

or two of this water and weed in his sitting-room for a few weeks. He will be rewarded by discovering rare forms of minute aquatic life. On examining a vessel of water brought from the canal, I discovered, in about a fortnight's time, the rare and beautiful *Stephanoceros*, several *Melicertæ*, *Paludicella* and young *Cristatellæ*. *Paludicella*, like *Fredericella*, is an exception to the rest of the family, being perennial.

I remain, Gentlemen,

Yours sincerely,

W. HOUGHTON.

General Considerations on the Circulation of the lower Animals.

By M. LACAZE-DUTHIERS.

It is difficult to take up and irritate any mollusk, such as a snail or slug, but especially a marine mollusk, without observing that the animal, affected by the violent contractions caused in it by the instinct of self-preservation, allows to flow from its body a liquid often sufficiently abundant to moisten and bathe the hands of the observer. What is this liquid? whence does it come? how does it escape?

It may be asserted that there exist a great number of animals of low organization, which, for purposes sometimes unknown, but often appreciable, deprive themselves, by bleeding, of a great part of the liquids of their economy. But it must be remarked that the same things do not take place in all groups, and that, to obtain an exact notion of the circulation in the lowest divisions of the animal kingdom, it is necessary to take our examples at once from the Mollusca, the Annulata, and the Zoophytes.

In the first place, with regard to the Mollusca, positive facts now prove, beyond the least doubt, that there is a communication between their circulatory apparatus and the exterior world. MM. Langer and Gegenbaur have seen this in a Lamellibranch and in some Pteropoda; and I believe the former has demonstrated the existence of perfectly definite external orifices of the apparatus of circulation, serving for the issue of the blood or for the entrance of water, in the Gasteropoda, which are comparatively very high in the scale of Mollusca.

The importance of such an arrangement will be understood without difficulty, and it will be seen how necessary it is to take it into account in studying the nutrition of these animals. We can hardly, therefore, bring too many proofs in support of the demonstration of a fact so unprecedented and so little in accordance with what we observe in the higher animals.

The new observations which I have the honour to present to the Academy are not isolated; they are related to an *ensemble* of zoological researches upon the Gephyrea, Zoophytes, and Mollusca which I have pursued for a long time; they were made at Cette in the months of August and September last.

If the existence of external orifices of the apparatus of circulation in the Mollusca does not appear to be doubtful, it is nevertheless very difficult to ascertain. *Thetys leporina* of the Mediterranean,

the history of which possesses so much interest in various ways, presents the most remarkable organic arrangements from the point of view which now occupies us.

It bears on its back, placed symmetrically on each side, from fourteen to twenty pairs of branchiæ, elegantly twisted into a spiral, between which may be observed an oval pit of a more delicate texture and more transparent than the rest of the integument of the body, upon the middle of which there rises a small mamilla pierced by an orifice like a button-hole.

If the extremity of the pipe of a syringe be applied to this orifice, and an injection be made with much care, so as to avoid injury and consequently all causes of error, the coloured liquids or air employed are soon seen filling the venous system. If the animals are in favourable conditions, the veins may even be injected merely by directing the stream of coloured liquid from a distance upon the mamilla of the oval interbranchial fossa.

The *Thetys* bearing, as we have just seen, from fourteen to twenty pairs of branchiæ on each side of the body, may therefore at pleasure introduce water into its blood, or get rid of a portion of this nutritive fluid, in front, behind, or towards the middle of its length, by means of from twenty-eight to forty orifices. Hence, when we take up this animal well expanded and developed, can we be astonished to see it, in the hands which it inundates with fluid, change its form, retract itself, and gradually lose more than one-third of its volume? It is sufficient, however, to consider this in order to understand that, if the animal could not reject a portion of the liquids which impregnate its tissues like the water imbibed by a sponge, it would be impossible for it to diminish its volume.

In *Thetys leporina*, as in all the naked Mollusca the observation of which is easy, effects may be produced by irritation which it is very useful to study. When a part of their body is touched, it is seen, under the influence of irritation, to contract and return upon itself, driving off the liquid lodged in the meshes of its tissues, and causing the dilatation or inflation of some other part. If the latter be irritated, the same thing takes place, it contracts in its turn; and by multiplying the points of contact, the blood, being driven in all directions, and no longer finding any place in the economy, is forced to escape outwards: if orifices exist, it is through them that it issues; and if these orifices are insufficient, it ruptures the tissues in order to make a passage for itself. Direct observation can leave no doubt upon this latter fact.

But when the issue of the blood is not violent, but natural, it is subjected to a veritable appreciation on the part of the animal. Of this the organization of the orifices furnishes a proof. In *Dentalium* and *Pleurobranchus* I have described two muscles and a valve which oppose the escape of the blood when the animal does not consider it desirable. Here a muscle with circular fibres forms a sphincter sufficiently developed to produce the mamilla of the oval fossa. It is indeed this sphincter, which is usually much contracted, that retains the liquids injected into the nervous system, and renders

the detection of the orifices very difficult, causing us still to be ignorant of their position in most species.

In studying in detail the nervous system of *Thetys*, I have ascertained that two very distinct and comparatively very large nerves pass to each of the sphincters of the orifices, and that sometimes, before penetrating into the muscle, they even become inflated into a very small centre or nervous ganglion. I should add that these nerves have their origin from the central parts of the nervous system of the life of relation, and not from the great sympathetic.

From this anatomical arrangement we must evidently think that the opening of the orifices is not effected without a direct influence emanating from the nervous centres, and that the animal certainly appreciates the occasion for the relaxation of the sphincter and the escape or admission of fluids.

But things do not go on in the same way in all the lower animals.

In the Gephyrea, and especially in *Bonellia*, I have shown that one liquid fills the general cavity of the body, and is distinct from a second, contained in proper vessels. The former can be poured out by the orifices of reproduction and by the terminal cups of the renal glands, which present a very curious arrangement. Imagine a racemose gland of which all the grains or *acini* are terminated, not as in ordinary glands, cæcally, but by elegant cups or urns, covered with vibratile cilia causing currents from the outside to the inside of the gland through a little canal,—imagine, besides, the kidney floating in the midst of the general cavity of the body, giving it a portion of the elements of the secretion, and on the other hand taking from it directly, by means of its vibratile cilia, a portion which it rejects outwardly,—and we shall have an idea of the very remarkable renal apparatus of *Bonellia*.

In no other animal belonging to a high order of the animal series has there been described a similar organ effecting direct depuration by motory organs, and independent of any physiological act of secretion properly so called.

In the Cœlenterate Zoophytes, again, things take place differently. The liquids which circulate in the innumerable canals hollowed out in the sarcosoma of these composite animals come directly from the stomach, without the intermediation of absorption. They pass through orifices pierced in the walls of the digestive cavity, and are thus poured directly into the apparatus of circulation; they may also be rejected by the way through which they penetrated, namely the mouth.

From the preceding facts we may conclude that the conditions under which nutrition is effected in these low animals differ profoundly from those which correspond with the same function in the higher animals; for the blood of the Mollusca, Gephyrea, and Zoophytes must be very different from that of the Vertebrata, even in consequence of the direct relation which it has with the outer world.—*Comptes Rendus*, December 18th, 1865, pp. 1101–1105.



Lacaze-Duthiers, Henri de. 1866. "General considerations on the circulation of the lower animals." *The Annals and magazine of natural history; zoology, botany, and geology* 17, 238–240.

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