XXVIII. On *Clavagella*. By W. J. BRODERIP, Esq., Vice-President of the Geological and Zoological Societies, F.R.S., L.S., &c.

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IN the fifth volume of the ‘ Histoire Naturelle des Animaux sans Vertèbres,’ published in 1818, Lamarck established the genus *Clavagella*, placing it with good judgment between *Aspergillum*, Lam., and *Fistulana*, Brug., and recorded four species, all fossil, referring at the same time to the ‘ Annales du Muséum,’ where he had described and figured the first of them under the name of *Fistulana echinata*. The following is Lamarck’s definition of the genus.

“ Vagina tubulosa, testacea, anticè attenuata et aperta, posticè in clavam ovatam, subcompressam, tubulis spiniformibus echinatam terminata: clavâ hinc valvam detectam in pariete fixam prodiente; altera in tubo libera.”

Mr. George Sowerby, whose attention had been attracted to a recent specimen in the British Museum, which he took for an *Aspergillum*, inclosed in a mass of stone, requested Mr. Children to allow a close inspection; and that gentleman, with his usual liberality and readiness to apply that part of the national collection committed more immediately to his care to the advancement of knowledge, its true and legitimate use, permitted some of the earthy part to be scraped away, when *Clav. aperta*, the first recorded recent species, was seen as it is described and figured in Mr. Sowerby’s ‘ Genera of recent and fossil Shells.’

Mr. Sowerby’s definition is nearly the same as Lamarck’s.

Upon the return of Mr. Samuel Stutchbury from his voyage to some of the islands of the Australian and Polynesian groups, Mr. George Sowerby, in his appendix to the catalogue of subjects of natural history brought home by Mr. Stutchbury, described and figured, in the year 1827, a second species under the name of *Clav. Australis*. Three specimens were obtained with great difficulty by Mr. Stutchbury, who discovered them at North Harbour, Port Jackson, in a siliceous grit, like that of the coal measures, just beneath low-water mark, by their ejecting the water from the opening of their tubes with considerable force. The specimen figured by Mr. Sowerby is in the British Museum, and another is in Mr. Norris’s collection at Manchester.

Soon after the publication of the latter species, Isaac Lyon Goldsmid, Esq., became possessed of a mass of coral (*Astræopora*, Blainv.), part of a collection which he had purchased at Aix la Chapelle. In 1829 Mr. Henry Stutchbury, to whom Mr. Goldsmid assigned the task of arranging this collection, observed an aperture which he concluded

to form part of the chamber of a *Clavagella*; and having obtained permission to break the mass, he laid open, by a well directed blow, two specimens of this rare genus, together with *Petricola*, Lam., and *Gastrochæna*, Spengl.: a small bivalve, the *umbones* of which have all the appearance of those of *Lithodomus*, Cuv., appeared also in the wall of one of the chambers occupied by one of the *Clavagellæ*. These specimens, by the kindness of Mr. Goldsmid, are now before me¹.

In the second edition of the 'Règne Animal' (1830) Cuvier mentions *Clavagella*; but he notices only one recent species, in these words: "Il s'en trouve une espèce vivante qui se tient dans les Madrépores des mers de Sicile et qui a été décrite par M. Audouin." This description I have not seen; nor does Cuvier give any reference. I now proceed to give the reader all the information which I have been able to collect as to this living species described by M. Audouin.

In the 'Annales des Sciences Naturelles'², the following paragraph appears: "179. CLAVAGELLE vivante. OPERCULE des Magiles.—M. Audouin a adressé à l'Académie des Sciences dans la séance du 29 Juin 1829, ses observations sur les coquilles des genres *glycimère* et *siliquaire* déjà annoncées dans cette revue, pag. 31 et 47; et il y a ajouté 2 nouveaux Mémoires sur une espèce de Clavagelle vivante et sur l'opercule des Magiles. Dans le 3^e Mémoire, dit M. Audouin dans sa lettre d'envoi, je fais connaître avec détails l'organisation d'une coquille singulière qui, au premier abord, paraît se rapporter au genre *Clavagelle*. Les conchyliologistes et les géologues savent que cette coquille, qui vivait enfoncée dans les Madrépores et dont une des valves leur était adhérente tandis que l'autre restait constamment libre, n'avait encore été rencontrée qu'à l'état fossile. L'espèce que je fais connaître dans mon Mémoire se trouve dans les mêmes circonstances, mais elle habite encore aujourd'hui les mers de Sicile. J'ai pu l'étudier avec soin sur deux individus, dont l'un appartient au Muséum d'Histoire Naturelle qui en a fait dernièrement l'acquisition, et l'autre à M. le duc de Rivoli, qui possède en même temps l'animal."

I have consulted the 'Mémoires de l'Académie Royale des Sciences,' and also the 'Mémoires des Savans Etrangers'⁴, down to the present period, the twelfth volume of the former and the fourth of the latter being the last publications that I have seen: these contain memoirs of a later date than June 1829, but I do not find the memoir of M. Audouin.

In the 'Manuel des Mollusques,' published in 1829, M. Sander Rang, under the title *Clavagella*, speaks of "la Clavagelle Râpe, seule espèce connue à l'état vivant, et que

¹ Plate xxxv. Figg. 1—4.

² Tom. xvii. p. 78. (Revue).

³ The words and syllable here printed in italics are transposed to the top of the column by an error of the printer.

⁴ Mémoires présentés par divers Savans à l'Académie Royale des Sciences.

nous venons de découvrir à l'île de Bourbon¹ :” he adds², “ Quant à l'animal, nous ne le connaissons pas.”

M. Sander Rang finishes the article on *Clavagella* with the following paragraph : “ On a découvert récemment dans les mers de Sicile une coquille assez voisine des Clavagelles, mais que, selon nous, on ne doit pas rapporter à ce genre. Cette coquille, logée dans une cavité particulière creusée dans les pierres, a ses valves libres, tandis que l'ouverture de cette cavité est munie supérieurement d'un tube faisant l'effet d'une cheminée, bordé à son orifice d'une manchette analogue à celle de certains Arrosoirs. Cette coquille ne peut point appartenir aux Clavagelles, qui ont une valve soudée ; nous pensons plutôt qu'elle devra former un genre dans le voisinage des Gastrochènes, car probablement le tube ne s'élève pas seulement à l'orifice de sa demeure. Il y a lieu de croire que, comme dans les Gastrochènes, il se prolonge inférieurement dans cette cavité qu'il tapisse, et par ce moyen enveloppe la coquille ; ce serait donc avant les Gastrochènes, et dans la division c), qu'il faudrait la placer.

“ c) Quelquefois un tube enveloppant toute la coquille et non soudé³.”

If M. Sander Rang here allude to the species communicated by M. Audouin to the Académie des Sciences, and if the description of the former be an accurate account of the “ Clavagelle vivante” of M. Audouin, the species cannot be that which I am about to describe in this memoir under the name of *Clav. Melitensis* ; for my species has “une valve soudée :” but I regret that I have not access to M. Audouin's memoir, which would probably relieve me from the doubt that I may possibly be describing his Sicilian *Clavagella* under the name of *Clav. Melitensis*.

Mr. Cuming, in the course of his voyage, dredged up from a depth of eleven fathoms, at the island of Muerte, in the bay of Guayaquil, a fragment of calcareous grit, of modern appearance, such as Mr. Samuel Stutchbury found forming the solid reefs which bound the islands designated by him as “ mineral,” in contradistinction to those which are, superficially at least, coral. In this calcareous grit was the greater portion of the chamber and tube, both valves, and the soft parts of a very fine *Clavagella*⁴. These parts are now in the able hands of my friend Mr. Owen, and form the subject of the interesting memoir which follows this paper.

A close examination of the recent species has convinced me, that though one valve is always fixed or imbedded in the chamber, and soldered, as it were, to the tube, so as to make one surface with it, the tube is not necessarily continued into a complete testaceous clavate shape. In Mr. Goldsmid's best and largest specimen⁵, the fixed valve is imbedded in the coral⁶, and, though continued on to the tube or siphonic sheath⁷, is surrounded by the wall of the coral chamber at its anterior extremity⁸. In the other specimen⁹ the fixed valve is also continued on to the tube.

¹ p. 339.

² p. 341.

³ p. 342.

⁴ Plate xxx. Figg. 8—16.

⁵ Plate xxxv. Fig. 1.

⁶ Ibid. a'.

⁷ Ibid. d.

⁸ Ibid. a.

⁹ Ibid. Fig. 2.

In the first-mentioned specimen, at the anterior or greater end of the ovate chamber, an insulated shelly plate has been secreted with the tubular perforations¹; that part of the chamber having afforded (apparently at a former period) the best communication with the ambient fluid: but a calcareous deposit having almost entirely cut off that communication, the animal appears to have been compelled to secrete a second shelly plate towards the anterior ventral edge of the fixed valve, where the perforation of some other shell (a *Lithodomus* probably) secured the necessary influx of the water². Nor is this the only instance of the secretion of a second tubular plate which has fallen under my notice.

In the last-mentioned or smaller specimen, the perforated shelly plate joins the anterior ventral edge of the fixed valve laterally³, that point of the chamber being evidently the most practicable for communicating with the water by means of the tubules: the rest of the anterior edge of the fixed valve is surrounded by the coral wall.

In Mr. Cuming's specimen the fixed valve is continued on to the tube⁴. The anterior edge of this valve is surrounded by the naked wall of the chamber, and the greater end of the chamber, or that part of it which is opposite to this anterior edge, being impracticable, from its thickness, as a water communication, (with a small exception⁵, which, not improbably, had ceased to be available,) the animal has been driven to secrete the perforated shelly plates not far from the throat of the tube on either side, where the chambers of *Petricolæ* or *Lithodomi* opened a passage to the surrounding water⁶. As a further proof of this, Mr. Owen informs me that the mantle is torn at these particular points.

I feel the difficulty of laying down specific characters from the specimens belonging to Mr. Goldsmid and Mr. Cuming. The tubes, or siphonic sheaths, of each of them are broken, and nothing is left sufficiently distinct to show the form of the aperture when it was perfect. The valves being nearly, perhaps altogether, excluded from the light, colour, at best but a treacherous guide, is absent entirely. I cannot conceal from myself that the shape of the chamber and of the valves, together with the comparative roughness or smoothness of their outer surfaces, may depend upon the greater or less degree of hardness of the material in which the chamber is formed. With such data, however, as these specimens afford, I shall endeavour to characterize them; and if, hereafter, they should prove to be mere varieties, the descriptions and drawings may at all events assist in elucidating the natural history of the genus.

¹ Plate xxxv. Fig. 1. *e*.

² Ibid. Fig. 2. *e*.

³ Ibid. Fig. 2. *α*.

⁴ Plate xxx. Fig. 8. *d*.

⁵ Ibid. *e''*.

⁶ Ibid. *e'*, *e'*.

CLAVAGELLA ELONGATA.

Tab. XXXV. Figg. 1—4.

Clav. camerâ elongato-ovatâ; valvâ liberâ elongatâ, subtrigonâ, convexâ, externè concentricè valdè rugosâ, intùs nitente; umbone acuto.

Hab. in Oceano Pacifico?

Mus. Goldsmid.

The *Astræopora* in which this *Clavagella* is chambered approaches very closely to one brought by Mr. S. Stutchbury from Bow Island, or Hao, in the Pacific Ocean, and I have therefore suggested that Ocean as its probable locality. The wall of the coral chamber against which the free valve rested, gives as exact an impression of the external rugosities of that valve as if it had been applied to a surface of wax.

CLAVAGELLA LATA.

Tab. XXX. Figg. 8—10 (Testa); 11—16 (Animal).

Clav. camerâ rotundato-ovatâ; valvâ liberâ latiusculâ, subtrigonâ, subconvexâ, externè concentricè rugosâ, intùs nitente; umbone subrotundato.

Hab. in Oceano Pacifico.

Mus. Cuming.

Both valves are nacreous internally, and the muscular impressions¹, especially in the fixed valve, are very strong.

CLAVAGELLA MELITENSIS.

Tab. XXXV. Figg. 5—8.

Clav. testâ subrotundatâ, rugosâ, intùs subnitente; tubo longitudinaliter corrugato.

Hab. ad Melitam.

Mus. Cuming, Miller.

Mr. G. B. Sowerby, finding that I was writing upon this subject, forwarded to me, with his usual liberality, two specimens of *Clavagella* from Malta. They are in an argillo-calcareous tufa? One of them belongs to Mr. Cuming, the other to T. Miller, Esq., Surgeon R.N., who brought them to this country.

The loose valve of Mr. Cuming's specimen² is not so much rounded as that of Mr. Miller's³, nor are its corrugations so large and distant. Mr. Cuming's specimen has a considerable portion of the longitudinally corrugated tube⁴ still projecting from the rock; but Mr. Miller's appears to have been abraded till it became even with the sur-

¹ Plate xxx. Figg. 8 & 10, *f'*., *g'*., & *h'*.

² Plate xxxv. Fig. 5.

³ Ibid. Figg. 6—8.

⁴ Ibid. Fig. 5. *a*.

face. The inside of the loose valve of the latter specimen¹ is almost nacreous, and the distant and broad corrugations appear upon the internal surface. In both, the casts of the backs of the loose valves may be seen on the stony chamber as if they had been impressed on wax. A great portion of the fixed or "soldered" valves, which are continued on to the tubes in both specimens, appears to have been surrounded by the naked chamber; and the situation of the secretion of the tubules² (the area of which is very extensive in Mr. Cuming's specimen) appears to have been varied according to the necessities of the case. In Mr. Miller's specimen, a perforated shelly plate is situated close to the tube and to the *umbones* of the valves³, so that it comes against the upper part of the back of the loose valve, which almost hides it from view when in its place; and tubules are visible at various points.

We are left to conjecture the causes which operate to determine the animal in the choice of its abode, if indeed it can be called choice, for most probably *Clavagella* is the creature of circumstances; and if, soon after its exclusion from the parent, (when I suppose it to be furnished with its two valves only, and to float free, with some voluntary impulse perhaps,) it arrives at the vacant hole of some small *Petricola*, *Lithodomus*, or other perforating *Testacean* which suits it, one valve soon becomes attached to the wall of the hole, and then the animal, being sedentary, proceeds to secrete the siphonic sheath or tube, to enlarge the chamber according to its necessities, and to form the shelly perforated tubular plate which is to give admission to the water at the practicable part of the chamber.

How the excavation is carried on is also a matter of doubt. The chambers of the individuals of *Clav. Australis* were formed in a siliceous grit, those of *Clav. elongata* in the substance of an *Astræopora*, that of *Clav. lata* in a calcareous grit, and those of *Clav. Melitensis* in an argillo-calcareous tufa. If the excavation be the work of a solvent secretion, it must be a solvent of extensive power. The situation of the glands detected by my friend Mr. Owen, leads me to think that they minister in some way to this operation; and I do not see how the anterior or greater end of the chamber, at all events, can be operated on by mere mechanical attrition with such parts as must have been contiguous to it.

It has been objected that any solvent which would act on a calcareous rock would equally act on the calcareous shell of the animal; but there is, perhaps, more of point than of strength in this objection. Without laying too much stress on that law of nature by which chemical and vital forces are placed in a state of hostility⁴, and which may or may not be applicable to such a substance as shell, the gland for the secretion

¹ Plate xxx. Fig. 7.

² Ibid. Figg. 5, 6.

³ Ibid. Fig. 6. a.

⁴ John Hunter's paper in the 'Philosophical Transactions' for the year 1772, "On the Digestion of the Stomach after Death," and Spallanzani's experiments on that organ, will readily occur to the reader.

of the supposed solvent, as well as the organ for applying it, may be so placed as that the solvent shall only come in contact with the inorganic or dead substance to be acted on, without touching the shell.

Again, it has been asked, what solvent would act equally on a calcareous and on a siliceous substance? To this it may be answered, first, that it is not pretended that the nature of the supposed solvent is known; secondly, that, in siliceous grits, there is more or less calcareous matter by which the mass is held together, and that the solution of the calcareous particles would be followed by the disintegration of the stone.

The fossil species are numerous, and as yet do not appear to have been detected below the supracretaceous group. One observation, arising from the various depths at which the recent species have been found, will not perhaps be deemed irrelevant. *Clav. Australis* was so near the surface at low water, that it was detected by its ejection of the fluid; *Clav. elongata*, from the nature of the coral in which it is chambered, could not have been living far beneath the surface; whereas *Clav. lata* was dredged up from a depth of sixty-six feet. Any inferences, therefore, as to the state of submersion of a rock during the life of the fossil species of *Clavagella* which there occur, should be made with caution by the geologist.

In conclusion, it may be observed, that though this genus is now rare in cabinets, it is, in all probability, widely diffused; and collectors cannot be too astute in examining masses of coral and submerged perforated rocks, with a view to the further elucidation of the habits and structure of these interesting animals.

PLATE XXXV.

Figg. 1, 2. The interior of the two parts of Mr. Goldsmith's specimen of *Astræopora*, containing two individuals of *Clavagella elongata*. The several points represented at α , β , γ , δ , come in contact when the two parts are placed together.

1. a . Anterior wall of the cavity in which the larger individual is situated.
- d . Broken termination of the posterior tube or siphonic sheath.
- α . Anterior portion of the cavity of the smaller individual.
- β . Portion of a cavity occupied by a *Petricola*.
- γ . Anterior edge of the wall of the coral chamber.
- δ . A broken group of *Serpulæ*.
- e . Insulated shelly plate, with tubular perforations at the anterior end of the ovate chamber.
- a' . Fixed valve imbedded in the coral.
2. α . Cavity of the smaller individual.
- $+$. Perforated shelly plate of the anterior ventral edge.

- β. Portion of a cavity occupied by a *Petricola*.
 - γ. Portion of the cavity of the larger *Clavagella elongata*.
 - δ. Broken group of *Serpulæ*.
 - e. Group of tubules proceeding from the insulated shelly plate, fig. 1. e.
- Fig. 3. Internal view of the free valve of *Clavagella elongata*.
- 4. External view of the same.
 - 5. Mr. Cuming's specimen of *Clavagella Melitensis*.
 - d. Termination of the posterior tube or siphonic sheath.
 - e. A large group of tubules opening into the perforated shelly plate, at the anterior ventral part of the cavity.
 - 6. Mr. Miller's specimen of *Clavagella Melitensis*.
 - e'. A large group of tubules opening into the perforated shelly plate on the right side of the throat of the posterior tube.
 - e. Another group of tubules opening into a perforated shelly plate at the anterior part of the cavity.
 - 7. Internal view of the free valve of Mr. Miller's specimen of *Clavagella Melitensis*.
 - 8. External view of the same.

G.B. Sowerby, del. et sc.

1-4. *Clavagella elongata*. 5-8. *Clavagella Melitensis*.
9-10. *Leptocoenochus striatus*.