ON THE SEXUAL ORGANS OF THE TUBIFICID WORM *AULODRILUS REMEX* STEPH.

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(Plate VI).

This species was originally described by Stephenson in 1921 (4) from three specimens collected in the Central Provinces. Large numbers of the worm, mostly non-sexual, were found by me in tanks in Trivandrum in 1925 (1). In August, 1928 a sample of mud containing specimens of the worm was brought from Neyyur (34 miles south of Trivandrum) and kept in the laboratory for 3 months. Sexual specimens became available in this culture during the months of October and November. Six of these were sectioned longitudinally, four transversely, and several were examined alive under the microscope.

The present specimens measure 15--20mm. during life. The number of segments is usually more than 100. One of the largest specimens examined had 156 segments followed by a short setaless unsegmented region.

The prostomium is bluntly conical. The buccal cavity is globular and is confined to segment i. The pharynx is thick-walled and occupies segments ii and iii. Surrounding the pharynx are a number of pear-shaped cells, the basal ends of which are drawn out into long narrow ducts. The narrow oesophagus dilates into the intestine in segment vii or viii. In sexually mature specimens the dilatation is in segment ix.

Large clusters of pear-shaped gland-cells occur in segments iii, iv, and v close to the ventral bodywall on either side of the ventral nerve cord. The cells have finely reticulate cytoplasm and round nuclei and their narrow basal ends are attached to the bodywall.

On the ventral side of segment vii, in sexually mature specimens, is a narrow median longitudinal opening with a puckered margin.

The opening alternately widens and narrows to a slit as the body of the animal contracts and expands during progression. The opening leads into a cavity or depression formed by the invagination of the bodywall, which may be termed the ' genital fossa ' since the male apertures open into it. Such a depression has been described by Mehra (3) in *A. kashi* and termed by him the ' spermiducal chamber.' I would prefer the term ' genital fossa.'

The Reproductive Organs.

The clitellum is conspicuous and extends over segment vii and the anterior half of segment viii (=$1\frac{1}{2}$ segments).

The testes were present in all the sectioned specimens. They are a pair of pear-shaped masses of cells in segment vi attached by the narrow base to the posterior face of septum 5/6. In all the specimens examined there is present in segment v and attached to septum 4/5

by their narrow bases a pair of structures similar to the testes in segment vi, but about half their size. These appear to be an anterior rudimentary and perhaps functionless pair of testes.

The sperm sac is single and occupies segment vii and may project into segment viii. Spermatozoa and sperm-morulae are seen in segment vi, in some specimens sparsely and in others abundantly.

The male funnels are placed on the anterior face of septum 6/7, one on each side of the oesophagus and a little below it. The funnels are almost equilateral in longitudinal section, and are 45-60μ wide at the mouth, according as they are partially or fully open. The wall is composed of a single layer of narrow elongate columnar cells and is ciliated internally. Bundles of spermatozoa are seen at the mouth.

The vas deferens is 12μ thick with a lumen about 5μ in diameter. On passing into segment vii the vas deferens describes a broad loop, gradually rises upwards, and opens into the atrium at its anterior end. In a few sections the distal half of the duct is slightly coiled.

The atria are elongate ovoid sacs in segment vii with their long axis parallel to that of the body. Each atrium is 157μ long, 67μ wide at the broad anterior part, and 31μ at the narrow rounded posterior end. The wall of the atrium is composed of three layers as in the other species of the genus. The inner epithelial lining consists of broad columnar cells with indistinct granules and basal nuclei. The nuclei alone stain with haematoxylin. The cells lining the anterior end of the atrium are smaller and are ciliated. The middle muscular coat is distinct and is 3·6μ in thickness. The outer coelomic epithelium is rather indistinct in sections. Twisted bundles of spermatozoa are present in the lumen of the atrium.

From the ventral side of the rounded posterior end of each atrium the straight atrial duct is given off, which, passing downwards and inwards towards the middle line, opens along with its fellow into the genital fossa at about its middle. The duct is distinctly marked off from the atrium by a constriction and is 72μ high and 30μ thick. At the constriction it is only 18μ thick. The columnar cells lining the lumen are of the same kind as those of the atrium. This epithelial layer is surrounded by a layer of circular muscle-fibres, which at the exterior opening of the duct form a distinct sphincter round it. The entire duct is enclosed in a muscular chamber composed of longitudinal muscle-fibres springing from the ventral bodywall.

Lying on the ventral side of each atrium is the prostate, a lobed mass composed of large pear-shaped gland-cells with finely-reticulate cytoplasm and small rounded nuclei. Both the reticulum and the nuclei stain deeply with haematoxylin. The prostate communicates with the atrium ventro-laterally at about the middle of its length where the muscular coat of the atrium is interrupted.

The ovaries are in segment vii attached to the ventral bodywall close behind septum 6/7. Each is broad and flat, about 160μ in length and is composed of a large number of ova a few of which are sometimes larger in size than the rest.

The ovisac is in segment viii, sometimes projecting slightly into segment ix. It is a backward pouching of septum 7/8 and contains a

single large ovum composed of minute rounded yolk granules and having a conspicuous centrally-situated oval nucleus with a nucleolus.

A pair of spermathecae are situated in segment vi, and each consists of an ampulla and duct. The ampulla is an ovoid sac 247μ long, 54μ wide at its ental end, 67μ wide about the middle and 27μ ectally. The wall is composed of a single layer of cubical cells with a thin muscular layer closely adherent to it. The lumen of the ampulla is filled with a twisted mass of tightly packed spermatozoa. The duct is 45μ long and 18μ thick. The two ducts open close together in the mid-ventral line in the setal zone of the segment.

The coelomic cavity of segment vi.—Mehra (3) describes in detail a division of the coelomic cavity of segment vi in *A. kashi* into two parts, a large central portion enclosing all the organs of the segment and a more peripheral surrounding the former ventrally and laterally. I give below an account of the condition observed in the present species.

In one of the series of transverse sections (the best of the four prepared) the bodywall of segment vi is very much thickened laterally and ventrally (but not dorsally). The thickness is caused by the development of a new layer of circular muscle-fibres at some distance from the bodywall and the filling up of the space between the two by a spongy tissue composed of irregularly shaped cells with reticulate cytoplasm and round nuclei. Numerous spaces exist in this tissue. The spongy tissue, which is widest ventrally, gets narrower and narrower dorsalward till it completely disappears dorso-laterally where the new muscular wall joins the bodywall. In transverse sections the thickened part of the bodywall has thus the appearance of a crescent. In a few of the sections of this series the new muscular wall has, in certain places, severed itself almost completely from the bodywall, the only connection between the two being very thin protoplasmic strands, remnants of the spongy network, at wide intervals (see Pl. VI, fig. 7). The strands may also be broken or absent. Thus distinct peripheral spaces result. These spaces can be due to nothing else than the accidental tearing of the loose spongy network during the process of paraffin embedding.

In the remaining three of my transverse series an almost continuous peripheral cavity occurs laterally and ventrally. In these sections the spongy tissue is present only in the dorso-lateral corners just before the new circular muscle layer fuses with the bodywall. After having examined the condition in the first series described above I think that the apparently continuous peripheral cavity in these is also caused by the accidental tearing of the loose spongy network during the process of paraffin embedding, and the consequent separation of the new layer of circular muscle-fibres from the bodywall.

With regard to the origin of the spongy tissue and the development of the new circular layer of muscles in segment vi I am unable to give a definite explanation. It may, however, be mentioned that in the present species the thickening of the bodywall is not restricted to segment vi but extends slightly into the posterior part of segment v and into the anterior part of segment vii.

Penial setae.—In sexually mature specimens the ventral setae of segment vi are lost and those of segment vii are modified as the penial

setae. The penial setae are *one* only on each side in fully-mature individuals, though in less mature worms two setae are present in a bundle. The penial seta is 135—144μ long and doubly curved and is without a nodulus. The distal fourth of the seta has a boat-like excavation on its concave side as in *A. pectinatus* (2).

Each penial seta passes through the central lumen of a setal gland situated external to the atrial duct of its side. The setal gland is 36μ wide and is almost globular in shape. It is composed of a single layer of elongate cells having distinct outlines and basally situated nuclei. The cytoplasm does not stain with haematoxylin. The proximal part of the penial seta projects beyond the gland for a distance of about 36μ. Investing the gland is a muscular layer which is continuous with the muscle bands of the setal sac.

Small compact pear-shaped masses of gland-cells occur in connection with each setal gland, as in *A. pectinatus* and *A. kashi*. The cells composing each pear-shaped mass are themselves pear-shaped and highly vacuolated. The long narrow stalk-like basal end of each mass (composed of the extremely long, thin and stalk-like basal ends of the individual cells) communicates with the setal gland. Communication is effected by the interruption of the muscle layer investing the setal gland. While the swollen parts of the cells stain deeply with haematoxylin, the narrow basal parts do not stain.

Parasites.—In two non-sexual specimens the body presented whitish blotches on each side except in the posterior segments. On examination it was seen that the whitish appearance was due to the presence, in the body-cavity of each segment, of two massive bundles, one on each side of the gut, of a species of bacterium. Each bacterium is 19μ long, straight, and rod-like, with an ovoid spore (?) near the anterior end. This is the second time I have noticed bacterial infection in aquatic oligochaetes. Some months ago a specimen of *Aulophorus tonkinensis* was obtained with the entire body swollen and which presented a glistening white appearance due to masses of bacteria in the body-cavity.

Remarks.—The presence of two pairs of testes in the present species is interesting. The anterior pair have apparently lost their function as is indicated by their small size and by the absence of an anterior pair of male funnels and of an anterior sperm-sac. In other respects the present species agrees very closely with *A. kashi*. Among minor differences may be mentioned the following :—

(1) The atrial duct in *A. remex* is straight and not convoluted.

(2) The spermathecal openings in *A. remex* are *ventral*, close to the mid-ventral line and not ventro-lateral as in *A. kashi*.

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