A "protonephridial" stage in kidney development of Antalis entalis (Mollusca, Scaphopoda)

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Introduction:

The renopericardial system of adult Scaphopoda is exceptional among the Mollusca in lacking a clearly defined heart. Functionally it is also of interest. Previous studies on Scaphopods show inconsistencies on details like the presence of a connection between the pericardium and kidney. This structure, usually present in molluscs, channels the primary urine from the pericard to the kidney (= metanephridium). There is only one old vague description of such a duct (Distaso, 1906) on the left side of the animal and another observation (Reynolds, 1990) of a duct on the right side. In the course of extensive studies on the larval excretory system of molluscs (e.g. Haszprunar and Ruthensteiner, 2000) we investigated the transition from the larval protonephridial organization to the metanephridial system in early juvenile development of Antalis entalis. The mode of the formation of the renopericardial system in other molluscs (Polyplacophora: Sakkin-Plawen and Bartolomaeus, 1995), has been used to establish the homology relations of such organs among different phyla. Additional data on other molluscs like scaphopods would be helpful for testing such hypotheses. A prerequisite for the understanding of the juvenile condition was the reinvestigation of the adult organization.

Results:

Reconstructions of serial sections of adult Antalis sp. revealed paired kidneys. The right kidney shows some differentiation for channeling eggs or sperm from the gonad to the outside. The left one is connected via a long tube to the pericardium which represents the renopericardial duct. The pericardium is located posteriorly to the kidneys. It shows a dorsal infolding, probably representing a homolog to the heart of other Mollusca.

In 13 days postmetamorphic juveniles, the organization is strikingly different to the adult. There are paired compact renopericardial complexes. The kidneys resemble the adult ones in consisting of the same two cell types, a lumen and a nephropore. However, there is no trace of a pericardium or a heart yet. Instead there is a small duct connected to each kidney, consisting of several cells. The distal end of this duct is formed by a cell that gives rise to a ciliary flame extending into the lumen of the duct. The surface of this cell shows areas with diaphragms and slits, strikingly resembling the ultrafiltration sites of protonephridial terminal cells. Obviously, this whole kidney complex forms a functional unit with the duct plus "protonephridial" terminal cells producing the primary urine for the kidneys. In the same juvenile stages remains of the protonephridia, the degenerated duct releasing cells can be found somewhat anterior to the kidney complex.

Conclusions:

The confirmation of the presence of a renopericardial duct partly clarifies the long debated question of urine formation in Scaphopods. The way of primary urine production remains unclear for the right kidney, which shows no connection to the pericardium.

The kidney complex of the juveniles is a functional "protonephridium" in having a terminal cell and a differentiated excretory duct. However, the presence of a portion of the real protonephridium makes clear that this is a different organ. Although this kidney complex differs extensively from the adult renopericardial system, there is no question on the homology of at least the kidney portion. Intermediate development stages are needed to clarify the homology relationship of the terminal cell and duct of the juveniles with the renopericardial duct and pericardium of the adults. However, the organization found in the juvenile does not indicate a formation mode of heart and kidney as observed in Polyplacophora, where the kidney is formed as an outgrowth from the pericard (Sakkin-Plawen and Bartolomaeus, 1995). As all. There is no doubt that the kidneys of the two molluscan classes are homologous, the way of formation of the organ is no decisive criterion for a homology of such organs. This should be considered when hypothesizing about the homology of such organs among different phyla like Mollusca and Annelida.

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