

Rhythmic Pulsation in the Madreporic Vesicle of Young Ophiuroids.

By

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With 1 Text-figure.

IN view of the interest attaching to the nature and function of the madreporic vesicle, I made a careful examination of a number of young living Ophiuroids from tow-nettings at the Millport Marine Station in June, 1918. In particular specimens (probably of *Ophioglypha albida*), at the stage when the young star is a flattened disc with five blunt arms, each with five tentacles, the madreporic interradius is slightly wider than the rest, and is marked by the projection in its neighbourhood of a still persisting larval arm-rudiment. Careful focussing through the tissues of this interradius, in recently taken specimens examined in salt water, never failed to reveal the presence of a rhythmically pulsating thin-walled cavity entirely comparable with the pulsating madreporic vesicle of an *Asterias* larvæ. The pulsations are extremely regular, occurring once in every eleven or twelve seconds, and they continued for over an hour in several of the specimens examined. They could be made out both from the oral and from the aboral side, and nothing similar was revealed by search in the other interradii. One gets the impression that the essential part of the pulsation is the emptying and filling of spongy tissue to one side of the vesicle, but this appearance is not nearly so definite as in *Asterias* (2, p. 248) and *Porania* (3, p. 40) larvæ. Bury (9, p. 76, 1896) noted in *Echinus micro-*

tuberculatus that during contraction the floor of the vesicle projects far up into its cavity, and that the pulsation is certainly continued in the earliest post-larval stages, though whether it occurs in the adult he was unable to say. Recently MacBride has figured and called attention to a similar projection in sections of late larvæ of *Echinocardium cordatum* (5, p. 263, Pl. 19, fig. 10A).

In a bilaterally symmetrical double-hydrocœle *Porania*

TEXT-FIG. 1.

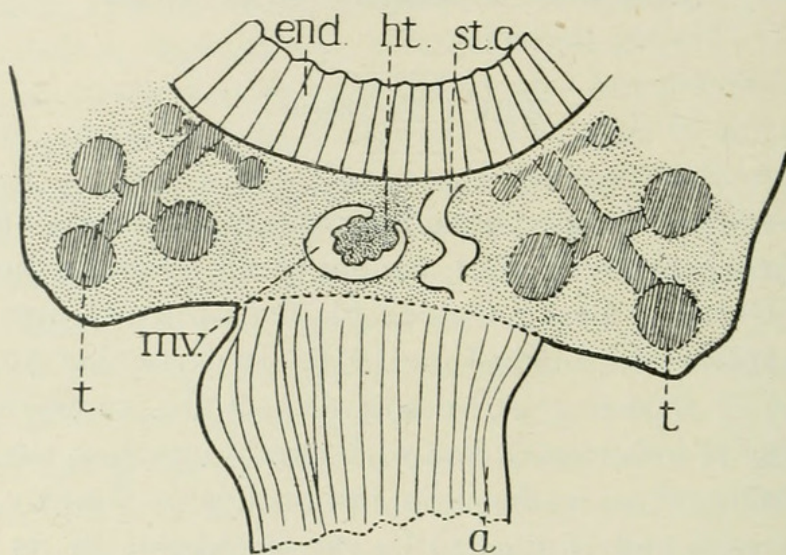


Diagram (optical section from aboral side) to illustrate position of pulsating cavity in madreporic interradius of young Ophiuroid near end of metamorphosis. *a.* A larval arm rudiment. *ht.* Spongy tissue invaginating the madreporic vesicle, and emptied and filled rhythmically. *end.* Lining of gut. *mv.* Madreporic vesicle. *st.c.* Stone canal. *t.* Terminal tentacle of arms I (on left) and II (on right).

bipinnaria (2, p. 249; 4, p. 72) the filling and emptying progressed from behind forwards, indicating that the contained "blood" flows in the same direction as that within the dorsal vessel and heart sinus of *Balanoglossus*. In starfish at metamorphosis (2, p. 249) the spongy tissue becomes permanently invaginated into the madreporic vesicle to form the so-called head process of the axial organ, which remains connected at its neck with the main part of the axial organ and with the rest of the adult hæmal system, and still ex-

hibits rhythmic pulsation (*Asterias*, *Porania*, *Solaster*, *Echinus*, *Echinocardium*) (2, p. 272). Accordingly, following out the view of Bury (1, p. 129) and Masterman (6, p. 398) that the madreporic vesicle = pericardium of *Balanoglossus*, I homologised the head process of the axial organ and its antecedent spongy tissue with the heart sinus of *Balanoglossus* (2, pp. 249, 278; 4, p. 63)—a conclusion taken as probably right by MacBride (5, p. 263), at any rate with reference to the larval spongy tissue. The homologies of the heart complex in *Balanoglossus*, and in *Asteroids*, *Ophiuroids* and *Echinoids* may thus be taken as on a moderately sound basis, and it seems legitimate to extend the comparison between the hæmal systems of *Balanoglossus* and *Echinoderms* to other details (cf. 2, p. 278¹), e.g. to the axial organ, which can represent the left pharyngeal or collar vessel of *Balanoglossus* with the addition of the left half of the glomerulus. The vessel in question is a spongy channel, comparable in structure to the axial organ (Spengel, 7, p. 753), and forming a fold or ridge within the left collar cœlom, like the axial organ within the axial sinus. In double-hydrocœle *Asterias* larvæ at metamorphosis there is a right as well as a left axial organ, and these meet aborally in a single head-process ("heart") invaginating the single madreporic vesicle ("pericardium," cf. 4, p. 63).

To consider the axial organ as primarily a genital stolon (see MacBride, 'Text-Book of Embryology,' i, pp. 480, 500, 516) does not appear to me to meet the case, in view of the following considerations: (1) There exists in *Enteropneusts* a spongy channel (the left collar vessel continued from the left part of the glomerulus), efferent from the heart sinus, comparable in structure to the axial organ and with similar relations, but unconnected with gonad rudiments. (2) The rudiment of the axial organ, including both vessels and lymphoid elements is formed prior to the downgrowth into it of the cells identified as primitive germ-cells by MacBride.

¹ Note † on this page should read . . . fold of the collar cœlomic wall, instead of . . . fold of the pharyngeal cœlom, etc.

(3) The axial organ persists in the adult, retaining its vessels and parenchyma but without recognisable germ-cells, and it cannot well be the seat of permanent production of germ-cells too embryonic to be recognisable, since the germ-tissue of each gonad is seen to be shut off by a membrane, as it is in the adult from the cellular contents of the aboral sinus (Gemmill, *Solaster*). On the histological side the resemblances between the hæmal systems of Enteropneusts and Echinoderms are very striking and have long received recognition.

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