

[APRIL, 1898.]

THE
SCIENTIFIC TRANSACTIONS

OF THE

ROYAL DUBLIN SOCIETY.

VOLUME VI.—(SERIES II.)

XIV.

JAMAICAN ACTINIARIA. PART I.—ZOANTHÆ. BY J. E. DUERDEN,
Assoc. R. C. Sc. (Lond.), Curator of the Museum of the Institute of Jamaica.

(PLATES XVII. A, XVIII. A, XIX., XX.)

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[Read MARCH 24, 1897.]

THE following account, restricted to the well-defined group of the Zoantheæ, is a first contribution from investigations now being carried out upon the Jamaican Actiniaria. It is remarkable that, with the exception of two species of *Palythoa*, collected by Sir Hans Sloane, probably about the year 1687, no Actinian has, so far as I can ascertain, been recorded from the island. Thanks to the labours of MM. Duchassaing and Michelotti (1850, 1860, 1866), and to the later researches of Professor M^cMurich (1889, 1889 *a*, 1896), we are acquainted with numerous examples from the other West Indian Islands, with which the Jamaican forms may be compared. These are proving that the Actinian fauna of the whole Caribbean region presents no marked difference. Professor M^cMurich has shown this for the Bahamas and the Bermudas, and of thirty-four Jamaican species now known, nearly all are forms recorded from one or more of the other islands of the Antilles. With the exception of the valuable work contributed by M^cMurich, practically no studies on Western forms have been conducted along the modern anatomical lines instituted and carried out elsewhere by Hertwig, Erdmann, Haddon, and others. Hence the necessity that the different representatives, many only partially known, should be submitted to microscopical examination to enable them to be arranged in the later systems of classification.

The following definition of the group of the Zoantheæ is the one given by Professor Haddon and Miss Shackleton (1891), and is practically the same as that accepted by all recent writers:—

ZOANTHEÆ.

Actiniæ with numerous perfect and imperfect mesenteries, and two pairs of directive mesenteries, of which the sulcar are perfect and the sulcular are imperfect. A pair of mesenteries occurs on each side of the sulcular directives, of which the sulcular moiety is perfect and its sulcar complement is imperfect; a similar second pair occurs in one section of the group (*Brachyenciminæ*), or the

second pair may be composed of two perfect mesenteries (Macrocneminæ). In the remaining pairs of mesenteries, of both divisions, this order is reversed, so that the perfect mesentery is sulcar and the imperfect is sulcular. The latter series of mesenteries are bilateral as regards the polyp, and arise independently (*i.e.* neither in pairs nor symmetrically on each side) in the exocœle on each side of the sulcar directives, in such a manner that the sulcular are the oldest and the sulcar the youngest. Only the perfect mesenteries are fertile or bear mesenterial filaments. A single sulcar œsophageal groove is present. The mesogloea of the body-wall is traversed by irregularly branching ectodermal canals or by scattered groups of cells. The body-wall is usually incrustated with foreign particles. The polyps are generally grouped in colonies connected by a cœnenchyme, the cœlenteron of each polyp communicating with that of the other members of the colony by means of basal endodermal canals.

Family. ZOANTHIDÆ, DANA, 1846.

(With the definition of the Group.)

Sub-family. BRACHYCNEMINÆ, Hadd. and Shackl., 1891.

Zoantheæ in which the sulcar element of the primitive sulco-lateral pair of mesenteries is imperfect.

GENERA.

Zoanthus, Lamarck, 1801.

Isaurus, Gray, 1828.

Gemmaria, Duchassaing and Michelotti, 1860.

Palythoa, Lamouroux, 1816.

Sphenopus, Steenstrup, 1856. (Not represented in the West Indian collections.)

Sub-family. MACROCNEMINÆ, Hadd. and Shackl., 1891.

Zoantheæ in which the sulcar element of the primitive sulco-lateral pair of mesenteries is perfect.

GENERA.

Epizoanthus, Gray, 1867.

Parazoanthus, Haddon and Shackleton, 1891.

One of the two type species of the genus *Mammillifera*, established by Lesueur, having been shown by M^cMurich (1896) to possess all the characters of a *Zoanthus*, and there being every probability that the other type species, when discovered, will have the same, this genus, formerly included in the *Zoanthidæ*, can no longer be recognized (see p. 334).

With the exception of an irregular arrangement of the mesenteries in the

genera *Gemmaria* and *Palythoa*, referred to below, nothing of importance has occurred differing from the diagnoses, mainly anatomical, of the tribe and genera given in the works of the writers referred to above.

Since the arrangement of the mesenteries in the Zoantheæ, which differs from that met with in all other Actiniaria, was first fully elucidated, it has also been recognized that the group presents a further distinction into two sub-divisions dependent upon the nature of the second pair of mesenteries on each side of the sulcular directives, according as the pair consists of a perfect and imperfect mesentery, or of two perfect mesenteries. The former was first termed by Dr. Erdmann the "microtypus," and the latter the "macrotypus"; a distinction emphasized later by Haddon and Shackleton (1891) in the formation of the two sub-families Brachyeminiæ and Macroeminiæ. Apparently no variation from these two seemingly well-fixed divisions has since been noted. It is therefore interesting to find that, in West Indian species of the genus *Gemmaria* and of *Palythoa*, an irregular condition has been met with. In *Gemmaria variabilis*, n. sp., a specimen sectionized showed the normal brachyemenic arrangement on one side and the macroemenic on the other. In a colony of *Palythoa mammillosa*, Ell. and Sol., one polyp was normally brachyemenic on the right, but macroemenic on the left side; and in another polyp, in the same colony, the brachyemenic condition was on the left side and the macroemenic on the right (Pl. XIX. A, figs. 2 and 3). Similar combinations exist in *Palythoa caribæa*, Duch. and Mich.; but one polyp exhibited the full macroemenic arrangement on both sides, in place of the normal brachyemenic (Pl. XIX., fig. 7).

It is thus clear that in these three species, at least, the fundamental distinction of the microtype and macrotype is not sufficiently fixed, so that both may appear in one colony, or even on opposite sides in the same individual. In a number of specimens examined the majority are, however, normal.

In the present communication the following ten species are described:—

ZOANTHÆ.

BRACHYCNEMINÆ.

- Zoanthus Solanderi*, Lesueur.
- Zoanthus flos-marinus*, Duchassaing and Michelotti.
- Zoanthus pulchellus* (Duchassaing and Michelotti).
- Isaurus Duchassaingi* (Andres).
- Gemmaria variabilis*, n. sp.
- Gemmaria fusca*, n. sp.
- Palythoa mammillosa* (Ellis and Solander).
- Palythoa caribæa*, Duchassaing and Michelotti.

ZOANTHÆÆ (*continued*).

MACROCNEMINÆ.

Epizoanthus minutus, n. sp.**Parazoanthus Swiftii** (Duchassaing and Michelotti).

All the examples having been partially studied in their living condition, and generally from an abundant supply of material, it has not been possible in some cases to draw up the specific characters in very hard and fast terms. The few external features one has to depend upon in the Zoanthidæ are well known to all workers in the group to be very variable; and especially will this be seen to be the case in the genera *Zoanthus* and *Palythoa*.

Recognizing the form of the sphincter muscle as of great importance in specific identification, I have figured it in all cases.

Practically all the material has been preserved by simple immersion in a four or five per cent. solution of formalin. Owing to the presence of abundant incrustations and the great thickness of the mesogloea, the internal tissues of the Zoanthidæ are rarely well preserved. It is satisfactory to find that, by means of formalin, the preservation and histology was, in every case, all that could be desired, while, in most, little alteration of form or dimensions occurred; thus allowing the number of capitular ridges and tentacles, measurements, etc., to be taken at leisure. The colours can likewise be observed for some time, but disappear ultimately.

A curious chromatic change occurred in most of the *Palythoa* material. The colonies, usually cream colour when alive, became strongly brick-red in their upper region after immersion for a short time in the formalin. This alteration extended also to the ectoderm of the œsophagus and to the mesenterial filaments.

Some importance must be attached to the method of preservation in determining the appearance of the various histological characters. With alcohol the mesogloea shrinks very considerably. To this disproportionate shrinkage, compared with that of the ectoderm and cuticle, is due the contorted or dendriform appearance of the outer part of the body-wall often seen in species of *Zoanthus*. The size and appearance of the mesogloæal cavities, especially those containing the sphincter muscle, may be much modified. Figs. 1, 2, and 3, on Pl. XVIII. A, should be compared. The last having narrow, almost closed cavities, was drawn from a polyp shrunk in alcohol, and the two first from colonies preserved without shrinkage in formalin. Specimens of *Z. pulchellus* preserved later in formalin show open cavities like figs. 1 and 2. The figure of the cavities of the sphincter muscle of *Zoanthus*, sp.?, given by Hertwig (1882, pl. xiv., fig. 1), is evidently partly determined by this shrinkage.

ZOANTHUS, LAMARCK, 1801.

Brachyencemic Zoantheæ, with a double mesogloæal sphincter muscle. The body-wall is unincrusted; the ectoderm is usually discontinuous; well-developed ectodermal canal system in the mesogloæa. Monœcious or diœcious. Polyps connected by a thin lamellar cœenchyme, stolons, or, more rarely, free.

The synonymy of the genus *Zoanthus* is given by most recent writers upon the Zoanthidæ.

The following are the references to the genus *Mammillifera*, which, as shown below, must be merged in *Zoanthus* :

<i>Mammillifera</i>,	. . . .	Lesueur, 1817, p. 178.
<i>Mamillifera</i>,	. . . .	Blainville, 1834, p. 329.
<i>Mammillifera</i>,	. . . .	Ehrenberg, 1834, p. 46.
<i>Mamillifera</i>,	. . . .	Duchassaing, 1850, p. 11.
<i>Palythoa</i> (pars.)	. . . .	Milne-Edwards, 1857, p. 301.
<i>Zoanthus</i>,	. . . .	Gosse, 1860, p. 296.
<i>Mamillifera</i>,	. . . .	Duchassaing and Michelotti, 1860, p. 327 ; 1866, p. 136.
<i>Mammillifera</i>,	. . . .	Verrill, 1869, p. 495.
<i>Mammilifera</i>,	. . . .	Hertwig, 1882, p. 111.
<i>Polythoa</i> and <i>Zoanthus</i> (pars.),	. . . .	Andres, 1883, pp. 306 and 323.
<i>Mammillifera</i>,	. . . .	Erdmann, 1885.
<i>Mammilifera</i>,	. . . .	Hertwig, 1888, p. 35.
<i>Mammillifera</i>,	. . . .	M ^c Murrich, 1889, p. 117.
<i>Mammillifera</i>,	. . . .	Haddon and Shackleton, 1891, p. 630.
<i>Zoanthus</i>,	. . . .	M ^c Murrich, 1896, p. 188.

The distinction between the Zoantheæ and other Actiniæ was first recognised by Cuvier in 1798, and the genus *Zoantha* first employed by Lamarck in 1801. Later, Cuvier (1817) restricted *Zoanthus* for Actinians occurring in groups adhering to a common base, which is sometimes broad and flat, and at other times a sort of creeping stem. In the same year, Lesueur (1817) separated, under the genus *Mammillifera*, those which have "A large cuticular expansion, serving as the base of numerous animals which, when contracted, assume the form of mammæ." This genus was received by Blainville (1834), Ehrenberg (1834), and Duchassaing (1850). Milne-Edwards (1857) united the included species under the genus *Palythoa*, established by Lamouroux (1816). Duchassaing and Michelotti (1860 and 1866) again separated the two genera, restricting *Palythoa* to the forms which have the integuments hardened by incrusting foreign matter. Gosse (1860) embraced, under *Zoanthus*, both the *Palythoa* of Lamouroux and the *Mammillifera* of Lesueur in addition to the other genera, all forms spreading

“in either a linear or incrusting manner.” Verrill (1869) distinguished the genus *Mammillifera* from *Zoanthus* “in having smaller, shorter, or more sessile polyps, and in the tendency to form continuous basal membranes, instead of linear stolons.” Hertwig (1882) states that “*Zoanthus* and *Epizoanthus* are distinguished from *Mammilifera* and *Palythoa* by the fact that, in the former two, the polyps project plainly above the common basis, whilst in the latter two they are united up to the free end by basal cœnenchyma.” Andres (1883) distributes the various species partly under *Polythoa* and partly under *Zoanthus*. Hertwig (1888), as a result of the researches of Erdmann (1885), separates *Mammillifera* from *Zoanthus* by the possession of only a simple mesodermal sphincter muscle. M^cMurich (1889) follows Erdmann in this. Haddon and Shackleton, however, in their “Revision of the British Actiniæ” (1891), in a footnote to *Mammillifera*, state:—“The position of this genus cannot be settled until the type species have been recovered and sectionized”—the types being Lesueur’s *Mammillifera auricula* and *M. nymphaea*. A form, covering considerable areas, occurs at Port Henderson and at Drunkenman Cay,* near Kingston, which I have no hesitation in identifying as closely allied to the *M. nymphaea*, of Lesueur, and with the better description of the species given by Duchassaing and Michelotti for colonies found by them at different islands of the West Indies. An anatomical study of this shows that, not only in the fundamental characters of the brachygenic arrangement of the mesenteries and the double mesogloæal sphincter muscle, but also in many minuter details of structure, the species agrees with other members of the genus *Zoanthus* as described by Erdmann, M^cMurich, and Haddon. Lesueur’s description and figure of *M. auricula*, the other type species, leave no doubt that, when found and examined, it will also have the characters of a *Zoanthus*.

Since this was first written, Prof. M^cMurich (1896) has obtained from the Bahamas an incrusting form which he identifies as *Mammillifera nymphaea*, and has shown that it is an undoubted *Zoanthus*. It is distinct from the Jamaican species (p. 345).

Following Haddon, M^cMurich removes the species placed in his earlier paper under *Mammillifera* to *Isaurus*.

The use of the sphincter muscle, for specific purposes, is well exemplified in the genus *Zoanthus*. Differences are readily seen in the figures of the three following species, and these again can be distinguished from the sphincters of others represented elsewhere. A marked difference, in the muscle, exists in

* The Port Royal Cays, known as Gun, Rackum, Drunkenman, Lime, Maiden, South, and South-east Cays, are a group of small coral islands outside Kingston Harbour. They are raised but a little above sea-level, some with and others without vegetation. The shores and shallow-waters around are the usual and most favourable spots for marine collectors.

the three Torres Straits species, described by Haddon and Shackleton (1891), compared with those of the West Indies. In all these latter, the proportion of the two parts differs much, the lower or proximal being several times larger than the upper or distal; in the former, very little distinction in size is met with. In *Z. Coppingeri*, the proximal (*i.e.* upper in figure, which would be lower or proximal in the extended condition of the polyp) is even slightly shorter than the distal; while in *Z. Jukesii* and *Z. Maegillivrayi*, the proximal is but slightly longer. Further, the muscle as a whole is much less developed than in the Antillean examples.

In partial contraction, a deep circular depression denotes externally the place of division between the two portions of the sphincter muscle. I use the term 'capitular fossa' for this, and speak of the two parts as the inner and outer capitula.

The genus *Zoanthus*, so far as I have observed it in the abundance occurring in Kingston Harbour and the Port Royal Cays, appears restricted in its distribution to a narrow belt of shallow water around the shores. It contrasts very markedly, not only in colour and firmness, but in its distribution with the equally abundant genus *Palythoa*. Colonies of the latter commence where the former begins to disappear, being most vigorous in the upper region of the breakers around the reefs. On the windward, more rocky side of the Cays, a distinct *Zoanthus* zone can be distinguished from the *Palythoa* zone; the former extends to a depth of one or two fathoms, and the latter to three or four fathoms, and gives place in its turn to the zone of living coral.

Zoanthus Solanderi, LESUEUR.

(Pl. xvii. A, fig. 1.)

<i>Zoanthus Solandri</i> ,	. . .	Lesueur, 1817, p. 177, pl. viii., fig. 1.
<i>Zoanthus dubius</i> ,	. . .	Lesueur, 1817, p. 177.
<i>Zoanthus Solanderi</i> ,	. . .	Milne-Edwards, 1857, p. 300, pl. c 2, fig. 3.
<i>Zoanthus dubius</i> ,	. . .	Milne-Edwards, 1857, p. 300.
<i>Zoanthus Solanderi</i> ,	. . .	Duchassaing and Michelotti, 1860, p. 325, pl. viii., fig. 1; 1866, p. 135.
<i>Zoanthus dubius</i> ,	. . .	Duchassaing and Michelotti, 1860, p. 326, pl. viii., fig. 2; 1866, p. 135.
<i>Zoanthus (Rhyzanthus) Solanderii</i> ,		Andres, 1883, p. 327.
<i>Zoanthus (Rhyzanthus) dubius</i> ,	. . .	Andres, 1883, p. 329.

Form.—Polyps erect, cylindrical, smooth, thin-walled with lines of attachment of mesenteries showing through, connected with one another at the base by lamellar narrow cœnenchyme or free stolons, or may be solitary. Column usually

non-pedunculate, practically of the same diameter throughout, but often with slightly expanded portions at the base. In extension the margin of the column is crenate, the elevations alternating with the outer row of tentacles; on partial retraction, the capitular fossa is well seen. Both inner and outer capitula bear fine ridges and grooves. In complete retraction, numerous minute capitular striæ can be seen only on the outer capitulum. Tentacles about 60, arranged in two cycles; one specimen had 32 in each row. Disc not much depressed, walls thin; the mesenterial lines can be seen through them; mouth slit-like, the œsophageal groove not distinguishable; œsophageal walls thin, showing the mesenterial lines; in some examples, the wall is thrown into ridges and furrows. Cœnenchyme little developed, appears only as a flattened expansion from one side of a polyp and connected with one or more other polyps near; in other cases, the connecting strand becomes constricted and stolon-like. Isolated polyps devoid of any cœnenchyme are met with, even when closely associated.

The polyps and cœnenchyme adhere firmly to the rocks or stones. New individuals arise by budding from the slightly expanded base of other polyps, and afterwards become more separated, the connecting tissue getting thinner and thinner until the polyps may become entirely isolated.

Colour.—Column in its lower part, especially when embedded in foreign matter, sand-coloured, becoming a dark blue or slate colour above. The margin has irregularly disposed, silvery white, triangular, narrow, radiating patches, often incomplete and variable in length; the toothed elevations are nearly opaque white. These white markings, which appear constant for the species, are best seen on partial contraction, at which time the inner capitulum appears as a distinct whitish, toothed, circular annulus. Colours of the tentacles and disc are variable. In a colony from Lime Cay both were a bright orange brown, and the peristome a bright green; in another large colony from Maiden Cay the tentacles were green on their inner aspect and dark brown on the outer, the disc a dark brown with bright green peristome; specimens at Rackum Cay showed a bright blue disc with green lips, and the tentacles a bright green.

Dimensions.—The height differs considerably, dependent upon the position of the polyps in a colony; it may vary from 2·7 cm. to 0·4 cm.; the diameter is about 0·6 cm., and is generally constant throughout the column, and independent of the length. The measurements are taken from specimens preserved in formalin, with but little contraction.

Locality.—Jamaica: Found in considerable abundance, growing on stones and coral rock, in shallow water, around the various Cays outside Kingston Harbour. The polyps are often partially embedded in sand and shore débris.

Range.—St. Thomas, Guadeloupe (Lesueur; Duchassaing and Michelotti).

Column-wall (Pl. XVIII. A, fig. 1).—A cuticle and sub-cuticla are present, the former having much adhering matter, such as diatoms; the sub-cuticla is in places minutely convoluted, evidently as a result of the excessive shrinkage of the mesoglaea. This is more especially seen in longitudinal sections.

The ectoderm of the column-wall is broad above, but very narrow below. It is much vacuolated, with only a small amount of cellular tissue remaining in the form of strands passing from the outer to the inner boundary; rarely a connecting strand of mesoglaea is seen. Some examples are not so highly vacuolated, particularly in the lower part. Abundant medium-sized, oval, non-staining nematocysts are present, the inner thread showing distinctly; pigment granules are met with at its internal boundary.

An irregular layer of spherical lacunæ appears in the mesoglaea, immediately below the ectoderm. Proximally the empty spaces extend further into the mesoglaea. The mesoglaea is broad in the region of the sphincter muscle, but narrows much below. Cells with long, fine processes are distributed sparingly throughout; delicate fibrils can also be easily seen passing from the ectoderm to an irregular, much broken, encircling sinus. The latter, situated either about the middle or very near the endodermal border of the mesoglaea, is formed of spaces varying in dimensions and form. They contain a small quantity of cellular tissue, and are connected with one another by larger or smaller canals, and also by canals with the ectoderm and the endoderm. The cells are multipolar in character.

The endoderm is low and contains abundant zooxanthellæ; nematocysts, similar to those in the ectoderm are present, and a weak circular muscle.

Sphincter muscle (Pl. XVIII. A, fig. 1).—The sphincter muscle is mesoglaeal and double, the two halves being distinctly separated. The upper or distal is smaller, and located in large irregular cavities extending almost across the mesoglaea, diminishing both proximally and distally; the lining of muscle cells is thin. The lower or proximal part of the muscle is contained in a large number of small, scattered, mostly circular, mesoglaeal cavities; the distal ones, however, are elongated, more like those in the upper. The muscle fibres are very small in section, and only a little loose tissue is present in addition.

Tentacles.—The ectoderm of the tentacles is without cuticle or sub-cuticla, and shows two kinds of nematocysts—an outer thick zone of the usual narrow form, and an occasional medium-sized, oval-shaped form similar to those in the ectoderm of the column-wall. The mesoglaea is very thin.

The endoderm is well developed, and crowded with zooxanthellæ. Both the ectodermal and endodermal musculatures are weak.

Disc.—The ectoderm of the disc is almost devoid of nematocysts. The mesoglaea is a little thicker, and the endoderm much thinner than in the tentacles. The endodermal muscle is seen in longitudinal sections.

Œsophagus.—The nematocyst and nuclear zone in the ectoderm is very regular, and situated close to the outer surface, while a non-staining nervous tissue intervenes between it and the mesogloea. The latter is very thin, and the endoderm resembles that of the mesenteries. In transverse sections, the œsophagus is oval. In the upper region, the ectoderm is not thrown into folds, and the œsophageal groove is barely apparent. Lower, as many as twelve longitudinal folds may be present on each side, and a slight indication of a groove. The mesenteries are attached to the œsophagus at about equal distances all the way round. The ectoderm is reflected on the mesenteries, and continued downwards as the mesenterial filaments.

Mesenteries.—The mesenteries are of the brachyememic type; generally about thirty pairs are present; one specimen had fifteen perfect mesenteries on one side, and only thirteen on the other.

The endoderm contains abundant zooxanthellæ, and medium-sized oval nematocysts. The digestive endoderm (1889, p. 116; 1891, p. 622) is not very thick.

The basal canal is large in both the perfect and imperfect mesenteries. It is elongated in the former, and full of deeply-staining cells.

The parieto-basilar muscles are clearly distinguishable, as also the retractor muscle of the mesenteries. The mesogloea is folded to support the muscle.

Gonads.—No reproductive elements were present in any of the examples studied.

The following may be regarded as distinguishing anatomical characters:

- (a). Pigment limited to the inner portion of ectoderm;
- (b). Mesogloéal lacunæ;
- (c). Form of sphincter muscle.

The Jamaican form above described appears to unite the two species *Z. Solandri* and *Z. dubia*, as originally described by Lesueur, and as known to Duchassaing and Michelotti from the same localities. Considering the variation in colour noted, it is evident that little importance can be attached to it. Referring to the first species, Duchassaing and Michelotti state: "Le couleur de cette espèce est sujet à varier, mais nous n'y avons jamais remarqué à l'état vivant la teinte qui lui donne M. Milne-Edwards dans l'atlas qui accompagne son ouvrage sur les coralliaires, la teinte verte se montre toujours dans une parti ou sur la totalité du corps de ces animaux." Some account must be taken of the character given by Lesueur that, when the animal is contracted, the summit is marked with deep blue angular spots and white lines, a feature agreeing with the present specimens. The polyps are usually non-pedunculate, resembling the figure of *Z. dubius* given by Duchassaing and Michelotti; but pedunculate forms, agreeing with Lesueur's original figure, also occur.

Zoanthus flos-marinus, DUCHASSAING and MICHELOTTI.

(Pl. XVII. A, fig. 2.)

- Zoanthus flos-marinus*, Duchassaing and Michelotti, 1860, p. 326,
pl. viii., fig. 6.
- Zoanthus flos-marinus*, Andres, 1883, p. 328.
- Zoanthus flos-marinus*, M^cMurrich, 1889, p. 113, pl. vii., figs. 3, 4.

Form.—Polyps erect, smooth, thin-walled, pellucid, clavate or cylindrical; arising either directly from a thin band-like incrusting cœnenchyme, or from a free irregular stolon, or from the base of one another. In full retraction, a little swollen above; in partial contraction, inner capitulum very narrow, with 24 to 30 minute rounded denticulations or capitular ridges, continued as thin lines for some distance down the column, and corresponding in number and alternating with the outer row of tentacles.

Tentacles dicyclic, slightly entacmæous, smooth, acuminate, overhanging in full extension, variable in number, from 48 to 60. In one colony, the numbers counted were 60, 52, 58, 54, 50, 54, 58; in another colony, 56, 50, 50, 48. In this latter colony, a curious condition of the tentacles was met with, each bearing near its origin one or two small tubercles,* suggestive of an additional cycle.

Disc thin-walled, with the radiating mesenterial lines showing through; outer part grooved, overhanging in full extension; central portion elevated and rounded; mouth slit-like. Cœnenchyme occasionally band-like and incrusting, more often stolon-like, constituting an irregular connexion for the polyps. Polyps, all about the same size, are often closely associated in a colony, and incrust some rock or stone; at other times, they are loosely attached to any object, and form bunches connected with one another in an irregular fashion by the loose stolon-like cœnenchyme. Sometimes the polyps are united to one another some distance above the base. Examples on the upper surface of stones are usually short and cylindrical; but those along the sides and underneath, or in crevices, become much elongated and narrow below.

Colour.—Lower part of column sand-coloured; upper dark green or lead colour; tentacles yellowish-green, blue-green, or brown; disc various light and dark shades of blue and green, often mixed with yellow and black; peristome a bright yellow or green; a darker triangular area at each or only one angle of the mouth may be present.

Dimensions.—Dimensions variable; column usually about 1.7 cm. in length;

* Verrill records a similar condition for *Mammillifera Danaë* (1869, p. 496), and for *Epizoanthus elongatus* (p. 498). It is not general in the present species.

diameter of capitulum in living retracted state 0·5 cm.; diameter of disc in extension 0·5 to 0·8 cm.; inner tentacles 0·25 cm. long.

Locality.—Jamaica: The commonest Zoanthus found around all the Cays. It occurs in masses, covering large surfaces of the rocks and stones in shallow water. Very often the polyps are almost embedded in débris of sand, mud, and calcareous algæ, so that in extension only the closely associated discs are exposed.

Range.—Bermudas (M^cMurrich); St. Thomas (Duchassaing and Michelotti).

Column-wall.—The cuticle, sub-cuticla, and ectoderm are of the same character as in the previous species. In preserved specimens the cuticle readily separates. Abundant oval nematocysts are present in the ectoderm, especially in the distal part. The boundary between the ectoderm and mesogloea is not well defined, cells and cell processes from the former passing into the latter.

The mesogloea is broad in the region of the lower sphincter muscle, but becomes thinner in both directions. It is without the empty lacunæ below the ectoderm, which are such a marked feature in the former; large and small spaces occur, the former containing but little cellular tissue and an occasional nematocyst. In transverse sections a broken encircling canal is shown, in some sections communicating with the ectoderm. Most of the cell-islets throughout the mesogloea contain fine pigment granules. The endoderm is occasionally elevated between the mesenteries, and triangular in transverse sections; elsewhere it is very thin, and loaded with zooxanthellæ. The endodermal muscle is clearly distinguishable.

Sphincter muscle (Pl. XVIII. A, fig. 2).—The form and arrangement of the cavities of the sphincter muscle are best realized from the figure. It bears a resemblance to the previous one, but the smaller proximal cavities are much more uniformly and regularly distributed. The smaller cavities terminating the proximal half are more numerous in some examples than in the one figured. In addition to the lining muscle cells, rounded cells occur in the cavities.

Tentacles.—The ectoderm is devoid of the cuticle and sub-cuticla. It is made up of narrow columnar cells, with oval, deeply-staining nuclei, amongst which are small oval nematocysts; pigment granules and a weak ectodermal muscle occur, the latter on very numerous, fine, mesogloéal plaitings. The mesogloea is thin and a little plaited on the endodermal border for the support of the circular muscle.

The endoderm is very thick, leaving only a small lumen; it is crowded with zooxanthellæ.

Disc.—The disc is much like the tentacles in structure, but the endoderm has about the same thickness as the ectoderm.

Œsophagus.—In section, the ectoderm of the œsophagus shows three strongly

marked zones, all of nearly equal breadth; an outer non-staining ciliated portion; a middle deeply-staining zone with oval-shaped nuclei, granular gland cells and narrow nematocysts; and an inner, slightly narrower, nervous layer, containing a few circular nuclei, and a little pigment matter. The mesogloea and endoderm are each narrow. In transverse section, the œsophageal groove is not very pronounced, and the ectoderm is thrown into folds in some cases, in others not.

Mesenteries.—The mesenteries are brachygenic in arrangement and very thin. In one specimen, twenty-four pairs were present; in another, twenty-one. The endoderm is well developed, made up almost entirely of zooxanthellæ and medium-sized, oval-shaped nematocysts. The mesogloea is folded and plaited on one side for the support of the longitudinal retractor muscle. A basal canal is developed in some a little distance from the column-wall, but is not present in others.

The reflected ectoderm, mesenterial filaments, and endoderm swollen in the lower region, are similar to those figured and described by M^cMurrich (1889, p. 115, pl. vii., figs. 3, 4), and the endoderm has embedded in it what I take to be the delicate acicular siliceous spicules referred to by him. The digestive endoderm is not so thickly developed in the previous species. The Drüsenwulst of von Heider (1895, p. 129) can be well studied.

Gonads.—None of the numerous specimens examined were fertile.

I identify this very common Jamaican form as the *Zoanthus flos-marinus* of Duchassaing and Michelotti, rather from the description by Prof. M^cMurrich of specimens from the Bermudas (1889). The diagnosis of the original authors is very incomplete for this variable genus. They state the tentacles to be thirty-six, while the later writer gives them as fifty to sixty in number, a number agreeing with the Jamaican examples. Andres places it amongst his *Zoanthi dubii*.

It may readily be distinguished from *Z. Solanderi* by its smaller size, usually clavate form, and stolon-like cœnenchyme; and from *Z. pulchellus* by never forming a broad lamellar cœnenchyme.

***Zoanthus pulchellus* (Duchassaing and Michelotti).**

(Pl. XVII.A, fig. 3.)

Mamillifera pulchella, Duchassaing and Michelotti, 1866, p. 137, pl. vi., fig. 4.

Polythoa (Mammothoa) nymphosa, Andres, 1883, p. 320.

Form.—Polyps erect, cylindrical, short or elongated, smooth, usually closely grouped, rising from a thin, tough, lamellar, incrusting cœnenchyme. In retraction, either a little enlarged above or of the same diameter throughout, terminating in a rounded or slightly conical manner, and showing a central

aperture and numerous fine radiating capitular ridges; where the polyps are more separated, they often appear as low mammiform prominences. In partial retraction, a double capitulum is formed by the groove situated between the two parts of the sphincter muscle. In full expansion, the disc and capitulum are greatly extended, so that, when all the polyps in a colony are in this state, their margins are wholly in contact. The mutual pressure produces a polygonal outline, giving rise to the appearance of a mosaic work of green discs with elevated, often pink, centres, the two rows of dark short tentacles simulating a thick cementing material. Tentacles short, digitiform, overhanging in extension, arranged in two alternating rows of about thirty in each. The number may be slightly more or less. Disc depressed below the thickened margin; the mesenterial lines are seen through the wall; in expansion the oral cone is considerably elevated, and the mouth slit-like; the œsophageal groove is not obvious. The cœnenchyme is smooth, continuous, lamellar, adhering firmly to the rocks and stones, and following the larger irregularities of the surfaces. The polyps all arise independently, generally in close association, but may be further separated, when the cœnenchyme becomes more ribbon-shaped. Owing to the thinness of the body-wall, there is often a partial collapse and transverse wrinkling in alcoholic specimens, especially in the more elongated examples.

Colour.—Column in lower part of elongated forms is pale buff and transparent, with the white mesenterial lines showing through; upper part olive blue; capitulum lighter with green radiating lines, seen more especially on retraction. Tentacles, nearly always dark brown, may be green or olive. Disc generally a bright green, with light radiating lines corresponding with the internal mesenteries; sometimes a pale green or yellow. In many, a darker triangular area extends towards the margin from each of the two extremities of the mouth; one is often more pronounced than the other. Œsophagus green, with white lines showing through. Peristome in many colonies pink, in others a bright green; more rarely yellow. An olive brown colour is first extracted by alcohol, leaving the colonies uniformly dark green, probably due to the abundant internal zooxanthellæ; later the polyps become a buff colour, a little darker above, and the mesenterial lines show through.

Dimensions.—Average diameter of column, 0.6 cm.; diameter of capitulum, in full expansion, 0.8 to 1 cm.; length of column very variable, depending largely upon the position of the polyp in the colony, average length 1.3 cm.; some may attain a length of nearly 3 cm., while others extend only 0.4 cm. above the cœnenchyme. Tentacles 0.2 to 0.3 cm. in length. Colonies often 20 or 30 cm. across. When preserved in alcohol, considerable contraction of the polyps occurs.

Locality.—Jamaica: Found in great abundance, forming large incrusting colonies on the rocks and stones in the shallow waters near the rocky parts of

the shore at Port Henderson, Kingston Harbour, and on the coral-rock at Drunkenman and other Cays.

Range.—St. Thomas (Duchassaing and Michelotti).

Column-wall (Pl. XVIII. A, fig. 3).—The column is partially coated with a layer of foreign matter, mostly diatom frustules and fine mud. The ectoderm is very thin, nearly continuous, and only slightly vacuolated. A sub-cuticula occurs, as in most species of the genus, more noticeable on the lower part; transverse strands of mesoglaea are rarely seen. The mesoglaea is very variable in thickness, according to the state of extension or contraction of the polyp; it is best developed in the region of the sphincter muscle, and also as the coenenchyme is approached; isolated cells, with elongated processes, occur; fine processes are seen extending across the mesoglaea from the ectoderm to the endoderm. Some of the more peripheral cell-islets contain dark granular pigment matter. An irregular, partially encircling, canal system is present, situated in the upper part nearer the endoderm, among the cells of which are nematocysts. The canals, in some sections, are seen definitely connected with the ectoderm.* The mesoglaea is much shrunk in preserved specimens, producing, especially in longitudinal sections, a very irregular external outline, followed by the ectoderm and foreign material. The endoderm is very narrow, crowded with zooxanthellae and small oval nematocysts, and gives rise to a weak endodermal muscle.

At the base, the ectoderm is thinner; the sub-cuticula is more clearly seen, also the ectodermal canals in the mesoglaea communicating with the ectoderm. Numerous irregularly distributed coelenteric canals, lined with ciliated epithelium, pass along the base of the polyps through the coenenchyme, and connect the cavity of one polyp with that of another. The cells of the canals are somewhat glandular, and a thin lining musculature is present.

Sphincter muscle (Pl. XVIII. A, fig. 3).—The upper (distal) portion of the sphincter muscle is much smaller than the lower (proximal). It is contained in about twenty small mesoglaeal cavities, arranged in an irregular row. The first section of the larger muscle is contained in an irregular series of small cavities stretching for some distance across the mesoglaea. The cavities are largest about the middle; lower they are again smaller, and located for the most part nearer the ectoderm. The lining of muscle cells is very thin, a few nucleated rounded cells are also present. In the figure of the muscle cavities, the latter are represented as flattened and almost closed. This condition is evidently due to the method of preservation in alcohol. Specimens preserved later, in formalin, have

* Hertwig (1882, p. 112) found a similar connexion in *Zoanthus Danae* (?). M^cMurrich states that, in *Z. sociatus*, he has observed the basal canal in the mesentery communicating with one of these spaces, and considers it open to question whether the cells in the large cavities of the mesoglaea are not in reality endodermal in their origin.

the cavities larger and more circular, as in the figures of the two previous species. The sphincter in this species differs from that of the two former in that the proximal part commences above with numerous small cavities.

Tentacles.—The ectoderm of the tentacles is ciliated and without any cuticle or sub-cuticla; it is much thicker than that of the column, and small nematocysts occur in restricted areas. The weak ectodermal muscle is supported on minute plaitings of the mesogloea. The mesogloea is thin, with a few isolated cells. The endoderm is thicker than the ectoderm, leaving scarcely any lumen in retraction. Abundant zooxanthellæ, small oval nematocysts, and a weak endodermal muscle are met with.

Disc.—The ectoderm of the disc is nearly as thick as that of the tentacles; the nuclei stain very deeply; an ectodermal musculature occurs. The mesogloea is broad, destitute of cell-enclosures, and contains a few isolated cells. The endoderm is like that of the mesenteries, and has an endodermal musculature.

Œsophagus.—The ectoderm in the œsophagus is rather broad and ciliated, and thrown into about eight deep longitudinal folds on each side, partially followed by the mesogloea; the œsophageal groove is elongated, occupying in some sections about one-third the transverse area of the œsophagus. The appearance is much the same as that figured by M^cMurich for the stomadœum of *Z. sociatus*. The ectoderm contains an occasional small oval nematocyst, in addition to the usual abundant narrow ones, and also a little pigment matter on its inner border. The mesogloea is thinner than the ectoderm, and contains no cell enclosures.

Mesenteries (Pl. XVIII. A, fig. 4).—The number of mesenteries varies, twenty-eight perfect ones occurring in one specimen, and twenty-six in another, corresponding with the varying number of tentacles. A slight parieto-basilar muscle is found on each side. The endoderm has zooxanthellæ and small nematocysts. A few isolated cells occur in the mesogloea. Below the œsophagus, the mesenteries, with the mesenterial filaments, assume, in transverse section, first a sagittate appearance, and lower a clavate form; in the lower region of the œsophagus, the reflected ectoderm has the characteristic pinnate appearance, the whole corresponding with that described and figured by Haddon and Shackleton for *Z. Macgillivrayi* (1891, p. 681). Nematocysts occur.

A very weak musculature extends along the whole surface of both sides of the mesentery, the mesogloea being slightly plaited in places. A single basal canal passes the whole vertical length; in the perfect mesenteries, it is oval in section in the distal region, but becomes elongated and stretches nearly the whole width in the basal part of the polyp.

In the imperfect mesenteries, the basal canal remains approximately circular in section. The tissue inside the canals is of the same character as the endoderm, being crowded with zooxanthellæ and nematocysts.

Gonads (Pl. XVIII. A, fig. 4).—Ova and spermata are borne in close proximity on the perfect mesenteries, both above and below the œsophagus. They were met with in three specimens taken from the same colony, but none were present in several examples sectionized from another colony.

Cœnenchyme.—The cœnenchyme is of similar structure to the body-wall, but the mesoglœa is much thicker and broken up by large ciliated cœlenteric canals passing in all directions; the endodermal lining is loaded with zooxanthellæ, and has a weak musculature. Isolated cells with fine processes, and the smaller ectodermal canals occur.

For some time during the preparation of this Paper, I had regarded this species, with little or no hesitation, as the *Mammillifera nymphæa* of Lesueur (1817). In the meantime, Prof. M^cMurich identified, with some amount of uncertainty, a form from the Bahamas as Lesueur's species. The external characters of the Jamaican representative agree with those of the Bahaman, as far as the latter are given, but a comparison of the sphincter muscles shows that they are undoubtedly distinct. Prof. M^cMurich, from an examination of my material and slides, entirely agrees with this. Whether his identification of the Bahaman form with that which Lesueur described be correct or not, it seems best that his conclusion should be followed for the future, seeing that with the addition of the anatomical features, the characters of the species are definitely fixed once for all. There must nearly always be an amount of uncertainty in identifying the species of the older authors, where external characters only were taken into account. I have therefore changed my manuscript identification of this species to that of *Mammillifera pulchella* of Duchassaing and Michelotti (1866), a form these authors regarded as a doubtful variety of *M. nymphæa*.

Isaurus, GRAY, 1828.

Large brachynermic Zoantheæ, with a single mesoglœal sphincter muscle. The body-wall is unincrusted; the ectoderm discontinuous; ectodermal and endodermal bays and small canals in the mesoglœa. Monœcious or diœcious. Polyps in small clusters or solitary.

Prof. Haddon and Miss Shackleton give (1891, pp. 682–4) a full discussion of the genus defined by them as above. They dwell particularly upon the reason why it should not be merged into the genus *Mammillifera* of Lesueur, as, accepting the characters Erdmann gives (1888, p. 35), has been done by M^cMurich (1889, p. 117). In his more recent paper (1896, p. 191), the latter author adopts *Isaurus*.

Isaurus Duchassaingi (ANDRES).

(Pl. XVII. A, fig. 4.)

- Zoanthus tuberculatus*, . . . Duchassaing, 1850, p. 11.
Zoanthus tuberculatus, . . . Duchassaing and Michelotti, 1860, p. 327,
 pl. viii., fig. 5.
Antinedia tuberculata, . . . Duchassaing and Michelotti, 1866, p. 136,
 pl. vi., figs. 2, 3.
Antinedia Duchassaingi, . . . Andres, 1883, p. 330.
Isaurus Duchassaingi, . . . M^cMurrich, 1896, p. 190, pl. xvii., figs. 6–8.

Form.—Base firmly adherent, expanding somewhat over the incrustated surface; usually much larger than the diameter of the column; irregular in outline. The flattened expansion may be regarded as a slightly developed cœnenchyme; but, although closely associated, the polyps were rarely connected with one another.

Column variable in shape, may be cylindrical or clavate, generally more expanded towards the base; slightly overhanging so as to present a concave and a convex aspect; the capitulum appears as a disc in retracted specimens, and is placed obliquely so that the small central aperture indicating the mouth is below the upper termination of the column. Proximal part, for from one-third to one-half of the total length of the column, smooth, with thin partial annuli showing through, which may become depressions on shrinkage; in the later state, numerous well-marked longitudinal ridges and furrows may also be rendered obvious. The column on its sides and convex aspect bears irregular rows of rather large, rounded tubercles, distinct from one another; the concave, shorter portion is smooth, giving rise to a marked asymmetry; four principal rows, of from five to eight tubercles, alternate with other rows of two or three smaller protuberances. Around the margin of the terminal disc is an incomplete circle of eight or nine tubercles, separated by deep depressions. These correspond with the rows and extend nearly round the margin, diminishing in size towards each extremity of the partial circle.

The flattened or slightly elevated and dome-shaped capitular disc is partially enclosed by these, and bears radiating ridges and furrows, not all equally developed; eight or nine which alternate with the marginal protuberances are more prominent than the one or two groups alternating with them. A depression indicates the position of the mouth. One young specimen, 2.5 cm. long, is quite smooth, having no elevations. In the living condition, the column-wall is firm, very tough, and partially transparent, so that the presence of the internal organs can be distinguished.

In none of the specimens could the disc and tentacles be noted externally; the individuals, as appears to be usually the case, maintaining a retracted condition.

Colour.—Cœnenchymatous base colourless in some, irregularly greenish brown in others; column dark brown, mottled with green and black, the pigment appearing in granular form. The green colouring matter seems largely external, and due to adhering unicellular algæ.

Dimensions.—Diameter of base may be 1.7 cm.; diameter at commencement of column varies from 0.4 cm. to 1 cm.; average diameter of column 0.6 cm.; height, from 2.2 cm. to 4.2 cm.; tentacles, measured in sections, 0.3 cm. long.

Locality.—Seven specimens were found associated and firmly adhering to a small block of coral-rock on the south-east side of Drunkenman Cay.

Column-wall.—The cuticle on the outside is devoid of adhering foreign matter, except in places where a unicellular green alga is attached, giving rise to the greenish patches seen on the living animal. The sub-cuticula is of regular thickness, but enlarged a little where it communicates with the internal mesogloea by strands across the ectoderm. The ectoderm is thick; the nuclei of the individual cells show no regular zonal arrangement; it is broken up by the strands of mesogloea into somewhat cubical or spheroidal blocks; large, thick-walled, highly refractive zooxanthellæ, and occasional large colourless stinging cells are present in places. In the uppermost part of the column the sub-cuticula is absent, and the ectoderm continuous. The internal boundary is often not clearly defined, portions being, as it were, cut off and isolated, and, as still smaller parts, often only individual cells, sunk further into the mesogloea.

The mesogloea is very thick, and contains abundant cell-inclusions, and uniformly distributed small cells with granular protoplasm. In the lower parts more especially these take the form of small communicating canals. M^cMurrich refers to the alteration in histological structure which some of the cells undergo in the mesogloea, by which they become filled with refractive, deeply staining granules, and suggests (p. 118) that they may be concerned in the formation of the mesogloea, their granules being particles which will later on be added to the matrix of the mesogloea. Many of the cells in my sections, generally in limited areas, appear to go a stage beyond, and instead of the granules filling the cells, they become arranged peripherally, giving the appearance of a thickened granular cell-wall, a distinct central nucleus remaining (fig. 6, Pl. XVIII. A).

The endoderm is thin, and contains abundant zooxanthellæ and small stinging cells. A circular endodermal muscle occurs along the greater part of the length of the column. Endodermal bays are met with at different levels, extending nearly as far as the ectoderm, and evidently correspond with the thin annuli noticed amongst the external characters. The endodermal muscle follows the outgrowths for only a short distance. Perhaps the bays serve to give flexibility

to the column. The projections seen on the upper part of the column are shown to be due to thickenings of the mesogloea, and contain a cavity lined with cells continuous with the endoderm, as is recorded by M^cMurich (p. 192), for the Bahaman forms; further, some polyps do not show any of the ectodermal bays mentioned by M^cMurich, and by Haddon and Shackleton, while they occur in others.

Sphincter muscle (Pl. XVIII. A, fig. 5).—The single mesogloéal sphincter muscle is strong, elongated, and in longitudinal sections extends nearly across the mesogloea. Proximally, the mesogloéal cavities are small and circular; distally, they are oval and more elongated; the muscle cells are arranged in different directions, and constitute a very thin layer, the remainder of the cavity being partially occupied with loose rounded cells, or more usually appears as an empty space. For the greater part of its length, the muscle cavities give a vesicular character to the mesogloea. The appearance is figured by M^cMurich, but the cavities appear more numerous and not so elongated in the Jamaican form. Some of my preparations show the constriction he refers to, but I have not obtained the long, branching, terminal cavities.

Tentacles.—The tentacles, seen in longitudinal sections, are as long as usual in the Zoanthidæ, and are acuminate in form. The ectoderm is very thick and shows a peripheral zone of colourless, narrow nematocysts and gland cells; below this a zone of deeply staining small nuclei; nearer the mesogloea abundant pigment granules occur, along with a few scattered nuclei. The mesogloea is thin, but thrown into fine, long, branching plaits on the ectodermal side for the support of the muscle, to such an extent that, in some sections, the mesogloea appears as if it had enclosed parts of the ectoderm. This condition is also described for *I. asymmetricus* (1891, p. 685). The endoderm, even in the state of retraction, is much thinner than the ectoderm, an unusual condition in the Zoanthidæ. It contains numerous ordinary zooxanthellæ, and occasionally others with thick, highly refractive walls, such as are found in the ectoderm of the body-wall, and are there also associated with the thin-walled form.

Disk.—The disk much resembles the tentacles, but the ectoderm is not so thick, nor nematocysts so abundant. The nuclei are more uniformly distributed; but the peculiar ectodermal musculature is similar in places. An endodermal muscle also occurs.

Œsophagus.—The Œsophagus is considerably folded; the three layers maintain a somewhat uniform thickness, but the mesogloea follows in places the more deeply folding ectoderm. It is slightly truncated opposite the sulcar directives, the two mesenteries extending from each corner being the only indication of an Œsophageal groove. The ectoderm is ciliated; the small, deeply-staining oval nuclei are arranged in a band a little below the surface. Gland cells, and

elongated nematocysts, showing a spiral thread, occur sparingly. The mesogloea is thin, and small granular cell-enclosures are scattered throughout.

The endoderm is a low band of cells resembling that of the mesenteries; zooxanthellæ, small nematocysts, and a weak muscle are present.

Mesenteries.—The mesenteries are brachygenic in type, and the perfect ones are arranged at about equal distances apart all round the œsophagus. Twenty-one pairs are present in one specimen. The endoderm is thin and crowded with zooxanthellæ and small oval nematocysts. A parieto-basilar muscle and a vertically arranged musculature occur on each side. The mesogloea is well developed throughout. Towards the insertion of the mesentery into the body-wall it is thrown into small irregular plaits or penons; still nearer it narrows a little. A basal canal and numerous irregular vertical canals and cell-enclosures occur the whole length of the mesenteries, continuous in places with those in the mesogloea of the column-wall. The reflected ectoderm rarely occurs, but the mesenterial filaments are met with as usual. Towards the base of the polyp the mesenteries begin to unite with one another, and ultimately form a reticulum-like structure filling the whole of the cœlenteron.

Gonads.—No gonads were present in three examples sectionized.

From the latest researches of Professor M^cMurrich, it appears that the West Indies possess two species of *Isaurus*, one from Bermuda, identified by him as the *Isaurus tuberculatus*, of Gray (1828), and another, the *Zoanthus tuberculatus*, of Duchassaing (1850), obtained from the Bahamas in the Northrop Collection, and previously collected from Guadaloupe and St. Thomas. In his Bermudan paper (1889 *a*), M^cMurrich, however, considered Gray's form as identical, not only with the Bermudan examples, but also with the *Z. tuberculatus*. Owing to these later results, and the specific name *tuberculatus* being occupied by both forms, he has followed Andres and adopted the term *Duchussaingi* for the Bahaman examples and for those known to Duchassaing and Michelotti.

Professor Haddon and Miss Shackleton (1891) have described as new, a form, *I. asymmetricus*, obtained by the senior author from Torres Straits. In doing this they state (p. 684):—"It is undoubtedly nearly allied to the *Mammillifera tuberculatus* of M^cMurrich. The specific differences are the lesser number and greater size of the tubercles, though their diameter is about the same, and their asymmetrical arrangement; the height of our species is about double that of the West Indian form."

The specimens described above seem to me to unite in a very marked manner the two West Indian and also the Torres Straits examples. I regard the differences in the external appearance of the tubercles, transverse annulations, &c., as largely dependent upon age and method of preservation. Even in the details of

microscopic structure, the Jamaican specimens appear to agree very closely, particularly so in the peculiar mesoglœal plaitings of the tentacles and the form of the mesenteries.

Colonies obtained later from Port Antonio convince me that it will be found impossible to maintain the separation of the three species, to such an extent is the form variable in external characters and structure.

Gemmaria, DUCHASSAING and MICHELOTTI, 1860.

Brachyenicemic Zoantheæ, with a single mesoglœal sphincter muscle. Solitary, or connected by cœnosare. The body-wall is incrustated. The ectoderm is usually discontinuous, but may be continuous. Lacunæ and cell-islets are found in the mesoglœa. Dicecious or monœcious.

The only difference between the definition of the genus here given and that in a former publication (1896, p. 142) is in connexion with the gonads. All the species hitherto examined have had the male and female reproductive cells, where present, in different individuals; but in the first representative described below, both ova and spermata occur on the same mesenteries (Pl. XVIII. A, fig. 8). It has already been shown (1891, p. 623) that a similar monœcious and dicecious condition exists in the genus *Zoanthus*, and doubtfully in *Isaurus*.

***Gemmaria variabilis*, n. sp.**

(Pl. XVII. A, fig. 5.)

Form.—Polyps erect, firm, smooth, arising independently from a lamellar cœnenchyme, or from around the base of one another, or may be solitary; often cylindrical in retraction; slightly enlarged and flattened distally, or occasionally narrowing and terminating bluntly; others, mostly long examples, are clavate, being narrow below and expanding above either slowly or more suddenly; transversely wrinkled, especially in spirit specimens. Capitulum with about thirty ridges and furrows. Tentacles acuminate, arranged in two alternating rows of about thirty in each row; the number may vary considerably, forty in each row being counted in one example. Peristome considerably raised; the mouth elongated and slit-like.

In full expansion, the capitulum and disc are much enlarged in proportion to the diameter of the column; and the individuals in a colony are so closely aggregated that, reaching the same level, the margins come in contact, and by mutual pressure produce a polygonal outline, leaving no interstices. Where examples in a colony incrust an irregular surface, or are fixed to the underside of stones, the

columns elongate sufficiently to bring all the individuals, with the disc looking upwards, to about the same level. A living colony when fully expanded thus presents the appearance of a mosaic work of brown or green depressed discs, with margins of a dark-brown colour.

When alive, polyps are found under three conditions:—

(1) Retraction, where the disc and tentacles are entirely withdrawn, leaving only a very small central opening.

(2) Partial expansion, with a small portion of the disc visible. This is considerably depressed, and the tips of the tentacles protrude from between the thick capitulum and the disc.

(3) Full expansion, in which the disc is completely exposed and only slightly below the capitular margin, and the tentacles are quite free. In this state the capitula are in contact with one another.

Cœnenchyme present around the base of each polyp, but otherwise not very freely developed, appearing rather as a consequence of the origin of the polyps from one another by basal gemmation, and connecting them only as a flattened band or ribbon; the band may become constricted, and finally the individuals sever their connexion with one another.

Colour.—Lower part of column light buff, upper dark brown. Tentacles usually dark brown, but may be olive or green. Disc in some is dark brown, with green radiating lines, and the peristome a bright green; or the disk may be green and the peristome brown; in others the disc and peristome are both bright green. Œsophagus colourless. The ectoderm containing the brown pigment readily rubs off when handled, the colourless mesogloea, with the enclosed sand grains, being exposed. In alcohol, the brown colour is first extracted, leaving the colony a uniformly dark green; later this gives place to a dirty buff colour.

Dimensions.—The dimensions of the individual polyps vary considerably even in the same colony, being largely dependent upon the position of the polyp in the colony. In the large masses spreading over an even surface, the individuals are all of the same thick-set type and approximately of uniform size. When the colonies are smaller, and the incrustated surface irregular, the specimens in the depressions become elongated in order to attain the same level as the majority. The length of the column of one of the longest is 5 cm., the diameter 1.2 cm.; an average height is 1.5 cm., and diameter 0.7 cm.; diameter of expanded disk 2.3 cm.; tentacles about 0.3 cm. in length. Owing to the rigidity of the column-wall there is not much contraction in preserved specimens.

Locality.—Found growing very abundantly upon rocks and stones in shallow water at Port Henderson, Kingston Harbour. Numerous irregular colonies are to be met with, sometimes one or two feet across; one was over two yards in

length, and one to two feet broad. Incrusting sponges grow freely on the cœnenchyme and amongst the polyps, and Ophiuroids meander around.

The specific name has reference to the amount of variation met with in the various external features of the polyps.

Column-wall (Pl. XVIII. A, fig. 7).—The cuticle of the column-wall is thickly coated below with a layer of foreign matter, principally diatoms. The ectoderm is continuous, and presents irregular internal limitations, especially towards the upper part of the column. This is due partly to the presence of incrustations, but also to the ectoderm passing insensibly into the cell-enclosures of the mesogloea. Numerous zooxanthellæ occur, and occasionally large colourless oval nematocysts, showing the coiled internal thread. The incrustations are sand grains, sponge spicules, and tests of Radiolarians, and extend from the inner border of the ectoderm to beyond the middle of the mesogloea.

The mesogloea is thicker above and below than in the middle; numerous cells occur bearing elongated processes, and cell-enclosures of various dimensions uniformly distributed. Fine radiating processes extend from the endodermal boundary, apparently throughout the layer; the large cell-islets contain zooxanthellæ and large oval nematocysts, as in the ectoderm.

The endoderm is of medium height, and contains zooxanthellæ and pigment granules; the circular endodermal muscle is easily distinguished.

Sphincter muscle (Pl. XVIII. A, fig. 7).—The sphincter muscle is single and enclosed in an extended series of small mesogloéal cavities, varying but slightly in size, shape, and distance apart. It is situated nearer the endoderm. The cavities in the upper part are a little larger, and the lining muscle-fibres are arranged in various directions, many being cut obliquely. A few small spherical cells are also present in the middle of the cavities.

Tentacles.—The ectoderm is thick and has an outer layer of small narrow stinging cells, and below this abundant deeply staining oval nuclei and numerous glandular cells. The mesogloea is broad, and contains isolated cells and foreign incrusting matter. An ectodermal and an endodermal musculature occur.

Disc.—The ectoderm is very broad and contains zooxanthellæ and glandular cells. The mesogloea is nearly as thick as that of the column-wall, but contains no foreign inclosures; minute cellular strands and a few cell-islets with large oval nematocysts occur in it. In the peripheral part of the disc, the mesogloea is very thin, while the ectoderm is a little thicker than in the more central region. The endoderm is low and contains zooxanthellæ; a weak endodermal muscle on plaitings of the mesogloea occurs.

Œsophagus.—The œsophagus is oval-shaped in transverse sections, with a well marked truncated œsophageal groove, the sulcar directives extending from the corners. The ectoderm is thrown into longitudinal folds, not followed by the

mesogloea; twelve occur on each side in one specimen, but there may be as many as 15 or 18. The large colourless nematocysts and pigment granules are present, and a weak nerve layer.

The cells are longer at the groove. The mesogloea is thin, but thickens towards the same place, and contains cells. The endoderm is low, and shows an outer zone of nuclei and an inner non-staining zone; the endodermal muscle is supported on mesogloéal plaitings.

Mesenterics (Pl. XVIII.A, fig. 9).—The usual brachygenic condition is present in most; but in two specimens the mesenteries are brachygenic on one side, and macrogenic on the other. In most, fifteen perfect mesenteries occur on each side, and the same number of imperfect. In one, twenty-seven pairs in all were present, and in another twenty-eight pairs. Each has an irregularly shaped basal canal a little beyond the origin, and, in the upper part of the column, others extend almost across the mesentery. The basal canal is continued the whole length of the mesentery, and contains zooxanthellæ and large oval nematocysts; it may be divided in the upper part into two or more closely approximated canals.

The parieto-basilar muscles are well developed. Beyond the basal portion the mesenteries are very thin, and the endoderm is crowded with large zooxanthellæ. The imperfect mesenteries are very short proximally, appearing in transverse sections as goblet-shaped projections of the body-wall; the muscle extends all round, while the basal canal is more circular than in the others. The reflected ectoderm and mesenterial filaments are well developed.

Gonads (Pl. XVIII.A, fig. 8).—In one specimen examined, both male and female gonads were found in abundance; sometimes both kinds would occur on one mesentery, while others bore either ova or spermata. The ova, which evidently were nearly ripe, were scarcely stained with borax carmine, while the spermata readily took up the pigment.

Cœnenchyme.—In its outer part, the cœnenchyme has numerous inclosures similar to those of the body-wall. Many large cell inclosures and cœlenteric canals are met with, the latter with a very regular epithelial lining and a weak musculature.

Under their genus *Gemmaria*, MM. Duchassaing and Michelotti describe (1860) four species of Zoanthidæ from the Antilles, viz.:—*G. Rusei*, Duch. and Michel.; *G. clavata*, Duch.; *G. Swiftii*, Duch. and Michel.; and *G. brevis*, Duch. The first has been recovered in the Bermudas by McMurrich (1889), while *G. Swiftii* is shown in the present Paper to belong to the genus *Parazoanthus*.

I have hesitated considerably as to the identity of the present form with *G. clavata*, but have finally decided that the characters given in the two descriptions of it will not admit of this. The original diagnosis (1850, p. 11) gives the

tentacles as about 30, and the later one (1860, p. 331) states the disc and tentacles to be violet.

The Jamaican form also appears to be a larger, more robust species. External characters readily separate it from *G. brevis*. *G. isolata*, described by M^cMurrich, from the Bahamas (1889), is also evidently quite distinct. It can likewise be distinguished from the other known members of the genus—*G. Macmurrichi*, Hadd. and Shackl.; *G. Mutuki*, Hadd. and Shackl.; and *G. canariensis*, Hadd. and Duerd.—obtained from localities more distant.

***Gemmaria fusca*, n. sp.**

(Pl. XVII. A, fig. 6.)

Form.—Polyps erect, firm, cylindrical, growing in colonies from a thin lamellar coenenchyme or solitary; smooth above, with sand grains showing through the ectoderm, and scarcely any adhering particles, but many more below. Capitulum with about 30 ridges and furrows, may be slightly more or less; greatly expanded and overhanging in full extension. Tentacles dicyclic, smooth, acuminate, overhanging in extension, short, slightly entacmæous. Outer part of disc overhanging in full extension, giving an umbrella-like appearance, with the radiating mesenterial lines showing through; central portion of disc appears as a rounded elevation with the slit-like mouth at the apex, and is devoid of incrustations. Coenenchyme spreading and closely incrusting the upper surface of rocks and stones, not very freely developed; exposed surface rough, due to adhering calcareous particles.

The individual polyps in a colony are usually closely apposed at the base, but may be separated a short distance from one another, or may ultimately become isolated. The polyps are practically the same diameter throughout, but may diminish a little below, expanding again towards the base. In retraction the distal part may be slightly swollen and rounded, with a central aperture; the number of capitular ridges, which extend for some distance down the column, is very variable. In preserved specimens the proximal part of the column is slightly wrinkled, but the distal is smooth.

Colour.—Distal part of column, tentacles, and disc dark brown; proximal part of column sand-coloured, often with foreign green matter; oesophagus white.

Dimensions.—Height of column varies from 1 to 3 cm., most are about 2.2 cm.; diameter 1 cm.; inner tentacles 0.15 cm. in length.

Locality.—Colonies and isolated individuals are found growing in considerable abundance attached to coral rock and stones in the very shallow water around

Drunkenman Cay; sometimes the polyps are partially embedded in sand and débris. Numerous young individuals arising directly from the cœnenchyme, or from the base of other polyps, are mingled with the older examples.

Column-wall (Pl. XVIII. A, fig. 10).—The ectoderm is continuous, and not much broken up by incrusting matter. The cuticle is thin, with few adhering foreign bodies. The ectoderm is broad in the distal part of the column, but narrows below, and the nuclei of the cells are uniformly distributed except near the cuticle, a regular columnar epithelium not being formed. Large oval nematocysts occur, and large zooxanthellæ are present in company with small narrow stinging cells and cells containing highly refractive pigment granules. The inner boundaries of the ectoderm are not well defined, and at the capitulum the layer becomes very thick and still more irregular in its internal outline; definite bays or growths into the mesoglœa appear in sections, probably due to the presence of capitular ridges and furrows.

The mesoglœa is of medium thickness, enlarging a little both proximally and distally; the incrustations are limited to the outer portion and the adjacent ectoderm. They occur very sparingly, not interfering with the cutting of thin sections, and consist of calcareous and a few siliceous sand grains, sponge spicules, and an occasional Foraminiferal or Radiolarian test. The mesoglœa contains isolated cells and cell-islets distributed with some uniformity, except in the lower part where an irregular zone of larger inclosures may be found a little nearer the inner boundary. The larger islets contain zooxanthellæ, large oval nematocysts, and occasionally pigment granules similar to those in the ectoderm, from which layer the cell-islets can be seen to originate.

The endoderm is thin, more so than in *G. variabilis*, and contains many zooxanthellæ. The circular endodermal muscle is well developed; fine fibrils from it stretch nearly across the mesoglœa, and others are seen connecting the various cells and cell-islets.

Sphincter muscle (Pl. XVIII. A, fig. 10).—The sphincter muscle is single and mesoglœal. It is long and situated near the endoderm. Proximally it commences in small irregular cavities in groups of two or three, and arranged in a not very regular row. The more distal cavities are much larger, irregular in form, and extend further across the mesoglœa; the muscle fibres are arranged obliquely, and isolated spherical cells occur. The muscle is shorter, the cavities less regular in arrangement, and not in such a single series as in *G. variabilis*; while the upper ones are closer, broader, and more irregular in outline.

Tentacles.—The ectoderm of the tentacles is very thick, and consists of an outer zone of small narrow nematocysts, and an inner zone of zooxanthellæ and nuclei irregularly arranged. A few pigment granules, a number of homogeneous

deeply staining bodies, and glands filled with clear contents, are met with, and an occasional large oval stinging cell. Transverse sections show a well developed ectodermal muscle on mesogloéal plaitings. The mesogloëa has small cells scattered throughout. The endoderm is made up of small regularly arranged cells; an endodermal circular muscle is supported on fine mesogloéal plaitings; and zooxanthellæ are present.

Disc.—The ectoderm of the disc is even thicker than that of the tentacles, and exhibits an outer zone of clear gland spaces and small narrow nematocysts. The deeper part is largely composed of zooxanthellæ, glandular cells or spaces, and an occasional large oval stinging cell. An ectodermal muscle occurs on mesogloéal plaitings, and an endodermal muscle is present. The mesogloëa is thick and contains cells and cell-islets, but is devoid of incrustations.

Œsophagus.—Only a slight œsophageal groove is indicated, the mesogloëa being a little thickened and truncate, and the directives extend from the two corners. Below it is oval-shaped in section, and the ectoderm remains unfolded; distally the latter is thrown into eight or nine well marked folds on each side, only exceptionally followed by the mesogloëa. In a second specimen, the number of folds was fifteen on each side. Immediately on passing, in longitudinal sections, beyond the lips of the mouth, the ectoderm undergoes a great alteration from that of the disc. It is richly ciliated, a narrow zone immediately below is colourless; then follows a thick zone of narrow, closely-arranged nuclei, gland cells, and nematocysts, which together form a dense deeply staining band, extending the whole length of the œsophagus. A zone below this has only a few scattered nuclei, and, in places, the large oval stinging cells and pigment granules. The mesogloëa is a homogeneous layer with rarely an enclosed cell, and the endoderm is extremely thin. A weak endodermal but no ectodermal musculature occurs. Terminally the ectoderm is reflected upwards on the mesenteries for a short distance, and folded in a double pinnate manner, and then descends, constituting the mesenterial filaments.

Mesenteries.—The mesenteries are brachymeric in arrangement. Twelve perfect pairs occur on each side in one specimen, and sixteen in another. In the middle œsophageal region each is extremely delicate, scarcely showing any enlargement towards the insertion at the body-wall or œsophagus; the usual basal canal is often absent, especially distally. The imperfect mesenteries are broad above, but very short below, not being readily distinguishable in places. The parieto-basilar muscle is present on each side; the retractor muscle is weak. A little beyond the insertion of the mesenteries is the flattened or oval-shaped basal canal filled with deeply-staining tissue, and now and then a large oval nematocyst. The endoderm is poorly developed, and has large zooxanthellæ.

Gonads.—No reproductive cells were present in the examples studied.

The combination of characters in which *Gemmaria fusca* differs from *G. variabilis* are: (1) the uniformly brown colouration, (2) the paucity of the incrustations, (3) the almost absence of basal canals in the upper part of the perfect mesenteries, (4) the appearance of the sphincter muscle, and (5) the generally more delicate structure throughout.

For some time I was inclined to regard these two species as being the same, and it was not until an anatomical examination had been made that their distinction was fully apparent. The sphincter muscle, quantity of incrustations, and other structures, are different. Externally they may be distinguished by their colouration. Though not inclined to regard this character as very constant, amongst numerous colonies I have met with no variations from the type in the present species, nor wholly brown examples of *G. variabilis*. *G. fusca* is longer and more regularly cylindrical than the other, without the same tendency to assume a clavate shape. It is also less rigid, the body-wall not being so thick and incrustated, and young individuals arise more numerous amongst the older polyps. The colonies are smaller and less associated.

Palythoa, LAMOUROUX, 1816.

Brachyenic Zoanthææ with a single mesogloæal sphincter muscle. The body-wall is incrustated. The ectoderm is continuous. The mesogloæa contains numerous lacunæ, and occasionally canals. Diccious. Polyps immersed in a thick cœnenchyme, which forms a massive expansion.

The above is the definition of the genus given by Haddon and Shackleton (1891, p. 691), who also add a detailed history of its complicated career.

In regard to the specific identification of its members, the genus *Palythoa* has always been recognized by specialists as one of extreme difficulty and uncertainty on account of its variability in form and the presence of only a few external diagnostic characters. Especially is this the case when, as usually obtains, its representatives are studied as alcoholic specimens in a condition of retraction and shrinkage in variable degrees. Great danger exists under these circumstances in the identification of isolated patches, or of even complete colonies. The external characters one has usually to depend upon are those of the amount of the column of the polyps free from the cœnenchyme, the dimensions, colour, wrinklings, number of capitular ridges and tentacles. All these are, however, very inconstant; only when a number of examples are obtainable for comparison can much value be placed upon them.

The height of the free portion of the column is mainly dependent upon the extent of retraction of the polyps, and is not a constant specific character. In one portion of a colony the upper surface may be almost uniform, none of the

polyps being raised above the general level of the cœnenchyme; in another part the polyps may be quite free for a few millimetres. Again, colonies would be collected which became quite flat on their distal surface, due to excessive retraction as a result of rough handling; but, on coming to observe them later, the polyps had elevated the upper part of their column distinctly above the level of the cœnenchyme, and the whole presented a very different aspect. Such variations have also been noted as occurring on the same colony at one and the same time. The dimensions, especially the height of the column and cœnenchyme, are also very variable, depending largely upon the irregularities of the incrustated rock and the presence of contiguous colonies; one side of a colony may be two or three times the height of another.

The colour is so very similar in all the Jamaican forms I have examined as to be of little assistance. So far I have only met with various tints of yellow and brown; a colony which appears yellowish in the water may become brown on removal. Transverse and longitudinal wrinklings are largely determined by the amount of shrinkage in preservation; alcohol material showing more than formalin. The number of tentacles has been used by Duchassaing and Michelotti as an important aid in distinguishing species. Generally, this can only be of service where one is able to study the forms in the living condition, most colonies appearing to prefer a retracted state after removal from their natural habitat. I have generally found that unless much injured in removal, the polyps open out sufficiently for investigation during the first day in the laboratory, and plunging into formalin has fixed them in this condition. I have studied the capitular or marginal ridges more particularly when the polyps have been thus partially or completely open. In the numerous cases counted, the ridges were always found to correspond with half the total number of the tentacles, *i. e.*, with one cycle.

Although varying somewhat, there is no doubt that the ridges and tentacles are of considerable utility for systematic purposes. How far they may be depended upon will be seen from the following observations made specially upon numerous colonies from the various Cays to test the reliability of the character. Each of the letters indicates a separate colony, or portion of one, and the figures the number of ridges counted upon the individual polyps sufficiently open for the purpose.

Lime Cay:

- A.—15, 13, 16, 16, 15, 15, 14, 15, 14, 16, 14, 15, 14, 16, 14, 15, 14, 14, 16.
- B.—19, 20, 19, 20, 19.
- C.—20, 19, 19, 20, 20.
- D.—22, 19, 19.
- E.—14, 14, 13, 14, 14, 15, 15.

South Cay:

- F.—14, 14, 14, 14, 14, 15, 14, 16, 14, 16.
- G.—18, 18, 18, 18, 19, 18, 18, 17, 19, 18, 18.
- H.—18, 18, 19, 18, 18.
- I.—18, 19, 18, 17, 19.

Drunkenman Cay:

J.—19, 18, 20, 18, 19, 19, 19, 20, 19, 19, 20, 20.

K.—17, 17, 19, 18, 18, 17, 18, 17.

L.—15, 20, 17, 16.

Gun Cay:

M.—14, 16, 15, 16, 15, 14, 15, 14, 17, 17, 14, 14, 16, 14, 16, 12, 12.

N.—14, 14, 16, 15, 14, 15, 16.

O.—16, 16, 17.

P.—16, 16, 16.

Q.—17, 16, 15, 14, 16, 14, 18, 16, 16, 14.

Maiden Cay:

R.—20, 18, 18, 16.

S.—18, 19.

T.—16, 16, 16, 17.

From these it will be seen that, in the series represented by B, C, D, G, H, I, J, K, R, S, the numbers vary from about 18 to 20, and in another, represented by A, E, F, M, N, O, P, Q, T, the numbers are roughly from 14 to 17. The average numbers of the capitular ridges of the two groups seem so constant and distinct that I have considered them of sufficient importance to justify a separation into the two accompanying species, and have found at the same time other distinctions which further support the conclusion. Although the genus occurs in such abundance around all the Cays, I have not found characters of sufficient stability to warrant the separation of more than these two species. Other diagnostic features will be discussed in dealing with their anatomy.

***Palythoa mammillosa* (Ellis and Solander).**

(Pl. XVII. A, figs. 7, 8.)

- Lapidis Astroitidis sive stellaris* Sloane, 1707, vol. 1, tab. 21, figs. 1-3.
primordia,
- Aleyonium mammillosum,* . . . Ellis and Solander, 1786, p. 179, tab. 1, figs. 4, 5.
Palythoa mammillosa, . . . Lamouroux, 1816, p. 361, [pl. xiii., fig. 2.
Palythoa mammillosa, . . . Milne-Edwards, 1857, p. 304.]
Palythoa ocellata, . . . Duchassaing and Michelotti, 1860, p. 329.
Palythoa mamillosa, . . . Duchassaing and Michelotti, 1866, p. 140,
 pl. vi., fig. 10.
Palythoa cinerea, . . . Duchassaing and Michelotti, 1866, p. 141,
 pl. vi., fig. 8.
Polythoa mammillosa, . . . Andres, 1883, p. 332.
Polythoa (Corticithoa) cinerea, . . . Andres, 1883, p. 323.

Form.—Polyps smooth, rigid, cylindrical, arranged in a somewhat rectangular manner; the smooth ectoderm is easily rubbed off exposing the mesogloea below, with a roughened surface due to the foreign incrustations; in retraction rounded or somewhat flattened above, free for a short distance beyond the surface of the cœnenchyme. In the living state, or when preserved in formalin without contraction, the polyps are equally free all round, and so closely arranged that they are separated above only by polygonal dividing lines, none of the cœnenchyme being visible (fig. 7). Specimens which have been preserved in alcohol and in which shrinkage has taken place are not equally free on all sides, but connected with one another by four (may be three or five when the polyps are not arranged in a rectangular manner) higher, occasionally grooved, ridges of cœnenchyme, and rounded depressions of cœnenchyme, are seen in the spaces between (fig. 8). A central, slightly depressed aperture remains in retracted polyps, and occasionally three to six longitudinal wrinklings along the free portion of the wall of the peripheral polyps are present in specimens preserved in alcohol, and also transverse wrinklings. The amount of the free portion varies according to the state of extension or retraction of the polyps in a colony. Usually in complete retraction about 0.4 cm. are free; in partial retraction, when the full capitular ridges can be counted, and in full expansion, about 0.6 cm. are free. In almost complete retraction the capitular ridges are wedge-shaped with very narrow furrows; as the polyps slowly open, the ridges become more convoluted or laterally undulating, and finally appear as so many acute marginal denticulations. These, as already shown above, are usually from 18 to 20 in number. The polyps of three other colonies from South Cay had a very regular number of ridges as follows:—

A.—19, 18, 18, 18, 18, 18, 18, 19, 18.

B.—19, 18, 18, 18, 18, 18, 18, 18, 19, 18, 19, 18, 19.

C.—18, 21, 18, 19, 18, 18, 18.

Tentacles very short, smooth, acuminate, dicyclic, inner row opposite the marginal denticulations, slightly entaemæous, overhanging in extension, 18 to 20 in each row. Disc cup-shaped in partial, and saucer-shaped in full, extension, but with the central part appearing as a dome and bearing the slit-like mouth at the apex. The peripheral zone of the disc is thin-walled, pellucid, smooth, devoid of incrustations, and raised into elevations and grooves corresponding with the number of tentacles, of which it appears as a continuation. In full extension it is flat or may be arched over; in partial extension it is nearly vertical. The central part of the disc is smooth, but contains a few incrustations. The species usually occurs in small, rather high colonies, closely associated with one another, but separated by deep channels. The incrusting base is much smaller in area than the distal surface, the peripheral polyps being arranged obliquely or

radiately. New individuals arise mostly along the side of those forming the periphery of a colony.

Colour.—Cœenenchyme and column pale yellow or cream colour, sometimes brown; tentacles and furrowed portion of disc pellucid; middle of disc grey, due to presence of sand-grains; lips white.

Dimensions.—Average height of polyps 1·3 cm., may be only 0·6 cm. or 1·8 cm.; diameter of flat expanded disc 1·2 cm.; average diameter of columns 0·6 cm.; distance of centres of contiguous polyps in retraction about 0·7 cm.; inner tentacles 0·2 cm. long. Colonies of various sizes are met with, but usually from 3 to 8 cm. across.

Locality.—Jamaica: found in abundance firmly encrusting the coral-rock in shallow water, mostly in the region of the breakers, at the Cays outside Kingston Harbour, and at other points around the coast.

Range.—Guadaloupe and St. Thomas (Duchassaing and Michelotti).

Column-wall (Pl. XIX., fig. 1).—The column-wall of the individual polyps is separable from the cœenenchyme for only a short distance at the upper surface of the colony. The two are not very thick compared with the size of the polyps. In transverse sections the cœenenchyme may be from 0·1 to 0·2 cm. in thickness, while the polyps are from 0·6 cm. to 0·3 cm. in diameter.

The ectoderm is a thick layer, and continuous over the outer surface of a colony; a cuticle, devoid of foreign adhering matter, is present. Its internal limitations are occasionally irregular, due to the incrusting sand-grains; these latter are limited to the inner part of the ectoderm and to the mesogloea. The outer portion of the ectodermal cells is largely glandular; the middle and inner parts contain the nuclei, numerous zooxanthellæ, and occasional large oval colourless nematocysts showing the internal thread.

The mesogloea varies in thickness, appearing in sections as a matrix in which the cylindrical polyps are embedded. The incrusting material is practically distributed throughout; in the periphery of a colony however it is rather limited to the outer half. The foreign objects are mostly calcareous, but a few siliceous sponge spicules and an occasional Foraminiferal and Radiolarian test may be present. Abundant small and large cell-islets or short canals are distributed with considerable uniformity; the latter in some sections exhibit somewhat of a concentric arrangement around the individual polyps, and may be seen communicating with the canals in the mesenteries. In others, a canal appears opposite nearly all the mesenteries. The islets contain zooxanthellæ and large oval nematocysts; the smaller islets have the protoplasm exhibiting peripherally a fine morula-like appearance, with a central more deeply staining nucleus. A similar

condition is described under *Isaurus tuberculatus* (p. 347). Fine threads connect one group of cells with another.

The endoderm is a uniformly thin layer, and contains zooxanthellæ. A weak circular endodermal muscle is present.

Sphincter muscle (Pl. XIX., fig. 1).—The sphincter muscle is single, mesogloæal, and contained in an elongated series of irregular cavities, situated near the endoderm; small cavities occur along with larger ones, all forming an irregular row.

Tentacles.—The ectoderm is very thick, consisting of an outer zone of small, elongated, narrow nematocysts, and an inner one with deeply-staining nuclei, zooxanthellæ, and pigment granules. The ectodermal muscle is well developed on mesogloæal plaitings. The mesogloæa in places is rather thick, and contains cell-islets. The endoderm is somewhat high, nearly filling up the lumen; the circular muscle is readily seen, forming a very regular layer in longitudinal sections.

Disc (Pl. XIX., fig. 4).—The peripheral grooved portion of the disc has a very thick, highly glandular, sinuous ectoderm, containing zooxanthellæ, small peripheral nematocysts, and occasional deeper oval ones; also a well developed radial muscle. The mesogloæa follows the projecting fold, and becomes very thick, and may contain a few sand-grains; between the folds it is very thin. The endoderm is the same as elsewhere. In longitudinal sections of contracted specimens the part next the tentacles is thick; it then becomes delicate, and again enlarges towards the lips where incrustations occur in the mesogloæa. An endodermal muscle is present.

Œsophagus (Pl. XIX., figs. 2, 3).—The œsophagus in different sections is either an elongate or a shortened pear-shape, with a well defined œsophageal groove. The ectoderm is richly ciliated; a zone of closely-arranged narrow nematocysts occurs peripherally, while the nuclei are arranged mostly in a middle zone; pigment matter occurs in the deeper parts, abundantly in some, sparingly in others. The ectoderm in most is thrown into folds which vary in number, but are generally between eight and eleven; in some sections the ectoderm is unfolded.

The mesogloæa is thin, becoming a little thicker at the groove; it does not follow the foldings of the ectoderm.

The endoderm is similar to that in the column-wall, but is slightly deeper between the mesenteries. It differs from that of the mesenteries in having little or no pigment matter.

Mesenteries (Pl. XIX., figs. 2, 3).—The mesenteries in most cases present the usual brachycnemic type, but irregularities may occur, and opposite sides have not always the same number of pairs. The usual arrangement is that of ten perfect

mesenteries on each side, but in one polyp there are ten on one side and nine on the other; in another seven and nine, arranged as shown in fig. 3. The fundamental distinction of the Zoanthidæ into Brachyreneminae and Macroreneminae is departed from in the sections of two polyps represented. In fig. 2 it is seen that the normal brachyrenemic arrangement holds on the left side, while the macrorenemic is present on the right side. This is also the case in fig. 3, only the order is reversed.

The manner of the connexion of the mesenteries to the œsophagus is best shown in fig. 2. Beyond the sulcar directives there is a considerable interspace before the other mesenteries are reached, and then the interspaces are about equal. The mesenteries are very thin near their attachment to the column-wall, but enlarge a little to form the basal canal. The imperfect mesenteries do not project far. The endoderm contains zooxanthellæ and pigment matter, and the mesoglœa is extremely thin. The parieto-basilar muscles are well developed. The basal canal is usually rounded, and contains numerous large oval nematocysts. The reflected ectoderm and mesenterial filaments present the usual structure. The digestive endoderm is very thick and granular.

Gonads.—No gonads were present in numerous examples sectionized.

Cœnenchyme.—The basal portion of the cœnenchyme is very crowded with canals in communication with the basal canals in the mesenteries and containing pigment granules and large oval nematocysts. Cœlenteric canals connect one polyp with another.

This species, first described by Ellis and Solander, is one of the two original representatives of the genus *Polythoa* of Lamouroux. The material upon which it was founded was originally obtained by Sir Hans Sloane from Jamaican waters, probably about the year 1687, when Sloane visited the island. The specimens were deposited by him in the British Museum; the collections of the famous naturalist and physician forming the nuclei of that national institution. Sloane, however, in his "Voyage," which deals largely with the Natural History of Jamaica, has no description of the objects beyond that given on the plate containing his three figures, "*Lapidis astroitidis sive stellaris primordia*," implying that this, along with the *Aleyonium ocellatum*, of Ellis and Solander, are the beginnings of the stony star-like corals, so abundant in the seas around.

Ellis and Solander first named, described, and again figured Sloane's specimen. Although their description, "This whitish leather-like Aleyonium is spread over rocks, with many convex teat-like figures, hollow in the middle, with a faint star-like appearance, and united close together," is rather incomplete for purposes of identification, still the excellent figure they give of a colony leaves me little hesitation in considering the form described above as the same these two authors

had under consideration. The dimensions, amount of the polyps not immersed in cœnenchyme, and the general form of the colony well agree. I feel all the more assurance in this seeing that similar specimens may be collected in abundance from what we may regard as the original locality of the type. It is not at all improbable that Sloane obtained his examples from precisely the same Cays, these being, as already mentioned, the usual and most favourable spots for marine collectors.

Duchassaing and Michelotti (1860) describe as *P. ocellata* a form which, in their later paper (1866), they place under *P. mamillosa*. They also regard the *Corticifera flava* of Lesueur as a variety. It seems pretty evident that these authors, taking the number of tentacles as a criterion, introduced some little confusion, so that it is now very difficult, if not impossible, to ascertain what forms they are really describing.

There is nothing appearing in the original description and figure of *P. cinerea* which is not met with in the large amount of material of *P. mamillosa* which has come under my observation, the colour, form of the original polyps, and incrustations of the latter presenting all the variations ascribed to the former, while the number of tentacles exactly corresponds.

The species is readily distinguished *in situ* from the next one by its habit of growth, occurring mostly in numerous, closely associated, irregularly shaped, small, high colonies, separated by channels 2 or 3 cm. across. The colonies are usually from 8 to 10 cm. in diameter, but may be more. The individual polyps are also larger, and appear to open more readily and constantly, and to have a greater free distal portion.

The larger number of capitular ridges, tentacles, and corresponding mesenteries is evidently constant. The variations in transverse dimensions are more clearly indicated in sections. In the present species the diameter is often 0.6 cm., while in the next it is rarely more than 0.35 cm.

Histologically I have not been able to detect much specific difference. Numbers of sections have been examined from various colonies, some with the incrustations *in situ* and others decalcified. Although the incrustations are abundant and uniformly distributed throughout the colony, the mesoglœa is apparently not so crowded with them as in *P. caribœa*.

The basal canals appear more rounded, and perhaps the internal pigmentation is not so dense in the present example; also, as shown in the figure, the cavities of the sphincter muscle are not in such a regular row.

***Palythoa caribæa*, DUCHASSAING and MICHELOTTI.**

(Pl. xvii. A, fig. 9.)

- Palythoa caribæorum*, . . . Duchassaing and Michelotti, 1860, p. 329.
Palythoa caribæa, Duchassaing and Michelotti, 1866, p. 141, Pl. vi.,
 fig. 11.
Polythoa (Monothoa) caraibcorum, Andres, 1883, p. 322.

Form.—Polyps smooth, rigid, cylindrical, closely associated and arranged in an irregular manner, usually free from the cœnenchyme for a short distance, free portion rounded or conical in retraction; in very strong retraction, the upper surface of the colony may be nearly flat; no wrinklings in specimens preserved in formalin. Capitular ridges and furrows variable, usually from 14 to 17. The following numbers counted on two colonies will indicate the amount of this variation:—

A.—15, 14, 16, 15, 14, 16, 14, 16, 15, 15, 15, 15, 14, 15, 15, 15, 15, 15, 16, 15, 14,
 16, 16, 17, 16, 17, 15, 14, 17, 15, 15.

B.—14, 18, 16, 14, 17, 15, 17, 17, 15, 17, 14, 15, 15, 14, 15, 14, 16, 15, 16, 16, 16, 16,
 16, 17, 17.

Tentacles dicyclic, smooth, pellucid, very short, acuminate, slightly entacmæous, inner row opposite capitular ridges, overhanging in full extension, vary from 28 to 34 in number. Disc considerably depressed in partial extension, overhanging in full extension, cup-shaped or saucer-shaped, according to amount of extension; divisible into two portions: an outer, thin, transparent, non-incrusted, circular area with rounded ridges and furrows corresponding to the number of tentacles, and a dome-shaped central portion, with a few minute incrustations, and bearing the slit-like mouth at the apex.

The polyps are arranged very closely, and the amount of cœnenchyme connecting the individuals is thin. At the periphery of the colonies, the outlines of the different marginal polyps are clearly indicated. New individuals appear to arise between previously existing ones. The colonies are usually very extensive, irregular in outline, and often incrust very uneven surfaces, the height of the polyps varying accordingly, so as to produce a regular undulating surface above.

Colour.—In the living condition, a pale yellow or cream colour, or sometimes brown, white when the ectoderm is rubbed off, lips white. In specimens preserved in formalin a curious change is effected. Nearly the whole of the upper surface of the colony may become a brick-red colour. The capitular ridges, however, for

some distance down the column, are quite colourless and hence readily counted. The tentacles, inturned disc, and edges of the mesenteries are likewise altered in colour.

Dimensions.—The length of the polyps and the thickness of the cœnenchyme differ very much, may vary from 0·3 or 0·4 cm. to 1·8 cm., usually about 0·7 cm.; diameter of disc in partial extension 0·5 cm., in full extension 0·9 cm., in retraction 0·4 cm.; distance of centres of contiguous polyps 0·5 cm.; height of free portion above the level of the cœnenchyme in partial retraction about 0·5 cm.; tentacles about 0·2 cm. long; diameter of polyps in section 0·35 cm.

Activities.—Quantities of bubbles of gas are given off when the colonies are exposed in the water to the direct rays of the sun. The polyps do not appear to open so readily as in *P. mammillosa*.

Locality.—Jamaica: Numerous colonies form flat expansions covering considerable areas of coral rocks, at all the Cays outside Kingston Harbour.

Range.—St. Thomas (Duchassaing and Michelotti).

Column-wall (Pl. XIX., fig. 5).—The lower boundary of the column-wall of the individual polyps in a colony can not be distinguished from the cœnenchyme in which the polyps present the appearance of being embedded, but above it is quite distinct. The ectoderm is continuous, and spreads as a uniform layer over the surface of the whole colony; a thin, well defined cuticle occurs on the outside. It is not readily separable from the mesogloea, appearing to pass insensibly into the cell-enclosures of the latter; narrow elongated nematocysts occur, as well as very large oval nematocysts, which do not stain; zooxanthellæ are present; foreign incrusting material is met with only in the deeper part of the ectoderm.

The mesogloea is densely crowded throughout its whole thickness with calcareous sand-grains; a few siliceous sponge spicules, Radiolarians, and rarely a Foraminifera occur; most of the material can be dissolved out by acids. Isolated cells and large and small cell-islets are scattered throughout; the large nematocysts, pigment granules, and densely staining tissue fill up the islets.

The endoderm is very thin and uniform in height, except in the upper region where the mesenteries are closer, when the endoderm elongates in the middle and appears triangular in section. It contains abundant granular pigment matter and zooxanthellæ; a weak endodermal muscle is present on slight plaitings of the mesogloea, especially in the upper region.

Sphincter muscle (Pl. XIX., fig. 5).—The single sphincter muscle is contained in a very regular series of small mesogloéal cavities; proximally they are situated close to the endodermal border, but are more central above, where also the cavities are not in such a single series and become a little larger. The muscular lining is thick, but does not quite fill the cavities.

Tentacles.—The tentacles have a very broad ciliated ectoderm crowded with narrow elongated nematocysts, zooxanthellæ, and pigment granules; the mesogloea and the endoderm are thin. The longitudinal ectodermal muscle is well developed on small mesogloéal plaitings.

Disc.—The ectoderm of the disc is broad and contains nematocysts, zooxanthellæ, and pigment granules in the deeper parts. The mesogloea thickens towards the middle, and incrustations are there present. The endoderm is like that of the column-wall.

Œsophagus.—The outline of the œsophagus varies in different regions and in different specimens. In most polyps it is the usual pyriform, truncated shape, with the ectoderm thrown into seven or eight longitudinal folds on each side, and the œsophageal groove well marked and occupying nearly one-third of the transverse diameter; but in others, it may be almost circular in outline with none of the folds showing. The ectoderm is very thick, stains deeply, is richly ciliated, and loaded internally with yellow pigment granules, and outwardly with elongated nematocysts. The mesogloea is narrow, thickening a little at the groove; the endoderm is like that of the column-wall.

Mesenteries (Pl. XIX., fig. 7).—The mesenteries present the usual brachyenic arrangement in most cases; but, as already mentioned, irregularities may occur, so that a polyp may be brachyenic on one side and macroenic on the other, while one polyp has been met with which has the latter arrangement on both sides. The number of pairs is variable, and the two lateral halves do not always correspond. In a portion of one colony two polyps have eight perfect mesenteries on each side; two have eight on one side and seven on the other; while another has six on one side and eleven on the other. The imperfect mesenteries are well developed. The endoderm is very thick, and contains zooxanthellæ, nematocysts, and abundant pigment matter. The parieto-basilar muscle is clearly seen on each side, but the retractor muscle layer is scarcely distinguishable. The mesogloea is extremely thin, except towards the column-wall, where the canals or sinuses extend nearly the whole vertical length; they occupy almost the whole transverse width in the uppermost region, but are elongated or oval below. The basal canals are well developed in both the perfect and imperfect mesenteries, and are crowded with oval nematocysts and pigment particles, and connected below with the sinuses in the coenenchyme. The ectoderm of the œsophagus is reflected and folded on the mesenteries. The endoderm on the lower part of the mesenteries is enormously thickened and loaded with granules; the mesenterial filaments become nearly circular.

Gonads (Pl. XIX., fig. 6).—Spermaria, arranged in vertical and transverse rows, were present in the mesenteries of some of the polyps examined.

I identify the abundant Jamaican material with Duchassaing and Michelotti's species, mainly from the number of tentacles which these authors give, viz., thirty to thirty-two; these coming nearest to those indicated above. The figure which they give is of a dried specimen with all the polyps withdrawn to their full extent.

At first I considered it to be *Acyonium ocellatum*, Ell. and Sol., obtained along with *A. mammillosum* by Sloane from Jamaica, there being nothing in the original descriptions and figures which is not met with in the specimens I have examined. M^cMurrich has, however (1889, p. 120), appropriated this name for some small colonies from Shelley Bay, Bermudas. He does this upon very slender grounds, this being the name given it by the collector. He has very kindly compared the Jamaican examples with those from the Bermudas, and states that they are quite different, especially in their anatomical characters, although acknowledging that it would seem as if they were the true *P. ocellata*. Under the circumstances, however, it seems best that M^cMurrich's identification should stand, and to allocate Duchassaing and Michelotti's name, with which the material very closely agrees. Andres (1883, p. 323) is evidently acting contrary to these two authors in considering the *Hughæa caraibeorum* of Duchassaing as a synonym of this species, as, in the "Mémoire" (p. 315), they place it in the genus *Paraetis*.

In a quantity of colonies, it can easily be separated from *P. mammillosa*, not only by the average number of capitular ridges and tentacles, but by the differences in size of the polyps, those of the present species being smaller and more closely aggregated than the former. Usually the colonies are flatter, and cover larger areas. The polyps generally retract to a greater degree, so that the upper surface of the colony becomes more uniform.

Sub-family.—MACROCNEMINÆ.

Epizoanthus, Gray, 1867.

Macrocnemic Zoantheæ, with a single mesoglœal sphincter muscle. The body-wall is incrustated. The ectoderm is usually continuous, but may be discontinuous; cell-islets in the mesoglœa. Diccious. Polyps connected by cœnenchyme, which may be band-like, incrusting, or greatly reduced, as in the free form.

The genus *Epizoanthus* is defined as above by Haddon and Shackleton (1891, p. 632) accompanied by a full account of its history. They recognize twelve

species from various parts of the world, and four doubtful forms. Some of the representatives of the genus form incrustations over the surface of univalve shells inhabited by hermit-crabs, the shells being ultimately dissolved away. The colony, known as a carcinæcium, retains somewhat the form of the shell, and contains the crustacean still within.

Epizoanthus minutus, n. sp.

(Pl. xvii. A, fig. 10.)

Form.—Polyps cylindrical, rising obliquely or vertically from a thin, incrusting, ribbon-like cœnenchyme. In complete retraction rounded above with a small aperture remaining, but no capitular ridges and grooves distinguishable. Slightly enlarged towards the base; about the same height as breadth in retraction, not much more in extension; surface rough, covered with very fine sand grains; occasionally with slight transverse wrinklings. In partial retraction swollen and flat above, with the wedge-shaped, acute, capitular ridges and furrows visible, and the slit-like mouth showing. In full extension the upper part of the column is spread out and the middle constricted; margin of column with fifteen or sixteen or twenty-one denticulations, each with parallel sides and a straight free edge, giving a castellated appearance. Disc much depressed, cup-shaped, transparent, with lines of attachment of mesenteries showing through; mouth elevated. The disc, as usual, is divisible into a grooved outer part forming the walls of the cup in extension, and appearing as a continuation of the united bases of the tentacles, and an inner, smooth, flat or slightly elevated, central part bearing the mouth in the middle. Tentacles dicyelic, thin, transparent, elongated, slightly swollen and rounded at the tips, outer series alternating with the denticulations, entacmæous, overhanging in extension, generally thirty or thirty-two in number, but occasionally forty-two. Cœnenchyme thin, incrusting, ribbon-shaped or irregularly expanded where the polyps are closer; surface same as that of column-wall. Polyps arise independently, and may be considerably separated or more closely grouped.

Colour.—Column-wall and cœnenchyme are a dirty brown, the colour of the sand particles; denticulations with white margins; disc brown, with darker radiating lines; tentacles transparent, several series of dark patches are present, more pronounced on the outer row, tips almost opaque white.

Dimensions.—Height of polyps in extension 0·6 cm., in contraction 0·35 to 0·2 cm. Diameter in extension 0·3 cm., in retraction 0·25 to 0·2 cm. Length of tentacles in full extension 0·4 cm.

Locality.—Found growing in abundance near the margin of one of the valves of a living *Pinna* shell, collected towards the eastern extremity of Kingston

Harbour in water of not more than half a fathom in depth, and only a few yards from the shore. The polyps are very sensitive and active, retracting immediately on being touched.

Column-wall (Pl. xx., figs. 1, 2).—The outline of the column-wall, owing to the presence of incrusting material, is very irregular in sections, especially in the lower part; in the region of the marginal denticulations it is sinuous, and thicker, and the incrusting matter is aggregated opposite the inner circle of tentacles. Where perfect, the ectoderm is continuous; in most places, it is broken up or absent. It is covered on the outside by a cuticle with an adhering layer of foreign material, mostly diatom frustules and fine mud.

The mesoglœa varies in thickness, being much better developed proximally. It contains isolated cells with long processes, cell-islets, and irregular communicating canals. The incrustations are sparsely distributed, and are mostly siliceous sand grains and a few sponge spicules.

The endoderm is very thin and regular, and the transverse muscle is well developed.

Sphincter muscle (Pl. xx., fig. 1).—The single mesoglœal sphincter muscle is small, and formed in a few, irregular, closely set cavities, extending about half way across the mesoglœa, and situated just at the base of the outer row of tentacles. The lining muscle-fibres are weak, and other rounded cells partially fill up the cavities.

Tentacles (Pl. xx., figs. 2, 3).—The ectoderm of the tentacles is thick compared with the two other layers, and the ectodermal muscle is well developed on small mesoglœal plaitings; numerous small oval nematocysts occur, and pigment granules in places. The nervous layer is clearly distinguished between the nucleated zone and the muscle fibres, and sends connecting strands to each. The mesoglœa and endoderm are both very thin. An endodermal muscle layer is present, seen in longitudinal sections.

Disc (Pl. xx., fig. 2).—The structure of the disc is much like that of the tentacles, but the ectoderm is not so well developed, and its outer grooved portion is in places loaded with pigment granules.

Œsophagus.—In extended specimens the œsophagus is almost circular in outline; the œsophageal groove is quite shallow. In longitudinal sections the wall is thrown into transverse folds. The ectoderm is a very regular, ciliated layer, with abundant gland-cells and a few small nematocysts; pigment granules occur in the deeper parts; it is reflected above the lower termination of the œsophagus, and below forms the mesenterial filaments in the usual manner. The mesoglœa and endoderm are very thin, especially the latter.

Mesenteries (Pl. xx., fig. 4).—Sixteen pairs of mesenteries, presenting the usual

macrocnemic arrangement, occur in one specimen, and are all very thin except near their origin and where fertile; the imperfect are very short; the parieto-basilar muscle is developed along each side; no basal canals, or only traces of them, are present. The mesenterial muscles are seen on slight plaitings; pigment granules occur in groups on the endoderm. The digestive endoderm is thick, and large oval nematocysts are embedded in it, along with groups of pigment granules. The imperfect mesenteries have the muscle fibres extending all round. In the distal region, just below the œsophagus, the mesogloea at the origin of the mesenteries is rectangular, but proximally it becomes goblet-shaped, the part produced beyond in perfect mesenteries being extremely thin. Proximally the mesenteries are branched.

Gonads (Pl. xx., fig. 4).—Spermata apparently enclosed in endoderm were met with in abundance in two specimens.

This species is most closely allied in outward appearance to the well known European *Epizoanthus Couchii* (Johnston), Hadd. and Shackl. Obvious differences occur in the number and form of the capitular denticulations, the Antillean representative having fifteen, sixteen, or twenty-one, truncated at their free edge; while the older species has twelve or fourteen triangular teeth. The tentacles differ in a corresponding manner. Histological characters indicate further distinctions. It is readily separated from the seven other species examined by the two authors mentioned above, and also from the "Challenger" species. Of American forms it appears to bear a close relation to the incompletely described *Epizoanthus humilis*, Verr. (1869), from Panama.

Parazoanthus, Haddon and Shackleton, 1891.

Macrocnemic Zoantheæ, with a diffuse endodermal sphincter muscle. The body-wall is incrustated. The ectoderm is continuous. Encircling sinus as well as ectodermal canals, lacunæ, and cell-islets in the mesogloea. Dioecious. Polyps connected by thin cœnenchyme.

This genus, with the above definition, was established by Haddon and Shackleton (1891, p. 653), to include macrocnemic Zoantheæ with a diffuse endodermal muscle, forms which previously had been referred by Hertwig and Erdmann (1888, p. 35) to the genus *Palythoa*. The authors recognize five species examined by them, and two described by Hertwig and Erdmann. The combination of anatomical characters renders it a well-defined genus.

Carlgren (1895) has shown that the genus *Gerardia*, Lac.-Duth., formerly included, with some hesitation, amongst the Antipatharia, is closely allied to the present genus, differing only in the presence of a strongly developed horny skeleton.

Parazoanthus Swiftii (Duchassaing and Michelotti).

(Pl. xvii. A, fig. 11.)

Gemmaria Swiftii, . . . Duchassaing and Michelotti, 1860, p. 331, pl. viii.,
figs. 17, 18: 1866, p. 138.

Polythoa (*str. s.*) *axinellæ*, Andres, 1883, p. 311, pl. x., fig. 7.

Form.—Polyps very short, cylindrical, mammiform in retraction, erect, firm, smooth, rising from small band-like branching patches of cœnenchyme incrusting the surface of a sponge; sometimes the polyps are arranged in a single linear series, at other times the cœnenchyme is expanded, and two or three individuals may occur abreast. Capitulum with twelve serrations at the apex. In partial retraction these appear as so many wedge-shaped ridges, with intervening furrows, around a central orifice; in full retraction the capitular ridges are scarcely visible, and the polyps are rounded above.

Tentacles minute, entacmæous, acuminate, dicyclic, twelve in each row, the outer alternating with the serrations, overhanging in extension. Disc concave, transparent, with mesenteries showing through; mouth slit-like and capable of considerable eversion; lips crenate; œsophagus shows longitudinal mesenterial lines; oral cone may be considerably elevated. The usual condition of the polyps appears to be that of retraction.

The cœnenchyme is smooth, thin, in irregularly shaped meandering ribbons or patches firmly incrusting and partially embedded in the sponge.

Colour.—Cœnenchyme and column-wall are a bright orange yellow, lighter on the upper part of the column; tentacles are pale yellow; disc a darker, and lips a bright yellow. The parts are sand-coloured where the ectoderm is rubbed off. The bright orange colour gives to the colonies a marked contrast with the dark green sponge.

Dimensions.—Height of polyps above the cœnenchyme varies from 0.15 cm. to 0.3 cm.; diameter of expanded disc 0.4 cm.; diameter of column in contraction 0.2 cm.

Locality.—Jamaica: Obtained growing in small colonies on a large, erect, blackish-green, branching sponge collected in water of about two fathoms around Rackum Cay; also from the shallow waters S. W. of Lime Cay, living on the same species of sponge.

Range.—St. Thomas (Duchassaing and Michelotti).

Column-wall (Pl. xx., fig. 5).—The column-wall is very thick. The cuticle

is well defined; the ectoderm continuous and variable in height, with irregular internal limitations. Excepting a narrow zone immediately below the cuticle, the ectoderm cells are crowded with abundant yellow pigment granules of various sizes and numerous medium-sized, oval, colourless nematocysts. It is practically free from inclosures, these being limited to the mesoglœa.

The mesoglœa shows a very marked division into two parts. The outer is a thick layer of variable dimensions, and crowded with foreign inclosures and abundant yellow pigment granules, limited internally by the encircling sinus. This latter is broken here and there by strands of mesoglœa, and has very irregular limitations; the cavities are filled with deeply staining tissue and pigment. The inner layer of the mesoglœa is clear and nearly homogeneous, devoid of incrustations and pigment granules, and plaited internally to support the endodermal muscle. The incrustated part in retracted specimens is enlarged a little below the middle of the column, and contains cell-enclosures. The incrustations consist of siliceous and a few calcareous sand grains, and sponge spicules. The mesoglœa is too crowded with incrustations and pigment matter to allow of any connecting canals which may be present between the ectoderm and the encircling sinus being distinguished.

The endoderm cells are high, especially between the mesenterics, and contain abundant yellow pigment spheres and granules; a little below the middle of the column, they give rise to a well developed circular endodermal muscle supported on folds of the mesoglœa.

Sphincter muscle (Pl. xx., fig. 5).—The sphincter muscle is diffuse and endodermal, and formed as a greater concentration of the ordinary endodermal muscle of the column-wall. Distally it is so deeply sunk in the folds of the mesoglœa that in some sections it appears to be entirely cut off from the endoderm, and to become a mesoglœal muscle enclosed in separate cavities.

Tentacles.—In transverse sections of retracted polyps, the tentacles are so closely arranged as to become polygonal in outline. The ectoderm is thick, and has an outer zone of narrow nematocysts capable of staining; below is an irregular zone of pigment granules. An ectodermal muscle on slight mesoglœal plaitings is seen in transverse sections. The mesoglœa is only a thin layer, and internally is thrown into folds for the support of the circular endodermal muscle.

The endoderm has abundant pigment spheres and fills the lumen in contraction. The distinction between the granular pigment matter in the ectoderm and the spherical form in the endoderm, although of the same colour, is very marked. A similar difference is found in the ectoderm and endoderm of the column, but not to such a degree as in the tentacles. All the three layers of the disc are but little developed, presenting a marked contrast to the tentacles.

Œsophagus.—The ectoderm of the œsophagus is richly ciliated and folded; the

deeply staining nuclei are arranged in a middle zone; narrow nematocysts occur and large deeply staining granular gland-cells. The mesogloea is very narrow. The endoderm is thick and crowded with pigment spheres. A sulcar groove occurs, and here the mesogloea is much thickened, but contains no cell-enclosures.

Mesenteries (Pl. xx., fig. 6).—Twelve pairs of mesenteries, macrocnemic in their arrangement, are present. In the upper region each is a little narrow at its insertion in the column-wall, but the mesogloea thickens rapidly; only for a short distance in the œsophageal region, but more below. In the perfect mesenteries, the mesogloea beyond is very thin, and appears to alter in character so that it takes the stain better. There are no basal canals nor any cell-enclosures in the upper region; but lower two or three short canals, or there may be only cell-enclosures with pigment granules, appearing in the thickened part of the mesenteries. The endoderm is like that of the column-wall. Below the œsophagus it thickens enormously, and contains much pigment and granular matter; the mesenterial filaments are well developed and branched. In these, the zone of nuclei stains deeply, and occasional very deeply staining glandular cells are present along with nematocysts and much pigment matter. The parieto-basilar muscle is well marked on each side of the mesentery, extending a very little along the column-wall. In the imperfect mesenteries, the musculature extends the whole way round; in the perfect mesenteries, scarcely any distinction can be made in the musculature of each side, and the mesogloea is finely plaited.

Gonads (Pl. xx., fig. 6).—All the specimens examined from one colony contained abundant ova, present only on the perfect mesenteries, and associated with much pigment matter and enormously thickened endoderm.

Cœnenchyme and Base (Pl. xx., fig. 5).—The proximal surface of the base and cœnenchyme, in contact throughout with the sponge, has a thin ectoderm crowded with yellow pigment granules. The ectoderm of the upper surface of the cœnenchyme is thick, and resembles that of the column-wall.

The mesogloea is rather thick, and its inclosures are similar to those of the column-wall, but with a larger proportion of sponge spicules; cell-inclosures are numerous, and contain pigment granules. The endoderm of the base of the polyp is very thin, and contains pigment spheres and granules.

This species was first described by Duchassaing and Michelotti from specimens obtained at St. Thomas. Of their figures (references to which are omitted from the "Explication des Planches"), fig. 18 gives an approximate representation of the appearance of the colonies on the sponge; but fig. 17 is probably erroneous in the number and appearance of the capitular ridges and furrows indicated. Eight of these are shown, while in every case I have found twelve. In their later paper (1866, p. 138) they state the number of tentacles to be twenty-four, and arranged in two series; and it is generally found that the capitular radiations

correspond in number with one series of the tentacles. Andres (p. 311) regards the species as synonymous with *Polythoa axinella*, Schmidt. This has since been described by Haddon and Shackleton (1891, p. 654), who make it the type species of the present genus. It will be found from the account here given, that the West Indian representative differs from the description of the European example, likewise commensal with a sponge, in many features both of form and anatomy.

The extraordinary abundance of the bright yellow pigment granules throughout the ectoderm and endoderm should be noted in the present species.

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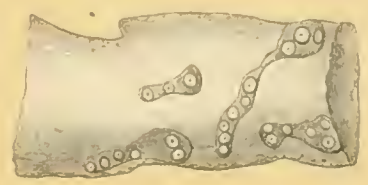
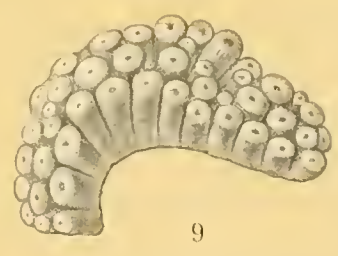
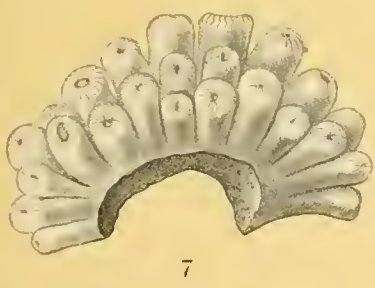
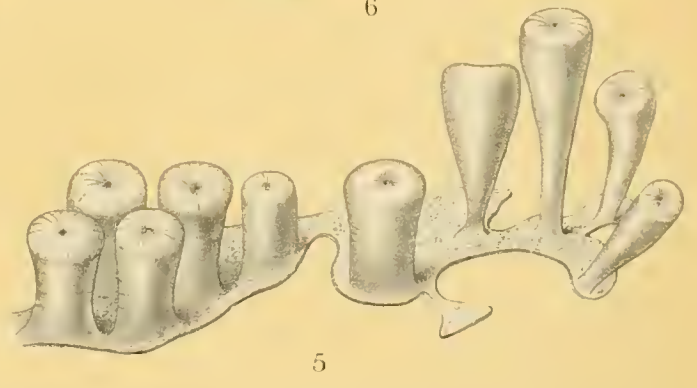
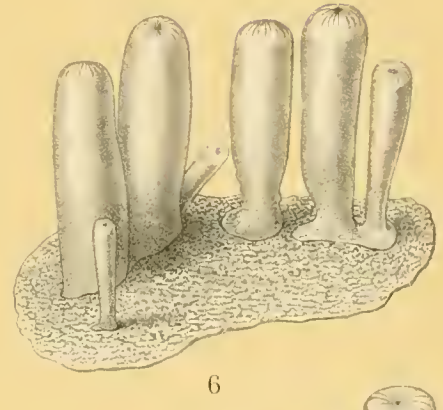
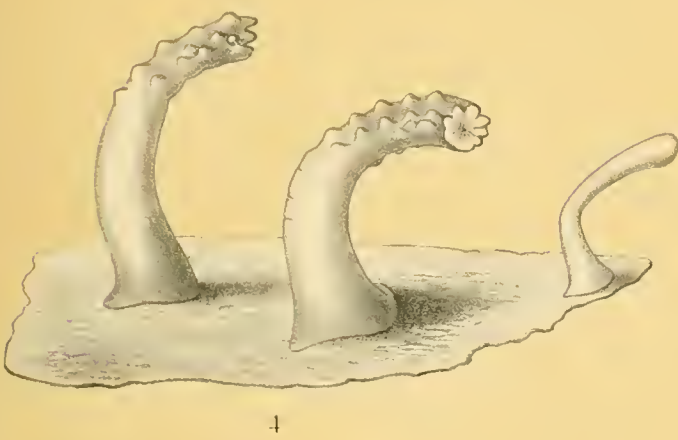
EXPLANATION OF PLATE XVII. A.

PLATE XVII. A.

Figure.

1. *Zoanthus Solanderi*, Les. (p. 335). Drawn from formalin material.
2. *Zoanthus flos-marinus*, Duch. and Michl. (p. 339). Drawn from formalin material.
3. *Zoanthus pulchellus* (Duch. and Michl.), (p. 341). Drawn from formalin material.
4. *Isaurus Duchassaingii* (Andres), (p. 346). Drawn from formalin material.
5. *Gemmaria variabilis*, n. sp. (p. 350). Drawn from alcohol material.
6. *Gemmaria fusca*, n. sp. (p. 354). Drawn from formalin material.
7. *Palythoa mammillosa* (Ell. and Sol.), (p. 359). Drawn from formalin material.
8. *Palythoa mammillosa* (Ell. and Sol.), (p. 359). Drawn from alcohol material.
9. *Palythoa caribaea*, Duch. and Michl. (p. 365). Drawn from formalin material.
10. *Epizoanthus minutus*, n. sp. (p. 369). Drawn from life.
11. *Parazoanthus Swiftii* (Duch. and Michl.), (p. 372). Drawn from formalin material.

The dimensions represented are practically the same as in the living condition.



8

11

EXPLANATION OF PLATE XVIII. A.

PLATE XVIII. A.

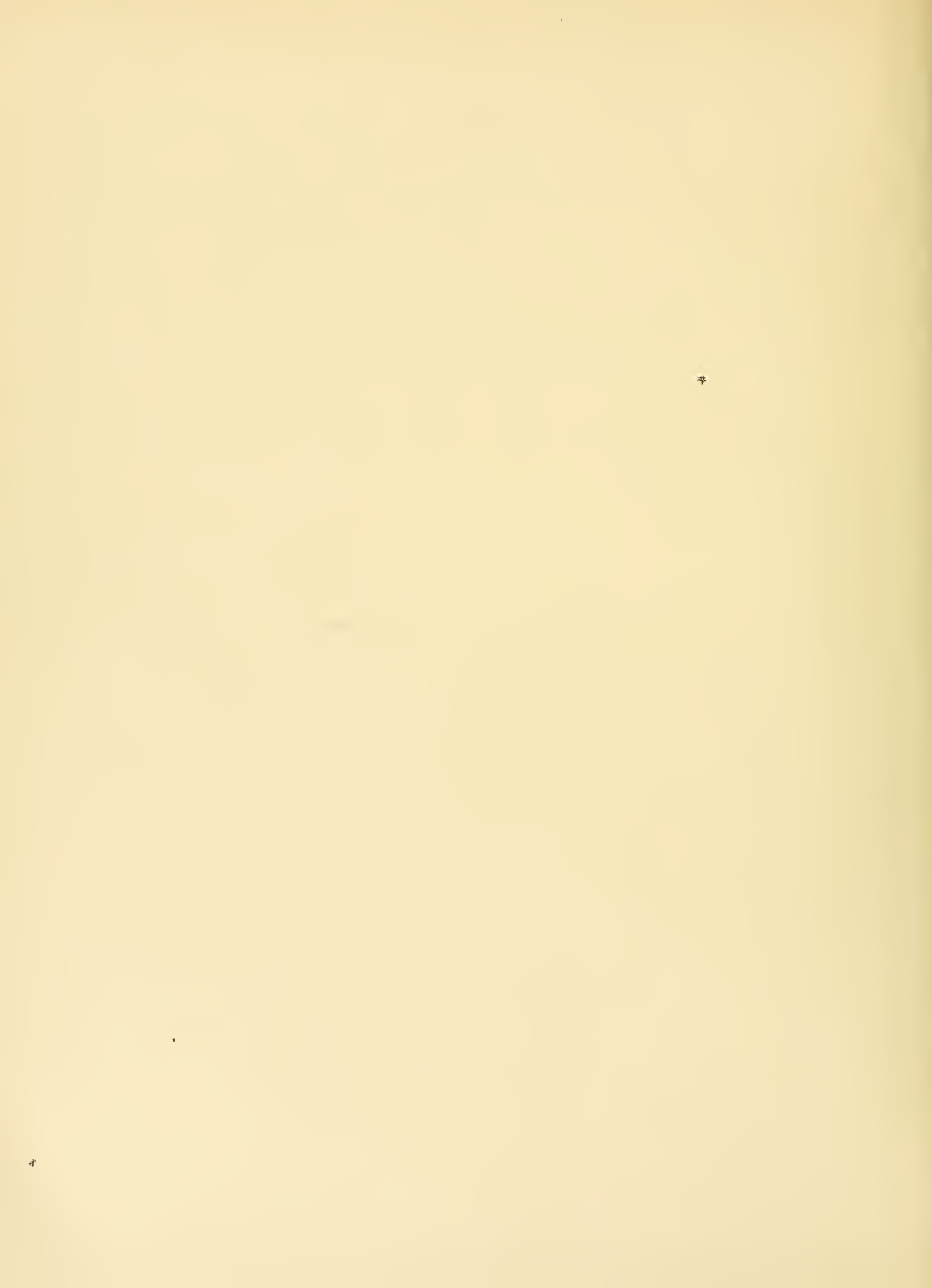
LETTERING ON THE FIGURES.

<i>b. can.</i> ,	basal canal.	<i>mes. sph. m.</i> , . . .	mesogloéal sphincter muscle.
<i>c. isl.</i> ,	cell-islets.	<i>mes. c.</i> ,	mesogloéal cells.
<i>ect.</i>	ectoderm.	<i>mes. lac.</i> ,	mesogloéal lacunæ.
<i>ect. fld.</i> ,	ectodermal folds.	<i>p. b. m.</i> ,	parieto-basilar muscle.
<i>d. mes. sph. m.</i> , . .	double mesogloéal sphincter muscle.	<i>nem.</i> ,	nematocysts.
<i>end.</i> ,	endoderm.	<i>ov.</i> ,	ovum.
<i>end. m.</i> ,	endodermal muscle.	<i>œs.</i> ,	œsophagus.
<i>incr.</i> ,	incrustations.	<i>p. gr.</i> ,	pigment granules.
<i>mes.</i>	mesogloæa.	<i>sub-cu.</i> ,	sub-cuticla.
<i>mes.</i> ,	mesentery.	<i>sp.</i> ,	spermarium.
<i>mes. fl.</i> ,	mesenterial filament.	<i>zoox.</i> ,	zooxanthellæ.

Figure.

1. *Zoanthus Solanderi*, Les. (p. 335). Vertical section through a portion of the column-wall, × 50.
2. *Zoanthus flos-marinus*, Duch. and Michl. (p. 339). Vertical section through a portion of the column-wall, × 50.
3. *Zoanthus pulchellus* (Duch. and Michl.), (p. 341). Vertical section through a portion of the column-wall, × 200.
4. *Zoanthus pulchellus* (Duch. and Michl.), (p. 341). Transverse section through a portion of the column-wall and a fertile mesentery, × 50.
5. *Isaurus Duchassaingii* (Andres), (p. 346). Vertical section through the upper portion of the column-wall, × 25.
6. *Isaurus Duchassaingii* (Andres), (p. 346). Section through a portion of the mesogloæa of the body-wall, showing cells with peripheral granular protoplasm, × 250.
7. *Gemmaria variabilis*, n. sp. (p. 350). Vertical section through a portion of the column-wall, × 25.
8. *Gemmaria variabilis*, n. sp. (p. 350). Transverse section through a portion of the column-wall and a fertile mesentery, × 200.
9. *Gemmaria variabilis*, n. sp. (p. 350). Transverse section through a portion of the column-wall and a perfect mesentery in the region of the œsophagus, × 50.
10. *Gemmaria fusca*, n. sp. (p. 54). Vertical section through a portion of the column-wall, × 40.





EXPLANATION OF PLATE XIX.

PLATE XIX.

LETTERING ON THE FIGURES.

<p><i>b. can.</i>, basal canal.</p> <p><i>br. m.</i>, brachynemic mesentery.</p> <p><i>c. isl.</i>, cell-islets.</p> <p><i>ect.</i>, ectoderm.</p> <p><i>ect. m.</i>, ectodermal muscle.</p> <p><i>end.</i>, endoderm.</p> <p><i>incr.</i>, incrustations.</p> <p><i>incr. lac.</i>, lacunæ produced by removal of incrustations.</p> <p><i>mes.</i>, mesogloea.</p>	<p><i>mes. fl.</i> mesenterial filament.</p> <p><i>mes. sph. m.</i>, mesogloea sphincter muscle.</p> <p><i>mr. m.</i>, macronemic mesentery.</p> <p><i>oes.</i>, œsophagus.</p> <p><i>oes. gr.</i>, œsophageal groove.</p> <p><i>p. gr.</i>, pigment granules.</p> <p><i>s. d.</i>, sulcar directive mesenteries.</p> <p><i>sl. d.</i>, sulcular directive mesenteries.</p> <p><i>sp.</i>, spermaria.</p> <p><i>t.</i>, tentacles.</p>
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Figure.

1. *Palythoa mammosa* (Ell. and Sol.), (p. 359). Vertical section through a portion of the upper free part of a polyp, from which most of the incrustations have been dissolved, $\times 50$.
2. *Palythoa mammosa* (Ell. and Sol.), (p. 359). Transverse section through the œsophageal region (diagrammatic), $\times 35$.
3. *Palythoa mammosa* (Ell. and Sol.), (p. 359). Transverse section through the œsophageal region of a younger polyp (diagrammatic), $\times 35$.
4. *Palythoa mammosa* (Ell. and Sol.), (p. 359). Transverse section through a partially extended polyp, passing through a portion of the grooved part of the disc, $\times 50$.
5. *Palythoa caribæa*, Duch. and Michl. (p. 365). Vertical section through a portion of the upper free part of a polyp, $\times 50$.
6. *Palythoa caribæa*, Duch. and Michl. (p. 365). Transverse section through a fertile mesentery, $\times 50$.
7. *Palythoa caribæa*, Duch. and Michl. (p. 365). Transverse section through the œsophageal region (diagrammatic), $\times 35$.



EXPLANATION OF PLATE XX.

PLATE XX.

LETTERING ON THE FIGURES.

<p><i>cu.</i>, cuticle. <i>c. isl.</i>, cell-islet. <i>ect.</i>, ectoderm. <i>ect. m.</i>, ectodermal muscle. <i>enc. sin.</i>, encircling sinus. <i>end.</i>, endoderm. <i>end. sph. m.</i>, endodermal sphincter muscle. <i>gl. c.</i>, gland-cells. <i>incr.</i>, incrustations. <i>mes.</i>, mesogloea. <i>mes. fil.</i>, mesenterial filaments. <i>mes.</i>, mesentery. <i>nth.</i>, mouth.</p>	<p><i>nem.</i>, nematocyst. <i>ner. l.</i>, nerve layer. <i>nuc.</i>, nuclei. <i>mes. sph. m.</i>, mesogloal sphincter muscle. <i>mr. m.</i>, macrocoenic mesentery. <i>æs.</i>, œsophagus. <i>p. b. m.</i>, parieto-basilar muscle. <i>p. gr.</i>, pigment granules. <i>r. ect.</i>, reflected ectoderm. <i>t₁</i>, outer row of tentacles. <i>t₂</i>, inner row of tentacles. <i>s. d.</i>, sulcar directive mesenteries. <i>sp.</i>, spermaria.</p>
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Figure.

1. *Epizoanthus minutus*, n. sp. (p. 369). Vertical section through a portion of the column-wall, showing the sphincter muscle, tentacles (cut obliquely), disc, œsophageal wall, and mesentery, × 50. Polyp extended.
2. *Epizoanthus minutus*, n. sp. (p. 369). Transverse section through a portion of the column-wall and the grooved part of the disc in a partially extended polyp, showing the united bases of the tentacles, × 50.
3. *Epizoanthus minutus*, n. sp. (p. 369). Transverse section through a portion of a tentacle, × 200.
4. *Epizoanthus minutus*, n. sp. (p. 369). Transverse section through a portion of the column-wall, and the mesenteries below the œsophagus, × 50.
5. *Parazoanthus Swiftii* (Duch. and Michl.), (p. 372). Vertical section through a portion of the column-wall, base, and cœnenchyme, × 50.
6. *Parazoanthus Swiftii* (Duch. and Michl.), (p. 372). Transverse section through a portion of the column-wall and a fertile mesentery, × 280.

