Relationship between conch geometry and shell thickness in ammonoids

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Ammonoids had a conch with chambered phragmocone that served as a buoyancy apparatus as in extant nautilus or spirulas. If ammonoids were nektonic or nektobenthic animals, weight saving may have been critical for their locomotion. The relative density of the ammonoid body depends on conch geometry as well as shell thickness. If the conch geometry is such that its surface area to volume ratio is high, a large amount of calcium carbonate is required to form such a conch. An effective way to avoid overweight in ammonoids is to control shell formation such that more inefficient shape with a high surface-area to volume ratio is correlated with thinner shell thickness. In the present study, the relationship between conch geometry and shell thickness was examined in a total of 87 ammonoid species ranging in age from Devonian to Cretaceous. Specific surface was computed for theoretical models of ammonoid shell morphology with various values of Raupian parameter to assess how efficient each shape is to save the body weight. The values of the Raupian parameters were examined for each growth stage of the specimens examined and the specific surface of the model defined by the parameter values was calculated for each whorl. The relative shell thickness was measured for actual specimens as the cross-sectional area of shell material divided by the perimeter of the whorl cross section standardized by the conch diameter. As a result of morphometric analysis, a significant negative correlation was found between the specific surface and relative shell thickness; that is, the species with inefficient shell shapes tend to form whorls that are made of a thin material. The result suggests that density control was critical for ammonoids and conch geometry was important for their hydrostatic properties.

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