BELEMNITES

Belemnites were marine animals that belonged to the classification of Phylum Mollusca and to the Class Cephalopoda.
Today you would find their still living relatives, the squid and cuttlefish, within the same classification. The similarities to their modern day relatives include ink sacs and the presence of ten tentacles however, the design of their tentacles also forms a difference between them; on the modern squid they have suckers in order to grab prey, whereas belemnite tentacles had hooks.

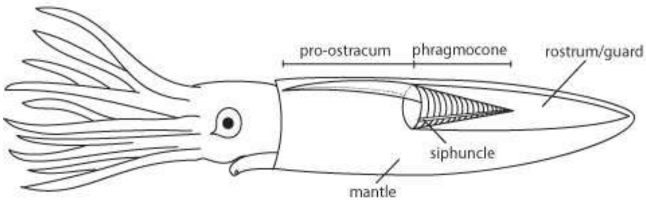
BELEMNITE GUARDS

ALIGNMENT OF BELEMNITE FOSSILS

When Belemnites died the hydrodynamic 'bullet' shape would have allowed the guards to be deposited and aligned with currents on the sea bed.
Analysis of the alignment of the long axes of Belemnite guards found in 'Death Assemblages' allows geologists to calculate the direction of Palaeo-currents.
The rose diagram opposite shows the orienatation of a sample of Belemnite guards. The graph shows that the palaeocurrent would have been in the direction shown by the arrow, ENE / WSW.

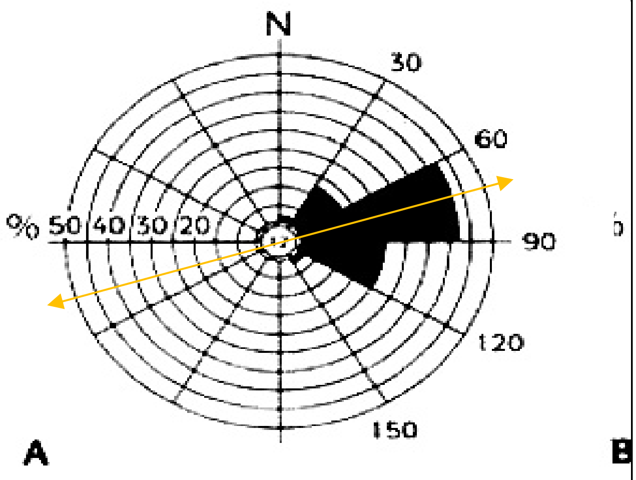
BELEMNITE DEATH ASSEMBLAGE

The Belemnites were present on the Earth for a period spanning over 140 million years. They first appeared on Earth some 208 million years ago, during the Carboniferous **period. It is currently believed that they evolved from the same ancestors as the Ammonites. The Belemnites became extinct about the same time that the majority of the dinosaurs disappeared. This is believed to be at the end of the** Cretaceous **Period, some 65 million years ago, known in paleontology as the time of the K-T mass-extinction.**



Lateral view of the internal shell of a generalized belemnite. ©Liz Shea, DMNH.

The complete belemnite 'shell' consists of three parts; the guard, the alveolus and the pro-ostracum . The fossil remains most normally found are the part of the shell that was originally located in the tail of the belemnite. This part is usually referred to as the guard (the correct name is the rostrum, the plural of which is rostra). This guard is elongated and bullet-shaped, cylindrical and either pointed or rounded at one end. It is this end that points towards the rear of the belemnite. The hollow chamber at the front of the guard is called the alveolus.



Class (degrees)	Number of observations	%
0-29	1	8
30-59	2	17
60-89	5	42
90-119	3	25
120-149	1	8
	12	100

geography john

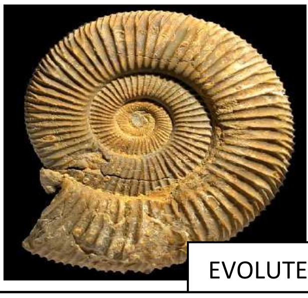
GEOLOGY

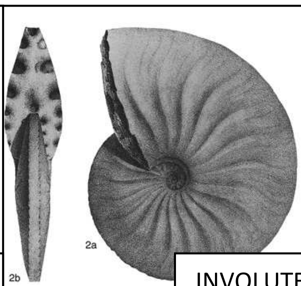
CASE STUDY REVISION BOOKLET

AMMONITES / NAUTILUS / BELEMNITES

- **Phylum: Mollusca**
- **Class: Cephalopoda**
- **Sub Classes:**
  - **Nautiloids (U. Cambrian - Recent)**
  - **Ammonites (L. Devonian - Cretaceous)**

Order: Belemnites (L. Carboniferous - Cretaceous)



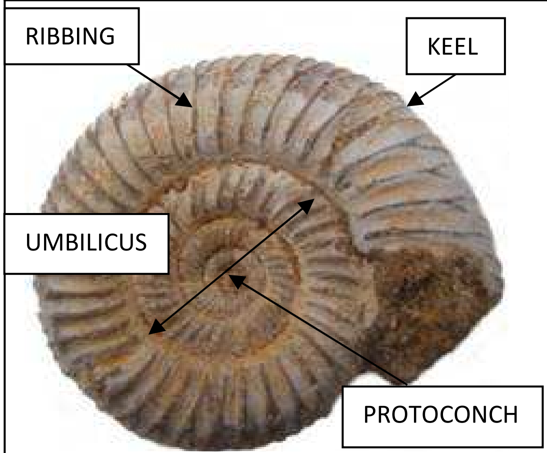


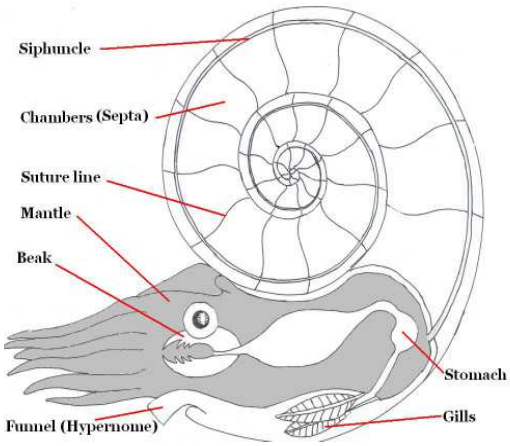
Ammonites are perhaps the most widely known fossil, possessing the typically ribbed spiral-form shell as pictured below. These creatures lived in the seas between 240 - 65 million years ago during the Mesozoic Era, when they became extinct along with the dinosaurs. The name 'ammonite' originates from the Greek Ram-horned god called Ammon. Ammonites belong to a group of predators known as cephalopods, which includes their living relatives the octopus, squid, cuttlefish and nautilus.

The shell – general

Ammonite shells (apart from in the heteromorphs) all follow a similar basic design, which is that of an expanding cone, spiralling around a centre point, in a single plane. In other words they are generally a flattish spiral, which gets thicker with each whorl. THIS IS CALLED PLANISPIRAL.

Where the outer whorl of an ammonite shell largely covers the preceding whorls, the specimen is said to be 'involute' (e.g. Anahoplites). Where it does not cover those preceding, the specimen is said to be 'evolute' (e.g. Dactylioceras).





The shell – inside

Sutures (septal sutures) are intricate patterns that run across the whorls and show how the outer edges of an ammonite's chambers fit together. The shapes of the lines are often used to recognise fossils.

It is thought that ammonites had these complex interlocking chamber shapes to give the shell more strength, so that the animal could dive to greater depths without being crushed by water pressure. However, it has been shown that Nautilus can, and did dive deeper than ammonites, but these animals have very uncomplicated suture lines. The reason for the Nautilus' greater depth tolerance, while retaining simple sutures is simply that they have thicker shells than the ammonites, which evolved a different way of strengthening themselves.

The phragmocone consists of many generally equally proportioned chambers, which begin at the centre of the ammonite. These were used as buoyancy aids and were filled with gas. When new chambers were formed, a tube called the siphuncle was used to transfer liquid from them, in order to maintain the animal's buoyancy.

The siphuncle is usually only seen in very small portions in cut ammonites and is generally much more noticeable in a Nautilus shell, where it can be seen roughly in the centre of the whorls. In ammonites however, it is found along the outside edge (venter) of the whorl.

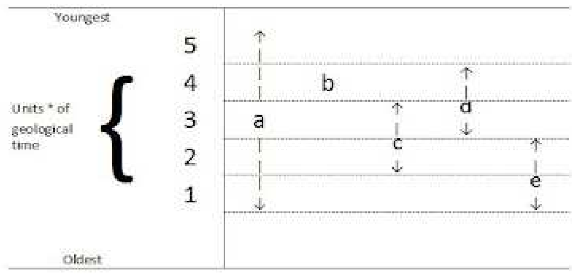
The body chamber is the final, longest chamber, in which the ammonite animal actually lived. It is not divided by sutures. The chambers of the phragmocone are largely sealed off from the body chamber.

The hypernome is a funnel used by the ammonite to propel itself through the water. A jet of water was expelled through the hypernome to 'jet propel' the creature .

AMMONITES AND STRATIGRAPHY

Ammonites are extremely useful to stratigraphers for a number of reasons-

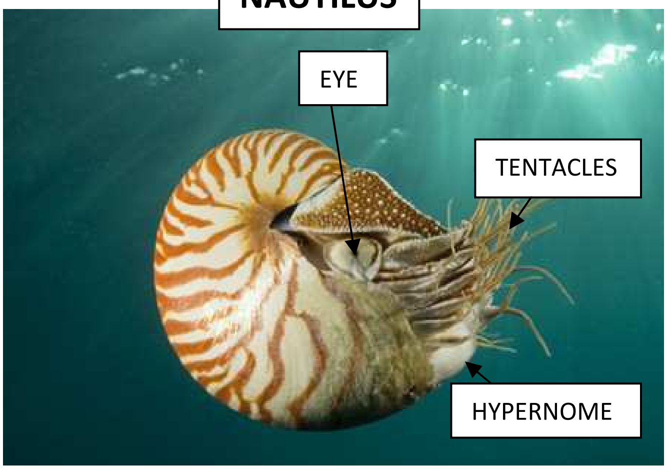
- They were extremely abundant in the Mesozoic.
- They were marine and therefore easily fossilised.
- They were facies independent, being found in many different rock types.
- They are widespread due to their nektonic mode of life.
- Many species had a short geographical range.
- Many species were short lived, due to rapid evolution.
- Evolutionary trends are easily recognisable.
- When correlating the ages of different sites across a country, a continent or the world, ammonites are often used with great effect. For example a species found in England, with a geological range of a million years can be correlated with the same species found elsewhere and hence can date the foreign site to within a million years.

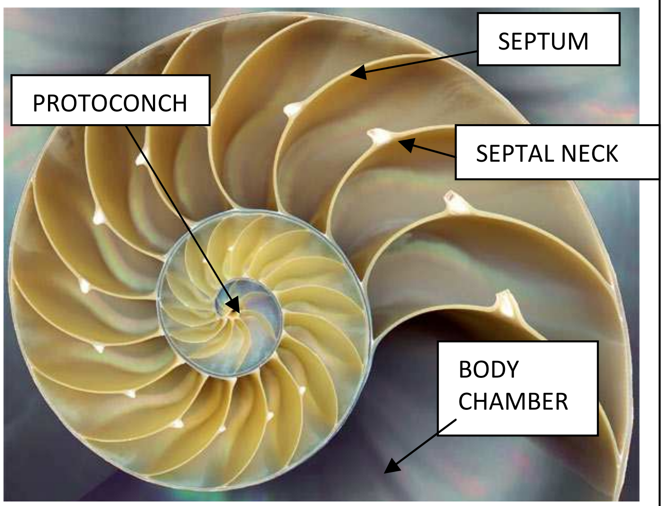


* Time units may be of any length: whole periods or smaller divisions of one period.

Fossil a has along range and is not a good zone or index fossil.
Fossil b is the best zone fossil as it is only found in rock unit 4 and can be used to date rocks of this age.
Fossils c,d and e are reasonable zone fossils since they have relatively short ranges.
Fossil asemblage c and d can be used to date rock unit 3 as both are only found in this unit.
The same is true of **fossil assemblage c and e** which can only be found in rock unit 2.

NAUTILUS





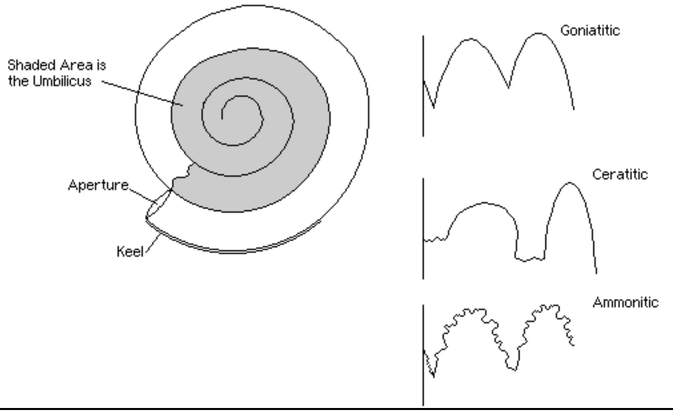
NECKTONIC MODE OF LIFE
EXTERNAL VIEW

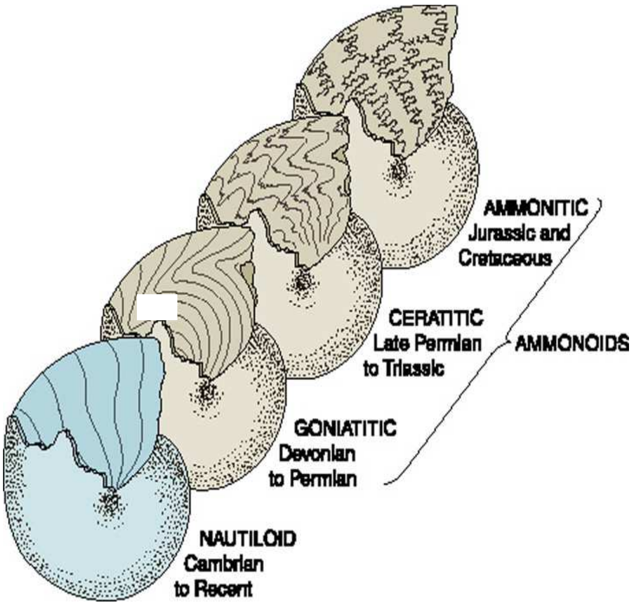
- Involute shell
- Large effective eyes
- Tentacles to catch prey
- Beak to eat prey
- Hypernome for jet propelled horizontal movement

INTERNAL VIEW

- PROTOCONCH, first chamber occupied by the baby nautilus.
- SEPTUM (septa) wall between chambers is smooth and simple.
- SEPTAL NECKS point backwards (towards the protoconch.
- SIPHUNCLE, tube passing through the septal necks connecting the chambers to control the gas/water levels in the chambers is located in the centre.
- BODY CHAMBER the last and largest chamber that contains the soft body of the nautilus.

NEAREST LIVING RELATIVE : Nautilus is the nearest living relative of the extinct ammonites. Nautilus has remained mostly unchanged since the Lower Palaeozoic to the present day. The features we find on Nautilus are very similar to those found on the extinct ammonites and so we can infer the functions of those features and to some extent the mode of life of ammonites. It may be that Nautilus lives in deeper water than the ammonites did, down to perhaps 400m, and it is likely that ammonites were faster and more maneuverable.





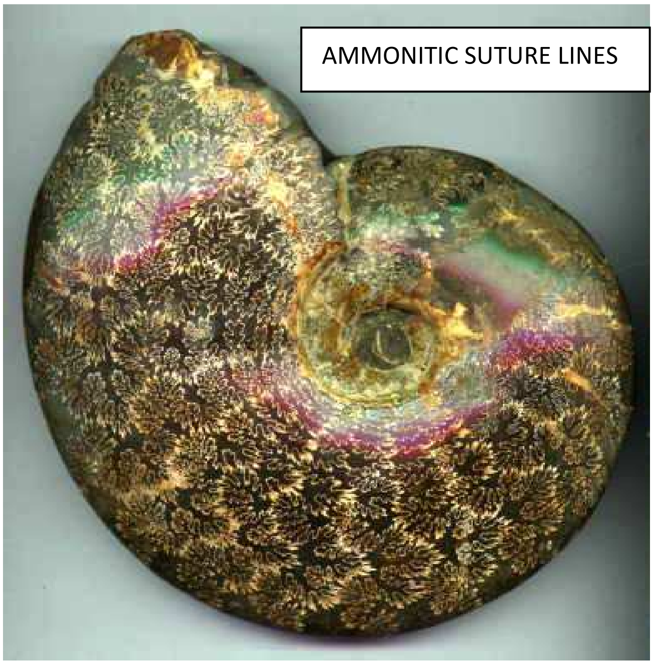
EVOLUTION – INTERNAL

SUTURE LINES : These lines mark where the walls of the chambers (the septa) join with the inside of the shell. The sutures are thought to have evolved and changed over time to add strength to enable the creature to inhabit different evironments, particularly the highre pressures found at depth. Increasing the length and comlexiity of the suture line increased the stength without increasing shell thickness which would have reduced speed and exceleration.
GONIATITIC : Early forms found in the lower Palaeozoic, had very simple sutures with smooth, rounded saddles and lobes. These are the Goniatites.
CERATITIC : While the Goniatites became extinct at the P/T mass extinction the Ceratites which took over had a more complex suture line with smooth saddles, but complex, frilly lobes.
AMMONITIC : True ammonites were important from the upper Triassic, dominating in the Jurassic and Cretaceous until they too died out at the K/T mass extinction along with the dinosaurs. Ammonitic sutures had complex and frilly saddles **and** lobes.

SIPHUNCLE AND SEPTAL NECKS : Over time the position of the siphuncle changed from the centre of the chambers and septal walls (like NAUTILUS) to a position nearer the outsde of each chamber. It is thought that this gave greater contol over depth.
The septal necks of early Ammonites and indeed Nautilus pointed backwards, whereas in later forms they point towards the aperture.

EVOLUTION – EXTERNAL

Earlier ammonites such as Goniatites and the Nautilus had smooth shells. Later ammonites developed more ornament on the outside of the shell. This included stonger ribbing which may have added strength to the shell and increased the protection without shells thickening. Some also became more streamlined with a more pronounced keel to increase stability and speed.



AMMONITIC SUTURE LINES

The **heteromorph** ammonites which evolved in the Cretaceous had a variety of shapes, including the basic ammonite spiral, only uncoiled (each new whorl not touching the last), a spiral that became significantly uncoiled in the lead up to the animal's maturity, and upwards coiling spirals like the type we see in snail shells.
This may have been an evolutionary trend to exploit different niches, particularly floating near the sea surface or crawling on the sea bed.