

MORPHOLOGY AND ANATOMY OF LEECH (JALAUKA) - A CRITICAL REVIEWShivanand Fulaji Kawane^{1*} and Swapnil Shivprasad Agrawal²¹Associate Professor in Dept of Shalyatantra At Ramrao Patil Ayurved College, Purna. Dist- Parbhani.²HOD & Associate Professor in Dept. of Striroga and Prasutitantra At Ramrao Patil Ayurved College, Purna. Dist- Parbhani.***Corresponding Author: Dr. Shivanand Fulaji Kawane**

Associate Professor in Dept of Shalyatantra At Ramrao Patil Ayurved College, Purna. Dist- Parbhani.

Article Received on 16/05/2023

Article Revised on 06/06/2023

Article Accepted on 26/06/2023

INTRODUCTION

All major Indian texts contains elaborate description about Leech and Leech therapy, about their morphology, method of collection, their food, preservation, aftercare, therapeutic uses, undesired effects, Indications and Contraindications, quality of good and bad leech. Leech therapy is always one of the important tools in Indian system of medicine.

Leeches were used in many countries and regions globally, as evident from the vast literature available. From the painting on an Egyptian Tomb of around 1500 BC we get the earliest and clearly documented records for the use of leech in medicinal purpose. During 17th and 18th century AD in Europe journey of leech reached its crowing point while as during the Arab era the leeches were used only for the bloodletting. Leech therapy was revived in 1970's with the limited use to the microsurgeries to relieve venous congestions. During the 21st century there were certain studies when the leeches were tried in certain ailments like arthritis and also permission for sale and use of leeches in USA is given by the Food and Drug Authority of USA (FDA) but limited its use in microsurgeries and plastic surgeries only. They are usually found in abundance in warm and temperate areas in the world. Reference of leeches is found in proverbs mentioned in Bible. It is mentioned as a warning in Talmund that drinking water from river pools should be avoided for there is most dangerous leech known as *Limnatis linotica*, about 10 mm in length.

There are more than 700 species identified at global level up to 2018. Out of them *Hirudo Medicinalis*, *Hirudo Nipponia*, *Hirudo troctina*, *Hirudo Quinquestrata*, *Hirudinaria Javanica*, *H. Manillensis*, *Poecilobdella Granulosa*, *Macrobodella Decora*, *Hirudo Verbena* and *Haementeria Officinalis* are most commonly used in clinical practice.

Interestingly, the *Hirudininae* family of leeches also contains 12 known species within six genera named as *Dinobdella*, *Hirudinaria*, *Hirudo*, *Limnatis*, *Myxobdella* and *Whitmania* [Moore 1927], which are found in temperate and tropical Asia, Africa and Caribbean islands. *Hirudininae* is one of the two sub-families of

Hirudinidae family, the second one is *Haemidipsinae*. *Hirudininae* are also known as Buffalo leeches. Extensive work has been done by various scientists in relation to taxonomy of leeches in India. Mahesh Chandra compiled a record of 52 species and 8 subspecies belonging to 25 genera and 5 families available in India, in a paper titled- A checklist of leeches which is found in records of Zoological Survey of India, 1983. Mandal and Mishra in 2017 have mentioned that 70 leech species have been recorded from India under 25 genera and 6 families. Overall 700 plus species are found globally, distributed in 91 genera and 7 families. *Americobdellidae* is endemic to America only. The families found in India are- *Piscicolidae*, *Glossiphoniidae*, *Erpobdellidae*, *Hirudidae*, *Haemadipsidae* and *Ozobranchidae*.

Conceptual review**Morphology of leech**

Presently genus *Hirudineria* group of phylum *Annelida* are nearer to ancient leeches. They live in ponds, lakes, tanks, swamps, sluggish stream and swim freely. They can attach on frogs, fishes, cattle etc. by their suckers and feed on their blood. They are sanguivorous.

Hirudinaria: External characters**Morphology of leech**

1. Shape and Size: It is soft, vermiform, Elongated and Dorsi-ventrally flattened worm, about 10 to 15cm long. Posterior end of body is broad as compare to anterior end which is narrow. The dorsal surface is somewhat convex and the ventral surface is more or less flat.

2. **Colouration:** Body is brightly coloured with dorsal surface is olive-green and the ventral surface is orange-yellow. Distinct stripes are seen on the body.
3. **Segmentation of the body:** The body is divided into 33 segments. Externally it is divided into more segments which are called annuli. There are 109 annuli in a leech. The number of annuli varies in different segments.
4. **Suckers:** Body bears 2 suckers. The anterior sucker or oral sucker includes mouth which is oval and ventrally-directed and formed by the first 3 segments. Posterior or anal sucker present at posterior end is circular and highly muscular is formed by fusion of seven body segments and meant for attachment and Locomotion.
5. **Regions of the body:** The entire body is divided into 6 regions.
 - Cephalic region
 - Pre-clitellar region.
 - Clitellar region
 - Middle region
 - Caudal region
 - Posterior region.

- 1) **Cephalic region:** It contains first five segments called ocular segments. In this region prostomium, anterior sucker, mouth and eyes are present.
 - a. First segments contain-one annulus.
 - b. 3rd segment contains 2 annuli.
 - c. 4 and 5th segments contain 3 annuli each.
2. **Preclitellar region:** It consists of 6th, 7th and 8th segments. The 6th segment has 3 annuli while 7th and 8th segments have 5 annuli each. They show nephridiopores.
3. **Clitellar region:** It consists of 9th, 10th and 11th segments. On the ventral surface of 10th segment in the middle line a male genital opening is present while of 11th segment female genital opening is present. During breeding season, a temporary clitellum is formed. Each segment has 5 annuli.
4. **Middle region:** It consists of 12 to 26 segments all show 5 annuli and pairs of nephridiopores.
5. **Caudal region:** It contains 23 to 26 segments and the 23rd segment has three annuli while segments 24, 25 and 26 have two annuli each. On dorsal surface of 26th segment anus is present.
6. **Posterior region:** This consists of last 7 single annular segments which unite to form posterior region.

External apertures

1. **Mouth:** Mouth is a triradiate aperture present in the anterior sucker.
2. **Nephridiopores:** 17 pairs of nephridiopores are present. One pair lies ventrally on the last annulus of each segment from 6 to 22 segments.

3. **Male genital opening:** Male genital aperture is a mid-ventral opening in between second and third annuli of 10th segment.
4. **Female genital opening:** Female genital opening lies mid-ventrally in between second and third annuli of 11th segment.
5. **Anus:** Anus is a small opening present mid-dorsally on the 26th segment at the base of posterior sucker.

Body wall of most medicinal leech has a granular appearance punctuated by numerous small pores when investigated at high microscope with scanning electron microscope. The discshaped sensory sensilla are easily distinguished from the surrounding body wall by the absence of pores and the presence of numerous filiform projections in the central region of each sensillum. Two types of projections can be distinguished: single, 3-9 μm long "S-hairs" and grouped (i.e., composed of several subunits), 1-2 μm long "G-hairs." Each sensillum supports 40-90 S-hairs and 15-20 G-hairs. The S-hairs may be the sensory structures mediating leech sensitivity to low amplitude water movements.

Body wall has 5 layers

1. Cuticle
 2. Epidermis
 3. Dermis
 4. Muscle layer
 5. Botryoidal tissue
1. **Cuticle:** Outermost temporary layer secreted by underlying epidermis which shed off time to time especially after having heavy meals or in dirty water and then renewed. It is thin transparent elastic protective covering.
 2. **Epidermis:** Single layer of columnar hammer shaped cells with broader outer ends and narrow inner. This layer is vascular and has respiratory membrane. Modified epidermal cells form unicellular glands and multicellular receptor organs. Different type of glands are present like slime glands, sucker glands, clitellar glands.
 3. **Dermis:** Consist of network of connective tissue and contain pigmented cells, fat cells, scattered muscle fibres, haemocoelomic capillaries and basal part of epidermal gland cells.
 4. **Muscular layer:** Form largest part of body and have circular, oblique, longitudinal, dorsoventral, vertical and radial muscles.
 5. **Botryoidal tissue:** It fills the entire coelom except the haemocoelomic spaces. It is found beneath the longitudinal muscles and surrounding the elementary canal.

Locomotion

The process of moving from one place to another is of two types:

1. Looping (Crawling or creeping)
2. Swimming

Muscular layers of leech

1. Outermost muscle layer in contact with the dermis is circular muscle fibres.
2. Middle layer consists of oblique muscles.
3. Inner most layer (Thickest) is composed of longitudinal fibres.
4. Well-developed dorso-ventral muscles are segmentally arranged on either side of alimentary canal. Their contraction results in greater dorso-ventral flattening of the body.

Digestive system

Digestive system: The digestive system consists of oral chamber, buccal sinus (proboscis), pharynx, esophagus, stomach (crop), intestine, rectum, and anus.

1. **Alimentary canal:** It is a straight tube running from mouth to anus and is adapted for blood sucking habits and its storage. It consist of following parts:
 - a) **Pre oral chamber:** It is narrow tri-radiate aperture guarded by membranous three flaps of lip (velum), situated at the base of anterior sucker.
 - b) **Buccal cavity:** Extended up to 4th segment and separated from preoral cavity by velum. In mucous membrane three crescentic jaws are there (one mid-dorso and two ventro-lateral). Muscular edges bears single row of denticles. Median jaw has 103-128 denticles while lateral jaws 85-115. The jaws work as semi-circular saws and when the leech bites, they form characteristic triradiate bite(Y shape) on the skin.
 - c) **Pharynx:** It is muscular oral sac extending from segment 5 to 7. The salivary glands with its ductules open in it. These secretions contain hirudin (anticoagulant) which checks coagulation of sucked blood.
 - d) **Oesophagus and crop:** Oesophagus is narrow with folded epithelial line and connect pharynx to crop. Crop is the largest part of alimentary canal (2/3of visceral space) and extends up to 18th segment from 9th segment.
 - e) **Stomach:** It is heart shaped and situated below crop at 11th segment.
 - f) **Intestine, Rectum and Anus:** Stomach open into intestine which is thin walled, straight, narrow tube extend from 20th to 22th segment. Intestine open into rectum (22th -26th) which is short, thin walled and ciliated. Finally rectum opens as anus (26th) dorsally above the posterior suckers.
2. **Digestive glands:** It includes the salivary gland and goblet cells. Salivary gland contains hirudin which does not allow host blood to clot. The goblet cells scattered in epithelial lining of the crop (also in gastric and intestinal epithelial) secretes mucus.
3. **Feeding and digestion in leech:** Leeches are sanguivorous in nature and sucks blood from cattle etc. Firstly leech attach to the victim with the help of posterior sucker and anterior sucker make a characteristic "Y" incision in the skin then sucks the blood with the help of pre oral chamber. Hirudin in the saliva prevents coagulation of ingested blood.

Even after detachment of leech, there is prolonged effect of substances poured into wound. They suck more blood as compare to their body weight and store it at crop and diverticula (uncoagulated blood). The blood passes from sphinctered aperture of a crop in drop form into the stomach (digestion) then to intestine (for absorption). A single full meal can nourish for the leech about a year or more.

Respiration

Leeches don't have respiratory organs. They live in damp surroundings and generally respire through their body wall by diffusion. The exception to this is in the Piscicolidae, where branching or leaf-like lateral outgrowths from the body wall form gills. Some rhynchobdellid leeches have an extracellular hemoglobin pigment, but this only provides for about half of the leech's oxygen transportation needs, the rest occurring by diffusion.

DISCUSSION**Reproduction****Male reproductive system**

- **Testis:** From 12th -22th segment on ventral side, 11 pairs of testis sacs are located, each pair on one segment. Sperms are secreted from the wall of testis in the form of spermatogonia that shed into coelomic cavity and then get mature.
- **Vasa efferentia:** It opens into vasa deferens on each side and carries sperm, which is short sinuous duct in structure.
- **Vasa deferenentia:** They are slender wavy longitudinal ducts enclosed coelomic space.
- **Epididymis:** It is a reservoir of spermatozoa, present in 10th segment.
- **Ejaculatory duct:** It is a short narrow duct runs transversally towards mid-ventral region on each side.
- **Atrium:** It extends from 9th -10th segment. It is pyriform in shape sac which joins the two ejaculatory ducts. It consists of two parts anterior and posterior. Anterior is prostate chamber, which have prostate gland and posterior is penis sac. Penis sac is highly vascular and open in male genital pore.

Female reproductive system

The female reproductive system consists of more or less elongated or small globular ovisacs which contain true ovaries and forms common oviduct opening to the exterior by the female pore.

- **Ovisacs:** One pair present ventrally at 11th segment on either side of ventral nerve cord. It is filled with coelomic fluid.
- **Oviduct:** They may be small or enlarged to form an ovarian vesicle before the formation of common oviduct. The common oviduct empties into the vagina at the internal blind end.
- **Vagina:** Present mid ventrally on posterior part of 11th segment. Ova are stored here till the fertilization take place during copulation.

The leech is hermaphrodite but auto-fertilization does not take place. During early spring (March & April) leeches reproduce through cross-fertilization.

- **Copulation:** Two individuals come close in head-to-tail position and ventral surface of one is placed against the ventral surface of the other in such a way that male genital pore of one animal lie opposite to female genital pore of other animal and the penis of one enters the vagina of the other and vice versa. Mating occurs for an hour, during which mutual exchange of spermatophores occur. Fertilization takes place in the vagina.
- **Cocoon formation:** The glands of the clitellar segments secrete snow-white foamy girdle around clitella, during mating. While the leeches pull out of the girdle, the fertilized ova from the vagina are forced out into the girdle. Before abandoning the girdle the leeches plug it's both ends with the secretion of prostomial glands and the cocoon is formed.
- **Development:** Development is direct and completed within fifteen days, following which the plugs of the cocoon drop off and young leeches come out.

Nervous system

As in other annelids, the leech nervous system consists of a ventral nerve cord comprising the cephalic ganglia (or head brain, which includes supra- and sub-esophageal ganglia) and the segmental ganglia. Also leeches have a prominent ganglion at the caudal end of the nerve cord (the tail brain), the main function of which is thought to be control of the rear sucker. The majority of the neurons of a leech are located in the segmental ganglia.

The main nerve center consists of the cerebral ganglion above the gut and another ganglion beneath it, with connecting nerves forming a ring around the pharynx a little way behind the mouth. A nerve cord runs backwards from this in the ventral coelomic channel, with 21 pairs of ganglia in segments six to 26. In segments 27 to 33, other paired ganglia fuse to form the caudal ganglion. Several sensory nerves connect directly to the cerebral ganglion; there are sensory and motor nerve cells connected to the ventral nerve cord ganglia in each segment.

REFERENCES

1. Shiksha Sharma, Family history as major predisposing factor in Varicose Veins, *EJBPS*, 2017; 4, 12: 392-396.
2. C.K.Mandal. Identification Key of West Bengal Leeches (AnnelidaHirudenia). *Rec Zool Surv India*, 2009; 109 (1): 77-87.
3. Kaviraja Ambikadutta Shastri. *Susrutasamhita of Maharsi-Susruta* edited with *Ayurveda-tattva-sandippika*, Part 1. Chaukhambha Sanskrit sansthan Varanasi; Sutrasthan, Chapter, 2014; 13: 56-61.

4. Kaviraj Atridev gupta. *Astanga Samgraha Chowkhamba Krishnadas academy, Varanasi; jalaukovidhim adhyaya*, 2016; 35: 237-239.
5. Munish Younis, Ara Irfat, Razique Huma et al. Leeching in the history--a review *Pak J Biol Sci*, 2008; 1, 11(13): 1650-3 doi: 10.3923/pjbs.2008.1650.1653 PMID: 18819614
6. Mahesh Chandra. *The Leeches of India- A Handbook*. Edited by the director, Zoological Survey of India, Calcutta, 1991; 6-7.
7. Mahesh Chandra. *A Checklist of Leeches of India*. *Rec. Zool. Surv. India*, 80: 265-90.
8. Fredric R., Govedich and Bonnie A. Bain, All about leeches of Montezuma Well. <https://www.nps.gov/learn/upload>.
9. Eldor A, Orevi M, Rigbi M. The role of leech in medicinal therapeutics. *Blood Rev*, 1996; 10: 201-9. doi: 10.1016/s0268-960(96)90000-4.
10. Jaruwan Tubtimon, Ekgachai Jeratthitikul, Chirasak Sutcharit, Bangon Kongim and Somsak Pantha. Systematics of the freshwater leech genus *Hirudinaria* Whitman, 1886 (Arhynchobdellida, Hirudinidae) from northern Thailand. *Zookeys*, 2014; (452): 15-33. doi:10.3897/zookeys.452.7528.
11. Moore, J. P. The Segmentation (metamerism and annulation) of the Hirudinea: Arhynchobdellae. In 'The Fauna of British India'. (Eds W.A. Harding and J.P. Moore), (Taylor and Francis: London U.K), 1927; 1-12: 97-302.