

Gastropods and their Study



Wanetta Valdez

First Edition, 2012

ISBN 978-81-323-3147-6

© All rights reserved.

Published by:

Research World

4735/22 Prakashdeep Bldg,

Ansari Road, Darya Ganj,

Delhi - 110002

Email: info@wtbooks.com

Table of Contents

Chapter 1 - Gastropoda

Chapter 2 - Gastropod Shell

Chapter 3 - Types of Gastropoda

Chapter 4 - Digestive System of Gastropods

Chapter 5 - Respiratory System of Gastropods

Chapter 6 - Circulatory System of Gastropods and Excretory System of
Gastropods

Chapter 7 - Nervous System of Gastropods

Chapter 8 - Sensory Organs of Gastropods

Chapter 9 - Reproductive System of Gastropods

Chapter 10 - Taxonomy of the Gastropoda (Bouchet & Rocroi, 2005)

Chapter- 1

Gastropoda

Gastropod

Temporal range: Late Cambrian–Recent



Air-breathing land gastropod *Helix pomatia*, the Roman snail

Scientific classification

| | |
|----------|-----------------------------------|
| Kingdom: | Animalia |
| Phylum: | Mollusca |
| Class: | Gastropoda Cuvier, 1795 |

Clades

"Paleozoic uncertain ..."

"Basal taxa ..."

clade Patellogastropoda

clade Vetigastropoda

clade Cocculiniformia

clade Neritimorpha

clade Caenogastropoda

clade Heterobranchia

The **Gastropoda** or **gastropods** are a large taxonomic class within the molluscs, a group of animals that are more commonly known as **snails and slugs**. The class includes snails and slugs of all kinds and all sizes: huge numbers of marine snails and sea slugs, as well as freshwater snails and freshwater limpets, and the terrestrial (land) snails and slugs. The class Gastropoda contains a vast total of named species, second only to the insects in overall number. The fossil history of this class goes all the way back to the Late Cambrian. There are 611 families of gastropods, of which 202 families are extinct, being found only in the fossil record.

Gastropoda (previously known as **univalves** and sometimes spelled Gasteropoda) are a major part of the phylum Mollusca and are the most highly diversified class in the phylum, with 60,000 to 80,000 living snail and slug species. The anatomy, behavior, feeding and reproductive adaptations of gastropods vary very significantly from one clade or group to another. Therefore, it is difficult or impossible to make more than a few general statements that are valid for all gastropods.

The class Gastropoda has an extraordinary diversification of habitats. Representatives live in gardens, in woodland, in deserts, and on mountains; in small ditches, great rivers and lakes; in estuaries, mudflats, the rocky intertidal, the sandy subtidal, in the abyssal depths of the oceans including the hydrothermal vents, and numerous other ecological niches, including parasitic ones.

Although the name "snail" can be, and often is, applied to all the members of this class, commonly this word means only those species with an external shell large enough that the soft parts can withdraw completely into it. Those gastropods without a shell, and those with only a very reduced or internal shell, are usually known as slugs.

The marine shelled species of gastropod include edible species such as abalone, conches, periwinkles, whelks, and numerous other sea snails that produce seashells which are coiled in the adult stage, even though in some cases the coiling may not be very visible, for example in cowries. There are also a number of families of species such as all the various limpets, where the shell is coiled only in the larval stage, and is a simple conical structure after that.

Etymology

The word "gastropod" is derived from the Ancient Greek words *γαστήρ* (*gastér*, stem: *gastr-*) "stomach", and *πούς* (*poús*, stem: *pod-*) "foot", hence stomach-foot. This is an anthropomorphic name, based on the fact that to humans it appears as if snails and slugs crawl on their bellies. In reality, snails and slugs have their stomach, the rest of their digestive system and all the rest of their viscera in a hump on the opposite, dorsal side of the body. In most gastropods this visceral hump is covered by, and contained within, the shell.

In the scientific literature, gastropods were described under the vernacular (French) name "gasteropodes" by Georges Cuvier in 1795. The name was later Latinized.

The earlier name *univalve* means "one valve", and contrasts with *bivalve* ("two valves").

Diversity

At all taxonomic levels, gastropods are second only to the insects in terms of their diversity.

Gastropods form the class of molluscs with the greatest numbers. However the estimated total number of gastropod species varies widely, depending on the cited sources. The number of gastropod species can be deduced from estimates of the number of described species of Mollusca with accepted names: about 85,000 (minimum 50,000, maximum 120,000). But an estimate of the total number of Mollusca, including undescribed species, is about 200,000 species. The estimate of 85,000 molluscs includes 24,000 described species of terrestrial gastropods.

Different estimations (from different sources) for aquatic gastropods give about 30,000 species of marine gastropods and about 5,000 species of freshwater and brackish gastropods. Total number of recent species of freshwater snails is about 4,000.

The number of prehistoric (fossil) species of gastropods is at least 15,000 species.

Habitat

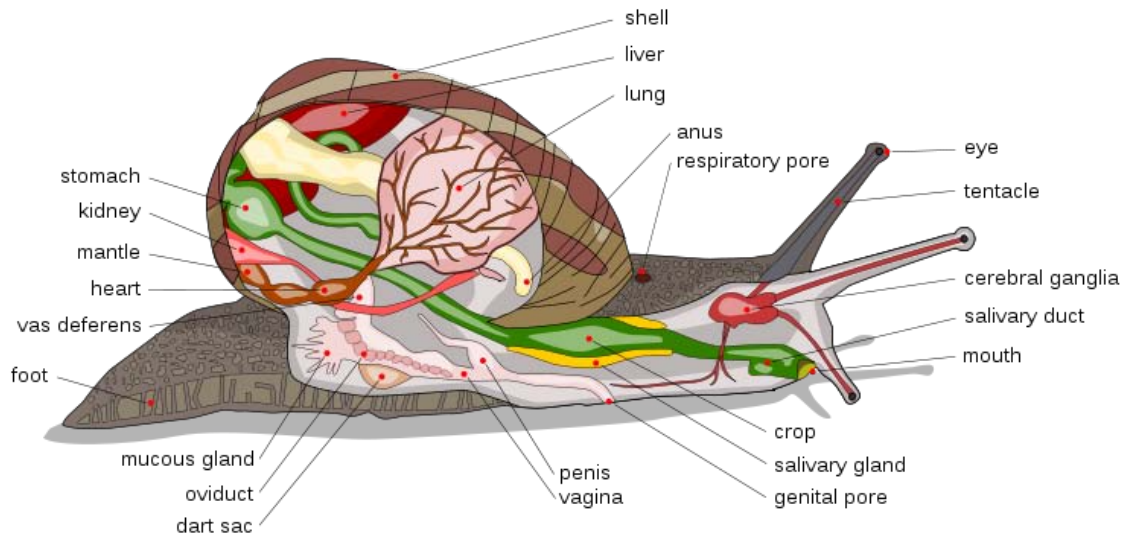
Some of the more familiar and better-known gastropods are terrestrial (the land snails and slugs) and some live in freshwater, but more than two thirds of all named species live in a marine environment.

Gastropods have a worldwide distribution from the near Arctic and Antarctic zones to the tropics. They have become adapted to almost every kind of existence on earth, having colonized every medium available except the air.

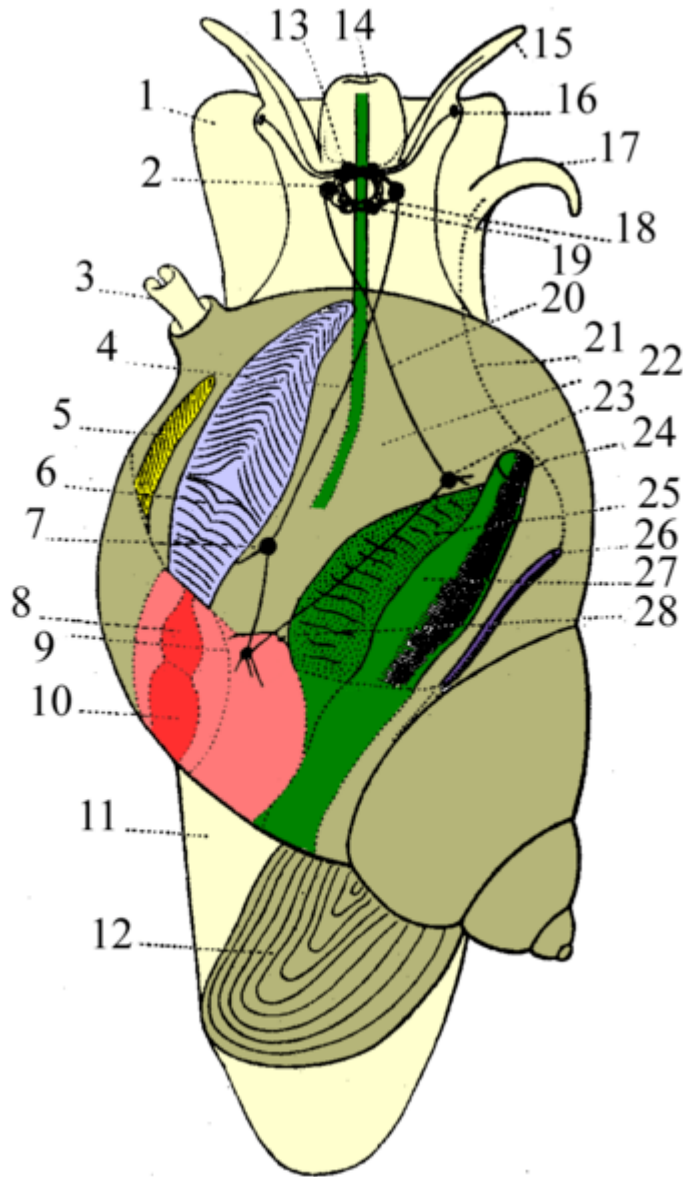
In habitats where there is not enough calcium carbonate to build a really solid shell, such as on some acidic soils on land, there are still various species of slugs, and also some snails with a thin translucent shell, mostly or entirely composed of the protein conchiolin.

Snails such as *Sphincterochila boissieri* and *Xerocrassa seetzeni* have adapted to desert conditions, other snails have adapted to an existence in ditches, near deepwater hydrothermal vents, the pounding surf of rocky shores, caves, and many other diverse areas.

Anatomy



The anatomy of a common air-breathing land snail such as *Helix aspersa*. Note that much of this anatomy does not apply to gastropods in other clades or groups.



The anatomy of an aquatic snail with a gill, a male prosobranch gastropod. Note that much of this anatomy does not apply to gastropods in other clades.

- Light yellow - body
- Brown - shell and operculum
- Green - digestive system
- Light purple - gills
- Yellow - osphradium
- Red - heart
- Pink -
- Dark violet -
- 1. foot
- 2. cerebral ganglion
- 3. pneumostome

4. upper commissura
5. osphradium
6. gills
7. pleural ganglion
8. atrium of heart
9. visceral ganglion
10. ventricle
11. foot
12. operculum
13. brain
14. mouth
15. tentacle (chemosensory, 2 or 4)
16. eye
17. penis (everted, normally internal)
18. esophageal nerve ring
19. pedal ganglion
20. lower commissura
21. vas deferens
22. pallial cavity / mantle cavity / respiratory cavity
23. parietal ganglion
24. anus
25. hepatopancreas
26. gonad
27. rectum
28. nephridium

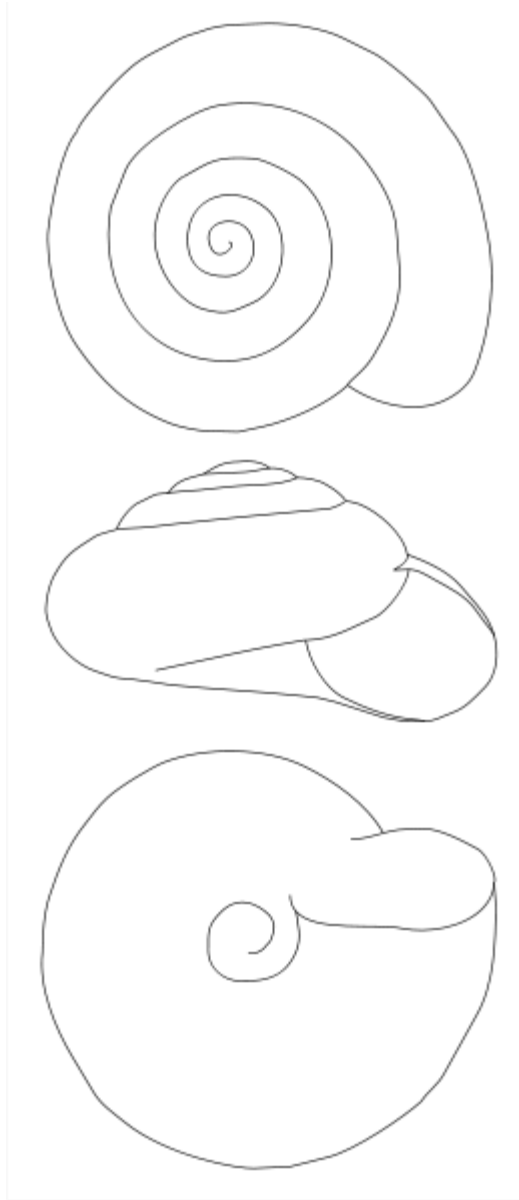
Snails are distinguished by an anatomical process known as torsion, where the visceral mass of the animal rotates 180° to one side during development, such that the anus is situated more or less above the head. This process is unrelated to the coiling of the shell, which is a separate phenomenon. Torsion is present in all gastropods, but the opisthobranch gastropods are secondarily de-torted to various degrees.

Torsion occurs in two mechanistic stages. The first is muscular, and the second is mutagenetic. The effects of torsion are primarily physiological - the organism develops an asymmetrical nature with the majority of growth occurring on the left side. This leads to the loss of right-paired appendages (e.g. ctenidia (comb-like respiratory apparatus), gonads, nephridia, etc.). Furthermore, the anus becomes redirected to the same space as the head. This is speculated to have some evolutionary function, as prior to torsion, when retracting into the shell, first the posterior end would get pulled in, and then the anterior. Now, the front can be retracted more easily, perhaps suggesting a defensive purpose.

However, this "rotation hypothesis" is being challenged by the "asymmetry hypothesis" in which the gastropod mantle cavity originated from one side only of a bilateral set of mantle cavities.

Gastropods typically have a well-defined head with two or four sensory tentacles with eyes, and a ventral foot, which gives them their name (Greek *gaster*, stomach, and *poda*, feet). The foremost division of the foot is called the **propodium**. Its function is to push away sediment as the snail crawls. The larval shell of a gastropod is called a protoconch.

The shell



The shell of *Zonitoides nitidus*, a small land snail, has dextral coiling, which is typical (but not universal) in gastropod shells.

Upper image: dorsal view of the shell, showing the apex

Central image: lateral view showing the spire and aperture of the shell

Lower image: basal view showing the umbilicus

Most shelled gastropods have a one piece shell, typically coiled or spiraled. This coiled shell usually opens on the right-hand side (as viewed with the shell apex pointing upward). Numerous species have an operculum, which in many species acts as a trapdoor to close the shell. This is usually made of a horn-like material, but in some molluscs it is calcareous. In the land slugs, the shell is reduced or absent, and the body is streamlined.

Body wall

Some sea slugs are very brightly colored. This serves either as a warning, when they are poisonous or contain stinging cells, or to camouflage them on the brightly-colored hydroids, sponges and seaweeds on which many of the species are found.

Lateral outgrowths on the body of nudibranchs are called cerata. These contain a part of digestive gland, which is called the diverticula.

Digestive system

The radula of a gastropod is usually adapted to the food that a species eats. The simplest gastropods are the limpets and abalones, herbivores that use their hard radula to rasp at seaweeds on rocks.

Many marine gastropods are burrowers, and have a siphon that extends out from the mantle edge. Sometimes the shell has a siphonal canal to accommodate this structure. A siphon enables the animal to draw water into their mantle cavity and over the gill. They use the siphon primarily to "taste" the water to detect prey from a distance. Gastropods with siphons tend to be either predators or scavengers.

Respiratory system

Almost all marine gastropods breathe with a gill, but many freshwater species, and the majority of terrestrial species, have a pallial lung. Gastropods with a lung belong to one group with common descent, the Pulmonata, however, gastropods with gills are paraphyletic. The respiratory protein in almost all gastropods is hemocyanin, but a pulmonate family Planorbidae have hemoglobin as respiratory protein.

In one large group of sea slugs, the gills are arranged as a rosette of feathery plumes on their backs, which gives rise to their other name, nudibranchs. Some nudibranchs have smooth or warty backs and have no visible gill mechanism, such that respiration may likely take place directly through the skin.

Circulatory system

Gastropods have open circulatory system and the transport fluid is hemolymph. Hemocyanin is present in the hemolymph as the respiratory pigment.

Excretory system

The primary organs of excretion in gastropods are nephridia, which produce either ammonia or uric acid as a waste product. The nephridium also plays an important role in maintaining water balance in freshwater and terrestrial species. Additional organs of excretion, at least in some species, include pericardial glands in the body cavity, and digestive glands opening into the stomach.

Sensory organs and nervous system



The upper pair of tentacles on the head of *Helix pomatia* have eye spots, but the main sensory organs of the snail are sensory receptors for olfaction, situated in the epithelium of the tentacles.

Sensory organs of gastropods include olfactory organs, eyes, statocysts and mechanoreceptors. Gastropods have no hearing.

In terrestrial gastropods (land snails and slugs), the olfactory organs, located on the tips of the 4 tentacles, are the most important sensory organ, The chemosensory organs of opisthobranch marine gastropods are called rhinophores.

The majority of gastropods have simple visual organs, eye spots, that are situated either at the tip of the tentacles or the base of the tentacles. However "eyes" in gastropods range from these simple ocelli which cannot process an image being only able to distinguish light and dark, to more complex pit eyes, and even to lens eyes. In land snails and slugs, vision is not the most important sense, because they are mainly nocturnal animals.

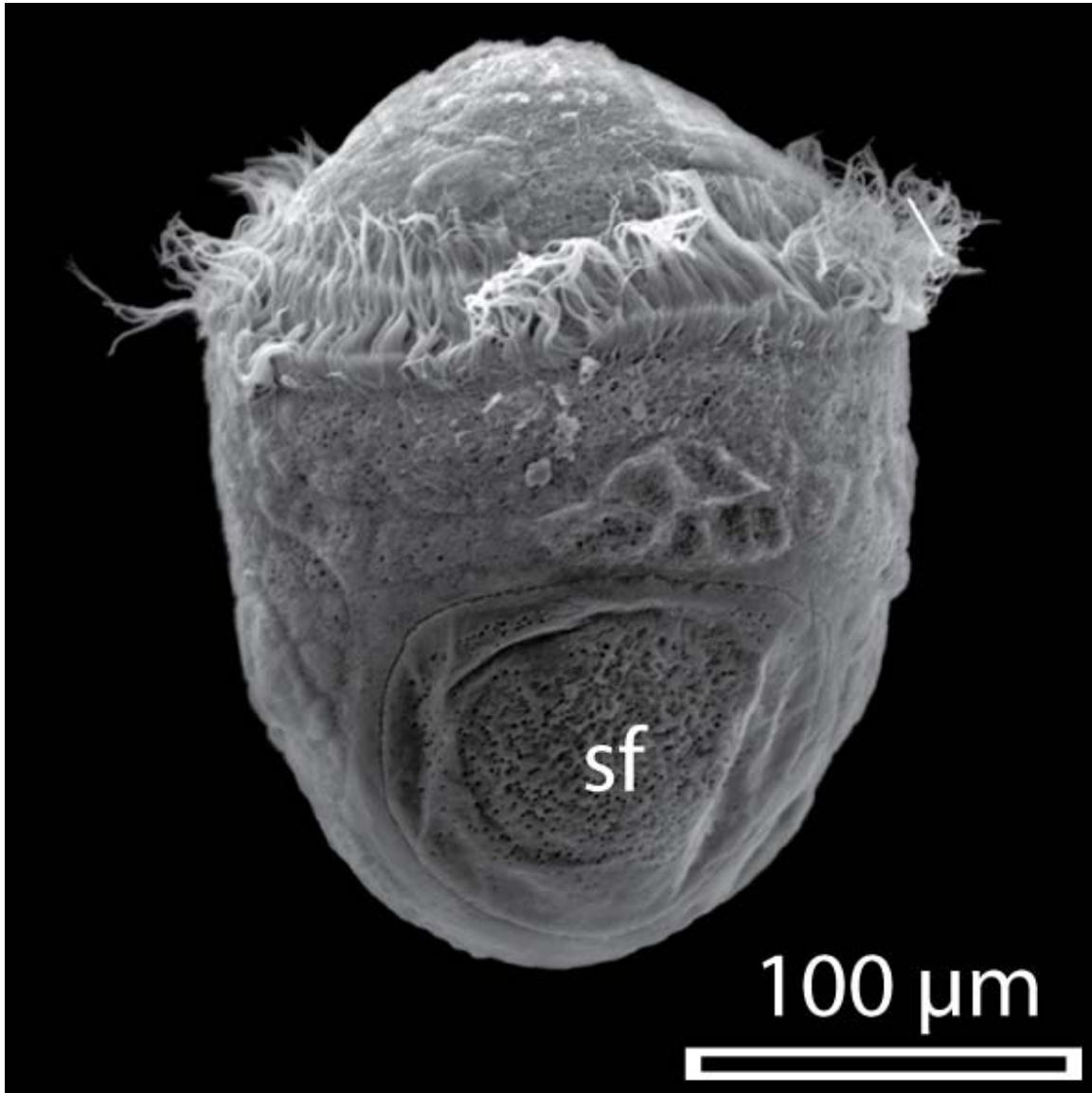
The nervous system of gastropods includes the peripheral nervous system and the central nervous system. The central nervous system consist of ganglia connected by nerve cells. It includes paired ganglia: the cerebral ganglia, pedal ganglia, osphradial ganglia, pleural ganglia, parietal ganglia and the visceral ganglia. There are sometimes also buccal ganglia.

Reproductive system

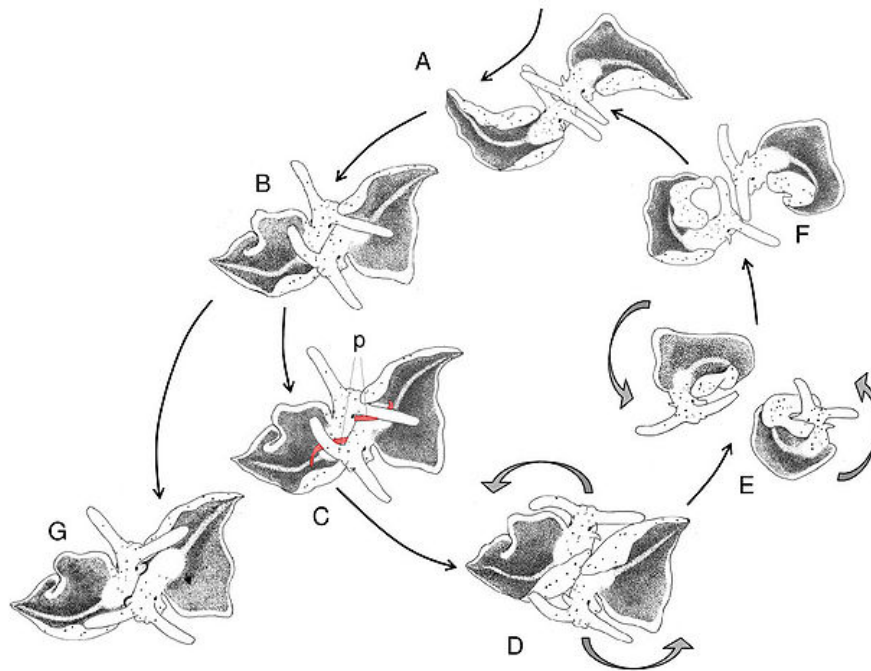
Courtship is a part of mating behavior in some gastropods including some of the Helicidae. Again, in some land snails, an unusual feature of the reproductive system of gastropods is the presence and utilization of love darts.

In many marine gastropods other than the opisthobranchs, there are separate sexes; most land gastropods however are hermaphrodites.

Life cycle



A 9-hour-old trochophore of *Haliotis asinina*
sf - shell field



mating behaviour of *Elysia timida*

The main aspects of the life cycle of gastropods include:

- Egg laying and the eggs of gastropods
- The Embryonic development of gastropods
- The larvae or larval stadium: some gastropods may be trochophore and/or veliger
- Estivation and hibernation (each of these are present in some gastropods only)
- The growth of gastropods
- Courtship of gastropods and mating of gastropods: fertilisation is internal or external according to the species. External fertilisation is common in marine gastropods.

Feeding behavior

Marine gastropods include some that are herbivores, detritus feeders, predatory carnivores, scavengers, parasites, and also a few ciliary feeders, in which the radula is reduced or absent. In some species that have evolved into endoparasites, such as *Parenteroxenos doglieli*, many of the standard gastropod features are strongly reduced or absent.

A few sea slugs are herbivores and some are carnivores. Many have distinct dietary preferences and regularly occur in close association with their food species.

Some predatory carnivorous gastropods include, for example: Cone shells, *Testacella*, *Daudebardia*, Ghost slug and others.

Genetics

Gastropods exhibit an important degree of variation in mt gene organization when compared to other animals. Main events of gene rearrangement occurred at the origin of Patellogastropoda and Heterobranchia, whereas fewer changes occurred between the ancestors of Vetigastropoda (only tRNAs D, C and N) and Caenogastropoda (a large single inversion, and translocations of the tRNAs D and N). Within Heterobranchia, gene order seems to be relatively conserved and gene rearrangements are mostly related with transposition of tRNA genes.

Geological history



Fossil gastropod and attached mytilid bivalves on a Jurassic limestone bedding plane of the Matmor Formation in southern Israel.



Helix aspersa: a European pulmonate land snail that has been accidentally introduced in many countries throughout the world.

The first gastropods were exclusively marine, with the earliest representatives of the group appearing in the Late Cambrian (*Chippewaella*, *Strepsodiscus*). Early Cambrian forms like *Helcionella* and *Scenella* are no longer considered gastropods, and the tiny coiled *Aldanella* of earliest Cambrian time is probably not even a mollusk. By the Ordovician period the gastropods were a varied group present in a range of aquatic habitats. Commonly, fossil gastropods from the rocks of the early Palaeozoic era are too poorly preserved for accurate identification. Still, the Silurian genus *Poleumita* contains fifteen identified species. Fossil gastropods were less common during the Palaeozoic era than bivalves.

Most of the gastropods of the Palaeozoic era belong to primitive groups, a few of which still survive today. By the Carboniferous period many of the shapes we see in living gastropods can be matched in the fossil record, but despite these similarities in appearance the majority of these older forms are not directly related to living forms. It was during the Mesozoic era that the ancestors of many of the living gastropods evolved.

One of the earliest known terrestrial (land-dwelling) gastropods is *Maturipupa*, which is found in the Coal Measures of the Carboniferous period in Europe, but relatives of the

modern land snails are rare before the Cretaceous period, when the familiar *Helix* first appeared.



Cepaea nemoralis: another European pulmonate land snail, which has been introduced to many other countries

In rocks of the Mesozoic era, gastropods are slightly more common as fossils, their shells are often well preserved. Their fossils occur in ancient beds deposited in both freshwater and marine environments. The "Purbeck Marble" of the Jurassic period and the "Sussex Marble" of the early Cretaceous period, which both occur in southern England, are limestones containing the tightly packed remains of the pond snail *Viviparus*.

Rocks of the Cenozoic era yield very large numbers of gastropod fossils, many of these fossils being closely related to modern living forms. The diversity of the gastropods increased markedly at the beginning of this era, along with that of the bivalves.

Certain trail-like markings preserved in ancient sedimentary rocks are thought to have been made by gastropods crawling over the soft mud and sand. Although these trails are of debatable origin, some of them do resemble the trails made by living gastropods today.

Gastropod fossils may sometimes be confused with ammonites or other shelled cephalopods. An example of this is *Bellerophon* from the limestones of the Carboniferous period in Europe, the shell of which is planispirally coiled and can be mistaken for the shell of a cephalopod.

Gastropods are one of the groups that record the changes in fauna caused by the advance and retreat of the Ice Sheets during the Pleistocene epoch.

Taxonomy



A group of fossil *Turritella cingulifera* from the Pliocene of Cyprus.

The taxonomy of the Gastropoda is under constant revision, and more and more of the old taxonomy is being abandoned as the results of DNA studies slowly become clearer. Nevertheless a few of the older terms such as "opisthobranch" and "prosobranch" are still sometimes used in a descriptive way.

The taxonomy of the Gastropoda as shown in various texts can differ in major ways, and on-going revisions of the higher taxonomic levels are to be expected in the near future.

In the older classification there were four subclasses:

- Opisthobranchia (gills to the right and behind the heart).
- Gymnomorpha (no shell)
- Prosobranchia (gills in front of the heart).
- Pulmonata (with a lung instead of gills)

According to newer insights based on DNA sequencing, the taxonomy of the Gastropoda must be rewritten in terms of strictly monophyletic groups. Integrating these findings into a working taxonomy will continue to be a challenge in coming years. At present, it is impossible to give a classification of the Gastropoda that has consistent ranks and also reflects current usage.

Convergent evolution, which appears to exist at especially high frequency in the Gastropoda class, may account for the observed differences between the phylogenies, which are obtained from morphological data and more recent gene sequences studies.

Bouchet & Rocroi (2005) made changes in systematics, resulting in a taxonomy that is a step closer to the evolutionary history of the phylum.

This classification system is based partly on the older systems of classification and partly on new cladistic research. In the past, the taxonomy of gastropods was largely based on phenetic morphological characters of the taxa. The recent advances are more based on molecular characters through research of DNA and RNA. This has made the taxonomical ranks and their hierarchy controversial. The debate about these issues is not likely to end soon.

In this taxonomy, Bouchet, Rocroi *et al.* have used **unranked** clades for taxa above the rank of superfamily (replacing the ranks suborder, order, superorder and subclass), while using the traditional Linnaean approach for all taxa below the rank of superfamily. Whenever monophyly has not been tested, or is known to be paraphyletic or polyphyletic, the term "group" or "informal group" has been used. The classification of families into subfamilies is often not well resolved, and should be regarded as the best possible hypothesis.

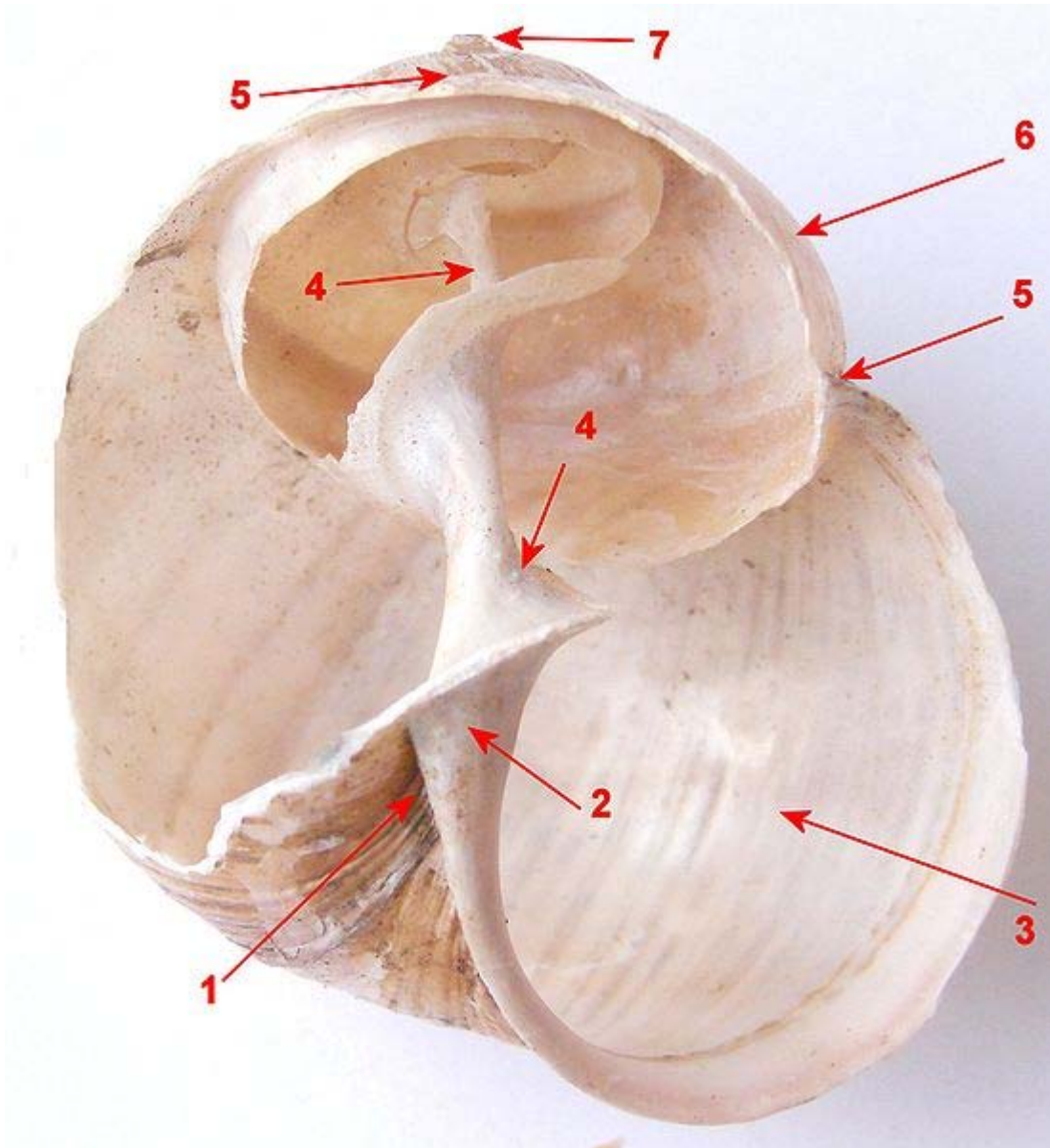
In 2004 Brian Simison and David R. Lindberg showed possible diphyletic origins of the Gastropoda based on mitochondrial gene order and amino acid sequence analyses of complete genes.

Chapter- 2

Gastropod Shell



Four views of a shell of *Arianta arbustorum*: Apertural view of (top left), lateral view (top right), apical view (bottom left), and umbilical view (bottom right).



The shell of a large land snail (probably *Helix pomatia*) with parts broken off to show the interior structure.

- 1 - umbilicus
- 2 - Parietal wall of the aperture
- 3 - aperture
- 4 - columella
- 5 - suture
- 6 - whorl
- 7 - apex

The **gastropod shell** is a shell which is part of the body of a gastropod or snail, one kind of mollusk. The gastropod shell is an external skeleton or exoskeleton, which serves not only for muscle attachment, but also for protection from predators and from mechanical

damage. In land snails the shell is an essential protection against the sun, and against drying out.

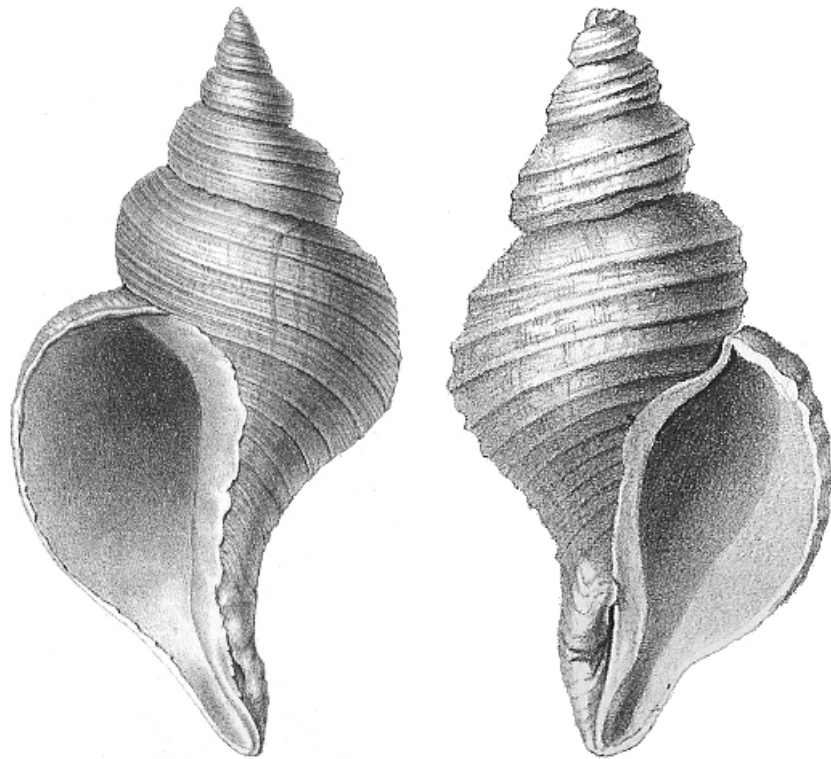
Most gastropod shells are spirally coiled. The coiling is usually right-handed, but in some taxa the coiling is left-handed and in a very few species there can be both right-handed and left-handed individuals.

The gastropod shell has several layers, and is typically made of calcium carbonate precipitated out into an organic matrix known as conchiolin. The shell is secreted by a part of the molluscan body known as the mantle.

Not all gastropods have a shell, but the majority do. In almost every case the shell consists of one piece, and is typically spirally coiled, although some groups, such as the various different families and genera of limpets, have simple cone-shaped shells as adults.

The study of mollusc shells including gastropod shells is called conchology.

Chirality in gastropods



Shells of two different species of sea snail: on the left is the normally sinistral (left-handed) shell of *Neptunea angulata*, on the right is the normally dextral (right-handed) shell of *Neptunea despecta*

Because coiled shells are asymmetrical, they possess a quality called chirality, the "handedness" of an asymmetrical structure.

By far the majority (over 90 %) of gastropod species have **dextral** (right-handed) shells in their coiling, but a small minority of species and genera are virtually always **sinistral** (left-handed), and a very few species (for example *Amphidromus perversus*) show an even mixture of dextral and sinistral individuals.

In species that are almost always dextral, very rarely a sinistral specimen will be produced, and these oddities are avidly sought after by some shell collectors.

If a coiled gastropod shell is held with the spire pointing upwards and the aperture more or less facing the observer, a dextral shell will have the aperture on the right-hand side, and a sinistral shell will have the aperture on the left-hand side.

This chirality of gastropods is often overlooked when photographs of coiled gastropods are "flipped" by a non-expert prior to being used in a publication. This image "flipping" results in a normal dextral gastropod appearing to be a rare and abnormal sinistral one.

The chirality in gastropods appears in early cleavage (spiral cleavage) and the gene NODAL is involved.

Mixed coiling populations

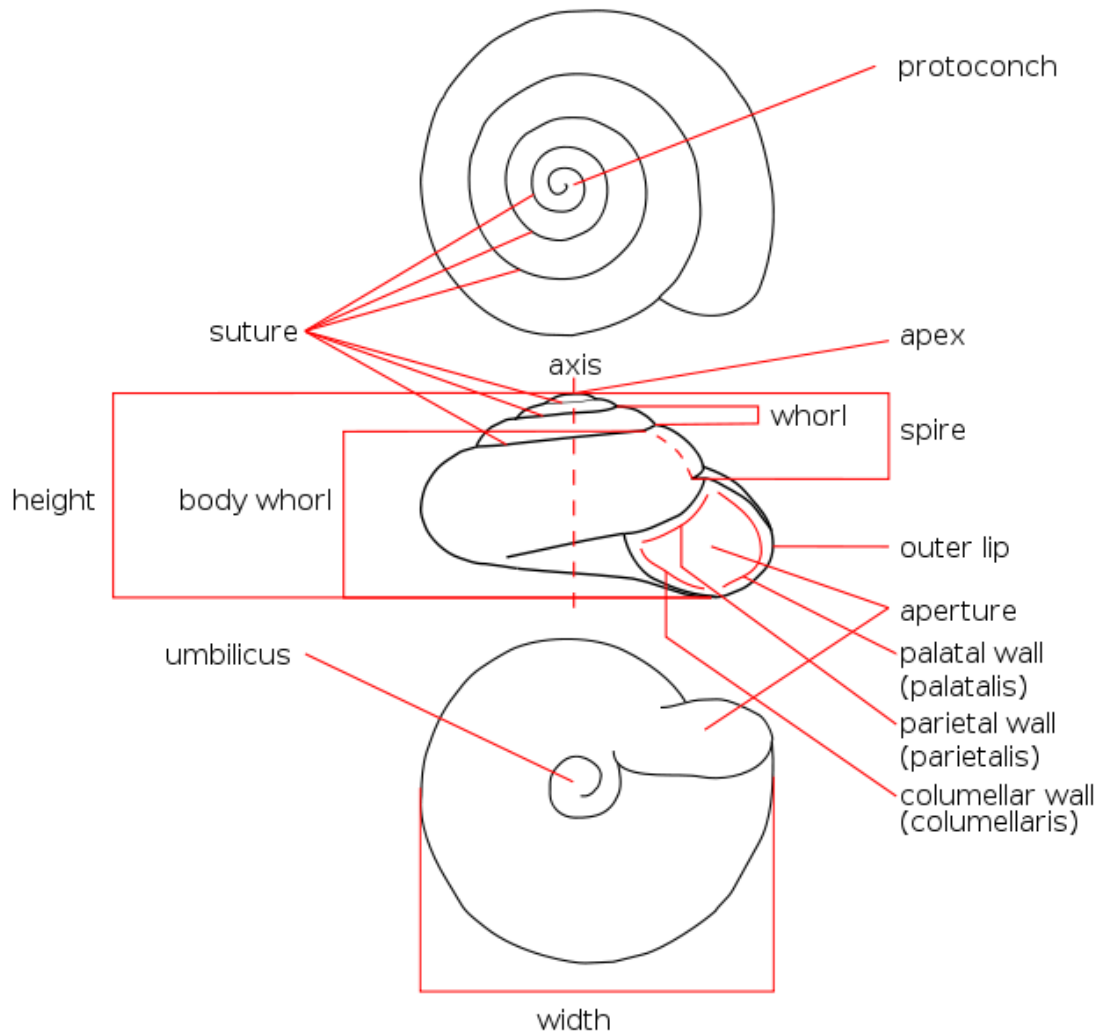
In few cases, both left- and right-handed coiling are found in the same population. Sinistral mutants of normally dextral species and dextral mutants of normally sinistral species are rare but well documented occurrences among land snails in general. Populations or species with normally mixed coiling are much rarer, and, so far as is known, are confined, with one exception, to a few genera of arboreal tropical snails. Besides *Amphidromus*, the Cuban *Liguus vittatus* (Swainson), Haitian *Liguus virgineus* (Linnaeus) (family Orthalicidae), some Hawaiian *Partulina* and many Hawaiian *Achatinella* (family Achatinellidae), as well as several species of Pacific Island *Partula* (family Partulidae), are known to have mixed dextral-sinistral populations. The independent appearance of this variation in unrelated groups is probably the result of a simple mutation, whose primary import is with physiological adaptations to arboreal life and not with the direction of coiling. In *Partula* both dextral and sinistral embryos have been recovered from the same brood pouch, although normally all embryos coil in the same direction. In *Amphidromus* there is no information on the heredity of this character.

A possible exception may concern some of the European clausiliids of the subfamily Alopiinae. They are obligatory calciphiles living in isolated colonies on limestone outcrops. Several sets of species differ only in the direction of coiling, but the evidence is inconclusive as to whether left- and right-handed shells live together. Soos (1928, pp. 372–385) summarized previous discussions of the problem and concluded that the right- and left-handed populations were distinct species. Others have stated that these populations were not distinct, and the question is far from settled. The Peruvian clausiliid,

Nenia callistoglypta Pilsbry (1949, pp. 216–217), also has been described as being an amphidromine species.

The genetics of reverse coiling in a rare dextral mutant of another clausiliid, *Alinda biplicata* (Montagu), has been studied by Degner (1952). The mechanism is the same as in *Radix peregra* (Müller), with the direction of coiling determined by a simple Mendelian recessive. Any change in direction caused by cross-fertilization is delayed one generation by an unknown mechanism.

Morphology



Morphology of typical spirally coiled shell. The shell of *Zonitoides nitidus*, a land snail, has dextral coiling.

Upper image: Dorsal view, showing whorls and apex

Central image: Lateral view showing the profile of the shell

Lower image: Basal view showing umbilicus in the centre.



Photo of the shell of *Zonitoides nitidus* with an apical view, an apertural view and a basal view

Gastropod shell morphology is usually quite constant among individuals of a species, and with exceptions, fairly constant among species within each family of gastropoda.

Controlling variables are:

- The rate of growth per revolution around the coiling axis. High rates give wide-mouthed forms such as the abalone, low rates give highly coiled forms such as *Turritella* or some of the Planorbidae.
- The shape of the generating curve, roughly equivalent to the shape of the aperture. It may be round, for instance in the turban shell, elongate as in the cone shell or have an irregular shape with a siphonal canal extension, as in the *Murex*.

- The rate of translation of the generating curve along the axis of coiling, controlling how high-spined the resulting shell becomes. This may range from zero, a flat planispiral shell, to nearly the diameter of the aperture.
- Irregularities or "sculpturing" such as ribs, spines, knobs, and varices made by the snail regularly changing the shape of the generating curve during the course of growth, for instance in the many species of Murex.
- Ontologic growth changes as the animal reaches adulthood. Good examples are the flaring lip of the adult conch and the inward-coiled lip of the cowry.

Some of these factors can be modeled mathematically and programs exist to generate extremely realistic images. Early work by David Raup on the analog computer also revealed many possible combinations that were never adapted by any actual gastropod.

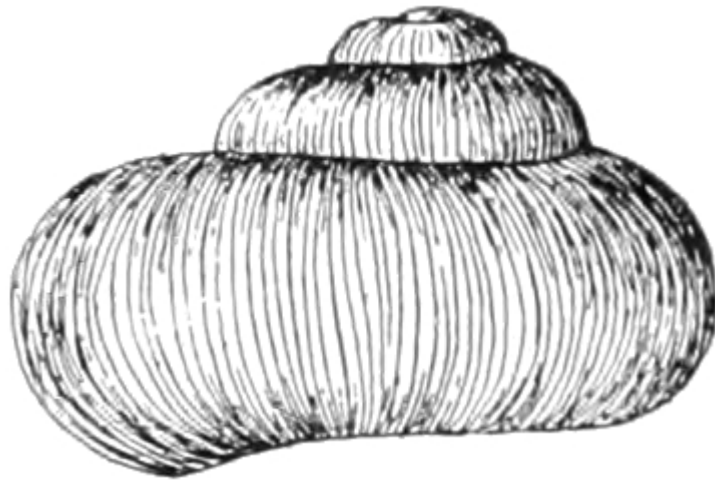
Some shell shapes are found more often in certain environments, though there are many exceptions. Wave-washed high-energy environments, such as the rocky intertidal zone, are usually inhabited by snails whose shells have a wide aperture, a relatively low surface area, and a high growth rate per revolution. High-spined and highly sculptured forms become more common in quiet water environments. The shell of burrowing forms, such as the olive and *Terebra*, are smooth, elongated, and lack elaborate sculpture, in order to decrease resistance when moving through sand.

A few gastropods, for instance the Vermetidae, cement the shell to, and grow along, solid surfaces such as rocks, or other shells.

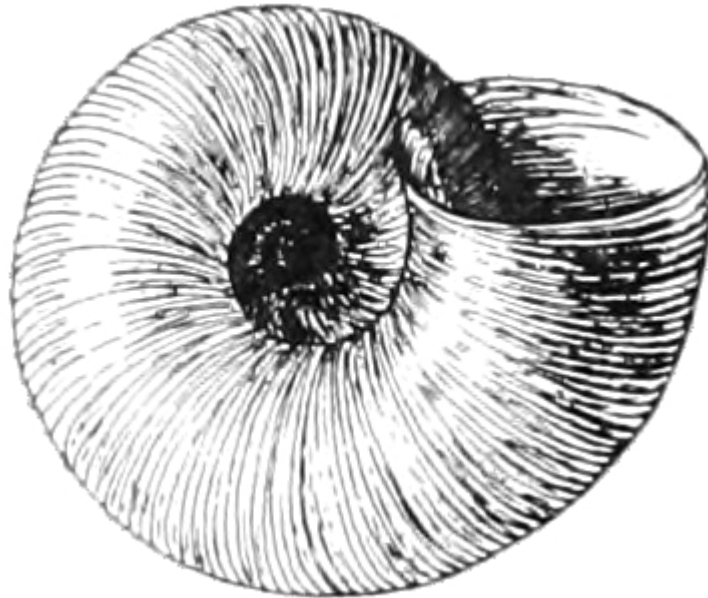
Standard ways of viewing a shell



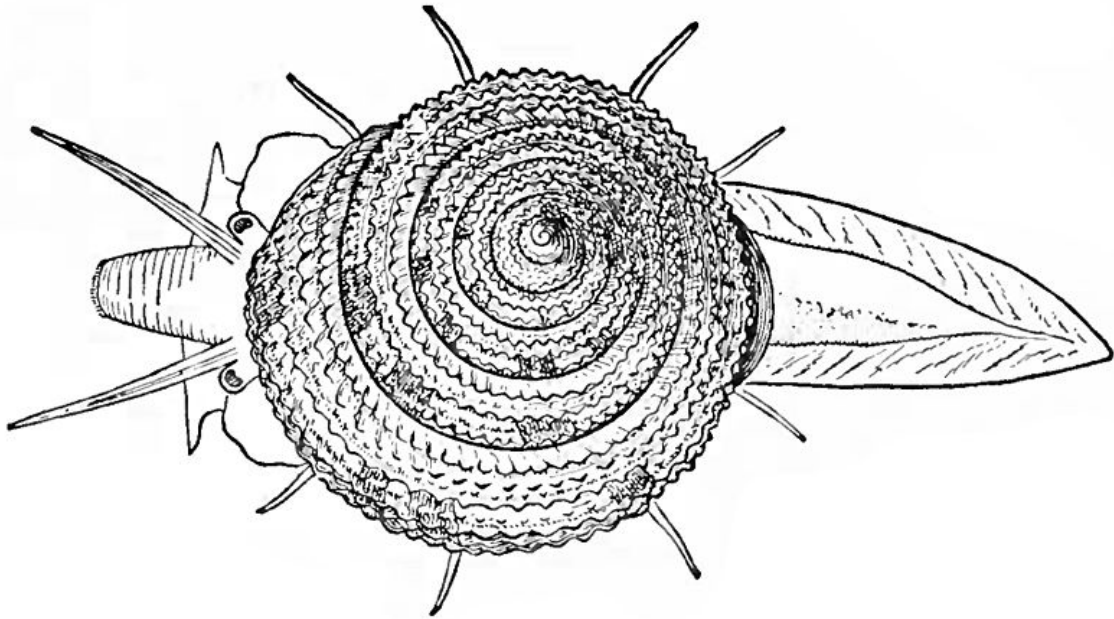
Apertural view of shell of *Valvata sincera*



Abapertural view of shell of *Valvata sincera*



Basal or umbilical view of shell of *Valvata sincera*



This dorsal view of the living animal *Calliostoma bairdii* also shows the dorsal view of its shell

In photographs or illustrations, a gastropod shell can be shown oriented in a number of standard ways:

- **apertural view**: this is the most common viewing angle. The shell is shown in its full length with its aperture to the viewer and the apex on top. When the aperture is on the right side, then the shell is called "right-handed"; if the aperture is on the left side, the shell is called "left-handed".
- **abapertural view**: the shell is shown in its full length with its aperture 180° away from the viewer and with the apex on top.
- **apical view** (or dorsal view): the shell is seen in its full width with the apex on top
- **basal view** (or umbilical view): the shell is shown in its full width with the apex below. In most cases, the umbilicus is in clear view.

Description

The shell begins with the minute embryonic whorls of the protoconch, which is often quite distinct from the rest of the shell. From the protoconch, which forms the apex of the spire, the coils or whorls of the shell gradually increase in size. Normally the whorls are circular or elliptical in section, but from compression and other causes a variety of forms can result. The spire can be high or low, broad or slender according to the way the coils of the shell are arranged, and the apical angle of the shell varies accordingly. The whorls sometimes rest loosely upon one another (as in *Epitonium scalare*). They also can overlap the earlier whorls such that they may be largely or wholly covered by the later ones.

When an angulation occurs, the space between it and the suture above it constitutes the area known as the "shoulder" of the shell. The shoulder angle may be simple or keeled, and may sometimes have nodes or spines.

The most primitive sculpture of the gastropod shell consists of revolving ridges or spirals, and of transverse folds or ribs. Primary spirals appear in regular succession on either side of the first primary, which generally becomes the shoulder angle if angulation occurs. Secondary spirals appear by intercalation between the primary ones, and generally are absent in the young shell, except in some highly accelerated types. Tertiary spirals are intercalated between the preceding groups in more specialized species. Ribs are regular transverse foldings of the shell, which generally extend from the suture to suture. They are usually spaced uniformly and crossed by the spirals. In specialized types, when a shoulder angle is formed, they become concentrated as nodes upon this angle, disappearing from the shoulder above and the body below. Spines may replace the nodes in later stages. They form as notches in the margin of the shell and are subsequently abandoned, often remaining open in front. Irregular spines may also arise on various parts of the surface of the shell. When a row of spines is formed at the edge or outer lip of the shell this sometimes remains behind as a varix as in (*Murex*) and many of the Ranellidae. Varices may also be formed by simple expansion of the outer lip, and a subsequent resumption of growth from the base of the expansion. These simple varices may project from the shell (*Epitonium*) or be reflected backwards (*Harpa*). Periodic enlargements of ribs (*Murex*, *Cerithium*) are not to be classed as varices.

The aperture or peristome of the shell may be simple or variously modified. An outer and an inner (columellar) lip are generally recognized. These may be continuous with each other, or may be divided below by an anterior notch. This, in some types (*Fusinus*, etc.) it is drawn out into an anterior siphonal canal, of greater or lesser length.

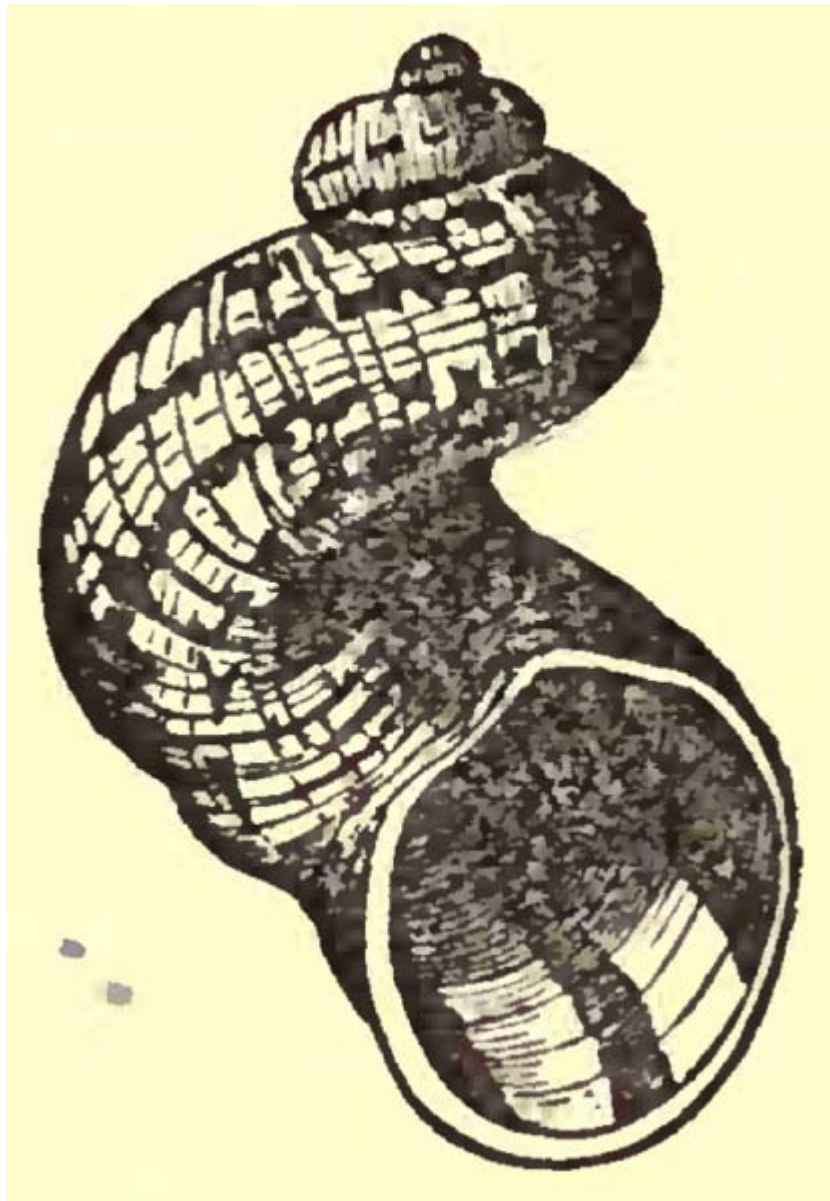
An upper or posterior notch is present in certain (chiefly old age) types, and this may result in the formation of a ridge or shelf next to the suture (*Clavilithes*). An outer (lateral) emargination or notch, sometimes prolonged into a slit occurs in certain types (Pleurotomidae, Pleurotomaridae, Bellerophonidae, etc.), and the progressive closing of this slit may give rise to a definitely marked slit band. In some cases the slit is abandoned and left as a hole (Fissurellidae), or by periodic renewal as a succession of holes (*Haliotis*). The outer emargination is often only indicated by the reflected course of the lines of growth on the shell.

On the inside of the outer lip, various ridges or plications called lira are sometimes found, and these occasionally may be strong and tooth-like (*Nerinea*). Similar ridges or columellar plicae or folds are more often found on the inner lip, next to the columella or central spiral twist. These may be oblique or normal to the axis of coiling (horizontal), few or numerous, readily seen, or far within the shell so as to be invisible except in broken shells. When the axis of coiling is hollow (perforate spire) the opening at the base constitutes the umbilicus. The umbilicus varies greatly in size, and may be wholly or in part covered by an expansion or callus of the inner lip (*Natica*).

Most modern shells are covered by a horny smooth or hairy epidermis or periostracum, which sometimes hides the (often brilliant) color markings of the surface. The *periostracum*, as well as the coloration, is rarely preserved in fossil shells.

The apertural end of the gastropod shell is the anterior end, the apex of the spire the posterior. Most authors figure the shells with the apex of the spire uppermost. French authors generally figure them with the anterior end uppermost. The aperture is often closed by a horny or calcareous operculum, of very variable form in the different groups. It is secreted by and attached to the upper surface of the foot of the animal.

Parts of the shell



A drawing of an abnormal scalarid form of the shell of the garden snail, *Helix aspersa*

The terminology used to describe the shells of gastropods includes:

- Aperture: the opening of the shell
- Apex: the smallest few whorls of the shell
- Body whorl: the largest whorl in which the main part of the visceral mass of the mollusk is found
- Columella: the "little column" at the axis of revolution of the shell
- Operculum: the "trapdoor" of the shell
- Parietal callus: a ridge on the inner lip of the aperture in certain gastropods
- Periostracum: a thin layer of organic "skin" which forms the outer layer of the shell of many species
- Peristome: the part of the shell that is right around the aperture
- Protoconch: the larval shell, often remains in position even on an adult shell
- Sculpture: ornamentation on the outer surface of a shell
 - Lira: one kind of shell sculpture
 - Plait: another kind of shell sculpture
- Siphonal canal: an extension of the aperture in certain gastropods
- Spire: the part of the shell that protrudes above the body whorl
- Suture: The junction between whorls of most gastropods
- Umbilicus: in shells where the whorls move apart as they grow, on the underside of the shell there is a deep depression reaching up towards the spire; this is the umbilicus
- Varix: on some mollusk shells, spaced raised and thickened vertical ribs mark the end of a period of rapid growth; these are varices
- Whorl: each one of the complete rotations of the shell spiral

Shape of the shell

The distinction of the shape of the shell may vary based on the purpose. For example distinguishing into three groups can be based on the height - width ratio:

- oblong - the height is much bigger than the width
- globose or conical shell - the height and the width of the shell are approximately the same
- depressed - the width is much bigger than the height



oblong shell of *Bulgarica denticulata*

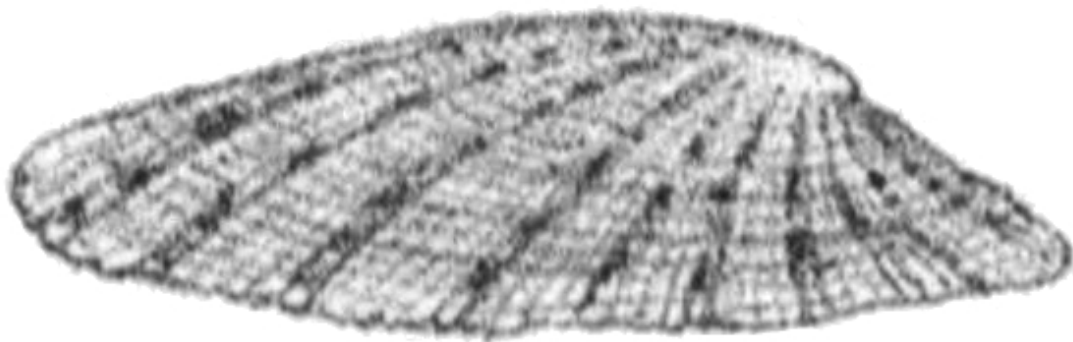


globose shell of *Sphincterochila candidissima*

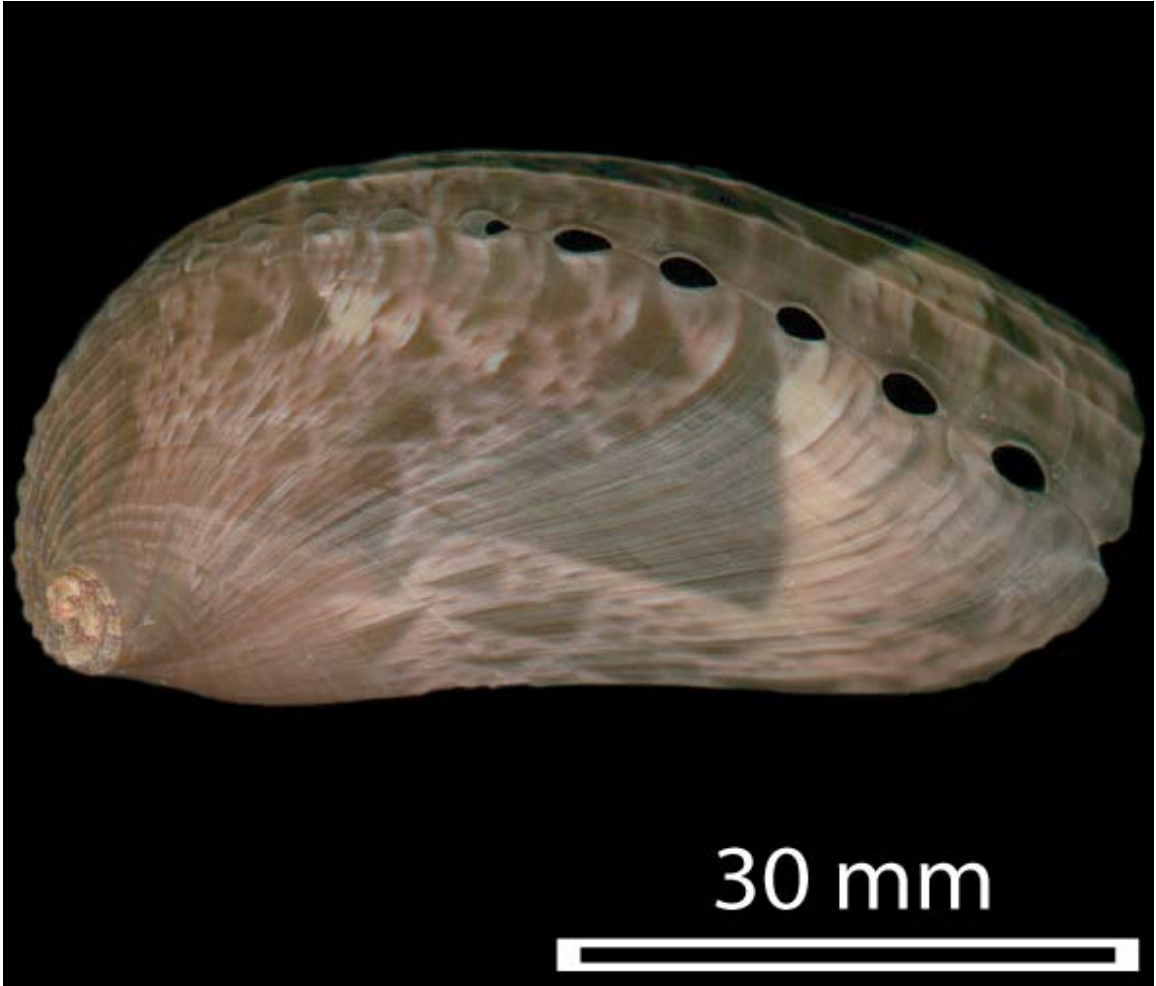


depressed shell of Escargot de Quimper

Detailed distinction of the shape can be:



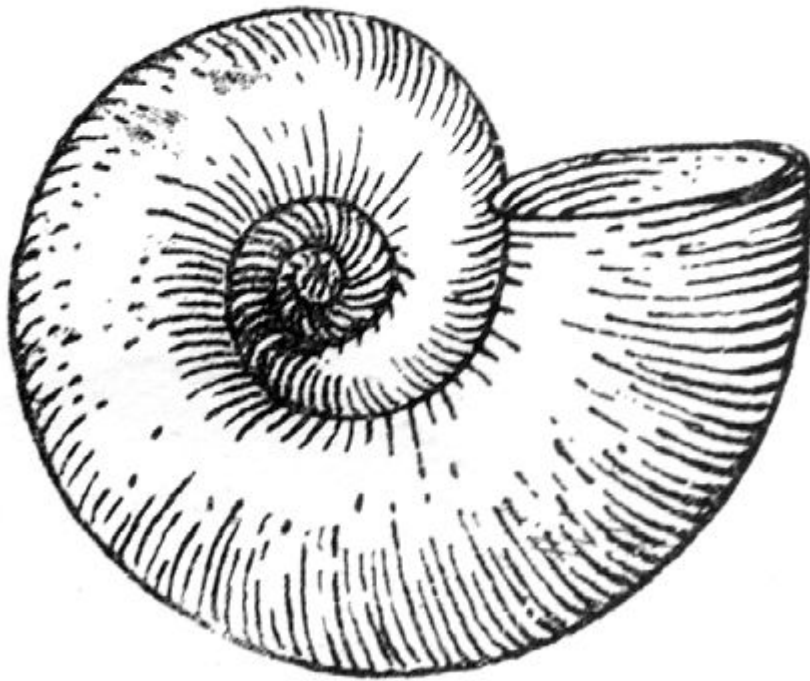
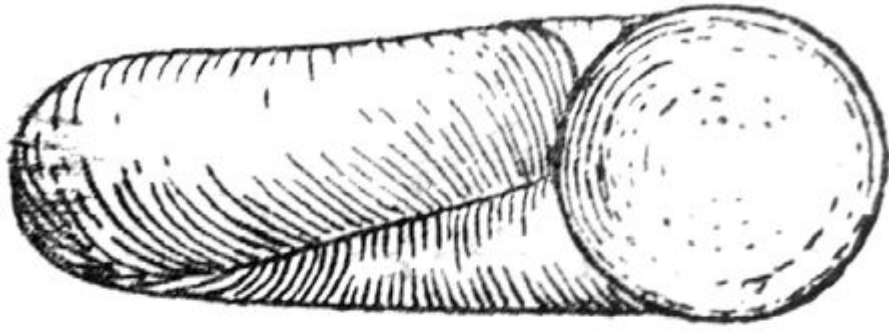
cap shape



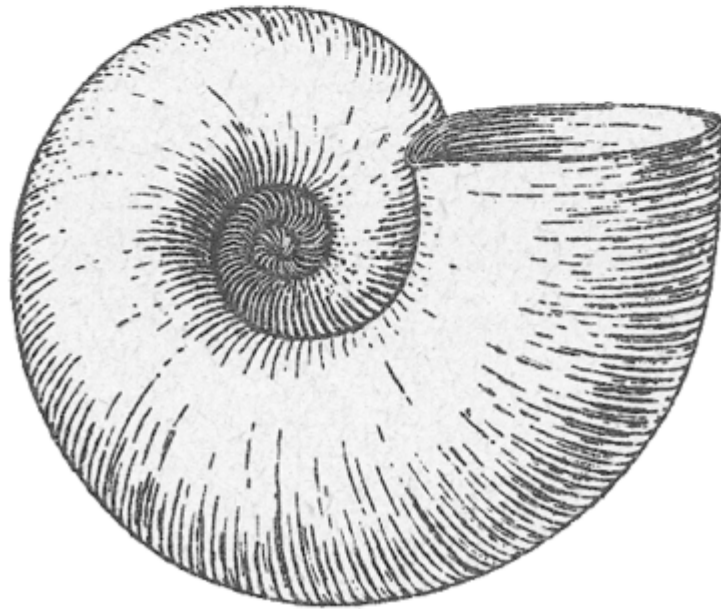
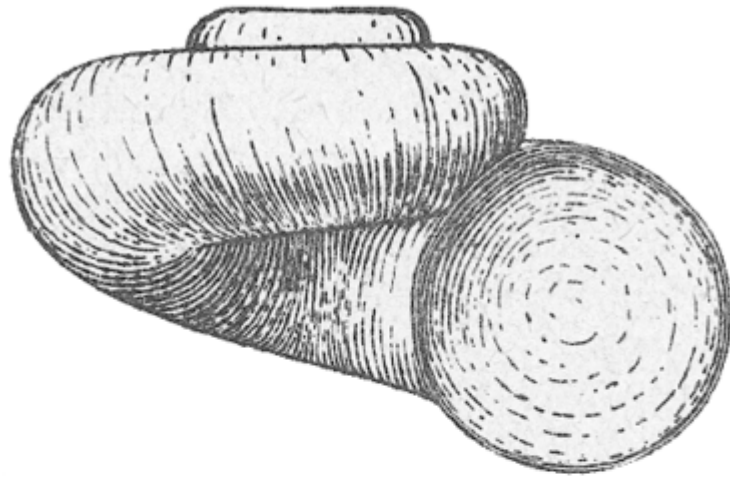
ear shape



neritiform



planispiral



depressed trochiform or valvatiform



trochiform



ovate-conic



conic



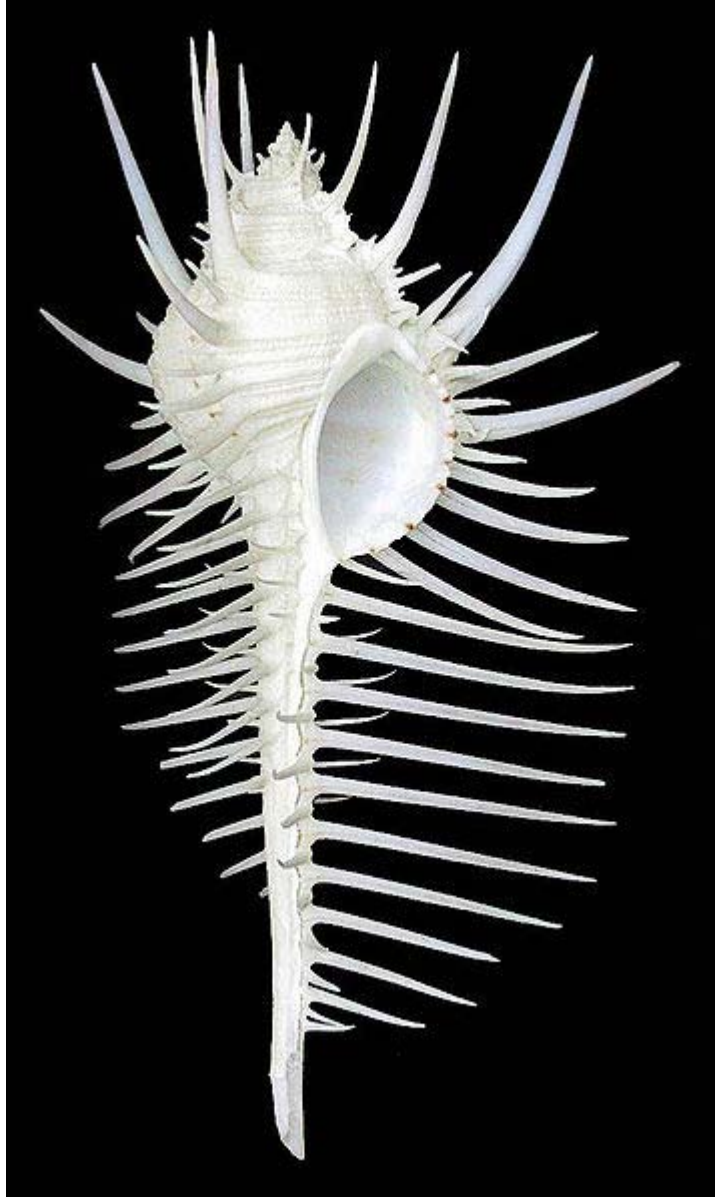
elongate-conic or turriform or cockscrew shape



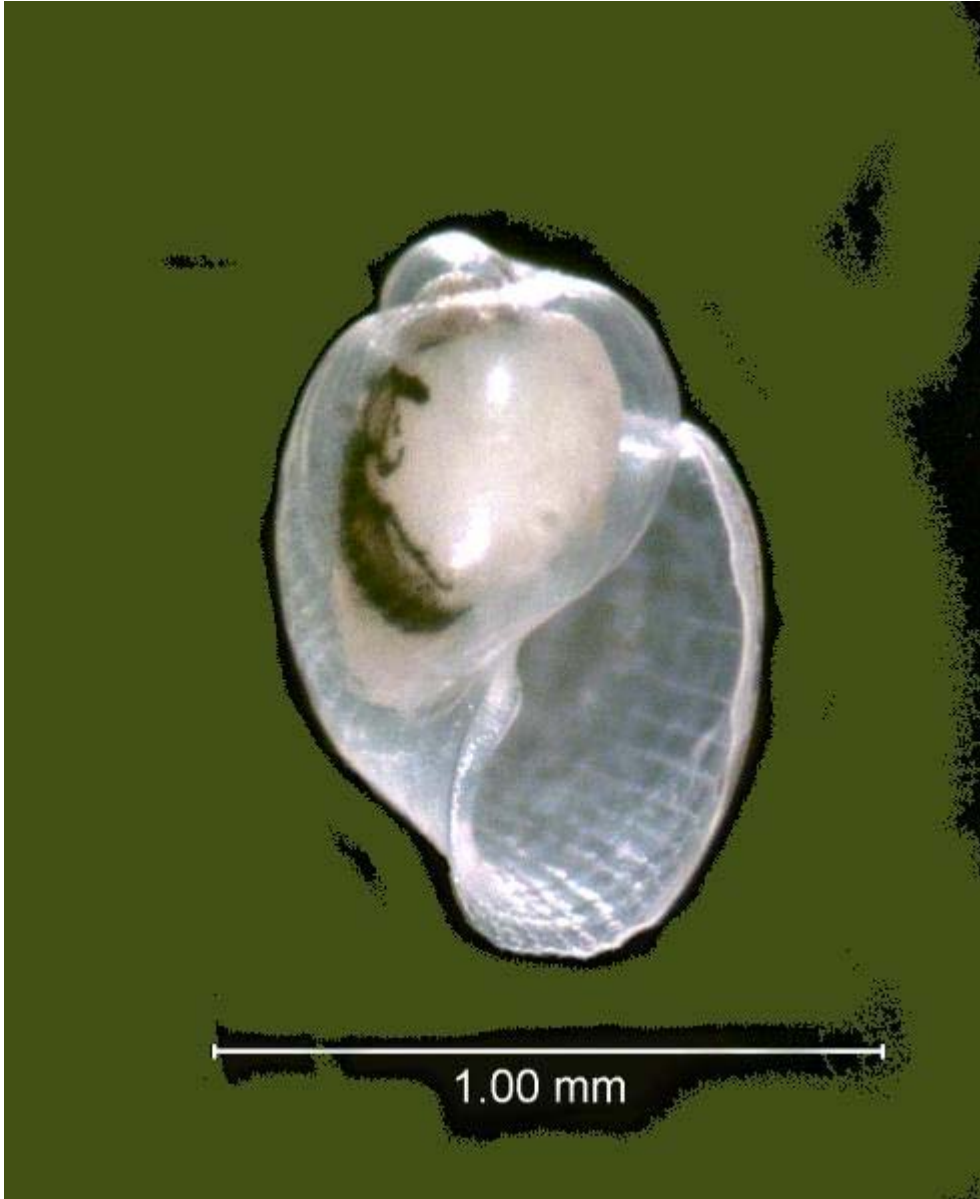
top shape



spindle shape - the sea snail *Syrinx aruanus* has the largest shell of any living gastropod.



club shape



barrel shape

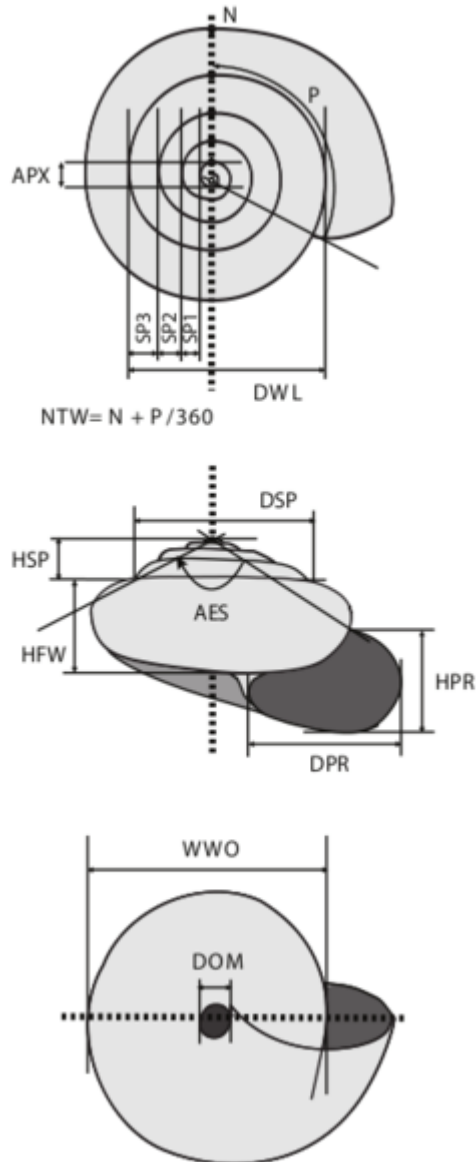


egg shape



irregular shape

Pear shape means both shapes: ovate-conic and conic.



Schematic representation of the apical, apertural and basal view of a shell, showing 14 different commonly used measurements. Dotted lines represent the orientation axes (except of lower image).

Dimensions

The most frequently used measurements of a gastropod shell are: the **height** of the shell, the **width** of the shell, the height of the aperture and the width of the aperture. The number of whorls is also often used.

In this context, the height (or the length) of a shell is its maximum measurement along the central axis. The width (or breadth, or diameter) is the maximum measurement of the

shell at right angles to the central axis. Both terms are only related to the description of the shell and not to the orientation of the shell on the living animal.

The largest height of any shell is found in the marine snail species *Syrinx aruanus*, which can be up to 91 cm.

The **central axis** is an imaginary axis along the length of a shell, around which, in a coiled shell, the whorls spiral. The central axis passes through the columella, the central pillar of the shell.

Evolutionary changes

Among proposed roles invoked the variability of shells during evolution include mechanical stability, defense against predators (evolution of shells against external attacks has been proved by nanoindentation), sexual selection and climatic selection.

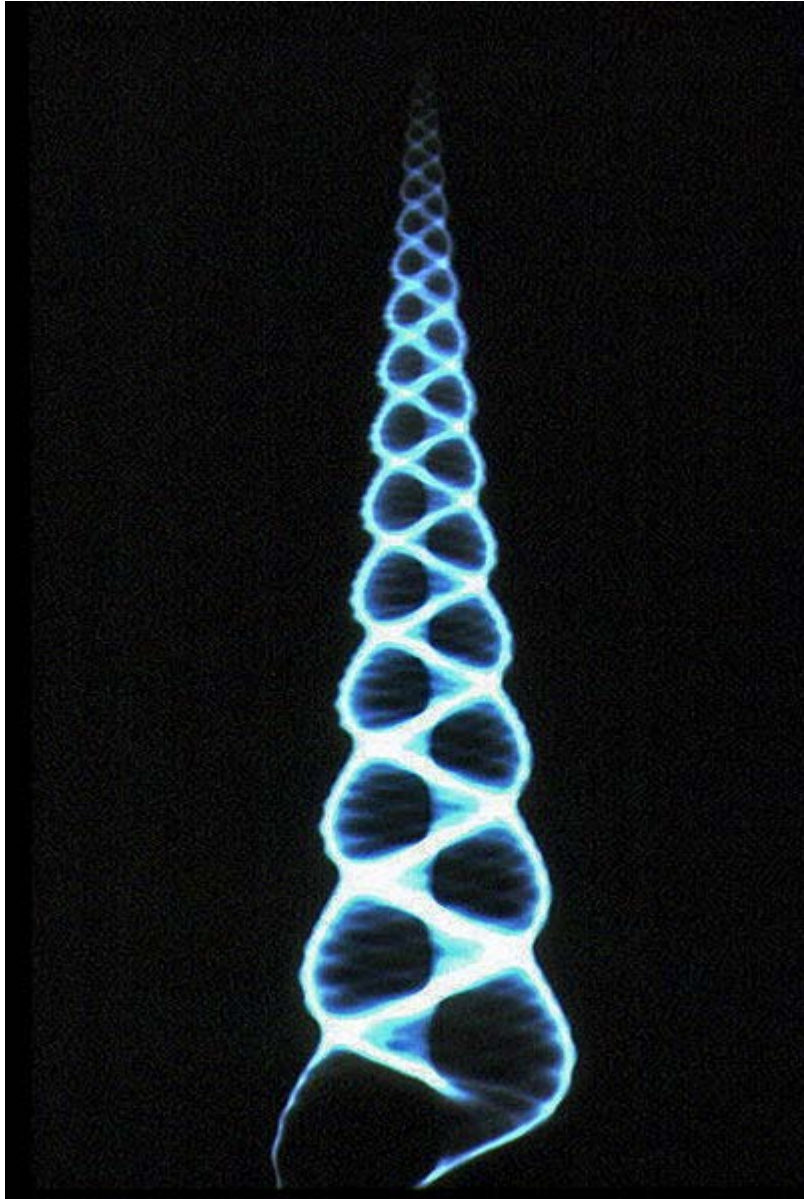
The shell of some gastropods have been reduced or partly reduced during the evolution. This reduction can be seen in all slugs, in semi-slugs and in various other marine and non-marine gastropods. Sometimes the reduction of the shell is associated with predatory way of feeding.

Some taxa even lost the coiling of their shell during evolution. According to Dollo's law, it is not possible to regain the coiling of the shell after it is lost. Despite that, there are few genera in the family Calyptraeidae that changed their developmental timing (heterochrony) and gained back (re-evolution) a coiled shell from the previous condition of an uncoiled limpet-like shell.

Variety of forms



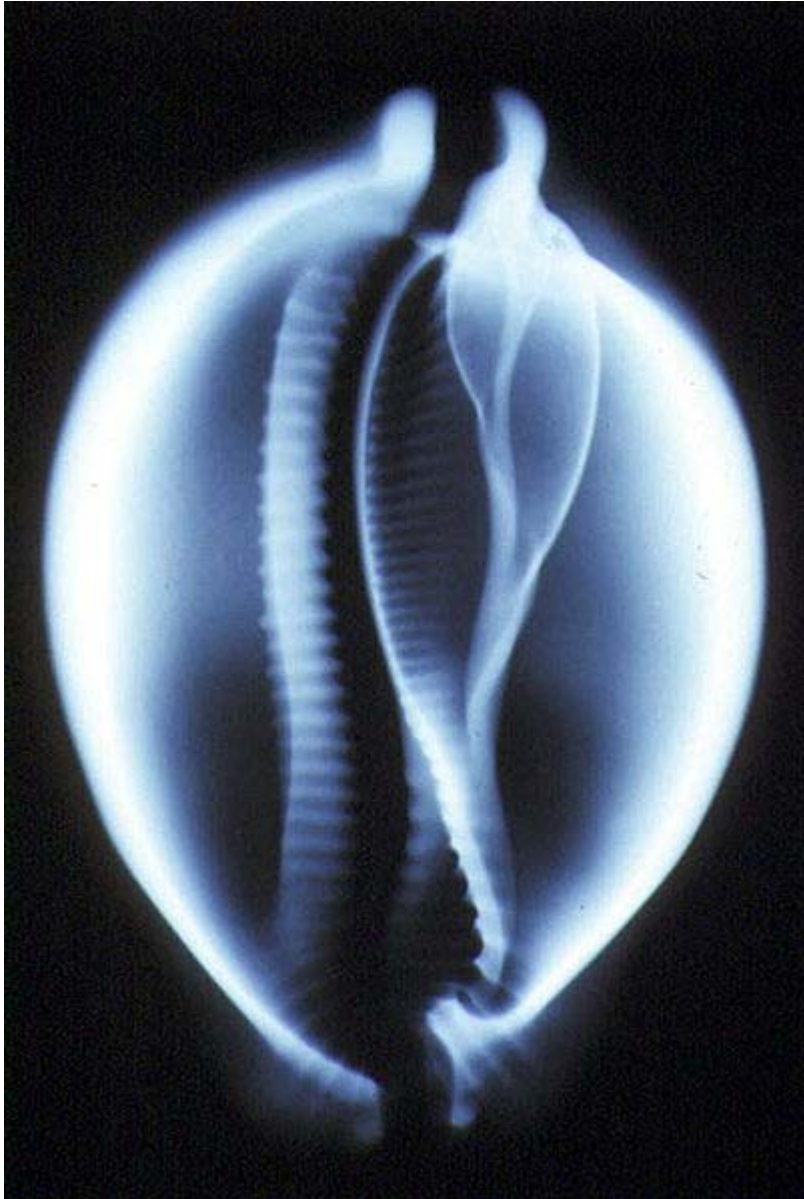
Turritella communis, many-whorled shell of tower snail



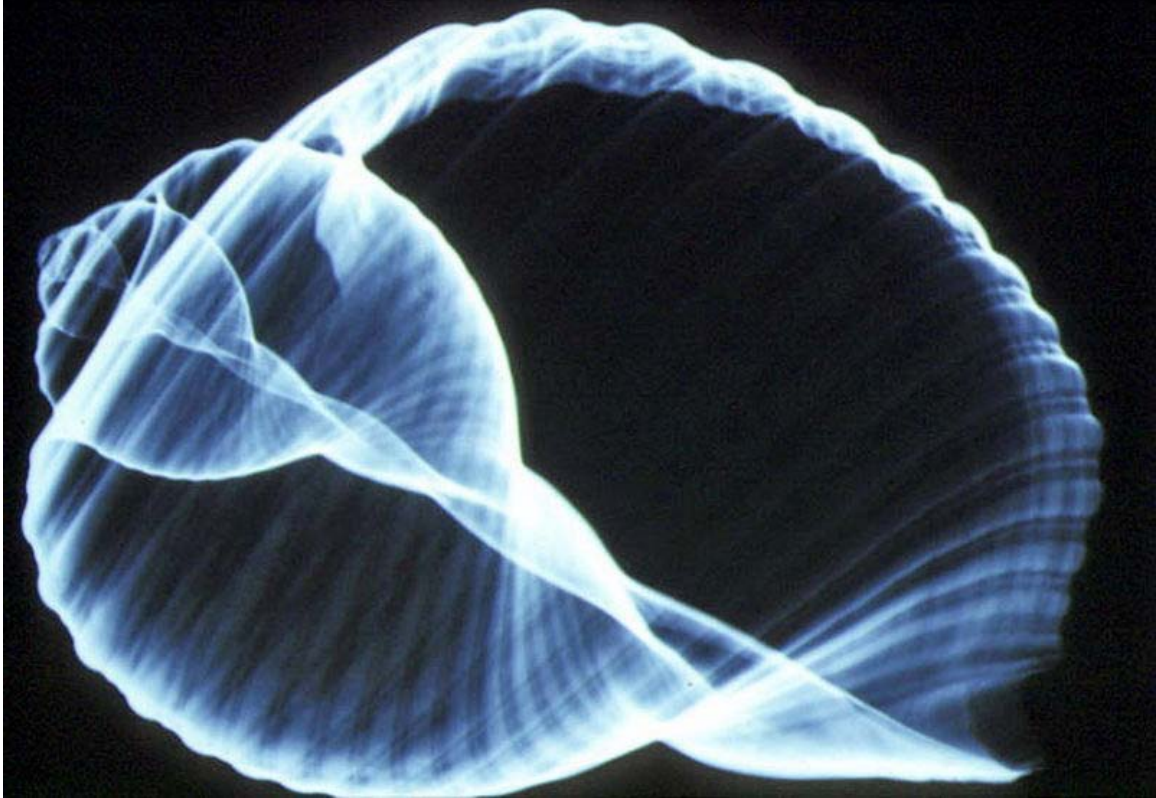
X-ray image of *Turritella*



Shell of marine cowry snail - *Cypraea nebrites*



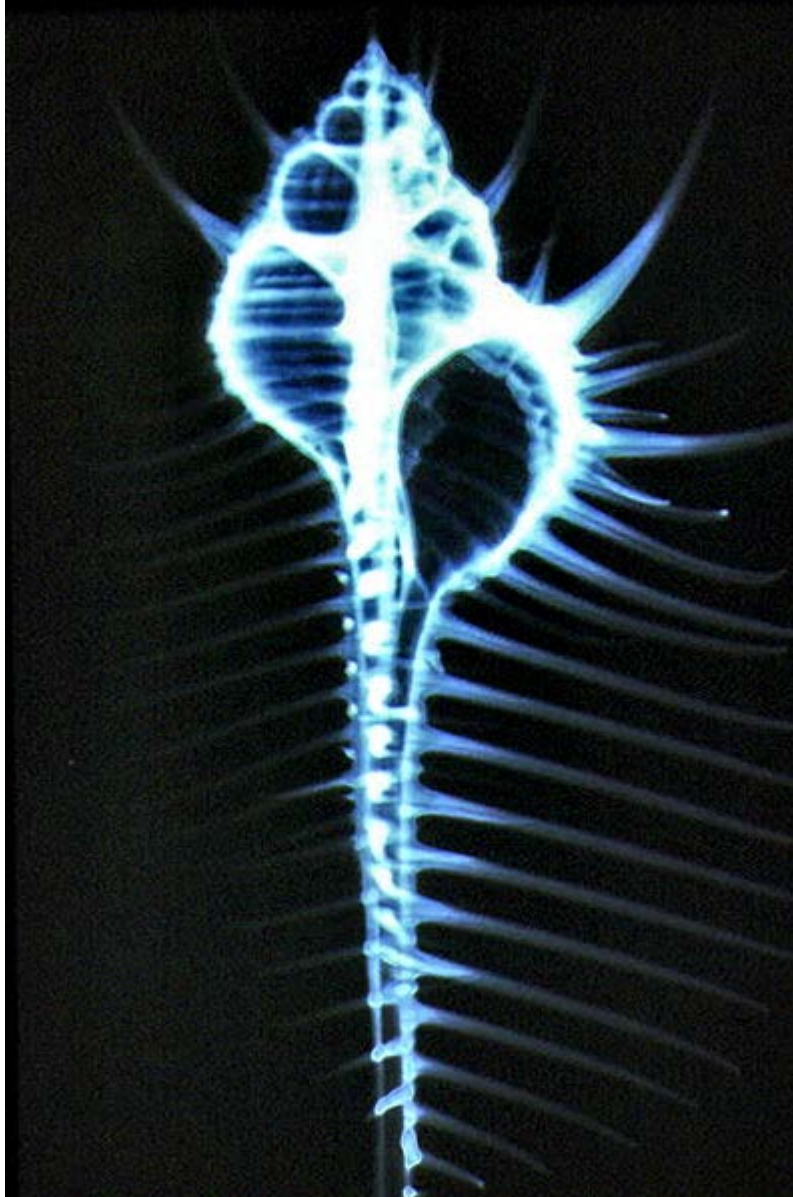
X-ray image of Cypraea



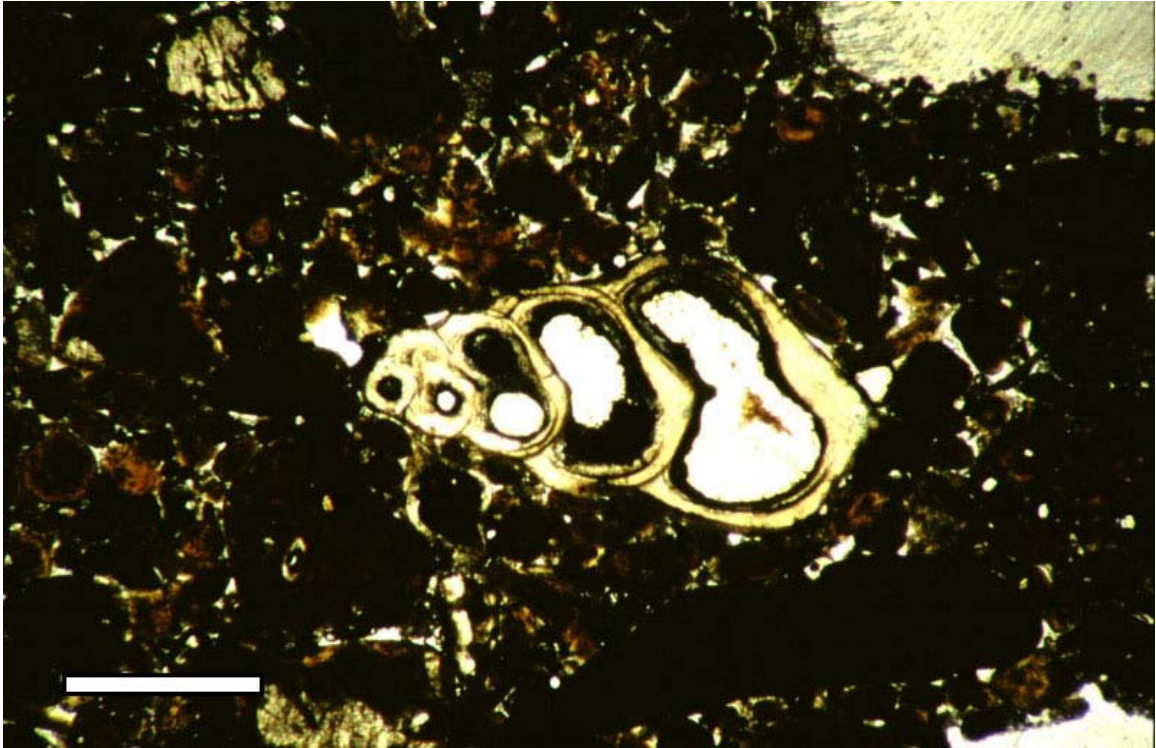
X-ray image of the shell of *Tonna galea*



Charonia



Murex pecten



Thin section in plane-polarized light of microscopic gastropod shell, from Holocene lagoonal sediment of Rice Bay, San Salvador Island, Bahamas. Scale bar 500 microns.

Chapter- 3

Types of Gastropoda

Patellogastropoda

True limpets



Images of true limpets, shell and live individuals of three species

Scientific classification

| | |
|-------------|--|
| Kingdom: | Animalia |
| Phylum: | Mollusca |
| Class: | Gastropoda |
| (unranked): | clade Patellogastropoda Lindberg, 1986 |

Patellogastropoda, common name **true limpets**, is a major phylogenetic group of marine gastropods, seen either as a clade or as a taxonomic order.

Taxonomy

Patellogastropoda was proposed by David R. Lindberg, 1986, as an order later included in the subclass Eogastropoda Ponder & Lindberg, 1996.

2005 taxonomy

Bouchet & Rocroi, 2005 designated Patellogastropoda, true limpets, as a clade, rather than as a taxon, but within included superfamilies and families as listed below. Families that are exclusively fossil are indicated with a dagger †:

- Superfamily Patelloidea
 - Family Patellidae
- Superfamily Nacelloidea
 - Family Nacellidae
- Superfamily Lottioidea
 - Family Lottiidae
 - Family Acmaeidae Forbes, 1850
 - subfamily Acmaeinae Forbes, 1850
 - subfamily Pectinodontinae Pilsbry, 1891
 - subfamily Rhodopetalinae Lindberg, 1981
 - Family Lepetidae
- Superfamily Neolepetopsoidea
 - Family Neolepetopsidae
 - † Family Daminilidae
 - † Family Lepetopsidae

With the exception of the choice of calling Patellogastropoda a clade rather than an Order as previously by Ponder and Lindberg, 1997 the two are rather similar and differ more in the arrangement of their content than in their overall composition. Bouchet and Rocroi leave out Ponder and Lindberg's suborders and add the Superfamily Neolepetopsoidea.

2007 taxonomy

Nakano & Ozawa (2007) made many changes in the taxonomy of the Patellogastropoda, based on molecular phylogeny research: Acmaeidae is a synonym of Lottiidae; Pectinodontinae is elevated to Pectinodontidae; new family Eoacmaeidae with the new type genus *Eoacmaea* is established.

A cladogram based on sequences of mitochondrial 12S ribosomal RNA, 16S ribosomal RNA and cytochrome-c oxidase I (COI) genes showing phylogenic relations of Patellogastropoda by Nakano & Ozawa (2007) and superfamilies based on World Register of Marine Species:

Note that family Neolepetopsidae is not in the cladogram above, because its members were not genetically analyzed by Nakano & Ozawa (2007). But two Neolepetopsidae species *Eulepetopsis vitrea* and *Paralepetopsis floridensis* were previously analyzed by Harasewych & McArthur (2000), who confirmed their placement within Acmaeoidea/Lottioidea based on analysis of partial 18S rDNA. There are also not included in the cladogram families Daminilidae and Lepetopsidae, because they are exclusively fossil families. All of these three families belong to superfamily Lottioidea.

Actual taxonomy based on data by Nakano & Ozawa (2007) with placement of the rest three families (Neolepetopsidae, Daminilidae, Lepetopsidae) into Lottioidea is like this:

- superfamily Eoacmaeoidea
 - family Eoacmaeidae
- superfamily Patelloidea
 - family Patellidae
- superfamily Lottioidea
 - family Nacellidae
 - family Lepetidae
 - family Pectinodontidae
 - family Lottiidae
 - family Neolepetopsidae
 - † family Daminilidae
 - † family Lepetopsidae

In 2007, two years following Bouchet & Rocroi, 2005, Tomoyuki Nakano and Tomowo Ozawa referred to the order Patellogastropoda.

Distribution

Representatives of the Patellogastropoda, true limpets, live on the rocky coasts of all oceans.

Habitat

Some true limpets live throughout the intertidal zone, from the high zone (upper littoral zone) to the shallow subtidal, but other species live in deep sea in and their habitat include hydrothermal vents, whalebone (baleen), whale-fall and sulphide seeps.

They attach themselves to the substrate using pedal mucus and a muscular "foot". They locomote using wave-like muscular contractions of the foot when conditions are suitable for them to graze. They can also "clamp down" against the rock surface with very considerable force when necessary, and this ability enables them to remain safely attached, despite the dangerous wave action on exposed rocky shores. The ability to clamp down also seals the shell edge against the rock surface, protecting them from desiccation during low tide, despite their being in full sunlight.

When true limpets are fully clamped down, it is impossible to remove them from the rock using brute force alone, and the limpet will allow itself to be destroyed rather than stop clinging to its rock. This survival strategy has led to the limpet being used as a metaphor for obstinacy or stubbornness.

Vetigastropoda

Vetigastropoda



Various examples of Vetigastropoda

Scientific classification

Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
(unranked): clade **Vetigastropoda**
Salvini-Plawen, 1989

Vetigastropoda is a major clade, a taxonomic grouping, of sea snails, marine gastropod molluscs. This is a very ancient evolutionary lineage.

In the current taxonomy of the Gastropoda (Bouchet & Rocroi, 2005), Vetigastropoda is one of the main clades.

The vetigastropods are considered to be among the most primitive living gastropods, and are widely distributed in all oceans of the world. Their habitats range from the deep sea to intertidal zones. Many have shells with slits or other secondary openings. One of their main characteristics is the presence of intersected crossed platy shell structure. Most vetigastropods have some bilateral asymmetry of their organ systems.

Description

Vetigastropods range in size from approximately 0.08 in (2 mm) long in the case of Scissurelloidea or Skeneoidea, to more than 11.8 in (300 mm) in length, as with the Haliotoidea. External colours and patterns are typically drab, but such groups as the Tricolioidea and some Trochoidea and Pleurotomarioidea have bright colours and glossy shells. The clade is characterized by having an intersected crossed platy shell structure.

Shells range from elongate turret-shaped structures, to near-spherical. Shell sculpture varies greatly from simple concentric growth lines, which may or may not be barely visible on the shell surface, to heavy radial and axial ribbing. The shell aperture is normally oval, and often tangential to the coiling axis. Most species have an operculum (a small lid-like organ). Within the shell, Vetigastropods have a single pair of cephalic tentacles, and a distinct snout containing the mouth. The lateral sides of the body typically have sensory epipodial tentacles.

Distribution

Vetigastropods are distributed throughout all oceans of the world, including tropical areas, temperate regions, and under polar ice.

Habitat

Vetigastropods are present in most marine environments from intertidal zones to the deep sea. They exist on rocky substrates, in soft sediments, and some have been found at deep-sea hydrothermal vents and cold seeps.

Behaviour

Most vetigastropods are dioecious, although some deep-sea varieties are hermaphrodites. Vetigastropods usually eject their gametes directly into the sea for fertilization, thus there is no courtship or mating between individuals for most species.

Diet

Vetigastropods typically feed on such organisms as bryozoans, tunicates, and sponges. Several species such as Haliotoidea and Trochoidea have evolved to feed directly on such plant material as algae and marine angiosperms. Deep-sea vetigastropods typically consume sediment.

Reproduction

Vetigastropods normally have very small eggs that produce lecithotrophic (yolk feeding) or non-feeding larvae. Many vetigastropods secrete egg envelopes and have glandular pallial structures that produce masses of jelly-coated eggs.

Larger species typically have yearly cycles of spawning, and produce millions of eggs per reproductive season. Smaller species produce fewer eggs, but can spawn year round.

Taxonomy

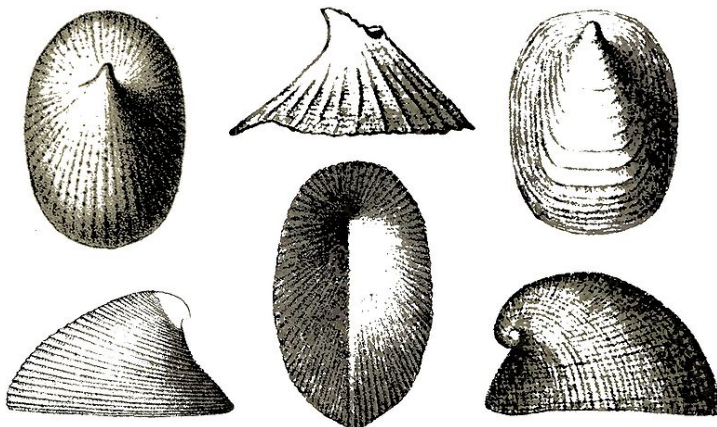
The Vetigastropoda have been referred to as a superorder as recently as at least 2007, by M. Harzhauser and in 2005 by D. Heidelberger and L. Koch following Ponder & Lindberg, 1997, although Bouchet & Rocroi, 2005 refer to this group simply as a clade, leaving taxonomic determination as a future option. The World Register of Marine Species (WoRMS) follows Bouchet & Rocroi regarding the taxonomic content of the Gastropoda but gives ranks to the higher taxa and defines Vetigastropoda as a subclass

Bouchet & Rocroi, 2005 treats the Vetigastropoda as a major clade and as a sister clade to the Caenogastropoda but includes the Vetigastropoda in what are referred to as Basal taxa that are certainly Gastropoda. Ponder & Lindberg, 1997 previously assigned the Vetigastropoda, as a superorder, to the Subclass Orthogastropoda.

Phylogenetic analysis indicates that this taxon is one of the four natural groups within the Gastropoda: Vetigastropoda, Caenogastropoda, Patellogastropoda, and Heterobranchia. Research on the mitochondrial genome arrangement has shown that the Vetigastropoda (and Caenogastropoda) mostly retain the ancestral gene arrangement.

Cocculinoidea

Cocculinoidea



Various examples of Cocculiniformia

Scientific classification

Kingdom: Animalia
Phylum: Mollusca

Class: Gastropoda
(unranked): clade **Cocculiniformia**
Hazsprunar, 1987
Superfamily: **Cocculinoidea**

Families

Bathysciadiidae
Cocculinidae

The **Cocculinoidea**, as now designated, is a superfamily of deepwater limpets, marine gastropods, the only superfamily in the clade Cocculiniformia, one of the main clades of gastropods according to the taxonomy as set up by (Bouchet & Rocroi, 2005). Cocculiniformia was previously designated as a superorder, but is no longer.

Taxonomy

According to Bouchet & Rocroi, 2005), the superfamily Cocculinoidea contains the families Bathysciadiidae and Cocculinidae.

The Cocculinoidea (Cocculinacea Dall, 1882) are combined with the Lepetelloidea (Lepetellacea Dall, 1882) in Cocculiniformia Haszprunar, 1987, referred to as a clade in Bouchet & Rocroi, 2005 although it was previously designated a superorder by Ponder & Lindberg, 1997. Bouchet & Rocroi(2005) leave the Cocculiniformia to consist only of the Cocculinoidea, having moved the Lepetelloidea to the Vetigastropoda.

(Note that before the recent stipulation by the ICZN , the majority of invertebrate superfamilies ended in -acea, or -aceae, not -oidea.)

Neritimorpha

Neritimorpha



Various examples of Neritimorpha

Scientific classification

Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
(unranked): clade **Neritimorpha**

Synonyms

Neritopsina Cox & Knight, 1960



Shells of the freshwater snail *Theodoxus danubialis*



Shells of the land snail species *Helicina rostrata*

Neritimorpha is a taxonomic grouping, an unranked clade of snails, gastropod mollusks.

This grouping includes land snails, sea snails, some deepwater limpets, and also freshwater snails.

This clade was previously known as the superorder Neritopsina.

1997 taxonomy

According to the taxonomy of the Gastropoda (Ponder & Lindberg, 1997) **Neritopsina** is a gastropod superorder in the subclass Orthogastropoda. The superfamily Palaeotrochoidea is contained within Neritopsina but its order placement is undetermined.

2005 taxonomy

The taxonomy of the Gastropoda by Bouchet & Rocroi, 2005 categorizes Neritimorpha as a gastropod mollusk clade. It is one of the 6 highest clades in Gastropoda. It contains

the clades Cyrtoneritimorpha, Cycloneritimorpha, as well as Paleozoic Neritimorpha of uncertain position.

Clades (and uncertain position taxa) in Neritimorpha include:

- † Paleozoic Neritimorpha of uncertain position
- † clade Cyrtoneritimorpha
- clade Cycloneritimorpha

Heterobranchia



Some examples of Heterobranchia

Scientific classification

Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
(unranked): clade **Heterobranchia**

Taxonomic subcategories

informal group Lower Heterobranchia
clade Nudipleura
clade Euopisthobranchia
clade Panpulmonata

Heterobranchia, the *heterobranchs* (meaning "different-gilled snails") or **Euthyneura**, is a taxonomic clade of snails and slugs, which includes species from the sea, the land and freshwater; marine, aquatic and terrestrial gastropod mollusks.

Heterobranchia is one of the main clades of gastropods, containing the largest number of species of any of the main clades. Currently Heterobranchia comprises three informal groups: the Lower Heterobranchia, the Opisthobranchia and the Pulmonata, also known as the lower heterobranchs, the opisthobranchs and the pulmonates.



A shell of the marine species *Bulla quoyii*, which belongs to the Opisthobranchia.

Diversity

The three subdivisions of this large clade are quite diverse:

- The Lower Heterobranchia includes shelled marine and freshwater species.
- Opisthobranchia are almost all marine species, some shelled and some not. The internal organs of the opisthobranchs have undergone detorsion (unwinding of the viscera that were twisted during torsion).
- The Pulmonata includes the majority of land snails and slugs, many freshwater snails, and a small number of marine species. The mantle cavity of the Pulmonata is modified into an air-breathing organ. They are also characterized by detorsion and a symmetrically-arranged nervous system. The pulmonates almost always lack an operculum and are hermaphroditic.

Taxonomy

Older taxonomy

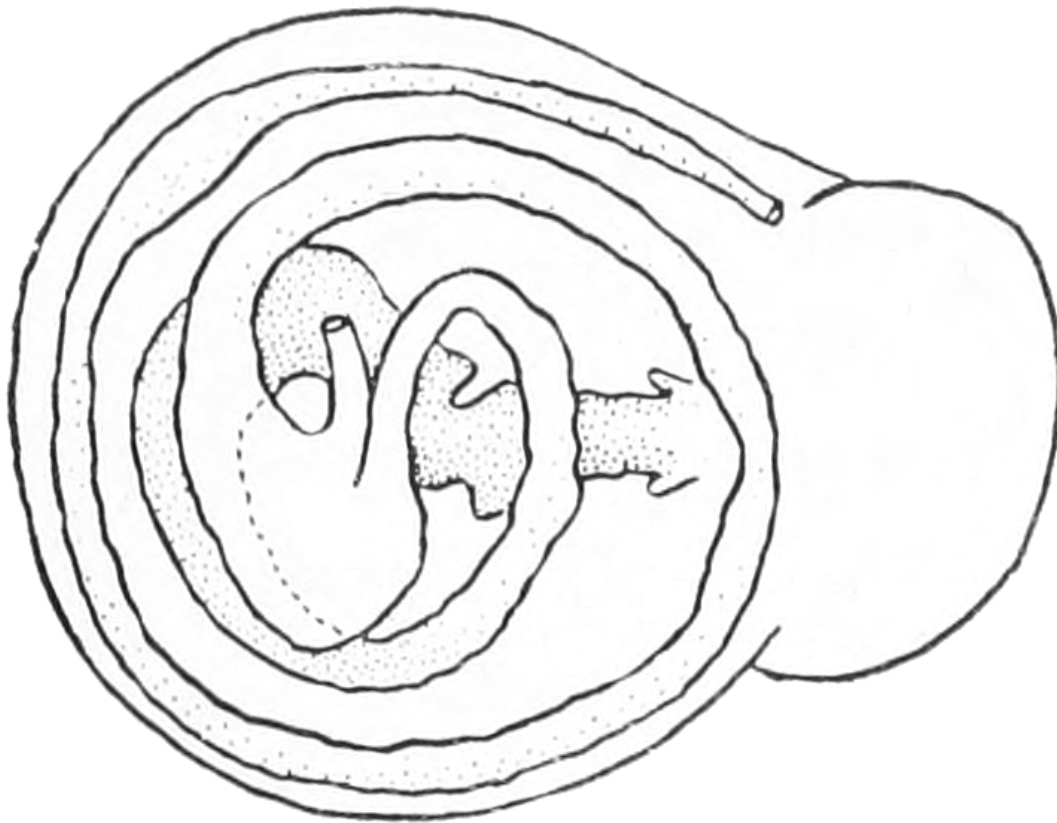
The families currently included in Heterobranchia have historically been placed in many different parts of the taxonomic class of gastropods. Earlier authors (such as J.E. Gray, 1840) considered Heterobranchia to consist of only marine gastropods, and conceptualized it as a borderline category, intermediate between the Opisthobranchia & Pulmonata, and all the other gastropods.

The (sometimes recognized) category Heterostropha within the Heterobranchia, which includes such families as *Architectonicidae*, the sundial or staircase snails, is primarily characterized by a shell which has a heterostrophic protoconch, in other words the apical whorls are coiled in the opposite plane to the adult whorls. The classification of this group was revised by Ponder & Warén in 1988.

According to the older taxonomy of the Gastropoda (Ponder & Lindberg, 1997) the Heterobranchia were ranked as a superorder.

Chapter- 4

Digestive System of Gastropods



Drawing of digestive tract of *Anostoma depressum* viewed from the apex of the spire.

The **digestive system of gastropods** (slugs and snails of every kind) has evolved to suit almost every kind of diet and feeding behavior. Gastropods as the largest taxonomic class of the mollusca are very diverse indeed: the group includes carnivores, herbivores, scavengers, filter feeders, and even parasites.

In particular, the radula is often highly adapted to the specific diet of the various group of gastropods. Another distinctive feature of the digestive tract is that, along with the rest of the visceral mass, it has undergone torsion, twisting around through 180 degrees during the larval stage, so that the anus of the animal is located above its head.

A number of species have developed special adaptations to feeding, such as the "drill" of some limpets, or the harpoon of the neogastropod genus *Conus*. Filter feeders use the gills, mantle lining, or nets of mucus to trap their prey, which they then pull into the mouth with the radula. The highly modified parasitic genus *Enderoxenos* has no digestive tract at all, and simply absorbs the blood of its host through the body wall.

The digestive system usually has the following parts:

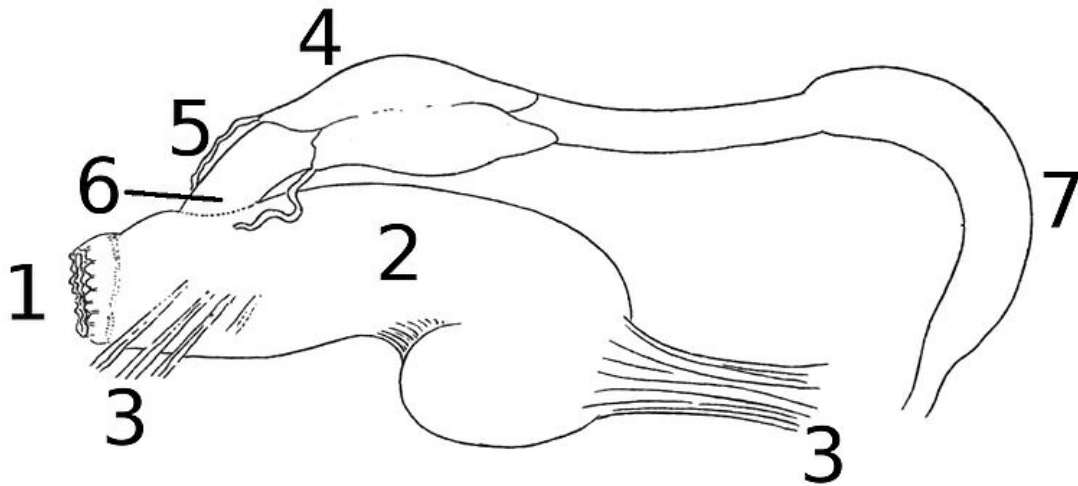
- buccal mass (including the mouth, pharynx, and retractor muscles of the pharynx) and salivary glands with salivary ducts
- oesophagus and oesophageal crop
- stomach, also known as the gastric pouch
- digestive gland, also known as the hepatopancreas
- intestine
- rectum and anus

Buccal mass

The buccal mass is the first part of digestive system, and consists of the mouth and pharynx. The mouth includes a radula, and in most cases, also a pair of jaws. The pharynx can be very large, especially in carnivorous species.

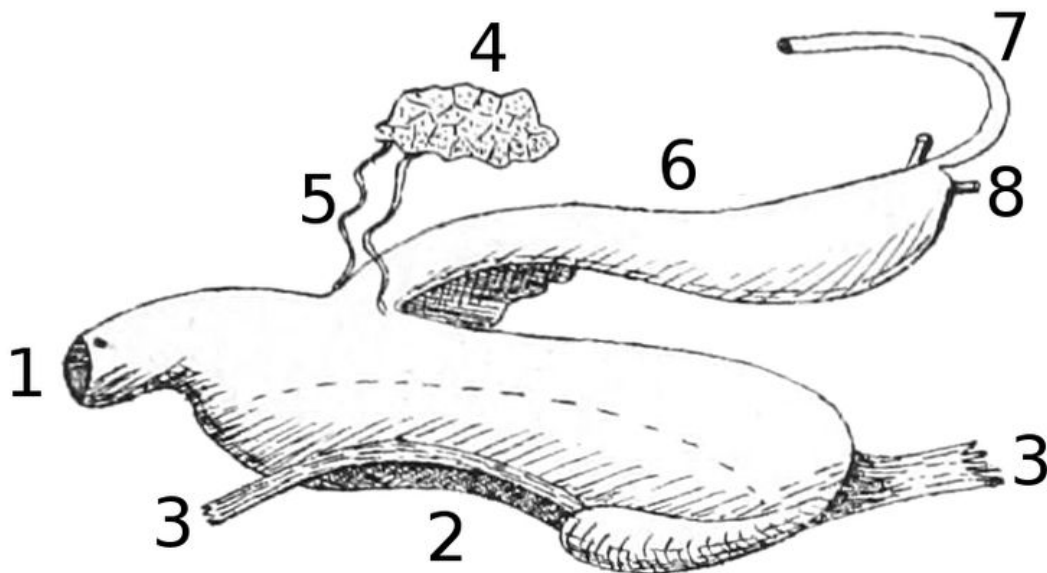
Ducts from large salivary glands lead into the mouth, and the oesophagus also supplies the digestive enzymes that help to break down the food.

Many carnivorous species have developed a proboscis, containing the oral cavity, radula, and part of the oesophagus. At rest, the proboscis is enclosed within a sac-like sheath, with an opening at the front of the animal that resembles a true mouth. When the animal feeds, it pumps blood into the proboscis, inflating it and pushing it out through the opening to grasp the gastropod's prey. A set of retractor muscles help pull the proboscis back inside the sheath once feeding is completed.



Drawing of the digestive system of *Paryphanta busbyi*.

- 1-2 - buccal mass,
- 1 - mouth,
- 2 - pharynx,
- 3 - retractor muscles of the pharynx,
- 4 - salivary glands,
- 5 - salivary ducts,
- 6 - oesophagus,
- 7 - stomach.



Drawing of the digestive system of carnivorous *Schizoglossa novoseelandica*, showing the large pharynx.

- 1-2 - buccal mass,

- 1 - mouth,
- 2 - pharynx,
- 3 - retractor muscles of the pharynx,
- 4 - salivary glands,
- 5 - salivary ducts,
- 6 - oesophagus and stomach,
- 7 - intestine,
- 8 - hepatic ducts.

Radula



The feeding track of *Triboniophorus graeffei* made by grazing with the radula.

The radula is a chitinous ribbon used for scraping or cutting food.

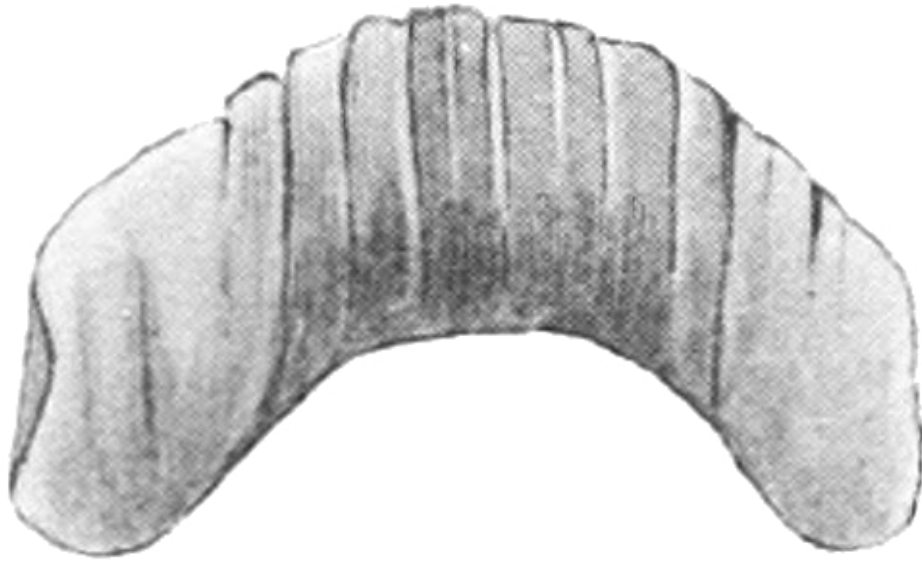
Jaw

Several herbivorous species, as well as carnivores that prey on sessile animals, have also developed simple jaws, which help to hold the food steady while the radula works on it. The jaw is opposite to the radula and reinforces part of the foregut.

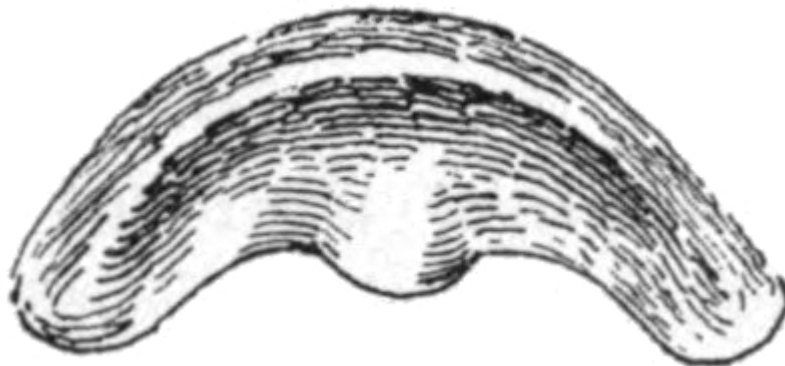
The purely carnivorous the diet, the more the jaw is reduced.

There are often pieces of food in the gut corresponding to the shape of the jaw.

The jaw structure can be ribbed or smooth:



Drawing of the jaw of the Kerry Slug *Geomalacus maculosus*. The jaw of this species measures about 1 mm and has broad ribs.



Drawing of the jaw of *Macrochlamys indica*.



Drawing of the jaw of Newcomb's snail.

Some species have no jaw.

Oesophagus

The mouth of gastropods opens into an oesophagus, which connects to the stomach. Because of torsion, the oesophagus usually passes around the stomach, and opens into its posterior portion, furthest from the mouth. In species that have undergone de-torsion, however, the oesophagus may open into the anterior of the stomach, which is therefore reversed from the usual gastropod arrangement.

In *Tarebia granifera* the brood pouch is above the oesophagus.

There is available an extensive rostrum on the anterior part of the oesophagus in all carnivorous gastropods.

Stomach

In most species, the stomach itself is a relatively simple sac, and is the main site of digestion. In many herbivores, however, the hind part of the oesophagus is enlarged to form a crop, which, in terrestrial pulmonates, may even replace the stomach entirely. In many aquatic herbivores, however, the stomach is adapted into a gizzard that helps to grind up the food. The gizzard may have a tough cuticle, or may be filled with abrasive sand grains.

In the most primitive gastropods, however, the stomach is a more complex structure. In these species, the hind part of the stomach, where the oesophagus enters, is chitinous, and includes a sorting region lined with cilia.

In all gastropods, the portion of the stomach furthest from the oesophagus, called the "style sac", is lined with cilia. These beat in a rotary motion, pulling the food forward in a

steady stream from the mouth. Usually, the food is embedded in a string of mucus produced in the mouth, creating a coiled conical mass in the style sac. This action, rather than muscular peristalsis, is responsible for the movement of food through the gastropod digestive tract.

Two diverticular glands open into the stomach, and secrete enzymes that help to break down the food. In the more primitive species, these glands may also absorb the food particles directly and digest them intracellularly.

Hepatopancreas

The hepatopancreas is the largest organ in stylommatophoran gastropods. It produces enzymes, and absorbs and stores nutrients.

Intestine



Garden Snail, *Helix aspersa* defecating.

The anterior portion of the stomach opens into a coiled intestine, which helps to resorb water from the food, producing faecal pellets. The anus opens above the head.

Chapter- 5

Respiratory System of Gastropods



In this image of an individual of *Cepaea nemoralis*, a pulmonate land snail, the pallial lung is visible through the translucent shell as the brightest yellow part of the body whorl



The dorid nudibranch *Chromodoris joshi* has a rosette of gills far back on the body. Nudibranch means "naked gills". Near the front of the animal are the two rhinophores.

The **respiratory system of gastropods** varies greatly in form. These variations were once used as a basis for dividing the group into subclasses. The majority of marine gastropods breathe through a single gill, supplied with oxygen by a current of water through the mantle cavity. This current is U-shaped, so that it also flushes waste products away from the anus, which is located above the animal's head, and would otherwise cause a problem with fouling.

In the pulmonate gastropods, which are found on both land and in freshwater, the gill has been replaced by a simple lung.

Gastropods with filamentous gills

In the most primitive gastropods, the gills are **bipectinate**, having an overall shape similar to a bird's feather, with narrow filaments projecting either side of a central stalk.

Gastropods such as abalone and keyhole limpets have two gills, which is also believed to be the arrangement in the earliest fossil gastropods. The water current to supply these

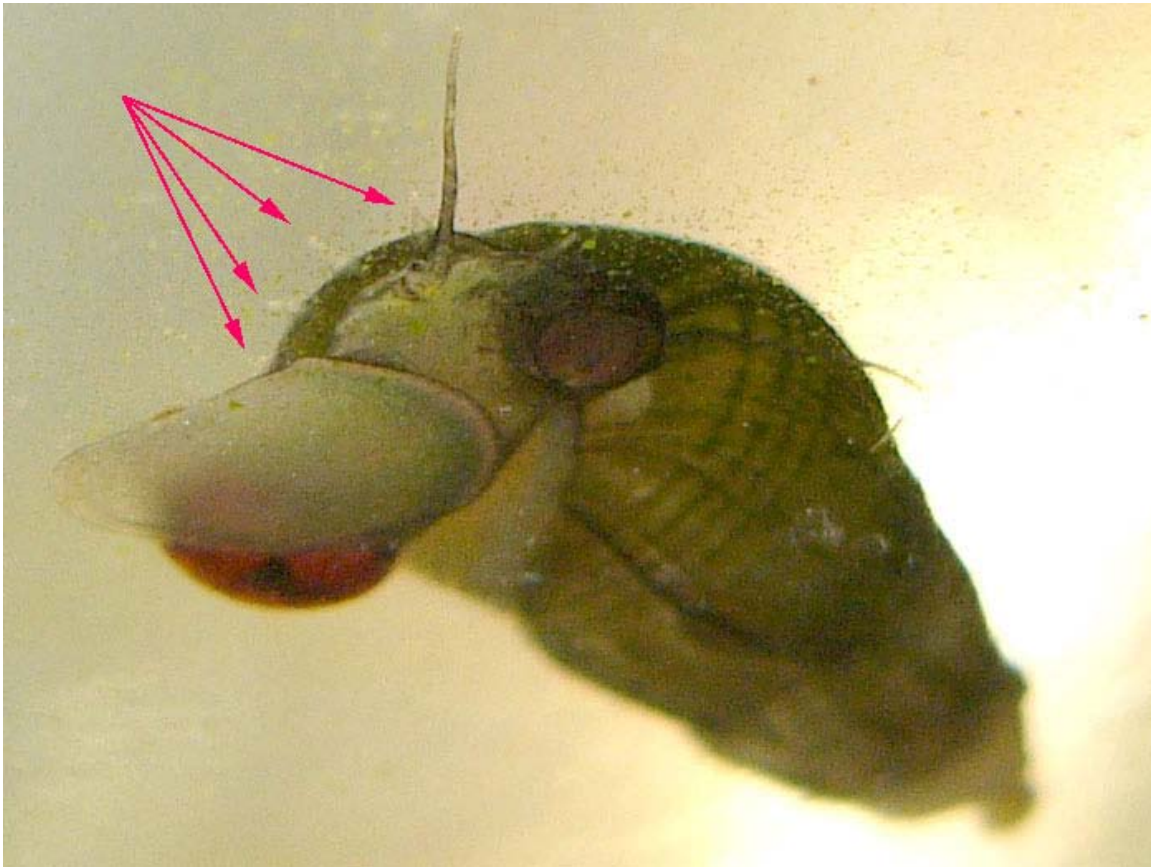
gills is evacuated through a slit or notch in the upper surface of the shell, below which the anus opens.

In most other gastropods, the right gill has become lost. In groups such as the turban shells, however, the gill still retains its primitive bipectinate form. In these animals, the water current is oblique, entering the mantle cavity on the left side of the head, flowing over the gill, and then being flushed out on the right side. The anus is also on the right side of the body, so that waste matter is efficiently carried away.

Bipectinate gills must be supported by membranes that can become fouled with debris and sediment, restricting such gastropods to relatively clean water environments, such as water flowing over solid rock. In living gastropods, a **unipectinate** arrangement is more common, allowing species to invade muddy or sandy environments. This type of gill is firmly anchored to the mantle wall along its length, with a single row of filaments projecting down into the water stream.

Unipectinate gills are found in a wide range, including marine, freshwater, and even terrestrial forms. Examples include periwinkles, conches, and whelks. The water current is oblique, as it is in the turban shells, but many have developed a siphon from the margin of the mantle. The siphon sucks in water to the mantle cavity, and may be long enough to extend through the substrate in burrowing species. In one amphibious group, the Ampullariidae, the mantle cavity is divided into two, with a unipectinate gill on one side, and a lung on the other.

Other gill arrangements



Freshwater snail *Melanoides tuberculatus*. Arrows are pointing to the pallial tentacles for breathing.

In many gastropods, the filamentous gill has been replaced by a "plicate", or folded, structure. Many of these gastropods have also undergone de-torsion, with the mantle cavity and gill shifting round to the right side of the body. This type of arrangement is found in the bubble shells and also in the sea hares, which also possess an exhalant siphon that projects fouled water away from the body.

In the nudibranchs, the mantle cavity and the original gill have disappeared altogether. Instead, the upper surface of the body has numerous club-shaped or branched projections called **cerata** that function as secondary gills. Secondary gills are also present in the unrelated genus *Patella*, in which they are found as folds within the mantle cavity.

Some smaller gastropods have neither true gills nor cerata. The genus *Lepeta* uses the whole of the mantle cavity as a respiratory surface, while many sea butterflies respire through their general body surface.

Pulmonates

The pulmonates have lost their gills and adapted the mantle cavity into a lung. The lung has a single opening on the right side, called the pneumostome, which either remains permanently open, or opens and closes as the animal breathes. The roof the lung is highly vascularised, and it is through this surface that gas exchange occurs.

Despite the presence of a lung, many pulmonates spend much of their lives underwater. Some of these possess secondary gills within the mantle cavity, while others must regularly return to the surface to breathe air, keeping their pneumostome closed while they submerge. A few freshwater species living in deep lakes have lost the ability to breathe air, and flood their mantle cavity with water.

The majority of pulmonates, however, are fully terrestrial. Most have the typical lung arrangement described above, but in the Athoracophoridae, the mantle cavity is replaced by a series of blind tubules, while the Veronicellidae respire through their skin, and have lost the lung altogether.

Although not true pulmonates, some operculate land snails, such as the Cyclophoridae have also lost their gills, and developed a vascularised lung from the mantle cavity. These groups lack a pneumostome, having a much larger opening to the cavity. Since this opening is usually closed by the operculum when the animal retreats into its shell, there is often a separate breathing tube or a notch in the shell to allow air in and out.

Chapter- 6

Circulatory System of Gastropods and Excretory System of Gastropods

Circulatory system of gastropods

As in other molluscs, the **circulatory system of gastropods** is open, with the fluid, or haemolymph, flowing through sinuses and bathing the tissues directly. The haemolymph typically contains haemocyanin, and is blue in colour.

Circulation

The heart is muscular and located in the anterior part of the visceral mass. In the great majority of species, it has two chambers; an auricle, which receives haemolymph from the gill or lung, and a ventricle, which pumps it into the aorta. However, some primitive gastropods possess two gills, each supplying its own auricle, so that their heart has three chambers.

The aorta is relatively short, and soon divides into two main vessels, one supplying the visceral mass, and the other supplying the head and foot. In some groups, these two vessels arise directly from the heart, so that the animal may be said to have two aortas. These two vessels in turn divide into many finer vessels throughout the body, and deliver haemolymph to open arterial sinuses where it bathes and oxygenates the tissues.

De-oxygenated haemolymph drains into a large venous sinus within the head and foot, which contains the nephridium, an excretory organ with a function similar to that of the vertebrate kidney. From here it passes into vessels within the gill, or into the capillary network of the pulmonate lung, before returning to the heart.

In some genera, such as the large marine snail *Busycon*, the main anterior artery (which supplies the head and foot) includes an enlarged muscular region. This structure is effectively a secondary heart, and probably helps to maintain blood pressure in the vessels of the head.

Haemolymph

Because of the open circulatory system of gastropods and other molluscs, there is no clear distinction between the blood and the lymph, or interstitial fluid. As a result, the circulatory fluid is commonly referred to as haemolymph, rather than blood.

The majority of gastropods have haemolymph containing the respiratory pigment haemocyanin. This is a copper-containing protein that helps to carry oxygen, and gives the haemolymph a pale blue colour. In the freshwater Planorbid snails, however, the haemocyanin is replaced by haemoglobin, and thus their haemolymph is red rather than blue. Some gastropods, such as the sea hare *Aplysia*, appear to lack respiratory pigments altogether.

Regardless of whether they employ haemocyanin or haemoglobin, the pigments are dissolved directly in the serum, with no equivalent of the red blood cells found in mammals. However, the haemolymph does contain amoebocytes, which may have a role in the immune system.

Excretory system of gastropods

The **excretory system of gastropods** removes nitrogenous waste and maintains the internal water balance of these creatures, commonly referred to as snails and slugs. The primary organ of excretion is a nephridium.

Structure

The most primitive gastropods retain two nephridia, but in the great majority of species, the right nephridium has been lost, leaving a single excretory organ, located in the anterior part of the visceral mass. The nephridium projects into the main venous sinus in the animal's foot. The circulatory fluid of gastropods, known as haemolymph directly bathes the tissues, where it supplies them with oxygen and absorbs carbon dioxide and nitrogenous waste, a necessary waste product of metabolism. From the arterial sinuses bathing the tissues, it drains into the venous sinus, and thus flows past the nephridium.

The main body cavity of most aquatic gastropods also includes **pericardial glands**, often located above the heart. These secrete waste into the haemolymph, prior to further filtration in the nephridium. Pulmonates lack these glands, so that the nephridium is the only major organ of excretion.

In some gastropods, the nephridium opens directly into the sinus, but more usually, there is a small duct, referred to as the **renopericardial canal**. In aquatic gastropods, the nephridium is drained by a ureter that opens near the rear of the mantle cavity. This allows the flow of water through the cavity to flush out the excreta. Terrestrial pulmonates instead have a much longer ureter, that opens near the anus.

In addition to the pericardial glands and nephridium, excretory cells are also present in the digestive glands opening into the stomach. These glands have a metabolic function, somewhat similar to that of the vertebrate liver, and excrete waste products directly into the digestive system, where it is voided with the faeces.

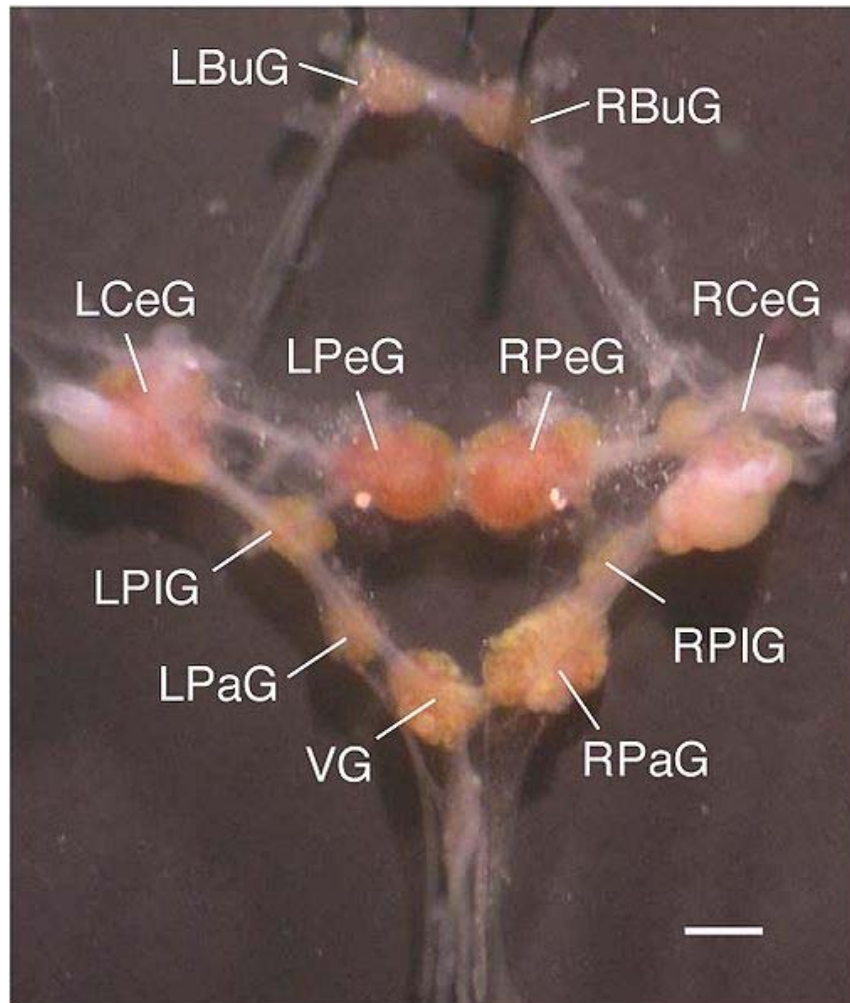
Water balance

In aquatic gastropods, the waste product is invariably ammonia, which rapidly dissolves in the surrounding water. In the case of freshwater species, the nephridium also resorbs a significant amount of salt in order to prevent its loss through osmosis into the surrounding water.

Terrestrial species instead excrete insoluble uric acid, which allows them to maintain their internal water balance. Even so, most species require a somewhat humid environment, and secrete a considerable amount of water in their slime trail. Those few species that dwell in arid environments typically hibernate or aestivate during dry periods to preserve moisture.

Chapter- 7

Nervous System of Gastropods



The dissected central ring ganglia of *Lymnaea stagnalis*. Scale bar is 1 mm.

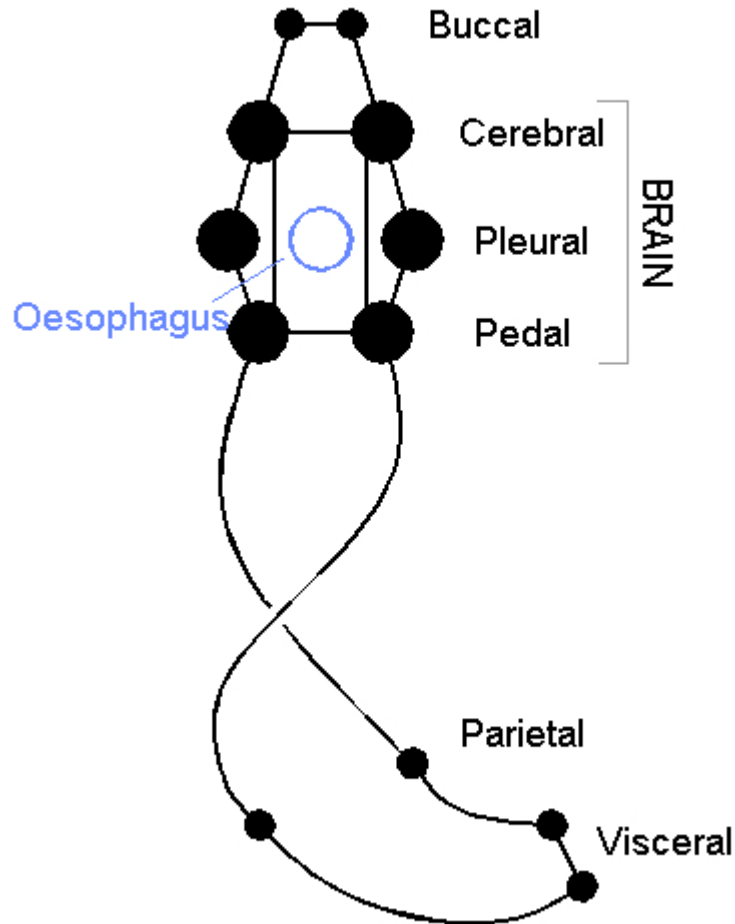
LBuG and RBuG: left and right buccal ganglia

LCeG and RCeG: left and right cerebral ganglia

LPeG and RPeG: left and right pedal ganglia

LPIG and RPIG: left and right pleural ganglia
LPaG and RPaG: left and right parietal ganglia
VG: visceral ganglion.

The **nervous system of gastropods** consists of a series of paired ganglia connected by major nerve cords, and a number of smaller branching peripheral nerves.



General layout of the gastropod ganglia. In most species, the brain is fused into a single, six-lobed, organ



Buccal ganglia of *Aplysia californica*.

The brain of a gastropod consists of three pairs of ganglia, all located close to the oesophagus. In some primitive forms, these ganglia are relatively discrete, but in most species they have become so closely bound together as to effectively form separate lobes of a single structure.

The cerebral ganglia are located above the oesophagus and supply peripheral nerves to the eyes, tentacles, and other sensory organs in the head. Beneath the oesophagus, at the forward part of the foot, lie the pedal ganglia. As their name implies, these supply nerves to the foot muscles.

The third pair of ganglia within the brain lie slightly behind and below the cerebral ganglia. These are the pleural ganglia, and supply nerves to the mantle cavity. Bundles of nerves connect the cerebral, pedal, and pleural ganglia together, as well as running above and below the oesophagus to connect the right and left cerebral and pedal ganglia to each other.

In most gastropods, a short pair of nerve cords passes forward from the cerebral ganglia to a pair of buccal ganglia located above the back of the mouth. These supply nerves to the radula and other parts of the mouth.

The main nerve cords of the central nervous system run through the length of the body from the pleural ganglia. In the ancestral gastropod, these would presumably have run down either side of the animal, but because of the torsion of the visceral mass found in many modern forms, they now cross over each other. However, a number of species have undergone de-torsion, restoring their original bilateral symmetry.

A pair of parietal ganglia lie along the length of the main nerve cords, supplying nerves to the gill and associated olfactory organ. Because of the torsion of the nerve cords, one

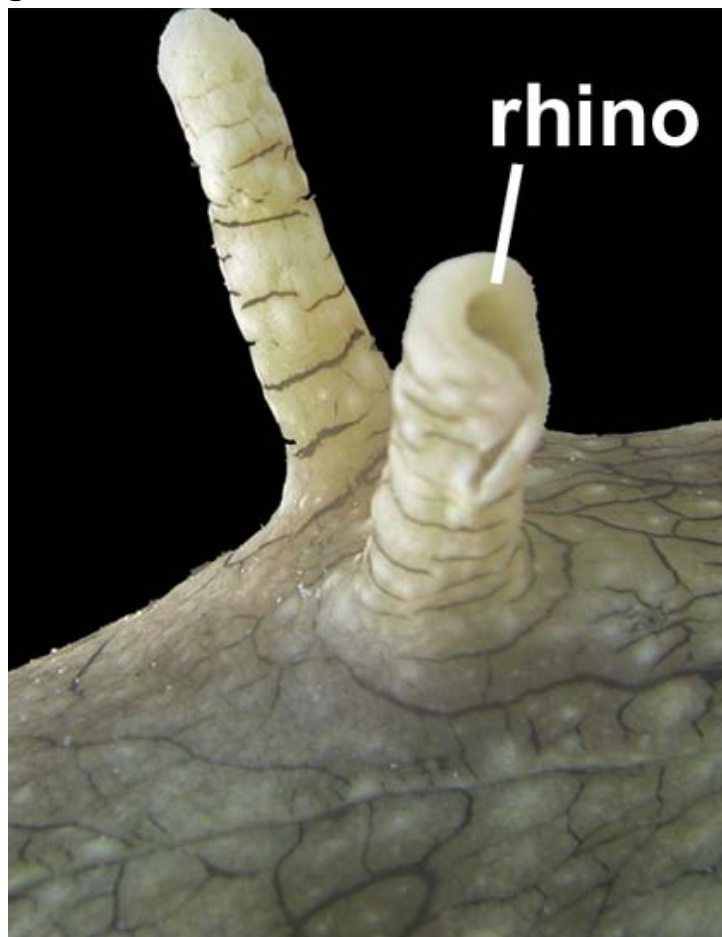
parietal ganglion is typically higher in the body than the other. Finally, the nerve cords terminate in a linked pair of visceral ganglia, which supply nerves to the remaining organs of the visceral mass.

Chapter- 8

Sensory Organs of Gastropods

Sensory organs of gastropods (snails and slugs) include olfactory organs, eyes, statocysts and mechanoreceptors. Gastropods have no sense of hearing.

Olfactory organs



Rhinophores of *Aplysia californica*.



The upper pair of tentacles on the head of the edible snail *Helix pomatia* have eyes, but the main sensory organs are sensory neurons for olfaction in the epithelium of the tentacles.

In terrestrial gastropods the most important sensory organs are the olfactory organs which are located on the tips of the 4 tentacles.

In opisthobranch marine gastropods, the chemosensory organs are two protruding structures on top of the head. These are known as rhinophores.

An opisthobranch *Navanax inermis* has chemoreceptors at sides of its mouth in and it can track mucopolysaccharides from the slime trails of prey, and of potential mates.

Freshwater snail *Bithynia tentaculata* is capable of detecting the presence of molluscivorous leeches through chemoreception and of closing its operculum to avoid predation.

Deepwater snail *Bathynnerita naticoidea* can detect mussel beds with mussel *Bathymodiolus childressi*, because it is attracted by a water altered by this species of mussel.

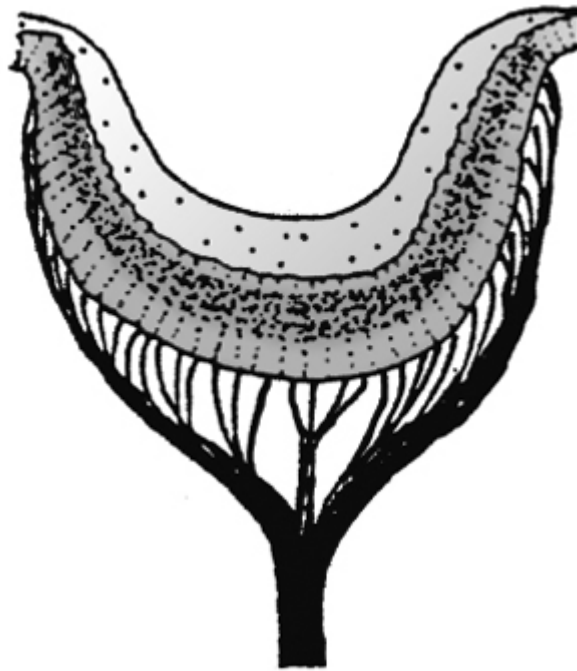
Some terrestrial gastropods can track odour of food and they uses tentacles (tropotaxis) and wind (anemotaxis).

Eyes

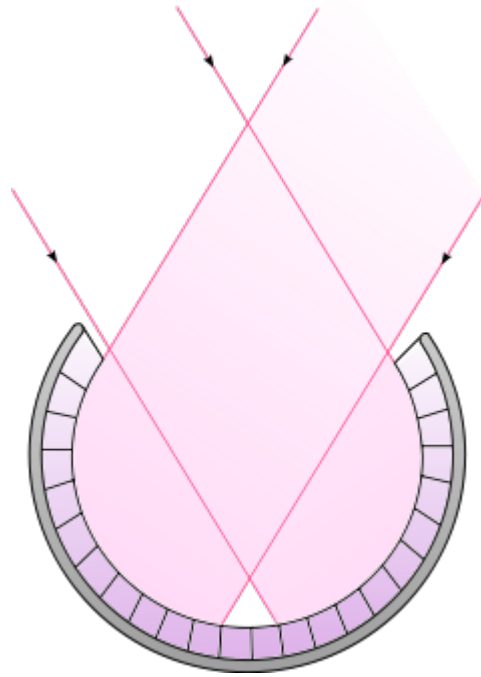
In terrestrial pulmonate gastropods eye spots are present at the tip of the tentacles in the Stylommatophora or at the base of the tentacles in the Basommatophora. These eye spots range from simple ocelli that cannot project an image (simply distinguishing light and dark), to more complex pit and even lens eyes. Vision is not the most important requirement in terrestrial gastropods, because they are mainly nocturnal animals.

Some gastropods, for example the freshwater Apple snails (family Ampullariidae) and marine species of genus *Strombus* can completely regenerate their eyes. The gastropods in both of these families have lens eyes.

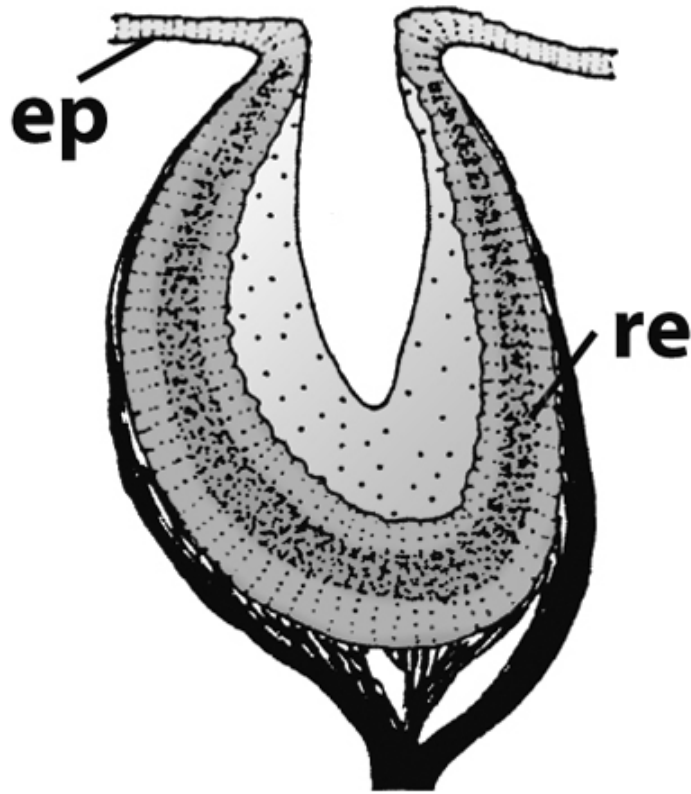
Morphological sequence of different types of multicellular eyes exemplified by gastropod eyes:



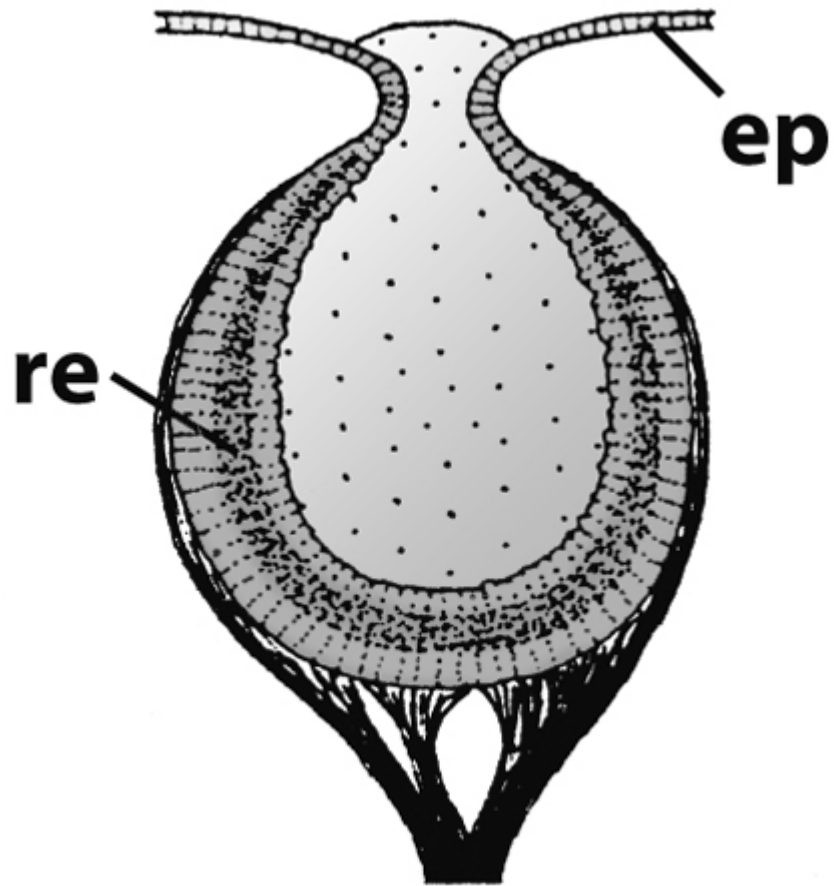
Eye pit of *Patella* sp.



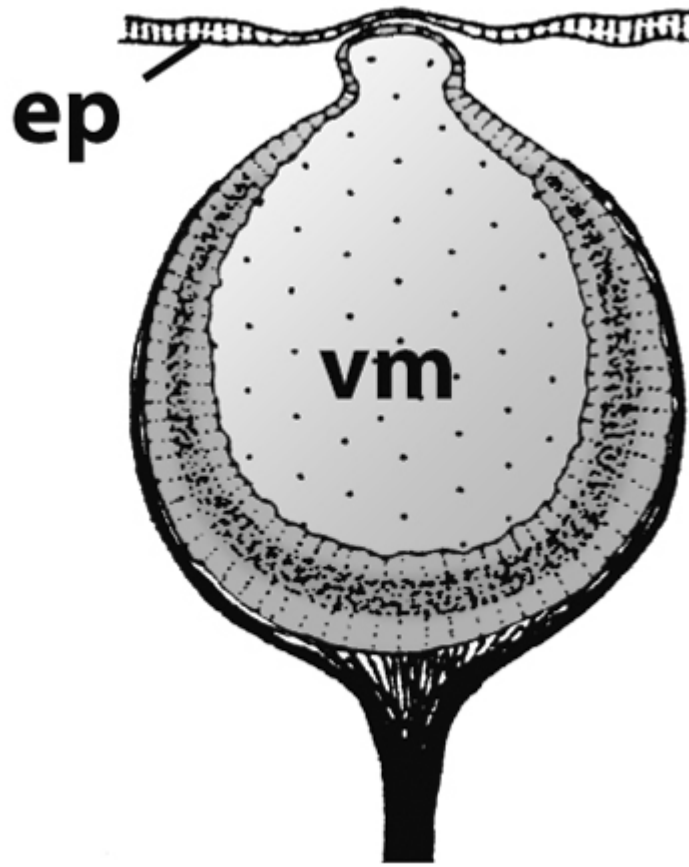
Scheme of pit eye.



Eye cup of *Pleurotomaria* sp.

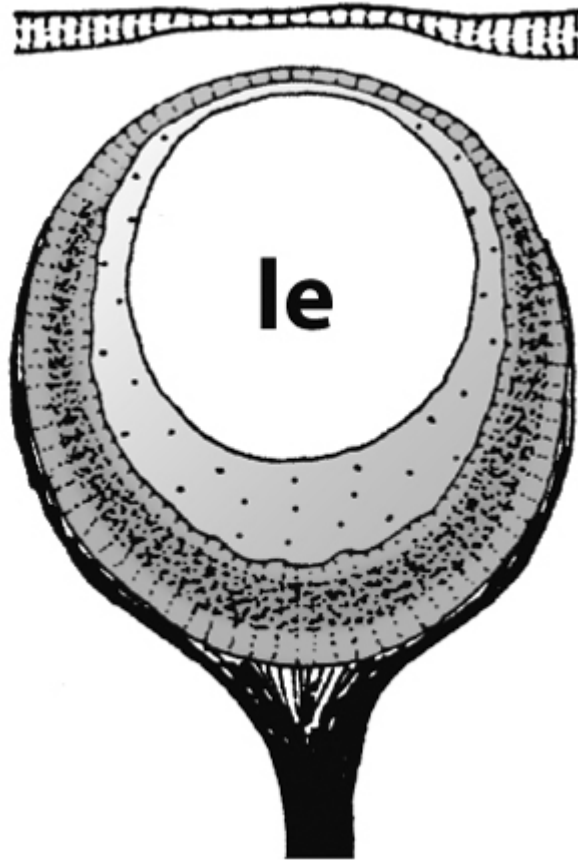


Pinhole eye of *Haliotis* sp.

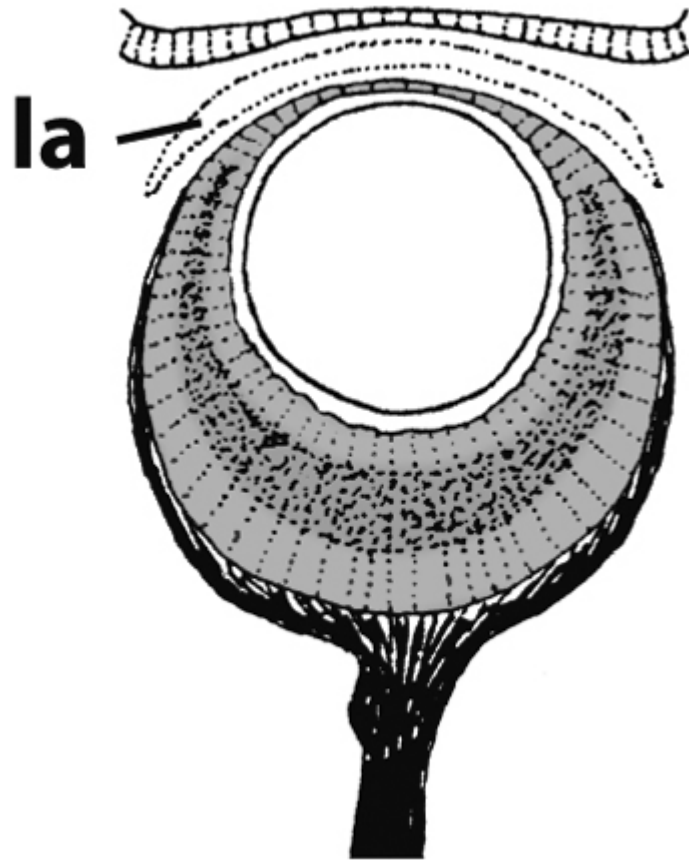


Closed eye of *Turbo coronatus*.

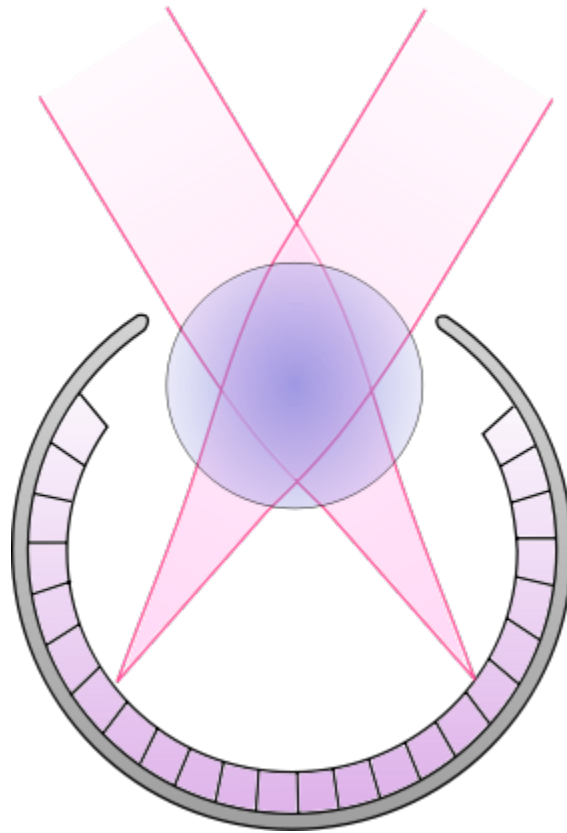
Lens eyes



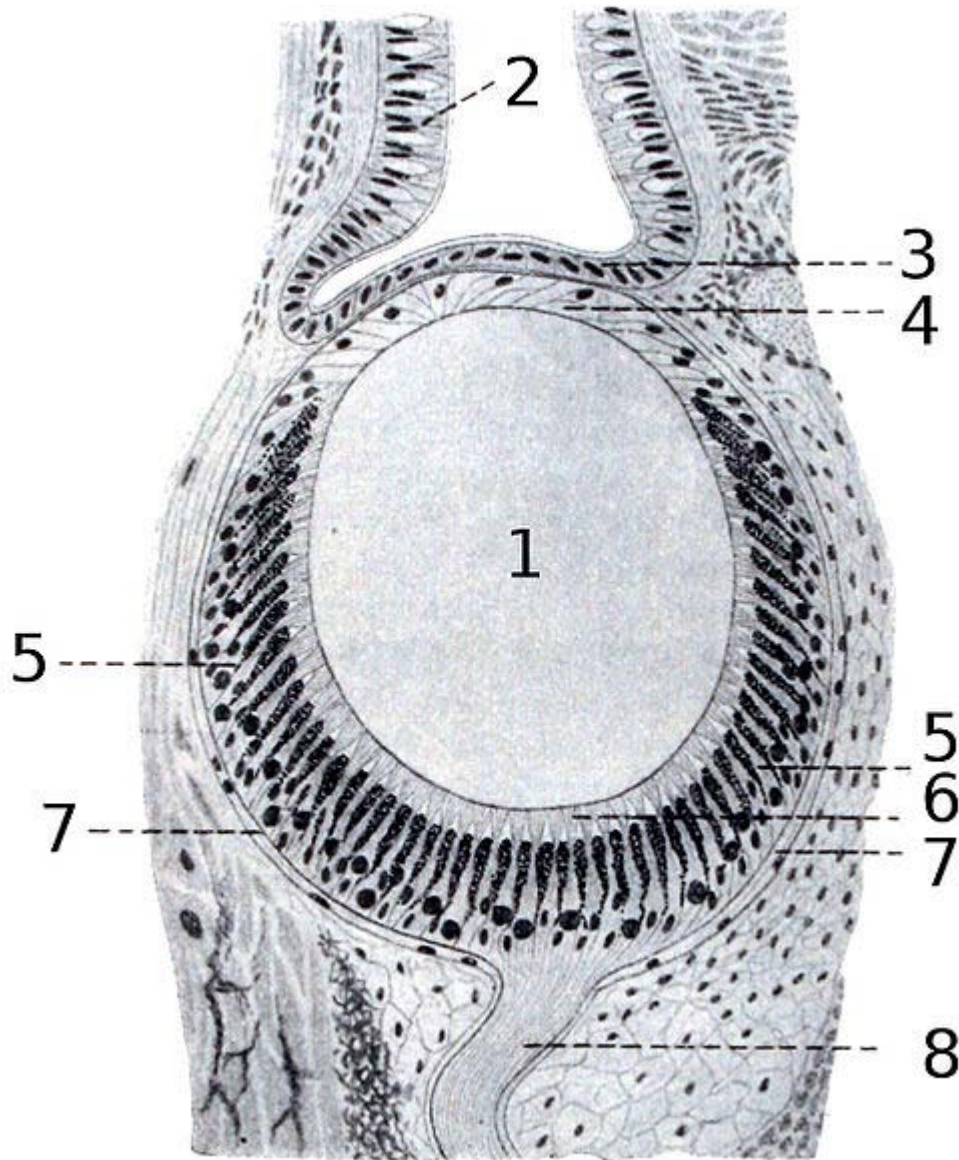
Lens eye of *Bolinus brandaris*.



Lens eye of *Nucella lapillus*.

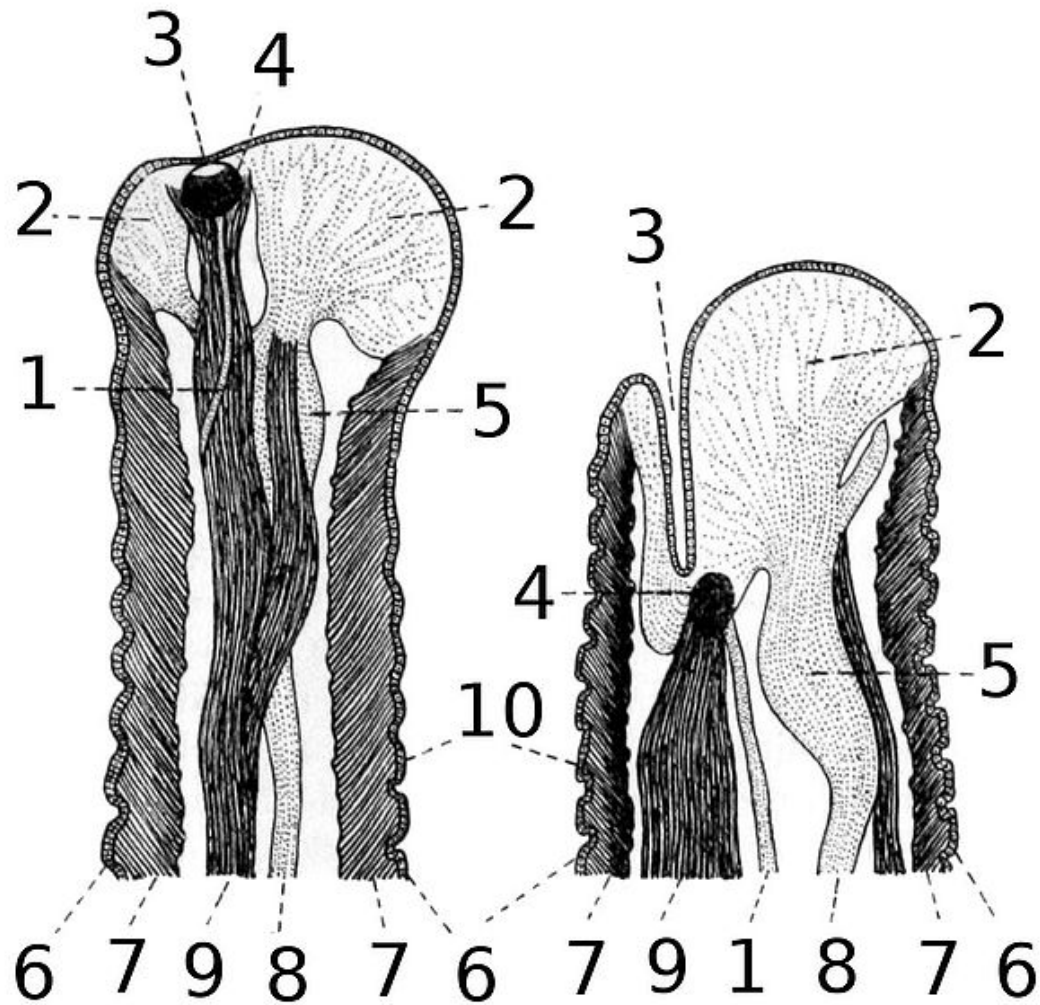


Scheme of lens eye.



Drawing of cross section of the eye of *Helix pomatia*.

- 1 - lens
- 2 - olfactory epithelium
- 3 - corneal epithelium
- 4 - corneal endothelium
- 5 - retina
- 6 - layer with rod cells
- 7 - fibrous connective tissue layer
- 8 - nerve of the eye



Drawing of cross sections of the extracted tentacle (left) and constricted tentacle (right) with and eye of *Helix pomatia*.

- 1 - nerve of an eye
- 2 -
- 3 -
- 4 - eye
- 5 - tentacle ganglion
- 6 - epidermis
- 7 -
- 8 - nerve of an tentacle
- 9 - retractor muscle
- 10 -



Well-developed lens eye of *Eustrombus gigas* on eyestalk has a black iris. There is a small tentacle on the eyestalk also.

another drawing of eye of *Helix pomatia*

Statocysts

In the statocysts of *Haliotis asinina* was found the expression of a conserved gene (Pax-258 gene), which is also important for forming structures for balance in eumetazoans.

Chapter- 9

Reproductive System of Gastropods



Entwined everted penises of a pair of mating hermaphrodite slugs in the species *Limax maximus*.

The **reproductive system of gastropods** (slugs and snails) varies greatly from one group to another within this very large and diverse taxonomic class of animals. Their reproductive strategies also vary greatly.

In many marine gastropods there are separate sexes (male and female); most terrestrial gastropods however are hermaphrodites.

Courtship is a part of mating behavior in some gastropods.

In some families of pulmonate land snails, one unusual feature of the reproductive system and reproductive behavior is the creation and utilization of love darts.

Reproduction in marine gastropods

Separate sexes

In many taxonomic groups of marine gastropods, there are separate sexes (i.e. they are dioecious).

The great majority of species in some of the main gastropod clades have separate sexes. This is true in most of the Patellogastropoda, Vetigastropoda, Cocculiniformia, Neritimorpha, and Caenogastropoda.

Protandrous sequential hermaphrodites



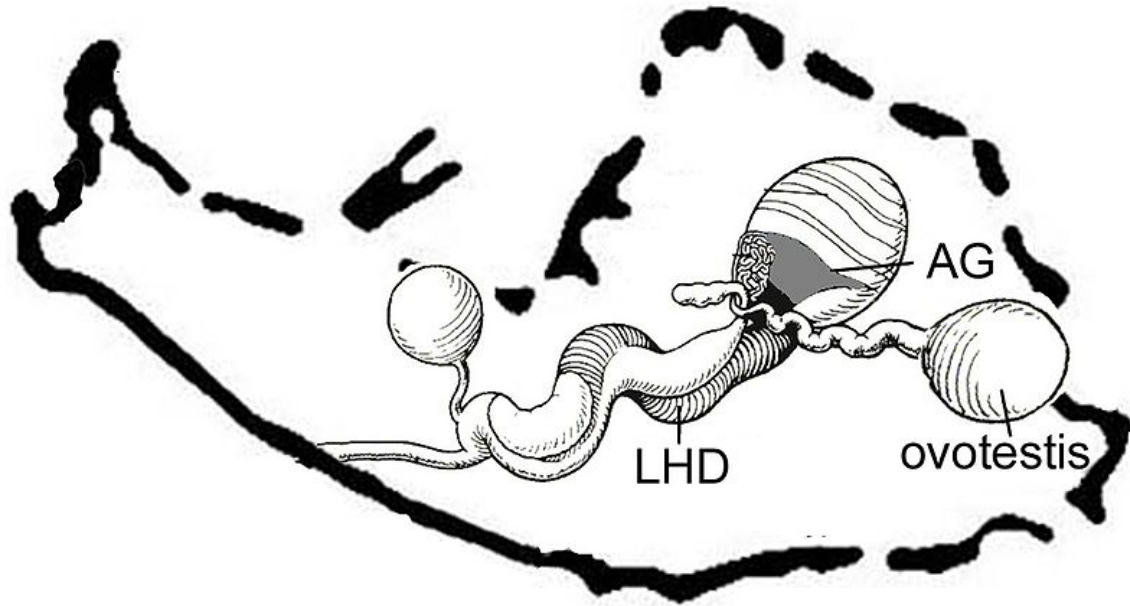
A stack of the protandrous species *Crepidula fornicata*: the small individual at the extreme lower left is currently a male, the other individuals are large enough to have become female

Within the clade Littorinimorpha however, the superfamily Calyptraeoidea are protandrous sequential hermaphrodites. Protandry means that the individuals first become male, and then later on become female.

Simultaneous hermaphrodites



Two hermaphrodite opisthobranchs mating, the nudibranch species *Nembrotha rutilans*



Drawing of reproductive system of *Aplysia californica*. AG - albumen gland, LHD - large hermaphroditic duct.

Within the main clade Heterobranchia, the informal group Opisthobranchia are simultaneous hermaphrodites (they have both sets of reproductive organs within one individual at the same time).

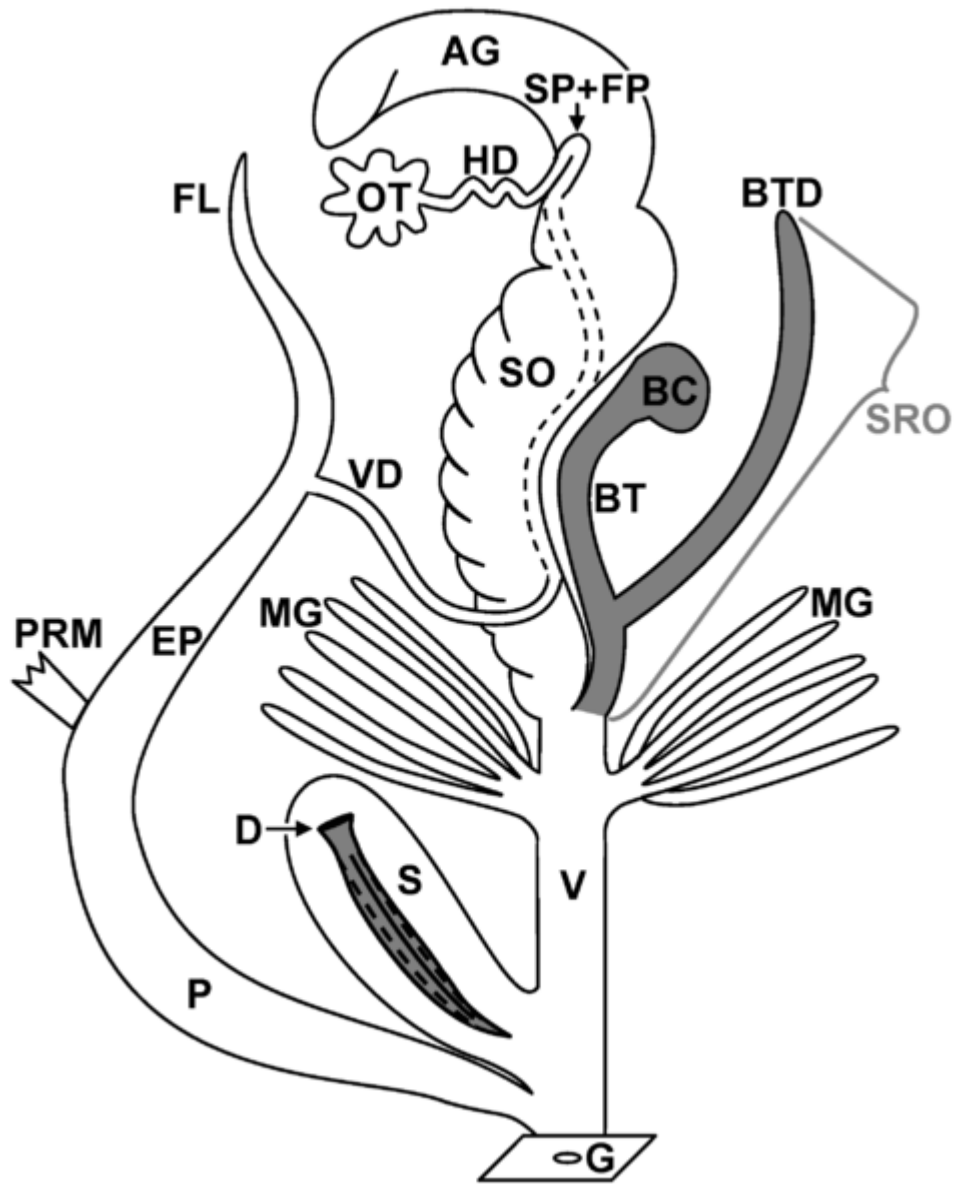
There are also a few marine pulmonates, and these are also hermaphroditic, for example, see the air-breathing sea slug family Onchidiidae, and the family of air-breathing marine "limpets" Siphonariidae.

Reproductive system of land gastropods

Separate sexes

Although most land snails are pulmonates and are hermaphrodites, in contrast, all of the land-dwelling prosobranch snails are dioecious (in other words, they have separate sexes). This includes the snails in the families Pomatiidae, Aciculidae, Cyclophoridae, and others. These land snails have opercula, which helps identify them as "winkles gone ashore", in other words, snails within the clade Littorinimorpha and the informal group Architaenioglossa.

Simultaneous hermaphrodites



Simplified diagram of the reproductive morphology of a pulmonate land snail with one love dart and a diverticulum.

AG = albumen gland

BC = bursa copulatrix

BT = bursa tract

BTD = bursa tract diverticulum

D = love dart

EP = epiphallus

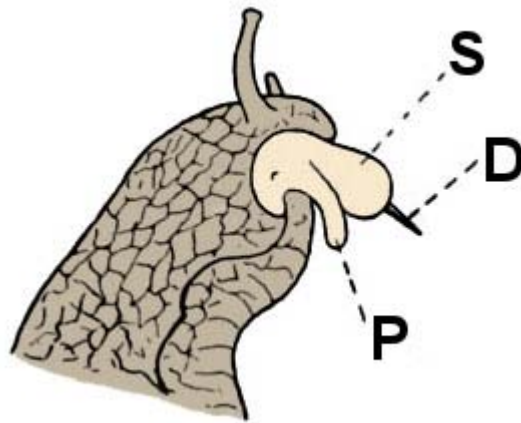
FL = flagellum

FP = fertilization pouch

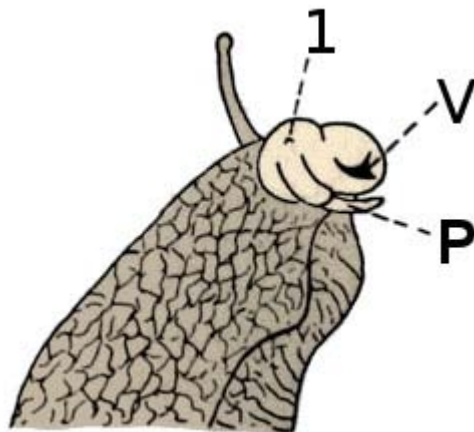
G = genital pore

HD = hermaphroditic duct

MG = mucus glands (nidamental gland)
 OT = ovotestis
 P = penis
 PRM = penis retractor muscle
 S = stylophore or dart sac (*bursa telae*)
 SO = spermoviduct
 SP = spermathecae
 SRO = spermatophore-receiving organ (indicated in grey)
 V = vagina
 VD = vas deferens



Head of a mating *Helix pomatia* showing the everted penis (P), and the dart sac (S) in the process of shooting a love dart (D).



Head of *Helix pomatia* after mating with everted vagina (V) and penis (P).

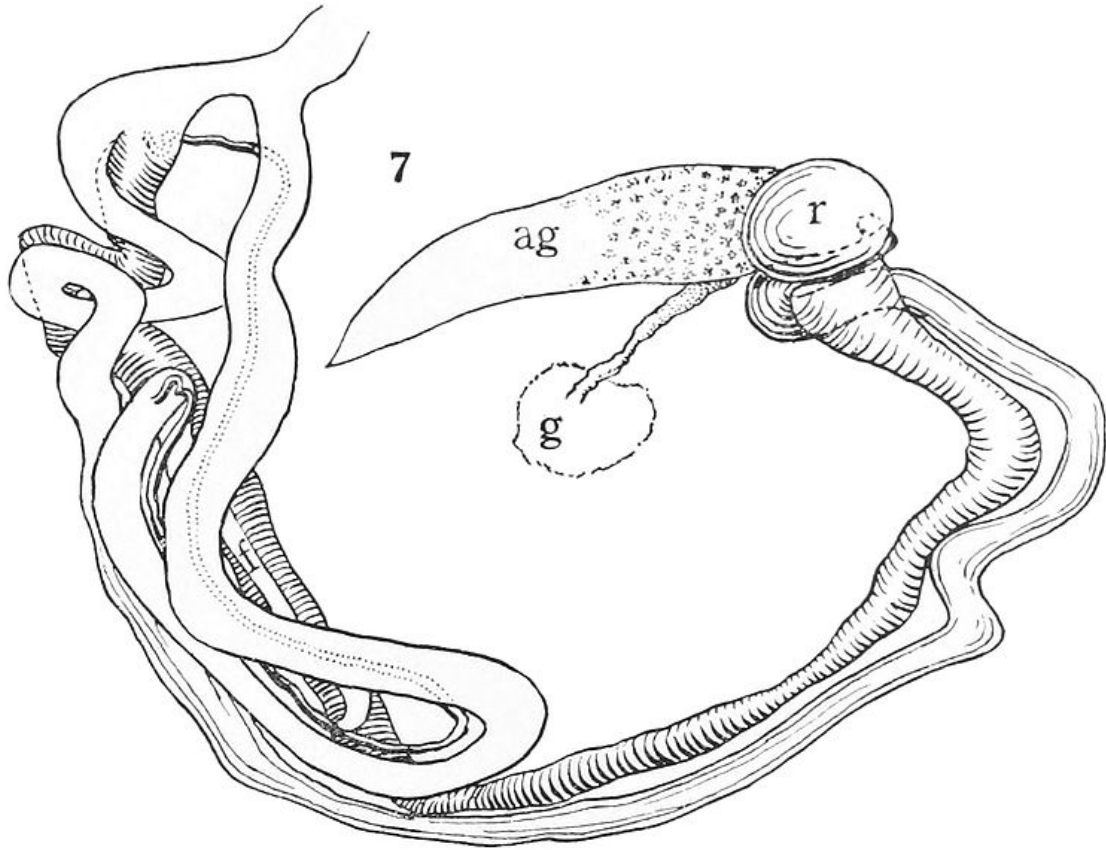
Pulmonate land gastropods are simultaneous hermaphroditic and their reproductive system is complex. It is all completely internal, except for the active protrusion (eversion) of the penis for copulation. The outer opening of the reproductive system is called the "genital pore"; it is positioned on the right hand side, very close to the head of the animal. This opening is virtually invisible however, unless it is actively in use.

The love-dart (if available) is produced and stored in the stylophore (often called dart sac) and shot by a forceful eversion of this organ. The mucus glands produce the mucus that is deposited on the dart before shooting. The penis is intromitted to transfer the spermatophore. The sperm container is formed in the epiphallus, while the spermatophore's tail is formed by the flagellum. When a bursa tract diverticulum is present, the spermatophore is received in this organ. Together with the bursa tract and bursa copulatrix these form the spermatophore-receiving organ, which digest sperm and spermatophores. Sperm swim out via the tail of the spermatophore to enter the female tract and reach the sperm storage organ (spermathecae) within the fertilization pouch-spermathecal complex.

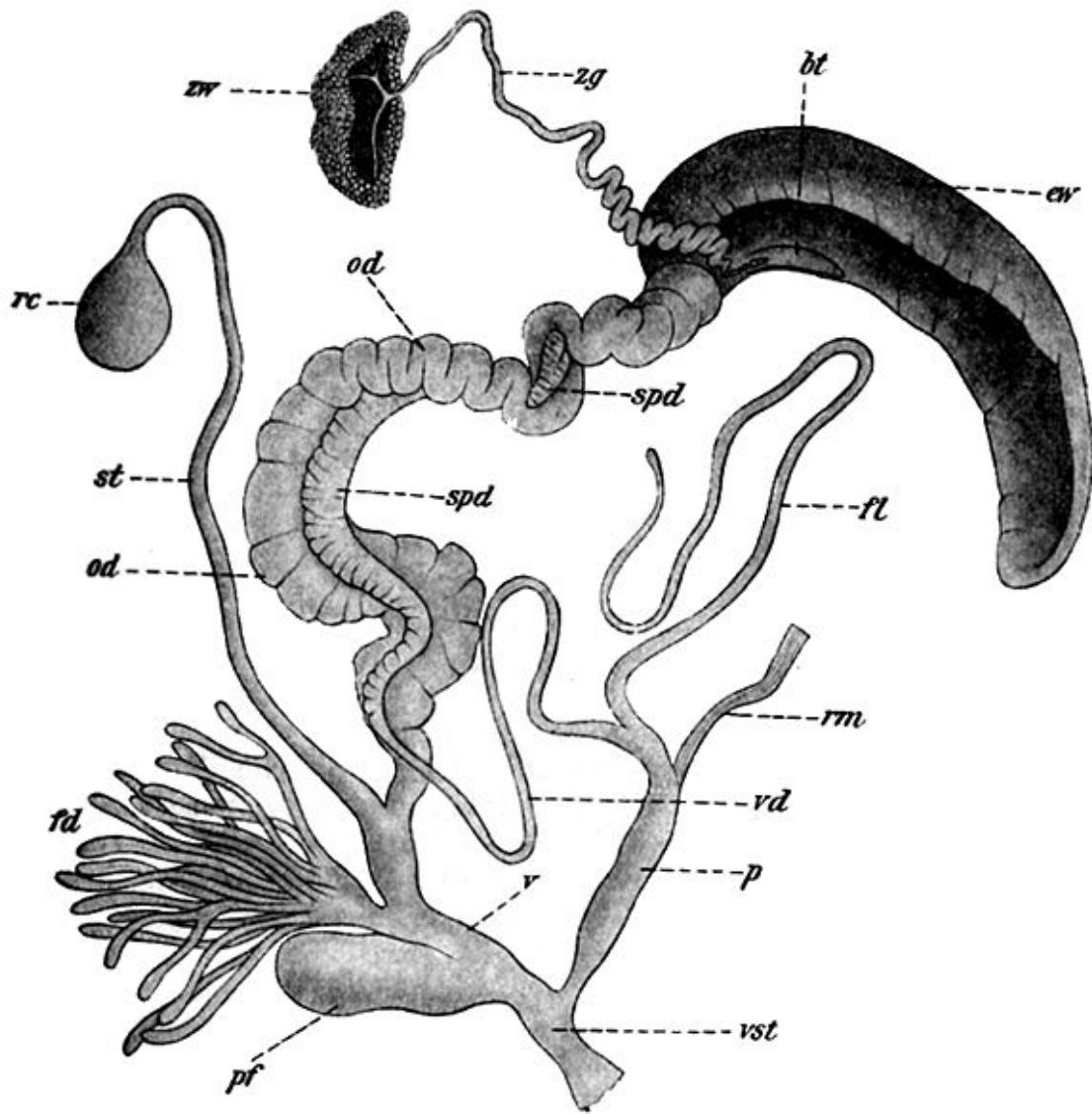
Variability (polymorphism) of reproductive system in stylommatophorans is common feature. Such variability may include:

- euphallics = male copulatory organs are developed as usual
- hemiphallics = male copulatory organs are reduced
- aphallics = there is no male copulatory organs developed
- in *Heterostoma paupercula* is presence or absence of epiphallus and flagellum
- in *Arion hortensis* is usually bipartite oviduct but there sometime can appear tripartite free oviduct
- in *Fruticicola fruticum* is various number of mucous gland lobes in auxiliary copulatory organs

Examples of reproductive system of various land snails:



Anostoma depressum



Helix pomatia

Chapter- 10

Taxonomy of the Gastropoda (Bouchet & Rocroi, 2005)

The **taxonomy of the Gastropoda** as it was revised by Philippe Bouchet and Jean-Pierre Rocroi in 2005 is currently (2011) the most up-to-date overall system for classifying gastropod mollusks. Gastropods are a taxonomic class of animals which consists of snails and slugs of every kind, from the land, from freshwater, and from saltwater. Systems of classification such as this one are primarily of value to malacologists (people who study mollusks) and other biologists. Biological classification schemes are not merely a convenience, they are an attempt to show the actual phylogeny (the evolutionary relatedness) within a group of organisms. Thus a taxonomy such as this one can be seen as an attempt to elucidate part of the tree of life, a phylogenetic tree.

The Bouchet & Rocroi 2005 system of gastropod taxonomy was laid out in a book-length paper entitled "Classification and Nomenclator of Gastropod Families", which was published in the journal *Malacologia* and which was written in collaboration with J. Frýda, B. Hausdorf, W. Ponder, Á. Valdés and A. Warén. This system supersedes the system of Ponder and Lindberg from 1997. Subsequent revisions by other authors have been made since the publication of this paper.

The taxonomy set out by Bouchet & Rocroi is considered to be one step closer to representing the evolutionary history of the phylum Mollusca. This classification system is a hybrid of the pre-existing, more traditional Linnaean taxonomy along with some more recent far-reaching revisions which are based on molecular work and use clades as taxa. In the past, the taxonomy of gastropods was largely based on the morphological characters of the taxa, such as shell characteristics and the internal anatomy, including the structure of the radula and details of the reproductive system. Recent advances are based more on the molecular characteristics of the DNA and RNA. This has made the newer taxa and their hierarchy controversial, and the debate about these issues is not likely to end soon.

This proposed classification has tried to integrate these recent advances in understanding by using **unranked** clades for taxa below the traditional rank of class (class Gastropoda)

but above the rank of superfamily (replacing the ranks subclass, superorder, order, and suborder), while still using the traditional Linnaean approach for superfamilies and all taxa below the rank of superfamily (i.e., family, subfamily, tribe, genus, subgenus, and species). The clades have been given names which are similar to, or in some cases the same as, traditional Linnaean names for taxa. Whenever monophyly (a single lineage) has not yet been tested and confirmed, or where a traditional taxon of gastropods has now been discovered to be paraphyletic or polyphyletic (contains more than one lineage), the term "group" or "informal group" has been used.

In this taxonomy 611 valid families are recognized. Of these, 202 families are exclusively fossil, and this is indicated here with a dagger †. The superfamily names are standardized so that they all end in the suffix "-oidea"; there are no longer any that end "-acea". The classification of families into subfamilies however is often not well resolved, and should be regarded as the best possible hypothesis.

The publication Bouchet & Rocroi (2005) also includes a nomenclator of about 2400 suprageneric taxa (taxa above the level of genus) of gastropods, from the subtribe to the superfamily. A full bibliographic reference is provided for each taxon, giving the name of the authority, the original publication, the date of that publication, the type genus for the taxon, its nomenclatural status, and its validity under the rules of the ICZN.

Taxonomy

In the following more detailed list, indentation is used only for the ranks of superfamily and family. The clade names are not indented, but their hierarchy is indicated by the size of the font used in their names. A clearer sense of their actual hierarchy can be drawn from the list immediately above this one.

Paleozoic molluscs of uncertain systematic position

(existing as fossils only)

Uncertain position (Gastropoda or Monoplacophora)

- unassigned to superfamily
 - † Khairkhaniidae
 - † Ladamarekiidae
 - † Metoptomatidae
 - † Patelliconidae
 - † Protoconchooididae
- Archinacelloidea
 - † Archinacellidae
 - † Archaeopragidae
- Pelagielloidea
 - † Pelagiellidae
 - † Aldanellidae

- Scenelloidea
 - † Scenellidae
 - † Coreospiridae
 - † Igarkiellidae
- Yochelcionelloidea
 - † Yochelcionellidae
 - † Stenotheceidae
 - † Trenellidae

With isostrophically coiled shells of uncertain position (Gastropoda or Monoplacophora)

- Bellerophontoidea
 - † Bellerophontidae
 - † Bucanellidae
 - † Bucaniidae
 - † Euphemitidae
 - † Pterothecidae
 - † Sinuitidae
 - † Tremanotidae
 - † Tropidodiscidae

With anisostrophically coiled shells of uncertain position (Gastropoda?)

- Euomphaloidea
 - † Euomphalidae
 - † Helicotomidae
 - † Lesueurillidae
 - † Omphalocirridae
 - † Omphalotrochidae
- Macluritoidea
 - † Macluritidae

Basal taxa that are certainly Gastropoda

(existing as fossils only)

- unassigned to superfamily
 - † Anomphalidae
 - † Codonocheilidae
 - † Crassimarginatidae
 - † Holopeidae
 - † Isospiridae
 - † Opisthonematidae
 - † Paraturbinidae
 - † Planitrochidae

- † Pragoserpulinidae
- † Pseudophoridae
- † Raphistomatidae
- † Rhytidopilidae
- † Scoliostomatidae
- † Sinuopeidae
- Clisospiroidea
 - † Clisospiridae
 - † Onychochilidae
- Loxonematoidea
 - † Loxonematidae
 - † Palaeozygopleuridae
- Ophiletoidea
 - † Ophiletidae
- Straparollinoidea
 - † Straparollinidae
- Trochonematoidea
 - † Trochonematidae
 - † Lophospiridae

Clade Patellogastropoda

- Superfamily Patelloidea
 - Family Patellidae
- Superfamily Nacelloidea
 - Family Nacellidae
- Superfamily Lottioidea
 - Family Lottiidae
 - Family Acmaeidae
 - Family Lepetidae
- Superfamily Neolepetopsoidea
 - Family Neolepetopsidae
 - † Family Daminilidae
 - † Family Lepetopsidae

Clade Vetigastropoda

- Not assigned to a superfamily:
 - Family Ataphridae
 - Family Pendromidae
 - † Family Schizogoniidae
- Superfamily †Amberleyoidea
 - † Family Amberleyidae
 - † Family Nododelphinulidae
- Superfamily †Eotomarioidea
 - † Family Eotomariidae

- † Family Gosseletinidae
 - † Family Luciellidae
 - † Family Phanerotrematidae
- Superfamily Fissurelloidea
 - Family Fissurellidae
- Superfamily Haliotoidea
 - Family Haliotidae
 - † Family Temnotropidae
- Superfamily Lepetelloidea
 - Family Lepetellidae
 - Family Addisoniidae
 - Family Bathyphytophilidae
 - Family Caymanabyssiidae
 - Family Cocculinellidae
 - Family Osteopeltidae
 - Family Pseudococculinidae
 - Family Pyropeltidae
- Superfamily Lepetodriloidea
 - Family Lepetodrilidae
 - Family Clypeosectidae
 - Family Sutilizonidae
- Superfamily †Murchisonioidea
 - † Family Murchisoniidae
 - † Family Cheeneetnukiidae
 - † Family Hormotomidae
- Superfamily Neomphaloidea
 - Family Neomphalidae
 - Family Melanodrymiidae
 - Family Peltospiridae
- Superfamily Pleurotomarioidea
 - Family Pleurotomariidae
 - † Family Catantostomatidae
 - † Family Kittlidiscidae
 - † Family Phymatopleuridae
 - † Family Polytremariidae
 - † Family Portlockiellidae
 - † Family Rhaphischismatidae
 - † Family Trochotomidae
 - † Family Zygitidae
- Superfamily †Porcellioidea
 - † Family Porcelliidae
 - † Family Cirridae
 - † Family Discohelicidae
 - † Family Pavlodiscidae
- Superfamily Scissurelloidea
 - Family Scissurellidae

- Family Anatomidae
- Superfamily Seguenzioidea
 - Family Seguenziidae
 - Family Chilodontidae
 - † Family Eucyclidae
 - † Family Laubellidae
- Superfamily Trochoidea
 - Family Trochidae
 - Family Calliostomatidae
 - † Family Elasmonematidae
 - † Family Eucochlidae
 - † Family Microdomatidae
 - † Family Proconulidae
 - Family Solariellidae
 - † Family Tychobraheidae
 - † Family Velainellidae
- Superfamily Turbinoidea
 - Family Turbinidae
 - Family Liotiidae
 - Family Phasianellidae

Clade Cocculiniformia

- Superfamily Cocculinoidea
 - Family Cocculinidae
 - Family Bathysciadiidae

Clade Neritimorpha (= Neritopsina)

Contains the Palaeozoic Neritimorpha of uncertain position and the clades **Cyrtoneritimorpha** and **Cycloneritimorpha**

- Unassigned to superfamily
 - † Family Craspedostomatidae
 - † Family Pragoscutulidae
- Superfamily Nerrhenoidea
 - † Family Nerrhenidae
- Superfamily Oriostomatoidea
 - † Family Oriostomatidae
 - † Family Tubinidae
- Superfamily Palaeotrochoidea
 - † Family Palaeotrochidae
- Superfamily Platyceratoidea
 - † Family Platyceratidae

Clade Cyrtoneritimorpha

- - † Family Orthonychiidae
 - † Family Vltaviellidae

Clade Cycloneritimorpha

- Superfamily Helicinoidea
 - Family Helicinidae
 - † Family Dawsonellidae
 - † Family Deaniridae
 - Family Neritiliidae
 - Family Proserpinellidae
 - Family Proserpinidae
- Superfamily Hydrocenoidea
 - Family Hydrocenidae
- Superfamily Neritoidea
 - Family Neritidae
 - Family Phenacolepadidae
 - † Family Pileolidae
- Superfamily Neritopsoidea
 - Family Neritopsidae
 - † Family Cortinellidae
 - † Family Delphinulopsidae
 - † Family Plagiothyridae
 - † Family Pseudorthonychiidae
 - Family Titiscaniidae
- Superfamily Symmetrocapuloidea
 - † Family Symmetrocapulidae

Clade Caenogastropoda

Contains the Caenogastropoda of uncertain systematic position, the informal group **Architaenioglossa** and the clades **Sorbeoconcha** and **Hypsogastropoda**

- Caenogastropoda of uncertain systematic position
 - † Family Plicatusidae
 - † Family Spanionematidae
 - † Family Spirostylidae
- Superfamily Acteoninoidea
 - † Family Acteoninidae
 - † Family Anozygidae
 - † Family Soleniscidae
- Superfamily Dendropupoidea
 - † Family Dendropupidae

- † Family Anthracopupidae
- Superfamily Paleostyloidea
 - † Family Palaeostylidae
 - † Family Goniasmatidae
 - † Family Pithodeidae
- Superfamily Peruneloidea
 - † Family Perunelidae
 - † Family Chuchlinidae
 - † Family Imoglobidae
 - † Family Sphaerodomidae
- Superfamily Pseudomelanoidea
 - † Family Pseudomelaniidae
 - † Family Trajanellidae
- Superfamily Subulitoidea
 - † Family Subulitidae
 - † Family Ischnoptygmatidae
- grade Zygopleuroid group
 - - † Family Zygopleuridae
 - Family Abysochrysidae
 - † Family Polygyrinidae
 - † Family Protoculidae
 - Family Provannidae
 - † Family Pseudozygopleuridae

Informal group Architaenioglossa

- Superfamily Ampullarioidea
 - Family Ampullariidae
 - † Family Naricopsinidae
- Superfamily Cyclophoroidea
 - Family Cyclophoridae
 - Family Aciculidae
 - Family Craspedopomatidae
 - Family Diplommatinidae
 - † Family Ferussinidae
 - Family Maizaniidae
 - Family Megalomastomatidae
 - Family Neocyclotidae
 - Family Pupinidae
- Superfamily Viviparoidea
 - Family Viviparidae
 - † Family Pliopholygidae

Clade Sorbeoconcha

- Not allocated to superfamily
 - † Family Acanthonematidae
 - † Family Canterburyellidae
 - † Family Prisciphoridae
- Superfamily Cerithioidea
 - Family Cerithiidae
 - Family Batillariidae
 - † Family Brachytrematidae
 - † Family Cassiopidae
 - Family Dialidae
 - Family Diastomatidae
 - † Family Eustomatidae
 - † Family Ladinulidae
 - † Family Lanascalidae
 - Family Litiopidae
 - † Family Maoraxidae
 - Family Melanopsidae
 - † Family Metacerithiidae
 - Family Modulidae
 - Family Pachychilidae
 - Family Paludomidae
 - Family Planaxidae
 - Family Pleuroceridae
 - † Family Popenellidae
 - Family Potamididae
 - † Family Procerithiidae - If the genus *Argyropeza* is placed in the Procerithiidae, then this family is not all fossil.
 - † Family Prostyliferidae
 - † Family Propupaspiridae
 - Family Scaliolidae
 - Family Siliquariidae
 - † Family Terebrellidae
 - Family Thiaridae
 - Family Turritellidae
- Superfamily Campaniloidea
 - Family Campanilidae
 - Family Ampullinidae
 - Family Plesiotrochidae
 - † Family Trypanaxidae

Clade Hypsogastropoda

Contains the clades **Littorinimorpha**, **Neogastropoda** and the informal group **Ptenoglossa**.

- Not allocated to a superfamily
 - † Family Coelostylinidae
 - † Family Maturifusidae
 - † Family Pommerozygiidae
 - † Family Settsassiidae

Clade Littorinimorpha

- Superfamily Calyptraeidea
 - Family Calyptraeidae
- Superfamily Capuloidea
 - Family Capulidae
- Superfamily Cingulopsoidea
 - Family Cingulopsidae
 - Family Eatoniellidae
 - Family Rastodentidae
- Superfamily Cypraeidea
 - Family Cypraeidae
 - Family Ovulidae
- Superfamily Ficoidea
 - Family Ficidae
- Superfamily Littorinoidea
 - Family Littorinidae
 - † Family Bohaispiridae
 - Family Pickworthiidae
 - Family Pomatiidae
 - † Family Purpurinidae
 - Family Skeneopsidae
 - † Family Tripartellidae
 - Family Zeratulidae
- Superfamily Naticoidea
 - Family Naticidae
- Superfamily Pterotracheoidea
 - Family Pterotracheidae
 - Family Atlantidae
 - † Family Bellerophonidae
 - Family Carinariidae
- Superfamily Rissoidae
 - Family Rissoidae
 - Family Amnicolidae
 - Family Anabathridae
 - Family Assimineidae
 - Family Barleeiidae
 - Family Bithyniidae
 - Family Caecidae
 - Family Calopiidae

- Family Cochliopidae
- Family Elachisinidae
- Family Emblandidae
- Family Epigridae
- Family Falsicingulidae
- Family Helicostoidae
- Family Hydrobiidae
- Family Hydrococcidae
- Family Iravadiidae
- Family Lithoglyphidae
- † Family Mesocochliopidae
- Family Moitessieriidae
- † Family Palaeorissoidae
- Family Pomatiopsidae
- Family Stenothyridae
- Family Tornidae
- Family Truncatellidae
- Superfamily Stromboidea
 - Family Strombidae
 - Family Aporrhaidae
 - † Family Colombellinidae
 - † Family Pugnellidae
 - Family Seraphsidae
 - Family Struthiolariidae
 - † Family Thersiteidae
 - † Family Tylostomatidae
- Superfamily Tonnoidea
 - Family Tonnidae
 - Family Bursidae
 - Family Laubierinidae
 - Family Personidae
 - Family Pisanianuridae
 - Family Ranellidae
- Superfamily Vanikoroidea
 - Family Vanikoridae
 - Family Haloceratidae
 - Family Hipponicidae
 - † Family Omalaxidae
- Superfamily Velutinoidea
 - Family Velutinidae
 - Family Triviidae
- Superfamily Vermetoidea
 - Family Vermetidae
- Superfamily Xenophoroidea
 - Family Xenophoridae
 - † Family Lamelliphoridae

Informal group Ptenoglossa

- Superfamily Epitonioidea
 - Family Epitoniidae
 - Family Janthinidae
 - Family Nystiellidae
- Superfamily Eulimoidea
 - Family Eulimidae
 - Family Aclididae
- Superfamily Triphoroidea
 - Family Triphoridae
 - Family Cerithiopsidae
 - Family Newtoniellidae

Clade Neogastropoda

- Unassigned to a superfamily
 - † Family Johnwyattiidae
 - † Family Perissityidae
 - † Family Sarganidae
 - † Family Speightiidae
 - † Family Taiomidae
 - † Family Weeksiidae
- Superfamily Buccinoidea
 - Family Buccinidae
 - Family Colubrariidae
 - Family Columbelloidea
 - Family Fasciolaridae
 - Family Nassariidae
 - Family Melongenidae
- Superfamily Muricoidea
 - Family Muricidae
 - Family Babyloniidae
 - Family Costellariidae
 - Family Cystiscidae
 - Family Harpidae
 - Family Marginellidae
 - Family Mitridae
 - † Family Pholidotomidae
 - Family Pleioptygmatidae
 - Family Strepsiduridae
 - Family Turbinellidae
 - Family Volutidae
 - Family Volutomitridae
- Superfamily Olivoidea
 - Family Olividae

- Family Olivellidae
- Superfamily Pseudolivoidea
 - Family Pseudolividae
 - Family Ptychtractidae
- Superfamily Conoidea
 - Family Conidae
 - Family Clavatulidae
 - Family Drilliidae
 - Family Pseudomelatomidae
 - Family Strictispiridae
 - Family Terebridae
 - Family Turridae
- Superfamily Cancellarioidea
 - Family Cancellariidae

Clade Heterobranchia

Contains the informal groups **Heterobranchia**, **Opisthobranchia** and **Pulmonata**

Informal group "Lower Heterobranchia" (= Allogastropoda)

- Unassigned to a superfamily
 - Family Cimidae
 - † Family Dolomitellidae
 - † Family Heterosubulitidae
 - † Family Kuskokwimiidae
 - † Family Misurinellidae
 - Family Orbitestellidae
 - Family Tjaernoeyidae
 - Family Xylodisculidae
- Superfamily Acteonoidea
 - Family Acteonidae
 - † Family Acteonellidae
 - Family Aplustridae
 - Family Bullinidae
 - † Family Zardinellidae
- Superfamily Architectonicoidea
 - Family Architectonicidae
 - † Family Amphitomariidae
 - † Family Cassianaxidae
- Superfamily Glacidorboidea
 - Family Glacidorbidae
- Superfamily Mathildoidea
 - Family Mathildidae
 - † Family Ampezzanildidae
 - † Family Anoptychiidae

- † Family Gordenellidae
- † Family Tofanellidae
- † Family Trachoeidae
- Superfamily Nerineoidea
 - † Family Nerineidae
 - † Family Ceritellidae
 - † Family Nerinellidae
- Superfamily Omalogyroidea
 - Family Omalogyridae
 - † Family Studraxidae
- Superfamily Pyramidelloidea
 - Family Pyramidellidae
 - Family Amathinidae
 - † Family Heteroneritidae
 - Family Murchisonellidae
- Superfamily Ringiculoidea
 - Family Ringiculidae
- Superfamily Rissoelloidea
 - Family Rissoellidae
- Superfamily Streptacidoidea
 - † Family Streptacididae
 - † Family Cassianebalidae
- Superfamily Valvatoidea
 - Family Valvatidae
 - Family Cornirostridae
 - Family Hyalogyrinidae
 - † Family Provalvatidae

Informal group Opisthobranchia

Contains the clades **Cephalaspidea**, **Thecosomata**, **Gymnosomata**, **Aplysiomorpha**, **Sacoglossa**, **Umbraculida**, **Nudipleura** and the groups **Acochliidae** and **Cylindrobullida**.

Clade Cephalaspidea

- Superfamily Bulloidea
 - Family Bullidae
- Superfamily Diaphanoidea
 - Family Diaphanidae
 - Family Notodiaphanidae
- Superfamily Haminoeidea
 - Family Haminoeidae
 - Family Bullactidae
 - Family Smaragdinellidae
- Superfamily Philinoidea

- Family Philinidae
- Family Aglajidae
- Family Cylichnidae
- Family Gastropteridae
- Family Philinoglossidae
- Family Plusculidae
- Family Retusidae
- Superfamily Runcinoidea
 - Family Runcinidae
 - Family Ilbiidae

Clade Thecosomata

- Superfamily Cavolinioidea
 - Family Cavoliniidae
 - Family Limacinidae
 - † Family Sphaerocinidae
- Superfamily Cymbulioidea
 - Family Cymbuliidae
 - Family Desmopteridae
 - Family Peraclidae

Clade Gymnosomata

- Superfamily Clionoidea
 - Family Clionidae
 - Family Cliopsidae
 - Family Notobranchaeidae
 - Family Pneumodermatidae
- Superfamily Hydromyloidea
 - Family Hydromylidae
 - Family Laginiopsidae

Clade Aplysiomorpha (= Anaspidea)

- Superfamily Aplysioidea
 - Family Aplysiidae
- Superfamily Akerioidea
 - Family Akeridae

Group Acochliaceae

- Superfamily Acochlidioidea
 - Family Acochliidae
- Superfamily Hedylopoidea
 - Family Hedylopsidae

- Family Ganitidae
- Family Livorniellidae
- Family Minicheviellidae
- Family Parhedyllidae
- Family Tantulidae
- Superfamily Palliohedyloidea
 - Family Palliohedyllidae
- Superfamily Strubellioidea
 - Family Strubelliidae
 - Family Pseudunelidae

Clade Sacoglossa

Subclade Oxynoacea

- Superfamily Oxynooidea
 - Family Oxynoidae
 - Family Juliidae
 - Family Volvatellidae

Subclade Placobbranchacea

- Superfamily Placobranchoidea
 - Family Placobbranchidae
 - Family Boselliidae
 - Family Platyhedyllidae
- Superfamily Limapontioidea
 - Family Limapontiidae
 - Family Caliphyllidae
 - Family Hermaeidae

Group Cyliindrobullida

- Superfamily Cyliindrobulloidea
 - Family Cyliindrobullidae

Clade Umbraculida

- Superfamily Umbraculoidea
 - Family Umbraculidae
 - Family Tylodinidae

Clade Nudipleura

Subclade Pleurobranchomorpha

- Superfamily Pleurobrancoidea
 - Family Pleurobranchidae

Subclade Nudibranchia

Contains the clades **Euctinidiacea** and **Dexiarchia**

- Unassigned to superfamily
 - Family Rhodopidae

Clade Euctenidiacea (= Holohepatica)

Contains the subclades **Gnathodoridacea** and **Doridacea**

Subclade Gnathodoridacea

- Superfamily Bathydoridoidea
 - Family Bathydorididae

Subclade Doridacea

- Superfamily Doridoidea
 - Family Dorididae
 - Family Actinocyclusidae
 - Family Chromodorididae
 - Family Discodorididae
- Superfamily Phyllidioidea
 - Family Phyllidiidae
 - Family Dendrodorididae
 - Family Mandeliidae
- Superfamily Onchidoridoidea
 - Family Onchidorididae
 - Family Corambidae
 - Family Goniodorididae
- Superfamily Polyceroidea (= Phanerobranchiata Non Suctoria)
 - Family Polyceridae
 - Family Aegiretidae - Aegiretidae is incorrect subsequent spelling of this family in Bouchet & Rocroi (2005). Correct is Aegiridae.
 - Family Gymnodorididae
 - Family Hexabanchidae
 - Family Okadaiidae

Clade Dexiarchia (= Actenidiacea)

Contains the clades **Pseudoeuctenidiacea** and **Cladobranchia**

Clade Pseudoeuctenidiacea (= Doridoxida)

- Superfamily Doridoxoidea
 - Family Doridoxidae

Clade Cladobranchia (= Cladohepatica)

Contains the subclades **Euarminida**, **Dendronotida** and **Aeolidida**

- Not assigned to a superfamily
 - Family Charcotiidae
 - Family Dironidae
 - Family Dotidae
 - Family Embletoniidae
 - Family Goniaeolididae
 - Family Heroidae
 - Family Madrellidae
 - Family Pinufiidae
 - Family Proctonotidae

Subclade Euarminida

- Superfamily Arminoidea
 - Family Arminidae
 - Family Doridomorphidae

Subclade Dendronotida

- Superfamily Tritonioidea
 - Family Tritoniidae
 - Family Aranucidae
 - Family Bornellidae
 - Family Dendronotidae
 - Family Hancockiidae
 - Family Lomanoridae
 - Family Phylliroidae
 - Family Scyllaeidae
 - Family Tethydidae

Subclade Aeolidida

- Superfamily Flabellinoidea (= Pleuroprocta)
 - Family Flabellinidae

- Family Notaeolidiidae
- Superfamily Fionoidea
 - Family Fionidae
 - Family Calmidae
 - Family Eubbranchidae
 - Family Pseudovermidae
 - Family Tergipedidae
- Superfamily Aeolidioidea
 - Family Aeolidiidae
 - Family Facelinidae
 - Family Glaucidae
 - Family Piseinotecidae

Informal Group Pulmonata

Contains the informal group **Basommatophora** and the clade **Eupulmonata**

Informal Group Basommatophora

Contains the clade **Hygrophila**

- Superfamily Amphiboloidea
 - Family Amphibolidae
- Superfamily Siphonarioidea
 - Family Siphonariidae
 - † Family Acroreiidae

Clade Hygrophila

- Superfamily Chilinoidea
 - Family Chilinidae
 - Family Latiidae
- Superfamily Acroloxoidea
 - Family Acroloxidae
- Superfamily Lymnaeoidea
 - Family Lymnaeidae
- Superfamily Planorboidea
 - Family Planorbidae
 - Family Physidae

Clade Eupulmonata

Contains the clades **Systellommatophora** and **Stylommatophora**

- Superfamily Trimusculoidea
 - Family Trimusculidae

- Superfamily Otinoidea
 - Family Otinidae
 - Family Smeagolidae
- Superfamily Ellobioidea
 - Family Ellobiidae

Clade Systellommatophora (= Gymnomorpha)

- Superfamily Onchidioidea
 - Family Onchidiidae
- Superfamily Veronicelloidea
 - Family Veronicellidae
 - Family Rathouisiidae

Clade Stylommatophora

Contains the subclades **Elasmognatha**, **Orthurethra** and the informal group **Sigmurethra**

Subclade Elasmognatha

- Superfamily Succineoidea
 - Family Succineidae
- Superfamily Athoracophoroidea
 - Family Athoracophoridae

Subclade Orthurethra

- Superfamily Partuloidea
 - Family Partulidae
 - Family Draparnaudiidae
- Superfamily Achatinelloidea
 - Family Achatinellidae
- Superfamily Cochlicopoidea
 - Family Cochlicopidae
 - Family Amastridae
- Superfamily Pupilloidea
 - Family Pupillidae
 - Family Argnidae
 - Family Chondrinidae
 - † Family Cyllindrellinidae
 - Family Lauriidae
 - Family Orculidae
 - Family Pleurodiscidae
 - Family Pyramidulidae
 - Family Spelaeodiscidae
 - Family Strobilopsidae

- Family Valloniidae
- Family Vertiginidae
- Superfamily Enoidea
 - Family Enidae
 - Family Cerastidae

Informal Group Sigmurethra

- Superfamily Clausilioidea
 - Family Clausiliidae
 - † Family Anadromidae
 - † Family Filholiidae
 - † Family Palaeostoidae
- Superfamily Orthalicoidea
 - Family Orthaliciidae
 - Family Cerionidae
 - Family Coelociontidae
 - † Family Grangerellidae
 - Family Megaspiridae
 - Family Placostylidae
 - Family Urocoptidae
- Superfamily Achatinoidea
 - Family Achatinidae
 - Family Ferussaciidae
 - Family Micractaeonidae
 - Family Subulinidae
- Superfamily Aillyoidea
 - Family Aillyidae
- Superfamily Testacelloidea
 - Family Testacellidae
 - Family Oleacinidae
 - Family Spiraxidae
- Superfamily Papillodermatoidea
 - Family Papillodermatidae
- Superfamily Streptaxoidea
 - Family Streptaxidae
- Superfamily Rhytidoidea
 - Family Rhytididae
 - Family Chlamydephoridae
 - Family Haplotrematidae
 - Family Scolodontidae
- Superfamily Acavoidea
 - Family Acavidae
 - Family Caryodidae
 - Family Dorcasiidae
 - Family Macrocyclidae
 - Family Megomphicidae

- Family Strophocheilidae
- Superfamily Plectopyloidea
 - Family Plectopylidae
 - Family Corillidae
 - Family Sculptariidae
- Superfamily Punctoidea
 - Family Punctidae
 - † Family Anastomopsidae
 - Family Charopidae
 - Family Cystopeltidae
 - Family Discidae
 - Family Endodontidae
 - Family Helicodiscidae
 - Family Oreohelicidae
 - Family Thyrophorellidae
- Superfamily Sagdoidea
 - Family Sagdidae

limacoid clade

- Superfamily Staffordioidea
 - Family Staffordiidae
- Superfamily Dyakioidea
 - Family Dyakiidae
- Superfamily Gastrodontoidea
 - Family Gastrodontidae
 - Family Chronidae
 - Family Euconulidae
 - Family Oxychilidae
 - Family Pristilomatidae
 - Family Trochomorphidae
 - Fossil taxa that probably belong to the superfamily Gastrodontoidea:
 - Subfamily † Archaeozonitinae
 - Subfamily † Grandipatulinae
 - Subfamily † Palaeoxestininae
- Superfamily Parmacelloidea
 - Family Parmacellidae
 - Family Milacidae
 - Family Trigonochlamydidae
- Superfamily Zonitoidea
 - Family Zonitidae
- Superfamily Helicarionoidea
 - Family Helicarionidae
 - Family Ariophantidae
 - Family Urocyclidae
- Superfamily Limacoidea
 - Family Limacidae

- Family Agriolimacidae
- Family Boettgerillidae
- Family Vitrinidae

Informal group Sigmurethra continued

Two other superfamilies are part of the clade Sigmurethra, but they are *not* in the limacoid clade:

- Superfamily Arionoidea
 - Family Arionidae
 - Family Anadenidae
 - Family Ariolimacidae
 - Family Binneyidae
 - Family Oopeltidae
 - Family Philomycidae
- Superfamily Helicoidea
 - Family Helicidae
 - Family Bradybaenidae
 - Family Camaenidae
 - Family Cepolidae
 - Family Cochlicellidae
 - Family Elonidae
 - Family Epiphragmophoridae
 - Family Halolimnohelicidae
 - Family Helicodontidae
 - Family Helminthoglyptidae
 - Family Humboldtianidae
 - Family Hygromiidae
 - Family Monadeniidae
 - Family Pleurodontidae
 - Family Polygyridae
 - Family Sphincterochilidae
 - Family Thysanophoridae
 - Family Trissexodontidae
 - Family Xanthonychidae