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lated, reticulation regular with quadrangular areolæ, and covered with many slender linear tubular spines or their bases, somewhat quincuncially arranged; spines smooth, dilated at the base, a little above which they remain of nearly uniform size throughout or very slightly tapering, and are regularly and transversely sulcated or contracted, giving the spines a beaded or jointed appearance.

The general form of the shell and quincuncial arrangement of the spines resemble *S. aculeata*, Kutorga, but as that author does not figure or allude to any reticulated structure or the moniliform spines*, this is considered to be distinct; unfortunately the specimen is much compressed, so that all the characters are not fully shown, and I have provisionally given the name of *S. anglica* until it can be compared with all the Russian species.

Locality. From the Wenlock shale near Dudley. Collection of Mr. J. Gray.

EXPLANATION OF PLATE VII.

Fig. 1. Siphonotreta anglica. a. Shell, natural size. b. Shell, magnified view. c. Spines enlarged. d. Portion of ditto, magnified. e. Outer surface of shell, magnified.

Fig. 2 a. Siphonotreta verrucosa. b. Side view. c. Surface of shell, magnified. d. Interior of dorsal valve.

Fig. 3 a. Schizotreta = Orbiculoidea, D'Orb., *O. Forbesii*. b. Showing longitudinal furrow and contracted perforation.

Fig. 4. Acrotreta = Cyrtia? a. Dorsal valve. b. Ventral valve.

Fig. 5. Aulonotreta = Obolus.

XXXIII.—On the *Animal of Dentalium Tarentinum*.

By WILLIAM CLARK, Esq.

To the Editors of the *Annals of Natural History*.

GENTLEMEN,

Norfolk Crescent, Bath, Sept. 1, 1849.

THE animal I am about to present to your notice exhibits a series of characters of the highest interest, in its anatomy and functional developments, some of which are so anomalous that it must be considered one of the most singular of the testaceous mollusca.

From my observations in the September Number of the '*Annals*,' it appears that the minute species of the genus *Cæcum*, from their configuration, have generally been located with the *Dentalia*, though it will be seen that there is little concordance

* The moniliform character of the spines may not be peculiar to this species, but will probably be found to belong to the whole genus, when the spines of the other species are carefully examined by a higher magnifying power than that used by Dr. Kutorga.

between the animals of the two genera. I believe, with the exception of M. Deshayes's monograph, nothing has been done to elucidate this curious molluscum; and as I think that eminent malacologist has mistaken the uses of some of its organs, I am induced, by the facility of obtaining live specimens of the *Dentalium Tarentinum*, to review and augment what is at present known of it: the present species inhabits the coralline zones of the South Devon coasts, five or six miles from land, in twelve or fifteen fathoms water.

Dentalium striatum, Montagu.

————— *Tarentinum*, Lamarck.

Animal yellowish white, conically elongated, mantle circular, anteriorly thick and fleshy, edge dentated, posteriorly of the thinnest texture; the penultimate and antepenultimate portions of its margin are bounded by two intense white muscular elastic cordons; the united action of these has the power of completely opening and closing the anterior aperture; when at rest, the animal, including the foot, is entirely inclosed by the tougher part of the mantle which supplies the place of an operculum.

The foot is a very long and singular organ, placed in the centre of the anterior end of the body, and from its position is applicable for use in every direction; it is divided into three parts: the anterior one is a pointed cone acting in some measure as a tentaculum, and lies in the middle portion, which consists of two lateral, sinuated, symmetrical flaps or tenacula, that are usually protruded simultaneously with the terminal portion, and are the parts subservient to the animal's very confined locomotion, to turn from side to side by using the lateral appendages as *points d'appui*, and also to climb and secure its food from the stems of the foraminiferous polyparia; the third or basal section is a long flattish pedicle deeply grooved on its upper and lower surfaces, extending to the base of the stomach, into which it opens, as it is hollowed out as far as the tenacular flaps, but there is no passage to the exterior surface. I have failed to discover the reason for this connection with the stomach: the hollow part is filled with water, but from what source does not appear, though I think it must come from the buccal aperture; the use of this singular structure is clearly to augment the flexibility of the foot, as the animal frequently and suddenly doubles it up as the elephant does its trunk; and also to withdraw the two anterior parts into the hollow portion: this retractile action is necessary in consequence of the peculiar mouth of the animal and rigid character of the anterior end of the mantle, to convey the sustentation captured by the tenacula into the cavity of the mantle within the reach of the very short foliaceous cirrhi at the buccal

orifice: from the foot an elastic fibrous ribbon runs, on each side of the body, to the posterior terminus, and affords the animal the power of greatly contracting and dilating that end of it, as may be seen by the creases of contraction, which in some degree give the appearance of annulations.

At the base, and above the pedicle of the foot, if that surface of the animal is upwards which lies in the concavity of the shell, and *vice versa*, in the convexity, is inserted a distinct light yellow tubular buccal appendage, without eyes or tentacula, which can only be considered a kind of external œsophagus, and as regards its accessories and form, has no pretensions to be styled a head; it is encircled by about eight or ten short dendroid tentacular strands; its cavity forms two extremely dilatable pouches divided by a longitudinal septum, which become compressed and merge apparently into one at the point of passage into the stomach; these external receptacles invariably contain from ten to forty, or even more, very minute Foraminifera, a convincing proof of the voracity of these animals. I have never failed to find in them either the *Quinque*-, *Tri*-, or *Biloculina*-, or the *Rotalia Beccarii*, the *Lobatula vulgaris*, *Bulimina pulchella*, *Textularia oblonga*, *Lagena amphora*, or the *Robulina subcultrata*, and more rarely a minute bivalve, either the *Kellia suborbicularis* or *Astarte triangularis*: this fact is another proof, if any additional ones were necessary, that an animal inhabits the minute calcareous forms which were formerly supposed to inclose Cephalopoda, or to be inserted in their membranes; they are not inhabitants of the littoral, but of the coralline zones, and appear to be the sole aliment of this decided zoophagous molluscum. These shells are *in transitu* to be acted on by the appendage within the stomach, which will be noticed shortly, and after having undergone its action the rejectamenta are discharged anteriorly with other mucal and fæcal matters, and not at the posterior terminus agreeably to M. Deshayes's determination, and I shall presently demonstrate that the posterior aperture is not for anal uses, but to supply the branchiæ with water.

It is now necessary to mention the figure and situation of the heart and branchiæ; these points must be carefully kept in mind, as the demonstration I propose rests on a due consideration of them. The heart is a subrotund minute ventricle with a linear depression on its summit, and when opened shows the corresponding ridge; its surface is fortified with muscular raised lines; it is fixed centrally on the convex range at the posterior end of the branchial cavity and base of the stomach, and in some transparent animals may be seen in the pericardium; in the very young pellucid shells seven inspirations and as many nearly isochronal expirations have been counted in a minute, and the

corresponding ingress and egress of the water seen*. I have not detected auricles on each side of the heart, nor near it, as might be expected from the symmetry of the branchiæ; there are certainly minute points on each side of that organ, but I demur to call them auricles, and rather think they denote the valvular appendages of the heart to prevent regurgitation into the branchial veins. The blood of the posterior part of the body is brought to the branchial artery which runs at the inner base of the branchiæ, by two longitudinal veins, which pass between the branchiæ on their convex surface, receiving tributaries; I could not trace those of the anterior part; the arterial blood is then distributed into the ramifications of the branchiæ, and after aëration is passed by each principal vein, which coats the edges of those organs at their dichotomous points, to the heart, which throws out a posterior and anterior short trunk, both of which bifurcate into two smaller arteries, which supply veins infusing a renewed vitality into all parts of the body, from whence the blood is again returned to the arterial centre. Under the microscope the blood of the tributary and superficial veins appears to be in some individuals of a pale pink colour, and in others of a purplish pale red cast. I have preparations to illustrate this order of the organs.

The branchiæ are two symmetrical, sublateral, and somewhat post-centrally situated, dark greenish brown, elongated, suboval organs, having their bases fixed on and hanging from the concave surface of the animal with their points vertically parallel to the bases; the two branchiæ are united at their inner surfaces by a bridle of branchial strands arranged symmetrically.

The heart in the testaceous Gasteropoda, spiral and otherwise, is always placed at the posterior end of the branchial cavity, or, in other words, is fixed at that extremity of the branchiæ *furthest* from the entry of the aërating fluid: this statement of position is of importance in coming to a conclusion as to the mode of entry of the water. But if the position of the organs of *Dentalium* is examined under the view of the water approaching the branchiæ under the mantle, as in the ordinary Gasteropoda, they will be found to be the reverse of what I have stated to be the usual natural position; the heart will be found at the *anterior* end of the branchial cavity instead of at the posterior, and *nearest* to the entrance of the water instead of furthest from it: here is a subversion of the order of nature in respect to the position of these essential organs: how are they to be placed in harmony with her laws? The solution of this question is simple: we have

* Lamarck in the last ed. 'Anim. sans Vert.,' Milne Edwards's, 3rd vol. p. 13, says, "Car, après les animaux vertébrés, la nature n'offre, dans aucun

only to consider that the water in this genus flows to the branchiæ by the posterior aperture instead of at the front; this view removes every difficulty, and may be regarded as a demonstration of this fact, which is satisfactory and decisive, because it is founded on the organization which nature has conferred on these animals.

I will state some facts in support of the conclusion that the branchiæ in *Dentalium* receive the water posteriorly. I admit that notwithstanding a constriction, it may possibly enter in front under the mantle and be discharged posteriorly, and *vice versa*; but this action would be contrary to the natural position of the organs and the evidence I shall now adduce. But first it will be necessary to mention the mode of fixture of the animal to the shell: this is not at the centre, as in the spiral Gasteropoda, but at the posterior end, a little more than an eighth of an inch from the terminus, where, on the inner surface, may be seen the striæ, in the hollows of which the fine filaments issuing through the mantle and proceeding from the longitudinal elastic ribbon running from the foot are deposited, and together with the strong sphincter of the posterior process, which is imbedded in an indentation not visible from without, firmly secure, by constriction, that end of the animal to the shell. This is a striking example of the admirable adaptations of nature of the organs of animals to their wants and œconomy; for if this animal was fixed to the middle of the shell as in the spiral ones, the contractibility of the posterior part of the body would be destroyed, and its vermicular motion to aid and accelerate the passage of the branchial fluid and its expulsion through the comparatively narrow medial duct paralysed. I may state in corroboration of the foregoing observations, that I have removed the posterior hyaline process and enlarged the orifice as much as possible, and then dropped therein some grains of fine sand to irritate the membranous spoon-shaped process, when instantly pure water, without the slightest admixture of fœcal substances, was ejected; and this result was invariable in all and many individuals. I have stated that in young transparent specimens an uninterrupted but slow action of systole and diastole might be observed, and was apparent from the distinct ascent and descent of the water in the branchial canal; but this action cannot take place in a merely excretory tube; it can only exist in a circulatory, or inhalant and exhalant one. I have carefully dissected the body from the

animal, ces mouvements alternatifs et mesurés d'inspiration et d'expiration du fluide inspiré," &c.

On this point that great naturalist is in error, as in *Dentalium Tarentinum* I have with a chronometer showing seconds, repeatedly marked nearly isochronal inspirations and expirations of the aerating fluid, the two together amounting to about twenty-six in a minute.

branchiæ to its terminus, and submitted its substance to microscopic powers without discovering a trace of an intestine, which is usually the easiest organ to be detected by its colour and distension. I have carefully watched thirty individuals at a time, and never saw any rejectamenta from the posterior process; but in the same period frequent discharges anteriorly from the centre of the mantle, of foraminiferous spoil enveloped in mucus. I finally observe, that on the animal being removed from the shell, the medial branchial canal is distended, but in a short time collapses from the evaporation of the fluid, and exhibits a deep canaliferous groove; and when the canal is not quite full, one or two globules, precisely like those of a spirit-level, may be made with the slightest pressure to float backwards and forwards from the posterior sphincteroid process to the branchiæ. Many other circumstances can be added in proof of the posterior entry of the branchial water, but I have already transgressed the limits of conciseness, and it is time to take some notice of the nervous system, salivary glands, the stomach and its contents, and the substances which fill up the body from the branchiæ to the posterior terminus.

At the base of the œsophagus is a cerebral mass of four minute, pale pink, subcircular, finely-punctured ganglions, in form somewhat like the letter X, united by a nervous thread or collar, which encircles the œsophagus at the point where it passes at the base of the foot into the stomach, and the fine filaments therefrom are distinctly visible passing to the stomach, and throwing off anastomosing lateral threads anteriorly to the foot, buccal orifice, and the other front parts of the body.

The salivary glands are very large, covering the base of the foot and the œsophageal ganglions, and envelope the buccal pouches so completely that they seem imbedded in them; they spring from each side the base of the mouth, and are two thick fasciculi, which consist of a multitude of very fine, long, light yellow capillary strands; their extraordinary volume is necessary to produce a copious supply of fluid to lubricate the enormous quantity of Foraminifera these animals swallow, especially of the scabrous ones, as *Bulimina pulchella*, and the sharp-pointed *Lagena amphora*.

The œsophagus, after emerging from the nervous collar, instantly enters the stomachal cavity, which is composed of a muscular membrane of a broad oval form, the anterior and larger portion thereof being occupied by an extremely strong gizzard, formed of a pair of subelliptical folding jaws with eighteen laminæ bent towards the points on each side, and studded with very strong blunt teeth: this denticular frame is supported by fleshy lobes encased in corneous plates, and appears to be an organ nearly similar to the buccal mass of the ordinary Gasteropoda;

it is not however placed, as in them, immediately at the anterior orifice of a pharyngeal œsophagus leading to a stomach and fixed thereto by strong elastic threads, but it is the stomach itself most slightly attached to the membrane which envelops it. This powerful machine undoubtedly acts as a gizzard to grind the testaceous food of this animal; it empties itself by a very short scoop-shaped canal into an intestine of three or four intricate gordian knot-like folds, which, strange to say, often contain a dozen or more shells that have escaped the action of the gizzard; the intestine does not entwine with the liver, but is inclosed within the same cavity as the gizzard; it pierces its inclosure on the right side, passes through the liver, and discharges the rejectamenta at the base of the branchial cavity under the mantle about the middle of the shell, from whence they are passed by the deep groove of the foot, which the animal can by the compression of its sides make canaliferous, as far as the middle section of the foot, around which, when the animals are fresh from the sea, they form repeated collars of mucus, which in a short time, from frequent aggregations of matter, become ponderous, break and fall off, and when examined are found to be composed of the spoil of shells: this circumstance, independent of all others, shows that the fæces are not discharged posteriorly.

The liver is an extremely scanty light yellowish green organ placed under the stomach, and is continued under the branchial cavity, and then joins the ovarium, with which it becomes almost imperceptibly amalgamated throughout its whole length. The ovarium is very long and large, and fills up the whole of the posterior part of the body from the branchiæ; it consists of from four to six longitudinal rows of distinct granular yellowish white masses of ova, with scanty interweavings of the liver, which exhibit three stages of development; the more forward ones become broken into six portions, and when ready for exclusion these again break into perfectly round, pale brown globules; all these phases vary in different animals according to the advancement of fecundation. The oviduct is in the centre of the longitudinal rows of ova formed by their junction, and the ova are undoubtedly discharged by the posterior spoon-shaped process, from whence I have seen volleys of fifty or a hundred ejected with considerable force in minute round points: these must not be mistaken for fæcal pellets, neither must the oviduct be confounded with the branchial canal, which is the cavity formed between the mantle and the membrane of the ovarium. The homogeneity of the masses of this part of the body in many conditions, especially when fecundation is not far advanced, renders the discrimination of organs of this character a matter of some difficulty. I have not discovered any exerted organs of repro-

duction, and I think from various considerations that this animal is an hermaphrodite, but without congression. Under the microscope, in the midst of the general mass, several small egg-shaped globules, having at one of the axes a minute, apparently tubular filament filled with a glary fluid, may be seen in some individuals, but not in all, as I have sometimes searched in vain for them ; these may be the virile fecundating organs, which are perhaps only apparent at certain stages of gestation.

I have extended these observations to an unusual and almost inconvenient length : the curious and anomalous structure of this molluscum, and the multitude of interesting characters attached to it, exhibit such modifications of the organs of the typical Gasteropoda as appear to give it a claim to be considered as the point of transition from the bivalve mollusca to the great change in figure and faculties which nature has produced in the superior developments of the Gasteropoda ; and perhaps from a review of this account of these organs, malacologists may be induced to think that it will appropriately form one of the first, if not the first link, in the chain of the Gasteropoda. The symmetrical subventral position of the branchiæ, the posterior flow of water to them, and the resemblance of the foot to that of some of the bivalves, combined with the similar character of its action, appear in a striking manner to show its connection with the Conchiferæ ; whilst by its œsophageal cerebral ganglions and completeness of the circulation, it has established its claims as a Gasteropod. There are also traces of alliance with some of the inferior classes : the red blood and vermiform configuration of the posterior part of the animal show some of the characters of the Annelides ; but though we acknowledge these sources of its origin, we cannot fail to see how clearly the animal of *Dentalium* displays at various points the progress of advancement, and the ameliorations nature has so beneficently effected in its animality.

I have only seen one live specimen of the *Dentalium entalis* : the organs have the same characters as those of the present species, but it is very distinct ; the colour is snow-white, and on comparison of two shells of the same size, the *Dentalium entalis* will be found much more slender ; the branchiæ are also of a paler green, more scanty, thin and delicate.

I had written thus far when I received from Paris M. Deshayes's memoir on the *Dentalia*, which I had not seen for twenty years, and its contents had nearly passed from my memory ; on looking it over I find that the differences between that gentleman and myself are more important than I was aware of, but I am not inclined to abandon my own views. I am also glad to find that I am enabled to fill up many gaps as regards the functions and habits of these animals.

This gentleman, in stating the anus in *Dentalium* to be pos-

terior, observes that it is the only molluscum that has it so situated ; but this anomaly, if it be so, I think I have disposed of.

Those organs which I consider to be the symmetrical branchiæ are termed by M. Deshayes the lobes of the liver, each pouring into the stomach the bile by their biliary vessels. I cannot persuade myself that this view is correct ; I have submitted them to the microscope, and in each principal strand I have seen the leading vein distended with red blood as well as in the net-like connecting ramifications ; I therefore consider what are called the biliary vessels to be the branchial veins conveying the blood to the heart instead of bile into the base of the stomach. M. Deshayes in his figure has omitted to mark the vein which runs at the dichotomous points of his organ, which, when viewed under high powers, is very visible, and which I take to be the branchial vein.

What I term the salivary glands, are the branchiæ with M. Deshayes, combining the functions of tentacula : he does not mention such glands. I must consider this assumption incorrect ; and to support this opinion I state that the heart is separated the whole length of the stomach from the bases of what M. Deshayes terms the branchiæ : this is a position without parallel, as that organ is invariably in the closest contact with one end of the branchiæ. That naturalist certainly connects the two organs by stating, as I think erroneously, that the heart sends great and numerous vessels to the branchiæ. Now the heart never transmits blood directly to the branchiæ, but impels it into the system by arteries and veins, from whence, as I have already stated, it reverts to those organs.

The filaments in dispute I have submitted to microscopical observation ; they only present the appearance of a complicated mass without a trace of particular arterial and branchial vessels, and they have nothing like the symmetry of branchiæ ; I believe them to be merely secreting glands, and may perhaps combine tentacular functions.

M. Deshayes is, I think, in error in stating that the aliment undergoes a second mastication : this idea has arisen from his having divided the gizzard into two parts, one of which he describes as "*mâchoires*," and the other as an "*appareil dentaire assez compliqués* ;" the fact is, there are no hard parts in the buccal pouch, which, when removed, there being no internal œsophagus, exposes to view the anterior part of the gizzard, which is likened to two spherical black points gaping like a small bivalve : these are only part and parcel of a *whole*—the gizzard, which may almost be called the stomach itself, as it fills the entire stomachal membrane, with the exception of the convoluted intestine at its base, consequently the aliment has no other mastication but of one denticular apparatus.

That there are no errors in these observations would be an undue assumption ; for who, on such subjects and in the examination of these minute objects, can hope to escape from occasional error ? I invite malacologists to offer their corrections, if I have differed on insufficient grounds from so eminent a naturalist as M. Deshayes ; and I conclude with the evocation,

..... "Si quid novisti rectius istis,
Candidus imperti."

I am, Gentlemen, your most obedient servant,

WILLIAM CLARK.

P.S. I beg that the notice relative to the *Venus orbiculata* of Montagu, in my paper on the genus *Cæcum*, in the 'Annals' for August, may be considered as cancelled.

XXXIV.—*On the Classification of some British Fossil Crustacea, with Notices of new Forms in the University Collection at Cambridge.* By FREDERICK M'COY, Professor of Geology and Mineralogy in Queen's College, Belfast.

[Continued from p. 179.]

Enoploclytia (M'Coy), n. g.

Etym. *ἐνοπλος*, *armatus*, and *Clytia*.

Gen. Char. *Carapace* fusiform, back rounded, sides convex, gently compressed, posterior end slightly narrowed and deeply

Enoploclytia.

notched for the insertion of the abdomen, much contracted anteriorly, the front extended into a long, sharp-pointed depressed rostrum, the sides of which are armed with three or four strong spines ; one strong spine over the upper external angle of the orbit ; *eyes* on short, thick peduncles ; *nuchal*