

Animal Diversity:

(Non-Chordates)

Phylum Nemertea or Rhynchocoela (Minor Phyla)

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PHYLUM NEMERTEA / PHYLUM RHYNCHOCOELA

INTRODUCTION:

Phylum Nemertea comprises approximately 1200 species of

- elongated and often flattened worms, called ribbon worms (many have flattened body) or
- bottle worms (because of narrow anterior end)
- proboscis worms, (because of the presence of a remarkable proboscis apparatus used in capturing food).

The Nemerteans are named for Nemertes, one of the Nereids, sea-nymph of Greek mythology. They are commonly looked upon related to the Turbellaria and were formerly included in them, but the fact that they possess a complete digestive system with anus and also a blood vascular system makes them higher in organization than the Turbellaria.

However, presence of a protrusible proboscis with a separate proboscis pore, other than mouth, is the most characteristic feature of the phylum.

Almost all nemerteans are free living, bottom-dwelling, marine animals. Few commensal and parasitic species have been described. *Nemertopsis actinophila* is a slender form living beneath the pedal disc of sea anemones. *Carcinonmertes* may be found on gills and egg masses of crabs. Some species of *Tetrastemma* live in the branchial cavity of tunicates. Only few exhibit commensal mode of life eg. *Gonomertes parasitica* is a commensal species found on crustaceans., *Malacobdella* and *Uchidaia* have been found in the mantle cavity of clams.

EXTERNAL STRUCTURE:

The body is nearly always narrow and elongated, cylindrical or flattened, unsegmented and devoid of appendages. A few species are annulated but only externally (Fig. 1). In length, they vary from a few millimeters to as much as 27m. The greatest reported length is approximately 30m for some specimens of the European *Lineus longissimus*, which lie irregularly coiled beneath stones. However, some texts quote lengths of up to 60 m, in which case, *L. longissimus* would be the longest animal alive (female [blue whales](#) reach about 34 m). In some cases there is a short narrower posterior region or 'tail', a head is rarely marked off from the body proper. The entire surface is covered with vibratile cilia. Most nemerteans are pale, but some are brightly colored with patterns of yellow, orange, red and green. Gland cells of the epidermis secrete a mucous matter which may serve as a sheath or tube for the animal. The mouth is at or near the anterior extremity on the ventral side. Near it in front, there is an opening through which proboscis, a very long muscular raptorial organ, is protruded .

BODY WALL:

The body wall is composed of outer most epidermis, middle dermis and inner layer of muscles. The epidermis of columnar ciliated cells is made up of single layer of columnar ciliated cells. The unicellular mucous glands are with single or clusters of glands in between. These secrete the mucus with which the surface is usually covered and which may form a gelatinous tube. Beneath the epidermis is basal lamina or a basement membrane. Dermis is a

layer of connective tissue, which is continuous with the general connective tissue of the body. Beneath the connective tissue, the body wall musculature is well defined. In some nemerteans (Dimyaria), there are only two layers of muscular fibres, an outer circular and an inner longitudinal (Fig.2); in others (Trimyaria), a third longitudinal layer is present. Inner to musculature and around the internal organs, the space is filled with parenchyma made up of connective tissue.

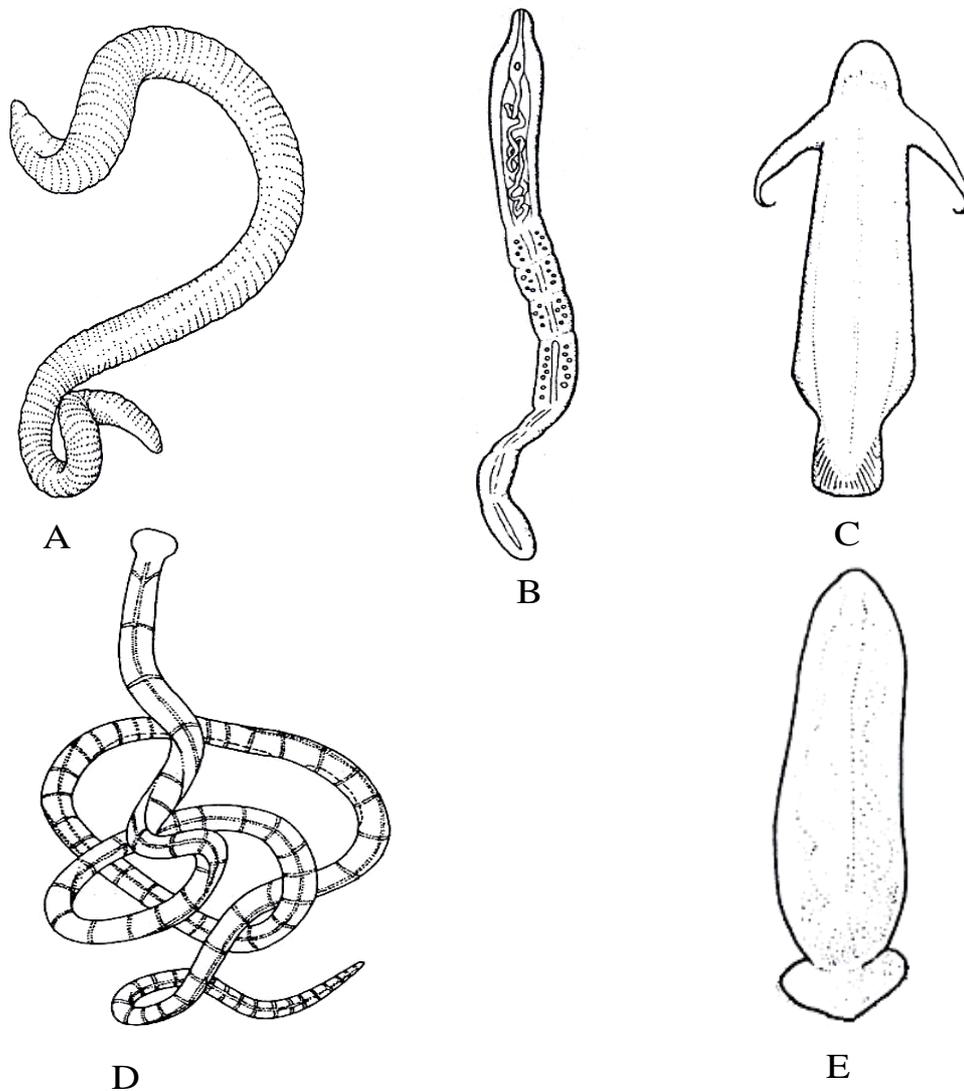


Fig.1.A – *Cerebratulus californiensis* – a large burrowing nemertean
 B – An annulated sand-dwelling paleonemertean
 C – *Nectonemertes mirabilis* – a pelagic hoplonemertean
 D – A large banded species of *Tubulanus*
 E – *Malacobdella grossa* – a bdellonemertean commensal of bivalves

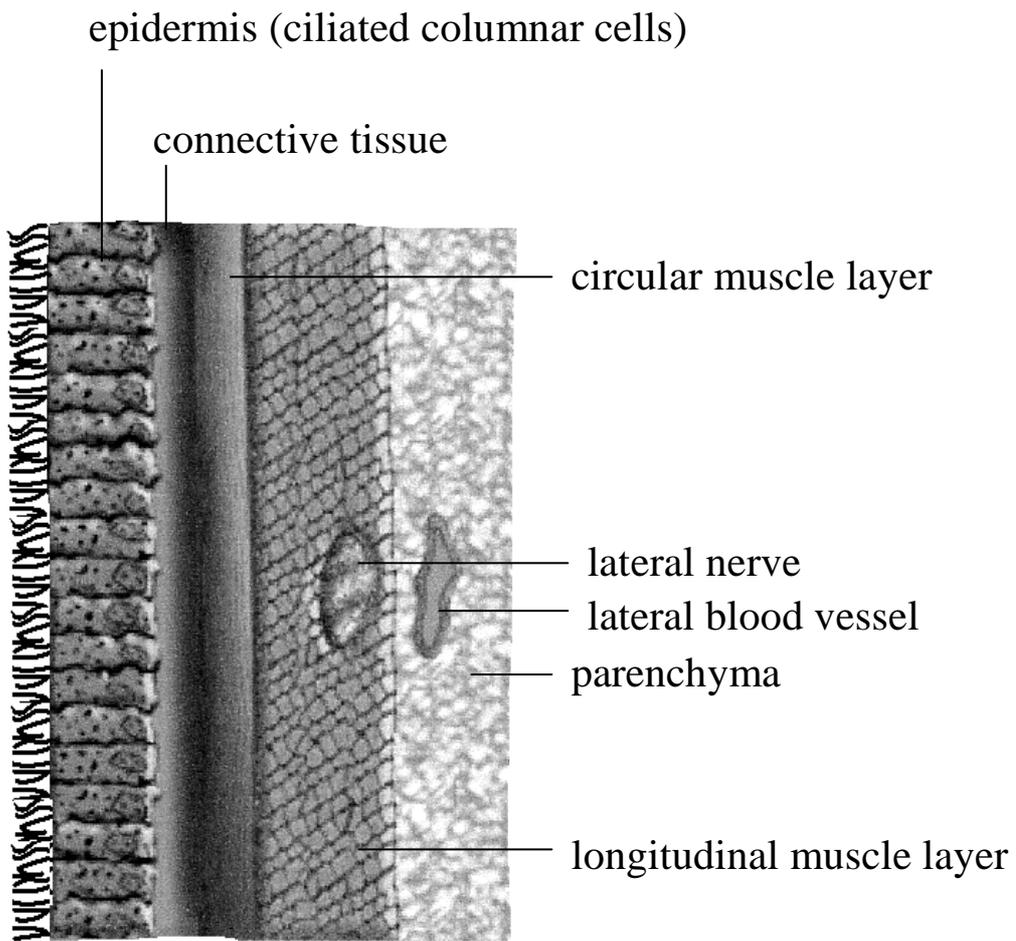


Fig.2. Body wall in Nemerteans (Paleanemertean)

LOCOMOTION:

Most nemerteans like turbellarians use their epidermal cilia to glide over the substratum on a trail of slime, much of which is secreted by Cephalic glands on the head. Nemerteans, that burrow in sediments, such as *Cerebratulus*, *Carinoma* do not use cilia for locomotion but instead move using peristalsis (Fig.3). Other ribbon worms, particularly certain pelagic species but also the benthic *Cerebratulus* are able to swim using dorsoventral undulations exclusively. In these, the dorsoventral musculature is particularly well developed.

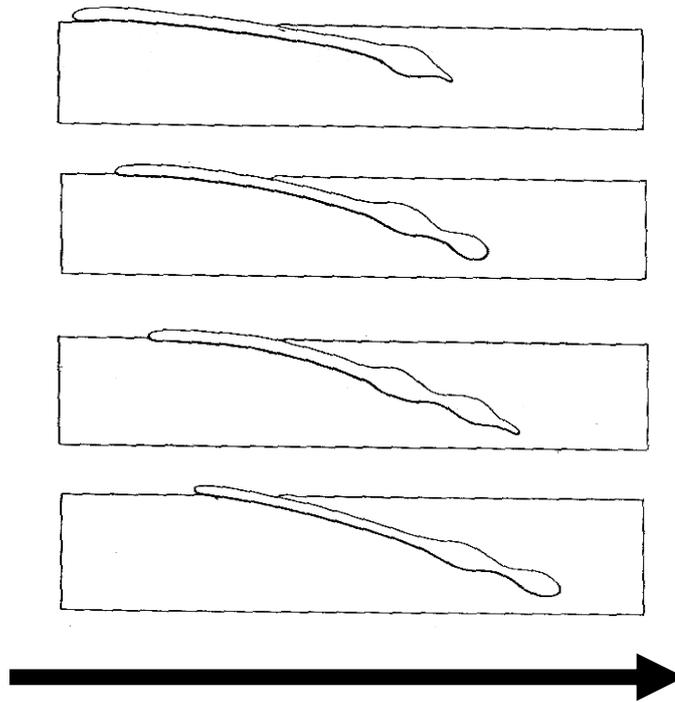


Fig.3. Peristaltic burrowing in *Carinoma tremaphorus*

NUTRITION AND DIGESTIVE SYSTEM:

The characteristic feature of the phylum is the proboscis apparatus. Unlike other invertebrates, the Proboscis is generally separate from the digestive tract, though in some it might get secondarily associated with the digestive tract. The proboscis apparatus opens through a pore at or near the anterior tip of the worm. This proboscis pore leads into a short canal known as the rhynchodeum, which extends approximately to the level of the brain. The entire proboscis apparatus, including rhynchodacum is formed by the invagination of ectoderm and structurally it is similar to the body wall.

The lumen of rhynchodeum is continuous with that of proboscis proper. The proboscis consists of a long tube, often coiled, lying free in the fluid filled cavity called the rhynchocoel (which is a coelom both in structure and in origin). The posterior end of the proboscis is blind and is attached to the back of the rhynchocoel by a retractor muscle.

In some nemerteans (class Anopla) proboscis is a simple tube, but in others (class Enopla), the proboscis has become more specialized and is armed with a heavy, calcareous barb called a stylet, which is set in the proboscis wall. A group of accessory stylets may also be present at the sides of the main stylet. These accessory stylets take the place of the main stylet when the latter gets lost during feeding. In the everted proboscis, these are borne at the free anterior

extremity and are thus capable of being used as weapons (Fig. 5A). It is by the contraction of the muscular walls of the sheath, the cavity of which (rhynchocoel) contains a corpusculated fluid, that the proboscis becomes everted. The abundant nerve supply of the proboscis points to its being used partly as a tactile organ. The proboscis also serves to catch the prey (Fig. 5B). It secretes sticky mucus which entangles small prey and it may coil around a victim. It is also used in locomotion, for attachment and in mud-burrowing.

The digestive canal consists of a tube which extends throughout the length of the body from the mouth, which is situated near the anterior extremity, ventral to the proboscis pore, to the anus at the posterior extremity. The mouth is near the level of brain and opens into a foregut; the latter is further subdivided into a buccal cavity, an esophagus and a glandular stomach (Fig. 6). The foregut opens into a long intestine, which has lateral diverticula and in some species, extends anteriorly beyond the junction with the foregut as a cecum. The intestine opens at the anus located at the tip of the tail.

In many armed nemerteans, the mouth has disappeared and the esophagus opens into rhynchodeum while in commensal bdellonemerteans, the rhynchodeum has disappeared and proboscis opens into anterior part of gut. In rest, the digestive canal and the proboscis open separately.

CIRCULATORY SYSTEM:

Nemerteans are the only acoelomate having a true but a very primitive and inefficient circulatory system. They possess a system of vessels with well defined walls consisting of a layer of epithelium surrounded by a thin layer of muscular fibers arranged circularly. There are three principal longitudinal trunks - a median dorsal and two lateral vessels (Fig. 7). But there is no heart and therefore no regular circulation of blood. In most cases, the blood is colorless and contains rounded or elliptical usually colorless corpuscles. The blood vessels do not break into capillaries as in higher animals. Thus oxygen and food still diffuse some distance through fluid before arriving at the cells. Blood corpuscles are generally colourless but some species have red, yellow or some other pigment.

EXCRETORY SYSTEM:

The primitive excretory system consists of one pair of protonephridia (Fig. 4). A nephridiophore is located on each side of the foregut and a tubule extends anteriorly from the opening of each nephridiophore. The terminal cells in most nemerteans project into the wall of the lateral blood vessel. The protonephridial tubules are limited to foregut region. The role of protonephridia in excretion, if any, is still unknown.

NERVOUS SYTEM AND SENSE ORGANS:

Nervous system consists of an anterior brain of four ganglia surrounding the rhynchocoel and a pair of larger, lateral ganglionated nerve cords (Fig. 8). Some minor longitudinal nerves may also be present. Sense organs are concentrated in the anterior end and consist of sensory epidermal pits, pigment-cup eyes, ciliated cephalic slits or grooves and cerebral organs. The cerebral organs are a pair of ciliated canals associated with the brain and their external openings are in the cephalic slits or in a pair of pits over the brain area. The cerebral organs appear to have a neuroendocrine function (Fig. 4).

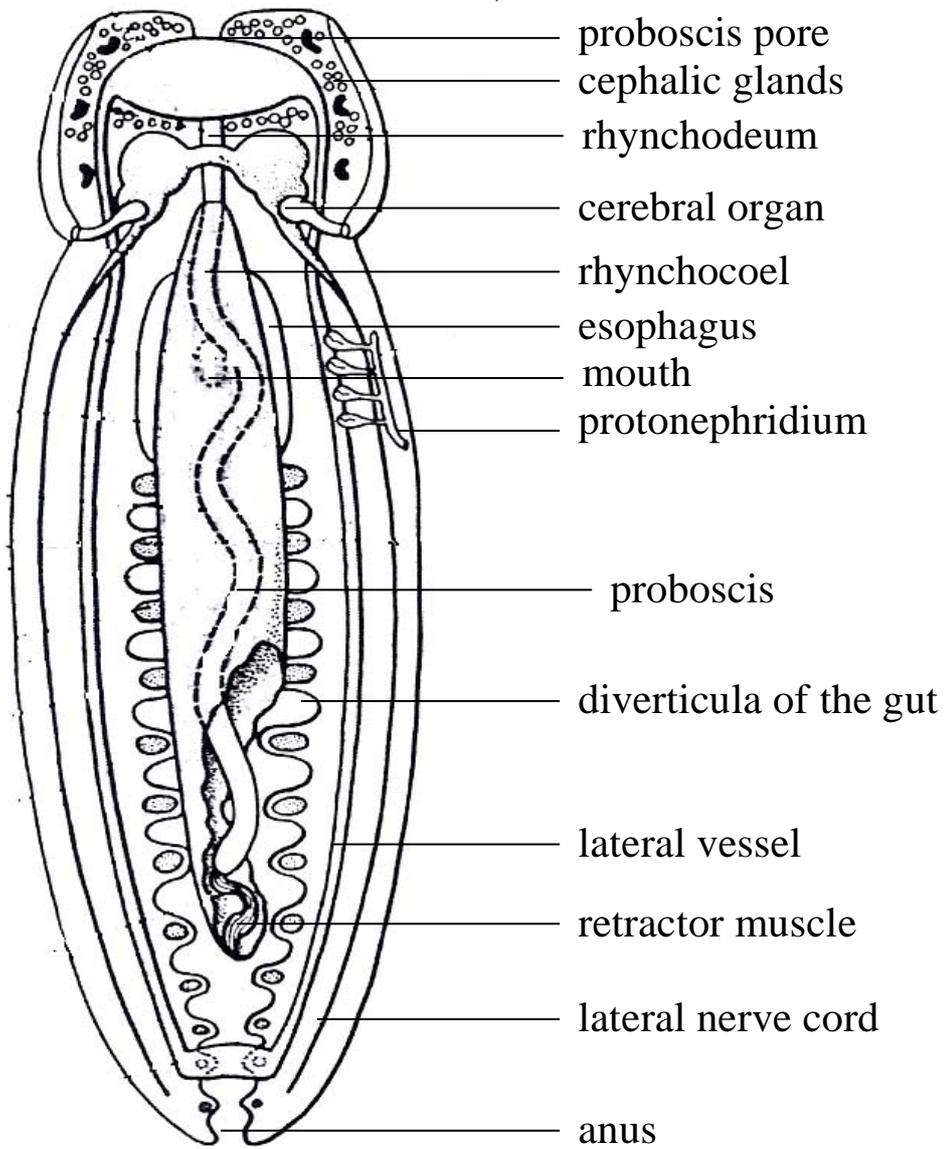


Fig.4. Body organization of a nemertean (Dorsal view)

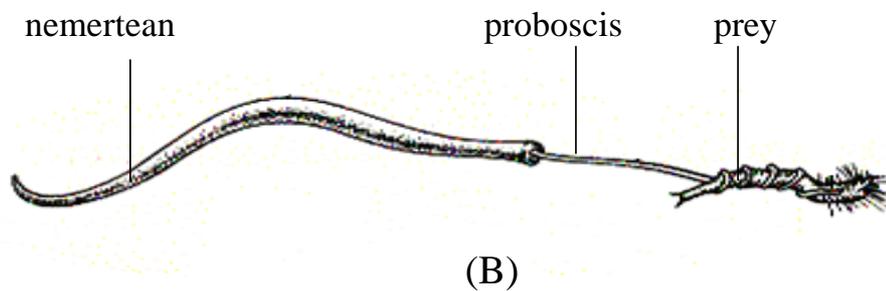
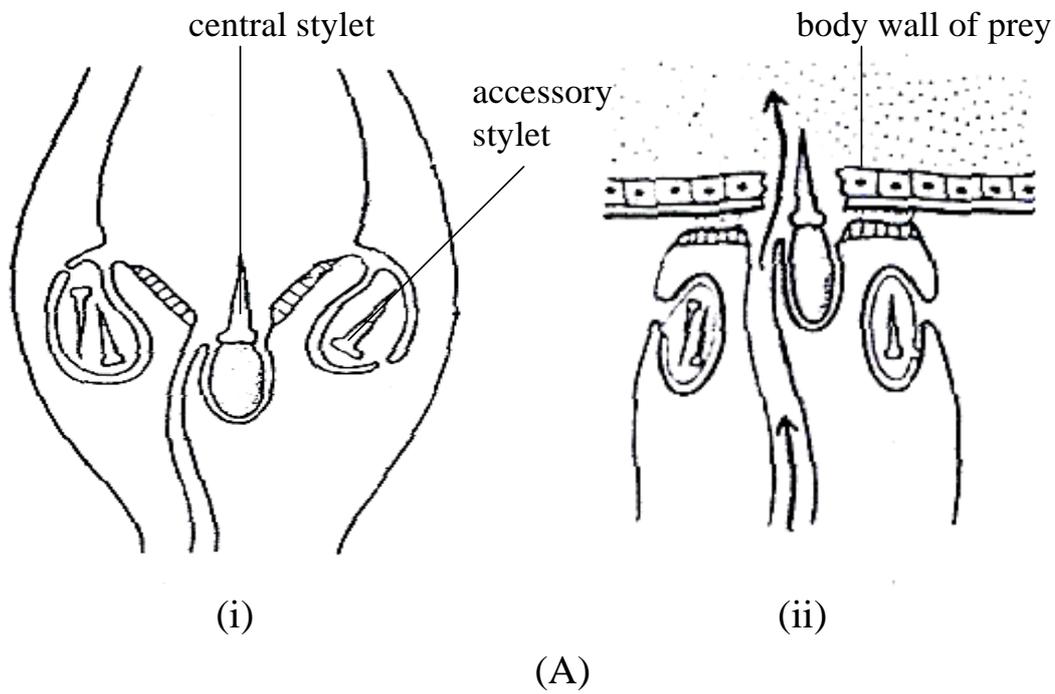


Fig.5.(A) – Stylet apparatus of armed nemertean
 (i) Before eversion
 (ii) After eversion
 (B) – A nemertean attacking its prey

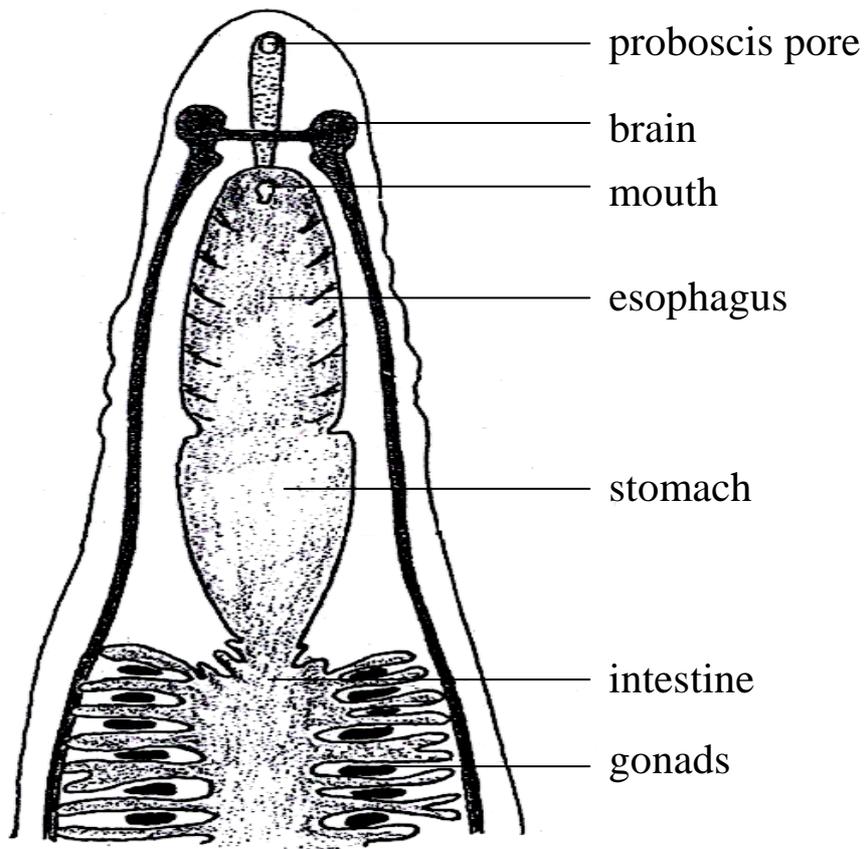


Fig.6 Digestive tract of *Carinoma*

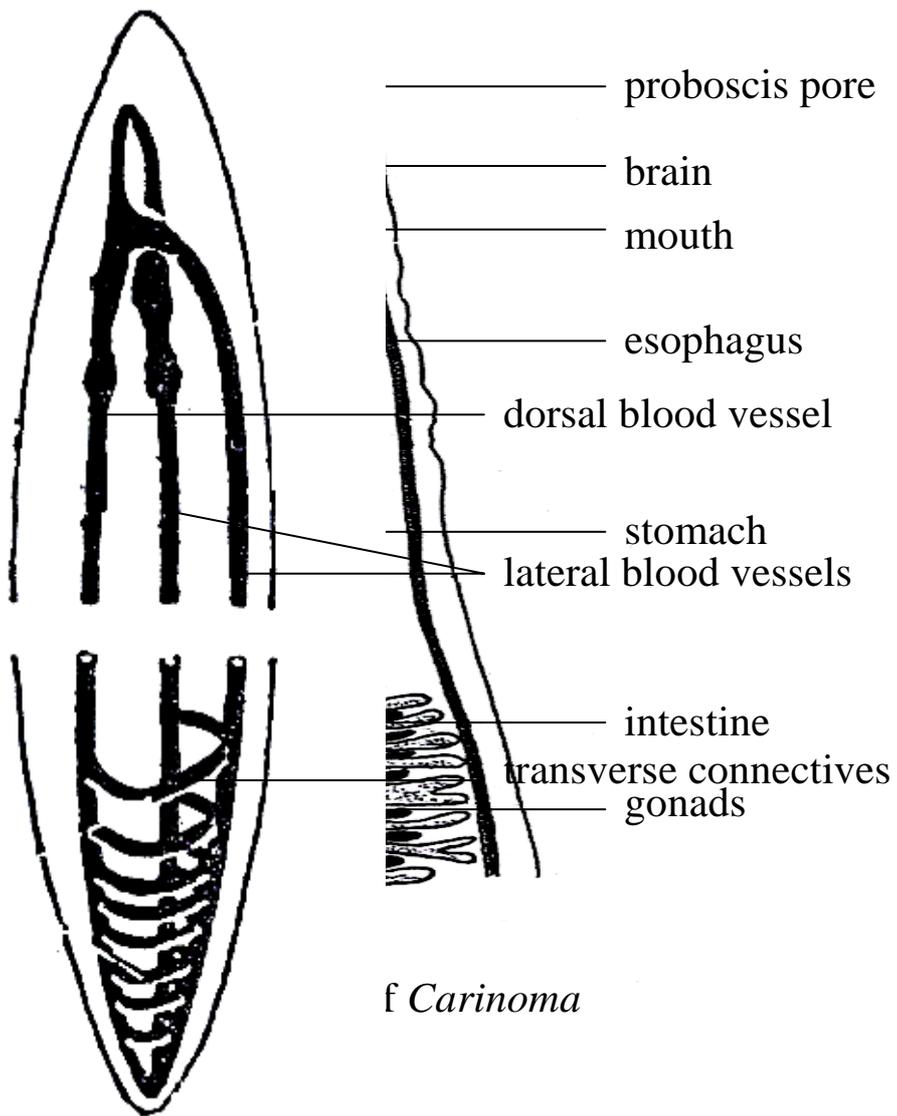


Fig.7 Circulatory system (lateral view) of a nemertean

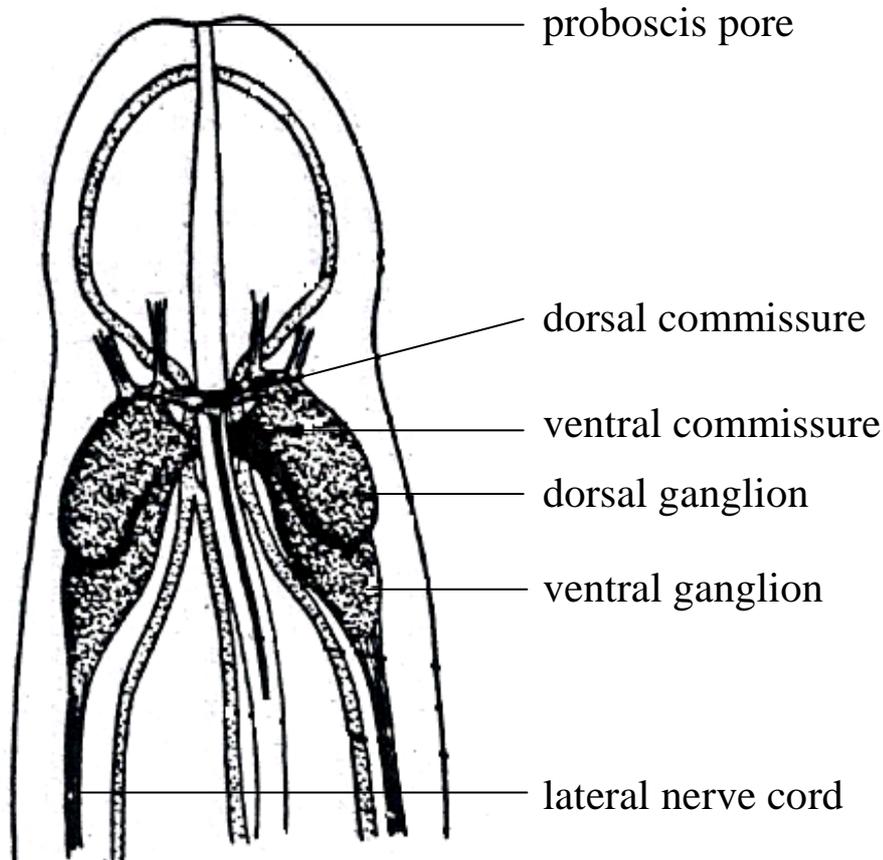


Fig.8 Nervous system (anterior end) of a nemertean

REGENERATION:

Nemerteans display a marked tendency to fragment when irritated. Very frequently the proboscis becomes detached when everted. The proboscis soon regenerates, but when the body has fragmented, the ability of fragments to regenerate varies greatly, depending on the species. Some species including some members of the genus *Lineus* reproduce asexually by fragmentation (autotomy) and even posterior sections of the body have the capacity to regenerate.

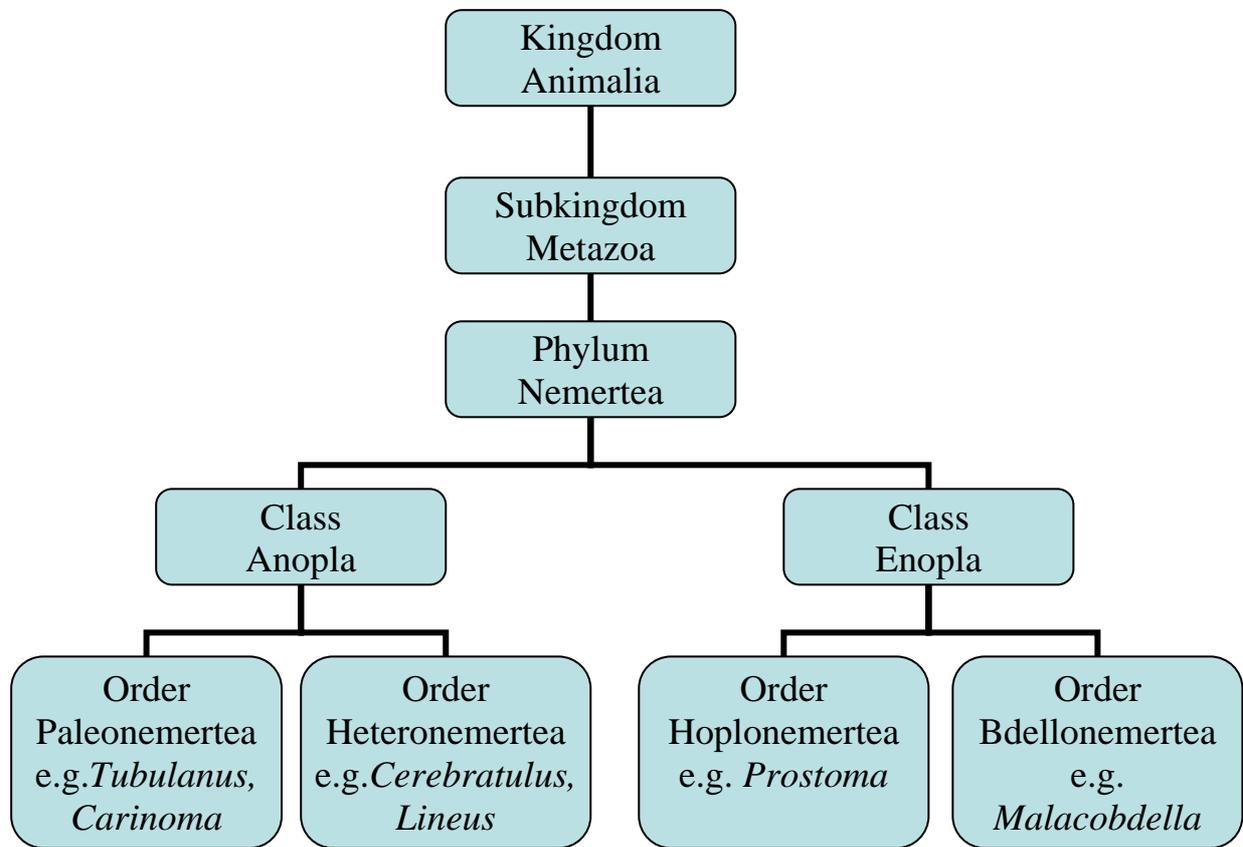
REPRODUCTIVE SYSTEM:

Most nemerteans are dioecious (but some may be hermaphrodite). The ovaries and testes are situated in the intervals between the intestinal caeca (Fig. 6). The ovary or testis is a sac lined by cells which give rise to ova or spermatozoa. When the sex cells are ripe, each gonad develops a short gonoduct to the surface, where a gonopore opens. Copulatory structures are lacking. Fertilization can be either external or internal.

EMBRYOGENY:

Cleavage is spiral and determinate, resulting in a ciliated hollow coeloblastula. It gastrulates by invagination forming a solid stereogastrula. Hoplonemertini have no free swimming larval stages while heteronemertini have an indirect development. They pass through a free swimming and feeding larval stage, called a *pilidium larva* (Gr: *pileos*-a cap) which possess an apical tuft of cilia and is somewhat helmet-shaped (Fig. 9). After a free swimming stage, the pilidium metamorphoses into a young worm. *Paranemertes peregrina* has a life span of about a year and a half. Spawning occurs in spring and summer and adult die in winter. Juveniles resulting from the spring and summer spawn attain sexual maturity the following spring and summer.

CLASSIFICATION OF NEMERTEANS (from Barnes-Vth ed.)



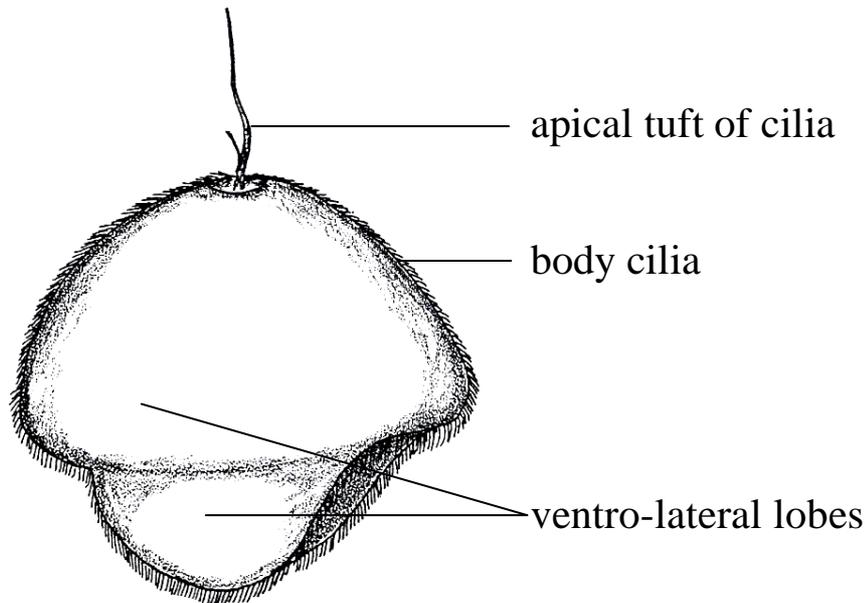


Fig.9 Pilidium larva (external view)

GENERAL CHARACTERS OF NEMERTEANS:

Phylum Nemertea (Rhynchocoela):

Bilaterally symmetrical, dorsoventrally flattened and acoelomate organisms. They are further divided into two classes, Anopla and Enopla.

A) Class Anopla

Unarmed nemerteans. Mouth located below or posterior to brain. The class has following orders:

Order Paleonemertea: Primitive neritic nemerteans. Body wall musculature two or three layered, with longitudinal layer located between two circular layers. Nerve cords outside muscle layers or within longitudinal muscle layers. e.g. *Tubulanus*, *Carinoma*

Order Heteronemertea: Body wall musculature is three layered, with circular layer between two longitudinal layers. Nerve cords within outer, longitudinal muscle layer. e.g. *Cerebratulus*, *Lineus*

B) Class Enopla

Armed nemerteans. Mouth located anterior to brain. Nerve cords are inside body wall musculature, composed of outer circular and inner longitudinal layers.

Order Hoplonemertea: All armed nemerteans are in this order. e.g. *Prostoma*, *Amphiporus*

Order Bdellonemertea: This order has only one genus *Malacobdella*, with four species, three are commensal in the mantle cavity of marine clams and one is commensal in the mantle cavity of a fresh water snail. Proboscis is unarmed in this case.

AFFINITIES

Nemerteans have similarities with vertebrates, lower chordates and the platyhelminthes.

Affinities with vertebrates: Nemerteans have following homologies with vertebrates:

1. Proboscis sheath shows similarity to the notochord of vertebrates.
2. Presence of red blood cells in same nemerteans.
3. Median dorsal nerve cord is homologous to spinal cord of vertebrates.
4. Cerebral ganglion corresponds to vertebrate brain.

Affinities with lower chordates: Nemerteans bear many affinities with certain lower chordates like *Balanoglossus*:

1. Vermiform, elongated body.
2. No external metamerism
3. Terminal anus
4. Metamerically arranged simple gonads.
5. Presence of proboscis
6. Smooth skin with unicellular glands

Affinities with Platyhelminthes: Nemerteans have long been thought to have been derived from turbellarian flatworms. They bear following similarities with platyhelminthes:

Similarities:

1. Body is flat, ribbon or tape like, bilaterally symmetrical and without external segmentation.
2. Body wall has ciliated epidermis and thick contractile muscles.
3. The space between the gut and the body wall is filled with mesenchyme. No true coelom present.
4. Pilidium larva of nemerteans, like Muller's larva of flatworms is ciliated, has ventral mouth and is devoid of anus.
5. Respiratory system is absent
6. Nervous system is analogous to that of flatworms.
7. Three primary germinal layers and cephalization.

Differences:

1. Body wall is defined.
2. Complete gut with defined mouth and anus.
3. Closed blood vascular system present
4. Excretory system present with protonephridium functioning as primary excretory organ

5. Presence of retractile proboscis and its sheath independent of the gut.
6. Brain is big and forms a ring around the digestive tract.

CONCLUSION:

Nemerteans have similarities with turbellarians. However, two advances have been made by them over the turbellarians which include, closed blood vascular system and complete digestive system. However, the simplicity of the gonadal structures and absence of hermaphroditism makes them less specialized than the flatworms. Though the nemerteans bear great similarity to turbellarians, placing them into separate phyla therefore seems justified.

Glossary

Autotomy: Self amputation. Deliberate loss of appendages, typically at specialized breakage points.

Basal lamina: Thin, collagenous, fibrous sheet secreted by epithelial cells and on which they rest.

Benthic: Bottom-dwelling.

Bilateral symmetry: The upper side of the body (dorsal side) is different from the lower (ventral side) so that only one plane of symmetry divides the body into mirror-image halves.

Cerebral organ: One of a pair of ciliated sensory canals associated with the nemertean brain.

Dioecious: Having separate sexes i.e., some individuals contain the male reproductive system and other individuals contain the female reproductive system.

Epidermis: Outer epithelial layer of the body.

Gonopore: External opening of any reproductive system.

Hermaphroditic: Having both male and female reproductive systems in the same individual.

Larva: An independent, motile, developmental stage that typically is just barely visible to the naked eye and looks different from the adult.

Metemorphosis: Transformation from a larva into an adult.

Nephridium: An excretory tubule that usually opens to the exterior via a nephridiophore.

Parenchyma: Connective tissue compartment between the body wall musculature and gut of platyhelminthes.

Pilidium: A free-swimming and planktotrophic larva of many heteronemerteans which is characterized by an apical tuft of cilia and is somewhat helmet-shaped.

Proboscis: Any tubular process of the head or anterior part of the gut, usually used in feeding and often extensible.

Spiral Cleavage: Type of cleavage pattern in which the cleavage spindles or cleavage planes are oblique to the polar axis of the egg.

Stylet: A dagger-like structure associated with various systems of different animal groups.

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