THE

# TRANSACTIONS

OF THE

# MICROSCOPICAL SOCIETY

OF

# LONDON.

VOL. II.

"Minimus partibus, per totum Naturæ campum, certitudo omnis innititur; quas qui fugit pariter Naturam fugit."—*Linnæus.*

LONDON:

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M.DCCC.XLIX.

## XIX.—*Observations on the Shepherd's Purse Coralline of Ellis*, (*Notamia bursaria*, Fleming). By GEORGE BUSK, Esq., F.L.S.

(Read October 27th, 1847).

SEVERAL particulars connected with it, conspire to render the *Shepherd's Purse Coralline* one of the most interesting subjects of its class. The elegance of its habit, the peculiar conformation of the polypidom, and the great comparative transparency of its texture, all invite the attention of the observer. I believe also that the study of this species will, in particular, serve hereafter to throw considerable light upon the structure and functions of those mysterious organs, the "Bird's-head" processes, found upon so many *Bryozoa*, &c., and with respect to the true nature of which we are as yet so much in the dark. Another point of interest also connected with this species consists in the circumstance that it may in some measure be regarded as a new subject for investigation, for since its original discovery and description by Ellis, in 1755, it appears almost to have escaped the notice of naturalists. The description of it given by the Father of Zoophytology is still in reality the only one extant; all subsequent notices having evidently been derived either from that source, or from reference to his figures, and not from actual observation of the creature itself, at all events, in the living state. Neither am I aware, that, with the exception of one or two outline figures, by Dr. Clarke, given in the plate (Pl. LI.) of this species in the last edition of Dr. Johnston's valuable work, there has been any addition to, or at least any improvement upon, Ellis's original figure. His description, therefore, and representation, like all those traced by the pen and pencil of that excellent observer, though graphic, and as far as his means of observation allowed, correct, will, as may naturally be supposed, admit at the present time of considerable amplification and amendment. The only sufficient reason that can be assigned for the apparent neglect into which this *Bryozoon* has fallen, is its comparative rarity. Whether this rarity be real or not, I am unable to decide, but I am inclined to think that the species will be found not to be so rare as has been supposed.

In the month of August and September last (1847), at Swanage, in the Isle of Purbeck, I met with no zoophyte so abundant, and so generally distributed on almost every kind of submarine object — Fuci, stones, Crustacea, and shells—as the *Notamia bursaria.* It appeared to live and flourish in from three to ten fathoms water, off several miles of the coast, as from Bournemouth to Swanage Bay, but to the southward of this point, as in Durlstone Bay, where the sea is rougher and the bottom more rocky, I did not meet with it. It has also been found, according to Dr. Johnston, on the coast of Devonshire, off the Isle of Wight, and off Essex ; and I have been favoured with specimens of it, collected by Mr. Bowerbank, off Weymouth.

It appears, therefore, very strange that a species so abundant as this has proved to be in one locality, and which occurs at such widely distant points of the coast, as in Devonshire and Essex, should be so rare elsewhere, at least in sheltered and shallow bays. I would remark, however, that on a careful inspection of all the zoophytes collected at various times by dredging, in numerous different and very distant parts of the coasts of England and Wales, by Mr. Bowerbank, I did not observe among them any instance of the *Notamia bursaria,* excepting among those species collected by him last autumn at Weymouth. I am not aware that any foreign habitat has as yet been assigned for it. The conditions under which it occurs, present therefore an interesting subject for inquiry.*

The earliest notice, as I have before remarked, that we have of this *Bryozoon,* is in Ellis's Corallines, p. 41, Pl. 22, No. 8, and accompanying this notice is a figure designed with considerable elegance, and very correct, as far as the means of observation at that time allowed. Ellis's description runs thus : —" This most beautiful Pearl-coloured *Coralline* adheres by small tubes to fucuses, from whence it changes into flat cells ; each single cell like the bracket of a shelf, broad at top, and narrow at bottom : these are placed back to back in pairs, one above another, on an extremely slender tube, that seems to run through the middle of the branches of the whole *Coralline.* The cells are open at top. Some of them have black spots in them,

* In the course of the present autumn I have met with the *Notamia bursaria* in great abundance off the East end of the Isle of Wight. It has also, I believe, been found at Southend and Ramsgate.

and from the top of many of them, a figure seems to issue out like a short tobacco-pipe; the small end of which seems to be inserted in the tube that passes through the middle of the whole. The cells in pairs are thought by some to have the appearance of the small pods of the *Shepherd's Purse*, by others, the shape of the seed-vessel of the herb Veronica or Speedwell."

The species, after several changes of appellation, received its present systematic name from Dr. Fleming. Whether this name should be retained or not, need not here be discussed, but it may be observed that as far as its derivation is concerned, we shall find that it is inapplicable, and that the appellation of *Epistomia* suggested by the same learned naturalist is equally inappropriate.

The polypidom of this *Bryozoon*, like those of most of its congeners, may be said to consist of a radical portion by which it is affixed to the objects upon which it grows, and of a celliferous portion, or branches upon which the polypes themselves are lodged. The radical portion in the present species consists of a central discoid body of a nearly circular form, and of branches radiating from the periphery of the disk, which thence exhibits something of the aspect of the body of an *Ophiura*. The radical tubes or branches, springing from the margin of the disk, are usually five or six in number, and they are given off at pretty regular distances apart; but besides these radical tubes, one or more celliferous branches are not unfrequently seen to arise immediately from the upper surface of the discoid portion.

The central disk, and the radical tubes arising from it, exhibit a similar structure, and are formed of a thick, firm, apparently horny envelope, containing a coarse granular matter of a yellowish white colour, and which in some portions of the tubes assumes the form of distinct irregularly globular masses of nearly uniform size. The central disk is subdivided into distinct compartments by septa of considerable thickness, and each radiating branch arises from one of these distinct compartments, so that there appears to be no communication between one radical branch and another. The radical branches give off, at irregular distances, secondary branches, which ultimately become celliferous. Each of these secondary branches, however, arises from a distinct compartment, as it were, of the tube from which it springs. This compartment is formed, like those of the central disk, by a thick septum, which shuts off the origin of the secondary branch from the main cavity of the primary one. The secondary branches may usually be observed in all stages of development. Besides the dissepiments at the origin of each lateral branch of the radical tubes, the latter, especially towards their extremity, present transverse septa, and thus exhibit, in their mode of growth, a close resemblance to many *Confervæ.*

It will be difficult to make the more complicated conformation of the celliferous portion clear without reference to the figures.

The celliferous branches which constitute the principal part of the whole polypidom, arise, as has been said, either immediately from the discoid central body of the root, or from the radiating radical tubes or their lateral branches. They vary infinitely in number in different individuals, and differ also extremely in length,—some being nearly an inch long, but in the majority of individuals they are about half an inch in length when laid straight. When the zoophyte is living or recent, and unaltered by the fluid in which it may have been placed, the celliferous branches are always much curled, reminding one in their habit, thence derived, of the vernation of the fronds of many ferns, and the whole zoophyte from this acquires a peculiar and very elegant aspect. The branches divide dichotomously at tolerably regular intervals. They support the bracket-like polypiferous cells, which are placed in pairs, and with extreme regularity. It is to be observed, however, that at the bottom of every branch or at each bifurcation, the lowermost cell is single, or has none opposed to it on the other side of the rachis. This is uniformly the case. Above almost every pair of polypiferous cells, is to be noticed a pair of smaller cells, not unaptly compared by Ellis to the bowls of tobacco-pipes, with short stems. The larger or polypiferous cells will, in what follows, be termed "cells," and the smaller tobacco-pipe shaped organs will be termed "cups." It may then be stated that usually there is a cup above each cell, and this arrangement obtains throughout the polypidom, excepting immediately below each fork, where the cup is invariably absent above one of the cells of the pair from between which the fork springs. (See fig. passim).

This is the general arrangement of the cells and cups. It will be less easy to make clear the mode in which the cells and cups are mutually connected, and to render the description of this intelligible, it is necessary to consider each branch as presenting an anterior and a posterior aspect. The former of which is exhibited in fig. 2, *a*, and the latter in fig. 2, *b*.

The celliferous branches originate usually in a short trunk, similar in structure to the radical disk and its branches, and sometimes at the extremity of the radiating tubes or their lateral branches. In either case, the formation of the polypiferous cells commences in the same way; the radical tube, forming the initial trunk of the celliferous branch, becomes dilated laterally to about twice its diameter, the dilated portion being separated from the rest by a transverse partition,—it being in fact one of the terminal joints or cells of the radical tube, such as I have mentioned above, expanded, (fig. 3). The walls of this dilated portion are thinner than the rest of the tube, as if the expansion were eccentric, and its cavity is divided into two by a longitudinal septum. In this way, what may be termed two initial cells are constituted, from which in continuous succession the whole of the rest of the branch appears to be formed. We now come to a more complicated part of the subject. It will be observed in fig. 3 that the whole branch appears to originate in two cells, marked $c$, $c''$, and farther, that the branch divides dichotomously at tolerably regular intervals, so that the number of secondary branches rapidly multiplies; but if the two primary cells $c$, $c''$, and those derived from them in *continuous* succession, were coloured red and blue respectively, it would be found that notwithstanding this multiplicity, the two original colours would be continued uninterruptedly to the extremities of two among the numerous branches; or in other words, it may be said that each primary cell is the origin of a distinct series of polypiferous cells and cups, that each of these series continues single to the last, and that each of them constitutes one half of the cells and cups on the branches upon which it occurs. It is clear, then, that at each bifurcation two fresh elements or series of cells are introduced, and it would be found, upon colouring each of these new series continuously throughout, that they also constitute continuous distinct elements of the polypidom, from their origin to the termination of two branches. It is to be borne in mind, however, that any two series or colours are never united in the same internode after the bifurcation of the one in which they first make their appearance.

It may then be said that the celliferous branch is compounded of numerous distinct series of cells, each forming a continuous chain from its origin to its termination at the ultimate extremity of the branch itself, and that at each bifurcation the due number of fresh series to complete the tale—viz. two—are introduced.

It remains to point out the mode in which these series of polypiferous cells originate, and are afterwards continued. The two primary series, or those marked $d$ and $d''$, arise, apparently immediately, from the two initial cells before described, in two cells usually smaller than the other polypiferous cells, and of a different form, and I have not yet been successful in seeing polypes in them. One of this primary pair, moreover, differs from every other cell in the branch, in its supporting a cup, and it is at this point that we first notice the appearance of the latter very curious organ. There is no communication, however, between the cup and the cell. The first two polypiferous cells being formed in this way, the series of which each of them is the commencement is thus continued. The primary cell which bears the cup is continuous by a contracted portion with the cell immediately above it (see fig. 3, *d*), which gives off from its superior and internal or axial angle a narrow tubular prolongation, which *above* the next pair of cells expands into the cell on the opposite side of the axis, and which constitutes one of the pair of cells next but one above; unless, as is frequently the case, the branch bifurcates immediately above the second pair of cells, in which case, the tubular prolongation of the cell is continued into the inferior or single cell at the base of one of the branches of the fork. The other primary cell, or that which forms the pair with the cup-bearing cell, sends up a prolongation from its superior and internal angle, which above the level of the first regular pair of cells expands into the alternate cell on the same side as itself, or one of those constituting the second pair of cells. The continuation of the series along the branch takes place in the same way, by each cell giving off a tubular prolongation from its superior and internal angle, which, *after* the first bifurcation, is always placed on the *anterior* aspect of the branch, and gives off or expands into a polypiferous cell at each alternate pair, and always at the same side of the axis in the same internode, and alternately on the other side in each fresh internode into which the series enters. We have thus from the primary pair of cells traced the origin of two series, each of which constitutes half of the two first branches into which the polypidom divides, and to each of which series one of the first pair of regular cells belongs, and one of the second pair, if there be two pairs before the first bifurcation. Supposing this to be the case, as in fig. 6, it will be seen that the primary cells are marked *a* and *a''*, the second pair of cells or the first regular pair *b* and *b''*, and the third pair *c* and *c''*. Now, of these four regular cells, two only are derived from the primary pair, viz. *b* from *a*, and *c''* from *a''*. It remains to account for the origin of *b''* and *c*. This will be seen, looking at fig. 6, to take place thus:—Above and behind the primary cell (*a''*) is placed a cup, which forms, as it were, the fellow of the cup placed upon the primary cell (*a*). This cup, marked (*d*) in the figure, arises in a dilated ampulla, like those in the branches (to which I shall allude afterwards), on the same side of the axis as the cell *a*″. This ampulla or dilated portion, which must be considered in the light of a distinct cell or compartment of the axis, analogous to the other compartments in the radical disk and tubes before described, gives off laterally the stem of the cup, and is continued upwards into the cell *b*″, which, from its superior and internal angle, gives off a tubular prolongation, which passes on the *posterior* aspect of the branch till it reaches nearly the level of the upper border of the next pair of cells, where it expands either into two branches supporting cups, or into one such branch, and a wider one which expands into the lowermost or solitary cell of the other branch of the first fork, or the branch which forms the fellow to the one, the lowest cell of which was derived from the primary cell *b*, as before described. The remaining cell (*c*) also arises in a distinct compartment, like the former, and in this case, the arrangement, though apparently different, is actually the same. The new element of the polypidom, from whence the cell (*c*) is derived, originates in a narrow tube, also seen on the posterior aspect of the branch on the opposite side of the axis to the ampulla of the first cup, from which it is separated by a partition, and ascending on the posterior aspect and between the first regular pair of cells *b* and *b*″, when it reaches their upper border, it divides into or gives off two lateral branches (supporting the cups *e*, *e*) and is continued upwards into the cell (*c*), from the upper and internal border of which a tubular prolongation arises, which follows the same course as the similar processes from the other cells. I have been thus prolix in describing the mode of origin and continuation of the cells, as I think the structure I am describing so imperfectly is extremely curious and deserving of close investigation. But the arrangement will be better understood by the inspection of the figures or of specimens than from any verbal description.

It may be sufficient to say, that corresponding to each fork, two fresh series of polypiferous cells are, as it were, intercalated into the polypidom, in a manner precisely similar to the two last described. I would also particularly draw attention to one point, which may perhaps, hereafter, serve to throw considerable light upon the real nature of the cups, and consequently upon the true nature and relations of the analogous organs in the other *Bryozoa*. It will be observed that each separate series of cells is connected at its origin with one or more cups, according to the number of pairs of cells on the internode in which the series commences. The series, for instance, which begins with the single cup, as at fig. 5, *a*, presents its second cup at the first bifurcation and on the opposite side, so that the pair of cups exists, but they are not opposite each other, and as the series presents but one cell before the branch bifurcates, no other cup is formed in that series. For it is also to be remarked, that the tubular prolongation from the cells of each newly intercalated series, as long as the internode in which the series commences is continued without bifurcation, ascends on the *posterior* aspect of the branch, and gives off cups at each pair of cells immediately above that, of which the cell whence the tubular prolongation arises constitutes one; but that at the bifurcation, each series sends up its tubular prolongation on the anterior aspect of the branch, and never again affords origin to a cup. So that each series is connected with cups only at or near its origin, and is quite distinct, morphologically, from all the cups above the first bifurcation into which it enters. Thus, therefore, it may be said, that each series of polypiferous cells constitutes an individual or distinct organism, composed of a variable number of cells, and having near its inferior extremity or towards its origin, one, two, or three cups, which are either opposite each other in pairs, or not. I will not here enter into any long disquisition, as to the light which this curious relation between the cells and cups may throw upon their nature respectively, as in the present stage of inquiry, any speculation would, at least, as far as I can perceive, be premature and unsatisfactory. But the fact is curious, and taken in connexion with it I will remark, that although the polypiferous cells at the bottom of the branches, or at the bottom of each series, as it may be expressed, are always empty, and having performed their functions have become apparently useless; yet the cups belonging to the same series, and which consequently are placed below all these effete cells, retain their vital activity, and exhibit the same motions as those higher up the branch, and *seemingly* in more immediate connexion with active polypiferous cells. It would almost appear as if the polypiferous cells were to be regarded in the same light as the joints of a tape-worm, which as they maturate their ova are thrown off, and are replaced by a continued succession from above, as long as the head or nutrient organ of the aggregate animal retains its connexion with the source of nutrition. In the same way the polypiferous cells, as they are most probably the organs in which the ova are formed, appear after a time to discharge their contents, consisting not only of ova, but also of the polype itself, whose special function seems to have been to provide for the formation of the ova, and of them alone; in which case is it not allowable to suppose that the nutrition of the whole aggregate animal, that is of each distinct series, is in some way connected with the more persistent nature of the cups?

This must, however, be left undecided, and I will proceed to describe more minutely the structure of the cups and cells and their contents. First, of the cups, which constitute the great peculiarity of this species, and which, as Dr. Johnston suggests, are clearly the analogues of the " bird's-head processes " in other *Bryozoa*, and with which, in fact, they exactly correspond in structure. The rudimentary cups (as they may be termed) in *Laomedea obliqua*, can hardly be deemed in any way analogous to the curious organs in question; at all events, they present nothing of the same structure, as might be supposed upon considering the absolute distinction of the classes of animals to which the *Campanulariadæ* and *Bryozoa* respectively belong. In form, as stated by Ellis, they resemble the bowl of a tobacco-pipe placed upon a short stem. The walls of the cup are tolerably thick, but brittle and opaque, from the abundance of calcareous matter contained in them, and which is present in greater quantity in them than in any other part of the polypidom. The mouth of the cup, which is directed upwards, has a sinuated margin, rising anteriorly into a sharp, curved beak, like that of the cuttle-fish, or hawk-billed turtle: when the earthy matter is dissolved away by acid, this beak is found to be formed principally of a horny substance, and it will be seen to be supported and rendered more firm by the anterior wall of the cup, from which it rises, being strengthened by the same material. The posterior edge of the cup is even and semicircular, and about midway between the front and back of the cup, the lateral margins rise up on each side into a small elevation, for the articulation of a movable beak or mandible. This beak, when viewed laterally, appears curved and sharp pointed, and when viewed *en face*, presents the form of an equilateral triangle, (fig. 4, *d*). It is formed of a firm, horny framework, the interior space of which is filled up with a membrane, in the centre of which, or rather nearer the apex of the triangle than its base, may be observed a small transparent spot, indicating the point of attachment of the tendon of the muscles by which the mandible is depressed or closed. The base of the triangle reaches across from one side of the cup to the other, and the mandible is articulated to the sides of the cup by the two angles of the base. A flexible membrane connects the base of the mandible to the posterior lip of the cup, and thus completely closes the orifice when the mandible is depressed. The articulation, in fact, between the mandible and cup, bears a close resemblance to the joints of the *Articulata* in general. When partially closed, the point of the mandible comes close to the beak of the cup, but when completely depressed it lies within the latter, like the lower mandible of a parrot within the upper. The two beaks then would appear to constitute an admirable instrument of prehension. In the interior of the cup are contained two pairs of muscles, and a peculiar body of unknown nature. Of the muscles, one pair, and that much the larger, is for the purpose of depressing, and the other pair, for the purpose of elevating the mandible. The former, or occlusor muscles, form on each side of the cup a fan-shaped expansion; the broad part of the fan extending across the bottom of the cup, from before to behind. The muscles are composed of strong fibres, which are marked with distinct and regular transverse striæ, in all respects like those which characterize the voluntary muscles in the higher classes of animals. These fibres appear to form small bundles or fasciculi, each of which terminates abruptly in a narrow tendon, the union of all which tendons goes to constitute the common tendon of each muscle, and the conjoined tendons of the two ultimately constitute the tendon which is inserted into the mandible at the point above indicated: the function of this pair of muscles is evidently to close the mandible, slowly and with force. The other pair, or the elevator muscles, are placed in the back of the cup, from the posterior wall of which they arise and are inserted into the base of the mandible. Their position and size would indicate that their function is to open the cup by elevating the mandible, and that this motion is effected with rapidity, and without much power. This difference in the respective actions of the two pairs of muscles is shown very clearly in the motions of the mandible during life: it opens suddenly with a sort of snap, and is closed slowly. The bottom of the cup is entire.

The polype-cells are several times larger than the cups, and their walls are much thinner, in fact, sufficiently transparent to allow of the contents of the cell being pretty well seen without any preparation, even during the life of the animal. In shape they are inversely conical, and the outer and upper angle is usually produced into a prominent, sharp point. From the internal and upper angle arises the tubular prolongation going to form the next cell or cup, as the case may be, in succession. They are entirely closed at the top, contrary to what is stated in all previous notices, and, as has been shown, there is no connexion whatever between the cell and the cup placed *immediately* above and behind it. The aperture of the cell is on the anterior face, and towards the upper margin; it is of a crescentic form, and placed obliquely as it were across the upper or internal angle of the cell, with the convexity of the curve directed upwards and inwards. The lips of the aperture are strengthened by thin bands of horny material, and under favourable circumstances, indications of short, muscular fibres, for the purpose of opening or closing the aperture, may be observed. This aperture, therefore, bears a strong resemblance to that of the cells in *Gemellaria loriculata*, figured by Dr. Van Beneden, and of many other *Bryozoa* belonging to the same sub-division.

The cell which I believe to be entire at the bottom, though closed only by a very delicate membrane, contains an ascidioid polype, any detailed description of which I am unable to give, and which would perhaps be superfluous, as the animal did not appear to present any peculiarity in which it differed from the typical form of that class of polypes, now so well known to us from the labours of Milne Edwards, Lister, Farre and Van Beneden. It has ten tentacula and no gizzard. Two sets of muscular fibres, at least, may be distinguished as appertaining to the polype. The most important of these are the retractor muscles, which, arising from the bottom of the cell, in the form of long, somewhat flattened, transversely striped, isolated fibres, about the $\frac{1}{10.000}$th of an inch in width, are inserted some of them at the base of the tentacles, and others lower down the body of the polype. Other muscles, which may perhaps, as suggested by Dr. Farre, be considered as the extensors, exist, in shorter transverse fibres, which, arising from the sides of the cup, are probably inserted into the sac in which the polype is contained. These fibres exhibit very distinctly a nucleus, nearly in the middle of their length, and the portion of the fibre between this nucleus and the wall of the cell is wider than the other portion, and in that wider portion only, and there rarely, have I been able to see transverse striæ.

With respect to the mode of development and the generation of this *Bryozoon*, I have little to offer, want of time not having allowed me to observe these points sufficiently in the living animal. But with respect to the mode of development of the cells and tubes at the extremities of the growing branches of the polypidom, it may be stated that the posterior and anterior connecting tubes of the cells and the two lateral cups, constitute, at the end of each branch, four distinct buds, containing a fine granular matter, and appearing to be gradually developed into their respective complete forms, in the mode common to all hitherto observed *Bryozoa*, and so well depicted and described by Dr. Van Beneden in the instance of the *Laguncula* and others.

## EXPLANATION OF PLATE XXV.

Fig. 1. A magnified view of a whole small specimen of *Notamia bursaria.*

Fig. 2. *a.* Front view of a portion of a branch.

*b.* Back view of the same.

Fig. 3. Front view of the initial portion of the stem. *c, c''.* Initial cells. *d, d''.* Primary cells.

*b.* Back view of the same.

Fig. 4. Enlarged view of polype cell and tobacco-pipe process or cup.

*a.* Retractor muscles of polype.

*b, b, b.* Extrusor muscles?

*c.* Cup, shewing the muscles by which the beak is elevated and depressed, and indistinctly a hollow viscus contained in the cup.

*d.* Front view of the beak of the cup. The spot in the centre is the point of attachment of the depressor muscles.

Fig. 5. *a, b.* Diagrams to show how the branches are constituted of two series of cells, each of which has a cup or pair of cups at the bottom of the series.

Fig. 6. A diagram to explain the mode of derivation of each series from one or other of the primary cells.

Fig 5


Fig 4 d.

Fig 4 c.

Fig. 4.


Fig. 2.a.

Fig 2.b.

Fig. 6.

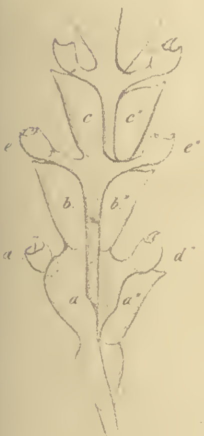


Fig 1.

Fig 3.b.


Fig 3.a.


Nat size