

Structure and Affinities of Minor Phyla Ctenophora

Phylum: Ctenophora

The name ctenophore comes from the Greek word which means “comb bearer”. Its name is better described by H. Foundalis and T. Christopoulos where the word “ctena” means comb and “phora” means to bear. The members of the phylum Ctenophora are known by many other names including comb jellies, sea walnuts and sea gooseberries. This phylum is small and contains about 50 species, the majority of which are planktonic and are found in throughout the water body. All ctenophores are pelagic and marine water living but some live in brackish water particularly in surface waters near shores. Most ctenophores are transparent, bioluminescent, fragile and gelatinous. *Pleurobrachia pileus*, *Bolinopsis infundibulum* and *Beroe cucumis* can be found in the coastal waters of the Irish Sea. *Pleurobrachia* and *Beroe* are cosmopolitan in their habitat, while majority have a more restricted distribution pattern. There is an endoparasitic species (*Gastrodes parasiticum*) known which is only 3 mm in diameter. Comb jellies are generally of small size except *Cestus* (*Girdle of Venus*) which may attain a length of more than 1 meter.

Classification

Phylum Ctenophora is classified into two classes depending upon the presence or absence of tentacles.

1. Class: Tentaculata: Ctenophores always bearing two long tentacles.

A. Order: Cydippida

- i. Body rounded or oval.
- ii. Tentacles branched and retractile into pouches.

Examples; *Pleurobrachia* and *Mertensia*

B. Order: Lobata

- i. Body moderately compressed with two large oral lobes to either side of tentacular plane.
- ii. Small tentacles not in pouches.

Examples: *Mnemiopsis*, *Bolinopsis*

C. Order: Cestida

- i. Body ribbon shaped and greatly compressed along tentacular plane.
- ii. The two principal tentacles and two of the four comb rows reduced.

Examples: *Cestum*, *Velamen*

D. Order: Platyctenida

- i. Body greatly flattened as a result of a reduction in the oral-aboral axis.
- ii. Adapted for creeping
- iii. Comb rows absent or reduced in adult.

Examples: *Ctenoplana*, *Coeloplana*

2. Class: Nuda: Ctenophores without tentacles.

A. Order: Beroida

- i. Body conical or cylindrical, somewhat flattened along the Tentacular plane.
- ii. Mouth muscular.

Example: *Beroe*

***Pleurobrachia* (Sea gooseberry)**

1. **Habit and Habitat:** *Pleurobrachia* is free swimming, transparent and a marine pelagic animal, commonly found in coastal waters. Its size varies from 17-20mm in length. It is biradially symmetrical instead of radially symmetrical.
2. **Body Structure:** It has a pear shaped body about 5 to 20mm. in diameter, broader at the aboral end and narrower at the oral end.
 - A narrow, slit like mouth is present at the oral end, while a balancing organ called statocyst and two anal pores are present at the aboral end.
 - The external surface of the body bears eight rows of transverse plates called meridional bands (costae or comb rows) placed at regular intervals. Each meridional band is present just above the meridional canals originating from the stomach inside the body. Each meridional band bears a series of small horizontally placed plates called comb plates.
 - Each comb plate is made of large cilia fused together at their attached ends on the surface of the body and resembles the teeth of the comb.
 - The cilia present on the comb plates help the animal in swimming. Towards the aboral end there are two tentacular pouches, one on each side of the animal.
 - The two tentacular pouches are deep ectodermal invaginations opening on the surface of the aboral end. They extend into the interior to terminate on opposite sides of the pharyngeal region of the digestive system.

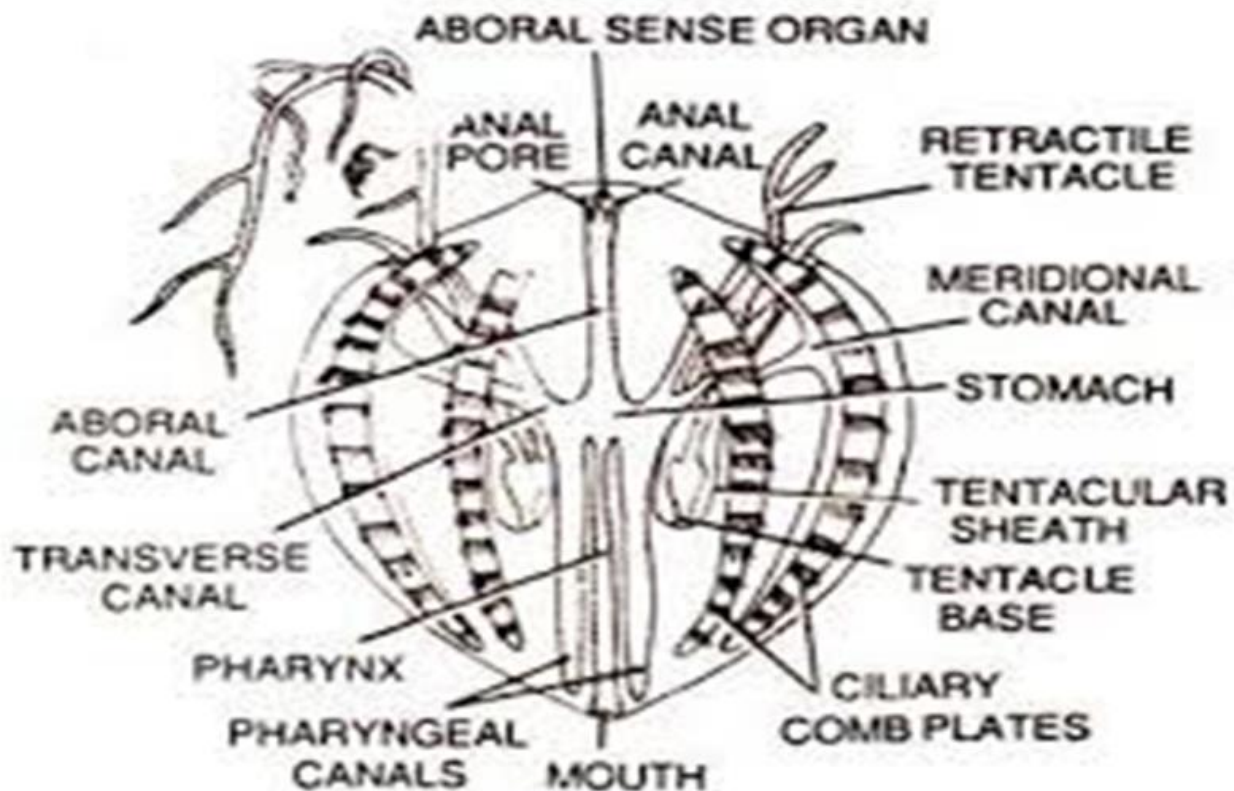


Fig. *Pleurobrachia* Side View.

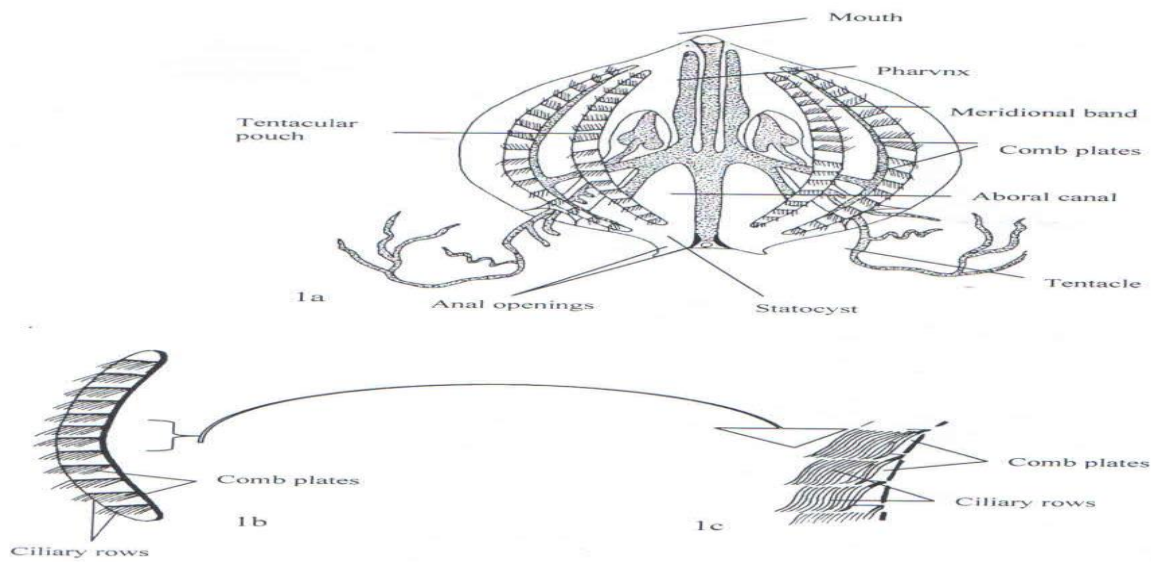


Fig. 1a Side view of *Pleurobrachia*. Fig. 1b. A single meridional band. Fig. 1c. Comb plates enlarged

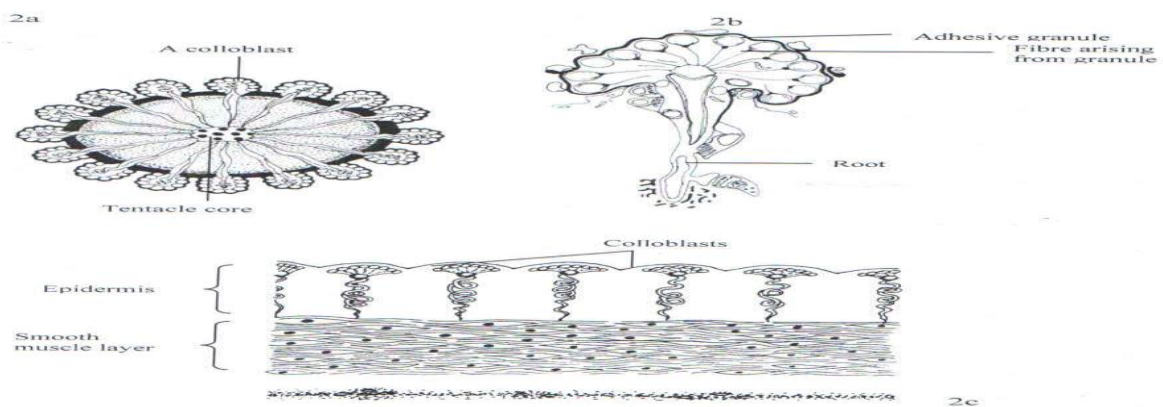


Fig. 2a. Transverse section through a tentacle
2b. A single colloblast
2c. A section of the epidermis showing arrangement of Colloblasts

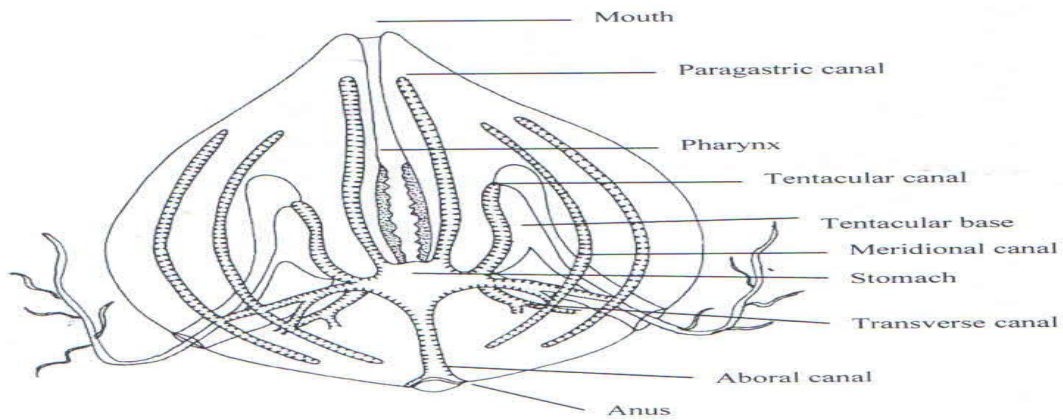


Fig. 3. Digestive system of *Pleurobrachia* shown with mouth upside.

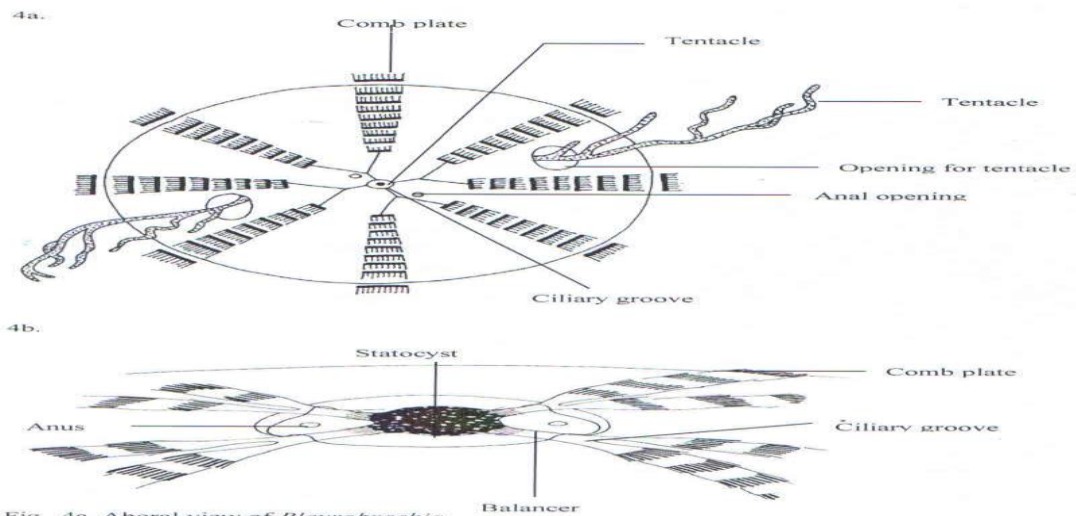


Fig. 4a. Aboral view of *Pleurobrachia*.
Fig. 4b. Enlarged aboral view of the ctenophore to show statocyst.

3. Body wall: The body wall consists of an outer epidermis, an inner gastrodermis, and a thick gelatinous mesogloea. Epidermis bear characteristic cells called colloblast.

- Each colloblast cell consists of a hemispherical, bulbous, sticky head connected to a long, straight filament and a spiral contractile filament.

- The epithelial walls of the meridional canals include cells specialized for light production (bioluminescent photocytes), osmoregulation (rosettes), endocytosis and intracellular digestion, gametogenesis (gonads), and fluid transport (monociliated cells).
 - The muscles of ctenophores develop from amoeboid cells found within the mesogloea. Therefore, the resulting muscle fibers actually are located in the mesogloea layers suggesting that ctenophores may be triploblastic.
- 4. Food and feeding:** They are voracious predators like other ctenophores. They capture their food by extending two long, tentacular arms. Prey is caught by becoming stuck on the adhesive colloblasts that line the tentacular branches. Once the prey is caught, the comb jelly retracts its arms and gets the food into its mouth.
- The food of this predator consists of fish eggs and larvae, molluscan larvae and adults, zooplanktons and even other ctenophores.
- 5. Gastrovascular system:** It starts with the mouth present at the oral end of the animal. Mouth leads into a flattened, highly folded pharynx lined by epidermis.
- The pharynx runs about two-third of the distance and narrows down to the stomach near the center of the animal. From the stomach arises an extensive system of canals.
 - It includes 8 meridional canals inside the body, bearing 8 comb plates on the external surface, 2 tentacular canals around the tentacles, 2 pharyngeal canals running parallel to pharynx.
 - Stomach and all the gastrovascular canals are lined with ciliated, secretory and phagocytic cells. All these canals are meant for the intracellular digestion, and also act as the distributing system for the food, water and oxygen.
 - Extracellular digestion starts in the pharynx with the secretion of hydrolytic enzymes. Partially digested food moves into the stomach.
 - From the stomach, food is circulated into the canal system with the help of ciliary current. Partially digested food is phagocytosed and digestion is completed intracellularly.
 - Undigested food passes through the aboral canal and is thrown out through one of the two anal pores present at the aboral end of the body.
- 6. Bioluminescence:** They exhibit luminescence. Light is produced in the walls of the meridional canals which appear to be emitted from the comb plates present on the meridional canals.
- 7. Locomotion:** Locomotion is performed by the activity of comb rows having partially fused long cilia.
- The power stroke of the cilia of each comb plate beat towards the aboral surface of the animal, and the ctenophore swims with the mouth forward.
 - Ctenophore locomotion depends largely upon the coordinated activities of the comb rows.

- Some ctenophores use these comb rows for feeding and to run away from the predators.
- 8. Nervous system:** Nervous system is in the form of net work of nerve fibers similar to those of the hydrozoan polyps. There is an epidermal net work of nerves and nerve cells underneath the epidermis. This nerve net is specifically better developed beneath the comb rows.
- 9. Sense organ:** An organ of equilibrium called statocyst is present at the aboral end and thus also called as an aboral organ.
 - It contains a calcareous statolith. The statolith is situated on four tufts of balancers.
 - Each balancer may consist of several hundred cilia. From each balancer arise two ciliary grooves. Each ciliary groove is attached to the posterior ends of the comb rows. Therefore, there are eight ciliary grooves attached to the eight meridional canals respectively.
 - When the body of the animal is displaced from its vertical orientation, pressure of otolith on one or two of the balancers are increased. With the result, beating rate of its cilia gets changed.

Mechanism to maintain equilibrium: Animal is displaced by water currents → pressure of statolith on any one or two balancer is increased → beating rate of cilia of balancer is changed → cilia of ciliary groove beats → cilia of comb plates beats faster → animal moves and restore its vertical position.

- 10. Respiration:** There is no special organ meant for respiration. Exchange of gases takes place through general surface of the animal by a simple process of diffusion.
 - As food enters within the body through mouth, a ciliary current is maintained within the body which helps in oxygenation of the body too. In addition carbon dioxide is diffused of the body in the outgoing water through mouth.
- 11. Reproduction:** It is hermaphrodite i.e. it bears both male and female sex organs.
 - Gonads of both sexes are located in the lining of the meridional canals (gastrovascular canals). Each of which has an ovary extending along the whole length of one side and a testis along the whole length of the opposite side.
 - The sex organs are so arranged that in adjacent canals those of the same sex face one another.
 - Gametes are first released through numerous small gonopores in the meridional canal, then into the digestive tract, and finally released in the sea water through mouth.
- 12. Fertilization and Development:** The mature eggs and sperms are released out in the water through mouth. The mature egg consists of a central mass of vacuolated yolk and a peripheral layer of protoplasm containing the nucleus.
 - The fertilization is external and cleavage starts soon after fertilization. Cleavage is highly determinate i.e. cell fates are fixed at the first cell division.

- Gastrulation is achieved by epiboly (a process in which dividing micromeres spreads over the macromeres) or invagination (a process in which macromeres start moving inside the blastocoel and forms the inner layer).
- Mesogloea is secreted later on in between the two layers. The gastrula develops into a characteristic cydippid larva which resembles the adult. The body of cydippid larva is spherical and it has 8 comb rows, a mouth, a statocyst, two tentacles and it resembles the adult.
- The tentacles base invaginates to form a tentacular sheath and tentacular canal. The lateral filaments also develop on the tentacles. That is how cydippid larva grows into adult.
- Cydippid larva is considered as a true larval stage besides the fact that it undergoes a gradual change to metamorphose into an adult.

Affinities

The Ctenophores are of considerable zoological interest. It has many characters in common with cnidarians but still differ from them and other group of animals in many respects

A. Features of ctenophores which they share with cnidarians:

- i. The radial and tetramerous symmetry of the body like the medusa of the hydrozoans.
- ii. Presence of gelatinous mesogloea within ectoderm and gastroderm.
- iii. Arrangement of parts along oral-aboral axis.
- iv. Presence of branching gastrovascular canals and absence of coelom.
- v. Presence of tentacles and statocyst.
- vi. Endodermal nature of gonads.
- vii. Presence of nematocysts in the ctenophore *Euchlora rubra*, which possess them but it is reported that they are derived from the cnidarians it has used as a prey.

B. Ctenophores differ from the cnidarians in the following respects:

- i. Presence of 8 meridional rows of comb plates arranged in oral –aboral axis.
- ii. Origin of muscle cells from the mesoderm or mesenchyma.
- iii. Special adhesive cells called colloblasts instead of nematocysts of cnidarians.
- iv. Only two tentacles coming out from the tentacular sheaths instead of many tentacles present on the periphery of the medusa.
- v. Position of tentacles towards the aboral surface shows biradial symmetry.
- vi. Only one statocyst is present at the aboral end in contrast to medusa in which there are 8 statocysts present at the base of the tentacle.
- vii. Digestive system is better organized, with mouth on oral end, and two anal openings at the aboral end, while cnidarians have only mouth but no anal opening.
- viii. Determinate type of cleavage, which shows that the organ forming areas are determined at a very early stage.

- ix. Presence of distinct larval stage, the cydippid larva, and absence of planula larva of cnidarians.
- x. Absence of polymorphism which is exhibited by cnidarians.
- xi. Always found singly in contrast to hard, colonial structures like corals present in cnidarians.

C. Affinities with Platyhelminthes:

- i. Presence of dorso-ventrally and uniformly ciliated body as in *Coeloplana* and *Taenoplana*.
- ii. Presence of creeping forms like *Coeloplana* and *Taenoplana*.
- iii. Presence of branched gastrovascular canals and thus are considered related to Polycladida, which are supposed to be ancestral to the remaining flat worms.
- iv. Early cleavage, like segmentation and gastrulation are similar

Advancement of ctenophores over cnidarians:

- Among the Cnidarians, the Ctenophora seems to be more closely related to Hydroctena, a trachyline from which it arose along with the Scyphozoa and Actinozoa.
- Since among the turbellarians, acoela and not polycladida are regarded more primitive, the theory of the affinity with the turbellarians does not seem to be well founded.
- Possibly they are not directly in the line of evolution of the higher animals at all, but indicate to us how morphological differentiation has taken place by the development of the mesenchyma.
- There is no doubt that the ctenophores are much more advanced than the cnidarians. This is reflected by the nature of the development, the existence of separate muscle cells and their mode of origin and the presence of a permanent aboral nervous region.
- These features have led some scientists to regard the ctenophores as the ancestors of the turbellarians.