

scarcely reach the level of the second disk.—*Comptes Rendus*, February 21, 1881, p. 420.

On the Circulation and Respiration of the Ophiuridæ.

By M. N. APOSTOLIDES.

Having had at my disposal numerous living Ophiurans in the laboratories of Roscoff, the Sorbonne, and Port Vendres, I have been able to apply to these animals peculiar processes of fine injection; and these processes have furnished me with novel results, which I have the honour to communicate to the Academy. My investigations have been made upon the following species:—*Ophiura texturata*, Lam.; *Ophiura albida*, Forbes; *Ophiocoma granulata*, *filiformis*, and *neglecta*, Forbes; and *Ophiocoma rosula*, Johnst.

1. After a successful injection of the aquiferous system, on dissecting the interbrachial space of the madreporic plate, we come upon a dilated whitish canal, rendered rigid by calcareous plates; and on tearing this canal we see, towards the middle, a brownish inflated mass, the supposed heart of authors, on the side of which there is a fillet containing the injected material. This fillet is the sand-canal. This experiment, frequently repeated upon different species, shows that the sand-canal becomes injected at the same time as the aquiferous system, and that the supposed heart is independent of that system; further, the particles of injected material found outside the madreporic plate prove that the sand-canal, extending from the aquiferous ring to that plate, establishes a direct communication between the aquiferous system and the exterior.

2. “*The heart is the true centre of the circulation . . . it is a plexus of anastomosing vessels which unites the two rings, oral and aboral.*” It is thus that M. H. Ludwig defines the structure and function of the heart. With regard to the two rings, at the discovery of which he arrived by coloration with hæmatoxyline, he admits that he knows “neither their contents nor their structure.”

The organ called the *heart* presents very various structures and relations. By a careful dissection it is easy to see that it has an elongated form, and is produced into a rectilinear canal going to the madreporic plate; an injection, forced into the brown mass which represents it, immediately fills this prolongation and appears on the outer surface of the madreporic plate. Its structure, when studied in a heart taken from a living animal, shows that it is a gland with a proper excretory canal opening outward, and not an organ of circulation. On each side of this hitherto misunderstood gland we see two small fibrous bands, directed laterally towards the base of the arms; they become vividly coloured by hæmatoxyline, like the analogous bands which sustain the Polian vesicles; but the liquid injected into the heart never went in their direction.

3. An injection forced between the integument and the digestive tube (that is to say, into the general cavity) never shows itself externally, and never penetrates into the aquiferous system. The general cavity is therefore entirely closed; it is formed of a widened portion surrounding the digestive tube (*peristomachal space*), which

contracts at its upper part to lodge the ambulacral ring, and sends a flattened prolongation to the dorsal surface of the arms (*dorsal space*). Within the aquiferous ring we find the nervous band forming a complete ring around the œsophagus. To find this we have to tear a membrane which envelops it and separates it from the general cavity; then we see the injection which fills the space situated beneath it and surrounds the nervous system (*perinervous space*). If, now, we make a section of an arm, we find in the lower part a furrow hollowed out in the discoidal ossicle, and which contains the ambulacral canal and the brachial nerve. This latter, flattened and bent into a crescent-like form, is in contact with the canal by its thin margins, and thus bounds a rounded space independent of the cavity which surrounds it (*radial space*). What are the relations of the perinervous space and of the radial space to the general cavity? Around each ambulacral canal going to an arm there is a space hollowed out in the calcareous pieces and connected with the general cavity; in the same way, around every nerve issuing from the ring there is a space communicating with the envelope of the band. Now these two spaces advance to meet each other, at the same time as the parts which they contain, and unite at the level of the furrow, thus placing the perinervous space widely in communication with the general cavity. The two spaces unite into one, which occupies the whole cavity of the furrow enveloping the vessel and the nerve (*peripheral space*), and occupying the circular interspace between these two organs (*radial space*). Lastly the general cavity communicates with the incrustated envelope already indicated as surrounding the sand-canal and the heart, which was long regarded as the sand-canal itself (*stone-canal* of authors).

These observations show that no system of proper canals exists, but spaces in close connexion with the general cavity.

On observing a living animal from the dorsal side we see its body swell up and collapse alternately; if we turn it over in a liquid containing coloured particles we see a double current around the genital slits. By injecting a coagulable liquid through one of these slits we find that the orifice gives access to a large, closed sac, dilated in its ventral region, contracted towards the back, immersed in the general cavity, and having on its outer surface the genital utricles. These sacs, first seen by Ludwig, who suspected their function, were nevertheless regarded by him as appendages of the generative organs, and received the name of *pouches*. Experiment, and especially the close relations of the sac with the nutritive liquid of the general cavity, must lead us to consider them true *respiratory sacs*.

From these facts we regard the circulatory system as formed by the general cavity and the spaces connected with it; and we think that the respiratory sacs, by their alternate collapse and dilatation, invite the blood into the peristomachal cavity and afterwards drive it to the periphery. This very simple arrangement explains how the blood, bathing all the organs, respire and is set in motion.—*Comptes Rendus*, February 21, 1881, p. 421.



Apostolidés, M N. 1881. "On the circulation and respiration of the Ophiuridæ." *The Annals and magazine of natural history; zoology, botany, and geology* 7, 355–356. <https://doi.org/10.1080/00222938109459530>.

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