DID FLUID DYNAMICS DRIVE AMMONITE BIODIVERSITY DYNAMICS?

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Ammonoid cephalopods were some of Earth's most successful, and most vulnerable, marine clades. Detailed variations make their fossil shells essential tools for biostratigraphy, paleobiogeography, and biodiversity. Boom-and-bust cycles of fossil abundance and diversity record global mass extinction events. Recent advances in ammonoid biomechanics reveal increasingly complex assessments of conch motility. We can measure locomotory consequences provided by conch shapes; by shape change through ontogeny; by alteration with external ornament. Certainly, the practical consequences of conch shape influenced their behavioral options. Yet typical rankings of drag, or maximum speed, or apparent efficiency, fail to capture fundamental biological requirements. More nuanced consequences of conch shape – acceleration, momentum, and viscous drag – are inextricably linked to flow regime. We tend to categorize water flow as laminar or turbulent, and judge biomechanical function accordingly. But our work emphasizes that individual ammonoids inevitably navigated transitional flow regimes. Flow regime is responsive to overall body size, changing velocities through time, and orientation of soft-body tissues. Moreover, everyday activities like feeding or the growth and release of eggs introduce stochastic and periodic changes in body mass. The situation is particularly acute for planispiral conchs, which likely lacked substantial hydrostatic stabilization. Rather than focusing on the specific questions of ammonoid hydrodynamic inference, we here present a bold interpretation of ammonoid paleobiology: their shells looked so different, increased disparity so rapidly, and re-explored basic shapes so often, because they were constantly navigating wild scales of physics in a single lifetime. These animals could grow many orders of magnitude in size during their life; and a single jetting action could trigger sudden onset of new turbulence conditions. Debates persist: how to weigh their biodiversity; to link locomotion with fitness; evo-devo drivers of morphological disparity. In any case, we can easily imagine ammonoids' remarkable variety as a frantic and continual response to the drama of transitional turbulence physics.