The Anatomy of *Armandia leptocirris* Grube (Polychaeta)

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Introduction

The genus *Armandia* is one of the three genera of subfamily Polyophthalminae belonging to the Family Opheliidae (Hempelmann, 1927) and includes four known species *A. polyophthalma, A. cirrosa, A. lanceolata* and *A. leptocirris*. Of these the last two species occur in restricted localities in the Indo-Pacific region and have been collected from the Indian Ocean in the Persian Gulf, Gulf of Mannar, around the Andaman Islands and the Mergui Archipelago (Fauvel, 1932). Our knowledge regarding the anatomy of Opheliids is largely due to the early workers like Quatrefages (1850), Kükenthal (1887) and others, who have dealt with certain aspects in the anatomy of species of *Polyophthalmus* and *Ophelia*. Among the more recent papers Brown's account (1938) on the anatomy of *Ophelia cluthensis* and a similar study on *Thoracophelia mucronata* by McConnaughy and Fox (1949) are quite exhaustive. The larval development and metamorphosis in *Ophelia bicornis* by Wilson (1948 *a* and *b*) and that of *Thoracophelia mucronata* by Dales (1952), being perhaps the only detailed studies on the subject, provide several

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points of considerable interest as nothing was known until then regarding the development and settling of these larvae. Tebble's review (1953) of the genus *Ophelia* together with descriptions of some new species indicates scope for further study of the family as a whole. While we have thus some knowledge of the European forms, little information is available on the Indian species. The present account deals with the familiar Indian Genus, *Armandia* and is intended mainly to supplement our knowledge of the anatomy of the fascinating group of polychaetes, the Opheliidae, and bring out the comparison between *Armandia* and other species of the family.

This work was carried out between 1944 and 1946 at the University Zoological Laboratory, Madras, during the tenure of a research scholarship from the Madras University, and formed part of the M.Sc. thesis, but has since been brought up-to-date. This investigation was conducted under the guidance of Prof. R. Gopala Aiyar and it gives me great pleasure to thank him for his help and criticism. The author is also grateful to Dr. N. K. Panikkar for his constant encouragement and to Shri R. V. Nair for making some of the illustrations and also in arranging for the publication of this paper.

Methods

The material was collected on the sandy intertidal area on the western side of Krusadai Island in the Gulf of Mannar. These worms are capable of swift darting movement and easily disappear by burrowing themselves into the loose sand. The easiest method of collection was to dig out as quickly as possible a quantity of sand at a depth of about a few inches and lift it out of water over a basin when most of the worms wriggle out and fall into it.

Some observations made on the living worms under the binocular microscope were useful particularly in studying the course of blood circulation in the main vessels. Careful dissections were also made to study the disposition of the various internal organs.

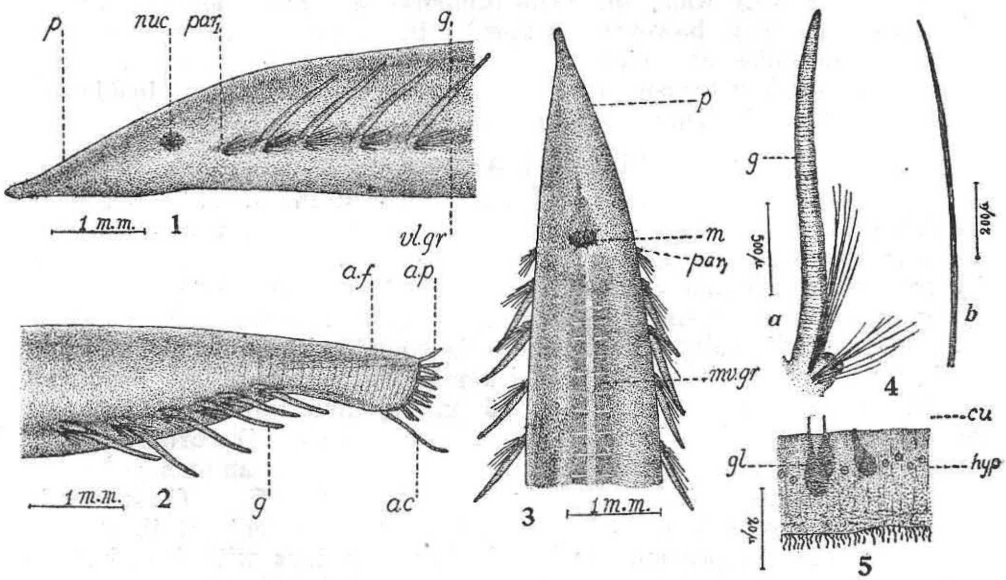
Specimens were kept in clean sea water and in about 12 hours the gut was free of sand particles for sectioning the material. Heidenhain's Susa was found to be a satisfactory general fixative and especially useful for the musculature and the nervous system. Bouin's fluid and Bouin--Duboscq were useful in studying the alimentary canal and the associated glands. Staining was done mostly with Heidenhain's iron haematoxylin and counterstained with eosin. Mallory's aniline blue collagen stain and Hoyer's thionin were employed for the glandular elements and the blood system.

External Features

The size of the species varies approximately from 25 to 40 mm. in length and in the adult the average width of the worm ranges from 2 to 3.3 mm. in its broadest region. There does not seem to be any difference in size or other external characters between the sexes. In general appearance, the shape of the body roughly resembles that of *Amphioxus* but is more round in cross section. The segments are not marked off by annulations, the whole body being smooth throughout (Figs. 1, 2 and 3). In the present collection all the specimens possessed 33 to 36 setigerous segments. However, Fauvel (1932) mentions that specimens from Krusadai examined by him showed 36 to 38 segments while those collected from Andamans had 33 or sometimes only 31 setigers. Thus the species seems to show variation in the number of setigers.

In freshly caught specimens the body has a light pink colour. The cuticle is iridescent and is somewhat transparent. The species is dioecious and most of the specimens caught in February and March were sexually mature. Mature females could be distinguished from the males by the presence of ova seen through the transparent body wall as small rounded structure floating in the coelomic fluid while the males appear pale white or slightly pinkish.

The dorsal aspect of the animal is highly arched whereas on the ventral side there is a prominent mid-ventral groove starting behind



the mouth (Fig. 3) and reaching up to the posterior end of the animal. In addition there are two ventro-lateral grooves (Figs. 1 and 2) one on each side throughout the entire length of the body beginning from the first segment giving the animal a characteristic appearance in cross section with two longitudinal ventrolateral folds. The parapodia arise from the dorsal margin of the ventro-lateral folds. They are small, each with two bundles of capillary setae. The setae of the notopodial bundle are longer and the dorsal cirri are absent (Figs. 4a and b) Branchiae are simple structures and occur from the second setigerous segment up to the last one. These arise from the notopodial regions of the parapodium as simple tubular structures with close transverse annulations. Beginning from about the seventh setigerous segment are 10 to 12 pairs of what have been called lateral eye spots occurring in the middle of each segment.

The anterior pointed region immediately in front of the mouth is the prostomium or the 'snout which is conical in shape and highly sensitive to touch. This is a very muscular organ aiding the animal to burrow in the sand. On the dorsal side of the prostomium can be seen two or three small brown pigment spots underneath the body wall which represent the cephalic eyes of the animal.

The posterior end of the body after the region of the setigerous segments is prolonged into a long anal funnel bordered by 11 papillae and also a median jointed anal cirrus usually much longer than the papillae.

Nephridia are not visible from outside in spite of the translucent nature of the body wall; the nephridiopores are also not prominent. The nephridia may, however, be seen if the animal is slightly pressed between two slides and viewed under a binocular microscope. They appear as small greenish brown funnel-shaped structures inside the ventro-lateral folds from the 12th segment.

Internal Anatomy

Body wall and musculature: The cuticle of the snout is relatively thicker than on the rest of the body and measures about 5 micra. When examined by reflected light, the whole cuticle appears iridescent, caused by the presence of fine cross-hatched straiations on the surface. Underlying the cuticle is a single layer of hypodermal cells which do not show well defined cell walls. The nucleus is round with a darkly staining nucleolus. The hypodermis is thicker in the region of the head and the prostomium, measuring about 15 micra, and thinner in the rest of the body where it is only 10 micra high. Among the ordinary cells of the hypodermis are certain unicellular glands having an enlarged basal portion containing a nucleus and a narrow neck (Fig. 5). These glands are more numerous in the anterior region. The contents of these cells have a granular appearance and stain intensely dark with iron haematoxylin. Probably these glands secrete the mucoid substance which helps in keeping the surface of the body smooth for easy burrowing into the sand.

The circular muscle is present as a very thin layer only in the anterior portion of the snout and is considerably reduced or even absent in the middle and posterior regions of the body. These circular muscles on the snout along with the longitudinal muscles make it a rigid organ adapted for burrowing.

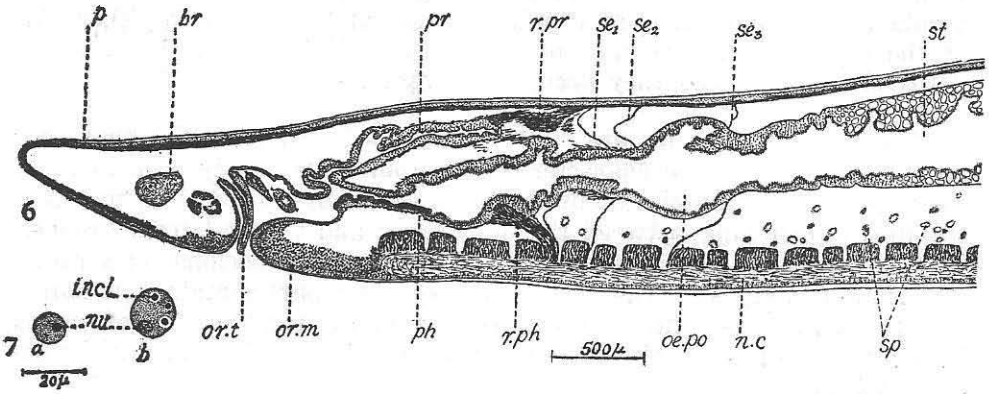
The longitudinal muscles are well developed throughout the entire length of the body except in the anal funnel where they are absent. In the prostomium the longitudinal muscles occur as a continuous sheet while at the region of the brain they get divided into four distinct bundles. Of these the dorsal pair is larger and each lies on either side of the dorsal arched portion of the body. The ventral bundles are relatively smaller and they occupy the ventro-lateral folds.

The oblique muscles are so well developed and powerful that they are responsible for the characteristic contour of the body seen in cross sections. These muscles occur in blocks or bands placed close together, the fibres stretching between the midventral and ventro-lateral grooves, forming almost a horizontal partition dividing the coelome apparently into three chambers. The dorsal more spacious part contains the dorsal longitudinal muscles and the alimentary canal and the two smaller spaces inside the ventro-lateral folds enclose the ventral longitudinal muscle bundles.

The oblique muscles present a series of interesting transitional changes in the different genera of the family. In *Travisia* these muscles are thin and are not very much different from those in other polychaetes. In *Polyophthalmus* these muscles are composed of a few fibres stretching obliquely between the midventral line and the sides of the body wall. In *Armandia* the oblique muscles are relatively shorter and stouter and their enormous development results in the formation of the three longitudinal grooves of the body. The next stage in the transition is seen in *Ophelia* in which the oblique muscles, which are wide apart in front, meet in the midventral line posteriorly, push up the nerve cord and pass upward and outward as a white sheet. A still further modification is undergone in *Ammotrypane* in which the oblique muscles seem to split into two divisions, the upper much modified one passes straight across the narrowed body wall from side to side, and separates the ventral lobe containing the ventral longitudinal muscles, whilst a short but powerful strip extends from the opposite edge of the ventral longitudinal muscles to the body wall at its inner border.

There is a pair of protractor muscles attached to the inner surface of each setal sac. The retractor muscle is attached to the base of the setal sac and the ventral body wall near the nerve cord. These two sets of muscles together control the movement of the setae.

The eversible anterior part of the alimentary canal is supplied with retractor muscles attached between the ventral body wall and the floor of the pharynx (Fig. 6, *r.pr*; *r.ph*). A series of powerful muscle fibres are attached to the lateral wall of the proboscis and the pharynx, and proceed to the body wall on either side (Figs. 9, 10 and 12, *r.ph*). The oral aperture is guarded by a ring of muscle fibres (Figs. 6 and 10, *or.m.*) forming a sphincter by the working of which the mouth is opened or closed.

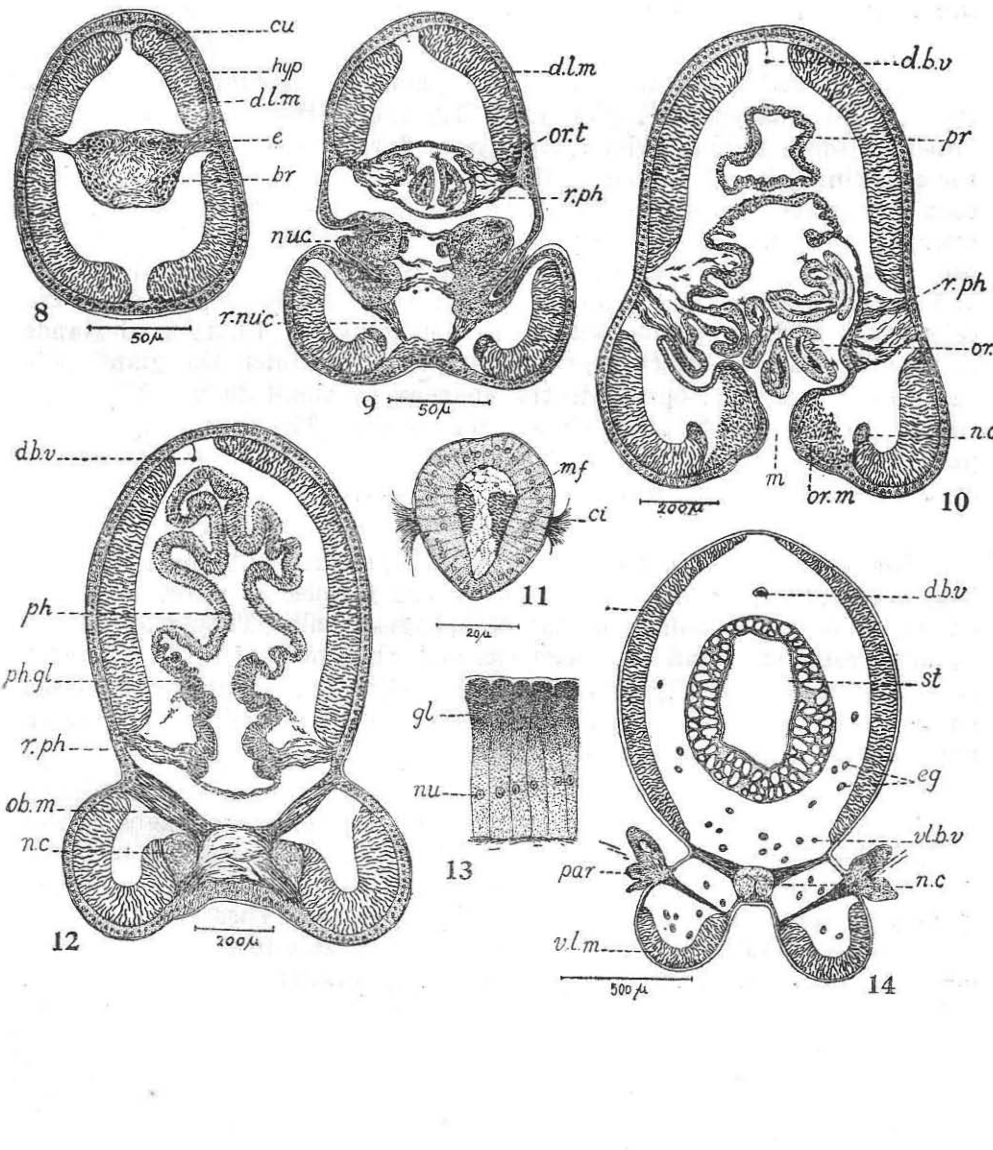


The ciliated nuchal organs which are also eversible have a set of well developed retractor muscles. These consist of about four separate bundles of which one is most prominent and is largely responsible for retracting the everted nuchal organs (Fig. 9, *r.nuc*). One end of this muscle is attached to the base of the organ and the other is anchored to the ventral body-wall on either side of the median line. The other three sets of fibres stretching between the two nuchal organs prevent their undue eversion.

Coelome: The body cavity is spacious and for the greater part it is a continuous chamber undivided by septa except in the anterior region where there are three septa at the ends of segments 2, 3 and 4. In a longitudinal section of the anterior region of the animal these septa are seen like thin vertical partitions of the coelomic cavity round the alimentary tract (Fig. 6, *se* 1, 2 and 3). The septa show no modification, unlike what is seen in certain other Opheliids. In *Ophelia cluthensis* Brown (1938) has observed that the septa which are only two and confined to the anterior region form a sort of conical caecum projecting backwards to the oesophagus, one septum being inside the other. Similar modified structures have been noticed in other Opheliids and on different occasions they have been described as a respiratory vesicle, a salivary gland, a fleshy heart, a digging organ, and an exertile funnel. However, Meyer (1882) has described the septa in *Polyophthalmus pictus* as normal structures. The presence of the peculiarly modified septa thus seems to be rather a special feature of the genus *Ophelia*.

Although it was described earlier that the oblique muscles by their enormous development tend to divide the coelome into three regions, these three sections communicate with each other by spaces between the muscle bands. The coelomic fluid therefore flows freely into the various regions of the body cavity. It is almost colourless and contains corpuscles which may be distinguished into two types by their relative size and inclusions (Fig. 7 *a* and *b*). Both are round discoid cells. The majority of these measure about 10 micra in diameter with an almost clear cytoplasm. The other type which are fewer in number are slightly larger with an average diameter of 15 micra. Their cytoplasm is granular and the cells are often characterised by the presence of two or three small spherical inclusions of light yellowish brown colour and which stain deep with borax carmine.

Alimentary canal: The mouth is situated on the ventral side of the anterior region immediately in front of the origin of the median ventral



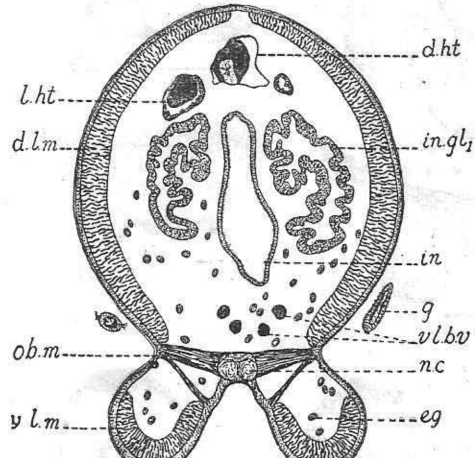
groove. In the living animal the 10 or 11 oral tentacles are intermittently protruded and retracted. Each of these oral tentacles has two longitudinal rows of cilia seen in a transverse section (Fig. 11, *ci*). Situated below these ciliary rows and beneath the hypodermis are two longitudinal bundles of muscle fibres. When the tentacles are protruded the cilia work vigorously in all the tentacles to produce a current of water near the mouth. There is also a small proboscis which is but a sacular outpushing of the roof of the mouth as can be seen in a longitudinal section in figure 6 (*pr*). In the everted condition this proboscis is not so very prominent as in most other Opheliids where it has been described as a button-shaped structure projecting from the mouth. The wall of the proboscis is made up of a layer of epithelium without any gland cells. It is also provided with a covering of muscle fibres rendering it elastic.

The mouth leads to a muscular pharynx. A transverse section through the pharyngeal region (Fig. 12) shows that the wall is composed of three regions which could be differentiated by the nature of the cells lining it. The floor of the pharynx is composed of low cuboidal cells and consequently this region is very thin. Laterally the cells are columnar and in sections appear as a darkly staining zone (Fig. 13, *ph. gl*). The cells show a glandular structure with a round basal nucleus and the cell contents are granular especially near the distal ends of the cells which stain deep blue with iron haematoxylin. Pharyngeal glands have been observed in *Polyophthalmus pictus* in which the gland cells occur in clusters and open into the pharynx by small ducts. The function of these glands in *Armandia* is not known. The dorsal half of the pharyngeal wall is thrown into a number of folds and is composed mostly of ciliated cells with clear cytoplasmic contents.

The pharynx is continued as the oesophagus. At about the 3rd body-segment a pair of lateral pouches are formed as a result of the enlargement or outpushing of the oesophageal wall. They may not be equally prominent in all the specimens and when present serve only as a receptacle in temporarily retaining food particles before they are passed on to the stomach. The cells of the oesophageal epithelium are ciliated and possess a centrally situated nucleus.

The anterior end of the stomach following the oesophagus shows complicated folds in the stomachal wall and is comparatively narrow. Beyond this region the stomach enlarges and has a thick wall composed of two or three layers of large cells (Fig. 14, *st*). These cells contain some yellowish substance and seem to be comparable to the chloragogenous cells described in *Arenicola* by Ashworth (1904).

The stomach leads to the intenstine at about the 8th segment without any constriction at the transition. A pair of digestive glands open directly into the anterior region of the intestine. Each gland is a conspicuous tubular structure measuring 1.2 - 2.0 mm. placed on either side of the intestine (Fig. 15 *in* gl_1.) and extending over two segments with their blind ends directed anteriorly. Transverse sections of the gland in relation to the alimentary canal at successive stages are shown in figure 16 *a*, *b* and *c*. where the opening of the glands on the ventral



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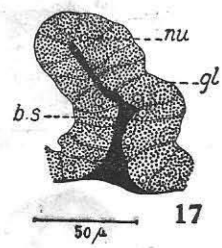

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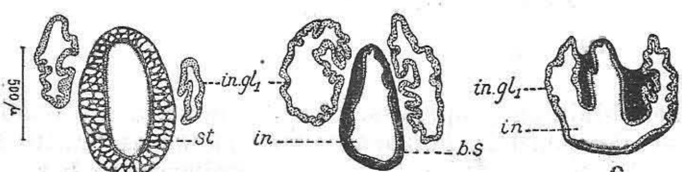
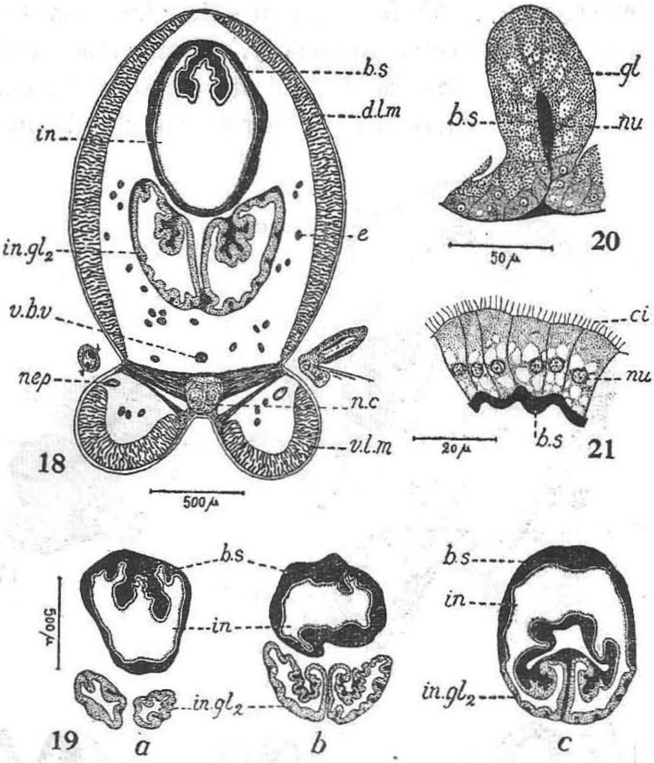


16 *a* *b* c

side of the intestine may be seen. The gland cells contain large granules most of which stain deeply with iron haematoxylin or acid fuchsin and are acidophilic while the others stain with aniline blue (Fig. 17). Posterior to these glands is another more or less similar pair of glands opening into the intestine but these are disposed more ventrally. The two glands (Fig. 18, *in.* gl_2) are seen in sections to lie closely pressed against each other on the ventral side of the intestine. Each has a tubular structure, the blind end of which is also directed anteriorly, with a central lumen and a thick wall often in a series of parallel folds. The lumen of each gland communicates with the intestine by means of a narrow opening on the ventral side (Fig. 19, *a*, *b* and *c*). The cells are large and contain a number of secretory granules as in the first pair of glands and these granules also do not show much differ-



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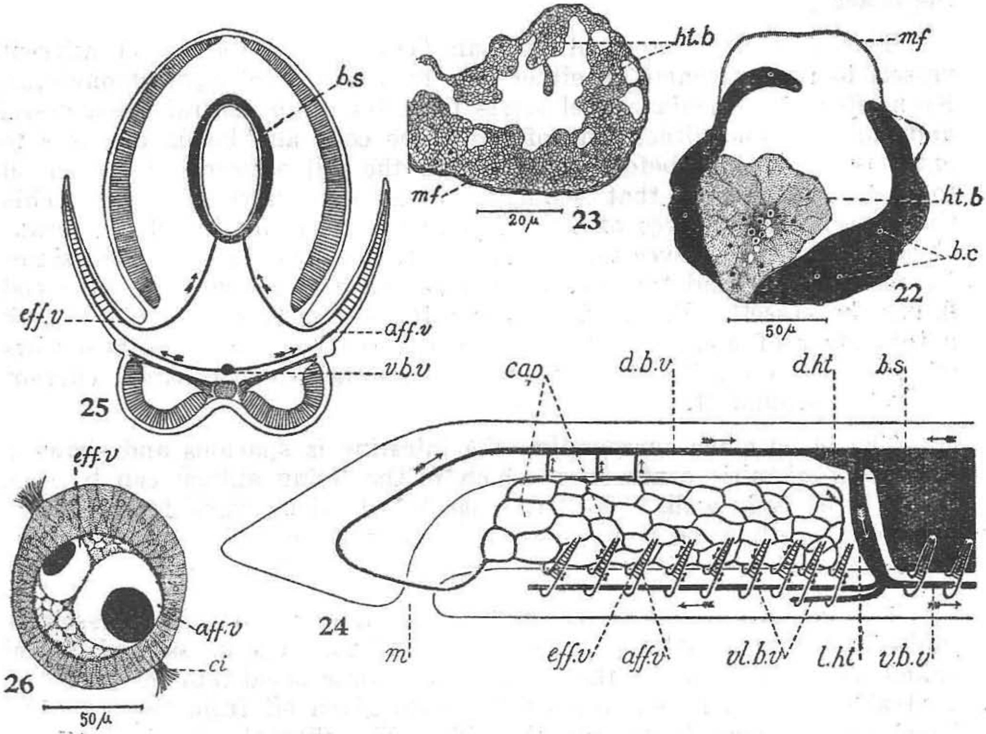
ence in their staining properties. These glands are probably comparable to those described in *Polyophthalmus pictus* as "Mittledarmdrüsen" (Meyer, 1882) on account of their close similarity in both position and structure. Brown (1938) does not describe the occurrence of any such intestinal glands in *Ophelia cluthensis*.

The wall of the intestine is composed of short ciliary cells (Fig. 21). In the initial region of the intestine there are usually one or two longitudinal folds, more or less like a typhlosole, either ventral or dorsal in position in the different specimens. The blood sinus surrounding the intestine also extends into these folds. The intestine is a straight tube and passes on to the anus without any structural change. Surrounding the anus is a long anal funnel which is a double-walled tube with a few transverse membraneous partitions between them. The posterior rim of the funnel is fringed with 10-11 anal papillae and a ventral median, long, anal cirrus.

Circulatory system: The heart is represented by a thin-walled expansion of the dorsal blood vessel at about the junction of the stomach and the intestine. In the living animal the heart is in a regular state of contraction and expansion and during systole it can hardly be distinguished from the dorsal vessel. The cardiac wall is supplied by a number of slender muscle fibres. Inside the heart and attached to its ventral wall is a core of tissue composed of large cells, some of which show small vacuoles in them. The cell walls are not very distinct whereas the nuclei stain well (Fig. 22, *ht.b*). Similarly, the heart gives off



two large lateral contractile vessels from its anterior end, often regarded as paired lateral hearts or lateral chambers of the heart, which also contain a loose spongy mass of cells extending into their cavity (Fig. 23). These structures found within the heart might correspond to the heart-body described in certain Opheliids and other families of polychaetes. The recent discussion by Kennedy and Dales (1958) on the function of heart-body in polychaetes reveals that it has a "haematopoieic" function.

The two lateral contractile vessels curve round the alimentary canal on either side and meet ventrally from where arise two pairs of anterior ventro-lateral vessels and a single, unpaired median vessel posteriorly. One pair of these anterior ventro-lateral vessels gives off branches to the gills of the 10th and 9th segments while the other pair is situated just above the oblique muscles and sends afferent branches to the branchiae of the rest of anterior segments. The efferent vessels from all these ten anterior gills break up into capillaries around the proboscis, pharynx and oesophagus. The blood is collected by three pairs of vessels closely adhering to the septa and opening into the dorsal blood vessel. In addition to these, there is a pair of vessels collecting blood from the region of the snout which also joins the dorsal blood vessel at its anterior end. Besides, the dorsal blood vessel also receives smaller paired vessels from the pharyngeal region and the body wall before it enters the heart.

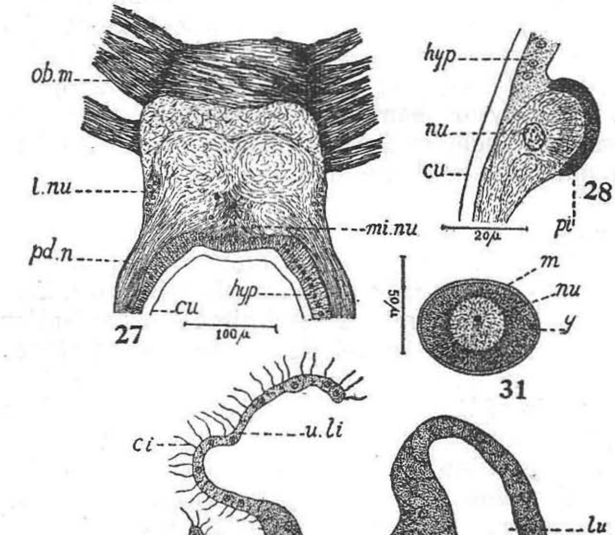
The posterior unpaired median ventral vessel gives off afferent vessels to the branchiae on either side from the 12th segment onwards. Each afferent branchial vessel starts from the main ventral blood vessel and curves round either side of the nerve cord and bends upwards to enter the gill. But before passing into the gill a branch is given off to the nephridium of that segment. Along the length of the branchia the efferent vessel gives off fine transverse vessels to the efferent branchial vessel which leaves the gill and enters the perivisceral blood sinus. In the living animal the gills appear red in colour owing to the blood filling the vessels. Figure 26 shows a transverse section of a gill with a thin layer of muscle fibres just beneath the epidermis and two rows of long cilia along its length to help in maintaining a constant current of water around it.

The blood sinus surrounding the intestine is spacious and shows a forward peristaltic contraction which in the living animal can be seen through the body wall. The blood has a red colour when fresh, due to haemoglobin dissolved in the plasma as in other Opheliids, and also contains a small number of round or slightly ovoid corpuscles.

The general course of circulation through the principal vessels is indicated diagrammatically in figures 24 and 25. The dorsal and lateral chambers of the heart by their contraction force blood into the posterior ventral vessels. Afferent branchial vessels given off from these ventral blood vessels carry blood into the gills. The efferent branchial vessels from the gills of the region in front of the heart break up into capillaries around the pharynx and the oesophagus and those of the posterior region enter the intestinal blood sinus. Small vessels from the prostomium and three principal vessels from around the pharynx collect blood and return it to the dorsal chamber of the heart by means of the dorsal blood vessel. On its way the dorsal blood vessel receives smaller vessels from the body wall and the alimentary canal. The blood from the posterior region is pumped back into the heart by the forward contraction of the perivisceral blood sinus.

Nervous system: The brain is situated in the prostomium and is composed of two cerebral ganglia fused to form the brain mass placed a little in front of the nuchal organs. It gives off anteriorly a pair of nerves to the tip of the snout. From either side of the brain arises a stout nerve entering the body wall just anterior to the nuchal organs. Pruvot (1885) and Brown (1938) consider these nerves as actual prolongations of the brain itself. A transverse section of the brain shows roughly a trapezoid shape (Fig. 8). The histology of the brain and the nervous system in Opheliids has been described earlier by Kukenthal (1887). In the brain mass two groups of ganglionic cells are seen, each in the dorso-lateral corner. Eyes occur as small pigment cups sunk in the tissue of the brain. Proceeding from the posterior end of the brain are a pair of nerves supplying the nuchal organs.

The circumpharyngeal connectives start from the ventral side of the brain, curve round the pharynx in a postero-ventral direction and meet ventrally at about the level of the second segment. At the point of fusion of the connectives is a slight enlargement representing a small sub-pharyngeal ganglion. The ventral nerve cord begins from the 2nd



segment and shows two main longitudinal nerve bundles with intermittent groups of ganglionic cells along its length. There is usually a central group and two lateral groups of nuclei (Fig. 27, *l. nu; mi. nu*).

Podial nerves (*pd. n*) and also slender branches to the body wall are given off in each segment.

Sense organs: The principal sense organs are the prostomium, the nuchal organs and the eyes. The hypodermis of the prostomium is highly sensitive and is supplied with a pair of nerves from the anterior region of the brain. The prostomium thus serves also as a tactile organ in addition to its burrowing function. At the place where the nerves enter the body wall the hypodermal cells are tall and columnar but do not show any definite modification into what may be called a sense organ. However, the nerve supply might indicate a kind of sensory function for these cells. The paired ciliated nuchal organs are situated on the dorso-lateral region of the head and are eversible in the living animal. These organs are innervated directly by a pair of nerves from the posterior part of the brain. Each is a cup-like structure lined by columnar cells having cilia (Fig. 9) which work vigorously when the nuchal organ is everted. In *Polyophthalmus pictus* Meyer (1882) has described a "Becherformiges organ" or the cupiliferous organ in a coresponding position on the prostomium. The function of the nuchal organ has not so far been properly established. These were considered by some early workers as organs for producing a current of water to help the animal in feeding. While their position and nerve supply strongly suggest either on olfactory or chemoreceptor function, their eversible nature may be explained as a device for getting rid of any particle that might get into them during burrowing into the sand.

Cephalic eyes, two or sometimes three in number, are submerged in the tissue of the brain as in other members of the family and in section each appears as a simple pigment cup with no differentiation into retinal cells. With their small size and simple organisation they are in no way comparable to the more well developed eyes of other errant forms (Tampi, 1947), but are more like those seen in some of the larval forms. The burrowing mode of life of these polychaetes may be largely responsible for such poorly developed eyes. In addition to these cephalic eyes there are a few paired lateral eye spots occurring on either side of the body from the 7th segment which appear as small dark brown pigment spots of about 36 micra in diameter. Each eye spot in section (Fig. 28) shows a structure almost similar to that of the cephalic eyes composed of a pigment cup enclosing a large central nucleus and innervated by a branch from the ventral nerve cord.

Nephridia: Nephridia occur from the 12th segment and are present in all except the last 4 or 5 segments. Each nephridium is divisible into three regions, an inner funnel, a short excretory zone and a slightly looped conducting tube opening to the outside by means of a nephridiopore. The funnel is provided with a hood-like lip and is composed of ciliated cells. The excretory part of the nephridium is usually greenish brown in colour owing to the presence of green and yellowish brown excretory granules in the cells (Fig. 30). Cilia are absent in this region.

The terminal conducting portion has relatively clear cells with cilia which work actively in a direction away from the nephrostome and towards the nephridiopore. There is no external prominence of the nephridial opening unlike in *Ophelia cluthensis* where the nephridiopore is situated on papillae. The lumen of the nephridia is so narrow especially in the terminal part that it is difficult to consider these functioning as ducts for conveying the genital products, particularly the comparatively large ova, to the outside. Blood supply to the segmental organs is by means of branches from the afferent branchial vessels. This small nephridial vessel lies along the length of the nephridium up to about its middle and ends blindly. The presence of such blindly ending vessels round the segmental organs in Opheliids and other polychaetes has been noticed by Schaeppi (1894) and Ewer (1941). Surrounding the nephridial vessels are a group of cells whose function is not known except in certain similar instances where they are believed to be excretory in function.

It may be seen from the above description that the segmental organs in *Armandia* conform to the metanephridial type. The nephridial funnel is narrow and is only the enlarged inner end of the nephridial tube. The cells of the funnel also have more or less the same structure as that of the rest of the nephridium forming a nephrostome with no indication of a true coelomostome. Although Brown (1938) does not mention the exact nature of the nephridia in *Ophelia cluthensis* his description seems to indicate that it is also of the metanephridial type. However, Goodrich (1900 and 1945) has mentioned Opheliids as possessing a nephromyxia and a more critical study of the development of the nephridia in *Armandia* and other Opheliids seem to be necessary to ascertain their true nature.

Reproductive elements: The coelomic oocytes are pale green, discoid, oval bodies with an average size of 65 $\times$ 35 micra. Each oocyte is surrounded by a membrane and has a large centrally placed nucleus (Fig. 31) with a darkly staining nucleolus. Small yolk granules are densely aggregated around the nucleus. The size of these oocytes compare with those in *Thoracophelia* (Dales, 1952) but are much smaller than in *Ophelia* described by Brown (1938).

Spermatozoa arise inside the body cavity of the males from "sperm plates" as in other polychaetes and until they are mature float in the coelomic fluid in small masses each consisting of a large number of spermatozoa attached by their heads to a hollow sphere of protoplasm. The ripe spermatozoon contains a large nucleus and a long vibratile tail.

Sexes are separate in the species as in other Opheliids. It seems probable that the reproductive elements escape by the rupture of the body wall and not by way of the nephridia for reasons already explained although no actual observation has been made. Benham (1901) believes that the eggs in Opheliids are laid in a jelly. There are very few records of observations on the actual spawning in these worms. Fauvel (1927) and Wilson (1948 a) have pointed out that *Polyophthalmus pictus* becomes pelagic at night during its sexual phase although recently Tampi (1958) has observed that even juveniles of this species sometimes exhibit this swarming tendency. McGuire (1935) in his original notes on *Ophelia cluthensis* from the Millport area mentions the species as having two broods in the year—in April and in September, while in *Thoracophelia mucronata* along the California coast Dales (1952) mentions a prolonged breeding period for the species throughout the summer. The only observation on *Armandia* is that most of the worms collected in February-March were sexually mature or nearly so indicating their maturity during this period of the year.

Summary

The anatomy of the common Opheliid polychaete *Armandia leptocirris* occuring in the intertidal areas in Krusadai Island in the Gulf of Mannar is described pointing out the salient comparative anatomical features with those of other known Opheliids.

The coelomic cavity is a continuous space excepting for three septa in the anterior region. The oblique muscles have attained remarkable development in the species and these together with the four longitudinal muscle bands help the animal in its swift movements in the sandy habitat. Two pairs of conspicuous digestive glands open into the intestine. Both the vascular system and the nervous system are of the true anneliden type. A heart-body has been observed in the species. Excretory organs of the metanephridial type occur from the 12th segment. The species is dioecious.

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Key to Lettering

a. c.	anal cirrus	*mv. gr.*	midventral groove
a. f.	anal funnel	*n. c.*	nerve cord
a. p.	anal papilla	*nep.*	nephridium
aff. v.	afferent branchial vessel	*nep. v.*	nephridial blood vessel
b. c.	blood corpuscle	*nu.*	nucleus
b. s.	blood sinus	*nuc.*	nuchal organ
br.	brain	*ob. m.*	oblique muscle
cap.	capillaries	*oe.*	oesophagus
ci.	cilia	*oe. po.*	oesophageal pouch
coe.	coelome	*or. m.*	oral muscle
cu.	cuticle	*or. t.*	oral tentacle
d. b. v.	dorsal blood vessel	*p.*	prostomium
d. l. m.	dorsal longitudinal muscle	*parl.*	first parapodium

d. h. t.	dorsal chamber of the heart	*pd. n.*	podial nerve
e.	eye	*ph.*	pharynx
eff. v.	efferent branchial vessel	*ph. gl.*	pharyngeal glands
eg.	oöcyte	*pi.*	pigment
g.	gill	*pr.*	proboscis
gl.	gland cell	*r. nuc.*	retractor muscle of the nuchal organ
ht. b.	heart-body		
hyp.	hypodermis	*r. ph.*	retractor of the pharynx
in.	intestine	*r. pr.*	retractor of the proboscis
$in.\ gl_1$, $in.\ gl_2$	first and second pair of intestinal glands	*se1, se2 & se3*	septa
incl.	inclusions	*sp.*	spermatogonium
l. ht.	lateral heart	*st.*	stomach
l. nu.	lateral nuclear group	*u. li.*	upper lip of nephridium
lo. li.	lower lip of the nephridium	*v. b. v.*	ventral blood vessel
lu.	lumen of the nephridium	*v. l. m.*	ventral longtitudinal muscles
m.	mouth	*vl. gr.*	ventro-lateral groove
me.	membrane	*vl. b. v.*	ventro-lateral blood vessel
mf.	muscle fibres	*y.*	yolk
mi. nu.	middle nuclear group		