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A CRITICAL REVIEW OF LEECHES

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Abstract

Leeches extract the blood of their victims in a painless manner. For this reason, leeches were extensively used, in the past, in surgery for blood letting (Phlebotomy) under the mistaken belief that removal of bad blood may cure the disease. From the time of early Greek medicine there are records of leeches for blood letting. They were also used to reduce swellings and discolourations from bruises. Infact they were employed for the partial exsanguinations of patients suffering from every variety of ailment from common cold to cancer.

The leech produces a number of important substances, which contribute to the special property of the bite, including an anticoagulant, a local vasodilator and local anesthetic. Like Hirudin, Hyaluronidase, Hementin etc.

Key words : Leech, Leeches, Hirudo medicinalis, Hirudin

Introduction

Hirudo medicinalis, was commonly used for phlebotomy in Europe in olden times and the practice, at one time spoken as "leechery", was so common that doctors themselves were often called "Leeches". Besides Hirudo medicinalis, other species were used in

various parts of the world. The medicinal leech of America is Macrobdella decoraso; great was the demand for leeches for medicinal use that suitable species were even cultured. Nachtrieb (1912) states that about 1850, one American leech farm

disposed of as many as 1000 or more leeches daily.

The famous English poet, Wordsworth, wrote a poem - "The leech Gatherer", based on the medicinal use of leech. The use of leeches in Ayurvedic medicinal practice in India is very ancient. Even now, some native medical men employ them. They are used as a drug to prevent loss or graying of hair and other symptoms of old age.

According to "Guinness World Records – 2002 [pp 23]" the lifespan of 27 years has been reliably recorded for the species *Hirudo medicinalis*.¹

Medicinal leech- *Hirudo medicinalis*:

Phylum	- Annelida
Class	- Hirudinea
Order	- H. Limnoblepharis
Family	- Hirudinidae
Species	- H. medicinalis
General	- Hirudinaria

HIRUDINARIA:²

The genus *Hirudinaria* comprises fresh water leeches, which are sanguivores (Blood sucking) in habit and attack domestic animals and man.

Four species of these are found in India, namely

- 1) *H. javanica*,
- 2) *H. manillensis*,
- 3) *H. Granulosa*
- 4) *H. viridis*

Habits and habitats:

Leeches are widely distributed and are found in fresh water ponds, lakes, tanks and slow streams and still water standing in rice fields. Few are terrestrial and found in damp places. It takes shelter under logs, stones, plants, and other objects in shallow water. Majority of leeches are blood-sucking parasites and live on animals like fish, animals and mammals. Some leeches live on dead animals, worms.

EXTERNAL FEATURES:

Size and shape

Leech attaining a size of 10-15 cm in length but a fully-grown or mature specimen may be 30-35 cm in length. About 300 specimens are known. Broadest at near the posterior end & narrowest at near the anterior end. A small sucker is present at the mouth at its anterior end and a large at its posterior end. All leeches have 33 body segments. Leech has got a soft smooth, slimy, worm form elongated and dorsoventrally flattened body. It is very flexible and can be stretched, contracted and dilated. It is

capable of causing great alterations in form and proportions it attains ribbon shape when extended and almost cylindrical when contracted. In normally stretched leech the dorsal surface remains convex and ventral surface remains plane. Its secretion from skin is mucus in nature and abundant quantity of mucus is secreted from its skin.

Colouration

The colour of the body in the dorsal side is bright with olive - green shade and orange red or orange - yellow ventrally with longitudinal lines and two sides bear stripes of orange or yellow or black colour. A median longitudinal black strip marks the dorsal side of the body.

Segmentation

The leeches have 33 segments or somites and each segment is broken up externally by grooves into rings called annuli. The body of the leech is divisible into six regions.

Six regions of leech:

1st – 5th seg.: **Cephalic region:** includes mouth and eyes.

6th – 8th seg.: **Pre-clitellar region:** bearing nephridiospores.

9th – 11th seg: **Clitellar region:** temporarily clitellum develops during the breeding season around this region.

12th - 22nd seg.: **Middle region.**

23rd – 26th seg.:

27th – 33rd seg.:

Caudal region: mid dorsal oral aperature

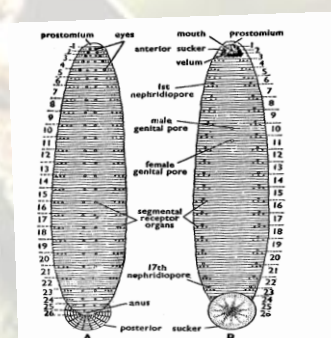


Figure No. 1 -External features of Leech A) Dorsal view B) Ventral view

Post-sucker region: each represents by a single annulus. This one segment is further divided by closely set transverse grooves of furrows into about 95 rings (Annuli).

All these rings do not have internal counterparts and the annuli do not correspond to internal segments of the body. In the middle of the body five annuli constitute one segment said to be complete somite. But on the anteriorly and posteriorly, there are fewer segments to each somite, and in some regions, a somite may contain a

single annulus only. Segments with less than five annuli are termed incomplete.

The surface of annulus is further divided into several more or less rectangular areas, the first annulus of each segment bearing a number of minute elevated sensory papilla, the annular receptor. 18 number of sensory papilla are seated on side of annulus. On the surface, 4 pairs of sensory papilla on dorsal side and 3 pairs on ventral side in the first annulus of each segment. Out of these, large sensory papilla called the segmental receptors, and first annulus of every segment is known as segmental receptor organs or sensillae.

Suckers:

Hollow muscular organ on each end of the body is known as sucker.

Anterior sucker (Oral sucker)

(Cephalic sucker):

It is formed by fusion of prostomium with few somites of anterior region. It is oval in out line and is placed on ventral surface of the anterior end .It possesses a ventrally directed cup like hollow pre - oral chamber which leads into the mouth.

The anterior border is free and mobile and bent over the mouth so as to form a structure like that of upper lip. The function of anterior sucker is to help in locomotion and adhesion. It contains 3 jaws with sharply serrated edges, which are used like circular saws, and on them are about 100 horny teeth used to incise the host.

Posterior sucker (Anal sucker):

The posterior sucker is formed by the fusion of 7 posterior body segments (27th to 33rd). It is highly muscular and circular and a disc shaped. It acts as a powerful organ of adhesion and thus serves for locomotion.

Clitellum:

During breeding season a girdle like clitellum is formed around segments 9th to 11th, rest of the year there is no clitellum.

Eyes:

On the dorsal side there are five pairs of eyes, one pair on each of the 1st and 2nd segments and one pair on first annulus of 3rd, 4th, 5th segments.

External apertures:

The body of leech bears 5 kinds of apertures, those are as follows

- 1) Mouth 2) Anus
- 3) Nephridia 4) Male generative aperture
- 5) Female generative aperture

Mouth: It is a narrow triradiate aperture situated in the center of the funnel like pre – oral chamber of anterior sucker.

Anus: It is a very small aperture situated mid dorsally on the 26th segment at the base of posterior sucker.

Nephridia: There are seventeen pairs of nephridiopores of which one pair lies ventrally on the last annulus of each segment from 6th to 22nd.

Male generative aperture: It is a mid ventral opening situated in a groove between 2nd and 3rd annuli of tenth segment. Some times a filamentous or thread like penis is visible protruding through this aperture.

Female generative aperture: It is usually smaller and than the male aperture situated mid ventrally in a groove between the 2nd and 3rd annuli of eleventh segment of the body.

Body wall:

Body wall of leech is made up of 5 layers from outward to inwards

- 1) Cuticle 2) Epidermis
- 3) Dermis 4) Muscular layer
- 5) Botryoidally tissue.

Cuticle: It is the outer most, thin, delicate, transparent, colourless and elastic protective covering and perforated by numerous epidermal glands.

Epidermis: It lies below the cuticle, consists of columnar and hammer shaped Cells and fibrous connective tissue in intercellular space. This layer contains pigment Cells

and hemocoelomic capillaries forming vascular membrane and unicellular glands and multicellular receptor organs (sense organs).

Epidermal glands:

- 1) Slime glands:** Distributed all over the body and secretes slimy mucous
- 2) Sucker glands:** Situated in both suckers, pear shaped or rounded in form. Their secretion helps in attachment and locomotion.
- 3) Clitellar glands:** Found in clitellar regions and become active in breeding season.

4) Prostomial glands: Found in prostomium, produces two plugs of the cocoon or egg case.

Dermis: It lies between Epidermis and muscles, consists of fibrous connective tissue, fat cells and pigment cells, hemocoelomic capillaries, basal part of epidermal glands.

Muscles: Musculature forms largest part of the body wall. They are arranged in either continuous layers or separate bundles. All movements of the body are performed by musculature.

Botryoidally tissue: It surrounds alimentary canal beneath the longitudinal muscles. Its intercellular

canal contain red fluid (hemocoelomic fluid)

Locomotion:^{3,4}

Leech moves by a) Crawling over substratum b) Swimming in water.

Crawling over substratum: During crawling body of leech is extended and contracted by muscular activity by looping movements and suckers help in

attachment and support.

Swimming: During swimming leech becomes dorsoventrally flattened like ribbon

and performs undulating movements this wave passes longitudinally over the body.

SYSEMIC INFORMATION:

Digestive system:

The alimentary canal of the leech is straight tube of varying diameter running from the mouth to anus it modifies in accordance with blood sucking habit of the animal. Major part of the canal serves to store uncoagulated blood and small portion serves for digestion for absorption. The alimentary canal consists following parts

- 1) Pre oral chamber 2) Buccal cavity
- 3) Pharynx 4) Oesophagus
- 5) Crop (largest portion of gut contains linear row of ten chambers having capacity to dilate and to store the blood)
- 6) Stomach 7) Intestine
- 8) Rectum

Hirudinea granulosa is parasitic and feed on the blood of mammals. It attaches to the host by means of its two suckers and bites the skin of its

victim. It has three jaws, which work back and forth during the feeding process, which usually lasts about 20 to 40 minutes and leaves a triradiate or "Y" shaped scar on the host. Three jaws that look like little saws, and on them are about 100 horny teeth used to incise the host.

Leeches only feed about once every six months; this is about how long the blood meal takes to be fully digested. Leech may even go longer than six months without food. Bacteria that live within the leeches' body help keep the blood from decomposing.

Reproductive: On the ventral surface in the clitellar region leeches have two openings, besides the usual paired nephridiopores. These are unpaired apertures of which, the male genital aperture is situated in the 10th segment, while the female genital aperture is situated in the 11th segment in the groove between the 2nd and 3rd annulus.

H. granulosa breeds once during an annual season during March and April.

The act of copulation takes place on land or water. Leeches are hermaphroditic (have both male and female reproductive organs) and

fertilization is internal. Two leeches come in contact by their ventral surfaces in a head to tail position, so that male genital pore of one lies against and enters the female genital pore of the other and mutual exchange of seminal fluid takes place. Copulation finishes in about an hour. Fertilization takes place in vagina and fertilized ova are into cocoon for further development.

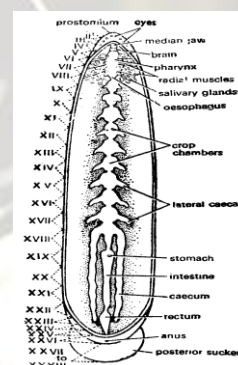


Figure No.2 - Alimentary canal of leech

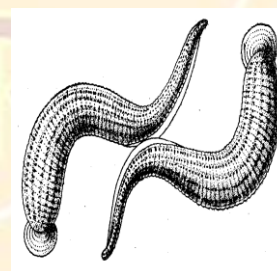


Figure No.3- Copulating Leeches

Respiration takes place through the body wall, and a slow undulating movement observed in some leeches is said to assist gaseous exchange. Aquatic leeches tend to move to the

surface when they find themselves in water of low oxygen content. As a fall in atmospheric pressure results in a small decrease in dissolved oxygen concentrations, rising leeches in a jar of water provided nineteenth century weather forecasters with a simple way of predicting bad weather.

Feeding: Most leeches are sanguivorous that is they feed as blood sucking parasites on preferred hosts. If the preferred food is not available most leeches will feed on other classes of host. Some feed on the blood of humans and other mammals, while others parasites fish, frogs, turtles or birds. Some leeches will even take a meal from other sanguivorous leeches, which may die after the attack.

Sanguivorous leeches can ingest several times their own weight in blood at one meal. After feeding the leech retires to a dark spot to digest its meal. Digestion is slow and this enables the leech to survive during very long fasting periods (up to several months).

Circulatory: There is a tendency in this group toward the loss of true blood vessels. The blood of some leeches is red. In others the blood

lacks oxygen-carrying pigments and is therefore colorless; the oxygen dissolved directly in the blood is sufficient for respiration. Gas exchange occurs through the body surface of most leeches, although many fish-parasitizing leeches have gills.

Sense Organs: Sensory organs on the head and body surface enable a leech to detect changes in light intensity, temperature, and vibration. Chemical receptors on the head provide a sense of smell and there may be one or more pairs of eyes. The number of eyes and their arrangement can be of some use in Identification, however to properly identify a leech, dissection is required.

The Bite: When a jawed leech bites it holds the sucker in place by making its body rigid. Using its semi circular and many toothed jaws like minute saws, it then makes a triradiate or "Y" shaped painless incision in the skin and excretes a mucus from the nephropores (external openings from the kidney-like organs). This helps the sucker to adhere. A salivary secretion containing the anticoagulant and histamine floods the wound and the leech relaxes its body to allow the blood to be ingested. This mixture

allows the blood to flow and also prevents clotting once inside the leech. A bacterium in the gut of the leech assists the digestion of the blood..



Figure No.4 - "Y" shaped Wound of Leech

CHEMICAL CONSTITUENTS OF SALIVA

The leech produces a number of important substances, which contribute to the special property of the bite, including an anticoagulant, a local vasodilator and local anesthetic. Like Hirudin, Hyaluronidase, Hementin etc.

Here therapeutic effect is not only by suction of blood but also by the secretions, which the leech injects in to the lesion. They secrete anticoagulants to prevent blood clots and relieve pressure due to pooling blood. Leech saliva helps to reestablish blood flow to the body parts by means of a vasodilator, produces a numbing effect by anesthetic action. These substances allow continued flow of blood normally up to 10 hours after it has detached.

Earlier Research indicates that after about 3 to 5 days, neovascularisation takes place around flap margins, which sufficiently restore effective venous drainage. Therefore, it is important

soon, but rather, continued over a period of time to avoid failure

Hirudin⁵

It was recognized in the saliva of leeches in 1884. It was used in early transfusion experiments 30 years before Heparin was used. Since 1986, when Hirudin was genetically engineered, it is identified as a systemic anti-coagulant free of some of heparin's side effects. It is also called as anti-coagulin.

Hirudin – A 65 – The mechanism of suppressing activity of hirudin⁶ on thrombin is investigated. Hirudin⁷ blocks the action of thrombin and it doesn't promote the transition of fibrinogen into fibrin. The saliva of medicinal leech blocks an initial attachment of thrombocytes and completely suppresses their aggregation on a surface of collagen. Thus, the secret of salivary of medicinal leech influences on cellular and plasma factors of blood clotting. In researches of many

authors it is marked that after the assignment of leeches there is, a normalization of separate parameters of coagulogramme -at initial combination of hyper coagulations the anticoagulating system is activated and on the contrary becomes more active. Similar effect was not received even when used such widely known anticoagulants as heparin and aspirin. Thus, continuous bleeding from wound made by leeches occurs for a long time nearly 10 hours, even after the leech has detached itself.^{8,9}

The lipotropical effect of enzymes of salivary glands of medicinal leeches has the ability to influence on blood lipids. At the beginning of the century some scientists expressed the assumption that applying of medicinal leeches can prevent the development of atherosclerosis. In 1984-1989 it was experimentally proved that at long intravenous introduction of a secret of salivary glands of medicinal leeches to the rats, which were in the condition of a strongly expressed atherosclerosis the last, ones had reduction of lipids in abdominal and lung arteries.¹⁰

Calin:

It also prevents the blood coagulation. On comparison with

hirudin it has a substantially longer time of period within which it is effective and will be cleansing the wound by a secondary haemorrhage.¹¹

Destabilise:

It is endo-epsilon- (gamma-Glu)-lys isopeptidase protein from medicinal leech. It inhibits arterial thrombus formation in rats by inhibition of induced and spontaneous platelet aggregation. And it is also reported that it completely blocks the spontaneous aggregation of human platelet. It's orally action in experimental animal was reported as the hydrophobic properties, inhibition of platelet aggregation, protection from proteolysis and absorption from the intestine into blood. It also ensures the protective antithrombotic effect.

Hyaluronidase:

An enzyme called hyaluronidase, which breaks down hyaluronic acid. It is a "spreading or diffusing substance" that modifies the permeability of connective tissue through the hydrolysis of hyaluronic acid, the bonding material of connective tissue. This temporarily decreases the viscosity of the cellular cement and promotes diffusion of injected fluids or of localized

transudates or exudates, thus facilitating their absorption. When no spreading factor is present, material injected subcutaneously spreads very slowly, but hyaluronidase causes rapid spreading.

Hyaluronidase not only improves blood circulation in organs-targets, also promotes capillary-tissues exchanging. It helps in the reduction of swelling, and dissolution of the organized blood clots. The using of leeches promotes the increasing of local immunity as well along with fastening the flow of blood and fluids from affected areas.

The active leech substances block the enzymic process activated and often exceeding within inflammation or traumas.

A human blood plasma kallikrein inhibitor

It is capable of blocking the amidolytic activity of the enzyme in an irreversible manner and suppresses the kininogenesis activity of kallikrein.

Anesthetic substance:

Unknown anesthetic substance is found in saliva of leeches. An anesthetic substance leads to pain insensitivity (analgesic) when sucking or such painkiller

chemical, which stops you from feeling of bite.

Piavit:

It contains leech prostanoids and highly purified destabilase fraction. It has protective antithrombotic effects. The active leech substances totally block the enzymic process activated and often exceeding within inflammation or trauma.

Antithrombine, Antitripsin and Antichymotripsin activities were found in the salivary gland secretion and intestinal chyme of medicinal leech. High antithrombine activity was maintained in starved leech.

Specific indications of leeches:

- Headache
- Piles venous congestion
- Tonsillitis
- Tumors
- Skin diseases
- Swelling and local inflammations
- Bruises
- Acute abdominal pain.

Leeches are currently used during post-operative care of reimplanted fingers, skin grafts and breast reconstructions.

- Each leech will feed for 30 minutes to an hour, removing around

20 ml of blood before falling off, although bleeding from the wound afterwards can result in a blood loss of ten times this amount. Fresh leeches are applied as required for several days or weeks until the venous congestion is relieved and normal venous drainage of the graft has had time to develop.

Complications:

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➤ The histamine emitted by the leech can lead to an allergic reaction, which may immediately occur, or within four days.

➤ Soreness after the bite rarely appears.

➤ A small scar at the bitten area may remain for weeks.

➤ A plaster allergy is more often found after a treatment with leeches.

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