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**M**olluscs are soft-bodied invertebrates belonging to the phylum Mollusca, which includes Gastropoda, Bivalvia and Cephalopoda. The remaining groups such as Monoplacophora (cap-shaped neopilinids), Polyplacophora (chitons), Scaphopoda (tuskshells), Solenogastres (crawling worm-molluscs), and Caudofoveata (shell-less burrowing worm-molluscs) are known to a much lesser extent. Brief description about the major groups of molluscs is given in Table 1.

Molluscs have been exploited for food, pearls, and shells. The estimate number of species of molluscs vary from different parts of the world, however, estimates number of existing species are about more than 1,00,000 (Haszprunar and Wanninger, 2012). About 5070 species have been reported from India belonging to 290 families and 784 genera. Nearly 3,370 species of molluscs are recorded from marine habitat (Venkataraman and Wafar, 2005). Among these, gastropods are the most diverse, followed by bivalves, cephalopods, polyplacophores and scaphopods. At present over 1.5 lakh tonnes of cephalopods, over 1 lakh tonnes of bivalves and nearly 20,000 t of gastropods are exploited from Indian waters. The large number of marine gastropods (19 species) followed by bivalves (4 species) and cephalopod (1 species) has been placed in the endangered list which is a major cause of concern (Table 2). The collection, possession and trading of these scheduled molluscs (Table 2) or their products (live or dead) are prosecuted and will attract a punishment of severe imprisonment up to 7 years along with heavy fine under section 50, 51 of wildlife (Protection) Act 1972.

Table 1. Major groups of molluscs (Source: Haszprunar and Wanninger, 2012)

Gastropoda	Comprises more than 1,00,000 species that inhabit all marine, freshwater and terrestrial habitats and size range from 0.5 mm to 100 cm in body length. All types of feeding habits (filter-feeders, herbivores, predators, ecto- and endoparasites, and detritivores) and all mode of reproduction are found in this group.
Bivalvia	Includes more than 20,000 extant species (1mm to over 150 cm) that live in all kinds of marine and freshwater habitats. They are not only filter feeder, but also include detritivorous and carnivorous bivalves. Some of them also use symbiotic zooxanthellae for nourishment. Most are epibenthic or burrow in soft bottoms, some burrow in limestone, wood (e.g. shipworms). Fertilization is mostly external. Trochophore, veliger and glochidia type larvae are known in this group.
Cephalopoda	Comprises only about 1,000 extant species that inhabit exclusively marine and range from 3 cm up to 7m in body length. Some members (Nautiloidea and Ammonitoidea) have external shells, while all other (Coleoidea) have internal, reduced / lost shells. All bear 8 - 10 arms (about 80 arms in Nautilus) for capturing prey. Fertilization is external.
Scaphopoda	Includes about 800 marine species of 2mm to 20 cm body length. They burrow in sand or mud and feed chiefly on foraminiferans. Fertilization is external and they have lecithotrophic (trochophore-like) larvae.
Monoplacophora	Comprises less than 30 extant species with a size range from 1-40 mm long. They inhabit from about 200 m down to 7000 m depth. Dorsal surface is protected by a single cup-shaped shell and the mode of feeding is more or less similar to those of chitons.
Polyplacophora	Includes about 1000 extant marine species with range from 3mm to 30 cm body length. Dorsal side is protected by eight serial plates. They are mostly either herbivorous or detritivorous. They have strong rasping tongue for food uptake. Fertilization is external and they have lecithotrophic (trochophore-like) larvae.
Solenogastres	Includes small marine group (280 species) of 1mm to 30 cm body length covered with cuticle with spicules or scales. They live interstitially and feed on cnidarians. The mode of reproduction is through copulation and they have lecithotrophic (modified trochophore or pericalymma - type) larvae.
Caudofoveata	Comprises small marine group (180 species) of 2mm to 15 cm body length covered with cuticle with spicules or scales. They burrow in sand or mud and lose their foot sole entirely. They have lecithotrophic (modified trochophore type) larvae.

Table 2. Scheduled marine molluscs from India

Endangered list of molluscs	
Class: Gastropoda	
1	<i>Cassis cornuta</i> (Linnaeus, 1758)
2	<i>Charonia tritonis</i> (Linnaeus, 1758)
3	<i>Conus milneedwardsi</i> Jousseume, 1894
4	<i>Cypraecassis rufa</i> (Linnaeus, 1758)
5	<i>Tudicla spirillus</i> (Linnaeus, 1767)
6	<i>Staphylaea limacina</i> (Lamarck, 1810) (= <i>Cypraea limacina</i> )
7	<i>Leporicypraea mappa</i> (Linnaeus, 1758) (= <i>Cypraea mappa</i> )
8	<i>Talparia talpa</i> (Linnaeus, 1758) (= <i>Cypraea talpa</i> )
9	<i>Pleuroploca trapezium</i> (Linnaeus, 1758) (= <i>Fasciolaria trapezium</i> )
10	<i>Harpulina arausiaca</i> (Lightfoot, 1786)
11	<i>Dolomena plicata siboldi</i> (G.B. Sowerby II, 1842) (= <i>Strombus plicatus siboldi</i> )
12	<i>Ophioglossolambis digitata</i> (Perry, 1811) (= <i>Lambis crocea</i> )
13	<i>Lambis millepeda</i> (Linnaeus, 1758)
14	<i>Lambis scorpius</i> (Linnaeus, 1758)
15	<i>Lambis truncata</i> ([Lightfoot], 1786)
16	<i>Harpago chiragra</i> (Linnaeus, 1758) (= <i>Lambis chiragra</i> )
17	<i>Harpago arthriticus</i> (Roding 1798) (= <i>Lambis chiragra arthritica</i> )
18	<i>Rochia nilotica</i> (Linnaeus, 1767) (= <i>Trochus niloticus</i> )
19	<i>Turbo marmoratus</i> Linnaeus, 1758
Class: Bivalvia	
1	<i>Hippopus hippopus</i> (Linnaeus, 1758)
2	<i>Tridacna maxima</i> (Roding, 1798)
3	<i>Tridacna squamosa</i> Lamarck, 1819
4	<i>Placuna placenta</i> (Linnaeus, 1758)
Class: Cephalopoda	
1	<i>Nautilus pompilius</i> Linnaeus, 1758

## Commercially exploited molluscs of India

### Cephalopods

Squids, cuttlefishes and octopuses are the three groups of cephalopods exploited from Indian seas (Table 3). The main species occurring in commercial catches are *Uroteuthis*

(*Photololigo duvaucelii* (= *Loligo duvauceli*), *Sepia pharaonis*, *S. aculeata* and *Amphioctopus neglectus* (= *Octopus membranaceus*).

Table 3. Commercially exploited cephalopods from Indian Seas (Source: Mohamed and Venkatesan, 2017)

Species	Common Name	Distribution
<b>Squids</b>		
<i>Uroteuthis (P.) duvaucelii</i>	Indian squid	All along Indian coast
<i>Loliolus (N) uyii</i>	Little squid	Chennai & Visakhapatnam
<i>U (P) edulis</i>	Swordtip squid	SW coast
<i>U (P) singhalensis</i>	Long barrel squid	SW & SE coast
<i>Loliolus (L) hardwickei</i>	Little Indian squid	All along Indian coast
<i>Sepioteuthis lessoniana</i>	Palk Bay squid	Palk Bay & Gulf of Mannar
<i>Sthenoteuthis oualaniensis</i>	Purple-back Flying squid	Oceanic Indian EEZ
<i>Thysanoteuthis rhombus</i>	Diamond squid	Oceanic Indian EEZ
<b>Cuttlefishes</b>		
<i>Sepia pharaonis</i>	Pharaoh cuttlefish	All along Indian coast
<i>S. aculeata</i>	Needle cuttlefish	All along Indian coast
<i>S. elliptica</i>	Golden cuttlefish	Veraval & Kochi
<i>S. prashadi</i>	Hooded cuttlefish	SW & SE coast
<i>S. brevimana</i>	Shortclub cuttlefish	Chennai & Visakhapatnam
<i>Sepiella inermis</i>	Spineless cuttlefish	All along Indian coast
<b>Octopuses</b>		
<i>Amphioctopus neglectus</i>	Webfoot octopus	SW & SE coast and islands
<i>A. marginatus</i>	Veined octopus	SW & SE coast and islands
<i>A. aegina</i>	Marbled Octopus	SW & SE coast and islands
<i>O. lobensis</i>	Lobed octopus	SW & SE coast and islands
<i>O. vulgaris</i>	Common octopus	SW & SE coast and islands
<i>Cistopus indicus</i>	Old woman octopus	SW & SE coast and islands

### **Bivalves**

Clams, oysters, mussels, and windowpane oysters are the various groups of bivalves exploited along the Indian coast for food and shells (Table 4).

Table 4. Commercial important bivalves of India

Resource	Common name
<b>Clams and cockles</b>	
<i>Villorita cyprinoides</i>	Black clam
<i>Paphia malabarica, Paphia sp</i>	Short neck clam, textile clam
<i>Meretrix casta, Meretrix meretrix</i>	Yellow clam
<i>Mercia opima</i>	Baby clam
<i>Mesodesma glabaratum</i>	
<i>Sunetta scripta</i>	Marine clam
<i>Donax sp</i>	Surf clam
<i>Geloina bengalensis</i>	Big black clam
<i>Tegillarca granosa (= Anadara granosa)</i>	Cockle
<i>Placuna placenta</i>	Window pane oyster
<i>Tridacna sp, Hippopus hippopus</i>	Giant clam
<b>Mussel</b>	
<i>Perna viridis</i>	Green mussel
<i>Perna indica</i>	Brown mussel
<b>Pearl oyster</b>	
<i>Pinctada fucata</i>	Indian pearl oyster
<i>Pinctada margaritifera</i>	Blacklip pearl oyster
<b>Edible oyster</b>	
<i>Crassostrea madrasensis</i>	Indian backwater oyster
<i>Saccostrea cucullata</i>	Rock oyster

### Molluscan Fisheries in India

Cephalopods are the most important group of molluscs with estimated all India production of about 2, 61,663 tonnes in 2017 which was 11.6 % more compared to the previous year. They are landed either as by-catch or as a targeted fishery. Targeted fishery is mostly carried out in mechanized trawlers operating up to 200 m depth, and beyond in some areas.

Bivalve fishery is the next in importance and fishing is practiced in limited extent mostly at a subsistence level in various estuaries and coastal seas. Clams and cockles contribute 73.8%, followed by oysters (12.5%), mussels (7.5%) and windowpane oysters (6.2%) (Mohamed and Venkatesan, 2017). The annual average clam production is about 57,000 t, oysters about 18,800 t, and marine mussels about 14,900 t (Mohamed and Venkatesan, 2017). At present, there was no fishery for marine pearl oysters, but it was the major fisheries before 1962 in the Gulf of

Mannar area. Scallops occur in certain area in stray numbers and do not contribute in fishery, whereas the windowpane oyster formed considerable fishery till a few year back (Mohamed and Venkatesan, 2017).

Gastropods in India are exploited for both as food and as curios. Among gastropods, the sacred chank is most important with annual production of over 1,000 t till a few years back (Mohamed and Venkatesan, 2017). The fishing of top shell viz., *Rochia nilotica* and *Turbo marmoratus* has been banned as they have been declared as endangered. One species of Abalone viz., *Haliotis varia* occur in stray numbers and are not fished. Mining for subsoil shell deposits was carried out from time immemorial especially in the Ashtamudi and Pulicat Lakes for industrial purposes.

### **Mollusc biology**

Molluscs are extremely large group and diverse in all phases of life. They occur in all marine habitats of the world including deep-sea hydrothermal vents, freshwater environments up to 40° C, land (gastropod alone) and permanent ice (Haszprunar and Wanninger, 2012). They range in size from 0.4 mm (omalogyrid gastropods) to more than 15 m (*Architeuthis* squids) (Haszprunar and Wanninger, 2012). Their longevity can range from a few months to up to more than 150 years (Deep sea giant bivalves) (Haszprunar and Wanninger, 2012). They mostly crawl or glide through cilia or muscle waves with mucous (Haszprunar and Wanninger, 2012). Some animals can permanently cement to the substrate, such as giant clam and edible oyster while some can attach to the substrate through byssus thread such as mussels. Modes of feeding are also diverse including filter feeders, omnivores, predators, grazers, detritivores, ecto- and endoparasites, and various kinds of symbioses with bacteria, plankton (Zooxanthellae), and algae.

The body of theoretical molluscs comprises five fundamental parts – the foot, the head, the visceral mass, the mantle and the shell. The alimentary tract or system of theoretical molluscs consists of ingestion, digestion, absorption and assimilation of food. The system starts with mouth which leads to the buccal cavity having pair of jaws in each side. Pharynx, located at the anterior of the buccal cavity, is occupied by the *odontophore* which supports the tongue like

structure called *radula*. Ducts from one or two pairs of salivary glands are present at the anterior of pharynx which in some species (*Conus* sp) are modified into organs to secrete venom used to paralyze or kill the prey. The tract goes on with the esophagus and then enlarges in a stomach where the food has been partially digested as threads of particles linked together by mucus. Food is mostly digested in the ducts of two large digestive glands by tiny cilia (whip like structure). These digestive glands occupy almost all the space within the visceral mass. Digestion of molluscs takes place both extracellularly and intracellularly. Extracellular digestion occurs especially in the stomach while, intracellular digestion takes place especially in the hepatopancreas. These organs (stomach /hepatopancreas) do the dual functions – secretion of digestive enzymes and absorption of food particles. The structure of posterior portion of the stomach is conical in many molluscs and a translucent rod shape in bivalves. This structure is known as *crystalline style* which secretes enzymes to digest certain carbohydrates. After the stomach comes the intestine which opens at the anus into the pallial cavity.

Circulatory system in molluscs is open except cephalopods. Heart, made up of two dorsal auricles/atria and a single ventricle, gets only oxygenated blood from gills and send it to different regions of the body through posterior aorta. Blood/hemolymph transport through blood vessels directly to the openings or spaces between the organs. Respiratory pigments in molluscs are of two main types *viz.*, red hemoglobin and blue, copper containing hemocyanin.

Excretory system removes the waste materials that are formed from the breakdown of assimilated food chiefly nitrogenous waste such as ammonia and urea. This function is carried out by one or more kidneys which are diverse in the various groups of molluscs. In primitive group, these organs are linked to the pericardial cavity and at least one of the excretory passages is modified to form a gonoduct for transfer of gametes. Excretory system opens into the pallial chamber. Pallial chamber is also an important structure which mediates between the animal and its external environment.

Respiratory system in molluscs is generally formed by the pair of gills in the pallial chamber. However, most of the gastropods have single gill. Gills are the site of gas exchange and look like a feather, with a central axis. Gills are of different forms in different group of the

molluscs depending on their environment and feeding habits. Land snails do not possess gills instead they have primitive form of lung.

Molluscs show various mode of reproduction. Most of them are either gonochoristic or hermaphroditic. Percentage of gonochoristic and hermaphroditic species are more or less equal (Haszprunar and Wanninger, 2012). Few of them occasionally show parthenogenesis. Majority of the molluscs, especially gastropods and cephalopods transfer sperm by means of copulatory organs, whereas, many species, especially gastropods, scaphopods and chitons shed their gametes liberally into the water. Their egg sizes range from about 80  $\mu\text{m}$  (many bivalves and gastropods) to 2 cm (*Nautilus* spp) (Haszprunar and Wanninger, 2012).

Larvae of them are either intracapsular or direct development into miniature form or planktotrophic or lecithotrophic. Larvae may look different from adult form. Typical molluscan larvae are veligers which are usually more or less modified form of Trochophore larvae. Example of special type of larvae is glochidium of freshwater unionoids which is well known as parasite on fish gills.

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