

On *Acrossota liposclera*, a New Genus and Species of Alcyonarian with Simple Tentacles.

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With Plate 22.

THE Alcyonarian Colony to be described in the following pages was collected by Prof. A. Willey in the d'Entrecasteaux group of islands, British New Guinea, and sent to me, I am ashamed to say how many years ago, along with a collection of Actiniæ and Zoantheæ. Partly because of the difficulty and uncertainty of identifying spirit preserved actinians, partly because I had turned my attention to another group of animals, I have neglected this collection until, a short time ago, I began to prepare such specimens as were suitable for cutting into sections with a view of identifying and describing them. Among the Zoantheæ I found a colony of small translucent polyps apparently growing in a bunch attached to the fronds of a species of Halimeda. Some of these polyps were partly expanded and exhibited a few simple digitiform tentacles, and this character, together with their general appearance, suggested that they were non-incrusted Zoanthids. On closer examination I found that the polyps arose at intervals from a long, sparsely branched adherent stolon, and that the apparently single colony consisted of several such stolons so closely intertwined that the polyps arising from them were closely

bunched together, giving the deceptive appearance of a compact encrusting colony. And, as I shall describe in detail, I found that the tentacles, though simple finger-shaped structures, are always eight in number, and that the structure of the polyps, in almost all other respects, presents the well-known characteristic Alcyonarian features.

The entire absence of lateral pinnæ on the tentacles of the autozooids of an Alcyonarian has not, to my knowledge, been previously recorded, and as my colony presents some other interesting characters which differentiate it from any described species, I must make a new genus for its reception. It seems necessary also to make the genus the type of a new family, for the possession of simple digitiform tentacles is a unique feature among the Alcyonaria. But, as will appear from what follows, the general characters of the colony and polyps place the new family in the order Stolonifera, in close juxtaposition to the Cornularidæ and Clavulariidæ.

The specimen may be described as follows :

Order—STOLONIFERA, Hickson.

Family—Acrossotidæ, the tentacles simple, digitiform, without lateral pinnæ.

Genus—*Acrossota*¹ n. gen.

Zooids borne at intervals on a simple sparingly branched radiform adherent stolon; no spicules or calcareous skeleton of any kind; tentacles digitiform, without lateral pinnæ.

Acrossota liposclera n. sp.

Stolon subcircular where free, flattened where adherent, its cavity formed by a single solenium, but traversed by mesoglœal trabeculæ; the stolon branched and the branches

¹ *á*, without; *κροσσωτός*, fringed.

intertwined but not forming a network by anastomosis. Zooids subcylindrical, of various lengths, frequently giving off stolonar outgrowths from their proximal moieties, the distal moiety of each zooid invaginable within the proximal moiety. Tentacles digitiform, completely invaginable. Outer wall of stolon and zooids strengthened by a gelatinoid supporting tissue formed by the ectoderm, and in addition a thin parchment-like external cuticle, the latter forming the chief supporting tissue in the basal parts of the zooids, the gelatinoid tissue more largely developed in the subtentacular region and in the stolon; the walls everywhere relatively thin, and not differentiated to form calices into which the zooids can be withdrawn. Stolon and zooids translucent and colourless in spirit.

Locality, d'Entrecasteaux Group, British New Guinea.

The form and habit of the specimen collected by Prof. Willey are so irregular that they are difficult to define. The central part of the specimen consists of several relatively large zooids, measuring 5 mm. in length and 1.75-2 mm. in diameter and rather closely crowded together. From the bases of these zooids several stolons are given off which creep along the frond of a *Halimeda* and are closely attached to it at intervals. Where attached the stolons are flattened and tape-like, but in the greater part of their courses they are round and simply twined round their support. The stolons branch and the branches may subdivide several times in an irregular manner, but the branches do not anastomose with one another. The branches and their subdivisions are twined round one another and tangled together, and bear other zooids at irregular intervals. From place to place a branch of the main stolon or a stolonar outgrowth of one of the zooids projects for some distance from the support as a long, free, thin-walled tube, near the end of which a zooid is developed, and from this zooid other stolons are given off, which may in turn bear zooids of various sizes. These free tubular outgrowths are frequently constricted in places, and it is probable that they are eventually separated off from the

parental colony at the points of constriction, and so give rise to new colonies, for the specimen included several short lengths of stolon bearing two, three, four or more zooids, and quite independent of the main colony. But these and the stolons of the main colony were all tangled together and with the *Halimeda*, and it required some care to disentangle them. *Acrossota*, therefore, is remarkable, though not unique, among *Alcyonaria* for producing independent colonies by a form of gemmation. The stolons usually end in blunt, slightly swollen extremities, but sometimes are fixed by one extremity, which is then closely flattened against the surface of support (fig. 1). Evidently each stolon is at first a simple tubular outgrowth of the proximal part of the wall or of the base of a zooid; this outgrowth is lined by endoderm and forms what I have called a "solenium."¹ In *Cornularia*² the stolons are simple solenia, but in *Clavularia*, *Sarcodictyon* and other members of the *Stolonifera* the stolons are compound and contain several solenia. In *Acrossota* the stolons are not as simple as those of *Cornularia*, nor so complicated as those of *Clavularia*. The simple cavity is largely occluded, especially in the older parts of the stolons, by the formation of a spongy-looking tissue within the originally simple cavity. This tissue, as is shown in fig. 3, is formed by numerous fine branching trabeculæ, which pass from wall to wall and anastomose with one another. The trabeculæ are composed of a core of mesoglœa, covered by endoderm, and are more or less flattened in section. Some of the larger trabeculæ contain strings or islets of endoderm cells embedded in the mesoglœa, and the branching of the trabeculæ is apparently brought about by the formation of cavities in these intrusive endoderm cells, but there is no evidence of the formation of definite solenial outgrowths of the endoderm penetrating into the mesoglœa and forming compound stolons. The trabeculæ

¹ G. C. Bourne, "Anthozoa," in Lankester's 'Treatise of Zoology,' Part II, 1900, p. 16.

² G. von Koch, "Die Alcyonacea des Golfes von Neapel," 'Mitth. a. d. Zool. Stat. zu Neapel,' ix, 1891, p. 645.

become less numerous in the terminal and most recently formed portions of the stolons, and are absent or very few in number and imperfectly developed in the swollen extremities (fig. 3). They are also scantily developed in the long free outgrowths which give rise to separate colonies. On the other hand, in the flattened adherent portions of the stolons, the trabeculæ tend to fuse together to form laminæ, dividing the lumen of the stolon into several canals, running, on the whole, parallel to the long axis of the stolon.

It is assumed rather than demonstrated that the compound stolons of Clavulariidæ are formed by the union of the walls of a close-meshed reticulum of simple solenia such as is found in Cornularia. It is probable that many band-shaped or flat encrusting stolons are formed in this manner, and all encrusting stolons must be formed in part by the fusion of the walls of radial outgrowths containing solenia from the bases of the zooids, but it is equally probable that a large part of the inosculating channels seen in sections of such stolons have been formed as in *Acrossota*, by the ingrowth of trabeculæ from the walls of a primitively simple solenium.

The general structure of the zooids, with the exception of the tentacles, conforms to the Alcyonarian type.

The Actinopharynx (as van Beneden¹ has renamed the "Stomodæum" of the Anthozoa) is long, and its upper third is lined by a ciliated epithelium, of which the character is shown in fig. 5. The epithelial cells are elongated and attenuated, their nuclei stain deeply and appear closely crowded together in sections. The cilia take their origin from minute deeply staining granules, which give the free border of the epithelium a striated appearance. In this region there is a distinct sulcus or siphonoglyphe in which the cilia are specially long. But in the lower two thirds of the actinopharynx (fig. 6) the siphonoglyphe dies out; the epithelium is composed of less elongated prismatic ciliated cells, the nuclei are no longer crowded together and stand nearly on

¹ E. van Beneden, "Die Anthozoen d. Plankton Expedition," 'Ergebnisse d. Plankton Expedition des Humboldt-Stiftung,' ii, 1897.

the same level; the cilia are short and of uniform length. In contracted specimens this region of the actinopharynx is thrown into longitudinal folds and its lumen diminished, but the lumen is always considerably larger than in the upper third. At the lower border of the actinopharynx the prismatic ciliated epithelium passes rather abruptly into the endoderm, but is clearly continued down the edges of the two "dorsal" or asulcar mesenteries to form the grooved filament, which in section presents precisely the same characters as those figured by Hickson¹ for *Alcyonium*. In the grooved filaments the ciliated cells again change their character, becoming small and narrow, with small deeply staining nuclei. The remaining mesenteries have thickened edges covered by endoderm cells, but no distinct filament. As is invariably the case in Alcyonarian zooids, the two "dorsal" asulcar mesenteries bearing the grooved filaments extend much further down in the body of the zooid than the remaining six.

The section represented in fig. 4 shows that in other respects the mesenteries present the usual Alcyonarian features. The mesogloæal thickenings forming the muscle-banners are feebly developed, and only distinguishable in the region of the actinopharynx, but there they can be seen to be borne on the "ventral" or sulcar faces of all eight mesenteries. The peripheral parts of the mesenteries are very thin. Only one of the Zooids that I used for cutting sections was sexually mature. In it testes, in the form of small spherical follicles, were borne on short pedicles near the free edges of all but the dorsal asulcar mesenteries.

The tissues of the specimens I have examined were only moderately well preserved, and the cell elements so minute that I have not been able to work out histological details to my complete satisfaction. The structure of the body-wall in particular has proved very difficult to interpret, and the structure of the various regions into which the body of the zooid may be divided appears to differ in invaginated and

¹ S. J. Hickson, "The Anatomy of *Alcyonium digitatum*," *Quart. Journ. Micr. Sci.*, 37, 1895, p. 343.

extended specimens, from which fact I infer that the tissues are very elastic and extensile, capable of being drawn out into an exceedingly thin layer or contracted into thicker sheets, according to the state of contraction of the animal.

From a study of longitudinal and transverse sections of both extended and retracted specimens it appears that the following regions may be recognised: (1) The tentacles and the oral disc. (2) The portion of the body of the zooid immediately below the tentacles. This portion is invaginated in retracted specimens, but in both extended and retracted examples the body-wall in this region is moderately thick, and the tissues, both ectodermic and endodermic, are fairly clearly differentiated. In extended specimens this region is approximately of the same length as the actinopharynx, but in retracted specimens the latter structure is pulled down into the lower part of the cœlenteron and lies below the tube formed by the invaginated distal portion of the body-wall of the Zooid. (3) The middle and basal region of the Zooid, in which the body-wall is extremely thin. (4) The stolons, in which the mesoglœa is thickened, the endoderm fairly conspicuous, but the ectoderm reduced or absorbed in the formation of a gelatinoid supporting tissue.

The first two regions are clearly the seat of the chief physiological activities. The cavities of the tentacles, the walls of the actinopharynx and the central moieties of the mesenteries where attached to the actinopharynx are clothed with a thick highly vacuolated endoderm containing a profusion of zooxanthellæ (fig. 4). The mesoglœa is a thin layer exhibiting a faint striation, but not including any cellular elements. The ectoderm of the tentacles is formed by a layer of small cells, cubical in the extended but more columnar in the invaginated tentacles. The ectodermal muscular fibres are but feebly developed in the tentacles, the circular layer of endodermic muscular fibres being rather better represented, but still feeble. Minute oval refracting bodies can be recognised in the ectoderm of the tentacles, and I interpret them as nematocysts, but I was unable to resolve their structure

with the highest powers of the microscope at my disposal. The ectodermic lining of the actinopharynx has been described already. The ectoderm of the body-wall below the tentacles is illustrated in fig. 7. The continuous layer of cubical cells of the tentacles and oral disc here gives place to what I can only describe as a reticulum of vacuolated protoplasm containing nuclei, but in which the limits of the cell bodies are with difficulty or not at all recognisable. The body-wall is raised into a number of thickened ridges, one of which is shown in fig. 7. In this figure the mesogloea is seen as a thin but distinct structureless layer, produced on the inner side into small processes to which the muscular fibres of the vacuolated endodermic cells are attached. On the outer side of the mesogloea is an irregular aggregation of what may be called ectoderm cells, though, as mentioned, the cell outlines are not distinguishable. Some of these abut on the mesogloea, without, however, forming a continuous layer. Others, more peripherally situated, form a discontinuous lining to the thin darkly staining external cuticle. The intervening space is filled up by a homogeneous more or less vacuolated substance which seems to be formed by the dissolution and conversion into supporting tissue of the ectodermic cell-fusion. The homogeneous supporting substance stains more faintly than the mesogloea, but is probably of the same or similar chemical composition, for in older and more differentiated parts of the body-wall the ectodermic cell-fusion becomes scantier, the homogeneous substance increases in amount, and eventually fuses with the mesogloea, and can only be distinguished from it by its staining less deeply. Usually, however, tracts of ectoderm looking like cell ingrowths are included in the homogeneous supporting tissue.

Fig. 8 represents a portion of the extremely thin body-wall of the lower middle and basal part of the zoid. In comparison with fig. 7, it is seen that the endoderm is reduced to a very thin non-vacuolated flattened epithelium. The mesogloea is a distinct, very thin structureless layer. In one part of the section it seems to consist of two layers, between

which are a few flattened nuclei with remains of cytoplasm surrounding them. The outer layer, however, is nothing more than the deeper part of the homogeneous supporting tissue formed by the ectodermic cell-fusion, and the nuclei between it and the mesoglœa are ectodermic nuclei. Externally may be seen a few nuclei of ectodermic cells which have obviously been used up in the formation of local thickenings of the supporting tissue, and externally is the thin but tough deeply staining cuticle.

In the stolons the endoderm again becomes thicker and vacuolated, but does not contain zooxanthellæ. The external cuticle remains, but the nuclei of the ectodermic cell-fusion have almost entirely disappeared, and the ectoderm appears to have been nearly wholly used up in the formation of supporting tissue, which is now so closely applied to and fused with the mesoglœa as to be scarcely distinguishable from the latter. One would say at first sight that the section shows only endoderm, mesoglœa and cuticle, the ectoderm having disappeared altogether. In this region strings of endoderm-cells make their way into the mass formed by the fusion of mesoglœa and supporting tissue, and these ingrowths extend into the trabeculæ, which are themselves formed as local out-growths of mesoglœa covered by endoderm. This ectodermic gelatinoid supporting tissue of *Acrossota* is comparable in essential respects to the supporting tissue of *Stereosoma celebense* as described and figured by Hickson.¹ But there is this difference: that in *Stereosoma* there is a distinct external layer of cubical ectoderm cells, but no cuticle, whereas in *Acrossota* the definite external ectodermic epithelium is absent, but there is a distinct and continuous cuticle.

There are no spicules in *Acrossota*. I have searched for them in teased-up specimens, in sections, and in the residue left after boiling in caustic potash. A felt-work of filamentous algæ enclosing numerous diatoms, sponge spicules, and here

¹ S. J. Hickson, "A Revision of the Alcyonaria Stolonifera," 'Trans. Zool. Soc. Lond.,' xiii, 1895.

and there an alcyonarian spicule, covers the older parts of the stolons and the basal moieties of the older zooids. But all these spicules are adventitious and lie external to, though often closely adherent to, the cuticle.

It may be concluded, from the foregoing description, that *Acrossota* is an Alcyonarian exhibiting primitive Cornularian characters in the mode of growth and habit of the colony, in the simplicity of its stolons (which, however, are not so simple as those of *Cornularia*), and in the absence of calcareous spicules, the last character being shared by such clearly primitive forms as *Cornularia* and *Protocaulon molle*, and also by *Stereosoma celebense*, *Clavularia reptans*, *Clavularia celebensis*, and the variety of *Clavularia australiensis* described as variety B by Hickson.¹ The absence of spicules may be regarded as evidence of primitive organisation, but not certain evidence, for the spicules present in variety A appear to have been lost in variety B of *Clavularia australiensis*. The absence or disappearance of spicules appears to be correlated in the *Clavulariidae* with the formation of a supporting tissue derived from vacuolated branched ectoderm cells, and *Acrossota* shares this feature with *Stereosoma* and *Clavularia australiensis*, var. B. The feature peculiar to *Acrossota* is the absence of tentacular pinnæ, and it is a moot point whether this may be regarded as a primitive character. *Stereosoma* has but few pinnæ, and those spaced at considerable intervals along the tentacles. Further reduction of such pinnæ might lead to their ultimate disappearance, and the tentacles would then be simple and digitiform. On the other hand, it may be argued that simple tentacles must have preceded pinnate tentacles in phylogeny, and we have in *Acrossota* an otherwise primitive Alcyonarian with simple tentacles. The evidence seems to point to this being a primitive character, but in the absence of any criterion which shall enable us to distinguish between what is primitive and what is secondarily acquired by degeneration in such structures as these, one cannot be

¹ *Ibid.*

dogmatic. The one thing certain is that in the possession of simple tentacles *Acrossota* stands as an exception to a rule otherwise universal for Aleyonarians, and it was this that led me to make as exhaustive a study as I could of its structure.

EXPLANATION OF PLATE 22,

Illustrating Mr. G. C. Bourne's paper "On *Acrossota liposclera*."

[All the figures refer to *Acrossota liposclera* nov. gen. et sp.]

Fig. 1.—An independent stolon attached by one of its extremities to a fragment of *Halimeda*. The stolon bears four zooids, three of which are partially expanded and exhibit the simple tentacles.

Fig. 2.—Two zooids from a specimen stained in hæmalum and mounted in oil of cloves. One of the zooids is expanded, and exhibits the eight simple tentacles; the other is retracted, and shows the invaginated tentacles. *d. m.* Dorsal or asulcar mesenteries.

Fig. 3.—A retracted zooid and part of a stolon from a specimen stained in hæmalum. The body-wall of the zooid and part of the wall of the stolon nearest the observer have been cut away. *d. m.* Dorsal mesenteries. *st.* Stolon. *t.* The invaginated tentacles. *tr.* Trabeculæ in the cavity of the stolon.

Fig. 4.—A transverse section passing through the upper part of the actinopharynx of a retracted zooid, showing the actinopharynx with its sulcus, the eight mesenteries with the muscle banners, the eight invaginated tentacles and the thin external body-wall. The endoderm clothing the actinopharynx, the central moieties of the mesenteries and the tentacles is thick, and contains numerous zooxanthellæ. *aph.* Actinopharynx. *d. m.* "Dorsal" mesenteries. *v. m.* "Ventral" mesenteries. *t. t.* The invaginated tentacles.

Fig. 5.—A section through the upper third of the actinopharynx, highly magnified, showing the elongated ciliated cells, the sulcus or siphonoglyphe, and the vacuolated endoderm. *z.* Zooxanthellæ. Other letters as in fig. 4.

Fig. 6.—A section through the lower part of the actinopharynx, showing the disappearance of the sulcus and the changed character of the ciliated epithelium. Lettering as in the preceding figures.