Scaling laws for a compliant biomimetic swimmer

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Abstract

Motivated by the seminal work of Lord Lighthill in the sixties, we study the motion of inertial aquatic swimmers that propels with undulatory gaits. We have uncovered the law linking the swimming velocity to the kinematics of the swimmer and the fluid properties (Nat. Phys. 2014). At high Reynolds numbers, the velocity appears to be equal to $0.4Af/(2\pi)$, where A and f are respectively the amplitude and the frequency of the oscillating fin. We have constructed a compliant biomimetic swimmer, whose muscles have been modeled through a torque distribution thanks to a servomotor. A soft polymeric material mimics the flesh and provides the flexibility. By immersing our robot into a water tunnel, we find and characterize the operating point for which the propulsive force balances the drag. We bring the first experimental proof of the former law and probe large amplitude undulations which exhibits nonlinear effects. All data collapse perfectly onto a single master curve. We investigate the role of the fin flexibility by varying its length and its thickness and we figured out the existence of an efficient swimming regime.

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