

# 07

## Gastropod classification and taxonomy

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### INTRODUCTION

Gastropods are a large and highly diversified class within the phylum Mollusca. Many gastropods possess a shell whereas some are without shells. The shelled gastropods are also called univalves. Some of these gastropods are terrestrial while other gastropods live in marine or freshwater habitat. There are approximately 85,000 - 100,000 described species of molluscs (Strong *et al.*, 2008) found throughout the world from the garden to deep-water hydrothermal vent colonies. Current estimates place the total number of molluscs including undescribed species as high as 240,000 species (Appeltan *et al.*, 2011). Gastropods encompass 80 % of living molluscs species. In the conventional division of subclass, recognized species of prosobranchs (largely marine, but with terrestrial and freshwater representatives) formed 53 % followed by pulmonates (43% - terrestrial and freshwater, few marine littoral) and opisthobranchs (4% - marine) (Boss, 1971). Gastropods are considered as the oldest known fossils with their shells being evolved in rocks 540 million years ago. Many of the today's gastropod species have continued unaltered for over 350 million years.

Many gastropods possess a shell that protects the soft body of the animal. In most species, the coiled shell opens on the right-hand side (dextral). Rarely, right-hand coiled species will produce left-hand coiled (sinistral) shells and vice versa. Many species bears an operculum that assists to protect the animal in addition to the shell. During early larval stage development, gastropods display the most characteristic feature - torsion that means the visceral mass rotates 180 to one side, placing the anus above the head. Gastropods possess a distinct head with 2 - 4 sensory tentacles. They bear eyes that are located near the base of the tentacles or on separate eye stalks. Although most species (herbivorous / carnivorous) use a radula (tongue like apparatus) for feeding, the feeding habits of them are varied. Other species may be detritus feeder, scavengers or ciliary feeders.

Gastropod reproduction differs very much among species. Hermaphroditism is common in all gastropods but in the marine gastropods, one individual serves as either male or female during mating. Nevertheless, all gastropods reproduce through internal fertilization.

Many gastropods are used as food items throughout the world. Abalone, conchs, and periwinkle gastropods etc. are the popular food items. From the time immemorial, seashells have been used as ornamentation, cooking utensils, oil lamps, musical instruments, currency etc.

The global seashell trade has ruined populations of gastropods which results in banning the import and export of some shells. A total of 3271 species of molluscs was reported from India in which gastropods (58.1%) formed the largest numbers of species.

### Classification

Classification of gastropods based on different morphological and anatomical features of their bodies and shells has come across several problems. During the 19th century, researchers were proposed several different classifications of the Gastropoda based on the place of the mantle cavity or on the array of various organs and shape of the shells. By and large, all these classification methods used only a restricted number of distinctive characters. At the start of the 20th century, the German researcher, Johannes Thiele (1929 - 1935), put together earlier classifications and proposed Thiele's system of classifications which was used by zoologists for most of the century. He divided the gastropods into three subclasses: Prosobranchia, Opisthobranchia and Pulmonata. Besides, the Prosobranchia were divided into three orders: Archaeogastropoda, Mesogastropoda and Neogastropoda.

In the current decades, there is a need for the revision of existing classification because of the following reasons –

1. Accumulation of numerous new data on the morphology and anatomy of various gastropod groups due to the application of new methods for instance, transmission electron microscopy etc.
2. Finding of new gastropod groups with strange anatomical features in the deep sea region associated with hydrothermal vents.

Recent analyses of these characters of existing gastropods have led to a new classification method, which have been supported by outcome from molecular phylogenetics.

## The new classification of gastropods

Most of the earlier gastropods classification methods were based upon morphological features to categorize these organisms and used taxon ranks like order, superorder and suborder which are typical of traditional classifications.

Bouchet and Rocroi (2005) have given a new system for the scientific classification of gastropods which was mainly based on the concept of clades and was taken from research on molecular studies. Gastropods are divided into groups called clades. Clades are collection of life forms that have descended from a common ancestor. In the Bouchet and Rocroi system, clades are employed between the rank of class and the rank of superfamily while the clades are unranked. There is a great deal of debate in the scientific community on the topic of the biological grouping of some species. Bouchet and Rocroi use six main clades: Patellogastropoda, Vetigastropoda, Cocculiniformia, Neritimorpha, Caenogastropoda and Heterobranchia, which are generally recognized by researchers. In the first three clades, there are no nesting clades within them, in other words, the taxonomy goes directly to the superfamily stage. There is one extra clade within the Caenogastropoda. In Heterobranchia clade, there are six separate clades above the level of superfamily for some of the nudibranch groups and there are four clades above the level of superfamily in the case of most of the land snails. Bouchet and Rocroi used groupings of taxa as a "group" or an "informal group" instead of "clade" in some places of the classification.

By definition, a clade should have only one lineage while "informal groups" may either include more than one lineage, or only include part of a lineage. Detail classification of gastropods according to Bouchet and Rocroi (2005) is available at the link- [http://www.journal-malaco.fr/bouchet & rocroi\\_2005\\_Visaya.pdf](http://www.journal-malaco.fr/bouchet&rocroi_2005_Visaya.pdf).

### Neritopsina (= Neritimorpha)

This group includes old gastropods with a long fossil record. They are known to occur in all shapes and sizes from coiled shells, to limpet-like, to slugs. This includes terrestrial, freshwater, and marine species.

### Vetigastropoda

This clade includes top shells, abalone, keyhole and slip-limpets, and several other families.

### Caenogastropoda

This group is highly diverse and has colonized almost all marine, freshwater, and terrestrial environments. This clade (large group) consist of about 60 % of extant gastropods and contains a large number of ecologically and commercially important marine families such as Muricidae, Volutidae, Mitridae, Buccinidae, Terebridae, Conidae, Littorinidae, Cypraeidae, Cerithiidae, Calyptraeidae, Tonnidae, Cassidae, Ranellidae, Strombidae and Naticidae.

### Heterobranchia

This group includes pulmonates (comprises more than 20,000 species) and opisthobranchs includes sea hares, sea slugs and bubble shells. This group includes the gastropod groups positioned by Thiele's taxonomic scheme into the 'Opisthobranchia' and 'Pulmonata', as well as some 'prosobranch' groups.

### Patellogastropoda

This is a major group of marine gastropods that contains true limpets, traditionally called Docoglossa. Patellogastropods are known to occur mostly on rocky shores in all continents.

### Cocculiniformia

This group includes white limpets that attach to organic matter in the deep ocean.

### Distinctive characters of commercial important species of India

#### *Trochus niloticus*

This species belongs to the family Trochidae. Shell is large, thick, heavy and conical in shape. Spire is tall with pointed apex. Umbilicus present. Columella is long, curved and smooth; slightly thickened marginally, Aperture is more or less square in shape, broader than high. Outer surface of the shell is white with many reddish-brown longitudinal bands. The interior of shell is nacreous. In India, *Trochus niloticus* is found the Andaman and Nicobar Islands.

#### *Trochus radiatus*

The shell is conical with regular rows of spiral tubercles. The columella is devoid of denticulation. The outer surface of shell is whitish and marked with transparent reddish bands. The interior of shell is nacreous.

### *Turbo marmoratus*

The turbo shell belongs to the family Turbinidae. It possesses a thick and massive shell with blunt tubercles especially strong on shoulders and a wide aperture. Operculum is large, thick, heavy, smooth and white. The outer surface is dark green and spotted with brown and white. The pearly lustre underlines the shell surface.

### *Turbo intercostalis*

The shell is turban-shaped and thick with many smooth spiral cords. It has a well developed spire. The spiral ridges are transpirally grooved. Chalky operculum is hemi-spherical and smooth. The operculum is dark green in centre with yellowish and white margins. The outside of the operculum has a fine ridge and perforation in the centre. The body is greenish brown with well-marked yellowish patches.

### *Umbonium vestiarium*

The shell is small and lenticular shaped, much broader than high. Surface of shell is smooth and polished, devoid of concentric grooves on the surface. The spire is low, with slightly convex. Body whorl is broad, flattened and rounded. Umbilical callosity is large and thick. Columella is smooth, strongly curved anteriorly. Shell colour and pattern variable from pale brown or greenish or reddish brown with transpiral wavy lines to white and light pink with spiral bands or fine dark spots.

### *Laevistrombus canarium*

The shell is greatly calloused with polished columella and wing-shaped outer lip. The outer surface of shell is white and marked with irregular pattern of wavy light brownish lines. The aperture is glossy and the operculum is claw-like.

### *Lambis lambis*

The five-fingered chank is large, thick and heavy with a slightly high and pointed spire. Dorsal surface of body is rough, with uneven spiral cords and 2 or 3 spiral rows of blunt tubercles, forming large knobs on the shoulder. The outer lip is extended into digitate processes and forms six hollow digitations with notch. The siphonal canal is long and slightly turned to the left side forming digitations anteriorly. The columella and the interior of the aperture are smooth and shiny. Operculum is long, brown and transparent. Colouration of shell is variable from cream to tan, frequently with different patterns of brown, purplish-tan or bluish-black.

### *Oliva gibbosa*

The shell is oblong, stout and has a long and narrow aperture. Outer surface is smooth and shiny with attractive colour

pattern on the outer surface. The spire is very short and the columella is thickened. Operculum is absent.

### *Turbinella pyrum*

The shell is huge, thick, pear-shaped and coated with a brownish horny periostracum. The spire is elevated and apex pointed. The whorls contain slightly angulated shoulders in which the one of the body whorl is distinct. The shoulder ridges have a series of small, compressed tubercles. The columella is clogged with callus and has four transverse folds. The anterior canal is wide open when compared to posterior one. The shell is ivory white when the periostracum is removed.

### *Conus milneedwardsi*

This species has a rather thin and slender shell with a smooth surface, an acuminate spire and an angulate shoulder. The color of the shell is white with two chocolate spiral bands on the body whorl. This body whorl shows a pattern of axial reddish brown reticulated lines forming white triangles or quadrangular markings. This species occurs throughout the western Indian Ocean, including Madagascar, India and the East African coast.

### *Babylonia spirata*

Shell is thick, smooth with distinctive spiral and conical in shape. The shell coloration and pattern of colour design is variable from plain brown to white with brown or orange spots. There is notch at the bottom of the shell where the long siphon emerges. Operculum thin and flexible. Animal body is pale, with a long muscular foot which is dark in colour with an orange rim. Tentacles are short and siphon is long.

### *Babylonia zeylanica*

The Indian Babylon is a lean and smooth with a fine or well-marked suture. It has a large body whorl and a high spire. The aperture is lanceolate with a short siphonal canal. The columella is smooth with a single fold. It contains a white columellar callus and deep umbilicus. The apex and umbilicus are tinged with violet. The shell surface is white, adorned with distinctive irregular arrangement of brown or light-brown spots and fames.

### *Bufonaria echinata*

The shell of this species is easily recognized by its very elongate shape, its poorly sculptured surface, a border row of small nodules, and the three rows of abnormally long, narrow, recurved spines developed on the varices and posterior siphonal canals.

*Bufonaria crumena*

Shell is very distinctive because of its large size, its very short spire and wide shape, its large aperture with widely flared lips and its fine sculpture apart from the row of large, pointed nodules around the periphery and down the varices.

*Bufonaria margaritula*

This species is the smallest species of the genus. Shell is rather short and wide/dorsoventrally compressed shape with shorter spire and widely flared apertural lips. The posterior siphonal canal is longer and out-turned. Shell bears the few, extremely prominent antero-posteriorly compressed nodules on the dorsum of the last whorl.

*Cypraea tigris*

Shell is thick, heavy, inflated shell with coarse short teeth. Dorsum usually cream-white/whitish or bluish blotched with purple-black/brown spot. Ventral side is without axial ridges. Its base teeth and aperture are white. It is found extremely variable in shape, size and colour.

*Chicoreus ramosus*

Shell is large, heavy, globose ovate with a slightly low spire. Shell has three axial varices per whorl with two unequal nodes between them. Each axial varice has a strong, frond-like spine. Spine is a leaf-like, moderately short and recurved. Outer lip is crenulate with a noticeably tooth-like process anteriorly. Shell colour is white to light brown, sometime stained with scattered brown/pink flecks between varices and near sutures. Aperture is large, roundly ovate and colour is white interiorly, covered with pink to orange-red on margins. Siphonal canal is moderately long, broad and slightly curved with 2 or 3 spines.

*Tibia curta*

Shell fusiformly tower-shaped projection; spire very much tapering to point; canal straight, whorls somewhat flattened. The first few whorls is longitudinally ribbed while the rest smooth, columella has callous; Lip has four- to five-dentate, produced at the upper part, the canal being rather short and curved backwards. The shell colour is light reddish/brownish yellow or brown, with a rather broad pale chestnut/brown band close to the suture of the whorls. Columella and interior of aperture is white.

*Melo melo*

Shell is somewhat thin and rather fragile for such a large gastropod. The fleshy body is brown with white stripes. Foot is large which is plain and pale on the underside. It bears a pair of slender tentacles, a long siphon that comes out of the notch at the front of the shell, and a long proboscis, both brown with white stripes. Large shell is light brown to orange, sometimes with brown bands, others without any distinct markings.

**Suggested reading**

- Appeltans W., Bouchet P., Boxshall G.A., Fauchald K., Gordon D.P., Hoeksema B.W., Poore G.C.B., van Soest R.W.M., Stöhr S., Walter T.C., Costello M.J. (eds) (2011). World Register of Marine Species. Accessed at marinespecies.org .
- Appukuttan, K.K. 1996. Marine molluscs and their conservation. In *Marine Biodiversity Conservation and Management*. Central Marine Fisheries Institute, Cochin, eds. N.G.Menon and C.S.G. Pillai.
- Boss, K.J. 1971. Critical estimate of the number of recent mollusca. *Occas. Pap. Mollusks* 3: 81 – 135.
- Bouchet, P. & Rocroi, J.-P. 2005. Classification and nomenclature of gastropod families. *Malacologia*, 47(1–2): 1–397.
- Chapman A.D. 2009. Numbers of Living Species in Australia and the World, 2nd edition, Australian
- Strong, E. E., O. Gargominy, W. F. Ponder and P. Bouchet. 2008. Global diversity of gastropods (Gastropoda; Mollusca) in freshwater. *Hydrobiologia* 595: 149-166.
- Thiele, J., 1929-1935. *Handbuch der Systematischen Weichtierkunde* (4 volumes). Jena, Germany: Gustav Fischer Verlag.