Hydrostatic and hydrodynamic properties of shell form and their relation to taxonomic longevity in ammonoids

*Takao Ubukata[1]

1. Department of Geology & Mineralogy, Division of Earth & Planetary Sciences, Kyoto University

Because of their inferred nektonic or nektobenthic mode of life, ammonoids have been one of the most popular targets of hydrostatics or hydrodynamics in paleontology. Ammonoids had a conch with chambered phragmocone that served as a buoyancy apparatus as in extant nautilus. The relative density of the ammonoid shell depends on conch geometry as well as shell thickness and specific surface area of the shell represents a hydrostatic inefficiency of shell form. However, the specific surface area tends to be large in a laterally compressed shell form which is assumed to be the most efficient for swimming at high Reynolds number. Form drag acting on an ammonoid shell moving with respect to a surrounding water is in proportion to the cross sectional area of the shell. If a hydrodynamic inefficiency of shell form is assessed by the cross sectional area of the shell per unit of volume, a trade-off relationship can be derived between hydrostatic and hydrodynamic properties of shell form in ammonoids. In order to assess which property was more important in the macroevolution of ammonoids, the present study focuses on the relation of the hydrostatic and hydrodynamic inefficiencies to taxonomic longevity. The Raup’s parameters were collected from a total of 6013 species belonging to 1947 genera that are registered in the Paleobiology Database (PDBD) ranging in age from Devonian to Cretaceous. The specific surface areas and the cross sectional areas per volume were computed for theoretical morphologic models generated based on the same parameter values as the measurements. The generic longevity was estimated for each genus by its stratigraphic range recorded in the PDBD. The generic longevity was negatively correlated with the intra-generic mean of the specific surface area of the shell ($p < 0.01$) rather than with the cross sectional areas per volume. This result suggests that hydrostatic property is more important than hydrodynamic one in the macroevolutionary history of ammonoids.

Keywords: ammonoids, hydrostatic and hydrodynamic properties, taxonomic longevity

