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To cite this article: Geo. J. Allman M.B. F.R.C.S. M.R.I.A. (1845) XIV.—On the anatomy of Actæon, with remarks on the order Phlebenterata of M. de Quatrefages , Annals and Magazine of Natural History, 16:104, 145-162, DOI: [10.1080/037454809495921](https://doi.org/10.1080/037454809495921)

To link to this article: <http://dx.doi.org/10.1080/037454809495921>



Published online: 16 Dec 2009.



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# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

No. 104. SEPTEMBER 1845.

XIV.—*On the Anatomy of Actæon, with remarks on the Order Phlebenterata of M. de Quatrefages.* By GEO. J. ALLMAN, M.B., F.R.C.S., M.R.I.A., Professor of Botany in Trinity College, Dublin, late Demonstrator of Anatomy T.C.D.\*

[With three Plates.]

IN the seventh volume of the 'Linnæan Transactions' is a memoir by Colonel Montagu, in which is described, under the name of *Aplysia viridis*, a small gasteropod discovered by this naturalist on the coast of Devonshire. The *Aplysia viridis* of Montagu was afterwards separated by Oken from the true Aplysias, and made to constitute a distinct genus under the name of *Actæon*. A mollusk evidently referable to the same genus is named *Aplysiopertus neapolitanus* by Delle Chiaje, who describes and figures it in his great work on the Invertebrate animals of the kingdom of Naples. The Italian naturalist gives some details of its anatomy, but his account is manifestly full of errors, and he seems to mistake the ramified apparatus in connexion with the stomach for a vascular system. A mollusk also apparently referable to Oken's genus *Actæon* is described in the 'Faune d'Europe Septentrionale' of Risso, under the name of *Elysia timida*; and more recently M. de Quatrefages (Ann. des Sci. Nat. March 1844) has published a very elaborate description of the genus, in which he advances some new and startling views to which he had been previously led by the examination of *Eolidina*, a small nudibranch, apparently an *Eolis*, but for the reception of which this naturalist believes it necessary to construct a new genus. The claims of M. de Quatrefages' opinions to reception by naturalists will be considered in the present paper.

The following anatomical details have been drawn up from careful dissections of *Actæon viridis*, and as no figure which we have seen represents with sufficient accuracy the external characters of this little mollusk, we have thought it necessary to give among the illustrations of the present memoir a drawing made with great care from the living animal.

\* Read before the Meeting of the British Association at York, Sept. 1844.  
*Ann. & Mag. N. Hist.* Vol. xvi. M

ACTÆON, Oken, *Aplysia*, Mont., *Aplysiopterus*, Delle Chiaje, *Elysia*, Risso.

*Body* subcylindrical, with two foliaceous *lateral expansions* which are produced beyond the posterior extremity of the body, where they unite with one another along the mesial line. *Tentacula* two, auriform, not retractile. *Anus* lateral, placed at the right side.

*A. viridis* (Pl. V. figs. 1, 2, 3.).—The largest specimens of *A. viridis* measured about nine lines in length; the general colour of the body and foliaceous expansions is a dull green; the latter are margined with purple and dotted on both sides with small green, blue, and rose-coloured points of a brilliant metallic lustre, and arranged in groups without any definite order; similar dots are also found upon the upper surface of the body; a nearly colourless line extends from the posterior extremity of the body to the termination of the branchial expansions. The tentacula are of a dull purple, and the eyes are placed in the centre of a nearly colourless areola. The upper lip is dark purple.

This little mollusk was obtained abundantly by means of a small dredge among *Zostera marina* in the harbours of Glandore, Castletownsend and Crook Haven, co. Cork, in the months of August and September 1844.

When confined in a glass of sea-water it would creep upon the sides of the vessel, adhering not only by the under surface of the body, but by that of the lateral expansions along the whole length of their junction in the mesial line; external however to a narrow space corresponding to their line of junction, the expansions were entirely free, and possessed no power of attachment. Our little mollusk would also take delight in suspending itself in a horizontal position with its back downwards, from the surface of the water. It would sometimes separate its lateral expansions till they became placed nearly in the same plane, and again elevating them vertically, would bring their opposed surfaces nearly into contact.

#### ANATOMY.

*Digestive system.*—From a simple unarmed orifice in the anterior extremity of the body, a short but rather wide canal, Pl. VI. *c*, with membranous walls leads beneath a slightly bifid lip (Pl. V. fig. 3.) to an irregularly spherical body, Pl. VI. *a*, which consists of thick walls inclosing a central cavity. In this body is contained a tongue of very singular structure, Pl. VI. *b* and Pl. VII. fig. 5. It consists of a chain of hard transparent spines, and is curved so as nearly to return into itself, thus forming a loop, whose long diameter will be parallel to the axis of the buccal mass. M. de Quatrefages has given a correct figure of the organ as detached from the animal, but has overlooked a most singular

appendage with which it is furnished. This appendage is a pyriform sac, Pl. VII. fig. 5 *a*, which communicates by means of a canal with the left extremity of the tongue.

The sac is filled with spines, precisely similar to those of which the tongue is composed. They seem to be perfectly formed, and are placed without any apparent order in the sac. It is difficult to assign to this sac any other function than that of secreting the tongue-spines; and we can easily conceive that as the tongue is worn away at one extremity, additions are as constantly made to it from the contents of the sac at the other. The lingual sac is applied against the outer side of the buccal mass, being wholly external to this body.

The tongue terminates at the right side in a small unarmed prolongation, Pl. VII. fig. 5 *b*, which curves forwards along the convexity of the loop.

From the posterior part of the buccal mass a slightly sinuous *œsophagus*, Pl. VI. *d*, runs backwards and terminates in an oval, longitudinally striate stomach, *e*, from which a short intestine, *f*, runs transversely to the right side in order to terminate near the anterior margin of the lateral expansion. The direction of the intestine thus places the true position of the anus beyond all doubt, though so accurately is the external orifice kept closed, that it has hitherto escaped my attempts at detection.

The stomach and intestine are clothed internally with a ciliated epithelium, by which their contents are kept in a constant state of agitation.

In connexion with the alimentary canal just traced are several accessory organs which require special mention. Four glands analogous to salivary may be detected. Of these, two, Pl. VI. *g g*, are connected with the anterior extremity of the buccal mass, and appear to consist each of a cluster of small vesicles, which pour their contents into the commencement of the alimentary tract. The posterior pair of salivary glands, *h h*, consists each of a simple tube of great delicacy, which commences in the buccal mass just anterior to the origin of the *œsophagus*, and then becoming attached to the *œsophagus* runs over the supra-*œsophageal* ganglia, and soon exhibits a series of little caecal offsets forming small sacs appended to the tube for the remainder of its course, Pl. VII. fig. 6. The gland thus constituted runs back through the body of the animal, extending for a considerable distance behind the stomach.

The salivary glands in *Actæon* are highly interesting from their simplicity of constitution, and afford a fine illustration of the reduction of glandular structure to one of its least complex expressions.

At a short distance from the termination of the *œsophagus* there opens into this tube a small sac of a pyriform figure, Pl. VI. *i*;

but whether this is destined to receive from the œsophagus a portion of the alimentary matter, thus performing the office of a *crop*, or whether its function is that of simply discharging into the alimentary tract some peculiar product of secretion, I have been unable to determine.

But perhaps the most remarkable of all the organs accessory to digestion is the singular *ramified system* which constitutes so large a portion of the viscera of *Actæon*, and which M. de Quatrefages, conceiving it to be of high importance, has assumed, along with certain other peculiarities of structure which he supposes invariably to accompany it, as entitling him to unite into a new order a certain number of Gasteropodous Mollusca, distinguishing them under the name of *Phlebenterata*.

The system under consideration consists in our mollusk of two tubes which open, close to one another, into the stomach, at its cardiac extremity. Near to its termination in the stomach each tube divides into two branches, one, Pl. VI. *k k*, passing forwards towards the head, the other, *ll*, running backwards into the lateral expansions. Each of these branches then undergoes minute subdivision, the ramifications extending forwards nearly to the anterior margin of the head, and backwards to the posterior extremity of the lateral expansions. The ultimate ramuli terminate each in a *cul-de-sac*, *m m m*, and Pl. VII. fig. 4, filled with a green or brownish substance, in which the microscope enables us to detect oleaginous globules floating through a fluid of aqueous consistence.

It is to this curious system, visible through the semitransparent integuments, that the prevailing colour of the species must be attributed; its nature and function, and its claim to constitute a character of ordinal importance, will be presently considered.

*Vascular and Respiratory systems.*—The best way of detecting the vascular system of *Actæon* is to view the mollusk as an opaque object by means of a single lens and without compression, when a delicate ramification of vessels will be seen creeping over the upper surface of the foliaceous expansions, Pl. V. fig. 4. Those vessels which spread themselves over the posterior part of the expansions terminate in two trunks, *a a*, one for each lateral half, which running nearly parallel to the mesial line and at a short distance from it, at either side appear to end in a circular canal, *b*, into which the vessels from the anterior part of the expansions also open. This circular vessel cannot be satisfactorily seen without actual dissection; it is placed immediately beneath the integuments of the back and over the posterior part of the body, and embraces an organ, *c*, of an irregularly semicircular figure, into whose structure strong fibres may be seen to enter with a reticulated arrangement. Beyond this point my researches have failed

to trace the anatomy of the apparatus under consideration. We can however have no difficulty in recognising in the system now described a heart and vessels. That the vascular ramification observed upon the upper surface of the foliaceous expansions is a system of *branchial vessels*, there can indeed be no doubt, and the expansions themselves must therefore be considered as true *aërating organs*. It will at once be seen too, that the *ventricle* must be sought for in the reticulated organ just described, though, from the difficulty of the investigation, I have been unsuccessful in my attempts to discover its direct connexion with the vessels. The circular vessel also must be considered as performing the functions of an *auricle*, and it is indeed by no means improbable that what appears under the microscope as simply a circular canal surrounding the ventricle, is really the projecting margin of a delicate transparent auricle, whose central portion is rendered invisible by the stronger and more opaque ventricle.

The general opacity of the tissues in *Actæon*, the extreme tenuity of the walls of the vessels, and the transparency of the fluid which these contain, render the investigation of the circulatory apparatus a subject of great difficulty. If too much reliance be placed on the compressor, it will certainly escape detection; and I have no doubt that the abuse of this instrument will account for the fact of M. de Quatrefages having denied the existence in *Actæon* of a vascular system, as well as for many other errors into which this naturalist has fallen.

*Nervous system: Sensation.*—Soon after the œsophagus leaves the buccal mass it passes through a system of seven ganglia, Pl. VI. *n*, and Pl. VII. fig. 1, of which six are arranged in three symmetrical pairs, and one is azygous.

Of these ganglia, the two largest, Pl. VII. fig. 1 *aa*, are placed upon the upper surface of the œsophagus, being in contact with each other internally. The ganglia of the second pair, *bb*, are placed immediately below the first, upon the sides of the œsophagus, being thus separated to allow of the passage of this tube. The third pair, *cc*, seems like a protuberance upon the under side of each of the ganglia last mentioned, and the azygous ganglion, *d*, occupies an inferior and median position, completing the sub-œsophageal portion of this ganglionic collar. The different parts of this system of œsophageal ganglia are maintained in union by three commissures. One commissure, *ee*, springs from each of the large ganglia on the upper surface of the œsophagus, and then running down along the side of this tube, terminates in the azygous ganglion; while the third commissure, *f*, runs transversely beneath the œsophagus, uniting the two ganglia of the second pair. The œsophagus thus passes between the great supra-œsophageal ganglia above, and the transverse commissure below. Two small spherical bodies, Pl. VI. *o*, most probably

pharyngeal ganglia, are placed upon the œsophagus just as this organ emerges from the buccal mass; but the means by which they are connected with the other parts of the nervous system, I have not succeeded in detecting.

The great supra-œsophageal pair seems to be chiefly destined for the organs of sense. The optic nerves, Pl. VI. *p*, arise from this pair, and large nerves, *qr*, are sent off from it to the tentacula and lips and the parts immediately surrounding the mouth. Some nerves going to the generative organs would also seem traceable to the same source, while the digestive and other systems would appear to derive their nerves, *s*, from the remainder of the œsophageal mass.

*Vision*.—The organs of vision are placed at a short distance behind the tentacula, and to the naked eye present the appearance of minute black points; with the assistance of the microscope, the following parts may without difficulty be detected in them. The first thing which strikes us is a pigmental body, Pl. VII. fig. 2 *a*, of a somewhat pyriform figure, furnished posteriorly with a prolongation, at one side of which the optic nerve, *b*, may be seen entering. Whether this body contains a cavity with a retinal expansion I cannot assert as the result of observation, though all analogy would lead us to suppose such to be the case.

The pigment is of a deep black colour, and is doubtless intended to effect the absorption of all rays of light which may happen to fall on it. A crystalline lens, *c*, of a nearly spherical figure and powerfully refractive, is imbedded in the anterior extremity of the pigmental body, and surrounding the whole apparatus is a transparent capsule, *d*, perforated posteriorly by the optic nerve, and apparently performing the function of a cornea anteriorly.

*Hearing*.—The organs detected by Siebold in several mollusca, and supposed by this anatomist to be destined for the function of hearing, are demonstrable without much difficulty in *Actæon*. They look like appendages to the cerebral system, and present the appearance of nearly spherical bodies, Pl. VII. fig. 1 *gg*, with a transparent refractive nucleus, and supported upon a club-shaped peduncle. They would seem to consist of two spheres concentric with the nucleus, which become apparent when a short exposure has caused some degree of collapse in the bodies from a slight evaporation of their contents. The nucleus, which corresponds with the otolites observed by Siebold, is single, and did not present the peculiar oscillatory motion manifested by the otolites of other mollusca. The peduncles arise between the first and second pair of ganglia, but with which of these they are more intimately connected I have not been able to satisfy myself.

*Touch*.—Though the sense of touch is without doubt univer-

sally diffused over the soft and constantly lubricated skin of the mollusk, yet it would appear that the tentacula are specially appropriated to its exercise. These organs consist in auriform expansions rolled into a cylindrical tube, Pl. V. figs. 1 and 2, but capable of being to a certain extent opened out at the will of the animal. They are incapable of undergoing any true retraction, but may be slightly shortened and thickened, in which condition they present a number of transverse rugæ. They are supplied with large nerves from the supra-œsophageal ganglia. No fact has thrown any light upon the question whether another sense besides that of touch has also its seat in these organs.

The entire surface of the skin is copiously lubricated with a thick mucous secretion, which is poured out in large quantity when the animal is irritated. The source of this fluid would seem to be in certain pyriform bodies, Pl. VII. fig. 3, which are found in considerable numbers beneath the integument. Each terminates in a sinuous duct, which after running for some distance beneath the skin, opens, most probably, upon the surface. These organs are described and figured by Quatrefages, but the French naturalist is in error when he speaks of them as the source of the beautiful metallic tints with which the surface of our mollusk is adorned. These tints are due to a pigment inclosed in distinct cells, arranged in irregular groups beneath the epidermis, considerably smaller than the bodies just described, and evidently without any duct or external communication whatever. I am unable to bring forward any observations of interest relative to the senses of taste and smell in *Actæon*.

*Generative system: Embryology.*—The reproductive system of *Actæon* is one of great complexity, and one in which there must be great difficulty in assigning to each part its proper function. *Actæon* is hermaphrodite. A pyriform body, Pl. VI. *t*, placed anteriorly and at the right side, would seem to be the male intromittent organ. This body is furnished with a tubular perforation which occupies the axis, and leads from the apex into an oval cavity, *v*, situated in the base. From this cavity a sinuous tube, or *vas deferens*, *w*, may be traced backwards, which, after a course of considerable length, communicates with an oval body, *x*, to be presently described, and then pursuing its course backwards may be seen to bifurcate, one branch passing to the right and the other to the left. Beyond this point I have in vain attempted to trace the course of the tube. Its whole internal surface is thickly clothed with cilia, whose presence is rendered manifest by the constant rotatory motion imparted to the granular fluid with which the tube is filled.

Occupying a median position in the posterior part of the body is an oval sac, *y*, near whose anterior extremity two tubes may be



seen to enter close to one another. One of these tubes,  $z$ , runs a little forwards, then bends backwards and bifurcates, the divisions again bifurcating dichotomously: its ultimate distribution, however, I have not succeeded in tracing. The other tube,  $\beta$ , runs forwards to the oval body,  $x$ , just alluded to, into which it opens. This body is evidently furnished with a cavity; its anterior half is of a peculiar complex structure, perhaps glandular, and destined for the elaboration of some definite secretion. From its anterior extremity a tube may be traced forwards till lost beneath the edge of a large, irregularly-shaped, somewhat plicated body,  $\gamma$ . In this body the tube would seem to terminate, though here I cannot speak with certainty. The sac,  $y$ , contains a yellowish semifluid secretion, which can be forced by the action of the compressor forwards into the oval body,  $x$ , and backwards through the bifurcating tube,  $z$ . With the plicated body,  $\gamma$ , which I would feel inclined to look upon as a testis, a pyriform sac,  $\delta$ , is connected; this sac contains a substance of a semifluid consistence, and is furnished with a long neck, which can be traced into the plicated body; but whether it terminates here or is continued to some external outlet, I have been unable to satisfy myself.

Occupying the great lateral expansions, and placed immediately beneath the ramified organ already described in connexion with the digestive system, is a curious and very complicated body,  $\zeta\zeta\zeta$ . This body, which is perhaps an ovary, is double, being formed of two perfectly similar portions, one of which is placed in each branchial expansion, and consists of a delicate tube dichotomously ramified, and furnished along its entire length with closely-set sacciform appendages, Pl. VII. fig. 8 *a*. These contain a granular substance, but whether they communicate with the interior of the tube is not very manifest. Besides these appendages, numerous spherical capsules, Pl. VI.  $\theta\theta$ , and Pl. VII. fig. 8 *b*, may be seen arranged at tolerably regular intervals along the tube, and apparently communicating by means of a short neck with its interior. These capsules inclose a number of oval bodies, Pl. VII. fig. 8 *c c*, and fig. 7, in each of which is a granular mass surrounding a very distinct nucleus, which is placed towards one extremity, and is itself furnished with a secondary nucleus. The connexion between this curious system and the other parts of the reproductive apparatus has escaped my attempts at detection: neither can I speak positively as to the exact position of the external orifices of generation.

*Embryology*.—Some days after the capture of our little mollusk, I was much gratified at finding that it had deposited its spawn upon the sides of the glass jar in which it was confined. The spawn was laid in little spiral discs, Pl. VII. fig. 9, of four or

five lines in diameter, and I at once recognised it as similar to what I had observed in considerable abundance upon the leaves of *Zostera marina* in the locality where the *Actæon* was captured. It consisted of numerous ova enveloped in a gelatinous covering, and deposited in the form of a ribbon rolled into a plane spiral. In about six days after the deposition of the spawn the eggs were hatched, and the young Actæons, Pl. VII. figs. 10, 11, 12, escaped, not in any respect resembling the parent, but of a totally different type of organization,—very similar to what has of late years been observed in the young of *Doris*, *Aplysia*, and some other Gastropoda.

The embryo-*Actæon* is inclosed in a nautiloid shell, and furnished anteriorly with two oval discs, figs. 10, 11 *aa*, ciliated along the margin, and capable of being approximated till the upper surfaces are brought into contact, fig. 11, and again separated till they lie nearly in the same plane, fig. 12. The discs are continued anteriorly into a sort of foot, figs. 10, 11 *b*, also ciliated on the margin and provided with an operculum, figs. 11, 12 *c*, which is drawn after the little animal when it retires into the recesses of its shell, and thus completely protects it from all intrusion from without, fig. 12.

Near the place where the foot joins the discs are two ocelliform spots, figs. 10, 11, 12 *d*, doubtless visual organs, though Van Beneden considers what are evidently the same organs in the embryo of *Aplysia*, as the rudimental œsophageal ganglia. That the organs under consideration are not ganglia, would alone appear from their high refractive power.

I could not succeed in detecting a mouth, though a tube, fig. 11 *e*, which I believe to be an œsophagus, may with some care be traced from the root of the discs backwards, till it dilates into an oval cavity or stomach, *f*, part of which is concealed beneath a granular mass, *g*, which occupies the posterior convolutions of the shell.

Near the origin of the œsophagus are two spherical bodies, *h*; these I believe to be the true rudiments of œsophageal ganglia.

Two fibres, fig. 11 *ii*, may be seen to run from the root of the discs backwards, and would seem to have some attachment to the interior of the shell; they bifurcate near their termination. It is difficult to say whether they be nervous filaments connected with the œsophageal ganglia, or muscular fibres destined for the retraction of the embryo.

The little embryo is eminently natatory, swimming about with wonderful activity by means of its curious ciliated discs, and by its varied and elegant gyrations, constituting an object of great beauty and interest.

*General Observations.*

Such are the facts which, from a most careful examination of a great number of specimens, I believe myself justified in considering as demonstrated. I took much pains in again and again verifying their correctness; and as most of them have not as yet been recorded, while many are in direct variance with recently published statements, I lose no time in making them public. This I am the more desirous of doing, from the fact of the anatomy of our little mollusk having within the last year been assumed by an acute and indefatigable French zoologist as characteristic of a new order of Gasteropoda which he has thought fit to construct, but which appears to me to be constituted upon grounds totally insufficient, in some respects the result of imperfect observation, and in others of conclusions which the observations, supposing them to be correct, will in no degree warrant.

In the 'Ann. des Sci. Nat.' 2nde série, tom. xix., is a memoir by M. de Quatrefages on the anatomy of a small Nudibranchiate Gasteropod, which this naturalist conceives himself justified in separating, under the name of *Eolidina*, from all previously characterized genera of Nudibranchs. In this memoir M. de Quatrefages maintains, that in the anatomy of *Eolidina* there are peculiarities of such importance as to afford grounds for the establishment of a new order among the Gasteropodous Mollusca.

M. Milne Edwards had previously directed the attention of zoologists to a remarkable character of the stomach in the Eolidian Nudibranchs, demonstrating the existence in *Calliopæa* of an extensive system of ramified canals connected with this organ.

Upon this fact M. de Quatrefages seizes with avidity: he maintains that the gastric ramifications perform the office of branchial vessels; that they are therefore subservient to respiration as well as to digestion; and finding them also in his *Eolidina*, he connects them with other peculiarities which he asserts to have discovered in this mollusk, raises them to a rank of ordinal importance, gives them the name of *phlebenteric* system, and then surprises zoologists with the somewhat startling announcement of the existence of a new order among the Gasteropodous Mollusca.

The doctrines which the examination of M. de Quatrefages' *Eolidina* had thus led him to adopt, are carried out to their full extent in a subsequent memoir (Ann. des Sci. Nat. March 1844), in which, after the examination of *Actæon* and of five new genera of his own characterizing (*Zephyrina*, *Actæonia*, *Amphorina*, *Pelta* and *Chalidis*), he maintains the complete establishment of his new order, and enters into the details of its zoological affinities.

The general characters upon which the French naturalist maintains the distinctness of his new order of Gasteropods, are the disappearance in whole or in part of the circulatory system, and the transference of the respiratory function from special organs to the digestive system or common integument,—peculiarities which he asserts draw with them a general degradation of the organism, approximating it to the Acalephæ, and thus establishing a group of animals which depart from the type of their class, and are among the Gasteropods what the Entomostraca are among the Crustacea.

The memoirs of M. de Quatrefages are certainly characterized by great ingenuity and will well repay perusal. They have however, I fear, thrown themselves open to justly severe criticism, and by advancing statements of great zoological importance upon what must be admitted to be imperfect and too manifestly prejudiced observations, would, if not corrected, exercise a most injurious influence upon a science so strictly inductive as zoology. Of the various animals dissected by M. de Quatrefages in the construction of his *Phlebenterate* group, *Actæon* is the only one which I have had an opportunity of examining. The result of the examination of this one however is so totally at variance with the anatomy of the same animal as recorded by the French zoologist, that though we can hardly be justified in asserting from this, that his observations on the others are equally erroneous, we must yet surely hesitate before we adopt conclusions of such great importance in zoology as those to which M. de Quatrefages has arrived.

On comparing the description and figures of *Actæon*, as given by M. de Quatrefages in the memoir to which allusion has just been made, with the structure which my own observation of this animal had revealed to me, I was struck with a discrepancy, for which I must confess I found it difficult to account by reference to any of the ordinary and unavoidable errors to which the observation of these minute animals is necessarily liable.

Among the most important points in which the observations just recorded differ from those of M. de Quatrefages, may be mentioned the detection of a distinct heart and vessels, organs whose existence is denied by the French naturalist, and of a *lateral* termination to the intestine, which is described in the foreign memoir as opening dorsally and medially. The form and disposition of the gastric ramifications do not at all correspond with M. de Quatrefages' description; the terminal *culs-de-sac* of this system are arranged very differently from the disposition which he assigns to them, and the ramifications of opposite sides do not communicate. There is certainly no such organ in the posterior

extremity of the branchial appendages as M. de Quatrefages describes under the name of cloaca\*. The length of the œsophagus and the form of the stomach are altogether at variance with his description. The œsophageal collar consists of seven, not four, ganglia; and if to these points of discrepancy we add some others mentioned in the present paper, and call to mind that he has totally overlooked the salivary apparatus and made no mention of the highly-developed generative system, we cannot but conclude that the establishment of a new order of animals on observations so imperfect is unwarrantable and rash.

But suppose the observations of the French zoologist not altogether so erroneous as is here maintained, is he yet justified in the step which he has taken? We assuredly think not.

Let us consider for a moment whether the singular ramified system connected with the stomach in *Actæon* and other allied genera is really of that vast importance in a zoological point of view with which M. de Quatrefages would invest it. If the system in question be merely a ramification of the stomach, we can certainly see in it a disposition by which the surface of the gastric cavity is greatly increased; but this disposition, exercising no marked influence over the organism, cannot be supposed to demand any important modifications in the other organs, and surely offers no solid grounds for believing that its office is to expose the products of digestion to the influence of the aerated medium. In truth it is ill-adapted to this function, separating its contents from the surrounding fluid, not only by its own walls but by the intervention of a portion of the cavity in which it floats, and by the whole thickness of the integumentary structures.

But it may be asked, what office is it possible to assign to the system now under consideration, if it be not that of respiration? I believe that the ramified apparatus in *Actæon* and the *Eolididæ* is truly a hepatic system, and affords an interesting example of the reduction of a gland to one of its simplest conditions†.

We have in these gastric ramifications one or more offsets from the lining membrane of the alimentary canal greatly extended

\* We can in no way explain what M. de Quatrefages intended by the organ which he describes as a cloaca, unless we suppose that he really meant the oval sac (y, Pl. VI.) in the posterior part of the body, which we have described in connexion with the generative system, and which by some strange confusion he has transferred to the posterior extremity of the branchial expansions.

† Since the opinions here expressed were laid before the Association, there has been placed in my hands a number of the 'Comptes Rendus,' containing a paper by M. Souleyet on the *Phlebenterata* (Annals, xiv. p. 342), in which I find that the author's observations on this subject are entirely in accordance with my own.

and terminating in *culs-de-sac*, where doubtless resides the function of elaborating the biliary secretion. We have just such an appearance as a careful preparation of glandular structure would present with all its component ducts and terminal *culs-de-sac* accurately disentangled; we have in fact in the *Phlebenteric* system of M. de Quatrefages nothing more or less than an unraveled liver.

This view of the subject would appear to be admitted to a certain extent even by M. de Quatrefages himself, who describes the blind terminations of the branches as surrounded with a layer of a peculiar substance which he believes to be the liver. Of the connexion of this substance with the gastric ramifications I cannot speak, as in *Actæon* I could find nothing of the kind. As M. de Quatrefages however has not succeeded in isolating it from the *culs-de-sac*, his statement amounts to an admission that on these terminations of the branches devolves the function of secreting the bile\*.

To the view now taken it may be objected, that the biliary ducts ought to open into the intestine *behind* the stomach. Instances however of the bile being poured into the stomach itself are by no means without example among the Gasteropoda, and in some cases, as in *Scyllæa* and *Onchidium*, this secretion is discharged into the œsophagus. The remarkable *partition* of the liver in *Onchidium* moreover is an evident approach to the condition assumed by this organ in the mollusca now under consideration. Another objection to the hepatic character of the gastric ramifications may be urged from the curious discovery by Messrs. Alder and Hancock, that in *Eolis* the extremities of the ramuli are not really cæca, but open externally through the terminations of the branchial papillæ. This however cannot be considered as a valid objection. It is true that the termination of the ducts in *culs-de-sac* has been described as a universal condition of glandular structure, but it has been by no means proved that a perforate state of the terminations of these tubes is inconsistent with the performance of the secreting function. The purpose served by this curious condition of the organ in *Eolis* it is not very easy to explain. I cannot however avoid looking upon the perforations in the extremities of the branchial papillæ as analogous to the orifice placed at the base of the branchial plume

\* I have just seen an excellent paper on the anatomy of *Eolis* by Messrs. Hancock and Embleton (Annals, xv. pp. 1, 77), in which these gentlemen describe the terminations of the gastric ramifications in *Eolis* as lined by glandular structure, which in most species exhibits a complex follicular disposition. The cæca in *Actæon* are certainly much more simple, nor do they seem to be furnished with any distinct glandular lining.

in *Doris* where it gives exit to a part of the hepatic secretion,—an office which it is by no means unlikely the branchial apertures in *Eolis* are also destined to fulfil.

M. de Quatrefages maintains, that throughout the whole of his *Mollusca Phleboterata*, with the exception of *Eolidina*, there is a total absence of a heart and vessels. In *Eolidina* he allows the existence of a heart and arteries, but denies that of a venous system. We have already seen that so far as *Actæon* is concerned, the French anatomist is quite in error, and we have no doubt that future researches will still further prove the untenableness of his positions. When we consider the extreme tenuity of the venous tubes in these animals, and the colourless nature of their contents, we can surely place but little reliance on any statements which deny their existence solely from the fact of their having escaped detection.

But after all, is a diffused condition of the venous fluid of such great importance in determining the position of a molluscous animal in the zoological scale? Setting aside the *Ascidæ*, a group universally allowed to manifest a degradation of structure, we know that in *Aplysia* a diffusion of this very kind begins to show itself in the remarkably imperfect condition of the venous trunks in this genus, and yet M. de Quatrefages himself would hardly be rash enough to degrade from its co-ordinate Gastropods this highly organized mollusk.

It remains for us now to consider the zoological relations of *Actæon* and its true position among the Mollusca. We have seen that Montagu originally described this mollusk under the name of *Aplysia*, and all zoologists since his time have, with the exception of M. de Quatrefages, agreed in placing it in the vicinity of the *Aplysiæ*. Sander Rang, it is true, in his 'Manuel des Mollusques,' expresses in a note his opinion that the position of *Actæon* is in the neighbourhood of *Placobranchus*, a genus established by Van Hasselt for a mollusk discovered by him on the coast of Java; in the text however he follows the opinion of other zoologists, making *Actæon* a genus in his family of *Aplysiens*.

It is without doubt to M. de Quatrefages that we are indebted for having first decidedly removed *Actæon* from the Tectibranchiate Mollusca, and placed it in the vicinity of *Eolis* and its allies,—a position which is assuredly its true one, being fully borne out, not only by its internal structure but by its external conformation, however at variance this last may at first appear with the legitimacy of the position now assigned to it.

The lateral expansions of *Actæon* are truly analogous to the branchial papillæ of *Eolis*, their real homology being easily found

in the united branchiæ of an Eolidian mollusk; and if to this we add the gastric or hepatic ramifications, and consider the general character of the anatomy as detailed in the present paper, we can have no hesitation in making *Actæon* a genus of NUDIBRANCHIATE MOLLUSCA. As to the close affinity of *Actæon* to *Placobranchus*, I fully agree in the opinion of M. Sander Rang, expressed in the note just alluded to. Indeed I believe the relation between these mollusca to be closer than has been yet suspected, though, from the imperfect state of our knowledge of *Placobranchus*, it would be at present premature to urge with confidence any further opinion upon this subject.

While I have thus strongly objected to the establishment of a new order for the reception of the Eolidian Nudibranchs, I yet believe that strict zoology peremptorily demands the formation among the Nudibranchs of a distinct group for these mollusca, by which they may be kept apart from other Nudibranchs with which many zoological writers have too closely united them. Indeed the light which has of late years been thrown upon the anatomy of the Mollusca Nudibranchiata places us in a position for recognising those relations by which a natural subordinate grouping of the order may be effected. A dismemberment founded upon the differences of organization of the Mollusca Nudibranchiata had been to a certain extent carried out by M. de Blainville in the establishment of his groups *Polybranchiata* and *Cyclobranchiata*, the former corresponding to the family *Tritoniadæ* of subsequent zoologists, and the latter to that of *Doridæ*. De Blainville divides the *Polybranchiata* into two minor groups, *Tetracerata* and *Dicerata*, both natural, the former including *Eolis*, *Glaucus*, &c., and the latter *Tritonia*, *Scyllæa* and *Thetis*.

With the position here assigned to *Tritonia*, *Scyllæa* and *Thetis*, though the group is in itself natural, I cannot concur, as I believe these mollusca much further removed from *Eolis* and its allies than from *Doris*.

Sander Rang (Man. des Mol.) rejects De Blainville's groups *Polybranchiata* and *Cyclobranchiata*, and primarily divides the entire order into five families: 1. les *Ptérosomes*, established for the reception of a single genus *Pterosoma*, discovered by Lesson in the equatorial seas; 2. les *Glaucques* = *Polybranchiata Tetracerata*, Blainv.; 3. les *Tritonies* = *Polybranchiata Dicerata*, Blainv.; 4. les *Doris* = *Cyclobranchiata*, Blainv.; 5. les *Placobranches*, established for the *Placobranchus* of Van Hasselt.

*Pterosoma*, upon which Rang founds his first family, is certainly a very doubtful Nudibranch, and I believe admitted into this order upon very uncertain grounds. Lesson, its discoverer,



described it (Mém. de la Soc. d'Hist. Nat.) as a *Nucleobranch* nearly allied to *Firola*, and there is at least as much reason for considering it in this point of view as for assigning it a place among the Nudibranchs. Rejecting therefore *Pterosoma* from the Nudibranchs as a mollusk as yet too imperfectly understood, the remaining four families are judiciously constructed, based as they are upon true differences of organization, and consisting of really natural groups.

In the beautiful work of Messrs. Alder and Hancock on the British Nudibranchiate Mollusca, the first part of which, just published by the Ray Society, I have had an opportunity of seeing since the present paper was placed in the printer's hands, these gentlemen distribute the British genera under the three families, *Dorididae*, *Tritoniadæ* and *Eolididae*. They make moreover a most important revision of the old genus *Tritonia*, separating from it the *Tritonia arborescens* of previous authors, which they find, notwithstanding its divided branchiæ and general Tritonia-like appearance, to possess a true Eolidian structure, and which they accordingly locate in the family of the *Eolididae* as a distinct genus under the name of *Dendronotus*.

In order however that *Actæon* may also find a place among the Mollusca Nudibranchiata, an additional family must be formed for its reception. The family which it is thus found necessary to constitute will perhaps correspond with the *Placobranches* of Sander Rang, though, from our entire ignorance of the structure of *Placobranchus*, it is impossible to form a decided opinion as to the identity of the two families.

Having thus established four families among the Mollusca Nudibranchiata, the next question which suggests itself is, whether these families, when arranged in strict zoological co-ordination, are separated from one another by equal intervals? The answer must here be at once given in the negative, the *Dorididae* being much more nearly allied to the *Tritoniadæ* than these are to any of the remaining families of the order. This circumstance therefore demands the division of the entire order into two great primary sections, by which means a natural grouping of the families themselves may be effected, and their true relations to each other be rendered apparent.

The grounds upon which this primary division of the Nudibranchiata is based, will be found in the singular system of hepatic ramifications, to which attention has already been so frequently directed, and which, though far from being of that importance with which it has been invested by M. de Quatrefagès, is yet a decided indication of the existence of two subordinate groups in the order Nudibranchiata.

In accordance therefore with this arrangement, the Nudi-branchiate Mollusca will stand as follows :—

ORDER.	SECTION.	FAMILY.	GENUS.
NUDIBRANCHIATA.	Liver compact .....	Branchiæ in the mesial line, placed in a circle more or less complete around the anus. DORIDIDÆ.	Doris, Polycera, &c.
		Branchiæ arranged along the sides, or scattered. TRITONIDÆ.	Tritonia, Scyllæa, Thetis.
	Liver disintegrated...	Branchiæ papillose, or branched or muricated. EOLIDIDÆ.	Eolis, Alderia, Dendronotus*, Glaucus, &c.
		Branchiæ foliaceous. ACTÆONIDÆ.	Actæon, Placobranchus?

#### EXPLANATION OF THE PLATES.

##### PLATE V.

Fig. 1. *Actæon viridis*, viewed from above.

Fig. 2. The same, viewed in profile.

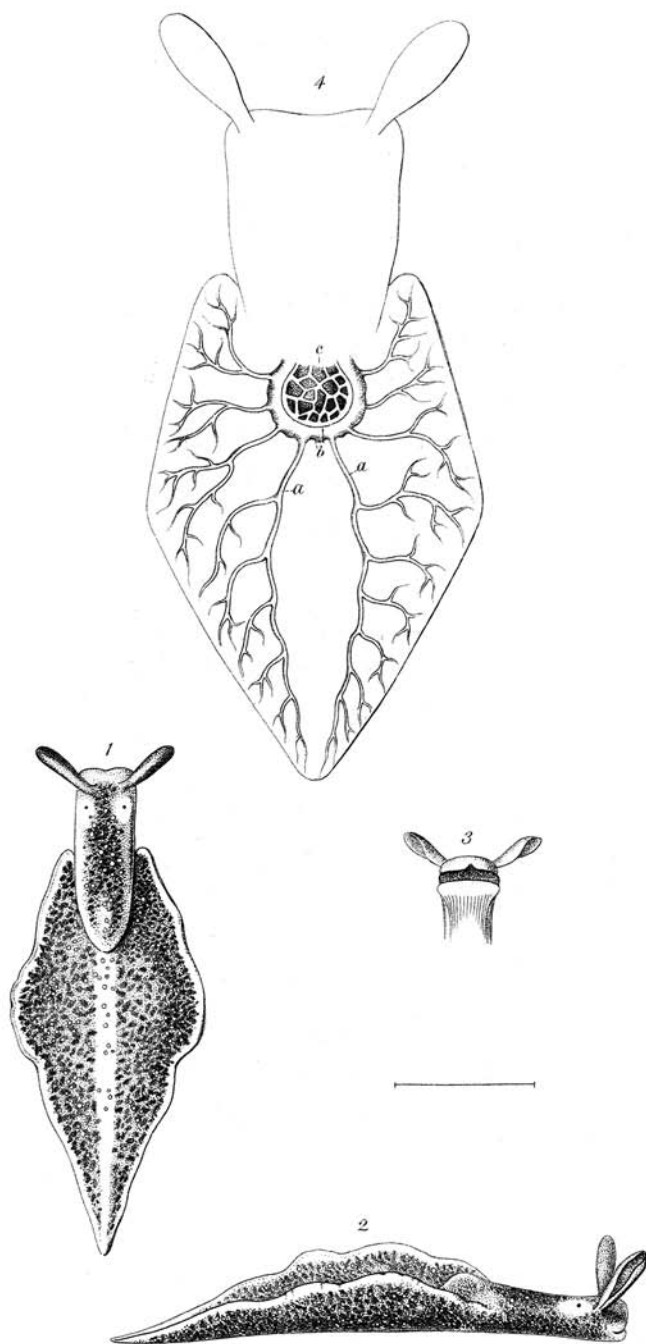
Fig. 3. The head seen from below.

Fig. 4. Vascular system : *a a*, trunks which receive the blood from the posterior parts of the branchial expansions; *b*, circular vessel into which the trunks *a a* open, and which also receives the blood from the anterior part of the branchial expansions; *c*, the ventricle.

##### PLATE VI.

*Actæon viridis* opened from above; that portion of the hepatic ramifications which occupies the right side has been removed in order to simplify the figure, and for the same reason the ovaries? have not been represented on the left : *a*, buccal mass; *b*, tongue; *c*, canal through which the buccal mass opens exteriorly; *d*, œsophagus; *e*, stomach; *f*, intestine; *g g*, anterior pair of salivary glands; *h h*, posterior pair; *i*, pyriform sac opening into œsophagus; *k k*, anterior trunks of hepatic ramifications; *l l*, posterior trunks; *m m m*, *culs-de-sac* in which the hepatic ramifications terminate; *n*, ganglionic collar of œsophagus; *o*, pharyngeal ganglia?; *p*, optic nerve; *q r*, nerves running to tentacula and lips; *s*, nerves supplying the digestive system; *t*, penis; *v*, oval cavity in base of penis; *w*, *vas deferens*;

\* I would feel well-inclined to separate *Dendronotus* as the type of a small family distinct from the true *Eolididæ*. With *Dendronotus* I would also join *Doto* (*Melibæa*, Johns.), and then the second section of Nudi-branchs would consist of three families, of which the *Dendronotidæ* would be exactly co-extensive with the subfamily *Melibœinæ* of Messrs. Alder and Hancock. With the animal assumed by Rang as the type of his genus *Melibæa*, I am not sufficiently acquainted to decide upon its exact location.



*x*, oval body with which *vas deferens* communicates; *y*, sac of unknown function; *z*, dichotomously divided tube which opens into the sac *y*;  $\beta$ , tube connecting the sac *y* with the oval body *x*;  $\gamma$ , the testis?;  $\delta$ , pyriform sac connected with  $\gamma$ ;  $\zeta\zeta\zeta$ , the ovary?;  $\theta$ , capsular bodies connected with ovary.

## PLATE VII.

- Fig. 1.* System of œsophageal ganglia: *a a*, great supra-œsophageal ganglia; *b b*, second pair; *c c*, third pair; *d*, azygous ganglion; *e e*, commissures connecting supra-œsophageal ganglia with azygous ganglion; *f*, commissure which runs beneath the œsophagus and unites the two ganglia of the second pair; *g g*, organs of hearing.
- Fig. 2.* Organ of vision: *a*, pigmental body; *b*, optic nerve; *c*, crystalline lens; *d*, transparent capsule inclosing pigmental body and lens.
- Fig. 3.* Subcutaneous mucous glands.
- Fig. 4.* Terminal *culs-de-sac* of the hepatic system.
- Fig. 5.* The tongue: *a*, lingual sac; *b*, unarmed prolongation, in which the tongue terminates at the right side.
- Fig. 6.* Portion of posterior salivary glands.
- Fig. 7.* One of the oval bodies contained in the ovarian capsules.
- Fig. 8.* Portion of the ovary with its capsule: *a a a*, sacciform appendages; *b*, capsule; *c*, oval bodies inclosed by the capsule.
- Fig. 9.* Group of ova as deposited upon the leaves of *Zostera marina*, &c.
- Fig. 10, 11, 12.* Embryo: *a a*, locomotive discs; *b*, foot; *c*, operculum; *d*, organs of vision; *e*, œsophagus; *f*, stomach; *g*, granular mass, beneath which the posterior part of the alimentary canal is concealed; *h*, rudiments of œsophageal ganglia; *i i*, filaments which pass backwards from the base of the discs.

## XV.—Description of a new genus of Night Lizards from Belize.

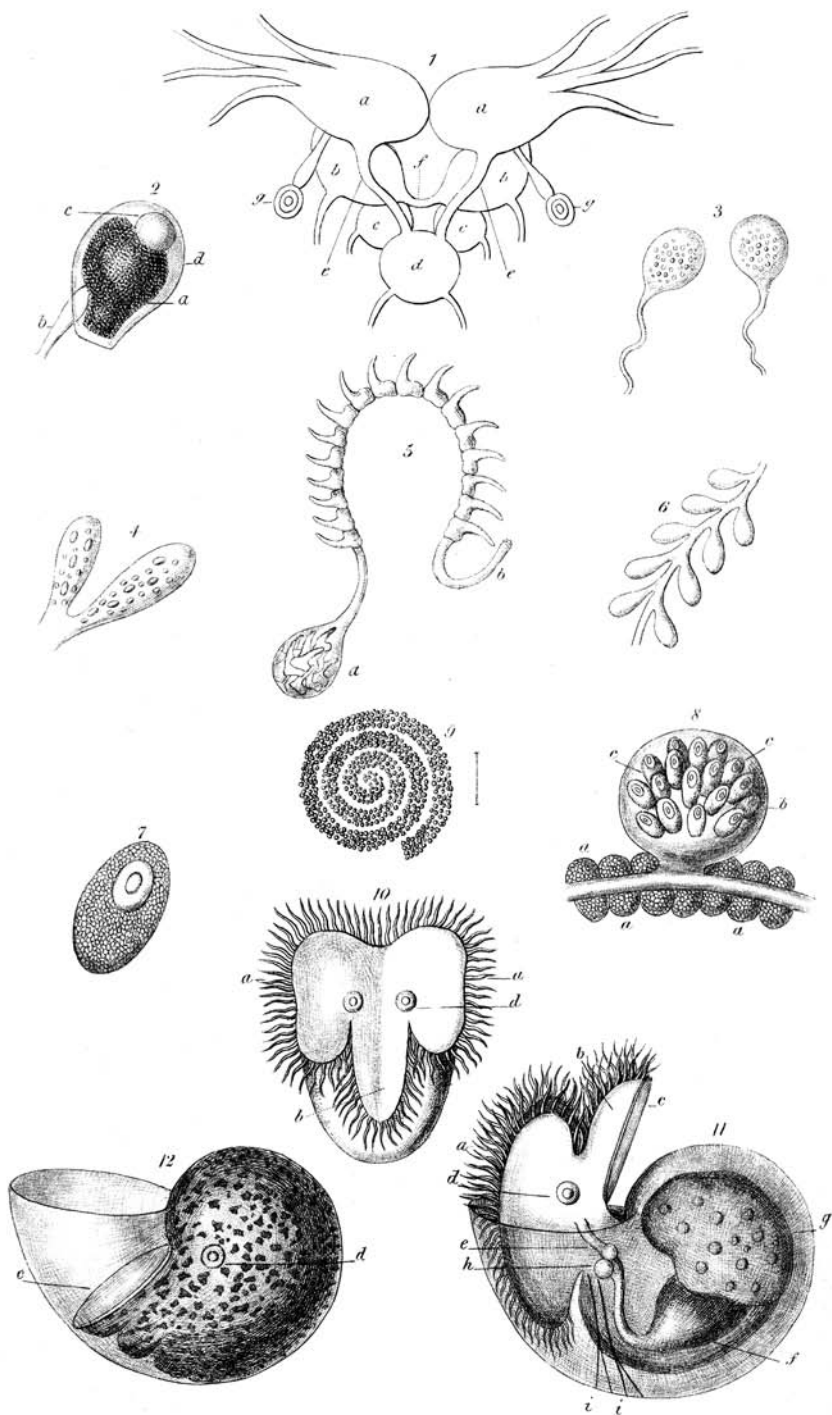
By J. E. GRAY, Esq., F.R.S. &c.

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

GENTLEMEN,—This interesting new form of *Gecones*, or Night Lizards, was sent from Belize by Mr. Dyson under the name of "*Gallwaspe*," a name which appears to be generically applied to most Lizards by the English in Tropical America. It is at once distinguished from all the genera of the family before known by the short, blunt, compressed, equal-diametered toes, but more particularly by the very small size of the claws, which are completely hidden between two large, half oblong scales, which have a narrow one between the base of the upper edge.

## Genus COLEONYX. Fam. GECOTIDÆ.

Toes rather compressed, equally thick their whole length, blunt at the end; edges simple, rounded; upper surface covered with a single, and the sides with three series of six-sided scales, the under surface with a single series of rather narrow, slightly convex, transverse scales; the end of each toe furnished with large, oblong, convex scales on each side, forming a complete sheath to the small claws, and with



*Anatomy of Actæon.*