

EARTHWORM (*Pheretima posthuma*): A Type Study

The earthworms are long cylindrical worms of brownish colour which live in burrows in moist earth particularly that contains decaying vegetation or humus. They are also common in agricultural fields where they increase the productivity of crops. The life span of earthworm is 3-10 years.

An adult worm measures about 15-30 cm in length and is dark brown in colour due to the presence of a pigment porphyrin in its skin. The body is made of 100 to 120 segments, of which the first segment is divided into an anterior **prostomium** and posterior ring-like **peristomium**. Segments 14-16 form a girdle-like thick band of glandular tissue called **clitellum** that secretes mucus, albumen and cocoon inside which eggs are laid. All segments of body except the first, last and clitellum have chitinous setae embedded in each segment. The setae are used in anchoring and in locomotion. Genital papillae are two pairs of protuberances on segments 17 and 19 on ventral surface. Each papilla bears a shallow cup-like depression on top which functions as sucker during copulation. On 18th segment there is one pair of male genital openings on the ventral side.

COELOM & HYDRAULIC SKELETON

The body of earthworm is partitioned by transverse septa which are formed by double layers of peritoneum and bundles of muscle fibres. The septa are both perforated and non-perforated type. Septa are lacking in the first four segments and the coelom is continuous. There are transverse and oblique septa anterior to clitellum while in the posterior region all septa are porous. The coelomic compartments are filled with coelomic fluid which is milky in colour and consists of plasma and four types of nucleated corpuscles, namely, phagocytes, nucleated cells, mucocytes and chloragogen cells. When the worm burrows in soil, its posterior muscles contract, forcing the coelomic fluid towards the anterior end. The hydraulic force of the fluid transforms transverse septa into oblique and oblique septa into transverse type. This makes the anterior four segments

very hard for burrowing into the soil. Earthworm does not have hard skeletal parts but hydraulic force creates hard skeleton-like anterior end.

The locomotion is brought about by an increase in the hydrostatic pressure of the anterior ten segments of the body and at the same time contraction of circular muscles begins at the anterior end and the wave passes backwards, resulting the anterior region to extend forward. The anterior end grips the substratum and setae act as anchors on the soil. Then the circular muscles relax and longitudinal muscles of the anterior segments contract in a wave beginning from the anterior end, which shortens the anterior end and causes the posterior part of body to pull forward. Again a wave of contraction of circular muscles starts from the anterior end and reaches the posterior end. Alternate contractions of circular and longitudinal muscles causes wave of thickening to pass backward. The coelomic fluid serves as hydraulic skeleton and setae cause the body to anchor firmly in soil.

DIGESTIVE SYSTEM

Earthworm feeds upon organic matter found in soil by eversion of the buccal cavity that helps in ingesting the food along with soil through the mouth by sucking force of pharynx.

The alimentary canal is a straight tube. Mouth opens into buccal cavity that leads into pharynx in segments 3 and 4, followed by oesophagus that leads to a thick-walled, muscular gizzard in which food is ground by muscular contractions. The salivary glands secrete mucin which lubricates food and protease which digests proteins. The stomach lies in segments 9-14. The wall of the stomach carries calciferous glands that neutralize humic acid. The intestine is wide tube and is divided into pretyphlosolar region in segments 15-26 and post-typhlosolar region after segment 26. The role of the typhlosole is to increase the surface of absorption. Intestinal caeca in segment 26 carry digestive glands which secrete digestive enzymes. The glandular cells of intestine secrete pepsin, trypsin, amylase, lipase and cellulase. Undigested food and soil are eliminated through anus to the outside in the form of castings.

RESPIRATORY SYSTEM

Respiratory organs are lacking and gaseous exchange takes place through the skin which is richly supplied with blood vessels and has to be kept moist by excretion of coelomic fluid through the dorsal pores. Carbon dioxide also diffuses from blood to the skin from where it is eliminated.

BLOOD VASCULAR SYSTEM

The blood vascular system is closed type. Blood contains haemoglobin dissolved in plasma. There are many types of corpuscles which are colourless and nucleated. There are two longitudinal blood vessels, the dorsal and the ventral running on the dorsal and ventral sides of the gut. Another longitudinal vessel, the subneural vessel, runs longitudinally below the nerve cord and splits into two, the two branches running on the lateral side of the stomach, oesophagus and pharynx. The dorsal and ventral vessels are connected to each other in segments 7, 9, 12 and 13 by means of paired pulsatile hearts. The hearts in 12th and 13th segments are called lateral oesophageal hearts while the anterior pairs in the 7th and 9th segments are called lateral hearts. There are also two pairs of non-pulsatile loops in segments 10 and 11, which connect the supra-oesophageal vessel to the lateral oesophageal vessels.

Embedded in the pharyngeal nephridial mass in segment 4-6 there exist blood glands which manufacture blood corpuscles and haemoglobin.

Blood collected by the dorsal vessel through the intestinal vessels and commissural vessels is distributed to the anterior part of the gut and through the hearts to the ventral vessel. In the ventral vessel the blood flows backward and is distributed to the body wall and to the organs in coelom, and through the ventral intestinal vessels to the alimentary canal.

The subneural vessel receives blood via the lateral-oesophageal vessel from the anterior region and supplies it to the dorsal vessel through the commissural vessels. The lateral oesophageal vessels also send blood through the anterior loops to the supra-oesophageal vessel, which then passes it through the lateral oesophageal hearts to the ventral vessel.

EXCRETORY SYSTEM

Nephridia are the excretory organs of earthworm, which are of three types, namely, septal, integumentary and pharyngeal.

Septal Nephridia

A typical septal nephridium consists of Nephrostome or ciliated funnel that drains coelom. Body of nephridium consists of a short straight lobe and a long twisted lobe with a narrow apical part. Lobes are made of syncytial mass, inside which run coiled ciliated tubules that end up in a narrow terminal excretory duct that opens into the segmental excretory canal and eventually into the intestine.

Integumentary Nephridia

These nephridia lie scattered in the body wall of each segment, except the first two. There are 200-250 nephridia in each segment but on clitellum their number increases to 2000-2500 per segment which is called the forest of nephridia. These nephridia lack nephrostomes and their terminal ducts open on body surface.

Pharyngeal Nephridia

These nephridia are located on either side of pharynx and oesophagus in segments 4-6. Each nephridium consists of hundreds of coiled branched tubules that lack nephrostomes. The nephridial ducts of 4th and 5th segments open into pharynx, while those of 6th segment open into buccal cavity. Ammonia and urea are the excretory products.

NERVOUS SYSTEM

The nervous system of earthworm is well developed and consists of a pair of cerebral ganglia forming the brain situated in the third segment above the pharynx. Circum-pharyngeal connectives encircle the pharynx and meet with a pair of subpharyngeal ganglia below the pharynx. The ventral nerve cord runs from the subpharyngeal ganglia

to the last segment of the body in the middle on the ventral side. In each segment there is one fused paired ganglion called segmental ganglion, from which arise 3 pairs of peripheral nerves. It includes the nerve plexuses situated in the wall of the alimentary canal and some other internal segment.

SENSE ORGANS

The sense organs or receptors of earthworm are as follows:

- **Epidermal receptors:** These receptors are scattered all over the epidermis making the skin sensitive to touch. The receptors are groups of long sensory tactile cells surrounded by supporting cells.
- **Photoreceptors:** Photoreceptors are solitary cells embedded in the epidermis which contain a crystalline structure in the cytoplasm and a nerve connection at the base. They are distributed on the anterior side of body.
- **Buccal receptors:** They are also bunches of sensory cells found in the buccal cavity that perceive chemical stimuli and help in smelling and tasting food.

REPRODUCTIVE SYSTEM

The earthworms are monoecious or hermaphrodite but protandrous, i.e. their testes mature earlier than ovaries to avoid self fertilization.

Male reproductive organs

There are two pairs of whitish testes in segments 10 and 11 which are enclosed in thin-walled coelomic spaces called testis sacs. Spermiductal funnels are attached to each testis sac that continues with the vas deferens that eventually lead to prostate gland of its side on 18th segment. One seminal vesicle is also attached to each testis sac in which maturation of sperms takes place. They lie in segment 11 and 12.

Prostate glands that extend from 16th to 21st segment are made of glandular and non-glandular parts. Ducts of prostate glands open to the exterior independently by a pair of male genital pores on the ventral side of the 18th segment.

On segments 17 and 19 is a pair of accessory glands which open to the exterior by a number of ducts on two pairs of genital papillae. Their secretion helps in holding the two worms together during copulation.

Female reproductive organs

A pair of small white ovaries lies in 13th segment on either side of ventral nerve cord. Each ovary is whitish made of finger like lobules in which ova are arranged in various stages of development. An oviductal funnel lies immediately behind each ovary in 13th segment and it leads behind into a short oviduct. The two oviducts run backwards and open to the exterior by the female genital aperture.

Spermathecae

There are 4 pairs of small pear shaped bilobed spermathecae which receive sperms from another worm during copulation and store them in their diverticula in *Pheretima* and in ampullae in other earthworms.

Copulation

July to October is the breeding season of earthworms. During copulation two earthworms come to lie close together with their anterior ends pointing in opposite directions. In this position the male genital apertures of each worm lie opposite to the spermathecal openings of the other and genital papillae help the worm to hold each other in this position. Mutual exchange of sperms takes place between the two copulating worms. Copulation lasts for about an hour after which the worms separate.

Cocoon formation

The cocoon secreting glands located on 14-16th segments secrete a girdle like cocoon around the clitellum, inside which ova are released. Albumen glands release albumen into the cocoon. Then the worm starts withdrawing itself from the girdle. As the cocoon passes over the spermathecae sperms are released through spermathecal pores and ova are fertilized to form zygotes. As the cocoon is released from the anterior end of body, the elasticity of its walls closes its two ends and the cocoon is deposited in a moist and protected place.

A cocoon contains many fertilized eggs but only one embryo completes development while other ova serve as nurse cells. The development is direct without free larval stage. After development of 2-3 weeks the young worm crawls out of the cocoon.