Reproductive system of Asterias

BSc. Part I Zoology (Subsidiary)

Reproductive System of Asterias:

Most species of Asterias are unisexual or dioecious, i.e., sexes are separate except a few species such as Asterias rubens which is hermaphrodite. There is no marked sexual dimorphism, however, during breeding season some sort of colour difference between both the sexes may occur.

The reproductive organs of Asterias are of primitive type and lack copulatory organs, accessory glands, receptacles for storing ova and reservoirs for storing mature sperms. There are only gonads that act as reproductive organs.

Gonads:

The male gonads are testes and female gonads are ovaries. Each sexually mature male or female individual contains five pairs of testes or ovaries, one pair is lying free laterally in the proximal part of each arm between the pyloric caeca and the ampullae.

The testes and ovaries are morphologically similar. Each gonad appears as an elongated feathery tuft or tuft of tubules or bunch of grapes, whose size varies greatly according to the proximity of spawning time.

At maturity, the gonads occupy the entire perivisceral space. The proximal end of each gonad is attached to aboral body wall near the inter-brachial septum by a very short gonoduct that is ciliated and opens laterally through a small gonopore on the aboral surface almost at the angle of two adjacent arms.

Each gonad is enclosed in a genital sac of coelomic nature with a wall of muscle and connective tissue fibres, covered externally with peritoneum. This genital sac is the outgrowth of the genital or aboral coelomic sinus. The gonad proper is lined by germinal epithelium, containing the germ cells.

The mature sperms and ova are discharged by male and female Asterias respectively in sea water. The release of sex cells from the gonads is regulated by neuro-hormonal secretion of radial nerve.

Life History and Development of Asterias:

(i) Fertilisation:

The most species of Asterias have only one breeding season in a year. During breeding season, both types of mature sexes shed their sex cells in the sea and union of male and female sex cells or gametes (sperms and ova) occurs in sea water. Thus, fertilisation in Asterias is external.

(ii) Embryogeny:

The embryological development of Asterias is indirect and includes various larval stages. The fertilised egg or zygote is spherical, half millimeter in diameter and contains little amount of yolk. The cleavage is holoblastic and equal and it converts the unicellular zygote into a single layered, hollow, ciliated and spherical structure called coeloblastula.

The coeloblastula possesses a fluid-filled central space, called blastocoel and it swims about freely. The blastula undergoes embolic invagination and becomes two layered cup-like gastrula. The gastrulation involves the inward pushing of blastomeres of one side. The in-pushing encloses a cavity called archenteron and it occupies the larger part of blastocoel which ultimately becomes obliterated.

This embryonic stage is called gastrula and it has an outer ectodermal and inner endodermal germinal layers. The archenteron or gastrocoel communicates to the exterior by a wide aperture called blastopore. The blastopore changes its relative position with the elongation of gastrula and becomes the anal opening of the larva. Two more openings appear on the surface of the larva.

On the ventral side, a tubular in-growth of ectoderm forms the larval mouth or stomodaeum. Another opening occurs on the dorsal side as the dorsal pore. The cilia of general surface of gastrula degenerate and certain definite ciliary band appears. The mesoderm is formed from two sources.

During the gastrular invagination, the advancing tip of archenteron (endoderm) buds off certain mesenchyme cells into the blastocoel. The growing archenteron is differentiated into a narrow proximal part and wide terminal part.

The narrow proximal part communicates to the exterior by the blastopore and in later stages forms the stomach, and intestine, while the wide terminal part of completed archenteron expands and cuts off on each side into a coelomic pouch, the hydroenterocoel.

These take up their position to the right and the left sides of the archenteron and develop into coelomic pouches. The latter give rise to coelom, its mesodermal lining and water vascular system. The embryo at this stage becomes a free-swimming larva.

(iii) Larval Development:

The larval development of Asterias includes the following larval stages:

Bipinnaria Larva:

The bipinnaria larva develops from the zygote in about one week. It is a bilaterally symmetrical larva which possesses a preoral and a postoral ciliated band, and a preoral lobe with preoral loop of ciliated band. The various projections emerging out of its body correspond to the arms. Inside the body appears the coelomic apparatus and the alimentary canal.

The bipinnaria larva feeds on diatoms, etc., by creating food-bearing currents by ciliary tracts in the stomodael wall. It swims freely by forwarding its anterior end, with a clockwise rotation, after some time the bipinnaria larva transforms into the next larval stage, the brachiolaria larva.

Brachiolaria Larva:

In the brachiolaria larva the side-lobes of bipinnaria increase in length to become long, slender and ciliated larval arms. The larval arms move and contract. The preoral arms also give out processes called the brachiolar arms. The arms of brachiolaria larva have coelomic prolongations and possess tips of adhesive cells.

The bases of these arms surround the elevated, adhesive, glandular area performing the function of a sucker or fixation disc by which the larva becomes attached at the time of metamorphosis.

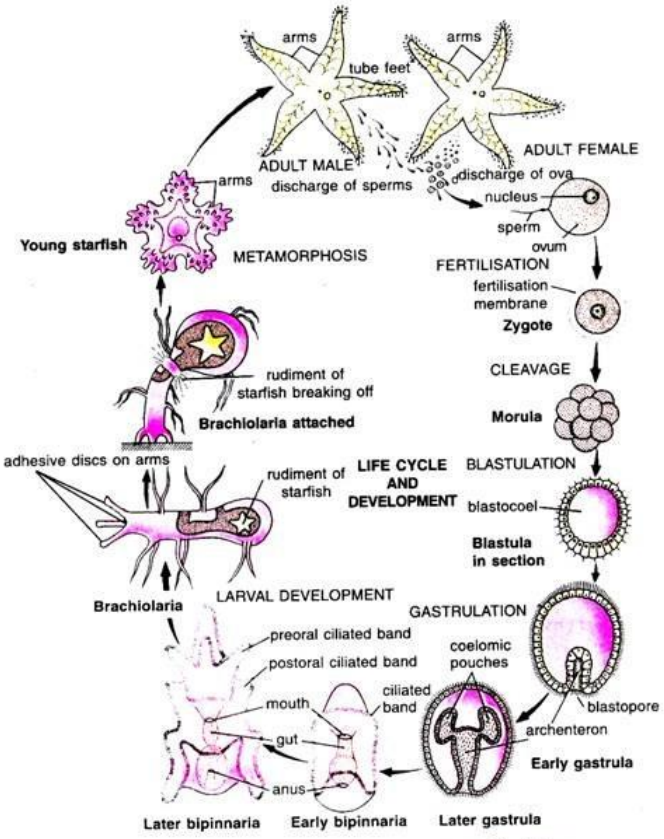

Fig. 85.14. *Asterias*. Development and life history.

(iv) Metamorphosis:

In about 6 or 7 weeks, the brachiolaria larva settles on the bottom or on some solid object and is fixed with that by its adhesive arms. Now the bilaterally symmetrical larva metamorphoses into a radially symmetrical adult. The larval mouth and anus close. A new mouth is formed on the left side of the larva and a new anus is developed on the right side.

The left and right side of the larva, thus, subsequently differentiated into oral and aboral surfaces of the adult. Five lobes called arm rudiments grow out around oral-aboral axis. In later stages, the skeletal elements appear on the arm rudiments and the radial canals grow into them.

In each arm two pairs of outgrowths from the coelom form the first tube feet and serve for attachment. Further complex re-organisational changes result in the formation of adult Asterias. The newly detached rudiment of the body of sea star is less than 1 mm with short stubby arms.

Regeneration and Autotomy of Asterias:

Asterias possesses considerable power of regeneration. It is capable to regenerate its any lost part of body at any time. Moreover, if an arm is injured or held up, Asterias usually casts it off near the base at the fourth or fifth ambulacral ossicle. This is called autotomy.

The opening left in the side of the central disc by the broken off arm is immediately closed by the contraction of the adjacent body wall musculature for the protection of internal body organs and regeneration of new arm starts at that place.

A disc deprived of all its arms regenerates. In Asterina vulgaris, a single arm with a portion of disc regenerates an entire animal. But in Linckia, an arm totally devoid of disc can also regenerate complete animal (Fig. 85.15). Specimens with small regenerating arms at the base of the large original arm are popularly called comets.

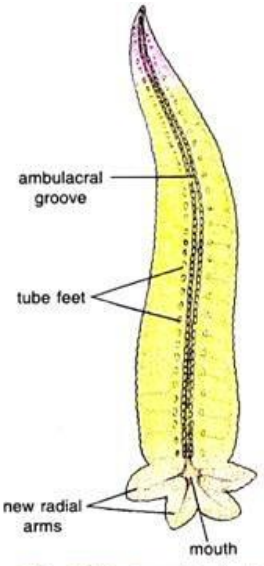

Fig. 85.15. Comet state of *Linckia*.