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## Notes on an archiannelid, *Saccocirrus major*<sup>1)</sup>

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(With 2 Text-figures)

Regarding the internal anatomy of the genus *Saccocirrus*, there have been published several papers by the following authors, such as Goodrich (1901), Salensky (1907), Haempelmann (1913) and Gusjewa (1929), but details for the most part still remain unknown. Concerning the development of the genus, however, there has been little reported. For the first, Repiachoff (1881) briefly reported that in the development of *S. papillocercus* in Odessa were found many abnormal forms. In 1906 Pierantoni described the development of *Saccocirrus* in Naples from fertilization to formation of young larvae just metamorphosed through the trochophora. In the vicinity of the Akkeshi Marine Biological Station the archiannelid, *Saccocirrus major*, is commonly found all the year round. Several years ago, while staying at the station the junior author studied, at the suggestion of the senior author, the metamorphosis of the worm, and after his death in 1950 he left behind some fragmental notes on it. The senior author utilizing these notes now proposes to publish the paper, together with some anatomical facts ascertained by himself.

The archiannelid occurs in sandy flats between tidal lines. The body is long, slender and very contractile, and when well stretched out, reaches over 40 mm. The dorsal side is roundly convex and the ventral side nearly flat. The prostomium is small and lobed anteriorly, with a pair of eyes and another of conspicuous tentacles. The tentacles are hollow, long, cylindrical and gradually tapering toward the tip; they are each connected in the base with the ampulla within the cephalic portion. They are highly movable in locomotion and very prehensile in living state. Nuchal organs are obliquely disposed in a pair just behind two black small eyes. The mouth, situated on the ventral side, leads to the oesophagus which extends to the 12th or 13th segment, but in some specimens the oesophagus barely reaches the 9th, 10th or 11th segment. The trunk is

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formed of many similar annuli, which are nearly similar in width except the posterior ones. Each annulus is provided with a pair of parapodia which are small, cylindrical and furnished with a bundle of setae. The bundle of setae is not present in the posterior annuli preceding the pygidium. The gonads begin to develop mostly from the 18th, 19th or 20th segment, but less occasionally from the 16th, 17th or 21th segment. In a few specimens the gonads were found to appear from more posterior segments, such as the 25th or 27th segment. It is very noticeable that the sexual products in both male and female are found to develop only on the right side of the body as shown in Fig. 1, G & H. The pygidium is the narrowest segment but it is provided with a pair of distinct caudal lobes, each of which bears from 8 to 15 adhesive papillae on the posterior margin. The glandular cells beneath the epidermis form oval fields, two by two on the dorsal side of each segment. The colour is generally yellow or orange. Eyes black. Tentacles, several posterior segments and pygidium white. On closer observation in living state, tentacles are found to be colourless, oesophageal region pinkish brown, containing no increment; midgut-region also pinkish brown, but containing

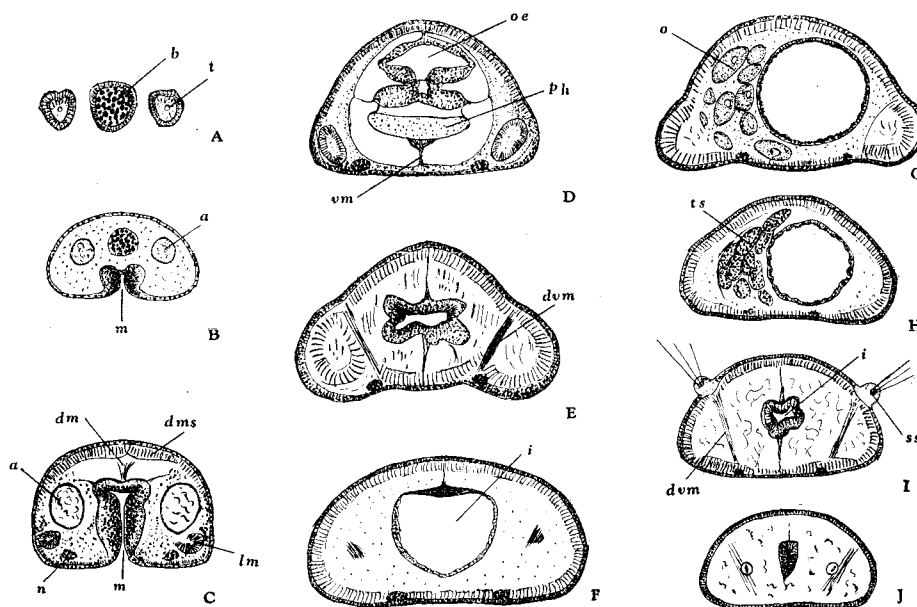


Fig. 1. Serial cross sections of *Saccocirrus major*; a ampulla, b brain, dm dorsal mesentery, dms dorsal muscle, dvm dorso-ventral muscle, i intestine, l longitudinal muscle, m mouth, n nerve, o ovary, oe oesophagus, ss setae-sheath, t tentacle, ts testis, vm ventral mesentery.

greenish brown increment seen through the dorsal skin. Ventral surface pinkish brown throughout the whole length, except near the pygidium. In about ten posterior segments increment can not be seen and these segments are faintly brownish in colour. The tentacles are composed of an outer glandular epithelium and a core of endoderm which contains many muscular fibres. Each endodermal core is connected with an ampulla, in which the muscular fibres become feebly developed in the second annulus.

The digestive system is straight through its whole length and is characterized by having a sac-like pharynx, a thick-walled oesophagus and a spacious intestine. The mouth opens ventrally and is provided with lips of thick epithelium. Under the oesophagus is present the sac-like pharynx which is hyaline but equipped with some muscular fibres. The peritoneal epithelium of the oesophagus is thick and glandular, while that of the intestine is very thin.

The longitudinal muscles are developed just under the epithelium around the whole periphery, forming paired ventro-lateral ones which are specially differentiated. The dorso-ventral muscles are well developed and always connected with the parapodia. As to the anatomy of the archiannelid the most important finding in the present study lies in the asymmetry of the gonads; so far as the senior author has observed, the right gonad alone in both sexes of the worm develops as shown in the figures. Haempelmann (1913) who studied the gonads of the two species of *Saccocirrus*; *S. major* and *S. papillocercus*, did not touch upon this fact. Therefore, it is probable that the Japanese worm forms a distinct species from or a race of *S. major*, if the original species is revealed to have symmetrical gonads.

The larvae reported by Pierantoni (1906) are all telotrochous; one of them 3 days of age and another one 15 days of age. The former is a trochophore, bearing apical cilia, paired eye-flecks, two ciliary girdles and a mouth. The larva is pyriform in shape, the upper half being rather better developed than the lower half. In the latter larva several remarkable subsequent changes are observable; the apical cilia become considerably reduced in number, the lower half become developed and elongated, with increasing number of segments. In the first and second segments of the lower half a group of two or three strong bristles appears, but the pygidium is not yet biloded. In this stage, the digestive system shows some differentiation.

On the other hand, Claparède and Meczniow (1869) studying the development of several polychaetes of Naples published a note on some annelid larvae, which are very similar to the *Saccocirrus*-larvae observed by the present writers. They described the larvae as those of Spionidae and pointed out that the larva was formerly described by Milne-Edwards (1845) as that of Amphinomidae. The larva of Milne-Edwards was obtained off the coast between Stromboli and Messina. The larvae described by Claparède and Meczniow seem to the senior writer rather to be the larvae of *Saccocirrus* than those of Spionidae. These larvae, especially in

later stages, agree in several points with those examined and reported herein. The youngest larva described by them is monotrochous, having an equatorial ciliary girdle, a mouth, 6 pairs of setae, and most noticeable of all, bilobed posterior end. As the later stage they reported in the same paper a telotrochous larva exceedingly differentiated from the stage just referred to. These larvae have 15-20 annuli and are over 2 mm length. The head is composed of a median prostomium and two lateral lobes present anterior to the ciliary girdle. Just posterior to the ciliary girdle occurs a bilobed pygidium. On account of the presence of the bifurcated pygidium, they identified the larvae with that of Spionidae, but they pointed out that the groove between the lobes is very deep, because the pygidium of Spionidae has a still shallower groove between the lobes. The body is greyish brown, especially deep in colour in the cephalic lobes and near the pygidium. From the lateral lobes of the prostomium, which possibly later develop into tentacles, and the bilobed pygidium, it is highly probable that these larvae belong to these of *Saccocirrus*. These larvae, however, are somewhat different from those of Pierantoni in several points. This will be discussed later on.

The youngest larva examined by the present writers was collected on July 16 and is telotrochous, cylindrical, and 0.23mm long and 0.098mm wide (Fig. 2, A). It seems to be a stage slightly more advanced than that figured by Pierantoni (Fig. 1B). In the present larva the cephalic lobe is roundly protruded and lateral lobes are not distinctly developed. The eye-flecks are situated, one on each lateral lobe. Just posterior to the protrochal ciliary band opens a large mouth furnished with rich cilia. The mouth becomes gradually triangular in shape, with an apex posteriorly. From the apex runs a ciliary furrow to the telotrochal ciliary band. The trunk is cylindrical, divided into six segments, the anterior two being wider than the posterior four. The pygidium, the last segment, is bifurcated into two rounded posterior lobes which form adhesive organs. The ciliary bands are two, one larger between the head and the trunk, and another on the pygidium. The body is greyish brown, especially deep in the cephalic lobe and pygidium. The intestine is extended, from the cephalic region to the fifth truncal segment.

The larvae which were abundantly found in plankton on July 20 showed some development from the previous stage (Fig. 2, B). The cephalic portion had become characterized by protruded lateral lobes. Truncal segments were seven in number. The pygidium still furnished with cilia became narrowed towards the end which is again bifurcated into adhesive organs. The digestive system was differentiated into the oesophagus, stomach and intestine. The intestinal part contained yolk-like masses. The larva was dark brown in colour and adhered to the substratum by means of the adhesive organs; it crept like a leech. Two days afterwards the larva had become larger, measuring 0.66 mm long, 0.154 mm wide in head region and 0.098 mm wide in trunk (Fig. 2, C). In this stage the truncal segments with the exception of the pygidium had increased to 8 in number. When well-elongated, these

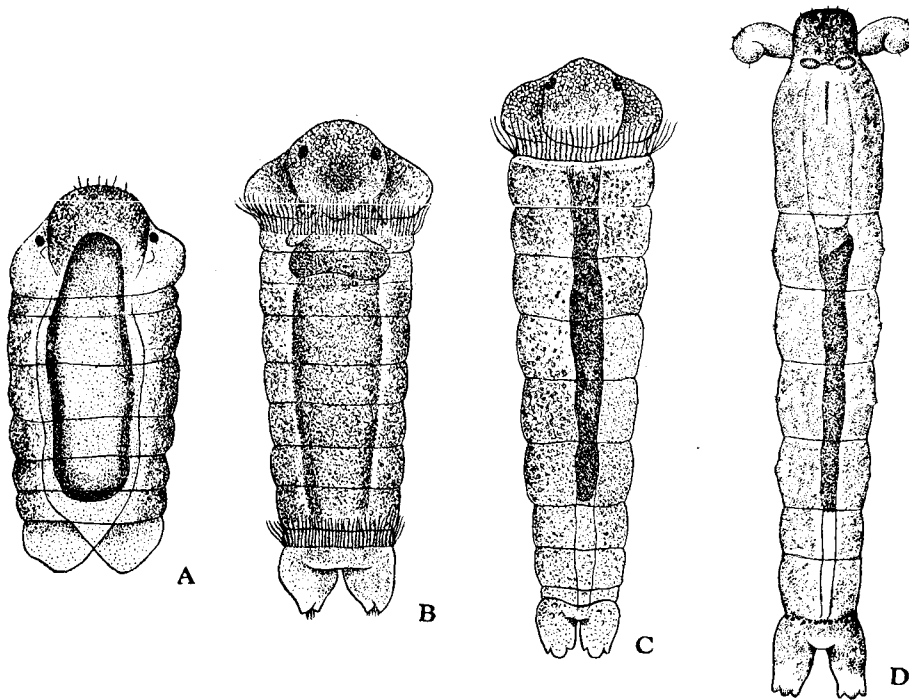


Fig. 2. Larvae of *Saccocirrus major*.

segments are distinctly narrowed posteriorly, moreover the ninth segment newly appears as a narrow band just anterior to the pygidium. On the ventral side of these larvae was observed the ciliary furrow running from the telotrochous corona to the prototrochal one. The furrow runs straight along the median line but is bifurcated in the third anterior segment, each branch leading forwards, slightly enlarged and ending in a rounded extremity. Just anterior to the Y-formed branches opens a mouth afterwards. In larvae developed slightly more from the stage just described, anlagen of setae appear from the third anterior segment to the posterior-most segment. The pygidium had become enlarged and its inner surface had become gradually notched, forming the adhesive organs of the adult.

Another set of larvae found on July 20 was 0.63 mm long and 0.14 mm wide. In these larvae the prototrochal and telotrochal ciliary bands had already disappeared. The cephalic region was oval in shape and was provided with a pair of broad tentacles of which the shaft was curled dorsally. On the dorsal side on the demarcating line between the head and the trunk were found hyaline nuckal organs

arranged in pair. The mouth was slit-like and opened just behind the cephalic region. The Y-shaped ciliary furrow was distinct on the ventral surface. The pygidium was furnished with four papillae on the inner side, which could be seen from the ventral side. The larvae were found to creep on the substratum.

These larvae were accidentally all lost. On August 1st some larvae possibly metamorphosed from the previous ones were caught in plankton (Fig. 2, D). They were 0.7 mm long and 0.09 mm wide. They could swim but were usually found to creep on the bottom of the aquarium and often to attach to the substratum by means of the adhesive organs already developed in the pygidium. The head was rather round in outline and contained black pigment. Eye-flecks had already disappeared. On the ventral side of the head were observed short curled rod-shaped tentacles which were provided with tactile cilia sparsely disposed. On the demarcating line between the head and the first truncal segment were found two hyaline nuckal grooves in pair, which were ovoid in shape, situated obliquely and furnished with cilia thickly set. The first segment was indistinctly separated from the second one, and was approximately twice the length of the latter. The succeeding four segments were similar in length to the second one, but the sixth and seventh ones were slightly smaller than the preceding ones. The pygidium was 0.08 mm long and bifurcated. In dorsal view their branches were blunt and each furnished with three adhesive organs. Both the protrochal and telotrochal ciliary bands had already completely disappeared in the region. Corresponding to the place of the telotrochal ciliary bands, black flecks were found arranged in a transverse row, thus demarcating the pygidium from the anterior segment. The alimentary tract was straight and especially blackly tinted from the third to the sixth segments. On both the lateral sides of the 3-6th segments were found hyaline processes which contained 2-3 anlagen of setae.

*Remarks.* The youngest larva observed by the present writers is quite different from the larva figured by Pierantoni (1906, Fig. 2B). The main differences lie in the presence of bundles of stout bristles and the absence of the bilobed posterior end of Pierantoni's larva. As regards the pygidium it is possible that it become bifurcated afterwards, but it seems to be impossible that the stout bristles so conspicuous shed off in later stage as indicated in the Japanese larva. Moreover, there can be seen several discrepancies in structure in view of stage between two kinds of larvae; such as differentiation of the lateral prostomial lobes, numbers of annuli and complication of the digestive system. The developmental condition of these organs does not coincide in these larvae. From these facts the two larvae seem to belong to quite different worms. Pierantoni's larva which is so different from the adult of *Saccocirrus*, probably belong to some other annelid. On the other hand, the larvae figured by Claparède and Mecznirow agree with our larvae in the following points; presence of the lateral prostomial lobes, bifurcated pygidium, and setae-bundles feebly developed. Moreover, the

coloration is similar to that of the Japanese larvae. The larvae seem to be referable to *S. papillocercus*.

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