DEPARTMENT OF ZOOLOGY

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B.Sc. Zoology Part I

WATER VASCULAR (AMBULACRAL) SYSTEM

INTRODUCTION

- The water vascular system is a modified part of coelom and it consists of sea-water filled canals having certain corpsules.
- It plays most vital role in the locomotion of the animal and comprised:-
  (1) Madreporite
  (2) Stone canal
  (3) Ring canal
  (4) Radial canal
  (5) Tiedemann's bodies
  (6) Polian vesicles
  (7) Lateral canals and
  (8) Tube feet

1. Madreporite:-

- The madreporite is a rounded calcareous plate occurring on the aboral surface of the central disc in inter-radial position.
- Its surface bears a number of radiating, narrow, straight or wavy grooves or furrows.
- Each furrow contains many minute pores at its bottom.
- Each pore leads into a very short, fine tubular pore canal which passes inward in the substance of the madreporite.
- There may be about 200 pores and pore-canals.
- The pore-canals unite to form the collecting canals which open into an ampulla beneath the madreporite.

2. Stone canal:-

- The ampulla opens into an S-shaped stone canal.
- The stone canal extends downwardly (orally) and opens into a ring canal, around the mouth.
- The walls of stone canal are supported by a series of calcareous rings.

- The lumen of stone canal is lined by very tall flagellated cells.
- In embryonic stages and in young Asterias, the stone canal remains a simple tube but in adult Asterias, lumen of stone canal possesses a prominent ridge with two spirally rolled lamellae which by branching become more complicated in structure.
- During its course, the stone canal is ensheathed by a wide, thin walled tubular coelomic sac, called axial sinus.

3. Ring canal:-

- The ring canal or water ring is located to the inner side of the peristomial ring of ossicles and directly above (aboral) to the hypo-neural ring sinus.
- It is wide and pentagonal or five sided.

4. Radial canals:-

- From its outer surface the ring canal gives off a radial water canal into each arm that runs throughout the length of the arm and terminates as the lumen of terminal tentacle.
- In the arm or the radial water canal runs immediately to the oral side of the ambulacral muscles.

5. Tiedemann's bodies:-

- The ring canal gives out inter-radially nine small, yellowish, irregular or rounded glandular bodies called racemose or Tiedemann's bodies, from its inner margins.
- The Tiedemann's bodies rest upon the peristomial ring of ossicles.
- The actual function of Tiedemann's bodies is still unknown, however they are supposed to be lymphatic glands to manufacture the amoebocytes of the water vascular system.

6. Polian vesicles:-

- The ring canal gives off on its inner side in the inter-radia position one, two or four, little, pear-shaped, thin-walled, contractile bladders or reservoirs with long necks called Polian vesicles.
- They are supposed to regulate pressure inside ambulacral system and to manufacture amoeboid cells of ambulacral system.

7. Lateral canals:-

- In each arm, the radial canal gives out two series of short, narrow, transverse called lateral or podial canals.
- Each lateral canal is attached to the base of a tube foot and is provided with a valve to prevent backward flow of fluid into the radial canal.

8. Tube feet:-

- There are four rows of tube feet in each ambulacral groove.

- A tube foot or podium is a hollow, elastic, thin-walled, closed cylinder or sac-like structure having an upper sac-like ampulla, a middle tubular podium and a lower disc-like sucker.
- The ampulla lies within the arm, projecting into the coelom above the ambulacral pore which is a gap between the adjacent ambulacral ossicles for the passage of the podium.
- The tube feet are chief locomotory and respiratory organs of *Asterias*.

LOCOMOTION

- ***Asterias*** lacks in head or anterior end, therefore, capable to move in any direction according to its desire.
- It can move on horizontal as well as on vertical surfaces by the help of tube feet.

A. Locomotion on a horizontal surface:-

- When an *Asterias* desire to move on a horizontal surface in a given direction, the arm or arms pointing in that direction is lifted.
- The ampulla of raised arm contract, the valve in the lateral canals close and the water of the ampulla is forced into the podia.
- The podia of the tube feet become extended, elongated and enlarged in the general direction of movement due to the hydrostatic pressure produced by influx of water into them.
- Subsequently, the terminal suckers of the tube feet become attached to the substratum and their central parts are withdrawn to form suction cups.
- Due to the vacuum so produced, the suckers acquire a firm grip over the substratum.
- Mucus secreted by the tips of the tube feet further aids in attachment.
- The tube feet now pivot forward on their attached suckers, assuming vertical position and thereby pushing the body forwards.
- The longitudinal muscles of the podia now contract and this forces their fluid back in to the ampulla and releases their suckers.
- The ampulla then contract again and whole sequence of events is repeated.

B. Locomotion on a vertical surfaces:-

- In climbing a vertical surface, the tube feet pull the body forward.
- By the alternate contraction and expansion of tube feet and by adherence of suckers of tube feet on surface *Asterias* climbs on the vertical surface.
- *Asterias* employs its tube feet, only when, it moves on hard rocky substratum.
- But, on soft mud or sand (substratum) the suckers of tube feet become useless, therefor, on such soft surfaces the animal literally walks on its extended tube feet which now act like small legs.

Besides locomotion, tube feet serves many other functions such as clinging of animal body to substratum, tactile and respiratory function.

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