist. Anim. sans Vert., ii, p. 284, 1816.

Amphelia and *Lophelia* Edw. and Haime, Comptes-rendus, xxix, p. 69, 1849.

Amphihelia and *Lophohelia* Edw. and Haime, Hist. Nat. Corall., ii, pp. 116, 118, 1857.

Lophohelia Pourtalès, Deep Sea Corals, p. 25.

It is well known that Linné (Syst. Nat., ed. x, 1758) did not include in his genus *Madrepora* any recognized species of the Lamarckian genus of that name, but placed by an error *M. muricata* (in which several species were included) in his genus *Millepora*, although it agrees with his definition of *Madrepora*. He corrected this mistake in the ed. xii, p. 1279, where *Madrepora muricata* appears. Pallas, (Elenchus, p. 327, 1766) had previously made the same correction.

No valid attempt to subdivide the great genus *Madrepora* seems to

have been made until 1801, when Lamarck (Syst. Anim., pp. 369–375) divided it into eight genera.* Unfortunately he restricted the name *Madrepora* to the group that included *M. muricata* and *M. porites* Pallas. The latter was made the type of *Porites*, by Link, 1807.

The next restriction of the name was by Oken (Lehrb., 1815), who established a number of additional generic subdivisions and restricted *Madrepora* (which he spelled *Matrepora*†) to four species, one of which, *M. ramea*, became the type of *Dendrophyllia* Bv., 1830 ; the others were earlier (1816) placed in *Oculina* by Lamarck. One of these (*M. oculata* Linné), which is the long-known and officinal "white coral" of the Mediterranean, the "*Madrepora vulgaris*" of Tournefort, may well be taken as the true type of *Madrepora*, not only on account of Oken's restriction, but also because of the rule, advocated and followed by many naturalists of the Linnæan period, that the type of a genus should be the most common or officinal and well-known species, if such were included. Certainly *M. oculata* would answer well to this requirement, and so would *M. prolifera*.

Moreover, in following the principle of elimination, this was one of the very last of the determinable Linnæan species to receive a special generic name (1849). *M. prolifera*, the second species of Oken, and the type of *Lophohelia* E. and H., is now made congeneric with *M. oculata*.

Therefore, it appears that *oculata* should be taken as the true type of the restricted genus *Madrepora*, if the Lamarckian nomenclature must, in this case, be abandoned, as argued by Vaughan‡ and other recent writers.

---

* These genera are as follows :—*Cyclolites*, p. 369 ; *Fungia*, p. 369 ; *Caryophyllia*, p. 370 ; *Madrepora*, p. 371 ; *Astrea*, p. 371 ; *Meandrina*, p. 372 ; *Pavona*, p. 372 ; *Agaricia*, p. 373.

† That Oken, in using *Matrepora*, did not intend it as a new name, but only as a corrected spelling of *Madrepora*, is proved by the fact that in citing the Linnæan names of species under various genera, he invariably quotes them as "*Matrepora*" or "*Mat.*" of Linné. The generic divisions of *Madrepora* proposed by Oken are as follows :—*Astrea*, p. 65 = *Astrea* (*pars*) Lam., 1801 ; *Acropora*, p. 66 ; *Turbinaria*, p. 67 ; *Favia*, p. 67 ; *Pectinia*, p. 68 = *Meandrina* Lam., 1801 ; *Undaria*, p. 69 = *Agaricia*, Lam., 1801 ; *Mycedium*, p. 69 ; *Mœandra*, p. 70 ; *Matrepora*, p. 71 (includes 4 species, viz.—*M. ramea*, *M. prolifera*, *M. virginea*, *M. oculata*) ; *Galaxea*, p. 72 (with 4 species) ; *Mussa*, p. 73 (2 species) ; *Fungia*, p. 74, 2 sp. = *Fungia* Lam., 1801.

Probably Lamarck's Systeme Anim. sans Vert., 1801, was not known to Oken, for he makes no reference to it. The coincidences in some of the names were probably due to the influence of the older specific and polynomial names. Neither does he refer to Link's work of 1807.

‡ Samml. Geol. Reichs-Mus., ii, p. 68, 1901.

Ehrenberg, in 1834, definitely restricted *Madrepora* to a group that included *Porites* and *Montipora*, while he called the Lamarckian genus, *Heteropora*. His nomenclature cannot be followed: 1st, because *Porites* had been separated and named by Link, 1807, and Lamarck, 1816; 2d, no recognizable species of *Montipora* was included in *Madrepora* by Linné, ed. x; 3d, *Heteropora* had previously been used by Blainville for a bryozoan; 4th, Oken's restriction has priority.

For several reasons, it seems to me doubtful whether, under the rules of priority usually accepted, it will not be thought by many unnecessary to abandon the name *Madrepora* for the *muricata*-type, as restricted by Lamarck, for the following reasons:—

1st.—By Linné and all other writers of his period *Madrepora* was used as a collective name for all corals of the order *Madreporaria*. It was rather an order or suborder than a genus, and therefore it seems useless to apply the rigid modern rules of priority to such a group name.

2d.—*Madrepora muricata* L. had been referred to *Madrepora* by Linné, as *M. spinosa*, before the date of ed. x (Mus. Tessin., p. 118), and its reference to *Millepora* in the later work was clearly an error speedily corrected.*

3d.—Linné, in ed. xii, gave his more mature and corrected views as to his own genera. Therefore, for the discussion of *generic* nomenclature, it might be better not to go back of that edition.

4th.—It is possible that at least one of his species in the ed. x, viz. *M. polygama*, No. 28, p. 795, belongs to the Lamarckian genus *Madrepora*, for it was described as having cylindrical, 12-rayed calicles, though the larger cells, mentioned by him, were probably parasitic barnacles. This species is probably indeterminable. It may have been a *Montipora*.

Should *M. polygama* L. be hereafter positively identified as a species congeneric with *M. muricata*, as is possible, this fact alone would, perhaps, make valid Lamarck's restriction of the name *Madrepora* in the opinion of many. Such a determination is not impossible, though this species has hitherto remained very doubtful.

In the meantime many persons will doubtless prefer to take the more recent and radical course, and apply some other name to Lamarck's *Madrepora*. Vaughan (op. cit., p. 68) has adopted *Isopora*, first used under *Madrepora* as a subgeneric name by Studer,

* By another error he referred the "red coral" (*Corallium rubrum*) to *Madrepora* (*M. rubra*, p. 797).

in 1878. Under this name he included the whole extensive genus. This name would surely be a very inappropriate one, so far as its significance is concerned, nor would Studer's definition apply to the genus, as a whole. Moreover, it may become necessary to separate *Isopora*, in Studer's sense, as a genus. I believe that *Acropora* Oken has much better claims for adoption in place of *Madrepora*. (See below.)

As restricted above, the genus will include branching oculinoid corals that increase by lateral or marginal buds; with turbinate corallites, and deep cup-like calicles. The cœnenchyma is usually abundant and solid in the main branches and trunk, but may be very scanty in the terminal branches. Pali lacking. Septa broad, entire. Columella small or lacking.

Besides the type and *M. virginea* (L.), which is considered identical with it by Edw. and Haime, the genus *Madrepora*, as restricted above, would include the following species and others:

M. venusta E. and H., Australia.

M. exigua (Pourt., as *Lophohelia*). Off Florida, 36–79 fathoms.

M. Carolina (Pourt., as *Lophohelia*). Off Havana.

M. prolifera (L.). Boreal and Arctic, and in deep waterto Florida.

M. infundibulifera Lam. (as *Oculina*). Kent, fig., 1871; Quelch, p. 53. Ternate.

M. subcostata (Edw. and H.). Locality unknown.

M. Defrancei (E. and H.). Pliocene of Europe.

M. candida (Moseley, 1881, as *Lophohelia*). Off Sombrero I., 450 fathoms.

M. tenuis (Moseley, 1881, as *Lophohelia*). Philippine Is.

M. anthophyllites (Ellis and Sol.); E. and Haime, as *Lophohelia*. E. Indies. Type is in Hunterian Mus., t. Young.

M. ornata (Duncan). North Atlantic.

Family **Eusmillidæ** Verrill, 1866.

Eusmillinæ (*pars*) and *Euphylliaceæ* Edw. and Haime, Hist. Corall., ii, pp. 144 and 183, 1857.

Corals dichotomous, glomerate, or massive, often meandriniform or astreiform, increasing chiefly by fission, complete or incomplete. Septa entire or nearly so, sometimes very finely serrulate. Paliform lobe, feeble or lacking. Columella variously developed, often lacking. Zoöids actiniform, much exsert in expansion.

Eusmilia aspera (Dana) Edw. and Haime.

Euphyllia aspera Dana, Zoöph. U. S. Expl. Exp., pp. 164, 720, pl. ix, fig. 7, 1846.

Eusmilia aspera Edw. and Haime, Hist. Corall., ii, p. 187, 1857.

Eusmilia Knorrii Edw. and Haime, Mon. Aster., Ann. Sci. Nat., Zoöl., ser. 3, x, p. 265, pl. v, fig. 2, 1849.* Gregory, op. cit., p. 261, 1895. Vaughan, op. cit., p. 13, 1901.

Dana's figured type is in the Yale Museum. The description is good and the outline figure is very correct. It represents a branch with three calicles, broken from a larger specimen, also in the Yale Museum. No. 466.

3.

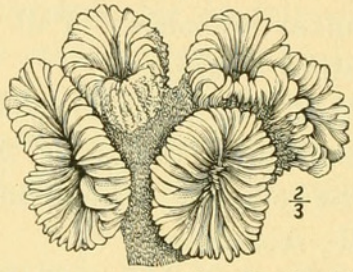


Figure 3.—*Eusmillia aspera* (Dana). Part of type, $\frac{2}{3}$ natural size.

This specimen has the columella well developed in most of the calicles, though small in some of the younger ones. It consists of variously contorted thin laminæ. The costæ are alternately large and small; the larger ones are thick, angular, uneven or lobed, often cristate near the calicles, and irregularly dentate, with small rough teeth.

There can be no doubt of its identity with *E. Knorrii* E. and H., as these authors themselves admitted in their Hist. Corall., 1857. Therefore it seems strange that both Gregory and Vaughan should have tried to restore this discarded later name without any legitimate reason.†

* Gregory (op. cit., p. 261) quotes the date of *Knorrii* Edw. and Haime, Monog., as 1848. Edw. and Haime themselves quote it in Hist. Corall., ii, 188, as 1849. Gregory also quotes *aspera* Dana as 1848. It is well known that his report was published in 1846. But Gregory repeats this wrong date under various other species, so that we cannot reckon it a typographical error. Edw. and Haime give the date as 1846, correctly.

† Gregory's statement that Dana's species was "so inadequately diagnosed that there can be no certainty regarding it," is obviously erroneous. Edw. and Haime certainly were able to recognize it. The figure and description are far better than those of most corals before Dana's work. Moreover, the type, duly labeled, was in the same case and on the same shelf with other specimens that Mr. Gregory examined when he made his very hasty visit to the Yale Museum, (see p. 145). He could have studied it and various other types of Dana, had he taken the necessary time.

Family **Mussidæ** Ver.

Fasciculate, glomerate, massive, and sometimes simple corals, increasing by fission, and with strongly dentate or spinose septa, without a paliform lobe. Calicles generally large, sometimes united in short or long series, but always with distinct centers and radial septa. Polyps much exsert in expansion, actiniform, with large tentacles.

Isophyllia Edw. and Haime (emended*). Rose Corals. "Cactus Corals."

Mussa (*pars*) Dana, Zoöph., p. 173, 1846.

Symphyllia (*pars*) Edw. and Haime, Ann. Sci. Nat., xi, p. 236, 1849; Corall., ii, p. 373, 1857; Duch. and Mich., Corall. Antill., p. 69, 1861.

Isophyllia Edw. and Haime, Pol. Foss. Paleoz., p. 87, 1849; Hist. Corall., ii, p. 974, 1857.

Mycetophyllia (*pars*) Edw. and Haime, Compt.-rend., xxvii, p. 491, 1848; Hist. Corall., ii, p. 375, 1857 (2d section).

Lithophyllia (*pars*) Duch. and Mich., Corall. Antill., pp. 67, 68, 1860, young, (*non* Edw. and Haime).

Ulophyllia (*pars*) Bruggmann, Ann. and Mag. Nat. Hist., Oct., 1877, p. 312.

Symphyllia (*pars*) Duncan, Revision, Journ. Linn. Soc., xviii, p. 91, 1884.

This genus, as now restricted, includes a group of *Mussidæ* in which the calicles, when mature, are large and open, isolated or in series, with numerous large, strongly serrate septa; the serrations are either subequal, or else larger toward the columella, which is

---

* The genus, as here limited, corresponds with that of Edw. and Haime of the same name, plus certain forms referred by them to *Symphyllia* and to *Mycetophyllia* (*M. Danaana* E. and H., Hist., p. 377, pl. D4, fig. 2). Most of their species of *Symphyllia* are simply *Mussæ* with coalescent walls. So *Symphyllia* and *Isophyllia* cannot be united in bulk, as was done by Duncan and by Pourtalès, under either name. *Symphyllia* should be dropped and its species should be distributed to *Mussa* and *Isophyllia*, according to their structure. But if retained at all, even as a subgenus, it should be used for the typical East Indian forms, like *S. radians* E. and H.

I cannot distinguish in *Mycetophyllia Danaana* E. and H. any characters apart from *Isophyllia*.

Nor can I find any good reason for separating *Ulophyllia*, or at least the typical species, widely from *Symphyllia* and consequently should consider such species as nearly related to the massive *Mussæ*. The only difference from *Symphyllia*, as stated by Edw. and Haime, consists in the denticles of the septa being larger toward the columella, while in the latter the distal ones are the larger. But I have studied specimens of *crispa*, the typical species, (see p. 131) and have found the teeth variable in this respect; in some calicles the larger teeth were distal, in others proximal, in one specimen, and these differences may be observed on the septa of a single calicle. The fossil forms of Edw. and

formed of loosely arranged processes of the septa. The costæ are distinct, but narrow, serrulate ribs. The primary collines are radial, dividing the margin, at one stage of growth, into several (normally six) calicinal lobes ; they may be solid, with a simple wall, or they may be double, with intermural exotheca and a groove on the summit. These variations often occur on one specimen. The union of the walls may also be so incomplete that they stand separately in many parts of some examples. The calicles vary greatly in size, form, and degree of union into series, even on one specimen of most species, when full grown.

The relative number and closeness of the septa, the granulation of their surfaces, the general character and size of their serrations, and the character of the costæ and their serrations afford much better characters for specific distinctions. But all these vary more or less, so that a large series must be studied with great care before one can reach an intelligent opinion as to the limits of any of the species of this group.

The figures that have been published of the species of this genus are entirely unsatisfactory. Even the beautiful lithographic figures drawn by Sonrel for Professor L. Agassiz (see Pourtalès, Florida Reefs, pl. vii) are by no means correct enough for systematic purposes.* Photographs alone can properly represent corals of this character. After a most careful study of the large series of *Isophylliæ* in my own collections and others that are in the Yale Museum, the Museum of Comp. Zoölogy, the American Museum, New York, and several other large collections, I am convinced that far too many species have been recognized. In the Bermudian series

---

Haime I have not seen. The absence of spinose costæ seems to be a character of more value for distinguishing true *Ulophyllia* than the position of the larger teeth. But the Red Sea species figured by Klunzinger look more distinct, on account of their acute, nearly naked collines, which thus approach those of *Tridacophyllia*. The American species that have been called *Ulophyllia* belong to *Isophyllia*.

In our Bermuda *Isophylliæ* similar variations in the position of the larger teeth often occur, as will be noted in the descriptions. Indeed, the larger teeth are more frequently the proximal ones.

It may eventually be necessary to reunite all these groups under the original genus *Mussa*, if a few additional intermediate forms should be discovered.

* This is due to the impossiblity of drawing by hand, with accuracy, the vast number of unequal septa and their numerous variable denticles. All the figures are, therefore, generalized or idealized by the artist, so that the septa and their teeth are much too regular and uniform, and for the same reason, they also appear too numerous and too crowded.

I can find no evidence of more than three species, and I am not certain that more than two of these can eventually be kept apart. Quelch, however, with a much smaller series, recorded (op. cit., pp. 10, 11) eight species from Bermuda, including the young forms that he called *Lithophyllia*. Probably all his Bermuda forms belong to *I. dipsacea* and *I. fragilis*.

When young, all species of this genus and of *Mussa* (including *Symphyllia*), etc., have a simple, more or less cup-shaped coral, attached by a rather broad base. These may become in some cases 25 to 40^{mm} in diameter before they begin to form marginal infoldings, as a commencement of the process of fission.

Such simple young forms have been put in a special genus (*Scolymia* Haime, 1852, or *Lithophyllia* Edw. and Haime, 1857). The type of this genus was *M. lacera* Pallas. It appears to be the young of *Mussa carduus* (Ellis and Sol., sp.).*

Therefore *Lithophyllia* is a synonym of *Mussa*, rather than of *Isophyllia*, though several species described by Duch. and Mich. unquestionably belong to *Isophyllia*, as indicated in the synonymy above. All the Bermuda simple forms are young of *Isophyllia*, and mostly of *I. dipsacea* and *I. fragilis*. Pl. xix, fig. 5.

The generic relations of these simple young forms can usually be told by the character and spinulation of the costæ. In *Mussa* the costæ are generally imperfect, with rows of strong, sharp spines, often recurved. In *Isophyllia* the costæ are generally raised and continuous ribs, often lamelliform, and their spines are small and more regular, usually more like serrations of the edge. In *Mussa* the septa are also more strongly and more unevenly serrate or lacerate, especially toward the outer end.

At a later stage, but varying in size, even in the same species, the edge of the cup begins to be undulated or lobed; most commonly there are six outfoldings and six infoldings at first, corresponding to the primary and secondary septa, but the number may vary from three to seven, or even eight or more. When four lobes are formed the coral is apt to be squarish. (See pl. xvii, fig. 4.) These primary folds and lobes may continue to grow regularly for some time, till several large marginal calicles, usually five or six, develop around the central, stellate, primary calicle (pl. xvii, figs. 1–2). This is the most normal and regular mode of growth for all the species of this

* This large species should, therefore, be called *Mussa lacera* (Pallas) Oken. The calicles are often 40 to 60^{mm} broad, mostly isolated; costæ strongly spinose. It is found throughout the West Indies, to South America, but not at the Bermudas. See below, p. 130.

genus. The infolding of the margin is often delayed till the calicle is 25 to 40^{mm} across.

But frequently the first outfoldings of the margin begin much sooner than usual to form secondary folds of the same nature, before the first series of calicles is fully formed. This gives rise to the early formation of a much larger number of calicles, some of which may long remain incomplete and united in series. For the same reason the calicles in such a coral will be, for some time, smaller in size than those that divide more slowly, thus giving them a very different appearance. But both conditions may exist at the same time on some specimens, and many irregularities constantly occur. (See pl. xvii, figs. 5, 6.) Some species, however, normally divide more rapidly than others. (Pl. xx, fig. 1.) The outfoldings of the margin may not much affect its regular circular outline, as in pl. xvii, figs. 1, 2, (*I. fragilis*). But in other cases they may be so extensive as to produce a deeply lobulated outline, when seen from below, as in pl. xvii, fig. 3, (*I. fragilis*). Large specimens of either species (see pl. xvii, figs. 5, 6 of *fragilis*) generally have a large number of calicles, irregularly arranged, many of them isolated, but mostly in short series.

Resorption of parts of the walls and septa or of the entire thickness of the collines frequently takes place, and thus alters the appearance. In some cases this results in breaking up the collines into detached portions or isolated columns. This I have seen in *I. fragilis*.

The genus is chiefly, or perhaps entirely, American. The simple form described as *I. australis*, first from Australia, was considered the type of a special genus, *Homophyllia*, by Bruggmann, 1877. The species described by Klunzinger from the Red Sea as *I. erythræa* appears to me to belong rather to *Ulophyllia* or *Mussa*.

Isophyllia dipsacea Dana. Rose Coral.

Mussa dipsacea Dana, Zoöph., p. 184, 1846.

Symphyllia dipsacea Edw. and Haime, Corall., ii, p. 373, 1857.

Isophyllia dipsacea Verrill, Bull. Mus. Comp. Zoöl., i, p. 49, 1864; Pourtalès, Deep Sea Corals, p. 71, 1871; Florida Reefs, pl. vii, figs. 1–8, 1880.

Isophyllia australis (*pars*) Edw. and Haime, Corall., ii, p. 375 (young), 1857.

? Symphyllia anemone + *S. comferta* + *S. aglæ* + *S. helianthus* + *S. Thomasiana* + *S. aspera* + *S. cylindrica* + *S. Knoxi* + *S. verrucosa* (abnormal) Duch. and Mich., Corall. Antill., pp. 71, 72, 1860.

? Lithophyllia argemone + *L. cylindrica* Duch. and Mich., op. cit., p. 68, pl. ix, fig. 121, pl. x, fig. 15, pl. ix, figs. 17, 18, 1860, (young).

Isophyllia australis + *cylindrica* + *Knoxi* + *Lithophyllia Cubensis* + *L. lacera* (*non* Pallas) + *L. argemone* Quelch, Voy. Chall., Zoöl., xvi, pp. 10, 11, 12, pp. 83–86, 1886.

PLATE XVIII. FIGURE 2. PLATE XIX. FIGURES 2, 3. PLATE XX. FIGURE 2.

This species occurs in abundance at the Bermudas, in shallow water (1 to 20 feet) on nearly all the reefs, and also along the shores attached to rocks, and even to small stones on shell-sand bottoms, where other corals do not grow. It is very abundant even in Harrington Sound, where but few species of corals are found, owing to the less density of the water.

I have personally collected and studied hundreds of specimens of this and the following species, and have kept large numbers alive, to ascertain, if possible, whether two or more species occur there, and to learn the character and extent of the variations.

Probably no coral varies more than this in form, mode of growth, union and separation of the calicles, and consequently in the size and form of the calicles, character of the columella, number and size of the teeth of the septa, extent of the epitheca, etc.

Therefore many nominal species have been founded, especially by Duch. and Mich., on mere stages of growth and on ordinary individual variations in the mode of growth, union of the walls, etc.

The colors of the living animals of this and *fragilis* are also extremely variable, and often very beautiful. Most commonly they are variegated with gray, lavender-blue, green, and flake-white in variable proportions. But specimens often occurred, especially in 1898, rarely in 1901, that were largely or wholly bright emerald-green, or grass-green. I have had some that were bright green over one-half the surface, and lavender and gray on the other half. The difference in the external appearance of the animals of this and *fragilis* are slight. Therefore the color of the animal cannot be used to distinguish species nor even varieties.

The same is true of the isolation and union of the calicles in series, for a single specimen often shows the extreme conditions on its different parts. The collines generally have simple, solid, rather thick walls, but sometimes they are double with a groove on the summit, as is the case more commonly in *fragilis*.

This species has a heavier and more solid coral than *fragilis*, with stronger and thicker walls. It can best be distinguished by the decidedly thicker and closer septa, which have stronger, stouter, and more regular, spiniform teeth on their edges, the size of the teeth decidedly increasing toward the columella, where the septa are also usually distinctly thicker.

The calicles, when well grown, are generally broader, more flaring, and more shallow. The costæ are less prominent, thicker,

closer, and strongly spinulose, with small, but strong, acute, rough spines. The collines are radial at first, but may soon become sinuous. They may be solid, or they may be double with a groove on top, more or less wide and deep. In many large specimens a considerable proportion of the calicles are simple.

A medium specimen, 80^{mm} across, has usually 10 to 12 septa to the centimeter, of which 7 or 8 are larger ones, the others being much smaller. The larger calicles are 20 to 25^{mm} wide, but others on the same coral are not over 15^{mm}; they are 8 to 10^{mm} deep. This example has double walls. The columella in this is made up of few strong trabeculæ and angular spines. In this specimen the larger septa are thickened toward the columella and bear on that part large, thick, spiniform teeth; more distally the teeth are smaller, decreasing to the margin. Pl. xviii, fig. 2.

A very well grown Bermudian specimen, 100^{mm} in diameter, has five pretty nearly circumscribed large marginal calicles; four of them are just beginning to have marginal infoldings, for new collines. In this the diameter of the undivided calicles is 28^{mm}, but some that are beginning to divide are 30 to 33^{mm} across, transversely, but 40 to 45^{mm} across the broadest parts; depth 10 to 13^{mm}. The collines are double-walled in most places, with a wide, deep, intermural groove.

The septa are numerous, close, rather thick, especially toward the columella; the edges are strongly and rather regularly toothed, the teeth being mostly acute and thickened, generally decreasing in length toward the margin of the calicles. The costæ are thickened, little elevated, roughly spinose, with small acute spines.

This coral was attached by a small central pedicel and the under side is six-lobed and imperfectly covered with epitheca to within 4 to 8^{mm} of the margin. The columella is formed of rather slender, loose trabecular and spinous processes. Pl. xix, fig. 2.

A Bermudian specimen with six unusually large and open, nearly simple, marginal calicles has six large, regular marginal lobes, conspicuous on the under side; only one of these has begun to infold the margin, for secondary divisions. The collines are thick and nearly solid. The five undivided marginal calicles are 22, 23, 28, 32, and 35^{mm}, in transverse internal diameter, from wall to wall; the one that has just begun to divide is 40^{mm} across and 52^{mm} long; the most regular one is 32^{mm} wide and 40^{mm} long; the central calicle is about 20 by 25^{mm} across, and 15^{mm} deep; the marginal calicles are about 8 to 10^{mm} deep. (Pl. xx, fig. 2.)

The septa are strong, thickest toward the columella, where they bear large, stout, angular, acute teeth, often irregular and united by their bases. Small thin septa usually alternate with the larger ones, and have long, thin, sharp teeth. There are usually about five larger and four smaller septa to a centimeter. The columella is small and composed of many slender processes in some of the calicles, and of fewer, stouter ones in others. The costæ are thick, not much elevated, roughly spinulose, with small acute spines.

This specimen is quite different from most, in appearance, owing to the great size, shallowness, and regularity of its calicles, but it seems to be simply a specimen that has delayed its secondary divisions longer than usual, so that its calicles have grown broader.

A few examples of this species have very shallow calicles, the inner surface of the cup being nearly flat, but in other respects they agree with the ordinary forms.

Two or more specimens, crowded when young, may graft themselves together and later form a solid coral similar to the normal ones, but usually somewhat more irregular.

Abnormal specimens, owing to injuries or disease, may have the septa very much thickened and often hollow, and their spines may be hollow, swollen, or even bulbous at the tips. *S. verrucosa* D. and M. was evidently based on a specimen of this kind.

Our largest perfect specimens are 150 to 200^{mm} (six to eight inches) in diameter, but larger and less perfect ones were often seen, perhaps the largest were 10 inches across.

This species is found from Bermuda and the Florida Reefs, southward, throughout all the West Indies.

Isophyllia fragilis (Dana) Ver. Rose Coral. Lettuce Coral.

Mussa fragilis Dana, Zoöph. Expl. Exp., p. 185, pl. viii, fig. 9, 1846.

Isophyllia fragilis Verrill, in Dana, Coral Islands, ed. 2, p. 380, 1874, ed. 3, p. 424, 1890. Quelch, Voy. Chall., Zoöl., xvi, p. 84.

Symphyllia Guadulpensis Edw. and Haime, Ann. Sci. Nat., xi, p. 256, 1849; Hist. Corall., ii, p. 373, 1857. (Young.)

Isophyllia Guadulpensis Pourtalès, Deep Sea Corals, p. 71, 1871.

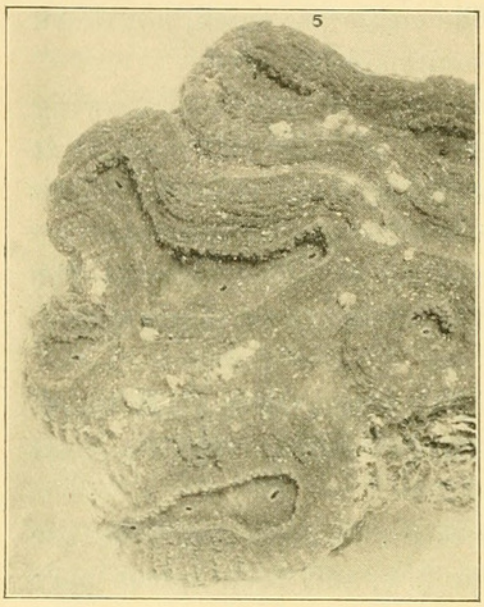
Symphyllia ? strigosa + *? S. anemone* + *? S. marginata* Duch. and Mich., Corall. Antill., pp. 70, 72, pl. x, fig. 16, 1860. (Indeterminable from the descriptions.)

PLATE XVI. FIGURES 1, 2. PLATE XVII. FIGURES 1–7.
PLATE XVIII. FIGURE 1. PLATE XIX. FIGURES 1, 4, 5.

This species, which is about as common as *dipsacea* at Bermuda, and lives with it, can best be distinguished from the latter by the thin, lacerate-toothed, very unequal principal septa, which are not

crowded, but have rather wide interseptal spaces, in which are the much thinner and narrower small septa ; by the usually deep, steep-walled calicles ; and by the prominent, thin, lamelliform, rather distant, and only slightly serrulate external costæ.

4.



4*a*.

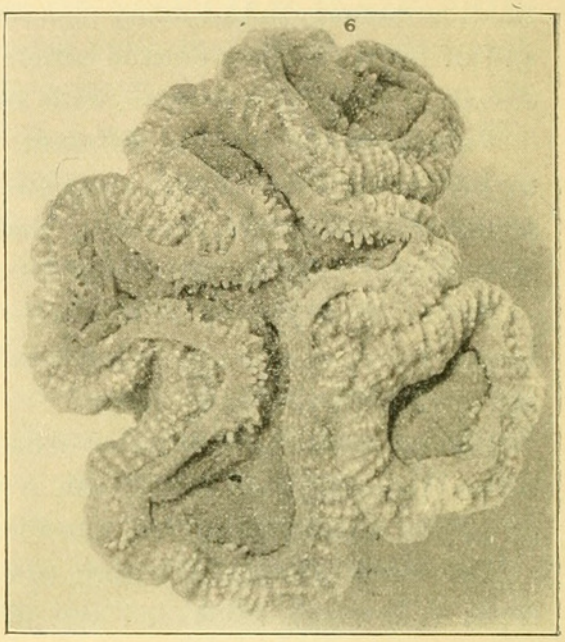


Figure 4.—*Isophyllia fragilis* (D.). Portion of a specimen having many of the calicles isolated, with the polyps partly contracted. Photographed from nature. About $\frac{3}{5}$ natural size.

Figure 4*a*.—The same, with the polyps. A specimen having two calicles isolated and the rest in a long connected series. About $\frac{3}{5}$ natural size.

The collines may be high, steep, and narrow, with a thin solid wall, or they may be double-walled, with a groove on top ; or they may be entirely disunited in some specimens, up to 2·5 inches (65^{mm}) in diameter. But these variations in the collines may occur on a single specimen. The septa are decidedly thinner, fewer, and much more openly arranged than in *dipsacea* of the same size, and the latter has shorter, much stouter, and more regular septal teeth, and less prominent, closer, thicker, and more spinulose costæ.

The original type* of Dana belongs to the Museum of Yale

* Vaughan (op. cit., pp. 41, 42, 1901) erroneously refers this species to *Colpophyllia gyrosa*. He says that from the descriptions "no specific distinction between the two can be discovered." This statement seems absurd, for the *Mussa fragilis=Isophyllia* was very well described and figured by Dana. He also described and figured the strong, spiniform teeth of the septa. Such a mistake seems unaccountable, and the more so because Quelch had already referred it to *Isophyllia*, in addition to my previous determination of it. The type of *I. fragilis*, in the Yale Museum, I have now figured. (See pl. xvi, fig. 1.)

University. It is attached to a stone on which the name and locality (Bermuda) were written in Dana's handwriting. The stone is of granitoid character, but it may have been taken to Bermuda in ballast, as often happens there. It belonged to the Redfield Bermuda collection, which was presented to Yale University many years ago. No. 4298.

This specimen, owing to its growing upon an angular corner of a stone, is quite irregular in form ; one side is closely adherent to the stone, almost to the edge, while the other side is free from 10 to 35^{mm}, and shows very well the thin lamellate costæ, finely, unevenly serrulate, especially distally where they are highest. They are about one-third as thick as the width of the intercostal spaces. The collines are irregular and crooked ; most of them are double-walled, with a slight groove on top, the walls themselves being thin ; in some places the walls are simple, or nearly so. The valleys are unequal ; most are elongated, deep, and narrowed by crowding ; others are nearly circular and less deep ; the longer ones are 14 to 20^{mm} wide, from wall to wall ; the larger circular ones are about 24^{mm} broad (in other specimens they are often 30^{mm} broad).

The septa are very thin, very unequal, openly arranged ; their edges are irregularly and sharply dentate, with long, thin, flat, acute or lacerate teeth, unequal in length and breadth, rough on their sides and ends ; the larger teeth are near the columella. There are about six principal septa to a centimeter, with four or five much thinner ones. The columella is open and loose in structure, composed of slender, irregular, rough spiniform processes from the septa. This coral is 80^{mm} broad and 49^{mm} high, where thickest (pl. xvi, fig. 1).

A somewhat younger, turbinate specimen from Bermuda (coll. 1901), agreeing very closely with the type in the characters of the septa, dentations, costæ, etc., has deeper and more flaring calicles of somewhat large size, 20 to 30^{mm} in diameter. In this the walls are in nearly all cases separate ; they have united partially in some of the collines, leaving a wide furrow, but in two collines they form only a very thin and simple wall, showing that this is a matter of small importance. This specimen was attached by a small pedicel, leaving the lobulated outer wall free for 30 to 35^{mm} all around ; the costæ are thin, high, laminar, and very finely serrulate. (Pl. xix, fig. 1.)

Other regular young specimens, when attached by a small pedicel, have an imperfect epitheca that covers most of the under side, except within 4 or 5^{mm} from the edge, and the base may be flat and horizontal, circular or lobed. (Pl. xvii, figs. 1-3.)

Simple young specimens, 20 to 25^{mm} in diameter, are low, shallow, nearly circular, and usually show no trace of division or lobulation of the margins. They may have five cycles of septa, with the larger ones lacerately toothed as in the adult. Plate xix, fig. 5.

The radial lobes and collines vary greatly with age; the most regular young ones, 40 to 65^{mm} across, usually have six regular, radial calicinal lobes, with six radial collines, and a central primary calicle, but the primary lobes are often five, more rarely four or three. The collines are frequently solid or nearly so, without a groove on top. (Pl. xvii, figures 1–3.)

In ordinary adult specimens the septa are thin, generally rather broad, unequal, and not very close together. The number to a centimeter may be eight to twelve, in fully formed calicles, but in imperfectly formed calicles there may be ten to twelve or more. The larger ones are normally thin, but firm, broadly rounded toward the margin, and not very prominent above the wall. But the form varies greatly in different calicles. The serrations are generally numerous, unequal, and mostly rather long, the larger teeth being flat, not very wide at base, and with the tips mostly acute, but sometimes forked or lacerate. Those toward the outer ends of the septa are usually decidedly shorter than the inner ones, but they are irregularly larger and smaller on the whole edge. The columella may be rather large and spongy, or it may be small and trabecular or laminose even on the same specimen.

The costæ are well developed, and like raised, thin ribs, separated by regular grooves, and with the edges sharply and rather regularly serrate, with the teeth very much smaller than those of the septa. Sometimes the costæ are sublamellar. They may be confined to a narrow zone close to the edge, or they may be more than 25^{mm} long, according to the variable extent of the epitheca.

This species is more apt to have part of the corallites isolated and nearly circular than *I. dipsacea*. Frequently many of them are disunited for much of their length. The larger round calicles may sometimes become 40^{mm} in diameter before they begin to divide.

One of our Bermudian specimens has, on one side, a simple, curved, linear valley, five inches long (125^{mm}), containing a row of uniform, united calicles, while on the other side the calicles are partly isolated, and partly in short groups of two or three, and of various forms.

In the form and colors of the soft parts this species does not differ materially from the last. Its colors are equally variable, but per-

haps the bright green colors are more common in this species. The tentacles are less numerous.

When full grown this species is often 6 to 8 inches (150 to 200^{mm}) in diameter and 4 to 5 inches thick.

When the calicles are crowded resorption of portions of the collines may break them up into detached cone-like or columnar portions, or may simply cause interruptions of their continuity.

Specimens partially killed by injury to the calicles may repair themselves by budding out new cup-shaped calicles from the mutilated parts, and then the new growth may go on just as in the case of young ones arising from eggs.

During the spring of 1901, owing to a period of unusually cold and stormy weather in February and March, many dead or partly dead specimens of this species and *I. dipsacea* were seen, in place, and even those that seemed to be uninjured refused to expand, though in previous years they expanded very freely in confinement. They expand best in bright sunshine and during hot days.

This species is common at the Bermudas, in shallow water. Florida Reefs. West Indies to St. Thomas. Probably generally distributed in the West Indies.

In most collections this species is confused with *I. dipsacea*, usually under the latter name. It is not always easy to distinguish the two, without careful examination. It is possible that the two forms may eventually have to be united as varieties of one species. But all the numerous specimens of this group that I have hitherto studied can be pretty definitely arranged under the two species, by the differences in the septa and costæ.

The following species seems to be so different that it can hardly be confused with either of the preceding, unless when young.

Isophyllia multiflora V., sp. nov.

? Isophyllia multilamella Pourt., Deep Sea Corals, p. 70, 1871 (*non* Duch. and Mich.)

PLATE XX. FIGURE 1. PLATE XXV. FIGURE 1.

This species is remarkable for the rapid division of the calicles, and the unusually small size of the calicles, which are very crowded, and many of them are isolated or in very short series.

The collines are mostly irregular, simple, narrow, with a thin solid wall, but in the larger examples they are often meandriniform. The calicles are rather deep, mostly decidedly stellate, generally 14 or 15^{mm} in diameter, but varying from 12 to 18^{mm}; depth 6 to 8^{mm}.

Septa rather narrow and thin, closely arranged, their edges covered with numerous rather slender, acute, rough teeth, the proximal ones usually the larger. The sides of the septa and teeth are covered with numerous, sharp, rough, conical grains, giving them a rough or hispid appearance, under a lens. The columella is well developed, rough, porous, composed of small, irregular, contorted and hispid lamellæ and spinous processes of the septa. There are usually 11 or 12 well-formed septa to a centimeter, besides some rudimentary ones. The costæ are not much elevated, except close to the edge, slightly thickened, hispid laterally, and sharply serrate with small rough spinules. The epitheca is imperfect, but usually covers much of the lower side.

The animals of this coral are smaller than in the other species, and they form elegant crowded groups, when expanded. The colors are similar to those of *dipsacea* and *fragilis*, but emerald-green is perhaps a more common color in this.

Our largest Bermudian specimen (pl. xx, fig. 1) is 40^{mm} thick and 85^{mm} across, with a nearly flat upper surface. This has 27 distinct calicinal centers, of which only five or six are isolated, most of the others forming series of two or three. The margin has about twelve small lobes.

A very regular small specimen (pl. xxi, fig. 1) is about 55^{mm} broad and 25^{mm} high, with twelve small marginal lobes and twelve radial collines, six of which are primary and extend to the central calicle in sinuous lines, mostly uniting to the five-lobed colline surrounding the central calicle, while the short secondary collines are nearly radial and unequally developed. Each of the six primary marginal calicles has already divided into three, more or less separated calicles, and the secondary central calicle has formed four smaller ones around itself, so that it is 5-lobed. Thus there are now 23 distinct calicinal centers on this small specimen. No. 4009.

A considerably larger one of *I. dipsacea* or *I. fragilis* would usually have but seven calicles. This rapid increase in the calicles seems to be characteristic of this species, which often resembles an astræan coral, such as *Acanthastræa*, in the size and shape of its calicles and septal teeth, though many of the calicles are not isolated, like those of the latter.

I am unable to refer this rather rare species to any of those described by Duch. and Mich., or others,* unless it be the form

* The *Isophyllia Danaana* (Edw. and H., as *Mycetophyllia*, Hist., ii, p. 377, pl. D4, fig. 2) resembles this species in the width of the calicles and valleys, and in its septa, but the valleys are long and sinuous; the collines low and obtuse; and the columella is feebly developed.

briefly described by Pourtalès as *multilamella*, which seems quite distinct from the species to which he doubtfully referred it.

Bermuda and the Florida Reefs. Occurs also in the West Indies, at the Bahamas, etc. It occurred on the Serpuline Atolls, near Hungry Bay, and in Great Sound, Bermuda.

Mussa (Symphyllia) hispida V., sp. nov.

Astræa dipsacea Dana, Zoöph., p. 225, pl. xi, figs. 4–4*d*, 1846 (*non* Lam.)

Acanthastræa dipsacea Verrill, in Dana, Coral Islands, ed. 1, p. 380; ed. 3, p. 421, 1890, *non* E. & H.

Plate XXI. Figures 2, 2*a*, 2*b*, 2*c*.

Dana's type of this species is preserved in the Museum of Yale University in good condition. No. 4287.

It is an astreiform, hemispherical mass, about 100^{mm} in diameter. The calicles are mostly simple and clearly circumscribed; some are circular, but many are elliptical or irregular; some are elongated and have 2, 3, or 4 centers in a series, as in *I. multiflora*.

The walls between the calicles are double and separated by an openly vesicular exothecal structure, the proper wall being thin and solid. The septa are thin, sharply granulated laterally, deeply laciniate, especially near the columella, and have long, rough, lacerate and hispid teeth, largest toward the top. The columella is large, loosely and coarsely trabecular, with rough spines on the surface. In a section the coral appears very cellular; the endothecal dissepiments are compound, long, and much inclined; septa are perforate and trabecular.

Diameter of calicles, 8 to 18^{mm}; the elongated calicles with two or three centers may be 25 to 30^{mm} long; 10 to 12^{mm} wide; depth 7–10^{mm}; distance between them, 2 to 4^{mm}. West Indies (t. Dana). Rare in collections.

This species resembles *Acanthastræa*, in which I formerly placed it, but it has the structure of a *Mussa*. The double wall and vesicular exotheca are not found in *Acanthastræa*, nor the elongated calicles with several centers, dividing by fission.

The locality of Dana's type was uncertain, but was supposed to be West Indian. A similar species is found at Pernambuco, Brazil. See below; List of Brazilian Corals, and pl. xxi, f. 3.

Mussa (Symphyllia) rigida (Dana) Ver.

Astræa (Fissicella) rigida Dana, Zoöph., p. 237, pl. xii, figs. 8*a*–8*d*, 1846.

Prionastræa? rigida Edw. and Haime, Hist. Corall., ii, p. 523, 1857.

Isophyllia rigida Verrill, Bull. Mus. Comp. Zoöl., i, p. 50, 1864; Coral Islands, ed. 3, p. 422 (*non* Pourtalès).

PLATE XXV. FIGURES 2, 3.

The *Isophyllia rigida* Verrill (Bull. Mus. Comp. Zoöl., i, p. 50, 1864) was based on *Astrea rigida* Dana (Zoöph., p. 237, 1846). The type of the latter is in the Museum of Yale University. It is a badly beach-worn, astreiform specimen, with irregular polygonal calicles, mostly 10 to 12^{mm} across. The walls are very solid, often 3 to 4^{mm} thick. The edges of the septa are entirely destroyed. In sections it resembles an *Isophyllia* with unusually well isolated calicles. Its origin is unknown; West Indies? No. 4297.

Several fresh specimens from the Bahamas (coll. R. P. Whitfield), Amer. Mus. and Yale Mus., are apparently of this species. These have deep, roundish or irregular, isolated calicles, 10–15^{mm} in diameter; many are dividing; septa about 30, stout, exsert, strongly spinose-dentate, the distal teeth larger, divergent; upper ones erect, prominent, acute; columella small, trabecular. Walls entirely united, nearly solid. The larger hemispherical masses are 90–100^{mm} across. No. 6616. Plate xxxiii, fig. 4.

Allied to *M. Harttii*, var. *conferta*, but septa are thicker, with the distal erect teeth much stronger; walls more solid.

Mussa Harttii Verrill.

Mussa Harttii + *Symphyllia Harttii* Verrill, these Trans., i, pp. 357, 358, 1868. R. Rathbun, Proc. Boston Soc. Nat. Hist., ii, p. 40, 1878; Amer. Naturalist, xiii, p. 542, 1879.

PLATE XXII. FIGURES 1–2. PLATE XXIII. FIGURES 1, 2.
PLATE XXV. FIGURE 4. PLATE XXXIII. FIGURE 3.

A larger series of this species than that first studied has convinced me that both the forms originally described by me, provisionally, as distinct, are really only extreme growth-forms of one variable species. In the Museum of Yale University there are several intermediate specimens, some of which I have now figured. (Pl. xxii, figs. 1, 2.) It occurs with all the corallites united to their summits by a vesicular exotheca (*Symphyllia*-form, pl. xxiii, fig. 1), var. *conferta*; in dichotomous groups with the calicles and branches disunited, and without exotheca (fig. 2), var. *laxa*; in masses with the corallites free for only a short distance, leaving only deep grooves between (pl. xxii, fig. 1); in groups in which the corallites are free for $\frac{1}{2}$ or $\frac{1}{3}$ their lengths, with exotheca below (fig. 2), var. *intermedia*; and in various other intermediate forms.

One specimen (pl. xxxiii, fig. 3) consists of a cluster of seven calicles of the *Symphyllia*-form, arising from a dichotomous branch of the typical *Mussa*-form. No. 4545.

The calicles generally separate rather quickly in all the forms, and a large part of them are circular and irregularly elliptical, or hour-glass shape, owing to imperfect division. The size of the calicles, even when circular, is quite variable, but is mostly between 12 and 18^{mm}; the elliptical ones are often 25 to 30^{mm} long.

The septa are generally very thin, deeply lacerately toothed, the longer teeth being on the wider and rounded upper portion. They are usually rather openly spaced, about 9 or 10 wide ones to a centimeter, with as many very narrow or rudimentary alternating ones. In some specimens there are 12 large septa to a centimeter.

In the extreme form, var. *confertifolia* (fig. xxii, fig. 1), there are 16 larger and 16 smaller, very thin septa to a centimeter.

The columella is generally well developed, very porous, composed of numerous rough, irregular trabecular processes, with free spines on its surface. But sometimes it is coarsely, rudely trabecular and very loosely arranged, or it may be almost lacking.

The costæ are usually rather thin and not much elevated, but they are covered with numerous, rather close, sharp, elongated, often recurved spinules. These costal spines are very characteristic for this species, but in some specimens they become fewer, more irregular and less elongated, on some parts at least.

Brazil, from Pernambuco to Abrolhos Reefs; Victoria; Porto Seguro, Bahia, Mar Grande, etc., common,—C. F. Hartt; R. Rathbun. According to Mr. Rathbun the clusters are sometimes 2 feet across.

Var. *confertifolia* Ver., nov.

Plate XXII. Figure 1.

The type of this variety is much more delicate than usual, with much more numerous, thinner, and crowded septa (about 16 larger and 16 smaller septa to the centimeter); they are covered with long, slender, sharp teeth. The columella is well developed and finely trabecular. The costæ are small, close, and crowdedly spinose, with small acute spinules, much as in the typical form, but smaller.

The corallites are short, pretty closely crowded, circular, elliptical, and some are irregular and rather smaller than usual. They are united for only a short distance, or not at all, by exotheca.

Pernambuco, Brazil,—Derby and Wilmot, 1870. No. 4551.

Mussa lacera (Pallas) Oken.

Madrepora lacera Pallas, Elench. Zoöph., p. 208, 1766. Esper, Pflanz., i, p. 148, pl. xxv, fig. 2, 1791.

Madrepora carduus Ellis and Sol., Zoöph., p. 153, pl. xxv, 1786.

Mussa lacera Oken, Lehr. Naturg., p. 75, 1815.

Caryophyllia carduus Lam., Hist. Anim. sans Vert., ii, p. 229, 1816; ed. 2, p. 357.

Caryophyllia lacera (*pars*) Ehr., Corall. R. Meeres, p. 92, 1834. Edw. and Haime, Ann. Sci. Nat., ii, p. 238, 1849.

Mussa carduus Dana, Zoöph. Expl. Exp., p. 175, 1846. Edw. and Haime, Hist. Corall., ii, p. 334, 1857.

Lithophyllia lacera Edw. and Haime, Hist. Corall., ii, p. 291, 1857 (Young) + *L. Cubensis*, op. cit., p. 292.

Scolymia lacera Haime, Mem. Soc. Geol. France, iv, p. 279, 1852. Bruggmann, Ann. and Mag. Nat. Hist., xx, p. 303, 1877. Vaughan, op. cit., pp. 6, 34, 1901.

This large species is common in the Bahamas and southward to Curacao.

On the Florida reefs it seems to be rather rare. It has not been found at the Bermudas. It forms dichotomous clumps, often more than a foot high and broad. The calicles, when full grown, are mostly isolated and nearly circular. They are from 40 to 65^{mm} in diameter, and sometimes more, but mostly about 50^{mm}. The calicles vary in depth, some being shallow, others rather deep. The septa are numerous and strongly toothed, but the teeth vary widely in form; usually the distal ones are much the larger. The larger septa are usually pretty thick, but sometimes they are thin and fragile. The exterior is covered with rows of strong, acute costal spines.

I regard the simple forms with broad calicles and wide base, referred by Edw. and Haime to *Lithophyllia lacera*, as the young of this species before fission takes place. The two forms occur in the same localities. It is certain that all the species of *Mussa* and *Isophyllia* have such a simple young stage, before they begin to divide, in which the diameter of the cup equals or exceeds that of the adult calicles after division. The size of the calicles and the number and character of the septa and their denticulations all correspond well in the two forms. Moreover, I have seen specimens of the simple *Lithopyllia*-form in which infoldings of the margin had already taken place, to begin the process of fission.

If this form be not the young of "*carduus*," as I believe, then its young have not been discovered, which would be remarkable in the case of such a large and common species.

Pallas described both forms and considered them the same, under the name of *M. lacera*. The type of *carduus* is still in the Hunterian Mus. (t. Young).

Probably the *Lithophyllia Cubensis* Edw. and Haime is only a slight variation of the same young form, for similar variations occur in the adult calicles.

Mussa angulosa (Pallas) Oken.

Madrepora angulosa Pallas, op. cit., p. 299, 1766. Esper, op. cit., i, p. 92, pl. vii, 1791.

Mussa angulosa Oken, Lehr. Naturg., p. 73, 1815. Dana, Zoöph., p. 176, 1846. Edw. and Haime, Hist. Corall., ii, p. 329, 1857.

This species is closely allied to *M. lacera*. It differs from it in the smaller size of the branches and calicles, which are usually from 25 to 50^{mm} in diameter, and are apt to be crowded and angular. The principal septa are generally rather wide and exsert. A study of a large series of specimens might, perhaps, compel us to unite them in one species.

It is much less common in collection than *M. lacera*, and most specimens are beach-worn. It ranges from Florida to the Antilles, but seems to be rare on the Florida reefs.

Ulophyllia crispa (Lam.) Edw. and Haime.

Oulophyllia crispa Edw. and H., Ann. Sci. Nat., ser. 3, xi, p. 268, 1849.

Ulophyllia crispa Edw. and H., Hist. Corall., ii, p. 378, 1857.

I have studied a fine large specimen from Singapore, in the Ward collection, now in the Field Columbian Museum, at Chicago.

This is 12 × 8 inches across, and about 6 inches thick. The valleys are mostly 15 to 20^{mm} wide, but some are 25 to 30^{mm} across in the widest places; depth 10 to 15^{mm}.

The septa are rather loosely arranged, usually 9 or 10 to a centimeter, mostly wide and strongly toothed at base, projecting but little above the walls, and not much thickened ; narrow ones alternate in some places between the wider ones, but not regularly. The large teeth of the wide septa are mostly broad at base, triangular, about as broad as high, subequal ; usually the larger ones are on the basal part, but not infrequently the larger ones are above the middle. The ridges or collines are angular, broad at base, thin and simple at the summit. Columella variable, sometimes well developed, trabecular, sometimes open or rudimentary. Exterior of the coral lobulated at the margin, faintly costulate, nearly smooth, and without spines.

This is not a West Indian species, as some writers have supposed. All specimens that I have seen were from Singapore.

Several other, apparently distinct species, have been described from the Indo-Pacific region. Among them are the following :—

U. aspera Quelch, op. cit., xvi, p. 88, pl. iii, figs. 5–5*b*. Banda.

U. cellulosa Quelch, op. cit., p. 87, pl. iii, figs. 6–6*c*, 1886. Banda.

U. maxima Rehberg, Abh. Geb. Naturw. Ver., Hamburg, xii, p. 18, pl. i, fig. 12, 1892. Duke of York Island.

U. Stuhlmanni Rehb., op. cit., p. 17. Zanzibar.

Addenda to Favitinæ.

The following species should have been inserted on page 91.

Favia Whitfieldi Ver., sp. nov.

PLATE XXV. FIGURE 5.

This coral forms rounded masses, up to four inches (100^{mm}) in diameter. Calicles a little elevated, rather large, 8–12^{mm} in diameter, mostly nearly circular ; some are elliptical and undergoing fission; a few are irregularly lobed. Their cavities are rather deep, funnel-shaped, narrow at the bottom.

Septa somewhat exsert, rounded at the summit, and roughly serrate ; paliform lobe well developed, serrate. Columella small, lamellose or trabecular ; walls thick, solid, separated by dense exotheca having few cellules in one row.

Nassau, N. P.,—coll. R. P. Whitfield. Two good, fresh specimens are in the American Museum Nat. Hist., New York. No. 543. I have seen other specimens that are beach-worn.

This species is quite unlike any of the other West Indian species of *Favia*. Its general appearance, and especially its large, round calicles cause it to resemble some of the East Indian species. Its septa are more roughly serrate than in most species.

Family **Echinoporidæ**. Emended.

Coral usually foliaceous or frondose, sometimes branched, rarely encrusting, generally thin, with the exotheca or cœnenchyma sparingly developed and usually cellular, but sometimes solid (*Acanthopora*). Corallites short, often obliquely appressed ; increasing chiefly by marginal, basal, or intercostal budding, generally scattered irregularly and only on one side of the foliaceous species, but sometimes on both sides, and not forming collines, but sometimes arranged in short rows.

Septa often strongly exsert, dentate or lacerate, the distal ones usually continuous with the costæ. Common base often thin, but firm, imperforate, irregularly costate, often echinulate.

These corals often resemble fungian corals, like *Agaricia* and *Podabacia*, but they have distinct and often large exothecal dissepiments and lack synapticulæ.

To this family I now unite the genus *Mycedium* Oken, as emended, = *Phyllastræa* Dana.

Mycedium (Oken) Edw. and Haime. Type *M. elephantotus* (Pallas; Esper.)

Mycedium (*pars*) Oken, Lehr. Naturg., i, 69, 1815.
Agaricia (*pars*) Ehr., Corall., p. 105, 1834 (*non* Lam.)
Phyllastræa Dana, Zoöph. Expl. Exped., p. 269, 1846.
Helioseris (*pars*) Edw. and Haime, Compt.-rend., xxix, p. 72, 1849.
Mycedium (*pars*) Edw. and Haime, Ann. Sci. Nat., xv, p. 130, 1851; Hist. Nat. Corall., iii, p. 72, 1860 (*non Mycedia* Dana, 1846).

The coral in this genus usually forms thin, foliaceous, often contorted fronds, simple or clustered. They may be unifacial or bifacial. The calicles are rather large, one-sided, oblique or appressed, stellate, usually scattered, not in long series. Collines rudimentary or lacking. Septa rather few, thickened, serrate or laciniate, exsert, prominent externally, continuous from calicle to calicle, as septocostæ. Costæ coarse, rough, serrate. Under side of coral rather coarsely costate.

Much unnecessary confusion has arisen as to the characters of this genus.

This has been due chiefly to the fact that most writers have failed to recognize the true characters of the type species, *Madrepora elephantotus** of Pallas, and have had very different species under this name, including two or more West Indian species of *Agaricia*, as will be shown under that genus, which have nothing to do with the true *elephantotus*. Milne-Edw. and Haime had, however, a more correct idea of the nature of the original genus, and their interpretation of it must hold good, even though they included some species that may better be placed elsewhere. But their species described as *elephantotus* is not the species of Pallas.

* It has been suggested by Quelch that this spelling was a typographical error for *elephantopus*, but the allusion is plainly to the resemblance of a broad foliaceous coral to an elephant's ear, not to the foot. Some of the early polynomial writers gave these foliaceous corals the vernacular name "Elephants Ears." See Voy. Chall., xvi, p. 116, foot note.

The *M. elephantotus* of Pallas was not an *Agaricia*, and was from "Oceanus Indicus." It belongs to a strictly Indo-Pacific group of corals. It was carefully described by Pallas, who said that he had seen but a *single* specimen. So that there was here no confusion due to an original mixture of several species. Such confusion was due to the confounding of other very unlike species with it by subsequent writers, even down to the present year.

Vaughan (op. cit., pp. 63, 64, 67, 1901) identifies it with a West Indian species very close to "*M. fragile*," from which he thinks it may be distinct (p. 67), and he states that he has seen good specimens, but does not give the characters. Therefore we can only infer that he considers it a West Indian foliaceous *Agaricia*.

Gregory (op. cit., pp. 280, 281, 1895) unites it definitely with the species *A. fragilis*, without a mark of doubt.

But the species described by Pallas, as plainly stated by him, was a widely different coral. He stated that the stars (calicles) are scattered, nearly in quincunx ; that they are prominent and lacerate; that the exterior of the coral has rather remote, rough, longitudinal costæ ; and that it seems intermediate between *M. agaricites* and *M. lactuca*.

None of these characters apply to the *Agaricia fragilis* and its allies, nor to any true *Agaricia*. His description* clearly indicates a coral with large, well-defined, stellate, scattered calicles, having lacerate septa, continuous distally with the subparallel, radial, granulated costæ, and with a coarse, roughly costate exterior surface, instead of one with the fine and even striations characteristic of *Agaricia fragilis* and its allies.

Pallas does not state that the calicles are in series, nor does he mention transverse sulci or collines, though these characters are carefully described by him under *M. agaricites* on a previous page. Hence we must conclude that they did not exist in his species, especially as he also says that the stars are nearly in quincunx. This is also the case in Esper's *elephantotus*.

* The original Latin description (Elench. Zoöph., p. 290) is as follows :—

"Madrepora conglomerata subturbinata, intus lamellis granulosis parallelis stellisque lacero-prominulis sparsis.

Corallium format laminam tenuem, subturbinatam, undato-crispam, laciniosam, sessilem, extus longitudinaliter porcis remotiusculis striatam ; intus prædita *lamellis* longitudinalibus, subparallelis, obtusis atque granulosis, quæ passim interruptæ sunt *stellis* rariusculis, fere in quincunces sparsis, lacero prominulis ; harum lamellæ istæ longitudinales quasi radii sunt. Locus : Oceanus Indicus.

Est quasi medium inter *M. Lactucam* & *agaricitis* quasdam varietates."

In fact, the description calls for a coarsely costate and rough coral, having scattered, stellate calicles, without collines.

The genus *Phyllastræa* Dana, based on *P. tubifex* Dana, corresponds to it in many respects, and is evidently congeneric with it, as noted by Edw. and Haime. Several other allied species are known to me.

Unfortunately, Edw. and Haime described as *elephantotus* a very distinct species, with very fine, close, equal costal striæ on the under side, and this has helped to perpetuate the confusion.

Esper (Pflanz., i, pl. xviii, figs. 1–4) figured as *M. elephantotus* Pallas, from the East Indies, a foliaceous species, with thin, clustered, convoluted fronds, strongly radially costate and serrate, but not echinate, below. Calicles stellate, appressed, raised proximally, with coarse, serrate, angular septa. This may well be the real *elephantotus* Pallas. It corresponds to it better than does any other figure.

Dana (Zoöph., p. 339) referred to a specimen of this species that he had seen in Peale's Museum, Philadelphia. This museum was burned many years ago, but Dana's sketch of this specimen is in the collections of the Yale Museum, with other unpublished drawings of corals presented by him.

It is probably of Indo-Pacific origin.

Ehrenberg described in 1834 a different species under the name of *Agaricia? elephantotus.** It had calicles six lines in diameter, which is much larger than those of Esper's species.

The *Mycedium Okeni* Edw. and Haime (Hist., iii, p. 75, pl. D12, figs. 1*a*, 1*b* (not 2)), also has large calicles, 10^{mm} in diameter, and is probably very close to *elephantotus*, if not the same. It has rough, dentate, angular septa and the calicles somewhat in series. There is evidently an error in the numbering of the figures on the plate. Quelch (op. cit., p. 116) referred this species to *Phyllastræa* Dana.

As for *M. cucullata* Ellis and Sol., it seems to be a species of *Agaricia* that cannot yet be positively identified. I have seen no specimens like it, nor do any of the modern descriptions agree very well with it. It is certainly *not* the same as *elephantotus* of Pallas, though it may be the species wrongly called by that name in some modern books; possibly it is the *M. elephantotus* of Edw. and Haime, but the latter is not the *elephantotus* Pallas. Gregory puts it as a synonym of *his* erroneous *elephantotus-fragilis*. The *A. cucullata* Dana is probably *A. purpurea* Les., described below.

* Doubting its real identity with the Pallasian species, he gave it the provisional name of *megastoma*, as noted also by Dana. It is perhaps a *Tridacophyllia*. Edw. and Haime, ii, p. 381, consider it the young of *T. lactuca*.

Some of the species of *Podabacia* resemble the *M. elephantotus* rather closely in form. This is particularly the case with an apparently undescribed species.*

Mycedium explanatum Verrill.

Phyllastræa explanata Verrill, Bull. Mus. Comp. Zoöl., i, p. 53, 1864.

Plate XXIX. Figures 1*a*, 1*b*, 1*c*.

Additional specimens of this species show considerable variations from the type.

The fronds may be 8–10^{mm} thick, but become very thin, about .05^{mm}, at the margin. The under side is covered with unequal, raised, rounded, dichotomous costæ, the larger ones separated by three to six smaller ones; they are not serrulate nor echinate. On the older parts of the upper side, the corallites are large, often crowded, sometimes erect, but usually much inclined, mostly 8–10^{mm} in diameter. The septa vary from less than 12 to 18. Most commonly there are about 12 larger, subequal, very thick and prominent ones, with several much thinner ones of the 3d cycle. The large ones are perpendicular within, acute-angular at the summit, and con-

* *Podabacia dispar*, sp. nov. Coral thin, foliaceous, in broad fronds, often concave above, and very thin at the edges. Common wall thin but compact, with few or no perforations, and covered with unequal, slightly raised, but continuous, costæ; often every 4th or 8th one is larger than the intermediate ones, which decrease in size according to the cycle of the septa with which they correspond, the smallest extending only a short distance from the edges. Their edges are finely granulated, and sometimes the larger ones are sparingly denticulate with very small, rough, irregular teeth, very much smaller than those of *P. crustacea*. The calicles are irregularly scattered; the larger ones are stellate, with a well developed columella, made up of irregular rough processes, sometimes united into a nearly solid mass. Septa thin, in three cycles, with some very thin perforated ones of the 4th cycle on the distal side. Usually there are nine to twelve larger septa; but in the outer calicles there are usually but six. The principal septa are wide, rise abruptly, and form a prominent, somewhat thickened lobe or angle at the summit, beyond which the edge is concave, thin, finely and sharply serrate, and continuous with the long septo-costæ. The prominent angle is often lacerate-toothed, but more frequently it is subentire. The septo-costæ are of several sizes, but generally the alternate ones are very thin, deeply lacerate, and much perforated close to the edge. The synapticulæ are large and conspicuous. Plate xxix, figs. 5, 5*a*.

Diameter of the larger calicles, 4-6^{mm}; thickness of coral, 1.5 to 2 inches from edge, 6-8^{mm}.

Samoa Is. (Coll. H. A. Ward). Museum of Yale Univ., No. 6178, and Field Columb. Mus., Chicago.

vexly rounded externally, where they pass into thick, stout costæ, bearing several conical, rough, often hollow spines.

The summit is roughly serrate or spinulose ; the inner edge and sides sharply and roughly granulated. The septo-costæ are often long, becoming thinner between the corallites than on their walls, and alternately thicker and thinner ; they bear rather fine, strong, suberect, acute or lacerate spines. Toward the margin of the coral the corallites are smaller, more appressed, but circular, and have 6 to 12 larger, thick, prominent, exsert, acute, lacerate or spinose septa. The septo-costæ here become thinner and higher, with erect, rough or lacerate, rather distant spines. The columella is generally pretty well developed and roughly trabecular.

In sections (fig. 1*c*) the exotheca is pretty compact, with numerous rather small dissepiments, much smaller than in the next species.

Tahiti; Mus. Comp. Zoöl.; Yale Mus.; Field Columb. Mus.

For the older, thick form, with stout, swollen or rounded corallites, I have used the variety name, *turgida*. It often looks like a distinct species, but it grades into the thinner form. The differences are probably due to age.

Mycedium tenuicostatum Ver., sp. nov.

PLATE XXIX. FIGURES 2, 2*a*, 2*b*, 2*c*.

Coral forms a large foliaceous frond, more or less bent and irregular, considerably thickened and cellular in the older parts, but thin at the margin.

Exterior dichotomously costate ; the costæ are unequal, 1 to 3 or 5 smaller ones between the larger ; all are broadly rounded, more than twice as wide as the narrow intervening grooves ; their surfaces are slightly rough with minute granules.

Corallites, toward the center of the upper side, are large and much crowded, expanded, prominent, often erect ; the larger ones are 15 to 18^{mm} across, with very exsert, excurved, very roughly lacerate and spinose septa, which are thick and broad at the summit, with the inner edge flaring and roughly dentate and the outer or costal portion lacerately dentate. There are often 24 septa, in three cycles, but frequently only 12 to 18 are present ; those of the third cycle are thin and narrow ; sometimes smaller septa of the fourth cycle appear. Many corallites are but little prominent, with the septa thinner and not much exsert, angular at the summit, and roughly

spinulose. The septo-costæ are very thin and high, separated by spaces 4 to 6 times as wide, with few angular teeth.

In sections (fig. 2*c*), the exotheca is abundant, coarsely cellular; the dissepiments are convex and numerous. Singapore (?); Mus. Yale Univ.; Field Columb. Museum.

Echinopora elegans Ver., sp. nov.

PLATE XXIX. FIGURE 3.

The coral forms broad, thin, contorted, foliaceous fronds, sometimes 20 inches (500^{mm}) broad and 10 inches high, while the average thickness of the foliæ may be 3 to 4^{mm}, becoming very thin and translucent toward the margins, but yet compact and strong. Under side has rather loosely scattered small calicles in some parts, but toward the margins they are absent and the surface is evenly and closely covered with very small, nearly equal costæ, roughened with minute granules.

The upper side is roughly echinulate, and bears larger and more prominent calicles, which are rather crowded in some parts, but irregularly arranged, and becoming more scattered toward the margins, where the intervals are often equal to three or four times their diameter.

The larger corallites are verruciform, 3 to 4^{mm} in diameter, with very roughly echinulate septa and costæ.

The septa, in the larger calicles, form three very unequal cycles. The six primaries are much exsert, a little thickened, hispid laterally, and with the edges finely lacerately toothed. Usually they consist of two or three deeply divided lobes, the outer one standing on the outer thecal margin; the next, just within the calicle, is a little wider; the third, usually smaller, may represent the paliform lobe or tooth. Those of the second cycle are smaller and thinner, but lobed in the same way. Those of the third cycle are very small and narrow, or often rudimentary.

The septo-costæ are numerous, even, and rather close, represented, in general, by rows of small, upright, echinulate or lacerate spinules of about equal size; toward the margins the costulæ become more elevated, with the edge echino-lacerate.

The columella is usually well developed, finely trabecular or spongy.

Samoa (coll. Ward); Mus. Yale University and Field Columbian Museum. No. 6180.

Echinopora concinna Ver., sp. nov.

PLATE XXIX. FIGURE 4.

The coral forms large, thin, foliaceous, bent fronds, a foot or more across, becoming very thin but firm at the edges. Both surfaces bear similar calicles in the type.

The septo-costæ are fine, very regular, only slightly raised, and each bears a row of regularly spaced, not crowded, small, erect, rough spinules, which give a neat and very regularly spinulose character to the surface.

The calicles are small, low, verruciform, rather open, with deep and conspicuous interseptal loculi. The septa are in three cycles, the smallest very thin and narrow. The larger ones are wide, thickened at the walls, a little prominent, angular at the summit, and lacerately toothed.

The columella is well developed and finely trabecular or spongy.

Diameter of calicles about 4^{mm}; their height about 1 to 2^{mm}.

Pelew I.,—coll. Ward; Yale Museum and Field Colum. Mus., Chicago. This is allied to *E. striatula* Studer, (Monatsb. Kong. Akad. Wiss., Berlin, 1877, p. 644, pl. iii, figs. 10*a*, *b*,) from New Britain.

Family **Agaricidæ** Ver., 1867.

Fungidæ (*pars*) Dana, Zoöph., p. 283, 1846.
Lophoserinæ (*pars*) Edw. and Haime, Compt.-rend., xxix, p. 71, 1849. Hist. Corall., iii, p. 35, 1860.
Lophoseridæ Duncan, Revision, p. 146, + *Plesiofungidæ* (*pars*), p. 133, 1884.
Agaricidæ Verrill, these Trans., i, p. 542, 1867.

Corals generally compound, increasing mostly by marginal budding, often thin foliaceous or frondose, either unifacial or bifacial, sometimes in thick plates or massive. Calicles small and shallow, often without definite solid walls. Septa usually numerous, low, finely serrulate or subentire, more or less of them continuous, as septo-costæ, with those of adjacent calicles.

Synapticulæ exist between the septa, and in thick or massive forms there are also dissepiments. Outer wall compact, imperforate, usually with slender, serrulate costal striations, seldom echinate.

Polyps short, scarcely exsert, with small, short, verruciform, blunt or clavate, or often rudimentary tentacles.

Agaricia Lam. (emended). Type *A. undata* Ellis and Sol.*

Agaricia (*pars*) Lamarck, Syst. Anim. sans Vert., p. 375, 1801 (1st species is "*M. cucullata* Ellis and Sol.," 3d species is *M. undata*; 2d species is now *Merulina ampliata*).

Undaria Oken, Lehr. Naturg., p. 68, 1815 (includes 1st, *agaricites;* 2d, *undata*).

Agaricia (*pars*) Lam., Hist. Anim. s. Vert., 1815.

Agaricia (subgenus *Mycedia*) Dana, Zoöph., pp. 333, 335, 1846 (*non Mycedium* Oken, 1815).

Agaricia and *Mycedium* (*pars*) Edw. and Haime, Corall., iii, pp. 72, 80, 1860. Duch. and Mich., Cor. Antill., pp. 80, 81, 1860.

Agaricia Quelch, Voy. Chall., Zoöl., xvi, p. 116. Gregory, op. cit., p. 279, 1895. Vaughan, op. cit., p. 63, 1901.

This genus cannot be divided into two, on account of the character of the unifacial or bifacial corals, as many writers have tried to do, nor on the character of an encrusting mode of growth, as distinguished from the *pedicelled*, cup-shaped or turbinate, and foliaceous corals, formed by several of the species, and perhaps by all under certain conditions, and when young. Better generic and specific characters are to be found in the finely striated under side of the coral, when it is free, and in the distinctly stellate calicles, usually arranged in concentric lines or grooves, often separated by ridges or collines, around the primary calicle, but this arrangement may become irregular, obscured, or wholly lacking, in parts of very old or crowded specimens of some species, like *A. agaricites.*

The septa are but little prominent, usually in two to four cycles, and are usually finely and rather evenly serrulate. The calicles are usually rather small or of moderate size, much larger and far more distinctly stellate than in *Pachyseris*, but not so large and prominent as in *Mycedium* (true sense). The septa and costæ are not coarse and not spinose, nor lacerately toothed, as in the latter.

The calicles often resemble those of some species of *Pavona*† very closely and so does the frondose structure of the coral.

The mistake of confounding true *Mycedium* with this genus has already been discussed above (pp. 133–135).

* I take *A. undata* as type, because there is still much doubt as to the real affinities of *cucullata*. The latter has been identified with *M. elephantotus* by many, and hence put under *Mycedium*. *A. undata* is evidently closely allied to *A. fragilis*. The original type is still in the Hunterian Mus. (t. Young, Ann. Mag. N. H., xix, p. 116, 1877).

† *Pavona* Lam., 1801, p. 372, but spelled *Pavonia* Lam., 1816; Dana, 1840, etc. The two examples given, in 1801, were 1st, *P. cristata*, with reference to Ellis and Sol., pl. 63; 2d, *P. lactuca* (Pallas). Edw. and Haime, Corall., iii, p. 81, 1860, and Gregory, op. cit., p. 279, 1895, quote *P. cristata* Lam., 1801, as a synonym of *Agaricia agaricites*. If this were so, then *Pavona* and *Agaricia*

Much confusion has always existed as to the number and characters of the species included in this group. Gregory and Vaughan, among recent writers, have gone too far in uniting diverse species, so as to reduce the number of American species to two or three only. Gregory (op. cit., pp. 279, 280) united with *agaricites*, not only *cristata*, but also *undata* (E. and S.); *purpurea* Les.; *gibbosa* D.; *Lessoni* D. and M.; *vesparium* D. and M.; and even "*A. arthrophylla*" Horn.* (i. e. *anthophyllum*), which has no resemblance to *agaricites* and belongs to *Pachyseris*. Probably some of the other species that he lumped together, perhaps rather hastily, may also be distinct.

Vaughan (op. cit., 1901) followed Gregory pretty closely, but was inclined to keep *fragilis* and *elephantotus* separate, and he was doubtful about *anthophyllum*. But under *agaricites* he puts *Lamarcki*, *Danai* (D. and M.), and with doubt, *Sancti-Johannis* D. and M. He has studied the types of *Danai* D. and M.; *Lessoni;* and *vesparium* at Turin, and his opinion is important as to these. But the *Danai* and *Sancti-Johannis* are referred to the *elephantotus-fragilis* group by Gregory.

This genus is almost exclusively West Indian, but *A. Forskalli* Edw. and H. is a fossil from the recent deposits of the Red Sea. Quelch (Voy. Chall., xvi, p. 118) described *Agaricia regularis* from Levuka I. In the Indo-Pacific fauna it is mostly replaced by *Pavonia* and *Pachyseris*, with numerous species.

---

would be synonymous. But Edw. and Haime refer the *M. cristata* of Ellis and Sol. to *Lophoseris* (op. cit., p. 66), which is synonymous with *Pavonia* of authors. So the reference, first named, is doubtless an error. On the same page "*Madrepora agaricites* Dana" is quoted, by error. The original definition of *Pavona* would apply equally to that genus and to some species of *Agaricia*, like *A. agaricites*. *Agaricia* was then separated wholly on account of the unifacial coral—a character of minor importance.

* *Pachyseris anthophyllum* (Horn, 1860) Ver. The type of this species was studied by me in the Philadelphia Acad. Nat. Science a number of years ago. It is a typical *Pachyseris*, closely allied to *P. monticulosa* Ver., and is doubtless of Indo-Pacific origin, like all the related species. The surface is covered with lobes and monticules, much as in certain examples of all the other species. The septa are laterally covered with numerous close and prominent, rough or crisped, flat or irregular granulations, which fill up much of the space between them, the granulations being often nearly in contact across the interseptal spaces, giving the septa a crowded and thickened appearance, though the septa themselves are rather thin for the genus, and alternately unequal. The ridges or collines are somewhat irregular, obtusely rounded, or somewhat angular, not very elevated, nor very close together. The calicinal centers are indistinct. The calicinal groove is narrow and deep, and contains a columella-lamella of variable thickness. The under surface of the frond is finely and regularly costulate.

Agaricia fragilis Dana. Hat Coral. Shade Coral.

Agaricia (*Mycedia*) *fragilis* Dana, Zoöph. U. States Expl. Exp., p. 341, 1846.

Mycedium fragile Verrill, Bull. Mus. Comp. Zoöl., i, p. 55, 1864. Pourtalès, Deep Sea Corals, pp. 48, 82, 1871. Florida Reefs Corals, pl. xi, figs. 1–10 (series of young), pl. xiii, figs. 1–5 (adult), pl. xiv, figs. 1–9 (details), 1880.

Mycedia fragilis Edw. and Haime, Corall., iii, p. 83, 1860.

? Agaricia Lamarcki and *? A. undata* (*non* Ellis and Sol.) Edw. and Haime, Hist. Corall., iii, pp. 82, 83, 1860.

Agaricia fragilis Quelch, Challenger Voy., Zoöl., xvi, p. 116, 1886. Vaughan, op. cit., p. 67, 1901.

Agaricia elephantotus (*pars*) Gregory, Quart. Journ. Geol. Soc. London, li, p. 280, 1895 (*non* Pallas).

Plate XXVI. Figures 1*a*–1*d*.

This elegant species has been so fully and beautifully illustrated by Sonrel in the plates of the Florida Corals Reefs, by Louis Agassiz, edited by Pourtalès, quoted above, that little need be added, except as to its synonymy and habits, and some special variations. It is the *only* species of *Agaricia* found at the Bermudas, where it is very common in very shallow water, as well as in two to four fathoms. So that Gregory's idea that it is a deep water variety is not valid. In Harrington Sound, where there is scarcely any tide, it can often be gathered by hand from water not over a foot deep, especially under the shade of overhanging cliffs, but it is most abundant in six to twelve feet of water. It generally lives in sheltered localities, where heavy surf does not occur. It often occurs in colonies.

In the spring of 1901, many recently dead and partly dead specimens, mostly of large size, were seen in Harrington Sound. This was due, without doubt, to a period of unusually cold and stormy weather in February and March, which also killed vast numbers of fishes, etc., in Bermuda waters.*

No forms like *M. elephantotus*, nor like *A. agaricites*, are ever found here, which is good evidence that they are distinct and more tropical species.

Hundreds of specimens from Bermuda, studied by me, show but slight variations, aside from those due to ordinary growth and to injuries. The specimens here are always pedicelled, with a broad, thin, delicate, cup-shaped, saucer-shaped, or salver-shaped frond, when normally grown ; rarely the edges bend down all around, and the upper side may then be flat or concave. After injuries the frond may become irregular, or even much deformed, owing to unequal repairs, but it never becomes truly encrusting.

* See Amer. Journ. Sci., xii, p. 88, 1901.

In some instances the coral has been penetrated by the double siphon-tubes of *Gastrochæna*, which may rise one to two inches above the upper surface. In such cases these tubes become covered to the tips with an encrusting growth of the coral, as is usual with corals of this and other groups, thus forming conical or chimney-like structures. These are the only instances in which I have seen this species assume, even in a small part, an encrusting mode of growth, but this does not affect the general form of the frond.

This coral does not become thick, except close to the region of the pedicel. Frequently, bilobed specimens occur, with two primary or large calicles around which the concentric circles of calicles have been formed (see pl. xxvi, fig. 1*c*). Large specimens at Bermuda are sometimes a foot across, but these are usually deformed, owing to injuries. Perfectly regular specimens are seldom more than half that size (150^{mm}).

Sometimes two or more specimens, coming in contact when young, graft themselves together by their edges, which are always very thin and fragile.

The calicles are always small, generally with their edges somewhat elevated. They are always plainly stellate. The septa and costæ are thin, nearly even, and finely serrulate. The collines vary considerably in height and the distance between them, but they are generally long, rather regular, rounded, and not much elevated, the calicles being mostly in long concentric series, but frequently they are isolated or form short series. The color of the animal, in life, is rich chocolate-brown or purplish brown. The tentacles are whitish, very small and short.

In respect to the size of the collines, this species often resembles the figure of *A. undata* in Ellis and Sol. But that figure represents a coral with less defined and smaller calicles, and having a thicker frond, quite unlike the delicate fronds of this species. Of course this may have been due to the fault of the artist, but the plates of that work are generally pretty accurate. Hence I believe it to be a distinct, much larger, and more massive species, probably inhabiting deeper water.* The type is still extant. See p. 140, note.

* It is doubtful whether many recent writers have seen specimens of the true *A. undata*, though Pourtalès said that he had seen it in Cuba. I am not sure that I have myself seen a specimen that I could refer to that species with confidence. But that does not prove that such a species does not exist. I have studied large numbers of undescribed West Indian Alcyonaria from moderate depths. Numerous unknown or rare corals are probably to be found in those waters. The early collections often contained rare and little known species, seldom seen in modern collections. Some of these were doubtless brought up on anchors or on the hooks of fishermen, a prolific source for obtaining rarities in all seas.

Dana (Zoöph., p. 336, pl. xxi, fig. 8) refers to two large specimens of *undata* that he had seen. One of these was in the American Museum, New York. The other in the Mus. Acad. Nat. Sciences, Philadelphia. I have been unable to find either of these specimens, but there is an unpublished sketch of the latter, by Dana, in the Yale Museum. Dana states that it was 15 inches long and 8 broad. The former was 18 by 12 inches, and was from Key West.

The "American Museum" referred to is not the present museum of that name. It was a small private museum that was destroyed by fire many years ago.

The coral described by Edw. and Haime (Hist., ii, p. 83) as *A. undata* does not seem to me to be the *undata* of Sol. and Ellis. It was described as very thin and fragile (thickness of frond 2^{mm}). The calicles are in series, separated by small, distinct collines, but they have only 10 to 12 septa, and are smaller than those of *fragilis*, the diameter being 1.5^{mm}. It is evidently near the latter and may be only a variety of it with smaller calicles and fewer septa than usual. *A. fragilis* usually has 15 to 20 septa, sometimes 24. But in the absence of a figure, it is hardly possible to decide this question, without a reëxamination of the type.

A. Lamarcki Edw. and Haime (Hist., iii, p. 82)=*A. undata* Lam., 1816, *? non* Ellis and Sol., has been placed as a synonym of *agaricites* by Vaughan, but according to the original description it agrees pretty closely with *fragilis* and *undata*. It was described as growing in a thin ($7–8^{mm}$ thick), expanded frond, undulated and very finely costellate below, and with broad, low, obtuse, unequal, concentric collines above. Calicles numerous and close, 2^{mm} broad, with 16–20 septa, and a large columella; septa pretty thin, close, very finely denticulated. Collines 19^{mm} apart.

This description applies very well, in many respects, to some specimen of *fragilis*, though the thickness of the coral is rather too great. In this respect and others it seems to be more like the true *undata* Ellis and Sol., where Lamarck placed it. Vaughan does not say that he saw the types of either of the last two species. Had he studied the types, his opinion of these species would be entitled to great weight, in each case. The *undata* Dana is another species.

A. Danai (Duch. and Mich.), *non* Edw. and Haime, was placed by Gregory under his *elephantotus-fragilis* group. But by Vaughan (from types) it was put under *agaricites*. Quelch (op. cit., p. 116) puts it down as a thick variety of *A. fragilis*. It forms a thick and solid, largely free frond, adherent at the center, but the original

description is very brief and poor, giving no account whatever of the calicles, septa, costæ, etc. I have seen examples of *agaricites* growing in the same form, but the same is true of *A. purpurea.*

The name was preoccupied by Edw. and Haime (Corall., ii, p. 84), who applied it to *A. cristata* Dana (*non* Lam.). This last belongs to the frondose *agaricites*-group. A part of the type is still in the Yale Museum (see p. 146, fig. 6, and pl. xxvii, fig. 5).

Gregory also makes the same disposition of *M. Sancti-Johannis* and *A. frondosa* Duch. and Mich. But Vaughan refers the former doubtfully to *agaricites* (types not seen). He does not mention *frondosa* D. and M. ; Quelch thought it distinct. (See p. 149.)

Mr. Gregory also studied the types of some of the species of Duch. and Mich., at Turin, but unfortunately he does not state which particular species he examined,* so that one cannot tell whose opinion has most value, as in the cases cited above, when he and Mr. Vaughan disagree.

Agaricia crassa Ver., sp. nov. "Pineapple Coral."

Plate XXX. Figure 6. Plate XXXIV. Figure 2.

Coral massive, very heavy, forming compact, spheroidal or hemispherical masses, up to 150^{mm} in diameter and 100^{mm} thick, covered with areolated and reticulated collines.

Calicles deep, rather crowded, 2–3^{mm} in diameter, with about 30–36 rather thin, finely serrulate, scarcely exsert septa ; the 12 larger ones vary but little in thickness and alternate with narrower and slightly thinner ones. Many calieles are isolated or in short rows of two to six. The collines, which are variable in height, form curiously and intricately reticulated patterns, consisting of angular or rounded areas, bounded by high, acute collines, each enclosing numerous smaller, sunken areas of various sizes and shapes, bounded by lower, irregularly reticulated collines. Exotheca and walls, in sections, nearly solid; endotheca cellular, with numerous transverse disscpiments ; columella solid.

Bahamas (coll. R. P. Whitfield), six or seven specimens, all much alike ; Amer. Mus., No. 514; and Yale Museum, No. 6617.

* Mr. Gregory states also (op. cit., p. 256) that he examined the collection in the Yale Museum. Unfortunately his visit to New Haven was made in vacation, when I was not in town. Apparently he overlooked various type of Dana which were in the cases that were opened for him. His examinations were very brief. See p. 114.

Agaricia agaricites (L.) E. and Haime.

Madrepora agaricites (*pars*) Linné, Syst. Nat., ed. x, p. 795, 1758; ed. xii, p. 1274, 1767. Pallas (*pars*) Elench. Zoöph., p. 287, 1766. Ellis and Sol., Zoöph., p. 159, pl. lxiii, 1786. Esper, Pflanz., i, p. 132, 1789.

Undaria agaricites Oken, Lehrb. Nat., p. 69, 1815.

Pavonia agaricites Lam., Hist. Anim. s. Vert., ii, p. 239, 1816.

Agaricia (*Mycedia*) *agaricites* Dana, Zoöph., p. 342, 1846.

Agaricia agaricites Edw. and Haime, Ann. Sci. Nat., xv, p. 127, 1851; Hist. Corall., iii, p. 81, 1860. Pourtales, Deep Sea Corals, p. 82, 1871; Florida Reefs, pl. xi, figs. 11–13, pl. xii, figs. 1–3, 1880.

Agaricia agaricites (*pars*) Gregory, op. cit., p. 279, 1895 (synonymy). Vaughan, op. cit., p. 64, 1901.

Agaricia (*Mycedia*) *gibbosa* Dana, Zoöph., p. 341, 1846 (var. from type).

Agaricia (*Mycedia*) *cristata* Dana, Zoöph., p. 343, 1846 (large celled var., from type), and var. *tenuifolia*.

Agaricia Danai Edw. and Haime, Corall., iii, p. 84, 1860=*cristata* Dana, *non* Lam. (*non Mycedium Danai* Duch. and Mich., 1860). Large celled variety.

Mycedium Danai Duch. and Mich., Corall. Antill., p. 81, 1860 (t. Vaughan, from type,) *non* Edw. and Haime. Lamellate variety.

Mycedium Lessoni and *M. vesparium* Duch. and Mich., op. cit., p. 81, 1860, (t. Vaughan, from types). Reticulated, encrusting varieties.

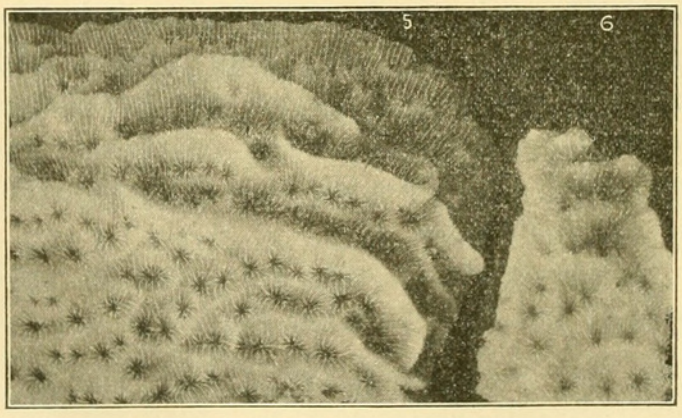
? Mycedium Sancti-Johannis Duch. and Mich., op. cit., Supl., p. 187, 1866, (t. Vaughan, but not from types).

? Agaricia frondosa Quelch, op. cit., p. 118, 1886. (*? non* D. and Mich.).

PLATE XXVI. FIGURES 2, 3. PLATE XXVII. FIGURES 1–3, 5–7.

This species varies greatly in mode of growth and form, and also in the size of the calicles and their arrangement, and in the character and size of the collines, which are nearly abortive in some cases.

5 6 7



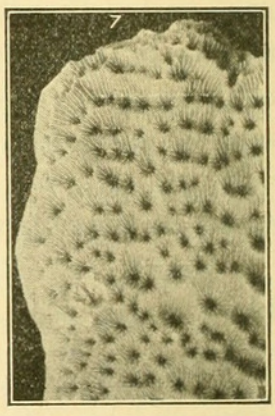


Figure 5.—*Agaricia agaricites*, var. *Danæ*. Part of a frond of a well-grown Bahamas specimen, natural size. Fig. 6.—The same. Part of the original type of Dana, natural size. Fig. 7.—*Agaricia agaricites*, var. *agaricites*. Part of a frond of a large, loculate, West Indian specimen, natural size.

Therefore it is natural that there should have been much confusion as to the limits of the species. It is even quite possible that two or more species are included in the above synonymy. Several of the forms referred to differ so much that no one would unite them did not intermediate specimens occur.

Hence it seems best to treat the following forms as varieties :

Variety *a.—agaricites.* Typical. Fig. 7.

PLATE XXVI. FIGURE 2. PLATE XXVII. FIGURES 7, 7*a*.

This usually has the base largely encrusting or attached, at first, but when larger it has more or less erect, crest-like, rounded or irregular, bifacial fronds, rising from the upper surface. Sometimes, in very large examples, these unite and form loculi. The edges of the basal part may be more or less free and unifacial, with the underside finely costulate. Calicles of medium size, when full grown mostly 2 to 3^{mm} in diameter, but variable on a single specimen. Septa usually 24 to 36, narrow, crowded, and subequal. Collines usually numerous, more or less developed, mostly transverse, or parallel with the edges of the fronds and crests, and mostly with angular or acute summits, but often reticulate. The valleys are angular, rather deep and narrow ; calicles plainly stellate, mostly in series, but often isolated or in pairs, and then usually pentagonal. Septo-costæ are small, numerous, closely crowded, finely and closely granulated, not conspicuously unequal, with very narrow spaces between them. Pourtalès (Florida Reefs, Corals, pl. xii, figs. 1, 2) gives excellent figures of this form.

It is common from Florida southwards. I have seen several specimens over a foot across, with frondose loculi, and folia over six inches high. A large and typical specimen of this variety 12 to 14 inches across and 8 to 10 high, from near Nassau, N. P. (coll. Whitfield), is in the Amer. Museum, New York. (Fig. 7, p. 146, No. 5671.)

Var. *b.—Danæ* E. and H. (*non* D. and M.);=*A. cristata* Dana. Figs. 5, 6.

PLATE XXVI. FIGURE 3. PLATE XXVII. FIGURES 5, 6.

This grows nearly like the preceding, but the coral is thicker and more massive, and the fronds are often very large and thick, usually rounded, with the edges bifacial and acute. The collines are usually strong and acute, often rising into sharp crests, but where the calicles are crowded on the basal parts, the collines may be nearly abor-

tive and some of the calicles may be in pairs or isolated, polygonal, and astreiform, separated only by angular walls. The principal distinction is in the much larger size of the calicles, which, when full grown, are usually 3.5 to 4^{mm} in diameter, and in the smaller number and marked inequality of the septa, the primary and secondary ones being thickened and so wide that they leave only a small central pit, while the smaller septa are much narrower and thinner, and are lacking in part of the systems. The columella is usually solid. Septo-costæ are strong, thin, conspicuously alternately unequal, not crowded, finely granulated. No. 4301, type of Dana.

Florida Reefs, etc.; Yale Museum. Large frondose specimens, 12–15 inches broad and about 10 high, from the Bahamas (coll. Whitfield) are in the Amer. Mus., New York. Single fronds may be 225^{mm} wide; 200 high; 44 thick. No. 275.

Var. *c.—gibbosa* (Dana)=*? vesparium* D. and M.

Plate XXVII. Figures 1, 1*a*.

This forms irregular, encrusting, nodular or lobulated masses, without distinct crests. The common base, in the type, is free, striated, and unifacial for some distance, and the edge is thin. The collines are low, mostly reticulated, or very irregular, and often lacking. The calicles are in short irregular series, or isolated, and angular or astreiform. They are nearly as large as in var. *Danæ*. (See pl. xxvii, fig. 1, from type.) No. 1860.

Var. *d.—pusilla* V.=*? M. Lessoni* (D. and M.).

Plate XXVII. Figure 3.

This form is almost entirely encrusting, often with the collines abortive, or nearly so, but when present they are small and near together, concentric or reticulated, rounded or obtuse. The calicles are generally irregularly arranged or in short series, crowded, and many are isolated; they are unusually small (mostly about 1 to 1.5^{mm}, rarely 2^{mm}) but otherwise they resemble those of typical *agaricites*. The septa are about 20 to 24, alternately unequal, rather thick, crowded. The small size of the calicles is the most important character. (Pl. xxvii, fig. 3.) No. 1489.

Var. *e.—tenuifolia* Dana (under *A. cristata*). Forms thin, foliaceous fronds; calicles small, 1.5^{mm} across, stellate, scattered, scarcely seriate, collines low, rounded. Similar to var. *d*, but foliaceous.

The relations of *Lamarcki*, which Vaughan refers here, have been discussed under *fragilis* (p. 144). If it really belongs to *agaricites*,

which I doubt, it should receive the variety name *Lamarcki* (E. and H.) on account of its thin, pedicelled fronds and small calicles.

A. frondosa (Duch. and Mich.) Quelch, is also a doubtful form, which Quelch thinks distinct. According to Quelch it forms solid crests ; the collines are irregularly arranged, close, and not acute. The calicles have about 30 septa, seldom more. This seems to me to be near *Danai* of Edw. and H.=*cristata* Dana (our var. *b*), but it may not be the same as the type of D. and Mich.

This common species and its varieties are found on the Florida reefs and throughout the West Indies to South America and Colon. From Colon I have received varieties *a*, *b*, *d*. They were all found in shallow water, under similar conditions. None of these forms have been found at Bermuda. A small form, near var. *d*, is found at the Abrolhos Reefs, Brazil, and a small, more nearly typical specimen near var. *a*, from Pernambuco, is in the Yale Museum.

Agaricia purpurea (Les.) Dana.

Agaricia purpurea Les., Mem. Mus. Hist. Nat. Paris, vi, p. 276, pl. xv, fig, 3, *a*, *b*, *c*, 1820. Dana, Zoöph., p. 340, 1846 (unifacial variety).

? *Mycedium Danai* Duch. and Mich., Corall. Antill., p. [81], 1860 (*non* Edw. and Haime).

Plate XXVII. Figures 4, 4*a*, 4*b*.

This species usually forms broad, thick unifacial fronds, generally attached near the middle or else partly encrusting. The fronds may be flat or cup-shaped. The collines are usually narrow, acute, short, and often irregular or reticulated. The calicles are large and open, deep, angular, often isolated, and deeply sunken between the sharp walls or collines. They are oblique and often so deep and curved that the wide bottom cannot be seen. The septa are thin and narrow, leaving a wide, open, central space, and wide spaces between them ; there are usually 24 to 36, alternately very unequal. (Pl. xxvii, fig. 4.)

In sections a small, solid, papilliform columella is present in some calicles, and there are well formed tabular dissepiments in the thicker parts, which extend quite across the calicles. The common wall is very solid, but it has some radial, angular cavities in the thick basal portion near the pedicel. The costæ of the under side are slender, pretty even, and regular.

This differs so much from the several varieties of *agaricites*, described above, that it seems probable that it is distinct. It is remarkable for the large and very deep, open, angular calicles, separated by rather thin, acute walls, and for the tabulate dissepiments.

The figured specimens are from Colon (Yale Mus.). They differ somewhat from Lesueur's type, in the size and depth of the calicles. This form may be distinguished as var. *faveolata* Ver. It was attached by a stout pedicel. No. 1201.

Agaricia nobilis Ver., sp. nov.

? Mycedium elephantotus Edw. and Haime, Hist. Corall., iii, p. 74, 1860. (Syn. excl., *non* Pallas sp.).

PLATE XXVIII. FIGURES 1, 2.

Coral grows in the form of broad, rounded, thin, foliaceous fronds, attached by a central pedicel. The frond may be flat, or concave, or variously bent and lobed, but when young and normal it is round and cup-shaped or salver-shaped. It is very hard and translucent, so that though very thin, especially towards the margins, it is stronger than most thin corals. The under side is finely and nearly evenly covered by fine costal riblets and striæ; these costæ are finely granulated on their edges.

The upper side is loosely covered with rather large, deep, prominent, appressed, stellate calicles. These are irregularly arranged; many stand singly; but most are in pairs, or series of three to six or more, in front of short, rather prominent, curved, obtuse-angled collines, having the longer proximal slopes concave and often lobulated, with swellings corresponding to each calicle. The short collines, when supporting one to three calicles, are crescent-shaped in outline, and look like curved brackets.

The calicles are inclined strongly outward, except those near the center; the central pit is rather large and deep, usually without a columella, but some of the calicles may have a small, solid, tuberculiform one.

The septa are alternately larger and smaller; usually there are 36 to 48 in the larger calicles, of which 16 to 24 are much the larger and thicker. The summits are prominent and angular; the inner edges of the outer septa descend abruptly, while those of the outer side are angulated at the top and concave above, and usually below, the angle. The edges of the septa are very finely serrulate or granulate.

The septo-costæ are of variable length, but usually rather long, especially towards the margin; their lengths are from 5 to 12^{mm} or more, but mostly about 10^{mm}. They are regularly alternately larger and smaller, the larger ones being distinctly thickened, while the smaller ones are thin and much lower. Their edges are very evenly, microscopically serrulate or granulate.

Breadth of the type, which is a single frond, 400^{mm} by 150^{mm}; thickness 5^{mm} to 0.5^{mm} or less; at 25^{mm} from the edge, about 1^{mm} thick; diameter of larger calicles, mostly 4 to 6^{mm}.

The type is from Turk's Island, W. I. (Mus. Yale University). It is a rare species in American collections. No. 850.

This is, perhaps, one of the species that have been confounded under the name of *elephantotus* Pallas, a very different East Indian species, and the type of *Mycedium* (see p. 134 above). The present species is destitute of the rough serrations and spinules of that species and differs in many ways, though it grows in a similar form. This may, however, be the *elephantotus* Edw. and Haime; but their synonymy does not apply to it.

Whether this is the form united to *A. fragilis* by Gregory under the name of *elephantotus* I do not know. Neither can I tell whether it be the *elephantotus* of Pourtalès, or of Vaughan (op. cit., p. 67), for they give no descriptions. But it is not the *elephantotus* of Oken, nor of Ehrenberg, nor of Dana, nor of Esper.

It is quite distinct from *A. fragilis*, though it grows in similar shaped, thin fronds. But the fronds of this species are much larger, thicker, and firmer. The calicles are much larger, more appressed, more prominent proximally, and much deeper. The collines are much shorter, larger, higher, and much more irregular. The septa and septo-costæ are also quite different.

Siderastræa siderea (E. and Sol.) Blainv.

Madrepora siderea Ellis and Sol., op. cit., p. 168, pl. xlix, fig. 2, 1786.

Astrea siderea Lam., Hist., ii, p. 267, 1816. Lesueur, op cit., p. 286, pl. xvi, fig. 14, 1820. Lamx., op. cit., p. 60, pl. xlix, fig. 2, 1824. Edw. and Haime, Hist. Corall., ii, p. 509, 1857. Gregory (*pars*), op. cit., p. 278, 1895.

Siderastræa siderea Blainv., op. cit., p. 335, 1830; Man. Actin., p. 370, 1834. Edw. and Haime, Monog., p. 141, 1849. Verrill, Bull. Mus. Comp. Zoöl., i, p. 55, 1864. Pourtalès, Reef Corals, p. 81, 1871. Vaughan, op. cit., p. 62, 1901. Verrill (*pars*), these Trans., x, p. 554, 1900.

Pavonia siderea Dana, Zoöph., p. 331, 1846.

Siderastræa grandis Duncan, op. cit., p. 441, pl. xvi, figs. 5*a*, 6, 1863, fossil, (t. Vaughan).

Plate XXX. Figures 2, 3.

This coral forms large, compact, hemispherical masses up to 2 feet or more in diameter.

The calicles are usually deep, narrow at the bottom, and larger than in either of the other American species (usually 5–6^{mm} in greater diameter when full grown). They are angular, mostly pentagonal

or hexagonal, usually with a definite, raised, acute or subacute bounding wall between them, which may show as a thin zigzag line between the ends of the septa. Usually 3 or 4 rows of synapticulæ show on each side of the wall, between the septa, with conspicuous loculi between them.

The septa are in five cycles, the last cycle being incomplete. There are usually, in well formed calicles, 50 to 64 septa ; the average number being about 58. But specimens often occur in which the number seldom exceeds 48 or 50.

The septa are finely serrulate and pretty even in height, though those of the different cycles can easily be distinguished by the gradations in breadth and thickness. Those of the last cycle are thin and often bend toward and join those of the preceding cycle. The columella is small, at the bottom of a small central pit. It usually consists of about 3 to 6 unequal papillæ.

It is very common on the Florida keys and reefs and throughout the West Indies. Also at Colon, Col. (variety *nitida*) ; and at the Bermudas (variety ?). It is hardy and can live in muddy situations, and where exposed at low tide, like *S. radians*, though it seems more partial to the reefs.

The Bermudian specimens that have been referred to this species, so far as I have observed them, are not of the typical form, and may be an extreme variety of *S. radians*. The calicles are not so large nor so deep as in the Florida form, nor are the septa so numerous, (about 42–48).

Var. *nitida* V., nov. Plate xxx. Figure 3.

The Colon specimens (Yale Mus.) are convex, encrusting plates. Their calicles are not quite so large as in the typical forms, and are much more shallow, while the bounding walls are less distinct, lower, and more rounded, so that the calicles seem less angular and more blended. The septa are numerous (about 50), crowded, and rather equal, giving the calicles a neat and even appearance. No. 1028.

When well grown this species seems quite distinct from *S. radians*. It has decidedly larger, deeper, and more angular calicles, which have more elevated and distinct walls. Usually there are about 5, sometimes 6, calicles to 2 centimeters, when in rows. The septa are more numerous (usually 50 to 60) and more equal in elevation.

But impoverished specimens occur, which are not always easy to distinguish from some of the varieties of *S. radians*.

For the reasons for retaining *Siderastræa* as the name of this genus, see above, pp. 88, 89.

Siderastræa radians (Pallas) Ver.

Madrepora radians Pallas, Elench. Zoöph., p. 322, 1766.

Madrepora galaxea Ellis and Sol., Zoöph., p. 168, pl. xlvii, fig. 7, 1786.

Astrea galaxea Lam., Syst., p. 371, 1801; Hist., ii, p. 267, 1816. Lesueur, op. cit., p. 285, pl. xvi, fig. 3, 1820. Lamx., op. cit., p. 60, pl. xlvii, fig. 7, 1821.

Astrea radians Oken, Lehr. Nat., p. 65, 1815.

Astrea (*Siderastrea*) *galaxea* Blainv., Dict. Sci. Nat., lx, p. 335, 1830; Man. Actin., p. 370, 1834.

Astræa radians Edw. and Haime, Hist. Corall., ii, p. 506, 1857. Gregory, op. cit., p. 277, 1895.

Siderina galaxea (*pars*) Dana, Zoöph., p. 218, pl. x, figs. 12, 12*b*, 12*c*. (Type examined.)

Siderastræa galaxea Edw. and Haime, Ann. Sci. Nat., xii, p. 139, 1850. Pourtalès, Reef Corals, p. 81, 1871; Florida Reefs, pl. xi, figs. 14–21, young, pl. xv, figs. 1–12, 1880. Quelch, op. cit., p. 113, 1886.

Siderastræa radians Verrill, Bull. Mus. Comp. Zoöl., i, p. 55, 1864; Coral Reefs and Islands, p. 380; ed. 3, p. 421. Vaughan, op. cit., p. 61, 1901.

Plate XXX. Figure 1.

This coral usually forms rounded spheroidal or hemispherical masses, which may become 12 to 15 inches (400 to 500^{mm}) in diameter; but it is often encrusting, especially when young, and it often grows in broad irregular masses; not infrequently it is almost globular and lies loose on the bottom, with calicles developed on all sides. Such loose masses are most commonly 2 to 5 inches (50–125^{mm}) in diameter. They were doubtless all attached when very young, but perhaps only to small bits of shell, etc.

The calicles are deep in the center and small, their diameter when full grown is mostly 2.5 to 3.5^{mm}, the average size being about 3^{mm}, rarely 4^{mm}. They are angular with rounded corners, and usually appear as if separated by thick walls, owing to the low rounded summits of the walls, which are, however, actually rather thin, with one or two rows of small synapticulæ showing on each side.

The septa are decidedly unequal in width and thickness, those of the first two cycles standing out very plainly from the others. They form three complete cycles, with part of the fourth cycle developed, so that the number is usually 36 to 40, in the larger calicles, (rarely 48). But the size of the calicles and the number of septa vary considerably on a single specimen, according to the amount of crowding, or the rapidity of growth.

The septa are closely arranged, with very narrow loculi. The larger ones are wide, broadly rounded, somewhat exsert, with all the edge pretty evenly serrulate, though the distal serrations are apt to be rather larger. The six primaries are distinctly larger than the

secondaries, and those of each cycle are successively narrower and thinner ; all are nearly straight and seldom united. The proximal half of the inner edge is nearly perpendicular, thus producing a deep central pit. The columella is small and papillose.

The polyps are but slightly exsert ; the tentacles are small, short, cylindrical, or clavate ; they form several circles, and appear somewhat scattered, those of successive cycles being in different circles and decreasing in size.

But they are not bilobed, nor trilobed, as Agassiz and Pourtalès supposed.* This appearance is due to a smaller one standing on one or both sides of a larger one, and close to it.

The general color in life is dull gray, yellowish gray, ocher-yellow, or rusty brown, sometimes tinged with a purplish rosy tint ; the polyps are paler, with the lips and tips of the tentacles whitish.

This species, which is abundant at the Bermudas, is more hardy than most reef corals, for it can live and grow well in shallow water on mud flats, where it is laid bare by nearly every tide, and where most other corals would be smothered in the mud, though *S. siderea* and some forms of *Isophyllia fragilis* are usually found with it in such places.

It is often partly buried in the white calcareous mud of the flats, and yet seems healthy there. It is also abundant in the small, shallow pools left on the flats by the tide. But it is equally common on the reefs, where it often grows larger. It is also found well grown in Harrington Sound.

Exposure to the dry air, or even to the hot sun, for an hour or so, does not kill it, if it be wet beneath. Probably its porosity enables it to absorb sufficient water to prevent drying up.

It is equally common on the Florida reefs and flats, and throughout the West Indies to South America and Colon.

The decidedly smaller size of the calicles, fewer septa, and the conspicuously larger primary and secondary septa serve to distinguish this species from *S. siderea.*

But it varies considerably in all these characters, so that some specimens may occur that seem almost intermediate between the two species. In all such cases the *average condition* of the full grown calicles must be considered as of primary importance.

* The observations of Prof. L. Agassiz on the polyps of this genus, in 1850, and his figures in "Florida Reefs," pl. xv, figs. 1–7, relate to *S. radians.* In my note on this subject (these Trans., x, p. 554, 1900), I referred to it under *S. siderea.* But my studies of the polyps included both species. They are very similar, but *S. siderea* has larger polyps and more tentacles.

New buds appear chiefly between the angles of the calicles. Fission of the larger calicles occurs occasionally.

Siderastræa stellata Ver.

These Trans., i, p. 352, 1868. Rathbun, R., Amer. Naturalist, xiii, p. 541, 1879, (habits). Vaughan, op. cit., p. 62, 1901.

PLATE XXX. FIGURES 4, 5.

This species is related to *S. radians* and has the same ability to endure impure shallow waters and exposure to the air and sunshine, without injury.

It is widely distributed on the coast of Brazil ; Bahia, Abrolhos Reefs, etc.,—coll. C. F. Hartt ; R. Rathbun.

I have figured one of the types, from a photograph. No. 1464.

Var. **conferta** Ver., op. cit., p. 353.

PLATE XXX. FIGURE 5.

This peculiar Brazilian form has not yet been figured. Therefore I have reproduced a photographic figure of one of the types,—the extreme form. No. 1464*a*.

Asteroseris Verrill.

This genus seems to be related to *Plesioseris* Duncan.*

Dana described in 1846 a rare, thin, laminar or foliaceous coral (*Agaricia planulata*) that is the type of this genus.

I have studied a fragment of the original type, which is here figured (pl. xxvii, fig. 8). No. 4309.

The genus is remarkable for the low, reticulated collines, enclosing polygonal areas in which there are usually two or several stellate calicles. Each of these groups consists of a parent calicle from which the others around it have been produced as buds from it. These calicles of a group are not at first separated by definite boundaries, the costæ being continuous from one to another. Columella is a minute tubercle, or is lacking. Under side naked, finely striated. Calicinal walls solid. Synapticula and trabeculæ few or lacking.

The type of that genus (*Mændroseris Australiæ* Rouss., from Australia) is a convex, gibbous, encrusting coral. But as both encrusting, massive, and foliaceous species occur in allied genera (*Pavonia*, *Agaricia*, etc.), it is possible that they might also occur

* *Mœandroseris* (*pars*) Rousseau, Voy. Dumont d'Urville, Zoöl., v, p. 121, 1854. Edw. and Haime, Hist. Corall., iii, p. 61, 1860. *Plesioseris* Duncan, Jour. Linn. Soc., Zoöl., xvii, p. 309, 1883 ; Revision Scler. Zoanth., op. cit., xviii, p. 161, 1884.

in this. But the type of *Plesioseris* has distinct synapticula and a well developed papillary columella, which are not found in our genus.

The resemblance to the fossil genus *Oroseris** is very close, in the form and mode of grouping of the calicles, and in the low, irregular collines, as well as in the foliaceous form of the coral. But *Oroseris*, according to Duncan, does not have solid mural and colline walls, these parts, as seen in sections, being trabecular. Were it not for this character, I should have considered this coral a living species of *Oroseris* or *Comoseris*, which it certainly closely resembles.

The grouped arrangement of the calicles is somewhat like that of *Polyastra venosa* Ehr.,† p. 106, 1874, but the latter seems to form a massive, astreiform coral. It is, however, only imperfectly known, the description being very incomplete and without a figure.

The form, general appearance, and the characters of the septo-costæ are somewhat like those of *Pachyseris*, but the latter does not have stellate calicles and its collines are much larger and more regular.

Asteroseris planulata (Dana) Ver.

Agaricia (*Mycedia*) *planulata* Dana, Zoöph., p. 338, 1846.
Agaricia? planulata Edw. and Haime, Hist. Corall., iii, p. 84, 1860.
Asteroseris planulata Verrill, in Dana, Coral Islands, ed. i, p. 383, 1872; ed. 3, p. 424, 1890.

Plate XXVII. Figure 8.

The type specimen was a broad, thin frond, half a line thick, attached only at one point. Dana states that it was in the Museum of the Lyceum of Natural History, Utica, N. Y.

A fragment of this specimen, used by him for figuring the details, and now preserved in the Yale Museum, affords the following description :—

The calicles are polygonal and very shallow or superficial, being only slightly concave, except at the minute central pit, which is deep ; they are about 4 to 4.5^{mm} broad when full grown, but many are only 2 to 2.5^{mm}. They are often placed singly, with a slightly raised solid wall over which the septa are confluent and in part

* *Oroseris* Edw. and Haime, Pol. Foss. Palæoz., p. 130, 1851 ; Hist. Corall., ii, p. 78, 1860.

† This genus is probably identical with *Tichoseris* Quelch, (Ann. and Mag. Nat. Hist., xiii, p. 295, 1884). The type of the latter is an astreiform coral from the Fiji Islands.

geniculate; many are in pairs, either equal or unequal, due to immediate budding; others form small groups of three to five, evidently resulting from budding from the larger one of the group. Such groups are surrounded by low, solid, reticulating collines, only a little larger than the walls around isolated calicles, and arranged without order. Rarely the calicles are in short rows of three or more.

The septa are numerous (24 to 36), very close, thickened, especially toward the inner ends, and closely, finely granulated or crispate on the sides, as in *Pachyseris;* their exposed, nearly horizontal edges are minutely and roughly serrulate or granulate, but the inner ends of the larger ones descend nearly perpendicularly at the minute central pit, and this portion, as seen in section, is rather regularly and finely serrulate. The septa are very unequal and form four pretty regular cycles, sometimes with some of a fifth cycle. The primary and secondary ones are decidedly larger and thicker than the others and most of them reach the central pit, but the secondaries are a little the shorter and thinner; those of the third and fourth cycles are successively shorter; the smallest are very short and extend inward only a short distance in some of the systems, but are often quite long and curved in the lateral systems. All the septa rise to about the same level. The columella, when present, is a minute solid tubercle, or sometimes two.

The under side is naked, with small concentric undulations, and also with shallow radial valleys, between which the surface is slightly convex; these convex parts are covered with fine, divergent radial striæ, which run obliquely to the valleys on either side in a fan-like manner.

These costal striæ are only slightly raised, closely crowded, and distinctly granulated. In vertical sections the coral is nearly solid, except close to the upper surface. The interseptal spaces fill up very quickly with a solid deposit and the interseptal walls are thick and solid.

The original type, according to Dana, was a thin frond ten inches broad and one-eighth of an inch thick. Thickness of the fragment, described above, 3 to 5^{mm}. The habitat is unknown, but it is probably Indo-Pacific.

The *Merulina ampliata* (E. and Sol.) Ehr. was included in the West Indian fauna by Duch. and Mich. (op. cit., p. 80, 1860), but not as from personal observation. It is found only in the Indo-Pacific region, like all the other species of the genus.

Family **Poritidæ** Dana, 1846.

Poritinæ (subfamily) Edw. and Haime, Corall., iii, p. 173, 1860.
Poritidæ Verrill, these Trans., i, p. 503, 1867.

Corals very porous, branched, encrusting, lobulate, or massive, increasing chiefly by budding. Calicles mostly small, shallow, stellate, circular, or angular, usually all of one kind, closely united, or not separated by much cœnenchyma, sometimes without evident walls. Septa more or less perforated, or fenestrate, often imperfect, mostly 12 to 24. Pali often present. Dissepiments few, sometimes tabulate. The calicles are generally all equal, but in some species of *Porites* a few larger ones, with more than 12 septa, appear irregularly and may divide by fission. The branches do not have a large leading or axial zoöid. Polyps much exsert in expansion. Tentacles 12–24, rarely more.

Porites polymorpha Link.

Madrepora porites (*pars*) Pallas, Elench. Zoöph., p. 324, 1766. Linné, ed. xii, p. 1279, 1767. Ellis and Sol., p. 172, pl. xlvii, figs. 1, 2, 1786.
Porites polymorphus Link, Besch. Nat. Samml., Rostock, p. 162, 1807.
Porites clavaria Lam., Hist. Anim. sans Vert., ii, p. 270, 1816. Dana, Zoöph., p. 554, 1846. Edw. and Haime, Corall., iii, p. 174, 1860. Pourtalès, Florida Reefs, pl. xii, figs. 4–6, 1880. Rathbun, Proc. U. S. Nat. Mus., x, pp. 356–361, pl. xvi, pl. xvii, fig. 2, pl. xix, fig. 1, 1887. Gregory (*pars*), op. cit., p. 282, 1895.
Porites porites Vaughan, op. cit., p. 73, 1901.

Plate XXXI. Figures 3, 3*a*.

The above synonymy includes only the leading references to the more typical form generally called *P. clavaria* Lam. Mr. Gregory has given a very full list of references to this and the other branched forms of West Indian *Porites*, all of which he masses together under the name of *P. clavaria*. Mr. Vaughan (op. cit., p. 73) also gives some additional synonyms and localities.* No doubt too many "species" have been named, but I very much doubt whether they should all be united into one species. However, I do not propose to discuss that question at this time.

* Mr. Vaughan states that he has examined the type of *P. nodifera* Klunz., and found it identical with *P. clavaria*. He thinks, like Rehberg, that the locality "Red Sea" is due to a wrong label. He also unites *P. valida* Duch. and Mich. with this species.

But, as having an important bearing on the subject, I will state that while *clavaria* (auth.), growing in irregular, stout-branched clumps, is abundant at the Bermudas, in a variety of stations, both in shallow water and on the reefs, and also in Harrington Sound, *P. furcata* has never been found there by me, nor by others so far as I can learn. This would certainly indicate that the latter is a distinct species, with a different physiological nature, or with a different embryology. It either requires warmer water, or else its free-swimming larvæ are too short-lived to reach the Bermudas in the northward currents. Were the two forms the same species, differing merely in form of growth, due to environment, they should both be found at the Bermudas, for the conditions are varied there.

Mr. Richard Rathbun (op. cit., 1887) has very fully described and figured most of the various varieties of these two species.

As for the name of this species, I cannot follow Vaughan in adopting *Porites porites* for it, for such a course would be contrary to the ordinary principles of elimination, which he, himself, employs in similar cases.

It is true that Pallas and all writers previous to Link (1807) included nearly all the species of *Porites* then known under the name *Madrepora porites*, which was a collective or generic group. Esper eliminated one species as *M. conglomerata*, and another as *M. arenosa*. Link eliminated another, the present form, by naming it *polymorphus*. Therefore, the specific name *porites*, if used at all, should be applied to one of the remaining species of those mentioned by Pallas, as varieties.*

---

* Pallas mentions *first* in his description (p. 324) a massive, gibbous species "massæ, gibbæ, tuberosæ, tunicatæ," and on p. 325, "Notæ," he speaks first of "massas informes, gibbas," "ex India," with stars subequal to those of *Mad. astroites* = *Orbicella annularis*.

This East Indian, gibbous, massive species, with large stars, was, without much doubt, a *Rhodarœa*, probably *R. calicularis* (Lam.) E. and H., but possibly the Chinese and East Indian form named *R. Lagreneii* E. and H. (diameter of calicles 4^{mm}), which may not be distinct from the former.

Therefore, it seems to me best to restrict *porites*, as a species, to the former and call it *Rhodarœa porites*, thus avoiding the repetition of *porites* and conforming with the principle of recognizing prior eliminations at one and the same time. None of the species of true *Porites* have the "stars" much more than 1.5^{mm} in diameter, rarely 2^{mm}.

Porites astreoides Lam.

Madrepora porites (*pars*) Pallas, Elench. Zoöph., p. 324, 1766.

Porites astreoides Lam., Hist. Anim. sans Vert., ed. 1, ii, p. 269, 1816; ed. 2, ii, p. 435, 1836. Lamx., Expos. Meth., p. 651, 1824, (*non* Ehr., 1834).

Porites astroides Lesueur, Mem. Mus. Hist. Nat., Paris, vi, p. 287, pl. xvi, fig. 15, 1820. Edw. and Haime, Hist. Corall., iii, p. 178, 1860.

Porites astræoides Dana, Zoöph. U. S. Expl. Exp., p. 561, 1846. Verrill, Bull. Mus. Comp. Zoöl., i, p. 42, 1864. Pourtalès, Reef Corals, Mem. Mus. Comp. Zoöl., ii, p. 85, 1871; Florida Reefs, pl. xvi, figs. 1–12, 1880. Quelch, Voy. Chall., xvi, pp. 11, 13, 182, 1886. Rathbun, Catal., Proc. U. S. Nat. Mus., x, p. 354, 1887. Gregory, op. cit., p. 284, 1895, (synonymy).

Porites superficialis, *P. incerta*, *P. Guadalupensis*, and *P. agaricus* Duch. and Mich., Corall. Antilles, pp. [82, 83] 358, 359, 1860 (t. Vaughan from types).

Neoporites littoralis, *N. superficialis*, *N. Guadalupensis*, *N. agaricus*, *N. incerta* Duch. and Mich., Supl. Corall. Ant., pp. 191–193 [97–99], 1866 (t. Vaughan from types).

Neoporites Michelini, *N. astræoides*, *N. subtilis*, and *Cosmoporites lævigata* Duch. and Mich., op. cit., pp. 192, 193 [98, 99], pl. x, figs. 7–10, 12, 16, 1866 (t. Vaughan, but types not examined).

Porites Collegniana Duncan, Quart. Jour. Geol. Soc. London, xix, p. 437, 1863; xxiv, p. 25, 1868 (t. Vaughan from types, fossil).

Porites astreoides (*pars*) Vaughan, op. cit., pp. 74–77, 1901.

Plate XXXI. Figure 4.

This coral is encrusting when young, but it soon forms thick rounded masses, with more or less raised lumps or low nodules over the surface, but it never becomes branched. It may form masses 2 feet or more in diameter.

When living its color is usually lighter or darker yellowish brown, or dull brownish yellow; sometimes it is yellowish gray, or even bluish gray.

The calicles are larger, deeper, and more distinct than in *P. clavaria*, and their walls are higher, thicker and more distinct at the surface. The 12 septa are also more distinct and less porous. The columella is rather small and porous, often with a small, central, irregular papilla, which may be lacking and is easily broken. The interseptal loculi are rather large and deep for this group. Small paliform papillæ are sometimes present, but more often are absent or rudimentary. The inner tooth or lobe of the septæ is often very distinct, erect, and paliform. The upper part of the wall is thin and divided into small, rough, flat denticles at the edge, higher than the septa, but it becomes thicker and rather solid a little farther down.

Well-formed calicles are from 1.25 to 1.50^{mm} in diameter; when in series there may be about 6 to a centimeter.

It is abundant both in shallow water and on the reefs at the Bermudas. It also occurs even in Harrington Sound. It is still more abundant on the Florida Reefs and throughout the West Indies to Colon, Columbia. A variety occurs at Pernambuco, Brazil. See below, Revised List of Brazilian Corals.

Quelch (op. cit., pp. 181, 182) has recorded two of the forms described by D. and Mich., as from the Cape Verde Islands. But the identity of his forms needs confirmation, by comparison of types. The descriptions and figures of D. and M. are too poor for determination.

I am not at all sure that all the forms described by Duch. and Mich., and referred to this species by Vaughan, are one species, though I have placed them among the synonyms on his authority. If his opinion be correct, then this species is more variable in the Antilles than it is at the Bermudas and Florida reefs, from whence I have examined large series.

There can be no doubt, however, that they have made too many species, by far, in this group. I have seen only two or three forms that could be recognized even as varieties, and doubt if more than two massive species are included in their list, even if all be not forms of *P. astreoides.*

But I believe that Mr. Vaughan is wrong in uniting *P. solida* Ver.=*P. Verrillii* Rehb. to this species. Possibly he has not seen the true *P. Verrillii*, for both species occur on the coast of Brazil.

Porites Verrillii Rehb.

Porites solida Verrill, these Trans., i, part 2, p. 358, 1868.* Rathbun, op. cit., p. 365, 1887, (*non* Forskal, sp., 1775=*P. solida* Klunz., p. 42.)

Porites Verrillii Rehberg, Abh. Naturw. Ver., Hamburg, xii, p. 48, 1892. Vaughan, op. cit., p. 76, 1901.

Plate XXXI. Figure 5.

Mr. Vaughan (op. cit.) considers this only a form of *P. astreoides*, but as the latter occurs with it on the coast of Brazil, he may not have studied a genuine example. I believe they are quite distinct. I have, therefore, figured a portion of the original type.

* The *Porites solida* (Forsk.) Klz., from the Red Sea, is a different, solid, massive species, of which the Yale Museum now has an authentic example. The use of the same name for the Brazilian coral was due to an oversight, on my part, in overlooking Forskal's name,—not to any intention of uniting the two species.

This coral is much heavier and more solid than *P. astreoides.* Its calicles are larger and deeper, and separated by thicker, more prominent, and more solid walls. The details of the calicles are also different, as best shown by enlarged photographic figures.

The 12 septa are well developed and wider than usual. The columella is large, nearly solid, and usually has a central tubercle. Pali are rudimentary or lacking.

That abnormal or imperfectly developed calicles of *P. astreoides* or *P. clavaria* (auth.) may resemble normal calicles of this or other species, is not sufficient proof that they are identical, as Mr. Gregory and Mr. Vaughan seem to think.

If we should use this as a crucial test, then all known species of *Porites* could be reunited into one polymorphic species, for all sorts of variations of this kind can be found in every species of the genus. The same is true of many other genera of corals, e. g. *Madrepora*= *Acropora* V., where the existence of imperfect or unusually formed calicles is a feature found in most of the 200 species.

The only reasonable way to group such corals into true species is to compare calicles that are normally and naturally developed, and those that are fully grown. Starved specimens or calicles, and those that are dwarfed or abnormal from other unfavorable conditions, are very liable to mislead, in this and many other genera, and should not be made too much of.

So the *average size* of *well-developed* calicles is generally characteristic of species, even though the *dwarf* calicles of one might not exceed the average calicles of another. The same rule will apply to all other characters, for all the characters are variable.

According to Mr. R. Rathbun, this species is common on the coast of Brazil, from Parahyba do Norte to the Abrolhos Reefs, and is abundant at Pernambuco. But perhaps part of his specimens were *P. astreoides*, variety. See p. 161. The type was from the Abrolhos Reefs,—coll. C. F. Hartt. No. 4539.

Porites Branneri Rathbun.

Porites Branneri Rath., Catal. Porites, Proc. U. S. Nat. Mus., vol. x, p. 355, pl. xix, fig. 2, 1887. Vaughan, op. cit., p. 77, 1901.

PLATE XXXI. FIGURES 6, 6*a*.

Two Brazilian specimens in the Yale Museum agree well with Mr. Rathbun's description. They are regularly and evenly rounded, very porous masses, formed by a thick encrustation over other species

of dead rounded corals (*Mæandra conferta* in one case), but they show no trace of branching.

The calicles are unusually small and shallow, nearly uniform in size, mostly closely crowded, polygonal, and separated by thin fenestrated walls. The septa are 12 narrow, thin, roughly echinolacerate and fenestrated, often a little exsert; their inner edges unite to a wide columelliform ring, leaving a circle of very small loculi; in the center of the ring-like columella there is a small pit. The pali are very slender, erect, lacerate, mostly 3 to 5, sometimes 6; frequently all are absent or broken off.

The whole surface of the coral has a delicate, lace-like appearance, owing to the uniformly small size of the calicles and the thinness and porosity of the walls.

The masses are 3 to 5 inches in diameter; breadth of the calicles 0.9 to 1.2^{mm}, mostly about 1^{mm}; when in rows there may be 9 to a centimeter.

Parahyba do Norte and Pernambuco, Brazil,—R. Rathbun. Our specimens are from Pernambuco,—coll. C. F. Hartt. No. 4552.

Mr. Vaughan suggested that this might be a young stage of *P. clavaria*. To me they seem to be perfectly distinct.

Family **Acroporidæ** Ver., nom. nov.

Madreporidæ Dana, Zoöph., p. 431, 1846.

Madreporidæ (*pars*) and *Poritidæ* (*pars*) Edw. and Haime, Corall., iii, pp. 89, 207, 1860.

Madreporidæ Verrill, these Trans., i, p. 501, 1867.

Corals very porous, usually branched or foliaceous, sometimes lobed or massive, encrusting when young, increasing by budding, rarely by fission. Cœnenchyma abundant, porous, often spinulose. Corallites cyclindrical, small, generally of two sizes, which may differ in structure. The larger ones may form the terminal or parent calicle of the branches, or occupy only the upper side of foliaceous species.

Calicles small, deep; septa usually 6 or 12; sometimes more in larger sporadic calicles; usually continuous, but perforated. Dissepiments few. Polyps much exsert in expansion; tentacles slender, tapered, generally 12, rarely more.

The genus *Acropora* is the only one in the West Indian fauna, where it has but one species. *Montipora* and *Anacropora* are wholly Indo-Pacific; the former has about 100 species.

Acropora Oken (restr.). Type, *A. muricata.*

Madrepora (*pars*) Lam., Syst. Anim., p. 371, 1801 (*non* Linné, ed. x). Lam., Hist. Anim. s. Vert., ii, p. 277, 1816. Dana, Zoöph., p. 435, 1846. Edw. and Haime, Hist. Corall., iii, p. 132, 1860 (*non* Ehr.).

Acropora (*pars*) Oken, Lehr. Naturg., p. 66, 1815 (type, 3d species=A. *muricata*).

Heteropora Ehr., Corall. Rothen Meeres, p. 333, 1834 (*non* Blainv., a Polyzoan).

Madrepora Rathbun, R., Catal. Genus Madrepora in U. S. Nat. Mus., Proc. U. S. Nat. Mus., vol. x, pp. 10–19, 1887. Klunz., Corall. Roth. Meeres, ii, p. 2, 1879.

Madrepora Brook (with ten subgenera), Cat. Mad. Brit. Mus., i, p. 22, 1893.

Isopora Vaughan, op. cit., p. 68, 1901.

On pp. 110–113 I have discussed the use of the name *Madrepora*, and its inapplicability to this great genus for which it has so long been used, if we are to follow the strict rules of priority and go back to ed. x of Linné.

The substitute-name that has the prior claim for adoption, and which seems available, is *Acropora* Oken, 1815. This originally included three generic types. The 1st is *Pocillopora damicornis;* 2d is a *Porites;* 3d is *A. muricata* (L.).

The first two having been eliminated by Link and Lamarck, *Acropora* can be restricted to the third species, which is the true West Indian *muricata.*

Vaughan used the much later and objectionable name *Isopora* Studer, 1878, originally applied to a small section of the genus in which the axial corallites are indistinct or clustered. This is so exceptional a character that the group may hereafter be separated as a genus. *Heteropora* Ehr. was preoccupied by Blainville.

The most prominent character of the genus *Acropora* is the existence of a special axial corallite, at the end of each branch, usually larger and more symmetrical than the radial corallites that bud out from its sides and cover the lateral surfaces of the branches.

The latter are various in shape, but are nearly always more or less one-sided and bilabiate ; except a few that are to become axial corallites of new branches.

On the under surfaces or on the bases of the branches, or in crowded positions, where the conditions are unfavorable, their prominent margins may be obsolete, or nearly so, or they may be wholly immersed in the cœnenchyma.

The septa are usually in two cycles, those of the second cycle being smaller, and often rudimentary or lacking. In the lateral corallites the directive septa are usually wider than the others.

Acropora muricata (Linné) Oken.

Millepora muricata (*pars*) Linné, Syst., ed. x, p. 792, 1758.

Madrepora muricata (*pars*) Pallas, Elench. Zoöph., p. 327, 1766. Linné, ed. xii, p. 1279, 1767. Esper (*pars*), Forts., i, p. 53, pl. 50, pl. 51. Lamarck, Syst., p. 371, 1801.

Acropora muricata Oken, op. cit., p. 66, 1815.

Madrepora cervicornis + *M. prolifera* + *M. palmata* + *M. flabellum* Lam., Hist. Anim. s. Vert., pp. 278, 281, 1816. Ditto, Dana, Zoöph. Expl. Exp., 1846. Edw. and Haime, Hist. Corall., iii, pp. 136, 139, 160, 1860. Dana, Coral Islands, ed. iii, pp. 99, 113, 124, 127. (Growth, etc.) Pourtalès, Deep Sea Corals, pp. 83, 84, 1871; Florida Reefs, pl. xvii, pl. xviii, pl. xix, 1880. Gregory, Ann. and Mag. N. Hist., vi, p. 20, 1900.

Madrepora subaquilis and *Madrepora perampla* Horn, Proc. Acad. Nat. Sci. Philad., 1860, p. 435, (=var. *palmata*, and *alces* auth., types examined).

Madrepora cornuta and *Madrepora Thomasiana* Duch. and Mich., op. cit., 1860, p. 82, (=var. *surculo-palmata* and *palmata*).

M. ethica D. and M., op. cit., p. 82, 1860, but not the figures, (=var. *prolifera*, young or dwarfed).

Madrepora Mexicana Rehb., op. cit., p. 38, pl. iii, fig. 16, 1892.

Madrepora muricata and varieties, Brook, Cat. Mad., i, pp. 23–30, 1893. Vaughan, op. cit., p. 69, 1901.

Madrepora palmata Whitfield, Bull. Amer. Mus., x, p. 463, pl. xxiv. (A very large and fine example.)

PLATE XXXII. FIGURE 1.

The name *muricata* should properly be restricted to this varied West Indian form, as has been done by Brook, Vaughan, and others.

That the five nominal West Indian species : *cervicornis*, *prolifera*, *alces*, *palmata*, and *flabellum*, formerly universally believed to be distinct, are really only variations of one species, must now be admitted, in view of the more careful studies of larger series made during recent years.

This view had been suggested several times, during many years, but Brook was the first modern writer to definitely unite them and consider them all varieties of *muricata*. My own experience had led me to the same conclusion some years ago, for I had seen many intermediate specimens.*

* Gregory, in Ann. and Mag. Nat. Hist., ser. 7, vol. vi, 1900, p. 20–31, dissents from this view, and objects to the use of *muricata* for any American species. The American branched forms were, however, certainly included under *muricata* by Linné, Pallas, Esper, and all other early writers, and Brook had a perfect right to restrict it to the American species. His usage must be followed, according to the ordinary rules of nomenclature.

The most remarkable specimen that I have studied is now figured (pl. xxxii, fig. 1). It is preserved in the Museum of Yale University. In most parts it is a typical specimen of variety *palmata*. But growing out of the upper side of one of its palmate fronds there is a cluster of typical branches of the variety *prolifera*. The two forms are in perfect continuity and there is no evidence of injury or other physical cause for this abrupt alteration in the character of the growth at this particular place. No. 6621.

Many specimens of var. *palmata* have the distal ends of some of the fronds divided into digitate branches of variety *prolifera*, but in such cases the change is gradual. Such subvarieties may be designated as *palmato-prolifera*, for convenience.

Var. *palmata*, when growing vigorously, often produces small, ascending, or incipient branchlets over the whole or part of its upper surface, which is then very uneven. Some of these branchlets sometimes become 75 to 100^{mm} long, and agree with *prolifera*. The large specimen from the Bahamas, in the American Museum, figured by Whitfield (op. cit.) is one of this kind. I have named this subvariety, *surculo-palmata*. *M. cornuta* D. and M. seems to have been based on a specimen of this kind.

Specimens intermediate between variety *cervicornis* and variety *prolifera* are to be found in many American collections, but I have never seen specimens clearly intermediate between *palmata* and *cervicornis*, though such probably exist. They seem to be the extremes of the variations in form.

Variety *flabellum* grows like *palmata*, but forms much thinner fronds than usual.

Many specimens occur, especially in the Bahamas, intermediate between *flabellum* and *prolifera*. In some of these there may be on one side of the same clump, broad frondlike branches of the flabelliform type, while on the other side digitate clusters of *prolifera* may occur ; or a flabelliform branch may end in free digitations ; or free branches, proximally of the *prolifera* form, may, farther out, coalesce into a flat frond, and distally may again split up into *prolifera* branchlets. The American Museum; New York, has a good series of such intermediate forms, from the Bahamas, (coll. R. P. Whitfield).

For these intermediate forms, I use the name *flabello-prolifera*.

Var. *infundibulum* Ver., var. nov.

This is similar to *palmata*, but it forms broad cup-like or funnel-shaped corals with a nearly even rim, without prominent lobes or digitations. Florida Reefs, Bahamas, etc.

Variety *alces* (auth., ? *non* Dana) = *perampla* Horn, is like *palmata*, but with longer and narrower, thick, digitate fronds.

The name, *M. alces*, was first applied by Dana to specimens said to have been collected in the East Indies by the U. S. Exploring Expedition. I believe that these specimens are still in the U. S. National Museum, where I saw them many years ago, but without careful study. A careful reëxamination of the types would be required to determine whether they be identical with the West Indian form usually called *alces*. Possibly the locality given by Dana was erroneous. But he also gives special differences in the form of the corallites, which he says are tubular and not nariform. Therefore it seems best to use *perampla* for this variety.

Var. *columnaris* Ver., var. nov.

This variety forms large, cylindrical, or long-conical, tapering columns, sometimes 6 to 10 inches in diameter at base, and 4 to 6 feet or more in height, without branches. There is a large conical specimen from Cumana in the Mus. of Comp. Zoölogy.

Varieties *palmata* and *alces* = *perampla* grow to great size. The trunk may become 12 to 18 inches in diameter, with the fronds spreading out to the breadth of 15 to 20 feet, and sometimes attaining a height of 16 to 20 feet or more. The broad, spreading fronds of adjacent trees of this kind may come in contact and partially join themselves together, so as to form large submarine arches. Divers describe the appearance of such growths, when seen from below, as somewhat resembling the trunks and branches of large forest trees. (See also Dana, Corals and Coral Islands, ed. ii, pp. 126, 127, 1874; ed. iii, pp. 126, 127, 1890.)

Var. *cervicornis* also grows to a large size, though much less massive than *palmata*. Tree-like specimens are often 10 feet high and broad, but are difficult to transport. The American Museum has three large ones from the Bahamas. They are about four to five feet high and six feet broad, with the main trunk about three inches (75^{mm}) in diameter. The terminal branches are long and divergent,

round, 35 to 20^{mm} in diameter, regularly and gradually tapered, often curved or even hooked. They grow isolated on a bottom of shell-sand and mud, in 12 to 15 feet of water, near Nassau, N. P.,—coll. R. P. Whitfield.

This species, in its several varieties, is abundant on the Florida Reefs and throughout the West Indies. It is also common as a fossil in the raised reefs of various islands. It does not occur at the Bermudas, nor on the Brazilian coast.

It has been recorded from the East Indies, etc., by Brook and others, but perhaps all such records are erroneous. I have seen no authentic example of either variety from the Indo-Pacific region.

It does not occur at Panama, nor elsewhere on the Pacific coast of America. The *genus* is absent from that coast, except *A. crassa* (E. and H.), recorded from the Galapagos Is.

Gregory (Ann. and Mag. Nat. Hist., 1900, pp. 20–31) gives details of the Indo-Pacific specimens, recorded by Brook, after an examination of the types, and concludes that none of them belong to either of the West Indian varieties, but to distinct species. The Singapore specimen, referred by Brook to *palmata* (No. 93, 4, 7, 24), may be the true *alces* of Dana. According to Gregory, it is distinct from *palmata* in its calicles and cœnenchyma, but grows in the same form.

The *Madrepora ethica* D. and M. (op. cit., p. 82, 1860) seems to be a dwarfed or young, slender form of var. *prolifera*. But the figures referred to it (pl. x, figs. 7, 8) do not agree with the description at all. They appear rather to represent a *Millepora*.

This species, in all its diverse forms of growth, retains pretty constantly the characteristic forms of its axial and radial or lateral calicles, and the characteristic porous and roughly echinulate texture of the cœnenchyma. The radial corallites and their calicles are larger than in most species of the genus. The corallites are rather openly nariform or tubo-nariform, costate, and porous. The septa are well developed, the directives wider. The axial corallites are stout, tubular, usually much exsert, not swollen ; walls porous and strongly costate externally ; calicles large, tubular ; primary septa well developed, subequal ; secondaries narrower ; the septa form a distinct, 12-rayed star.

8

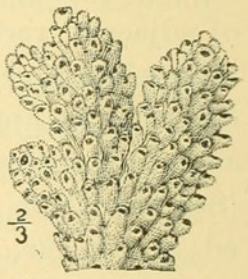


Fig. 8.—*Acropora muricata*, var. *prolifera*. After Pourtalès, the axial corallites are too small and short.

Errata.—Page 51, line 3 from bottom, for Flaggs read Flatts.—Page 128, line 17, for xxxiii, fig. 4, read xxv, fig. 3.

[For explanation of plates, see end of Article IV.]

Verrill, A. E. 1901. "Variations and nomenclature of Bermudian, West Indian, and Brazilian reef corals: with notes on various Indo-Pacific corals." *Transactions of the Connecticut Academy of Arts and Sciences* 11, 63–168.

View This Item Online: https://www.biodiversitylibrary.org/item/48122
Permalink: https://www.biodiversitylibrary.org/partpdf/140854

Holding Institution
MBLWHOI Library

Sponsored by
MBLWHOI Library

Copyright & Reuse
Copyright Status: Public domain. The BHL considers that this work is no longer under copyright protection.

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at https://www.biodiversitylibrary.org.

This file was generated 16 April 2022 at 12:36 UTC