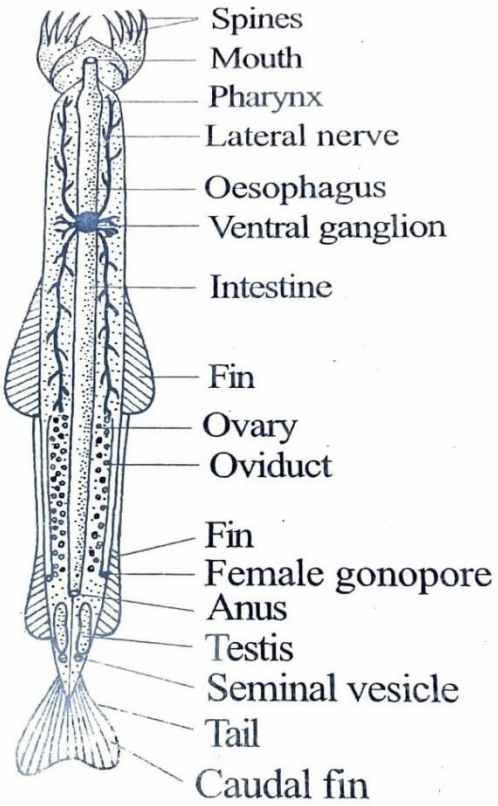
MINOR PHYLA

1. Chaetognatha

- The Chaetognatha are minute, transparent, bilaterally symmetical, coelomate, marine and pelagic animals.
- They are commonly known as the arrow-worms. Sagitta is a common example.
- They are primitive protocoelomates. They are cosmopolitan and pelagic animals. They are plankton.
- The body is straight, slender, elongated and torpedo-shaped. The body is divided into head, trunk and tail.
- The body is divided into an anterior head, a trunk and a posterior tail.



Sagitta

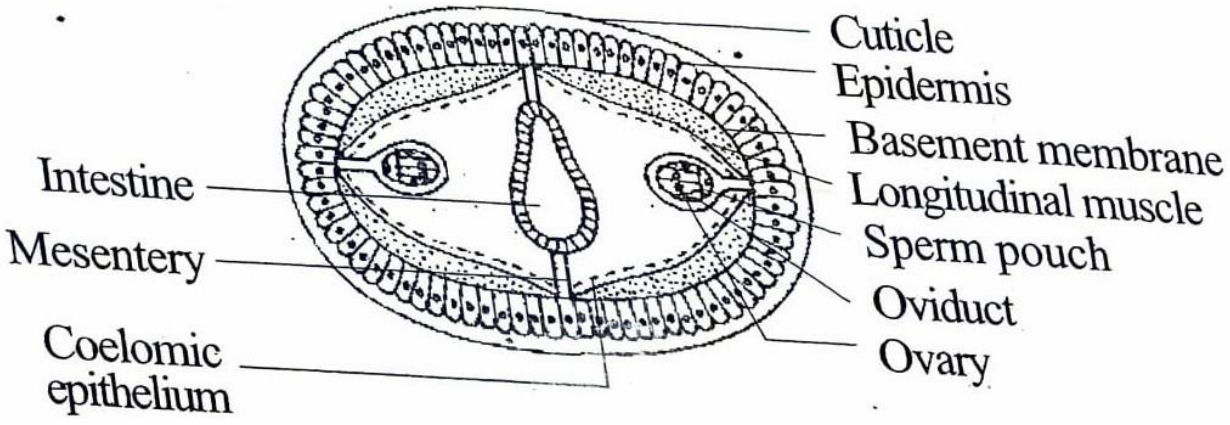
- The anterior end forms a head bearing a pair of eyes.
- Mouth is a slit-like opening located on the ventral side of the head. On either side of the mouth are present sickle-shaped chitinous hooks called **grasping spines or seizing jaws.**
- . These spines are used in seizing prey and operated by a complex musculature inside the head. The head is also armed with arcs of small spines anterior to mouth. An unique feature of the chaetognaths is the **hood**, a fold of body wall, containing a coelomic space, that can be drawn over the head.

• **The trunk** is slender and fusiform.

• There are one or two pairs of lateral fins in the trunk region and a caudal fin in the tail region.

• The anus lies between the trunk and the tail ventrally.

• The body wall consists of an outer thin cuticle secreted by the underlying epidermis. Below the epidermis is the basement membrane, followed by a muscular layer and the coelomic lining. The muscles are arranged in the trunk in four bundles, two dorsal and two ventral. The circular muscles are absent. There is a spacious coelom in the trunk. It is divided into a right and a left half by a longitudinal septum and also into three linear compartments by two transverse septa.



SagittaT.S

• **The alimentary canal** is straight. It consists of the mouth, pharynx, oesophagus and an intestine which terminates in the anus.

· A pair of lateral diverticula is present at the beginning of the intestine.

• There **are no specialized respiratory, circulatory and excretory systems**.

• The **nervous system** includes a large cerebral ganglion dorsal to the pharynx, a ventral sub-oesophageal ganglion near the middle of the body. The two ganglia are connected by a circum-oesophageal ring. Nerves are given off from the ganglia to the various parts.

- A pair of eyes are present on the head Dorsally. Each eye consists of five pigmented

cups or ocelli.

• There is an olfactory organ composed of ciliated cells arranged in a ring. It is present dorsally on the head between the eyes. It is a chemoreceptor.

• Tactile cells in the form of papillae are distributed all over the body and fins.

• Chaetognatha **are hermaphrodites**.

• A pair of elongated solid ovaries is present one on each side in the trunk. A oviduct is running along the outer surface of each ovary.

• The oviduct encloses another duct, the sperm pouch, which serves as a store house for the sperms obtained from another individual.

- . Both the ducts are closed in front and opened behind into a seminal receptacle, which opens to the exterior by the female **gonopore.**

• Two testes lie in the tail, one on each side. Two vasa deferentia are present. One end opens into the coelom and the other end dilates into a seminal vesicle at the posterior end. The seminal vesicle opens to the outside at the end of the tail by a male gonopore.

- Fertilization is internal Development is direct without a larval stage.

Affinities

They show affinities to Mollusca, Nematoda, Annelida, Arachnida, Crustacea, Hemichordata and even to Chordata. · .

Affinities with Annelida

Chaetognatha resemble the annelids in the following respects:

1.Large coelom is found in both with longitudinal septum.

2. Simple type of epidermis.

3. Muscle fibres occur in bundles.

4. Teeth and jaws of Chaetognatha re semble the chaetae of Chaetopoda.

5. Nervous system is annulate. Ventral ganglion is considered to be the concentrated nerve cord of Annelida.

But, Chaetognatha differ from Annelida in the following characters:

1. Their small number.

2. Segmentation of the body.

3. Oblique and circular muscles are absent.

4. Nephridia and circulatory systems are absent.

5. No larval stage.

Affinities with Brachiopoda

The following similarities are noted in both:

1. Coelom is divided into chambers by septa.

2. Coelomic sacs in Brachiopoda arise as in Chaetognatha.

3. The spines can be comparable to lophophore of Brachiopoda.

But these similarities are not convincing.

Affinities with Aschelminthes

The anatomy of the adult Chaetognatha shows the following similarities to pseudo-co elomate groups:

1. The entire construction is of pseudo coelomate type.

2. The wall lacks one of the two muscle layers characteristic of coelomate animals.

3. Straight alimentary canal. The intestine lacks the musculature expected in coelomate forms. It is not lined with regular coelomic epitheliun.

4. The histology of the mesenteries supporting the intestine is not similar to coelomate type.

5. The head with spines and teeth as in Aschelminthes.

6. Presence of tangoreceptive bristles on the body.

7. The division of the body into head and trunk is seen in priapulids, hectonema and gordiod larva.

8. Nervous system resembles that of nematodes.

9. Presence of pharynx with muscular bulb.

None of them is sufficiently specific to justify their relationship with Aschelminthes.

The cleavage pattern is equal and indeterminate in Chaetognatha, whereas in Aschelminthes it is unequal and determinate type. Embryology also proves that Chaetognatha are true coelomate animals.

Affinities with Enterocoelous Phyla :

In the possession of three divisions of coelom chaetognaths resemble Balanoglossus. But in Balanoglossus, the anterior portion of cmbryonic coelom is unpaired and median, whereas in chaetognaths, it is the posterior part.

Origin of coelom is also different. They arise as a pair of fold of archenteron in other enterocoelous groups. There are 3 division of coelom in echinoderms and hemichordates, while there are only two divisions in chaetognaths. No larval stage is found in chaetognaths while free-swimming larva is present in enterocoelous groups.

Conclusion

- Chaetognaths are regarded as the primitive protocoelomates. The Chaetognatha departed very early from the base of the deuterostome line and is only remotely related to the other deuterostome groups.

2. Rotifera

- The rotifers are **wheel animalcules**. They are microscopic animals. They live in freshwater. Example: *Brachionus*.
- Rotifers are microscopic, bilaterally symmetrical free living, pseudocoelomate animals. They are related to Platyhelminthes and Aschelminthes.
- The rotifers are cosmopolitan in distribution. They are the most common inhabitants of freshwater, a few are marine, some found in brackish water or on land in damp sites.

- They may be free or attached, solitary or colonial, creeping or swimming or pelagic. Some of them are **epizoic or parasitic**.
- The rotifers vary from 0.04 to 3 mm. in length.
- The body is divided into an anterior **head,** a trunk and a posterior **tail.** The head consists of a retractile, ciliated disc called the **corona** with a central · unciliated **apical field**. The corona is fringed with cilia.

• In some cases, the corona is surrounded by a double ciliated ring, the velum. It is made up of an outer ciliary band called **cingulum** and an inner ciliary band called **trochus.**

• There are three protruberances called **styligerous prominences** within the circlet of cilia. They bear s**tyles** or **vibratile hairs**.

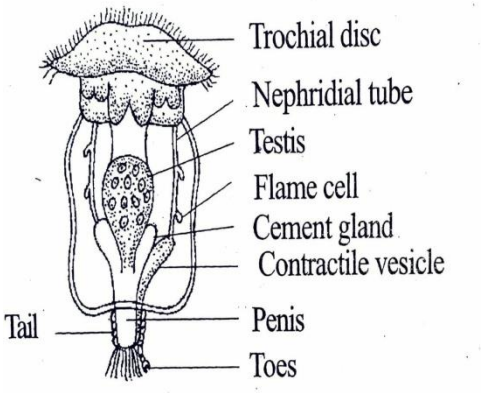
• The mouth is present on the ventral side of corona.

• An **eye** is present at the anterior end dorsally.

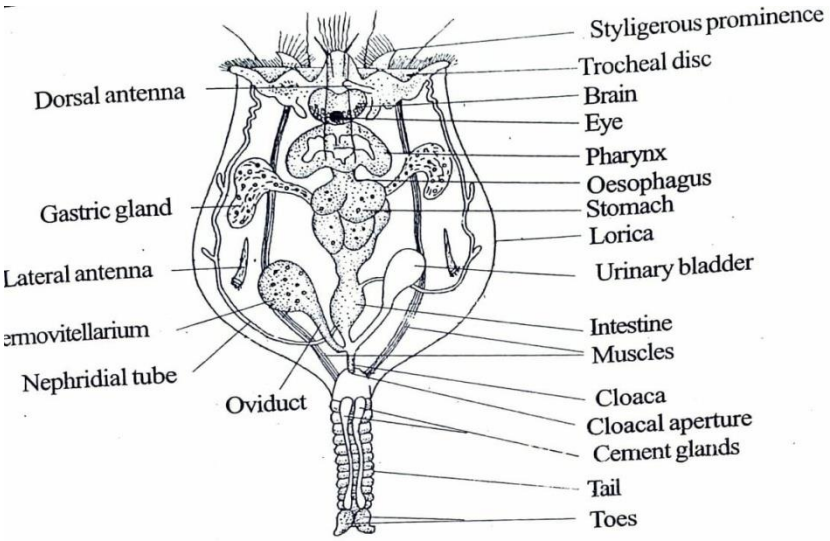
• The **trunk** is enclosed in a transparent case, the *lorica* which is formed of thickened **cuticle**.

• The **tail** is wrinkled and movable. It ends in two finger-like projections, the toes. The toes contain a pair of cement or pedal glands, the secretion of which serves for attachment.

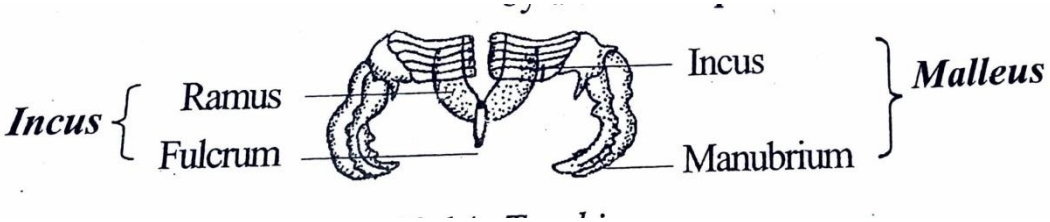
• At the junction of the trunk and the toes the cloacal aperture is situated.



Brachionous:male



Brachionous:Female



Trophi

- The body wall consists of a cuticle,
- Syncytial epidermis and isolated muscles. A continous layer of muscle is absent but there are isolated single muscle.
- , The body cavity is a pseudocoel. It is filled with a fluid containing a loose syncytial of amoeboid cells.
- , The mouth leads into a **buccal tube.** It leads into a **muscular pharynx or mastax**. The pharynx is provided internally with hard chitinous jaws called **trophy or internal jaw or dental mill.**
- The trophi are composed of a median incus and two lateral hammer-like bodies **mallei** .

- The incus is mae up of abasal piece called fulcrum which bears two branches, the rami,.
- Each malleus consists of a handle-like **manubrium** and an **incus**. .
- The trophi is used to grind the food materials.
- Two to seven **salivary glands** are present in the mastax wall.
- The mastax leads into an **oesophagus**. It opens into a stomach.
- A pair of gastric glands occurs inbetween the oesophagus and stomach. Stomach is followed by an intestine which opens into the cloaca. Cloaca opens out by clocal aperture.
- The digestive tract is lined by cilia (except pharynx). .
- Rotifers feed on micro-orgarusms.
- A pair of coiled nephridial tubes occurs on either side of the alimental canal. They extend and open behind into a **urinary bladder**. .
- Each tube is with lateral processes ending in flame cells.
- Anteriorly the nephridial canals are connected by a transverse renal commissure called **Auxle's anastomose** above the mouth.
- The nervous system consists of a bilobed ganglion, the brain, lying dorsal to the buccal tube. Various nerves radiate from the brain to various organs.
- **Cerebral eye** with red pigments is present.
- Papillae with sensory hairs called antennae or palps are present. They are tactile in function.
- There are 3 antennae, one is dorsal and median situated at the anterior end of the trunk and the other two are lateral in the posterior part of the trunk.
- The rotifers are **dioecious**. They ex hibit **sexual dimorphism** .
- The males are smaller than females.
- The body cavity is filled with a large testis. A **spermduct** leads from the testis and it opens to the exterior by the genital pore situated on a penis.
- female reproductive system consists of a single **germovitellarium**. It consists of an ovary and a large yolk gland or vitellarium. An oviduct leads from germovitellarinm to the cloaca.
- Fertilization is **internal**, cleavage is spiral and determinate. The embryos develops into the adult stage without metamorphosis.
- Reproduction takes place in two ways, by parthenogenesis and by **sexual methods**. There are two types of females, namely **amictic females** an **micticfemales**. The amictic females always produces thin shelled eggs, called **summer eggs or amictic eggs**.
- They are diploid eggs. They develop into both types of females. The mictic females lay mictic eggs. The .mictic eggs are thin walled and haploid. If the eggs are not fertilized, they develop parthenogenetically into males. If fertilized, the eggs are thick walled and called **dormant or winter eggs**. They can withstand

unfavourable conditions. After a dormant period they develop into females which produce summer eggs and the cycle is repeated.

Affinities

- Rotifers have relationsrup with arthropods: annelids and platyhehninthes.

Affinities with Arthropods

The affinity towards arthropods was based on certain resemblances such as:

1. Cuticle.

2. Apparent segmentation

3. Presence of jaws

4. The bristle bearing arms of Pedalion

suggest the resemblance to a crustacea.

Affinities with Annelida

1. Some rotifers show a close resemblance with the swimming trochophore larva. This resemblance leads to the conclusion that rotifers ,are simple annelids that have remained in a larval state.
2. At present this hypothesis is based chiefly on the peculiar rotifer **Trochosp-haera** whose

ciliary girdle, cmved intestine and excretory organs resemble the similar parts of the tro chophore. The corona resembles the ciliary circlets of trochophore.

Affinities with Platyhelminthes

The resemblance between the rotif ers and turbellarians are:

1. The coronal disc may be a remnant of the ventral ciliation of turbellarians.

2. The Protonephridial system with flame

cells is identical with that of the rhabdocoel.

3. The retrocerebral organ is homologous with the frontal organ of turbellarians.

4. The division off emale gonad into a vitellarium and germarium is similar to flatworms.

But rotifers have an anus. They are also .

lacking in a· continuous muscular layer and an

.

epideimal nerve plexus characteristic of_the turbellarians.

The development of the rotifers suggests that they are primitive forms and not a degenerate group. They are considered to have arisen from the creeping turbellarian. ·

They show a great resemblance to the turbellaria than to any other invertebrate group.

3. Phoronida

• Phoronida are tubicolous, vennif orm, coelomate, bilaterally symmetrical animals. It has two genera, the Phoronis and · Phoronopsis.

• They are lophophorate animals.

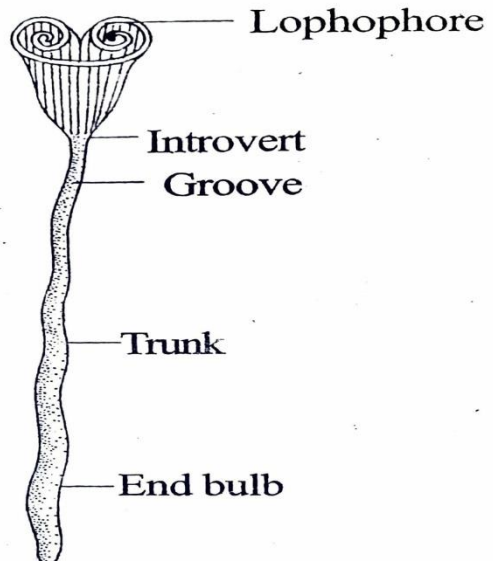
• The Phoronids are exclusively marine. • They are sedentary animals.

• They are **tubicolous** animals.

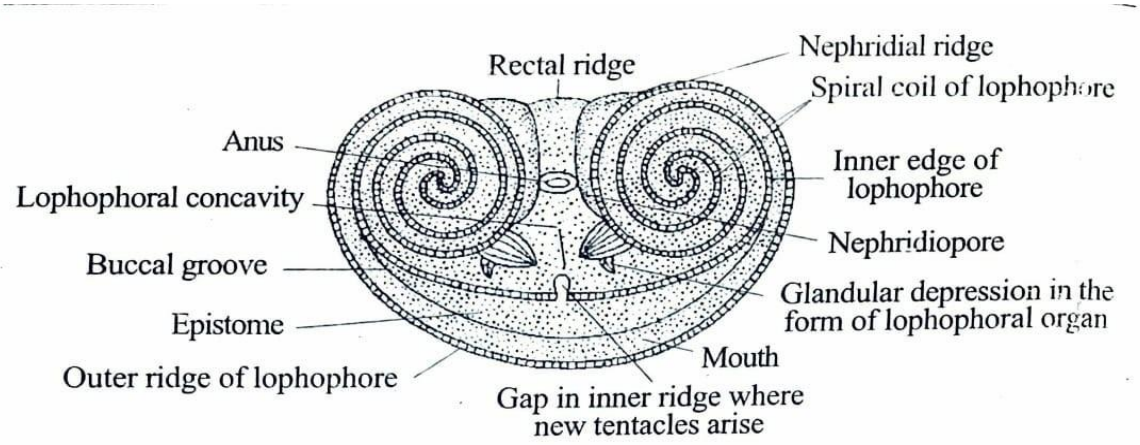
• • They live in groups. But they have no organic connection.

• Each phoronid occupies a membranous or leathery tube secreted by itself.

Phoronis



Phoronis: Lophophore magnified



- Inside the tube the animal can move freely. Particles such as sandgrains, sponge spicules, minute pebbles, etc. are adhering to the tubes.
- The body of phoronids is elongated, cylindrical and Unseg-mented. It is transparent ancl colour-less, but sometimes yellowish or greenish. The length varies in different species. the body is divided into an anterior **·lophphore** and a posterior **trunk**. The lophophore is a **horse-shoe shaped** tentaclar **crown**. It consists of two **prominent ridges** outer and inner, between which is a groove, the lophophoral groove leading into the median **mouth**. There are a number of hollow ciliated tentacles present on the lophophore. 'The tentacles are arranged in two rows, one ro borne by each ridge. The tentacles are supported by skeletal elements and are non retracti. The bases of the tentacles of each row are fused to form a membrane.
- The mouth lies between the two rows of tentacles and is continuous with the lophophoral groove on each side.
- Overhanging the mouth is a broad lobe known as the **upper lip or epistome**. At the base of the inner series of tentacles is a glandular pit called the **lophophoral gland**.
- The aus lies outside the lophophore. Two ciliated nephridial tubes open on either side of the anus.
- The trunkk is narrow, cylindrical and is without any appendages. The trunk is separated from the lophophore by a slight groove. It is of unifonn diameter throughout the lengtand terminates at the posterior end by an enlarged **end bulb**.
- The body wall consists of **cuticle, epidermis, basement membrane, muscular layers** (circular and longitudinal muscles) and the **coelomic epithelium**. The longitudinal muscles are not continuous but arranged in bundles.

- The body cavity is a coelom. It is divided into a small anterior section, the mesocoel or tentacular coelom and a large posterior section, the **mesocoel or trunk coelom** by a transverse septum.
- The coelom is lined with a **coelomic epithelium.**

The **alimentary canal** is 'U '-shaped and it consists of a mouth: oesophagus, the stomach, the intestine and rectum. The rectum opens out through the anus. Phoronids are **filter feeders**.

• **Circulatory system** is closed type. There are two contractile longitudinal vessels running along the trunk. A dorso-median or afferent vessel lies between the two limbs of the alimentary canal. The ventro-lateral or efferent-vessel runs along the left side of the oesophagus. These two vessels are connected anteriorly by a commissural vessel.

- Specialized **respiratory** organs are absent.

• **Excretory system** consists of a pair of **metanephridia** which opens to the exterior by **nephridiopore** on the side of the anus. It is an 'U' -shaped tube lined by the ciliated epithelium. It also acts as **gonoduct**.

• The **nervous system** includes nerve fibres and nerve cells which form a distinct nervous layer beneath the epidermis. This nervous layer is differentiated into a nerve ring surrounding the mouth. Nerves radiate to various organs from the nerve ring. There are two longitudinal nerve bands running along the body-wall.

• Special **sense organs** are absent. A pair of ciliated pits called lophophoral organs may be present. But its sensory function is doubtful.

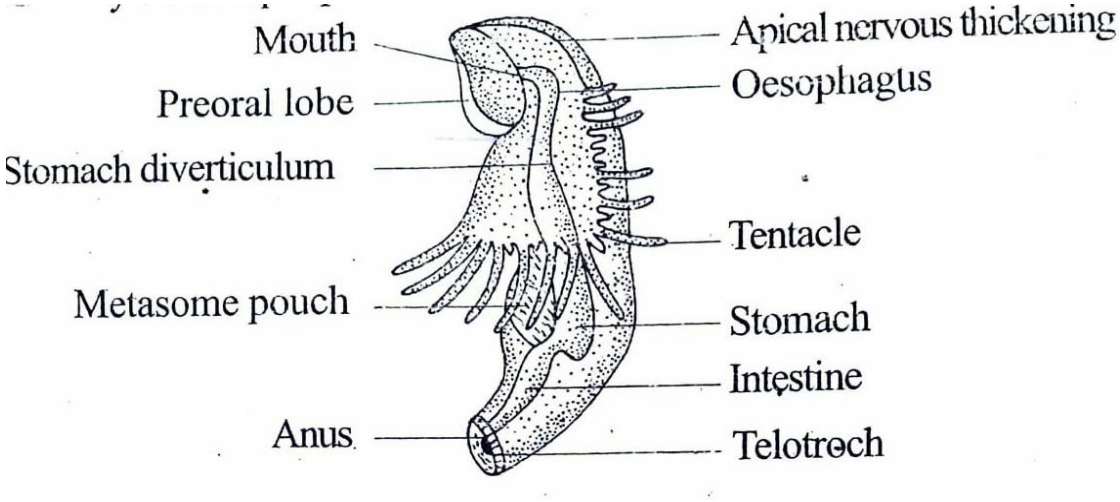
• Phoronis is **hermaphrodite**. Some may be **dioecious**. Genital elements are formed from the coelomic epithelium. The gonad are loose and indefinite masses located posteriorly

- The mature sperms and ova are released in the body cavity and pass out trirough the nephridia, to reach the concavity of the lophophore.

Development .

• Early stages of development takes place in the space between the tentacles .

• A free-swimming larva is formed. It is known as **actinotrocli**. It has a gelatinous transparent body and has a large ciliated pre oral lobe overhanging the mouth like a hood. Behind the mouth is a circlet of ciliated tentacles.



Actinotroch Larva

- The anus is surrouniled by a circlet of cilia, the **telotroch** is the chief larval locomotary organ. The preoral lobe has an apical thick- ening of ectoderm, the apical plate and an **eyespot**. A pair of excretory organs are present. They have no externa1 opening and are provided with solenocytes.
- A mid-ventral invagination or metasome pouch is present behind the girdle of tentacles. It is attached to the wall of the intestine.
- TI1e larva leads a free-swinmung life for a certain period and then settle down to the bottom and metamorphosis into an adult.

Affinities

Phoronida, Brachiopoda and Ectoprocta· are closely related. Hence they are together called **Lophophorata** or Tentaculata or Molluscoidea. Phoronids are related with Annelida, Gephyrea, Ascidiacea, Hemichordata, Brachiopoda and Ectoprocta.

Affinities with Brachiopoda

I. Occurrence of horse-shoe shaped lophophore.

2. Presence of an epistome.

3. The aliiuentary canal is 'U' –shaped.

4. A septum is present between mesosome and metason1e though poorly developed in Brachiopoda.

5. Presence of a sub-epidermal nervous plexus.

6. A pair of metanephridia occur which also serves as gonoducts.

7. Mouth originates directly from the blastopore.

8. Short dorsal surface between mouth and anus.

But a number of dissimilarities are noted between the two groups. ·

1. The nerve centre is supra-enteric in Phronida whereas in Brachiopoda~it is subenteric.

2. In Phoronida, larval tentacles are present which are lacking in Brachiopoda.

3. The shell of Brachiopoda cannot be comparable with the exoskeleton of Phoronida.

4. The chitinous setae are absent in Phoronida.

5. circulatory system in Phoronida is more advanced than that of the Brachiopod. lt is **closed type** in Phoronida.

6. The cleavage is spiral in Phoronida.

Affinities with Ectoprocta

. The relationship between Phoronida and Ectoprocta was emphasised by Caldwell (1882). They exhibit the following similarities.

1. Same type of divisions-in the body and coelom with definite septmn between mesocoel and metacoel.

2. Presence of horse-shoe shaped lophophore.

3. The alimentary canal is 'U'-shaped.

4. Presence of an epistome.

5. The nerve centre is located in the mesocoel and supra-enteric.

But they differ from both anatomical and embryological point of view. They differ in the

following respects.

1. The oringin of coelom in Phoronida is endomesodermal, whereas in Ectoprocta it is ectomesodermal.

2. The region between the mouth and anus is dorsal in Phoronida and ventral in Ectoprocta.

3. Circulatory system and nephridia are lacking in Ectoprocta while in poronida both are well developed.

Therefore due to the structural difference._the relationship between Ectoprocta and Phoronida can not be justified. 'The Phoronids are nearer to lophophorate ancestor because of the following similarities.

1. Presence oftentaculate lophophore.

2. Presence of septum between mesocoel and metacoel.

3. Closed type circulatory systein with dorsal and ventral vessels.

4. Larvae are of trochophore type.

5. 'U' -shaped alimentary canal:

Affinities with Annelida

• Phoronida show affinities with Annelida. The similarities are as follows:

1. The tentaculate lophophore of Phoronida can be comparable to the tentacular crown of Sipunculus.

2. Nephridial tubes act as gonoducts in both the groups.

3. The actinotrocha larva is considered to be a modified trochophore. Both are free swinuning, ciliated, pelagic forms with pre-oral lobe. Apical nerve plate and sensory cilia, similar digestive tract are present in both. Blastocoel communicates with the exterior through a pair of solenocytic protonephridia.

But phoronids and annelids are fundamentally different in their organization.

Affinities with Hemichordata

A relationship was established between Phoronida and Hemichordata by Masterman (1897) based on the following acts:

I. The division of body of Hemichordata (proboscis, collar and trunk) corresponds to the body division of Phoronida (epistome, mesosome and metasome).

2. A pair of glandular pockets opening into the anterior end of the stomach of Phoronida, is supposed to be the notochord.

3. A septum is present between the middle and posterior part of the body.

4. The location of lophophore is similar to the tentaculated anns of Cephalodiscus.

5. "Actinotrocha has 1nany enteropneust features of tornaria.

But they exhibit some differences also.

1. The three divisions of the body of Phoronida are not justified by embryological studies.

2. The mesocoel of Phoronida communicates to the exterior through the metanephridia which are absent in Hemichordata.

3. In Actinotrocha, the coelom is divided into three compartments, whereas in tro chophore the collar and trunk coelom are divided into two.

4. Glandular pockets in Phoronida are not considered to be the notochord.

So the relationship between Hemi chordata and Phoronida cannot be established.

Conclusion

- Members of Protostomia (Platyhelminthes, Nemertinea, Sipunculoidea, Echiuroidea, Annelida and Mollusca, etc.) appear to be related to one another because they exhibit spiral cleavage. formation of mouth at the site of blastopore, endomesodermal origin of coelom and free-swimming larva (trochophore). Deuterostomia (Hemichordata, Echino dennata, etc.) have body divisions into three parts, blastopore becoming anus, enterocoelous mode of origin of coelom and larva termed as **dipleurula**.
- The phoronids show similarities to Protostomia on one hand and to Deuterostomia on the other. So it f onns a sort of **connecting link** between Protostomia and **Deuterostomia**.