

The biology of ammonites

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TORRENS, H.S. (1986). The biology of ammonites. *Proceedings of the Shropshire Geological Society*, **5**, 7–8.
The account of a lecture describing the evolution and occurrence of ammonites.

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In 1796 William Smith discovered that strata could be identified by the fossils they contained and ammonites were one of the two groups for which he produced a stratigraphic distribution. Using the Cornbrash as an example, Smith in 1815 realised that the faunas of the Upper and Lower Cornbrash were different. The *Macrocephalites* zone, for example, can also be traced in rocks in Bulgaria, Switzerland, Sicily and Iran. We are therefore looking at rocks of the same age and using a very sharp and accurate tool, achieving a resolution equivalent to half a million years or less 150 million year ago. Ammonites are therefore twice as good as trilobites in terms of accuracy.

Ammonites are often very common and possess very thin shells. This helps in identifying strata because the internal cast is just as good as the whole shell. Ammonites also possess an incredible range of morphological features, producing an enormous diversity even at a specific level. This indicates that the group must have evolved very rapidly and characterised very short time ranges. It is also clear that many ammonites had a very wide geographical distribution.

Trying to infer the mode of life of ammonites is very difficult because of their distribution, which arises from their free swimming life style, resulting in only rare trace fossils. Also we are dealing with a totally extinct species and modern comparisons cannot be made. It is necessary therefore to start from first principles and make sure these are soundly founded and not based on a misconception.

Such trace fossils that do exist tell us that the shell was external and that the swimming attitude was with the coils above and the aperture just above the horizontal. To maintain this attitude, it must have been floating using the internal septate

portion of the shell to divide gas chambers which were regulated by the siphuncle. So how did ammonites regulate their buoyancy? Some clues are given by studying epifaunas. Ammonites have been found with such things as serpulid worms and oysters attached. Normally ammonites are perfectly plainly spiral, with an iso-symmetrical coil. With a hitch-hiker attached, the symmetry of subsequent growth is disrupted in order that buoyancy can be maintained and the centre of gravity is in equilibrium with the centre of balance. Serpulids have been found which have been overgrown by the shell. Because serpulids are extant, it is possible to calculate their rate of growth and hence that of ammonites. This suggests a life span of 6-7 years.

It would be wrong to assume that all ammonites had the same ecology. Taking the simple question of size, the largest found would have been some ten feet across, that is a coiled animal some 60 feet long and weighing 1½ tons. At the opposite extreme, the smallest known has a diameter of only 2.8 mm. Is it reasonable to assume therefore that these two ammonites shared the same ecology? There is a range of shapes such as uncoiling types and others looking more like gastropods. There was therefore an enormous range of ecologies and special adaptations for micro-ecologies. To this diversity must be coupled the diversity of geological range over which they operated, between 380 million and 80 million Ma. During this time ammonites were brought to the edge of extinction several times – at the end of the Permian, only one was carried across. Again at the end of the Triassic, a period with greatest diversity of ammonites, only one line survived to create the diversity in the Jurassic and Cretaceous. These were not sudden, catastrophic ends, since the decline began way back before the end of the period in question.

Most text books mention that there are three sub classes of cephalopods: belemnites with an internal balanced shell, similar to squids; nautiloids, an extent group which is becoming better known, and live in deep water. They have buoyancy chambers and are highly evolved with well-developed brains, very effective eyesight and the longest nerve fibres in the animal kingdom. The third class is the ammonites which some suggest belong to the same class as the nautiloids.

Because of similarities between *Nautilus* and ammonites, a close look at the former is useful. Much research is being directed to the former in the hope that it will reveal clues to ammonite biology. *Nautilus* has divisions into gas chambers with a central siphuncle which controls the gas pressure and therefore the attitude. The body chamber is shorter than in ammonites. There are two pairs of gills which are almost unique among molluscs. Although the number of gills in ammonites is almost unknowable, nevertheless Richard Owen the vertebrate palaeontologist has suggested that ammonites should be placed with the other tetrabrachs because of other similarities.

A new classification has arisen in the last few years by means of careful analysis of fossils for the first time. This allows a lot to be said about the soft anatomy of these fossils. Workers in Germany developed the technique, looking first at the ink sac, not found in *Nautilus* but present in belemnites and octopods, and now in ammonites.

Another feature of ammonites as well as gastropods, is that they have a jaw arrangement which includes radulae. These are used to classify gastropods at a high level. It was found that the number of rows of denticles in the radulae of ammonites places them with more biological affinity with belemnites, squids and cuttlefish, rather than *Nautilus*. The jaw of ammonites was originally misidentified as an opercula device. This was because only one part of the jaw usually survives. The upper jaw is made of chitin and does not fossilise easily. The lower jaw is calcified and is therefore more likely to survive in the fossil record.

Tentacles will not be found in the same way as jaws for example, but other evidence can be used. A paper written by a German researcher in the 1950's and forgotten until recently, remarks that amongst trace fossils associated with ammonites are eight marks which could only be caused by

tentacles extending out of the aperture. Ammonites were therefore octopods. *Nautilus* on the other hand has over 900 tentacles with groups having specialized functions such as feeding, food gathering and movement. Recent work has resulted in successful x-ray photographs of ammonites. These show a septate portion, body portion and tentacles.

Because ammonites and cephalopods in general are highly evolved, they show very well developed sexual dimorphism. Nautiloid males are broader than females. In living octopods, the female is much longer than the male. Mature ammonites also show the females to have been 4, 5 or 6 times larger than the male.

Recent research therefore suggests that ammonites have more in common with other cephalopods than *Nautilus* and that other research on the biology of *Nautilus* will yield little of direct relevance to the understanding of the biology of ammonites.

ACKNOWLEDGEMENTS

Based on notes by Joan Jones prepared during a lecture given by Dr Hugh Torrens to the Shropshire Geological Society on 13th February 1985.

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ISSN 1750-855x