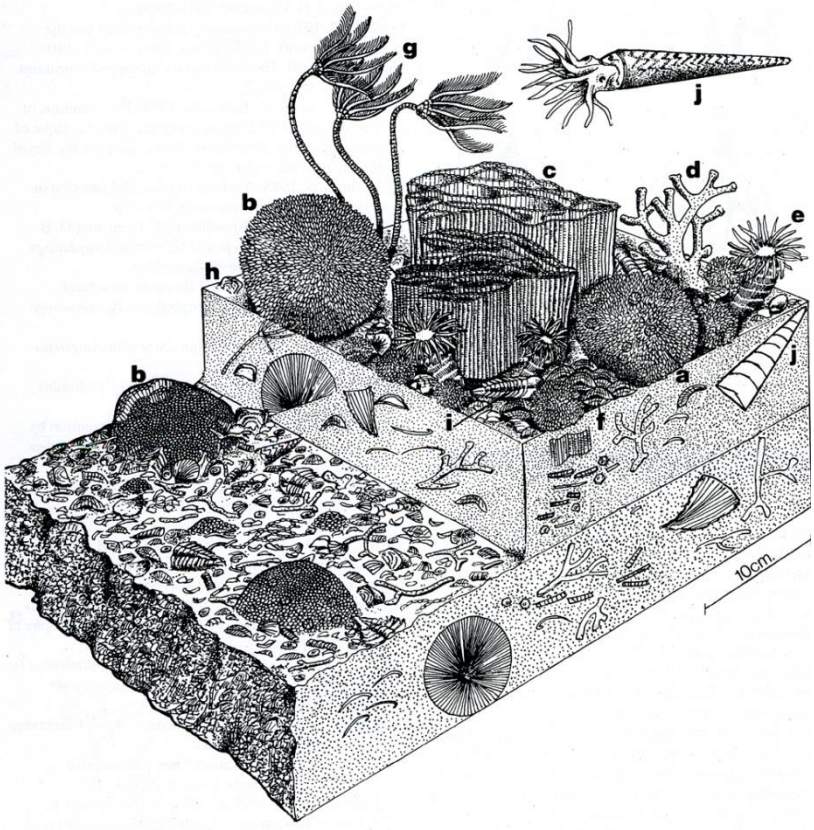
Practical Paleoecology

GEO 342



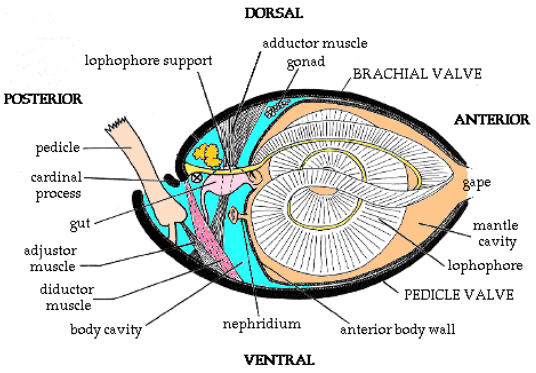
Compiled By: Dr. Osama Attia

Phylum Brachiopoda

Brachiopods or **lamp shells**

Name: Name means "arm" (brachio) + "foot" (pod).

Main characteristics:



- Bivalved (two shells), each with bilateral symmetry.
- The plane of symmetry passes through the center of each shell or valve.
- The two valves differ in size and shape in most. Sometimes the larger valve will have an opening near the hinge line through which the pedicle extended in life.
- Soft parts include a **lophophore** consisting of coiled tentacles with cilia. The lophophore circulates water between the two valves, distributing oxygen and flushing out carbon dioxide. Water movements caused by the lophophore also transport food particles toward the mouth.

Geologic range:

Lower Cambrian to Recent. Very abundant during the Paleozoic. A few species (belonging to only three families) remain today.

Mode of life:

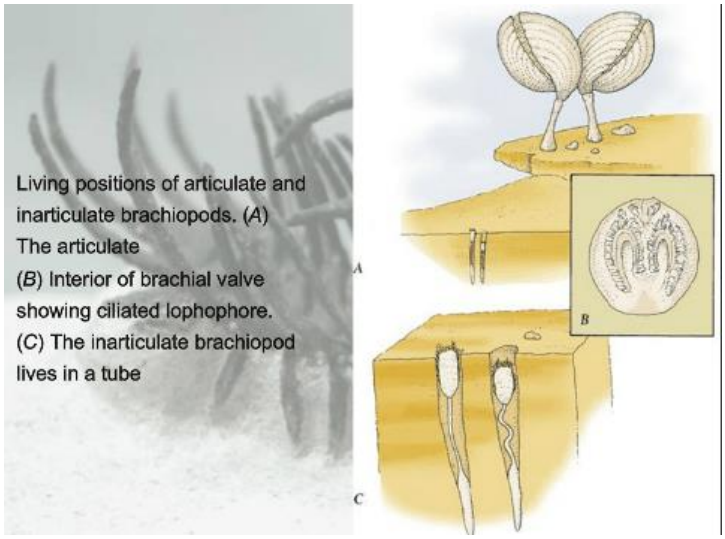
Inhabitants of shallow marine environments; they generally live attached in a fixed position on the seafloor. Inarticulate brachiopods are known to live in burrows in the sediment. Brachiopods are **filter feeders**.

Living positions of brachiopods.

A = Articulate brachiopod attached to the seafloor by its pedicle.

B = Interior of brachiopod valve showing lophophore.

C = Inarticulate brachiopod, Lingula, which lives within a tube or burrow in seafloor sediment.



A. CLASS INARTICULATA –

The Inarticulate Brachiopods

Primitive brachiopods with **phosphatic or chitinous valves**; no hinge. Spoon-shaped valves held together with muscles and soft parts. ***Lingula*** is a well known inarticulate brachiopod.

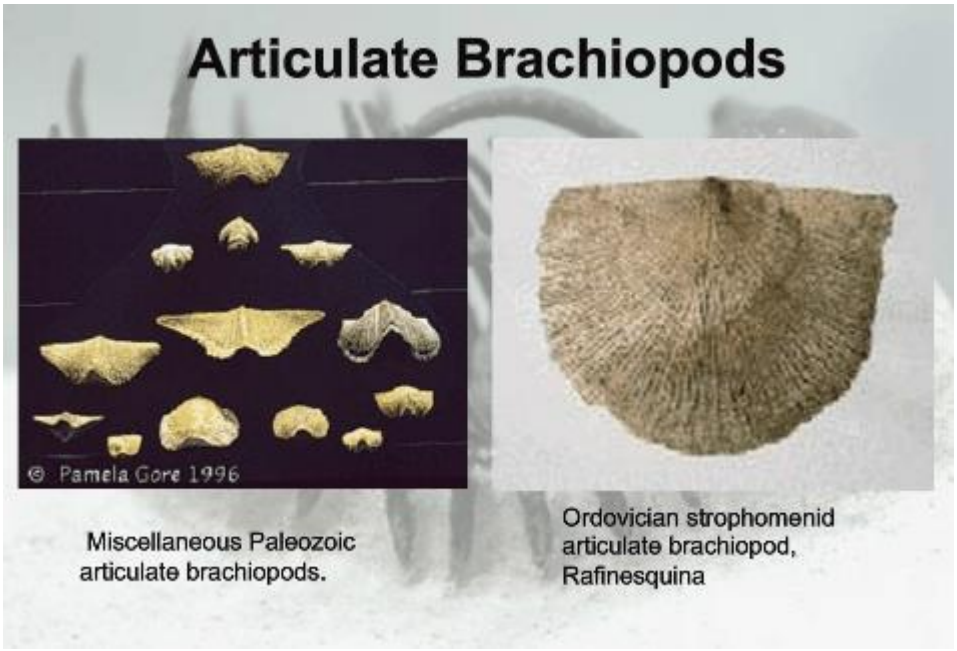
Geologic range: Lower Cambrian to Recent

Fossil inarticulate brachiopod from the Cambrian. Maximum length = 2.2 cm.

B. CLASS ARTICULATA - The Articulate Brachiopods

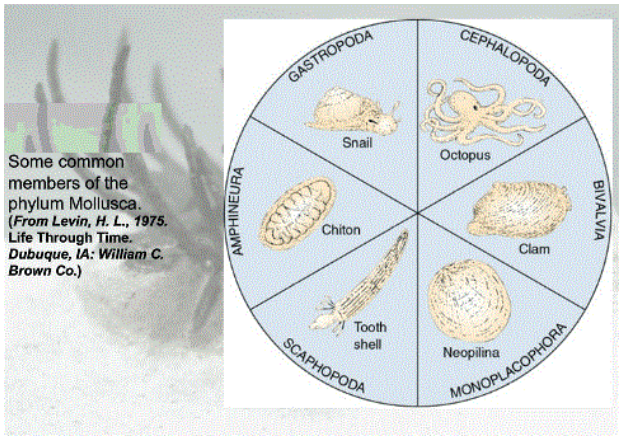
Brachiopods with calcareous valves attached together with a hinge consisting of teeth and sockets. Some of the more common articulate brachiopods are *Pentamerus*, *Rafinesquina*, *Atrypa*, *Leptaena*, and *Spirifer*.

Geologic range: Lower Cambrian to Recent. Spiny brachiopods (called productids) are characteristic of the Carboniferous and Permian.



Phylum Mollusca

(Clams, oysters, snails, slugs, *Nautilus*, squid, octopus, cuttlefish)



Some common members of the phylum Mollusca. (*From Levin, H. L., 1975. Life Through Time. Dubuque, IA: William C. Brown Co.*)

Name: Mollusca means "soft bodied".

Chief characteristics:

- Soft body enclosed within a calcium carbonate shell (a few, like slugs and the octopus, have no shell). Muscular part of body of clams and snails and some other groups of molluscs is called the **foot**.

Geologic range: Cambrian to Recent.

Mode of life:

Marine, freshwater, or terrestrial. They may: swim, float or drift, burrow into mud or sand, bore into wood or rock, attach themselves to rocks, or crawl.

Classification of Molluscs

Placophorans are primitive molluscs with multiple paired gills, and a "foot" like that in snails. This group includes both the **monoplacophorans** and the **polyplacophorans** (chitons).

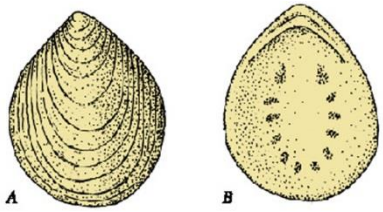
A. CLASS MONOPLACOPHORA

Name: Monoplacophora means "single plate-bearer".

Chief characteristics:

Single shell resembling a flattened cone or cap. Soft part anatomy shows pseudo-segmented arrangement of gills, muscles, and other organs. Suggests that the primitive mollusc was a segmented animal. Segmentation was lost secondarily. Monoplacophorans are regarded as ancestral to bivalves, gastropods, and cephalopods.

Geologic range: Cambrian-Recent, but only known as fossils from Cambrian to Devonian. Living monoplacophorans found in deep water off Costa Rica in 1952 and named ***Neopilina***. Considered to be a "living fossil".

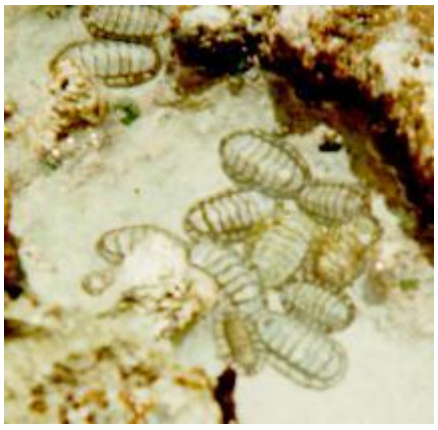


*Fossil monoplacophoran, **Pilina**, from the Silurian.*

B. CLASS AMPHINEURA OR POLYPLACOPHORA

(Chitons or amphineurans)

Name: Polyplacophora means "many plate-bearer".



Chief characteristics:

Chitons have 8 overlapping plates covering an ovoid, flattened body.

Geologic range: Cambrian to Recent.

Living chitons in Bermuda.

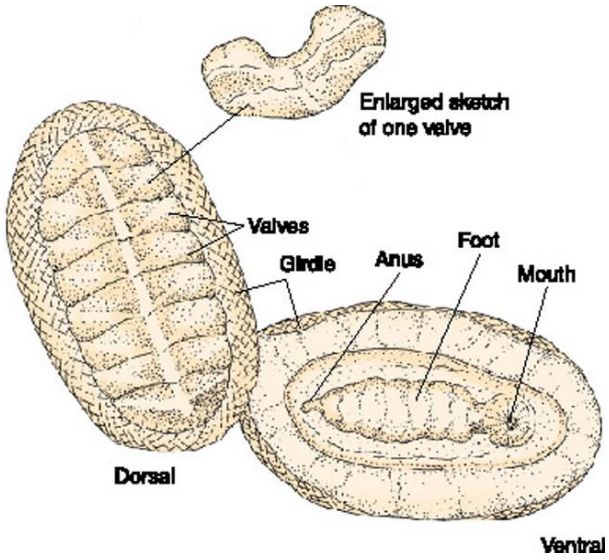
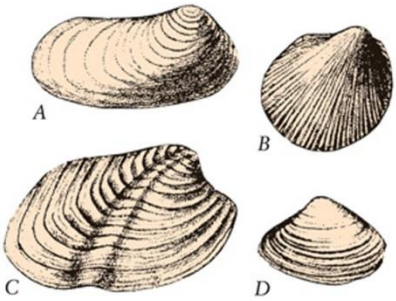


Diagram showing the anatomy of a chiton.

C. CLASS BIVALVIA OR PELECYPODA

(Clams, oysters, scallops, mussels, rudists)



Name: Bivalvia means "two" (bi) + "shells" (valvia).

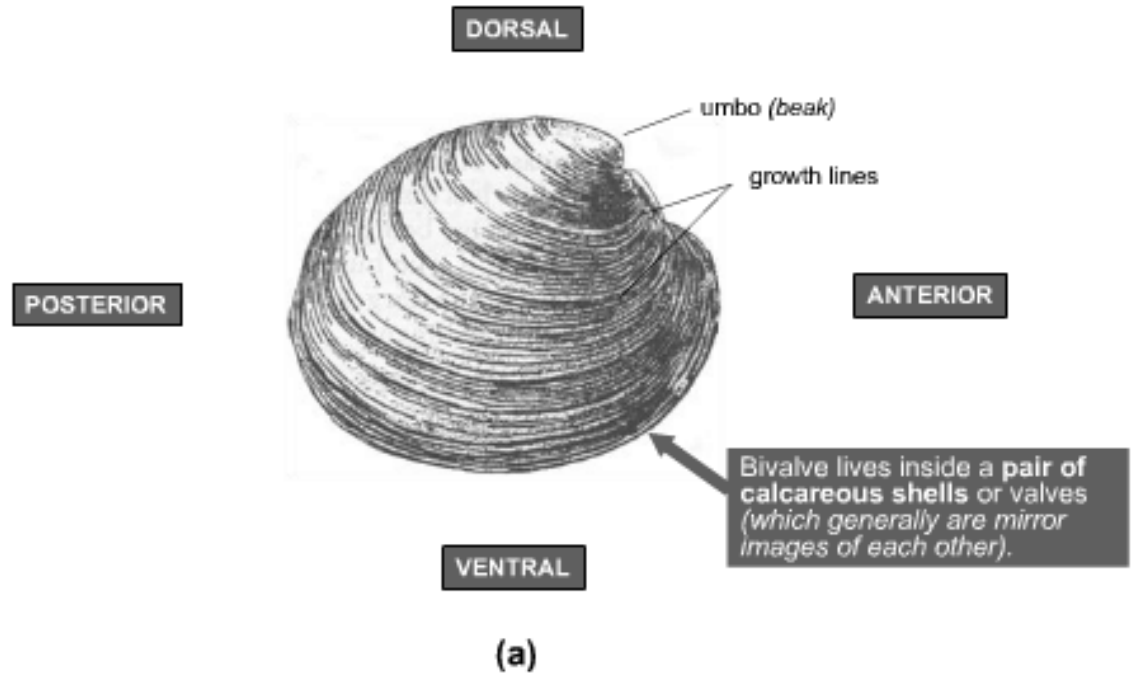
Chief characteristics: Skeleton consists of two calcareous valves connected by a hinge. Bilateral symmetry; plane of symmetry passes between the two valves.

Geologic range: Early Cambrian to Recent

Mode of life:

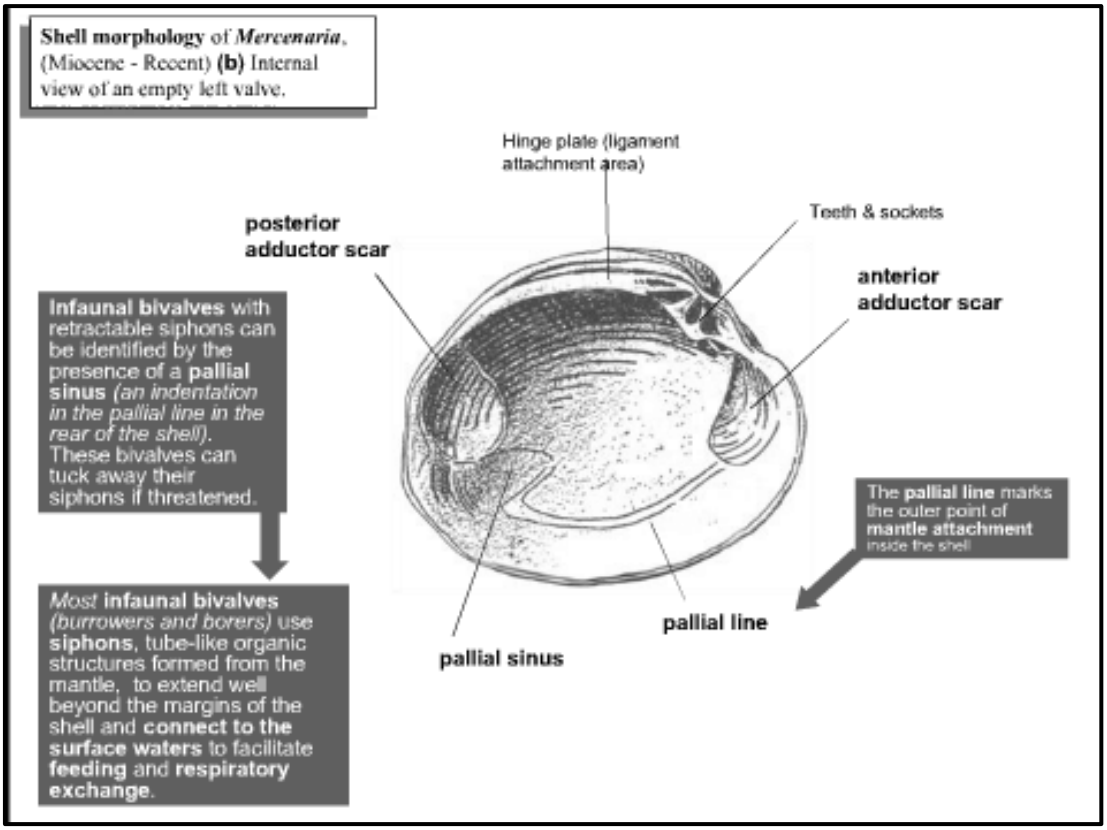
Marine and freshwater. Many species are infaunal burrowers or borers, and others are epifaunal.

Shell morphology of *Mercenaria*, (Miocene - Recent) **(a)** Exterior view of right valve.



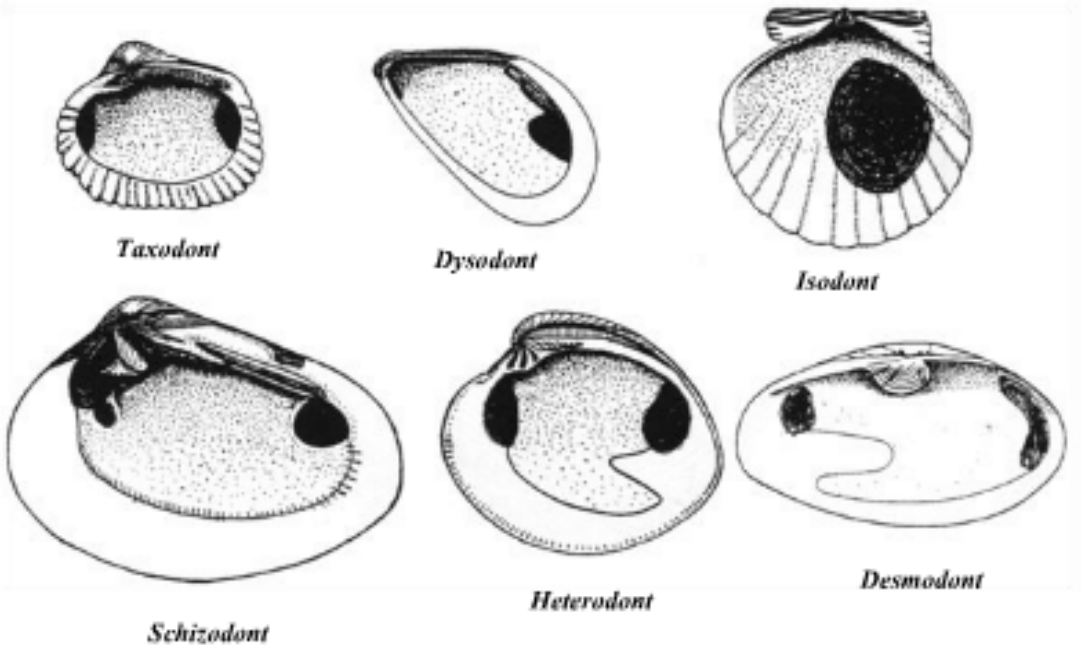
(a)

Shell morphology of *Mercenaria*, (Miocene - Recent) **(b)** Internal view of an empty left valve.



Palaeontologists have to rely solely on the **hard parts** and in particular on the type of **dentition** keeping the shells together near the hinge.

Main types of bivalve **dentition**.



Types of dentition

Taxodont – many small similar teeth & sockets all along hinge plate (eg *Glycimerus* and *Arca*)

Schizodont – two or three thick teeth with prominent grooves (eg *Trigonia*)

Dysodont – small simple teeth near the edge of the valve (eg *Mytilus*)

Heterodont – few teeth varying in size and shape, distinquished as cardinal teeth, beneath the umbo, and lateral teeth which lie obliquely along the hinge plate (eg most recent bivalves)

Isodont – teeth very large and located on either side of a central ligament pit (eg *Spondylus*)

Desmodont – teeth very reduced or absent (eg *Mya*) with a large internal process (the chondrophore) carrying the ligament

Terminology *commonly used to describe* **shapes of bivalve shell**:

Circular

Subcircular

Elliptical

Elongate elliptical

Oval

Subquadrate

Trigonal

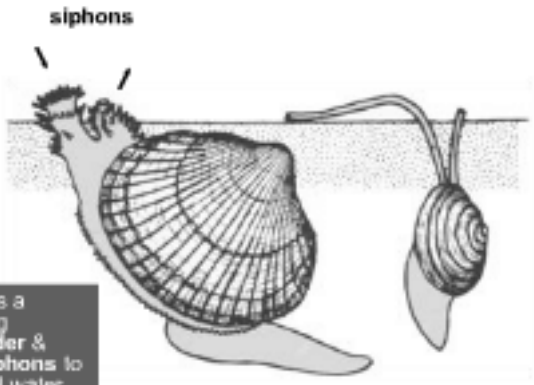
Mytiliform

Lanceolate

Pteriiform

1. *(infaunal)* burrowers.

Bivalves **burrow into sediment** to escape predation and many *(although <u>not</u> all)* use their siphons to connect to the surface to draw in water for feeding and respiration. **Shell morphology** depends on the **depth** the bivalve lives at and the **speed** with which it is able to **bury** itself.

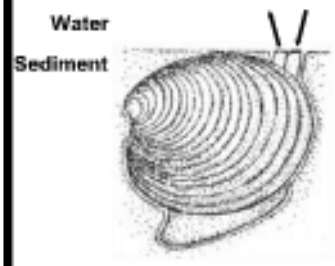


Cardium edule is a shallow burrowing **suspension feeder** & uses its **short siphons** to draw in and expel water

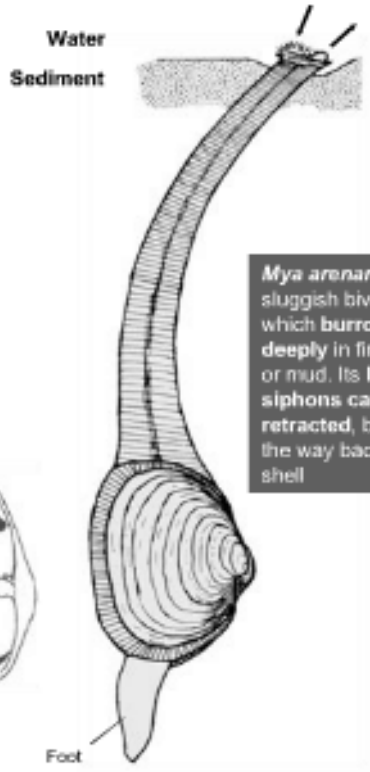
Tellina tenuis *is also a* ***shallow burrower****. It is a* ***deposit feeder*** *with long slender siphons which suck up water and particles close to the surface of the sediment*

1. *(infaunal)* burrowers (cont'd).

Venus is a **shallow burrowing** form with short retractable siphons.



Note difference in size of pallial sinus between the two bivalves. *(Generally the bigger the indentation the bigger the siphon and consequently the deeper the bivalve could burrow)*



Mya arenaria is a sluggish bivalve which **burrows** quite **deeply** in firm sand or mud. Its **long siphons can be retracted**, but not all the way back into the shell

<u>*Shell Features*</u> **(shallow burrowers):**

- **Equivalved**
- **Thick***(ish)* **valves**
- **Adductor muscles roughly equal in size**
- **Commonly with strong external ornament**

<u>*Shell features*</u> **(deeper burrowers):**

- **Generally more elongate shells**
- **Some have gapes in the shell commissure to allow siphons to remain outside when shell is closed**
- **Dentition reduced**

2. *(epifaunal)* byssally attached.

Byssate bivalves secrete thin **collagenous threads** (**byssus**) to attach themselves to objects for **anchorage**.

Shell Features (**byssally attached**):

- **Elongate shells with flat ventral surface**
- **Anterior of shell reduced**
- **Anterior muscle reduced**
- **Sometimes a byssal notch or gape through which the byssal threads emerge**

Mytilus, the common muscle with byssal attachment *(note barnacle encrustation)*

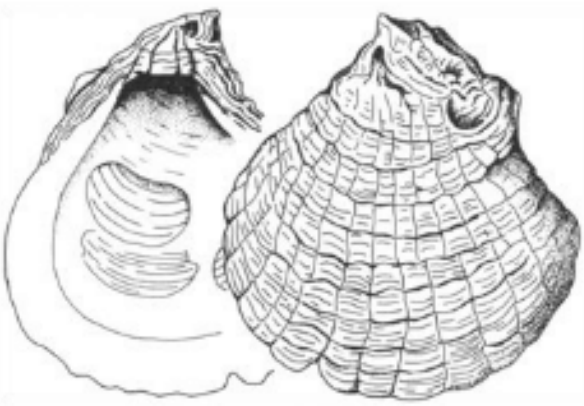
Detail of *Mytilus californianus* **byssus**

3. *(epifaunal)* cemented.

Several groups of bivalves *(including the* ***oysters****)* actively **cement themselves**, normally by calcareous deposits, to **hard substrates** on the sea floor. This provides the bivalve with a continual **stable** platform to grow on and prevents them getting dislodged and destroyed in high energy conditions.

Shell features (**cementers**):

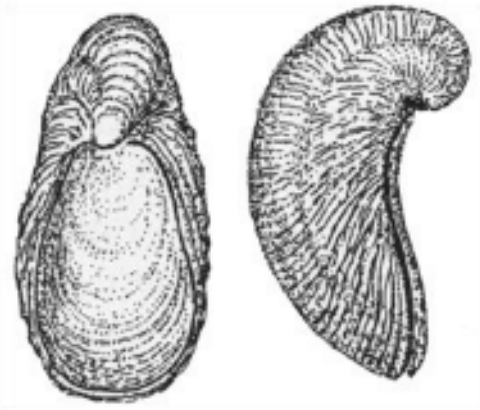
- **Valves are markedly different from each other and may take on the shape of the underlying** *(hard)* **substrate**
- **Commissures sometimes crenulated**
- **Generally found in-situ**
- **Generally a large single adductor**



Ostrea *(oyster)* cements to **hard surfaces** using its left valve, (which is **not** a mirror image of the *upper* right valve).

4. *(epifaunal)* free lying.

These forms are **unattached** and **rest on or partially buried in soft substrata.** They rely on the **mass** of the shell to keep themselves in place (rather like paper-weights).



Gryphaea

Shell features
(free lying):

- **Markedly different shaped valves**
- **Lower valve *sometimes* enlarged, convex and very thick, whilst upper valve is flat**
- **Sometimes spines are present for anchorage and stabilisation**

5. Borers *and* cavity dwellers

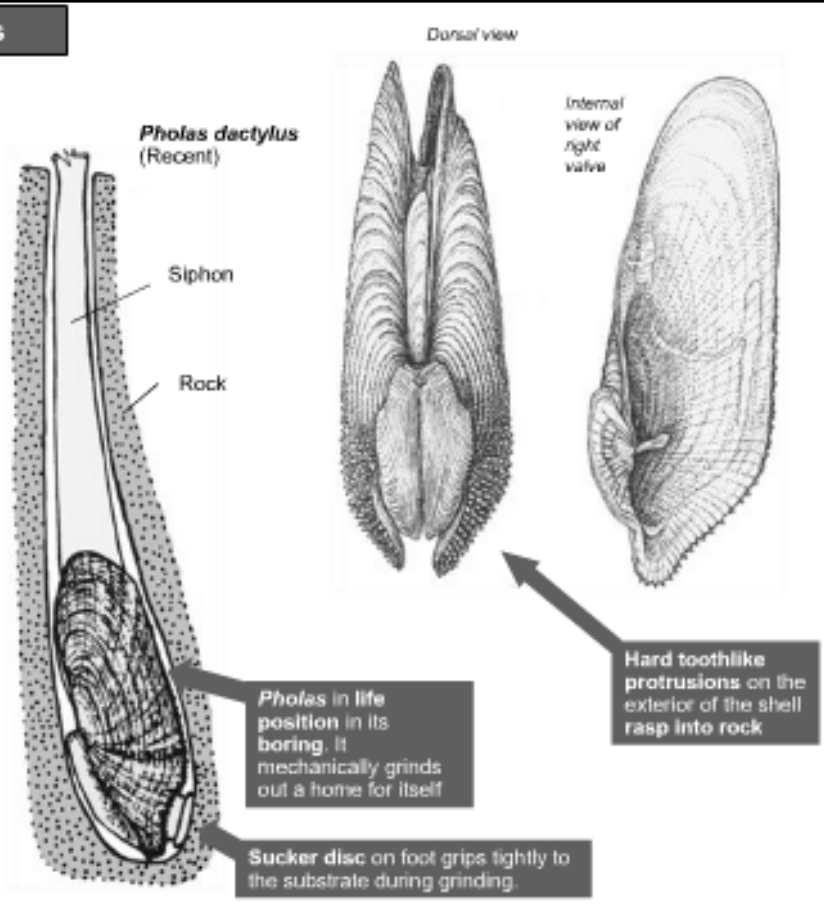
Some bivalves are adapted for life in **hard substrates** such as wood and rock. They achieve this through the rocking and scraping action of specially modified shells which effectively drill into the substrate. In some instances they can secrete corrosive acids secreted from the mantle.

Cavity dwelling bivalves are **opportunists** - they often occupy old vacated borings as well as other cavities and fissures. They sometimes use byssal threads to fix themselves in place and their shells may be distorted to fit the available cavity space.

Shell features

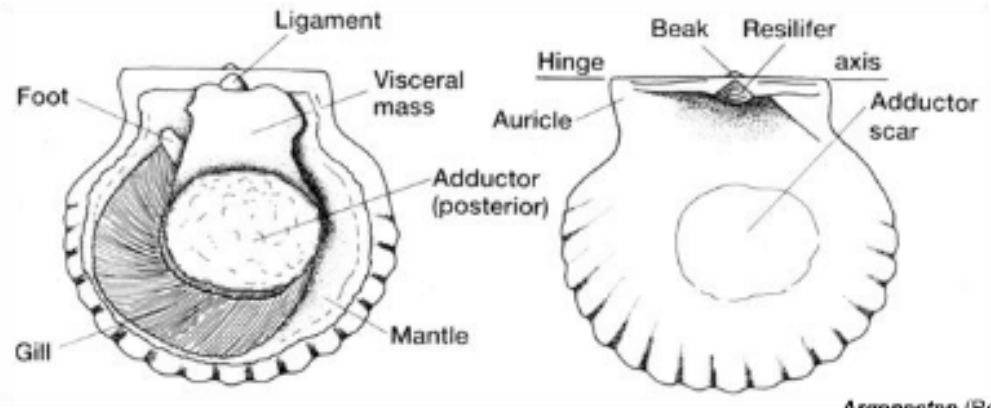
(borers *and* cavity dwellers):

- **Generally equivalved and elongate shells**
- **Strong sharp external ornament to facilitate excavation**
- **Cavity dwellers may have byssal attachment and commonly grow to suit contours of cavity**



6. Swimmers.

Several bivalves, unlike brachiopods, are able to **swim actively**. They achieve this by repeatedly clapping the valves together and expelling water out via the ears, squirting jets of water backwards and propelling the bivalve forwards. This uses up massive amounts of energy and modern bivalves thus are only able to swim intermittently.



Argopecten (Recent) a swimming bivalve

Shell features **(swimmers):**

- **Thin shell development**
- **A single large centrally placed adductor muscle developed to power swimming**
- **Hinge is extended near the umbo into pronounced 'ears'**
- **Shell becomes increasingly symmetrical about the midline (rather like brachiopod symmetry)**

D. CLASS GASTROPODA

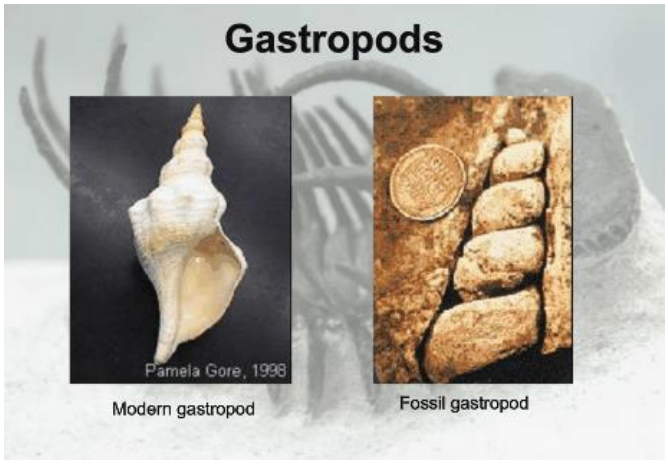
(Snails and slugs)

Name: Gastropod means "stomach" (gastro) + "foot" (pod).

Chief characteristics: Asymmetrical, spiral-coiled calcareous shell.

Geologic range: Early Cambrian to Recent.

Mode of life: Marine, freshwater or terrestrial.

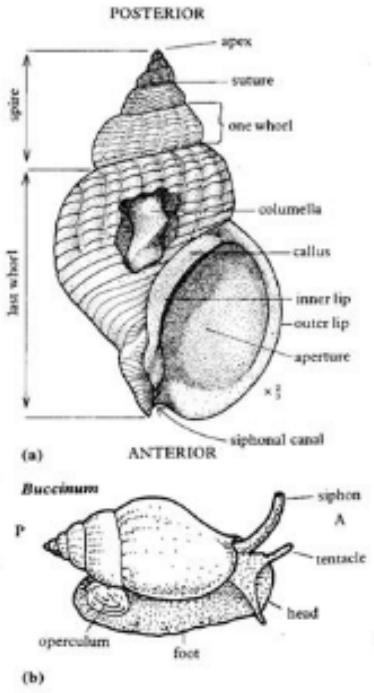


Gastropods - morphology.

Gastropods possess a head at the anterior end, and a muscular creeping foot on the ventral surface. In most forms the body is protected by a **univalve** shell, which is typically a tapering tube, coiled in a right-handed spiral. (Some forms are uncoiled, and a few have left-handed spirals.)

They are the most abundant molluscs of the present day and occupy a range of habitats – aquatic (marine & freshwater) and terrestrial. Modern examples include winkles, whelks, limpets, snails and slugs.

Generally classified by soft parts, which leave few clues in the empty shells.



32 Morphology of gastropods based on *Buccinum*.
a, shell with part of last whorl broken to expose the columella. b, gastropod crawling with head and foot extended.

Left-Handed Spiral

Right-Handed Spiral

'Limpet' – an uncoiled gastropod

E. CLASS CEPHALOPODA

(Squid, octopus, ***Nautilus***, cuttlefish)

Name: Cephalopod means "head" (kephale) + "foot" (pod).

Chief characteristics:

Symmetrical cone-shaped shell with internal partitions called **septae** (singular = septum). Shell may be **straight or coiled in a spiral which lies in a plane**. Smooth or contorted **sutures** visible on the outside of some fossils **mark the place where septae join the outer shell**.

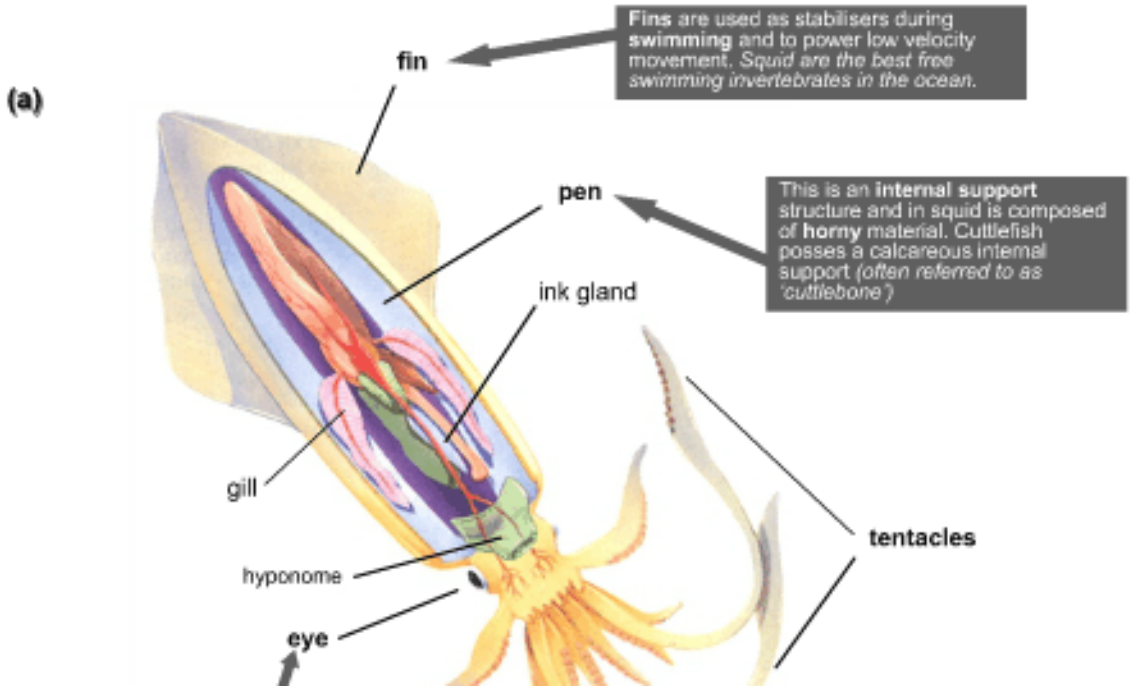
Geologic range: Late Cambrian to Recent.

Mode of life: Marine only; carnivorous (meat-eating) swimmers.

Cephalopods belong to the phylum **Mollusca**, and are related to gastropods and bivalves. They are **entirely marine** and possibly the most advanced group within the invertebrates. The vast majority are **highly mobile carnivores** and actively stalk and capture their prey. They have well developed nervous systems, reasonably complex brains, prominent eyes and excellent vision. Several, such as octopus and cuttlefish can very rapidly change colour to suit their surroundings *(or even their mood)*. All of these adaptations ideally suit their predatorial lifestyles.

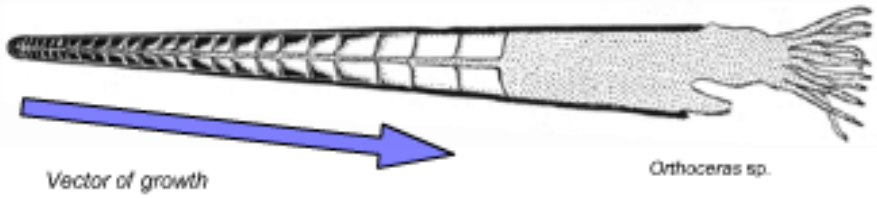
Cephalopods *may* secrete an external **calcareous shell** which is commonly fossilised *(e.g. ammonites)*, they may possess a reduced internalised skeletal structure *(e.g. squid and cuttlefish)* or they may have lost the shell altogether *(e.g. octopus)* - making them much rarer in the fossil record. Shelled cephalopods are not very common today, however they were abundant in the Palaeozoic and Mesozoic when they were very important in the marine realm as carnivores. In fact before the arrival of jawed fish in the Silurian and, in particular, the appearance of sharks in the late Devonian they were the **top predators** in the oceans.

Internally shelled *Cephalopods*



Cephalopods - Form & Function

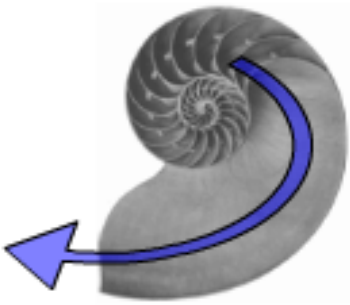
Growth



Vector of growth

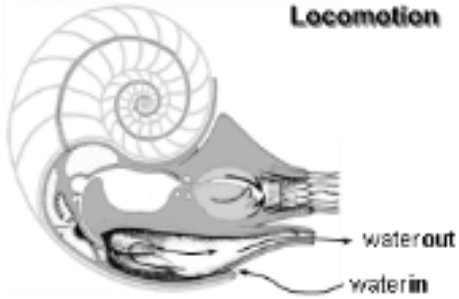
Orthoceras sp.

Cephalopods with straight or coiled external shells grow incrementally. They produce a new septum which seals off a new fluid and gas filled chamber immediately behind the body chamber.

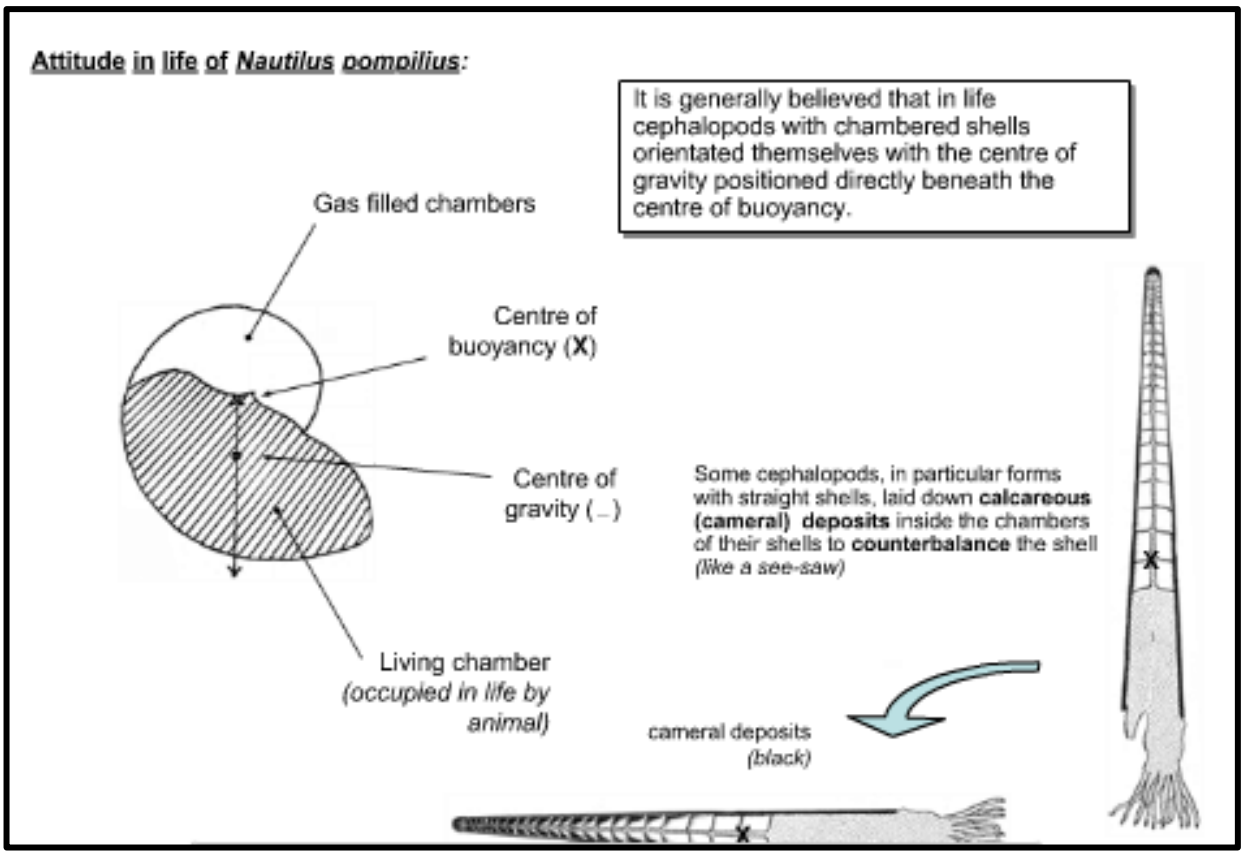


Vector of growth

Locomotion



Movement is achieved through a form of **jet propulsion**. Water is drawn into the mantle cavity via an inhalent slit. It passes over the gills *(facilitating respiration)* and is then directed out of the animal at pressure through the **hyponome**. The end of this tubelike structure is flexible and can be pointed many directions to **steer the creature**.



Tightly coiled involute shell (left) and slightly curved cyrtoconic shell (right)

1. SUBCLASS NAUTILOIDEA

The shells of nautiloid cephalopods have smoothly curved septa, which produce simple, straight or curved sutures.

Geologic range: Cambrian to Recent.

Nautilus

*Shell of a **Nautilus** sawed in half to show internal structure including living chamberand septae.*

Fossil of a straight-coned nautiloid. Note gently curving septae and the siphuncle passing lengthwise through the center.

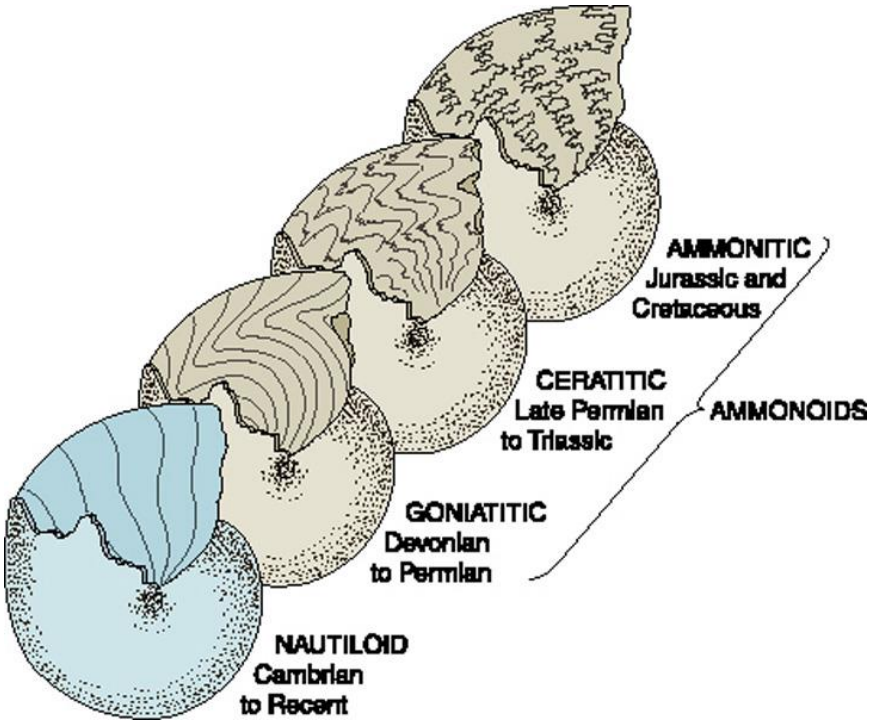
2. SUBCLASS AMMONOIDEA

Ammonoid cephalopods have complex, wrinkled or crenulated septa, which produce angular or dendritic sutures.

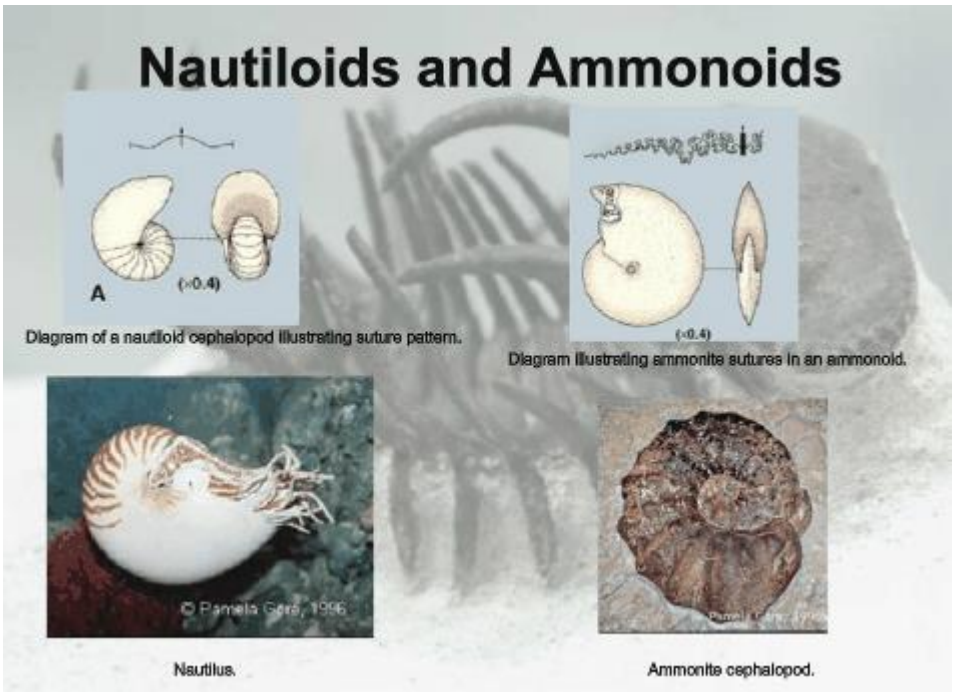
Geologic range: Devonian to Cretaceous - all extinct.

There are three basic types of sutures in ammonoid shells:

a. **Goniatite** or **goniatitic** (septae have relatively simple, zig-zag undulations)
b. **Ceratite** or **ceratitic** (septae have smooth "hills" alternating with saw-toothed "valleys")
c. **Ammonite** or **ammonitic** (septae are complexly branching and tree-like or dendritic)



Comparison of the sutures in nautiloid cephalopods with the three types of sutures in ammonoid cephalopods.



3. SUBCLASS COLEOIDEA

a. ORDER BELEMNOIDEA (belemnites)

The belemnoids have an internal calcareous shell (which resembles a cigar in size, shape, and color) called a **rostrum**. The front part of this shell is chambered, as in the nautiloids and ammonoids. The rostrum is made of fibrous calcite, arranged in concentric layers.

Geologic range: Mississippian to Eocene - all extinct.

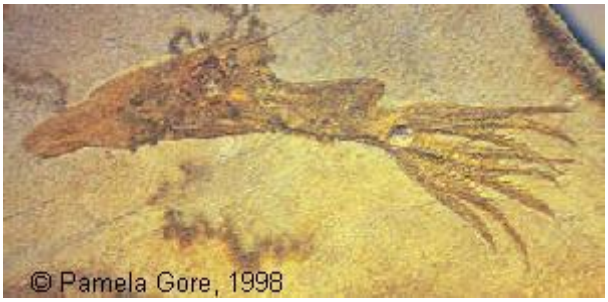
Fossil belemnoid in floor tiles of the Jurassic Solnhofen limestone from Germany.

b. ORDER SEPIOIDEA (cuttlefishes)

Geologic range: Jurassic to Recent

c. ORDER TEUTHOIDEA (squids)

Geologic range: Jurassic to Recent



*Fossil squid, **Acanthoteuthis sp**., Lower Jurassic (145-140 m.y.), Germany.*

d. ORDER OCTOPODA (octopi)

Geologic range: Cretaceous to Recent

F. CLASS SCAPHOPODA

(Tusk shells or tooth shells)

Chief characteristics: Curved tubular shells open at both ends.

Geologic range: Ordovician to Recent.

Mode of life: Marine.

Dentalium is a common genus.

Scaphopods,
***Dentalium sexangulare**, Pliocene, Piacenzia Blue Clay, Castellarquato, Italy.*

Diagram of a scaphopod.