EXPLORING THE HYDRODYNAMIC CONSEQUENCES OF CEPHALOPODS IN THE WESTERMANN MORPHOSPACE WITH NEUTRALLY BUOYANT, 3D-PRINTED ROBOTS

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The Westermann morphospace contains all planispiral cephalopod conchs with variable degrees of whorl exposure and compression/inflation. Each of these shapes have consequences in terms of hydrodynamic cost, with disc-like, streamlined forms traditionally interpreted as relatively better swimmers. Hydrodynamics are also influenced by hydrostatics (such as stability, orientation, and the relative direction of the thrust vector). Physical experiments with biomimetic ammonoid robots can help illuminate the contribution of these variables to hydrodynamics in chaotic, transient settings. Three-dimensional motion tracking allows kinematics to be monitored during these experiments, as well as the computation of detailed physical properties (drag force, velocity, acceleration, etc.). Furthermore, these models can be used to help validate flow simulations by comparing their hydrodynamic properties to computational fluid dynamics results. Propeller-driven robots can produce thrust with simpler components and smaller motors. However, these advantages come at the expense of artificial turbulence produced by the propeller. Water-pump driven robots produce more realistic propulsive wake, but require more complicated model components and larger motors. Hydrostatic simulations on virtual, theoretical models demonstrate that cephalopods with conchs from the majority of the Westermann morphospace were much less stable than extant *Nautilus* (e.g., serpenticones, sphaerocones, and the morphospace center), whereas forms with rapid whorl expansion (e.g., oxycones) had similar stability to *Nautilus*. The stability of *Nautilus* is integral in its movement, supplying a restoring moment after each jet pulse with a periodic rocking motion. This *Nautilus*-like form of movement likely differed from most planispiral ammonoids. Ultimately, these virtual and physical models help disentangle the fundamental advantages and disadvantages of particular conch morphologies, as well as their nuanced characteristics of movement.