UG CBCS Semester-II (Chordata)

Cyclostomata

General Characters

1. Body elongated, eel-like.
2. Median fins with cartilaginous fin rays, but no paired appendages. Tail diphycercal.
3. Skin soft, smooth, containing unicellular mucous glands but no scales.
4. Trunk and tail muscles segmented into myotomes separated by myocommata.
5. Endoskeleton fibrous and cartilaginous. Notochord persists throughout life. Imperfect neural arches (arcualia) over notochord represent rudimentary vertebrae.
6. Jaws absent (group Agnatha).
7. Mouth ventral, suctorial and circular, hence the class name Cyclostomata (Gr. *cyklos,* circular + *stoma* mouth).
8. Digestive system lacks a stomach. Intestine with a fold, typhlosole.
9. Gills 5 to 16 pairs in lateral sac-like pouches of pharynx, hence another name of class, *Marsipobranchii.* Gill-slits 1 to 16 pairs.
10. Heart 2-chambered with 1 auricle and 1 ventricle, with a conus arteriosus anteriorly. Many aortic arches in gill region. No renal portal system. Hepatic portal system present. Blood with leucocytes and nucleated circular erythrocytes. Body temperature variable (poikilothermous).
11. Two mesonephric kidneys with ducts to urinogenital papilla.
12. Dorsal nerve cord with differentiated brain. 8 to 10 pairs of cranial nerves.
13. Single median olfactory sac and single median nostril. Auditory organ with 1 or 2 semicircular canals.
14. Sexes separate or united. Gonad single, large, without gonoduct.
15. Fertilization external. Development direct or with a prolonged larval stage.

Classification

About 50 species of the living jawless fishes are recognized. They belong to two major divisions *(Petromyzontiformes* and *Myxiniformes)* termed variously as subclasses, orders or families. Because they possess a round jawless mouth, they are combined in the class Cyclostomata. The similarity of these two groups is probably the result of convergent evolution. However, they show important and basic morphological differences which can be attributed to their long phylogenetic separation and different habits and habitats.

Order 1. Petromyzontiformes (Gr., *petros,* stone + *myzon,* suck)

Members of this order are called lampreys or lamper eels or lamperns or sand pride etc,

1. Mouth ventral, within a suctorial buccal funnel beset with many horny teeth.
2. Nostril dorsal. Nasohypophyseal sac closed behind, not connected to pharynx.
3. Gill pouches and gill slits 7 pairs each, opening in a separate respiratory pharynx.
4. Dorsal fin well developed.
5. Branchial basket complete.
6. Dorsal and ventral roots of spinal nerves remain separate.
7. Ear with 2 semicircular canals.
8. Eggs numerous, small. Development indirect with a long larval stage and metamorphosis.
9. Both marine and freshwater forms.

Examples: Lampreys. Over 30 species. *Petromyzon, Lampetra, Entospherus, Ichthyomyzon.*

Order 2. Myxiniformes (Gr., *myxa,* slime + *oidea,* type of)

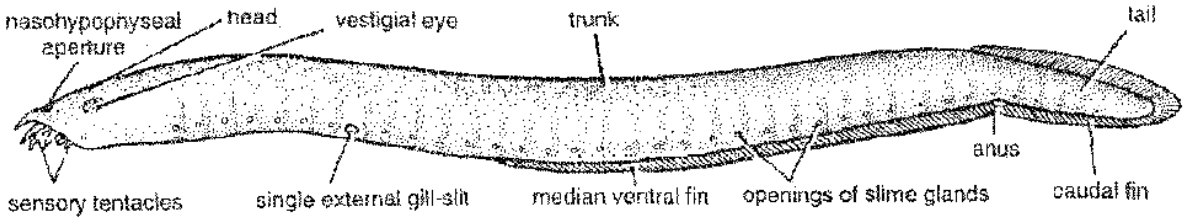
Representatives of this class are called hagfishes. They are exclusively marine.

1. Mouth terminal with 4 pairs of tentacles and few teeth. No buccal funnel.
2. Nostril terminal. Nasohypophyseal duct opens behind into pharynx.
3. Gill pouches 6 to 15 pairs. Gill slits 1 to 15 pairs.
4. Dorsal fin feeble or absent.
5. Branchial basket poorly developed.
6. Dorsal and ventral roots of spinal nerves united.
7. Ear with only 1 semicircular duct.
8. Eggs few, large. Development direct.
9. Hagfishes are till marine 15 species.

Example: *Myxine, Eptatretus (=Bdello stoma), Paramyxine.*

Other Cyclostomes

1. *Myxine*. Members belonging to the order Myxiniformes are commonly known as *hagfishes.* They are exclusively marine- *Myxine is* found of the coasts of Europe, America, Africa and Japan. It lives in colonies on the sea bottom, each individual in a mud burrow feeding on polychaete worms. Soft, scaleless, pinkish, elongated, eel-like or worm-like body reaches a length of 50-60 cm and differentiated into head, trunk and tail. It differs from lamprey *(Petromyzon)* in several ways. Suctorial mouth is terminal with soft wrinkled lips, like those of an old ugly woman or hag, hence the common name *hagfish*. Eyes are degenerate and covered with a thick skin. Six cartilage-supported cirri or tentacles around mouth compensate for the sightless degenerate eyes. The protrusible tongue, bordered by two multitoothed hornv plates, serves as a powerful rasping tongue. The single median nostril lies close to the mouth. 6 pairs of gill pouches are located far behind the head region and their efferent ducts join into a single pair of external gill slits, probably an adaptation to burrowing. Large mucous glands open along the sides of body and secrete enormous quantity of slime, hence another common name, the *slime eel.* A feebly developed mid-ventral fin and a caudal fin are present. Myxine attacks injured or dead fishes and burrows into their body for flesh consumption, hence also called a *borer.* It is really an internal parasite. It may pose a serious threat to fisheries in some regions. Unlike lampreys, the hagfishes do not migrate to fresh water to spawn. The eggs hatch directly into miniature adults without passing through a larval stage (Fig. 1).



2. *Eptatreius (Bdellmtuma).* It is also a common hagfish of the Pacific coasts of America, New Zealand and South Africa. Its structure and habits are similar to those of *Myxine* with few differences. It reaches a length of 1 meter. In different species, 6 to 15 very small external gill slits arc found, each connected to pharynx through a gill pouch. Behind the last external gill slit of left side is the opening of the *pahryngocutaneous duct* which opens directly into pharynx (Fig, 2).

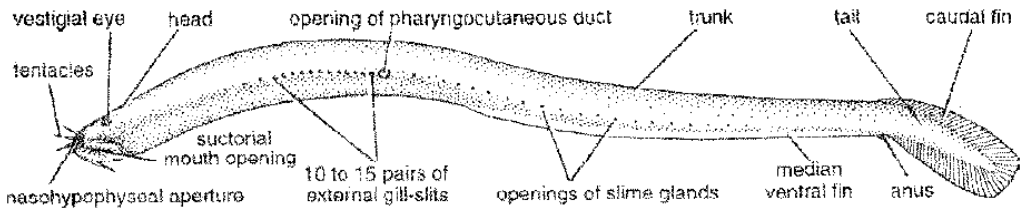


Fig. 2. *Eptatretus (=Bdellostoma).*

Affinities of Cyclostomata

The chordate characteristic of cyclostomes are clear-cut. They represent the most primitive members among living vertebrates. The similarity of several features of ammocoete larva of lamprey with Ceohalochordata *(Branchiostoma)* indicates primitive relationship. But the adult cyclostomes have certain specialized as well as degenerate features as adaptions to a parasitic habit.

[I] Primitive characters

1. Resemblances with Cephalochordata *(Branchiostoma).* The adult cyclostomes and *Branchiostoma* have many characters in common, such as: (i) Lack of jaws, exoskeleton, paired fins and gonoducts. (ii) Persistent and continuous notochord. (iii) Segmental muscle blocks or myotomes, (iv) Numerous gill slits, (v) Straight and simple alimentary canal, (vi) Dorsal and ventral roots of spinal nerves separate in lamprey. Besides these, the ammocoete larva of lamprey further resembles *Branchiostoma* in: (i) Fish-shaped body, (ii) Vestibule (oral hood) anterior to mouth, (iii) Continuous median dorsal and caudal fins, (iv) Ciliated gut, (v) Microphagus filter feeder, (vi) Endostyle functions in feeding.

2. Differences from fishes (vertebrates). Both cyclostomes and fishes are aquatic vertebrates, but cyclostomes present many primitive characters in which they differ from fishes, such as : (i) Absence of biting jaws, scales, true teeth, paired appendages, true fin rays, girdles, ribs, stomach, spleen and gonoducts, (ii) Diphycercal caudal fin, (iii) Continuous median dorsal fin, (iv) Single median nostril rather than paired, (v) Incomplete or poorly developed cranium, vertebral column, intestinal spiral valve, pancreas, brain, sympathetic nervous system and lateral line organs, (vi) Heart S-shaped tube, (vii) 9th and 10th cranial nerves not enclosed by cranium, (viii) Non-myleinated nerves, (ix) 1 to 2 semicircular canals in ear instead of 3 of advanced vertebrates, (x) Poorly developed lateral line sense organs.

3. Affinities with ostracoderms. The oldest fossils of vertebrates are fragments of ostracoderms belonging to Ordovician. They become abundant in Silurian but died out in Devonian. Paleontologists believe that they were the forerunners of higher fish. The fossil ostracoderms and living cyclostomes are grouped together under Agnatha because of the following structural similarities: (i) Absence of biting jaws, (ii) Single nasal opening, (iii) Pineal eye, (iv) No paired limbs, (v) Pouch-like branchial sacs, (vi) Internal ear with 2 semicircular canals, (vii) Lateral line system.

[II] Advanced or vertebrate characters

Cyclostomes are undoubtedly vertebrates as they have many advanced though simple features similar to those of fishes and higher vertebrates. These are: (i) Formation of a distinct head bearing paired eyes and internal ears. (ii) Differentiated brain like embryonic vertebrates with several pairs

of cranial nerves, (iii) Craiuum for housing brain, (iv) Beginning of segmental vertebrae, (v) Stratified or multilayered epidermis. (vi) Dorsal root ganglia on spinal nerves, (vii) Sympathetic nervous system. (viii) Lateral line organs, (ix) Gills primarily used for respiration and not for food collection as in *Branchiostoma*, (x) Water enters into pharynx by muscular activity and not by ciliary activity as in *Branchiostoma.* (xi) E-shaped myotomes as in fishes. (xii) Presence of liver, gall bladder, bile duct, pineal and parietal eyes, pancreatic cells in midgut wall and thyroid and pituitary glands, (xiii) Well developed circulatory system with a muscular, contractile heart, (xiv) Blood with erythrocytes and leucocytes. (xv) Hepatic portal system, (xvi) Lymphatic svstem, and (xvii) Mesonephric kidneys.

[III] Specialized characters

Adult cyclostomes are too specialized or too degenerative in many respects. It is probable that many adult characteristics are adaptations for parasitic mode of feeding. Some of their specialized features are: (i) Suctorial mouth and buccal funnel with attachment of horny spikes in lampreys for attachment to host body, (ii) Powerful, muscular tongue, heavily armed with sharp horny teeth serves as a rasping organ while feeding, (iii) Production of anticoagulants in saliva to feed on blood and body fluids of prey, (iv) Peculiar sac-like gill pouches located far behind head, (v) Posterior position of gill openings, probably an adaptation to burrowing, (vi) Complete separation of ventral sac-like respiratory pharynx from dorsal esophagus, (vii) Respiratory water entering gill pouches as well as leaving them through external gill openings and not through mouth which mostly remains attached to rocks or fishes for feeding, (viii) Large mucous glands secreting enormous quantities of mucus in hagfishes. (ix) Dorsal position- of single nostril high on head in lampreys.

[IV] Degenerate characters

The degenerate characters of cyclostomes include: (i) Simple, cylindrical eel-like body form compared to broad fish-like shape of ostracoderms. (ii) Lack of bony armor or exoskeleton. (iii) Lack of bony endoskeleton which is cartilaginous, (iv) Absence of paired fins and girdles, (v) Vestigial eyes covered by thick skin and muscle in hagfishes, (vi) Reduced liver and disappearance of gall bladder and bite duct in adult lamprey.

Phylogenetic Status of Cyclostomata

The oldest known group of vertebrates is regarded to be Agnatha which includes the extinct ostracoderms and the living cyclostomes. The living cyclostomes are regarded to be highly specialized relics of the ostracoderms line. Stensio (1927) believed that cyclostomes had descended from some group of ostracoderms by the evolution of a sucking mouth, loss of bony exoskeleton and paired limbs, and development of cartilage. Their structural organization has been considered higher than that of *Branchiostoma* (Cephalochordata), but lower than that of Gnathostomata (jawed vertebrates). There is increasing evidence to believe that there were two major and not so much related groups of ostracoderms: (i) the *cephalospides* having several pairs of gill slits, pairs fin-like appendages, heterocercal tail and a single median nostril; and (ii) the *pteraspids* having a single pair of gill-slits, no paired appendages, hypocercal tail and two separate nostrils where known.

References:

Kotpal RL (2009-2110). Modern Text Book of Zoology: Vertebrates (Animal Diversity – II). Rastogi Publications, India.