

Taxonomy of Phylum Mollusca

General characters of Phylum Mollusca

The name Mollusca (in Latin *mollis* = soft), was first used by the French Zoologist, Cuvier in 1798 to describe squids and cuttlefish, animals whose shell is reduced and internal or entirely absent. It was only later that the true affinities between squids and multiform and other molluscs such as snails and bivalves were fully recognised. Next to arthropods from biodiversity perspective, molluscs comprise the largest group of species. Over 160,000 species have been described, of which around 128,000 are living and about 35,000 have been recorded as fossil species. Molluscs range from forms that are only a few millimeters in diameter to the largest of all invertebrates many meters long. Like arthropods, molluscs are also found in all habitats. In the sea they occur from the deepest ocean trenches to the intertidal zone of inshore area. They are also found in estuaries, back waters, lagoons and rivers as well as on land. Molluscs occupy a wide range of habitats.

General characters

- 1. The body soft and bears no segmented appendages.
- 2. Body divided into three regions,
 - (i) Head (which may be indistinct in pelecypods).
 - (ii) Ventral, muscular foot (used for creeping, swimming) or even adhesion (arms of cephalopods).
 - (iii) Visceral mass
- 3. Bilaterally symmetrical; viscera and shell coiled in gastropods and in some cephalopods.
- 4. Body triploblastic made up of 3 germ layers.
- 5. Body skin single layered, mostly ciliated and with mucous glands.
- 6. Body usually small and soft, enclosed in an envelope, the mantle that secretes shell of various shapes and sizes.
- 7. Shell if present, usually univalve or bivalve, constituting an exoskeleton, internal in some species.
- 8. A visceral mass contains internal organs, including the digestive tract, paired kidneys and reproductive organs. Visceral mass surrounded by a tegument or mantle, the outer edge of which may secrete a shell.
- 9. A mantle that surrounds but does not cover entirely the visceral mass and secretes a shell (if present). The mantle also contributes to formation of gills or lungs. The mantle forms a fold delimiting a pallial or mantle cavity which is flooded by water entering from outside. The gills are housed in the mantle cavity.
- 10. A head/foot region containing sensory organs and a muscular structure (foot) used for locomotion. The foot a muscular structure used for locomotion, attachment to a substrate, food capture or a combination of functions.
- 11. In many animals radula or a rasping organ present, the radula appears in the buccal cavity, bears many rows of teeth, used for grazing on food. It tears up food.
- 12. Coelom reduced and represented mainly by pericardial cavity, gonadal cavity and kidney.
- 13. The alimentary canal either straight or coiled. Jaws present in many, especially in gastropods and cephalopods.
- 14. Respiration by general body surface or mantle or by one to many gills or a lung in the mantle cavity.
- 15. Sexes usually separate (some hermaphrodite and a few protandric); gonads 2 or 1 with ducts; fertilization external or internal.
- The phylum Mollusca is divided into six classes. The most important class of living molluscs is the Gastropoda comprising more than 80% of all living mollusc species.

Class 1: Monoplacophora

The Monoplacophorans were considered as fossils from the Cambrian and Devonian period. In the year 1952, 10 living specimens of *Neoplina* from deep water off the Pacific coast of Mexico were collected. The collected specimens were named as *Neoplina galathea*. In subsequent years, a second species *N. ewingi* was also discovered. These are the only two living species of this class.

Key characters

- Bilaterally symmetrical animals, metamerically segmented but segmentation internal.
- Shell dorsal and consisting of a single piece (hence the name Monoplacophora).
- Mantle covering the dorsal surface of body.
- A large flattened foot surrounded by the pallial groove, in which situated 5 or 6 pairs of gills externally.
- 8 pairs of dorso-ventral pedal retractor muscles.
- Coelom consists of pericardial cavity and the cavity houses two pairs of gonads.
- Mouth anterior, median and anus posterior-median.

Eg. Neoplina galathea

Class 2: Amphineura

In Greek, Amphi means both and Neuron means nerve. These are the most primitive molluscs.

Key characters

- Body either elongated and vermiform or dorso-ventrally flattened.
- Head indistinct, without eyes and tentacles.
- Foot broad, flat, sole-like and ventral in position.
- Shell and mantle covering the body from dorsal and lateral sides.
- 6-60 pairs of gills situated laterally in the pallial cavity on either side of foot, sometimes they may be reduced to a pair.
- Mouth and anus at the opposite ends of body.

Class Amphineura is divided into two orders,

Order-1. Aplacophora

- The body long, narrow, worm like, shell absent.
- Mantle contains tiny calcareous spicules.
- Foot reduced or absent
- Gills absent or reduced to a pair located in the cloacal cavity.

Eg. Chaetoderma, Neomenia

Order-2. Polyplacophora

- Body elliptical, convex dorsally and flattened ventrally.
- Shell dorsal and formed of eight calcareous pieces arranged in a longitudinal row.
- Mantle with spicules disposed along the margins.
- Gills 6 to 8 pairs, present in the pallial groove on the lateral sides of foot.
- Foot greatly expanded, forming a large flattened sole, used for locomotion and for maintaining firm contact with the rock surface.
- Head without eyes and tentacles.
- Well developed radula.

Eg. Chiton

Key to the family Chitonidae

Phylum : Mollusca

Class : Amphineura

Order : Polyplacophora

Family : Chitonidae

Family Chitonidae

- The shell valves generally clearly demarcated lateral areas, sculptured or more rarely smooth.
- The insertion plates are characteristically pectinately toothed.

- The girdle is covered with scales, elongated spines or small bristles.

Genus Chiton

- Body elongate, elliptical with a convex dorsal surface.
- Shell divided into eight overlapping transverse calcareous plates. The first one is cephalic plate and the last one is anal plate.
- Foot, head and visceral mass ventral in position.
- Head small, cylindrical inconspicuous structure not distinctly marked off from the rest of the body; provided with a labial palp on either side of the mouth.
- Eyes and tentacles absent.
- Peripheral area of mantle, called the girdle very heavy extending beyond the lateral margins of the plates.
- Foot broad, flat and muscular.
- Pallial groove lodges ctenidia or gills, mid-ventral anus, two real apertures and two genital apertures.

Class 3: Gastropoda

Key characters of class Gastropoda

In Greek, Gastro means stomach and Podos means foot. Gastropods are the most successful group of mollusc not only in terms of the number of species, but also in the wide range of habitats in which they are found. Marine species have become adapted to living on all types of substratum and have even adapted to a pelagic existence. Others have successfully invaded all types of freshwater habitats as well as the land.

Key characters

- Asymmetrical body with a mantle and shell.
- Single shelled animals, often conical, wound around an axis or columella. The shell as a whole constitutes the spire which is composed of a varying number of whorls. The tip of the cone is the apex, while the base is formed by the last whorl which is wider and borders a circular or oval opening.
- Shows greater degree of cephalization, as head is distinct, bearing tentacles, eyes and a mouth.
- Foot ventral and muscular.
- The visceral mass, placed dorsally, twisted into a coil.
- A dorsal tegumental fold forms the mantle delimiting a pallial cavity within which are generally located the respiratory organs and anus. The pallial cavity is in open communication with the surrounding water.

11.2. Morphology of a gastropoda shell

- The spire consists of windings or whorls juxtaposed at the level of the lines of suture. The last whorl encompasses the opening of the shell, the outer rim of which is called the outer lip. The columella may be solid or hollow and in the latter case it opens to the exterior by the umbilicus. Usually, the shell opening circular, having no notch; holostomatous; or provided with a siphonal canal; siphonostomatous.
- Dextral form shells twisting from left to right are most common and sinistral form shells twist from right to left.

Subclass 1. Prosobranchia (Streptoneura)

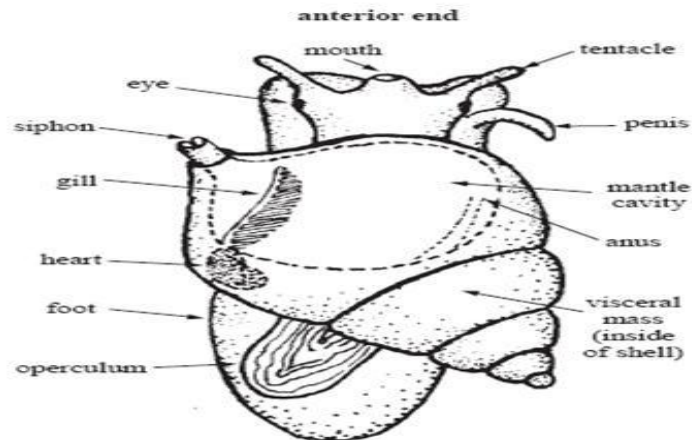
- All species that come under this class are exclusively marine. The visceral nerve commissures twisted, hence the name Streptoneura (Gr. streptos = curved, neuron = nerve).
- The mantle cavity containing the pallial complex opens anteriorly.
- The gills or ctenidia, if present, lie in front of the heart hence the name Prosobranchia.
- Head has a single pair of non-retractile tentacles.
- Calcareous shell with an operculum.

Subclass Prosobranchia is divided into three orders

- **Archaeogastropoda,**

- Mesogastropoda
- Neogastropoda.

Morphology of a prosobranch gastropod



Order 1. Archaeogastropoda (Aspidobranchia)

- Due to incomplete atrophy of organs, the kidneys, auricles, nephridia and ctenidia are paired.
- Ctenidia bipectinate or plume-like.
- Ospheridium poorly developed.

This order has two sub-orders.

- (i) Docoglossa
- (ii) Rhipidoglossa

Sub-order (i) Docoglossa

- Shell and visceral mass conical.
- Ctenidium single or absent or replaced by secondary gills.
- Radula with three marginals on either side.

Eg. *Patella*

Family Patellidae

- The shell either strongly elevated and conical or cap-shaped, with the apex placed either in the middle or nearer the front margin.
- The outer surface smooth or more often radiately ribbed, and sometimes even tuberculated. The aperture ovate or rounded.
- The animals popularly known as limpets, live firmly attached to the substratum by means of their broad, oval, flattened foot.

Systematic position

Class : Gastropoda

Sub-class : Prosobranchia

Order : Archeogastropoda (Aspidobranchia)

Sub-order : Docoglossa

Super-family : Patellacea

Family : Patellidae

Genus *Patella*

Characters

- Body oval with convex dorsal surface.
- Shell oval and cone-like, with a conical projection from its dorsal surface; no operculum.
- Head laterally produced into a pair of small, stout tactile tentacles.
- Simple eyes at the base of tentacles.

- Foot ventral and sole-like for creeping.
- True mantle restricted to the anterior end and secondary mantle cavity developed between foot and mantle.
- Radula with very few, strong hooked teeth.
- Secondary pallial cavity around the foot, containing a series of secondary branchiae.
- Heart with single auricle.

Suborder (ii) Rhipidoglossa

- Shell spiral.
- Ctenidia paired.
- Radula with numerous marginals.
- Eg. *Haliotis*, *Trochus*

Family Haliotidae

- The shell pearly within and marked by flattened with a greatly depressed spire;
- The body whorl and aperture very large.
- The margin of the body whorl is perforated by a series of circular openings through which sensory processes of the mantle project during life.
- The foot broad, ovate and without an operculum.

Systematic position

Class : Gastropoda

Sub-class : Prosobranchia

Order : Archaeogastropoda (Aspidobranchia)

Sub-order : Rhipidoglossa

Super-family : Pleurotomariacea

Family : Haliotidae

Genus *Haliotis*

- Ear shaped shell with small flattened spire;
- Aperture very large; without operculum;
- Shell perforated by a series of marginal slits through which project the tentacular processes of the mantle;
- Large foot with epipodia;
- Eyes stalked, at the outer bases of the tentacles;
- Large mantle cavity with bipectinate ctenidia or gill, right being smaller.

Family Trochidae

- Shell usually pearly with in, seldom porcellaneous and almost always with a well developed spire.
- Typically the shell cone-shaped, but sometimes more rounded with more or less inflated whorls and occasionally much flattened.
- The foot provided with an epipodium and operculum horny.

Systematic Position

Class: Gastropoda

Subclass: Prosobranchia (Streptoneura)

Order: Archaeogastropoda (Aspidobranchia)

Sub-order: Rhipidoglossa

Super-family: Trochacea

Family: Trochidae

Genus *Trochus*

- Small to large species with conical or globose shell having a flat or convex base and an oval aperture;
- Body whorl rounded or angular;
- Columella smooth or with a single blunt tooth;
- Base with or without an umbilicus;
- Outer lip smooth or ridged internally;
- Brightly coloured and boldly patterned, top shells pearly, within operculum chitinous, thin, flexible, circular and usually multi-spiralled, brown striate and heavy.

Order 2. Mesogastropoda (Pectinibranchia)

- Mesogastropoda are advanced snails showing complete atrophy of the left side with unpaired auricle, nephridium, osphradium and ctenidium.
- Ctenidium monopectinate or comb-like, attached to the mantle throughout its entire length. Edge of the shell opening lacks a siphonal notch or canal.
- Foot may be operculate.
- Osphradium pectinate and well differentiated.

Eg. *Lambis*, *Cypraea*

Family Strombidae

- Shell very large with high conical spires;
- Lips greatly expanded with variable number of spines or finger-like projections;
- Body whorls bear spirally arranged nodules;
- Operculum horny; curved and slender.

Systematic position

Class: Gastropoda

Sub-class: Prosobranchia

Order: Mesogastropoda (Pectinibranchia)

Super-family: Strombacea

Family: Strombidae

Lambis lambis

- Shell large and heavy;
- Outer lip prolonged into digitate processes;
- Siphonal canal long and slightly turned the left side;
- Columella and interior of aperture smooth and shiny;
- Aperture cream or light rose colour with yellowish ting;
- Operculum long brown and transparent.

Family Cypraeidae (True cowries)

- Dome-shaped hemispherical shell, ovate to pyriform, highly enameled;
- Smooth or occasionally pustulose surface;
- Aperture moderately narrow; labial and columellar lips denticulate;
- Fossula smooth or ribbed, extremities truncate or produced;
- Base of shell convex or flat;
- No spines in the adult, juveniles strikingly different from adult;
- A spiral shell present in the early stage but on maturity the outer lip turns in, thickens and teeth develop on it and the inner lip (columella);
- The shell then turns ovate pyriform, domed, globular or hemispherical; a pair of long, filiform tentacles bearing eyes at their outer bases;
- Foot broad and extensible; mantle cavity containing an arched ctenidium with several lamellae, a triradiate osphradium and a large hypo-branchial gland;
- Radula long and taenioglossate.

Genus *Cypraea*

- Shell very large, thick, pear-shaped;
- Dorsum strongly elevated;
- Basal surface concavely depressed;
- Teeth on both the lips very strong, especially labial tooth, stout;
- Aperture narrow at anterior and pale yellowish white with large rounded blackish spots;
- Each spot encircled by blue grey ring; base pure white.

Order 3. Neogastropoda (Stenopoda)

- Carnivorous species with an eversible proboscis.
- Osphradium large and bipectinate.
- Foot operculate.
- One gill with filaments in one row.
- Shell has a siphonal canal.

Eg. *Murex*, *Turbinella*, *Oliva*, *Conus*

The order Neogastropoda is divided into two sub-orders.

Sub-order 1. Stenoglossa

Radula narrow containing not more than three large teeth in each row.

Eg. *Murex*, *Turbinella*,

This sub-order consist the following Families.

Muricidae

Vasidae

Olividae

1. Family Muricidae

Shells spindle-shaped; varies ornamented by spines or tubercles; anterior canal present; carnivorous; radula rachiglossate.

Systematic Position

Class: Gastropoda

Sub-class: Prosobranchia

Order: Neogastropoda (Stenopoda)

Sub-order: Stenoglossa

Super-family: Muricea

Family: Muricidae

Genus *Murex*

- Shell spirally coiled with 3 or more rows of beautiful spines of different lengths.
- Bipectinate osphradium present.
- Head prolonged into a long proboscis; retractable within the proboscis sheath.
- Adrectal glands present, secreting a dye the Jyrian purple (Yellow in colour).

2. Family Vasidae

Shells large, thick and heavy; spires moderately elevated with tuberculated shoulder ridge; columella bears strong folds; radula rachiglossate.

Systematic Position

Class: Gastropoda

Order: Neogastropoda

Sub-order: Stenoglossa

Super-family: Volutacea

Family : *Vasidae*

Turbinella pyrum

- Shell large; thick, pear-shaped and covered with a brownish horny periostracum.
- Spire high and apex pointed;
- Whorls have slightly angulated shoulders;
- The one on the body whorl is distinct;
- Shoulder ridges bear a series of small, compressed tubercles;
- Columella thickened with callus and bears four transverse folds;
- Anterior canal wide open;
- Shell ivory white upon removal of periostracum.

3. Family *Olividae*

Shell oblong and barrel shaped; operculum absent; shell highly polished and glossy; columellar callus with numerous five folds; radula rachiglossate.

Systematic Position

Class: Gastropoda

Order: Neogastropoda

Sub-order: Stenoglossa

Super-family: Volutacea

Family : *Olividae*

Oliva gibbosa

- Shell smooth and shiny with beautiful colour pattern on the outer surface;
- Spire very short and the columella thickened;
- Mantle lobes meet over the back of the shell and protect the shell from erosive action shell oblong and stout and has a long and narrow aperture;
- No operculum;
- Very large and broad foot.

Sub-order 2. *Toxoglossa*

Radula has two rows of grooved harpoon-like teeth, arranged loosely; they are used to inject poison into the prey.

Eg. Conus

Family *Conidae*

- Small to large shells;
- Moderately long, conical spire and long and narrow aperture;
- Sculpture with spiral cords, grooves, granules or sutural coronations;
- Periostracum thin and moderately translucent or thick and opaque;
- Operculum small, horny and dark brown.

Systematic position

Class: Gastropoda

Sub-family: *Streptoneura*

Order: Neogastropoda

Sub-order: *Toxoglossa*

Super-family: *Conacea*

Family : *Conidae*

Conus milne-edwardsi (*Cone shells*)

- Shell upto 100 mm, heavy, glossy, elongate biconic;
- Spire elongate, whorls stepped, concave above and spirally ridged, shoulder of last whorl slightly keeled;
- Body with white netted with large, orange brown to darker brown tents and irregular areas and 3 irregular spiral bands of reddish brown blotches;
- Spire whorls with similar colour, aperture white to cream.

Sub-class 2. Opisthobranchia

- All species that come under this subclass are exclusively marine. Due to detorsion of visceral mass, visceral loop becomes untwisted hence named (Gr. Euthus = Straight, Neuron = nerve).
- Mantle cavity displaced posteriorly.
- Head with two pairs of tentacles.
- Shell and operculum, if present, reduced.
- Usually one auricle and one nephridium present.
- Ctenidia replaced by secondary gills.

Subclass Opisthobranchia is divided into eight orders.

Order 1. Cephalospidea

- Burrowing forms having shield like head.
- Shell and mantle cavity moderately developed.
- Lateral parapodial lobes prominent.

Eg. Bulla

Order 2. Anaspidea

- Crawling or burrowing forms, having a pair of rhinophores on head.
- Shell small and internal.
- Mantle cavity reduced on right side.
- Parapodial lobes prominent.

Eg. Aplysia

This order consists of the most common Opisthobranch, Aplysia.

Family Aplysidae

- The shell small, more or less completely covered by the mantle, horny or calcareous, scarcely inflated and with a reduced or rudimentary spire.
- The head without well defined shield and bears four flattened or cylindrical tentacles.
- Well developed parapodia present, directed upwards at sides of body. The sole of foot long and narrow.

Systematic position

Class : Gastropoda

Subclass : Opisthobranchia (Euthneura)

Order : Anaspidea

Family : Aplysidae

Sub-family : Aplysinae

Genus Aplysia (Sea hare)

Genus Aplysia

- Body soft, lumpy with a visceral hump;
- Head with 2 pairs of tentacles; anterior pair large and ear-like; posterior pair is olfactory and bear eyes at the base;
- Shell thin reduced, transparent; enclosed by mantle;
- Foot muscular elongated and pointed posteriorly with lateral out growths, the parapodia, mantle possesses unicellular ink glands.
- Order 3. Thecostomata (Shelled pteropods)
- Shell spirally coiled or a non-spirally pseudo-conch.
- Mantle cavity well developed.
- Parapodial fins large.

Eg. *Clio*, *Limacina*

Order 4. Gymnostomata (Naked pteropods)

- Planktonic animals without shell and mantle cavity.
- Small ventral parapodial fins present.

Eg. Pneumoderma

Order 5. Notaspidea

- Shell external or reduced and internal.
- Mantle cavity absent, but a skirt like projection of mantle covers gill on the right side.

Eg. Pleuorbranchus

Order 6. Acochliidae

- Small without shell and gill.
- Naked visceral mass projecting behind the foot and covered with spiracles.

Eg. Acochlidium

Order 7. Sacoglossa

- Herbivorous, arthropods with a modified radula and suctorial pharynx.
- Shell may be present or naked, slug-like, with a gill.

Eg. Elysia, Oxynoe

Order 8. Nudibranchia (Acoela) (True sea-slugs)

- Naked bilaterally, symmetrical sea-slugs without shell, mantle cavity, ctenidia and osphradium.
- They have secondary gills around anus or surface outgrowths or cerata.

Eg. Doris, Tritonia

Sub-class 3. Pulmonata

- The ctenidia absent and replaced by pulmonary sac or lung.
- Shell simple spiral or vestigial or absent and operculum never occur.
- Tentacles one or two pairs; a pair of eyes present.
- Due to torsion, the nervous system becomes secondarily symmetrical due to shortening of connectives and concentration of ganglia into a circum-esophageal ganglionic complex.

The sub-class is divided into two orders,

Order 1. Basommatophora

- One pair of tentacles with the eyes at the base.
- Shell delicate with a large aperture.
- Some forms with secondary gills.

Eg. Limnea

Order 2. Stylommatophora

- Two pairs of retractile tentacles. Eyes lodged on the tip of posterior pair of tentacle.
- Shell internal, reduced or absent.
- Mostly terrestrial.

Eg. Helix

Class 4: Bivalvia

The Bivalvia (also referred to by some authors as the Lamellibranchia or Pelecypoda) is the second largest class of the molluscs. They show much variation in body form yet share a basic morphology. They are mainly marine, but a few species are found in freshwater habitats, although none have invaded the land. Many species of bivalve are of commercial importance.

Key characters

- Body bilaterally symmetrical, laterally compressed with extensive mantle lobes which secrete a single shell composed of two halves.
- The two halves of the shell hinged dorsally where they held together by a new structure, the ligament and completely enclose the rest of the body, the inner side of the mantle delimits the pallial or mantle cavity which has an open communication with the surrounding water.
- No distinct head; eyes, tentacles and radula absent.
- Muscular foot wedge shaped or tongue shaped adapted for burrowing.
- Two lamellar gills one on either side of mantle cavity, the fusion of which produce respiratory and food-carrying currents of water.
- The visceral mass and the foot situated ventrally, the foot hatched-shaped and used to dig into the substrate or to adhere by elastic attachment threads (byssus) to hard objects.
- In the burrowing forms, the two edges of the mantle gets fused except at the level of the foot and form two siphons, one of which (inhalent or ventral siphon) allows the water to enter the pallial cavity and the other (enhalent or dorsal siphon) ejects the water together with the faeces.

Structure of a bivalve

Planes of symmetry

- Shell bilaterally symmetrical composed of a left and a right valve.
- Apex, umbo or beak correspond to the anterior region.
- Margins that can be distinguished in a shell anterior, posterior, dorsal, ventral and ligamentary

Shapes of the shell

The two valves may be alike (equivalve shell) or unequal (inequivalve shell) and in some groups ear-like. Shapes are variable.

Outer surface of the shell

The edge of the mantle secretes the shell which bears longitudinal or concentric growth striations, transversal or radiating striations. The shell may also bear ribs (radiating; or, concentric, which are sometimes ornamented with ridges, keels, spines spiny plates, or tubercles). The longitudinal striations may form folds or be grouped in ridges.

Inner surface of the valves

They bear the scars (traces of attachment) of the ligament which opens the shell and of the adductor muscles which close it. There are also scars left by the muscles of the siphon (Siphonal impression) and by the edges of the mantle (pallial line). There may be two adductor muscles (dimyous), either equal in size (homomyous) or unequal (heteromyous); or only one adductor muscle (monomyous). The hinge is formed by lateral and cardinal teeth set on a cardinal plate.

The class Bivalvia is divided into 3 sub-classes.

Sub-class 1. Palaeotaxodonta

Sub-class 2. Cryptodonta Resource

Sub-class 3. Pteriomorphia Resource

Sub-class 1. Palaeotaxodonta

- Contains primitive living molluscs.
- Shell valves similar to one another, often triangular or oval in shape.
- Numerous short teeth along the hinge between the two shells and the two adductor muscles are equal in size.

- Large foot having flattened ventral surface.
- Gills with leaf-like filament; not used for feeding.

Sub-class 2. Cryptodonta

- Primitive mollusks
- Hinge may possess a row of short teeth, but often absent.
- Two adductor muscles present.
- Gills with leaf-like filament; used for feeding too.

Sub-class 3. Pteriomorphia

- Fixed or sedentary bivalves that include the economically important mussels, scallops and oysters.
- Shell valves may have a wing-like process extending from the hinge area.
- Anteriorly situated beaks of each valve well separated from one another by a triangular area on the dorsal margin of one or both valves.
- Hinge may possess a row of teeth, but frequently reduced or absent.
- Two adductor muscles of equal size in some, but in others anterior one is reduced or absent.
- Foot is small; many are cemented to the substratum by one shell valve or attached by byssal threads.
- Edges of mantle not fused together to form siphons.
- Gills long and narrow; each is bent back upon itself.

Order 1. Mytiloida

- Contains mussels and pen shells.
- Shell valves similar; wedge or fan-shaped.
- Beaks situated at or close to the anterior end of each valve.
- Hinge teeth and anterior adductor muscles greatly reduced or absent

Family Mytilidae

- Shell anteriorly narrow, elongated, equilateral;
- Ligament external; true hinge absent;
- Mantle has one point of union posteriorly separating the exhalent aperture from the rest of the pallial opening.

Systematic position

Class: Bivalvia

Sub-order: Pteriomorphia

Order: Mytiloida

Super-family: Mytilacea

Family: Mytilidae

Genus *Perna*

- Umbo terminal, hinge teeth are not more than two;
- Anterior adductor muscle absent.
- Posterior byssal retractors are split into two widely separated bundles.

Examples:

1. *Perna viridis* (Green mussel)

- Umbonal end of the anterior extremity of the shell beak-like being directed downwards,
- Two small hinge teeth on the left valve and on the right valve,
- Ventral shell margin concave and the posterior margin of the mantle smooth without any papillae.

2. *Perna indica* (Brown mussel)

- Straight umbonal end of the anterior extremity of the shell without a beak-like bend,
- Only one hinge tooth on the left valve,

- Ventral margin of the shell straight and the posterior ventral margin of the mantle with about 20 branched papillae.

Family Pinnidae

- Large and moderately thin, with a pointed anterior extremity and a terminal umbo situated at this end, gradually widening posteriorly, hind end being gaping;
- Ligament elongated and placed in a groove;
- Hinge toothless;
- Anterior adductor muscle small;
- While the posterior large byssus strongly developed.

Systematic position

Class: Bivalvia

Sub-class: Pteriomorpha

Order: Mytiloida

Super-family: Pinnacea

Family: Pinnidae

Pinna bicolor (Fan shells)

- Shell broadly to attenuately triangular in shape, posterior margin truncate or convex-rounded, valves heavy and thick or rather thin and fragile;
- Valves translucent and of light horn to dark purplish brown colour, 8 to 17 radiating ribs which are sometimes scarcely visible present;
- Spines almost absent except in posterior region;
- Fine concentric growth lines present;
- Dorsal margin or straightly convex;
- Interior valves light smoky horn to dark purplish brown in colour, nacreous area iridescent.

Order 2. Pterioidea

- Contains scallops and oysters.
- Shell valves dissimilar and thickened; may be strongly sculptured, ribbed or having spiny projections.
- Wing-like processes of variable size and shape occur on the shell valves, but not in the oysters.
- Few or no teeth along the hinge.
- Anterior adductor muscle small or absent.

Family Pectinidae

- Shell inequivalve; often with radial ribs or folds;
- Hinge margin moderately long, without true hinge teeth, sometimes with diverging lamellar or stout anterior and posterior teeth;
- Anterior adductor muscle wanting;
- Ligament often bears a triangular and medial nodule placed in a groove; shell usually brightly coloured.

Systematic position

Class: Bivalvia

Sub-class: Pteriomorpha

Order: Pterioidea

Super-family: Pectinacea

Family: Pectinidae

Genus *Pecten*

- Two shells unequal; right shell being larger and more convex;
- Single large adductor muscle, divided into parts and larger of these served for rapid contraction which cause swimming movements;

- Foot very much reduced but in larva very well developed and used for locomotion;
- Two large and crescentic gills present; mantle tentaculiferous and encloses viscera;
- Large number of stalked eyes present at regular intervals along the edges of the mantle.

Classification of edible oysters

Some of the bivalve molluscs belonging to different families are commonly called 'hammer oysters' (Family: Isognomonidae), pearl oysters (Pteriidae), edible oysters (Ostreidae), window-pane oysters (Anomiidae) and finger oysters (Solenidae). However, whenever the name oyster is used without any prefix it means only the edible oyster. Though as many as 11 species of oysters occur in Indian Coasts, only 4 species occurs abundantly. They are *Crassostrea madrasensis*, *C. cucullata*, *C. gryphoides* and *C. discoidea*.

Family Ostreidae

- Foot very reduced;
- No byssus gland;
- Gills fused to the mantle;
- Shell fixed to the substratum by the left valve, larger than right one.

Systematic position

Class: Bivalvia

Sub-class: Pteriomorpha

Order: Pterioidea

Super-family: Ostreacea

Family: Ostreidae

Genus *Crassostrea*

- Shell irregular shaped;
- Attached to the substratum by the lower left valve;
- Hinge toothless, with linear margin, ligament partly external;
- Laminated upon a trigonal area in each valve;
- Only one adductor muscle (posterior adductor muscle) present;
- Promyal chamber present;
- Chalky deposits lamellated.
- *Crassostrea madrasensis*
- Shell straight, shape irregular, covered by numerous foliaceous laminae, left valve deep, right one slightly concave,
- Hinge narrow and elongated,
- Adductor scar sub-central, reniform and dark purple in colour,
- Inner surface of valves white, glossy and smooth, purplish black colouration on the inner margin of the valves.

Family Pteriidae

Systematic position

Class: Bivalvia

Sub-class: Pteriomorpha

Order: Pterioidea

Super-family: Pteriacea

Family: Pteriidae

Genus *Pinctada*

- Hinge long and straight;
- Long axis of the shell at right angles to the hinge, left valve little deeper than right;
- Byssal notch present on each valve at the base of the anterior lobe;
- Colouration of periostracum varies; often brownish with radial markings.
- *Pinctada fucata* (Gould) (Pearl oyster)

- Hinge teeth present in both the valves, one each at the anterior and posterior ends of the ligament;
- Anterior ear larger than in other species; by ear slit-like;
- Posterior ear fairly well developed;
- Posterior border of the shell has a small or moderately large sinus;
- Adductor impression large and subcentral;
- 12-15 small scars caused by the insertion of pallial muscles between the umbo and the anteroventral border;
- Convexity of valves greater than in other species of the genus.

Order 3. Ostreoida

Window pane oysters come under this order

Family Placunidae

- Shell usually irregularly rounded; often thin and translucent; smooth or sculptured; inner surface usually pearly;
- Byssal notch absent;
- Right valve bears a deep byssal cleft in the young shell which disappears completely in adult.

Systematic position

Class: Bivalvia

Sub-class: Pteriomorpha

Order: Ostreoida

Sub-order: Pectinina

Super-family: Anomoidea

Family: Placunidae

Placuna placenta (Window pane oyster)

- Shell large; subcircular, flat compressed;
- Left valve little convex, whereas the right valve little concave;
- Line straight;
- Very short, with two ventrally diverging crurlate teeth supporting ligament material;
- Concentric sculpture of very thin appressed lamellae which are radially vermiculate;
- Inner surface smooth, glossy and displays brilliant pearly iridescence;
- Umbo small, inconspicuous;
- Adductor impression occurs at about the centre of the valve as well as defined neniform mark.

Class 5: Scaphopoda

One of the smaller classes of molluscs, the scaphopods or tusk shells, are burrowing marine molluscs. They are found mainly in the deep sea but a few species occur in shallow waters.

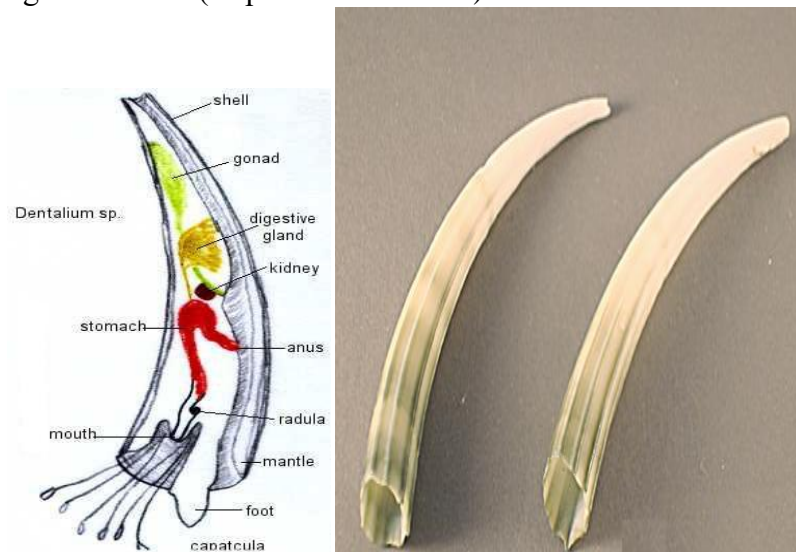
Key characters

- Body elongated, along the anterior-posterior axis.
- Body has a tubular tusk or tooth-shaped shell open at both ends.
- Head reduced and lacks eyes, but surrounded by numerous thread like tentacles or captacula.
- The captacula possess an adhesive knob at their tip together, small particles of food present in the sand and pass them to the mouth.
- Gills absent.
- Mantle tubular, completely enclosing the body.
- Mouth surrounded by lobular processes or outgrowth.
- Foot reduced for digging.

Scaphopoda has two families

Family (i) Dentaliidae

1. Foot trilobed having two epipodial lobes and one hypopodial lobe. Eg. Dentalium
Eg. Dentalium (elephant's tusk-shell)



Family (ii) Siphonodentaliidae

- Foot elongated and capable of expansion into a terminal disc.

Eg. *Pulsellum*

Class 6: Cephalopoda

Among the entire invertebrate groups, cephalopods are considered as much advanced groups. Though they have a good fossil record, presently 800 species of cephalopods have been recorded in world waters. They are one of the most interesting groups of molluscs due to their high level of organization and the complex behavior patterns that they exhibit. These species are exclusively marine.

Key characters of Cephalopoda

- Bilaterally symmetrical.
- Shell spiral chambered, usually with or without shell embedded in mantle. Mantle encloses posteriorly and ventrally a large mantle cavity.
- Body may be globular or oval or arrow-shaped and have fins on the sides.
- Body divided into a head and trunk.
- Head bears a pair of large lateral eyes and mouth. Mouth bears jaws and radula.
- Trunk consists of symmetrical and uncoiled visceral mass.
- Foot altered into a series of large prehensile suckers bearing arms of tentacles encircling the mouth.
- Ventrally, a tegumental fold forms a strongly muscular mantle delimiting a pallial or mantle cavity which houses 2 gills.
- Animal moves backward by means of a jet of water produced by a ventral siphon, or funnel placed behind the head.
- Fin inserted laterally may surround the body (cuttlefish) or divided into two lateral fins placed more or less posteriorly (squid).

Morphology of hard parts

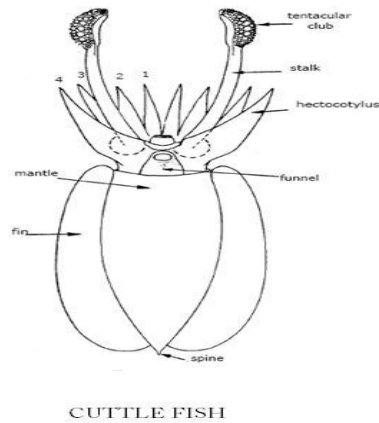
An internal shell, dorsal in position either calcified or horny and transparent (pen or gladius in squid and cuttlebone in cuttlefish). In Octopoda, the shell is reduced to a plate of connective tissues.

Cephalopods lacerate their prey with their parrot beak formed by a dorsal and a ventral mandible.

Cephalopoda is divided into two sub-classes.

Sub-class 1. Nautiloidea

Sub-class 2. Coleoidea or Dibranchiata



Sub-class 1: Nautiloidea

- Shell external, coiled and chambered, more than 10 (63 to 94) circumoral appendages without suckers,
- Two pairs of gills, funnel bilobed.

Eg. Nautilus pompilius



Sub-class 2. Coleoidea or Dibranchiata

- Shell internal, embedded in tissue, calcareous, chitinous or cartilaginous,
- 8 or 10 circumoral appendages with suckers,
- Only one pair of gills, funnel, tube-like.

This subclass is divided into 3 orders.

Order 1. Sepioidea

Order 2. Teuthoidea (Squids)

Order 1. Sepioidea (Cuttlefish)

- Internal shell (Sepion) calcareous and either straight and laminated or coiled and chambered or restaged and chitinous or absent.
- Eyes covered with skin and a supplementary eyelid present.
- Eight sessile arms.
- Two tentacular arms contractile and retractile into pockets.
- Suckers without stalks.
- Fin lobes free posteriorly.

Family Sepiidae

- Body either elongate and broad or very slender and dorsoventrally flattened.
- Fins marginal and narrow, extending all along mantle on either side.

- Internal shell (sepion) present.
- Head free from dorsal mantle.
- Light organs absent.

Genus *Sepia*

- Body without a glandular pore at posterior extremity.
- Cuttlebone mostly with a spine (rostrum) at posterior end.

Sepia pharaonis

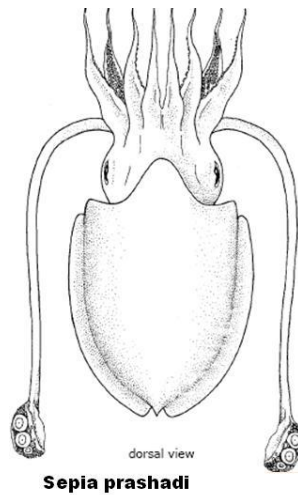
- Body wide muscular, ovoid or elliptical in shape;
- Broadest part of body excluding fins equal or distinctly more than half of mantle length;
- Fins marginal, moderate to wide;
- Cuttlebone chalky, elongate, wide nearly ovoid in shape.
- Fins broad commencing from edge of anterior mantle margin;
- Tentacular clubs moderately long and well expanded; 5 or 6 suckers in middle row of manus greatly enlarged;
- Cuttlebone broad, thick, with a midventral groove flattening anteriorly in striated area;
- Striae 'A' shaped;
- Inner cone forms a conspicuous yellowish flat ledge;
- A sharp thick spine present;
- When live, body brownish, tiger stripe pattern prominent.



Sepia pharaonis

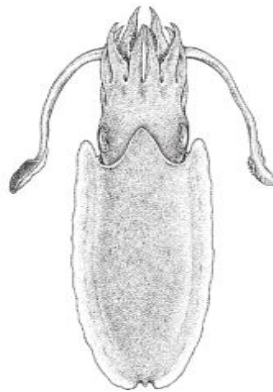
Sepia prashadi

- Body wide, muscular, ovoid or elliptical in shape;
- Broadest part of body excluding fins equal or distinctly more than half of mantle length;
- Fins marginal, moderate to wide;
- Cuttlebone chalky, elongate, wide nearly ovoid in shape.
- Fins narrow commencing a few mm behind edge of anterior mantle margin;
- Tentacular clubs short, expanded;
- Not more than 3 suckers in middle row of manus greatly enlarged;
- Cuttlebone narrow, midventral groove narrow and distinct, striae anteriorly broadly truncate with lateral corners slightly produced forward;
- Dorsal surface pinkish in colour;
- A sharp thin spine present, when live, dusty brownish, transverse stripes less distinct.



Sepia aculeata

- Body wide, muscular, ovoid or elliptical in shape;
- Broadest part of body excluding fins equal or distinctly more than half of mantle length;
- Fins marginal, moderate to wide;
- Cuttlebone chalky, elongate, wide nearly ovoid in shape.
- Tentacular clubs very long, with 10-14 rows of minute sub-equal suckers;
- Cuttlebone broad, thick with a median longitudinal ridge, a faint groove running medially on striated area;
- Inner cone forms a ledge-like callosity.



Sepia brevimana

- Body wide, muscular, ovoid or elliptical in shape;
- Broadest part of body excluding fins equal or distinctly more than half of mantle length;
- Fins marginal, moderate to wide;
- Cuttlebone chalky, elongate, wide, nearly ovoid in shape.
- Tentacular clubs short with 6-8 small subequal suckers.
- Cuttlebone flat and distinctly acuminate anteriorly, dorsal surface rugose, a shallow median groove in the striated area, the striae 'A' shaped with a median shallow groove broadening anteriorly;
- Inner cone and its limbs pinkish in colour;
- Spine small, sharp and slightly curved.

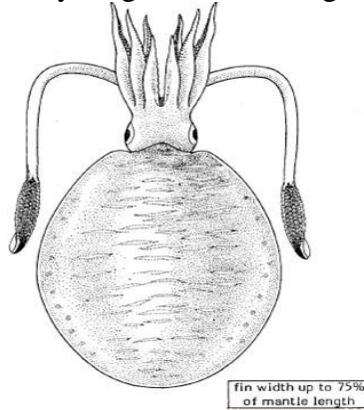
Order 2. Teuthoidea (Squids)

- Internal shell (gladius or pen) chitinous, feather or rod-shaped.
- Eight sessile arms.
- Two tentacular arms contractile but not retractile, pockets absent, tentacles lost secondarily in some.
- Suckers stalked and with or without hooks.
- Finlobes fused posteriorly.
- Eyes either covered or open and without supplementary eyelid.

- Sub-order Myopsida (Neretic squids)
- Eyes completely covered with a corneal membrane.
- Sub-order Oegopsida (Oceanic squids)
- Eyes not covered with a corneal membrane and open to the surrounding medium.

Sepioteuthis lessoniana

- Body elongate, cylindrical in outline.
- Elliptical in shape.
- Fins marginal, wide and muscular, very long almost running along entire length of mantle.



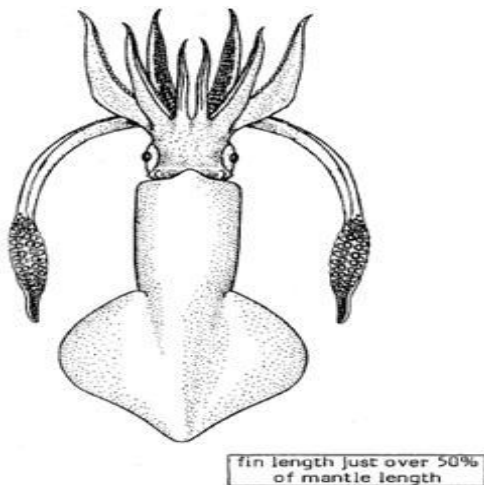
Sepioteuthis lessoniana

Loligo

- Body elongate, narrow, either slender or stout, sides parallel or tapering.
- Fins narrow, terminal, running less than 65% of mantle length, rhombic in shape.

Loligo duvaucelli

- Body elongate, moderately large, posterior end of mantle blunt;
- Head and arm crown more than 50 percent of mantle length; vane of gladius narrow throughout.
- Fins typically rhomboid.
- Mid-rib of gladius not visible through mantle skin;
- Length of fins 50-57 percent of mantle length;
- Tentacular clubs large, median manal sucker ring with 14-17 teeth;
- In males, distal half of left ventral arm hectocotylized, papillae not fused.



Doryteuthis sibogae

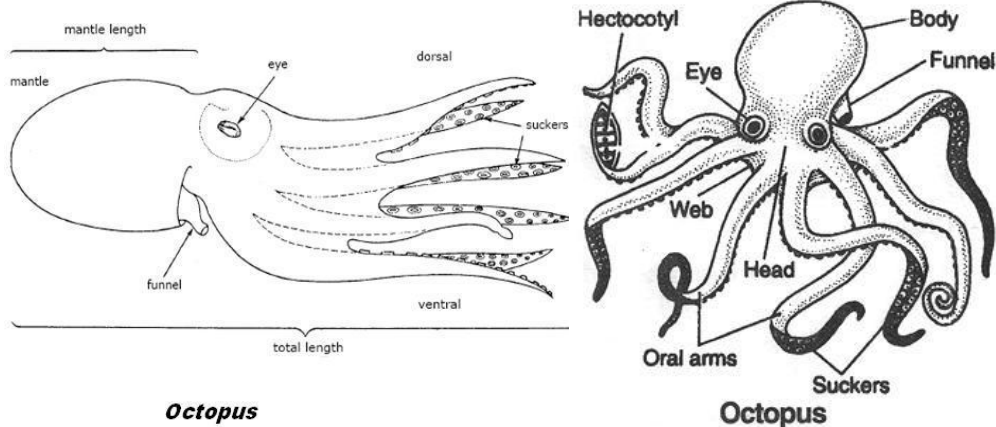
- Mantle long, narrow and slender; widest at middle; from the point of insertion it becomes narrow and tapers to a sharp end posteriorly.

- The middorsal projection of the mantle pointed anteriorly; the corresponding ventral margin of mantle emarginated.
- The fins typically rhombic in shape, narrow, occupying less than 60% of mantle length.
- Funnel short with an anterior free portion racking up to the anterior margin of the eyes; funnel furrow deep.
- Arms short, usually in the order 3:4:2:1.
- All arms keeled and slightly compressed.
- Less than half of left ventral arm hectocotylyzed distally in males.
- Gladius narrow, sharply acuminate posteriorly.



Order 3. Octopoda

- Shell and Nidamental glands absent.
- Body rounded or oval and with no lateral fins.
- Eight arms; suckers without stalks and without chitinous ring.
- Tentacles absent.
- Fins absent except in few deep water species.
- Light organs absent.



Family Octopodidae

- Octopus have eight arms;
- without an external shell;
- Internal shell either vestigial or lacking;
- Great disparity seen in males and females in size;
- Benthic in habitat.

Octopus aegina

- Body elongated-oval;
- Moderately large in size;
- Dorsal surface of body and arm with reticulate pattern;