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XXVIII.—*Notice of a British species of Calliopæa, D'Orbigny, and of Four new species of Eolis, with observations on the Development and Structure of the Nudibranchiate Mollusca.* By JOSHUA ALDER and ALBANY HANCOCK, Esqrs.*

THE genus *Calliopæa* was established by D'Orbigny for a small mollusk found near Brest, and published in Guérin's 'Magasin de Zoologie.' It is distinguished from *Eolis* by having only two tentacula, and also (according to D'Orbigny) by the longitudinal arrangement of the dorsal papillæ. The latter distinction, however, does not hold good, and a better may be had in the arrangement of the vessels of the gastro-vascular system, described by Milne Edwards in a second species found on the shores of the Mediterranean. We have now the pleasure of announcing a third species from the Devonshire coast, being the first that has occurred in Great Britain.

This beautiful species, which we have named *Calliopæa dendritica*, is about a quarter of an inch long, with seven or eight rows of large, elliptical, dark green papillæ on each side of the back, three in each row. The general colour of the body is a pale pellucid grass-green: two dark green lines run down the sides of the back, sending off branches of the same colour, which ramify in all directions, and give the little animal a peculiarly elegant appearance. These dendritical markings are caused by the vessels of the gastro-vascular system of Milne Edwards, of which we shall have occasion to speak afterwards. It was found on sea-weeds at low-water mark in Torbay, and appears to be gregarious. Nearly one hundred specimens were sent us from thence by Mrs. Wyatt.

Eolis stipata.—This species is also from Torbay, where we obtained it from the produce of a day's dredging in September last. It is about a quarter of an inch long, rather broad and depressed, and of a bright yellowish green on the body with short tentacula, and about nine rows of bluish-green papillæ covering the whole of the back. This species belongs to the section con-

* Read before the Natural History Section at the Cork Meeting of the British Association, and communicated by the Authors.

stituting Fleming's genus *Montagua*. It differs entirely from *Montagua viridis* of Forbes in the form and proportion of the different parts.

Eolis pellucida.—A very slender and graceful species, about three-quarters of an inch in length, with long slender tentacula, and the angles of the foot much produced. The body is pellucid white: the branchial papillæ long and slightly conical, of a bright rose-vermilion with white tips, set in about five clusters down the sides. This is a critical species, differing from *E. gracilis*, noticed last year, in the form and colour of the papillæ, and from *E. rufibranchialis* in the more lengthened tentacula and lateral portions of the foot.

Found on a coralline from deep water at Cullercoats, Northumberland.

Eolis curta.—The body of this is short in proportion to the other parts. It is about half an inch long, pellucid; the head and tentacula pale rose-coloured. The branchial papillæ are very long, of a brownish orange with white tips and a streak of the same in front. They are set in clusters down the sides; the first large, and three or four smaller ones behind nearly coalescing. Dorsal tentacula annulated, sides of the foot much produced and recurved.

Found under a large stone among the rocks at Whitley, Northumberland.

Eolis concinna.—A very distinct and well-marked species; about half an inch long, with nine or ten distant transverse rows of purplish-brown papillæ, tipped with white, on the sides of the back, five in each row: the external surface of these is tinged with pale blue, giving them a metallic lustre. Tentacula linear and smooth, the dorsal longest and inclined forwards. Sides of the foot very little produced. Four individuals were found together under a large stone between tide-marks at Whitley.

We have, during this summer, had an opportunity of studying the development of the ova in two or three genera of the Nudibranchia, the phenomena attending which we find to be very similar in all. The fact of their undergoing a complete metamorphosis, and during their larva state being provided with a nautiloid shell, is a striking peculiarity distinguishing these from the other families of gasteropodous Mollusca.

We learn incidentally, in a note to an article on the development of *Aplysia* by Dr. Vanbeneden in the 'Annales des Sciences Naturelles,' that M. Sars has already published an account of the development of some of the Nudibranchia; but the work containing it not being accessible to us, we are at a loss to know how far our observations agree with his, and shall therefore give a short description of the embryo as observed by us.

The spawn of *Doris tuberculata* is a broad gelatinous riband, attached by one of its edges to the underside of stones, in a circular coil of about three volutions, the whole forming a beautiful cup- or flower-like expansion. The number of ova imbedded in it, on a moderate computation, cannot be less than 50,000. Each egg contains a single yolk, but frequently there are two, and sometimes even three yolks in the same egg. The period necessary for their attaining the larva state appears to be about a fortnight; after that time the mass presents a very animated appearance. When observed with a common magnifier, in some the full-formed larva will be seen whirling itself round with great velocity in the transparent egg; others, having broken the shell, will be found performing more extended gyrations in the general envelope, while others again are swimming hither and thither in search of an aperture to escape into the open water. The larva forms a beautiful object for the microscope. Its body is inclosed in a very transparent calcareous nautiloid shell, furnished with an equally transparent operculum. The whole surface of the animal is covered with minute vibratory cilia, as are also the internal walls of the alimentary canal, which is visible through the transparent shell. Two large wing-like lobes form the principal part of the animal visible outside the shell; these are fringed with long cilia, by the motion of which it swims freely through the water; they are capable of being withdrawn into the shell and the operculum closed upon them. The mouth is situated between these lobes. It will readily be seen that these little creatures do not bear even the most remote resemblance to the future *Doris*. How long they remain in this state before their final transformation, or how that takes place, we have not yet been able to ascertain. The motion of these animals through the water by means of ciliated expansions recalls to mind some of the forms of the Rotifera, though sufficiently distinct from any of them. Comparing our drawings with those of *Aplysia* by Vanbeneden, we observe a very striking resemblance between the two animals: each has a similarly formed shell; though that of *Aplysia* is stated to be corneous, while ours readily dissolves in weak acids, from which we infer its calcareous nature. We do not see in M. Vanbeneden's figures the expanded lobes so peculiar in these, nor, on the other hand, can we trace in any of the parts of our animals the least resemblance to a rudimentary head or foot. In addition to that of *Doris*, we have succeeded in bringing out the larvæ of *Eolis*, *Melibæa* and *Tritonia*; they all bear a very great resemblance to each other.

The system of vessels pointed out by M. Milne Edwards in *Calliopæa*, connected with the alimentary canal, and extending through the whole body, which he calls the gastro-vascular sy-

stem, has been observed also by us in *Eolis*, with this difference, that while in *Calliopæa* there are two longitudinal vessels running the whole length of the body, in *Eolis* there is only one of these vessels, sending off branches to the papillæ. The passage of particles of matter from these vessels into the papillæ and back again in an irregular manner may occasionally be observed. These particles are of various sizes and forms, and have a crude undigested appearance. They are occasionally mingled with regular blood-like globules. Their motion is produced by the contraction of the walls of the vessel and of the stomach, which is every now and then perfectly collapsed. There is no decided onward current produced by this action, which takes place quite irregularly in different parts of the gastro-vascular system, but a mere oscillatory motion in the immediate vicinity of the action. We have observed another curious circumstance apparently connected with this system, which appears to have escaped the observation of M. Milne Edwards, and for which we can in no wise account. The end of each of the papillæ has internally a small ovate vesicle, which is connected by a transparent vessel with its central tube. By the contraction of this vesicle very minute bodies are occasionally sent out by a small aperture terminating the papilla. These bodies are of an elliptical form, with a long hair-like tail, and bear considerable resemblance to the Spermatozoa, but have no motion, nor is the organ from which they issue at all connected with the generative functions. We would therefore call the attention of comparative anatomists to this fact.

The functions of the gastro-vascular system as well as of the papillæ, which have generally been considered to perform the office of branchiæ, require further investigation. M. Quatrefages appears to think that the central coloured portion of the papillæ performs the functions of the liver; an opinion which is perhaps correct, but requires further investigation.

The fact, which we do not recollect to have seen stated, that the whole surface of the body in *Eolis*, as well as the papillæ, is covered with vibratory cilia, might lead us to infer that the organs of respiration are not specialized in this genus, but that the animal breathes over the whole body. The appendages in *Eolis* as well as in *Melibæa* are very deciduous, which is not usually the case with an important vital organ, and the animals are known to live for some time when deprived of them. But even though the papillæ should be considered the chief seat of the respiratory function, it is evident that they have at least some other office to perform, the nature of which is not well understood.

Dr. Siebold has announced the discovery of the organs of hearing in many of the pulmoniferous Gasteropodes as well as in se-

veral species of Conchifera*. We have lately had the pleasure of recognising the same organs in the Nudibranchia; they consist of two transparent vesicles connected with the two superior lobes of the brain by short nerves. These vesicles are filled with small concrete bodies or otolites, varying in number according to the species, and vibrating, when in a living state, with a continuous oscillatory motion.

In *Eolis papillosa* the otolites exceed eighty; they are elliptical and very minute; while in *E. olivacea* and *E. pallida* there is only one large globular otolite in each capsule. We have observed these organs in species of the genera *Eolis*, *Tritonia*, *Melibæa*, *Polycera* and *Doris*; in all of which we find them similarly situated and undergoing only very slight modifications.

The eyes are placed immediately before the auditory capsules, and the nerve that supplies the former arises from the same portion of the large ganglion above the œsophagus to which the latter is affixed. The eye is much more completely organized than has been supposed; it is formed of a well-defined cup of black pigment, through which in all probability the retina is dispersed. Before this cup is placed a large spherical crystalline lens, having a well-arched cornea in front. The whole is enveloped in a thin transparent vesicle attached to the ganglion by a pedicle, through which the optic nerve passes into the base of the cup.

The organs of smelling remain yet to be ascertained. De Blainville has suggested that this function may be performed by the dorsal tentacula, and a careful examination of the structure of these compared with that of the olfactory organs in other animals has led us to adopt the same opinion. The simplest form in which the organs of smelling are known to exist, is in fishes and in some of the Crustacea. If we examine this organ in a fish, the common herring for instance, we shall find it to consist of a delicately lamellated expansion contained within a cavity, open externally, but closed on its internal surface, and communicating with the brain by a nerve having a small ganglion at its base. Now if this lamellated portion were bent into a cylindrical form and raised upon a pedicel capable of being protruded from the cavity, we should have a structure exactly similar to the dorsal tentacula in *Doris*. It is easy to trace the modifications of this form through the other genera of the order, in most of which the plicated structure is more or less visible, the organ being in some carefully protected by a sheath. In all, the tentacula are furnished with a nerve which generally has a small ganglion at its base, as in the olfactory nerve in fishes. On examining the tentacula under a microscope, the whole surface is found to be very strongly ciliated; more strongly even than in the branchial

* See this Journal, vol. ix. p. 501.—Ed.

processes, and with this remarkable difference ; that while in the latter the cilia propel the water outwards, sending off a current at their apices ; in the tentacula, on the contrary, the cilia are directed downwards, drawing in and sending a current of water down their whole surface. This is exactly what we might be led to expect in the olfactory organs, and forms a beautiful compensation for the power of drawing a current of air through the nostrils in the higher animals. Upon the whole, therefore, we think that little doubt can remain of the real function of these organs.

P.S. Since writing the above, we have seen M. Quatrefages' elaborate paper on his *Eolidina paradoxum* in the 'Annales des Sciences Naturelles,' and are happy to find that many of his observations agree with our own. His *Eolidina* we consider to be undoubtedly an *Eolis* very nearly allied to our *E. angulata*, MS., communicated to the last meeting of the Association.

In the position which he assigns to the anus at the posterior end of the large central vessel of the gastro-vascular system, we conceive him to be under a mistake, deceived probably by the apparently abrupt termination of that vessel. The real anus, we have no doubt, will be found at the side, as in other species of this and the allied genera.

He appears also to have misunderstood the organs of vision, which, it can scarcely be doubted, are as complete as in other species of *Eolis*, as well as in *Polycera*, *Goniodoris* and *Melibæa*, in all of which a lens is distinctly visible ; he however figures and describes the eye in his *Eolidina* as merely a broad convex expansion of the retina and pigmentum nigrum. It would appear from his drawing that he has mistaken the auditory capsule for the optic ganglion or a swelling of the optic nerve, otherwise he has entirely overlooked the organ of hearing. His description of the generative organs is quite at variance with the well-known peculiarities of this order.

M. Quatrefages' remarks on zoological affinities are ingenious : on this interesting portion of the subject however we cannot at present enter, but hope to do so on a future occasion, when a further investigation of the subject shall have enabled us to speak with more certainty than we can possibly do at present.

XXIX.—On the Structure and Affinities of *Upupa*, *Lin.*, and *Irrisor*, *Lesson*. By H. E. STRICKLAND, M.A.*

THE African continent presents us with several species of birds constituting a well-marked genus, to which Lesson in 1831 ap-

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