Abstract Submitted
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The role of flexibility in sub-inertial swimming: An analysis of millimeter-scale ciliated structures[1] ADRIAN HERRERA-AMAYA, Department of Mechanical Engineering, The Pennsylvania State University, FERHAT KARAKAS, DAVID W. MURPHY, Department of Mechanical Engineering, University of South Florida, MARGARET L. BYRON, Department of Mechanical Engineering, The Pennsylvania State University — Ctenes are rectangular paddle-like structures approximately one millimeter in length, composed of packed bundles of very long cilia. They are used by ctenophores (gelatinous marine zooplankton) to swim at intermediate Reynolds numbers (Re). Using Particle Shadow Velocimetry (PSV), we experimentally examine variations in the beat kinematics and fluid dynamics across ontogeny of the ctenophore Bolinopsis vitrea. In smaller animals, the ctene kinematics resemble the physics of micro-cilia, using spatial asymmetry to produce net thrust. By contrast, the ctenes of larger animals show a decreased spatial asymmetry but maintain the overall thrust by increasing the velocity difference between power and recovery strokes (a strategy which would be ineffective in low Re, time-reversible flows). We also observe wall-normal displacement of the mesoglea which is detectable, nontrivial, and with a frequency approximately equal to that of the ctene beating. Overall, we show that flexibility is a major parameter in ctenophore swimming, and that further study of this system could help elucidate the physics of flexible propulsors at the boundary of the viscous and inertial regimes.

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