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Hydrodynamic aspects of thrust generation in gymnotiform swimming ANUP A. SHIRGAONKAR, OSCAR M. CURET, NEELESH A. PATANKAR, MALCOLM A. MACIVER, Department of Mechanical Engineering, Northwestern University — The primary propulsor in gymnotiform swimmers is a fin running along most of the ventral midline of the fish. The fish propagates traveling waves along this ribbon fin to generate thrust. This unique mode of thrust generation gives these weakly electric fish great maneuverability cluttered spaces. To understand the mechanical basis of gymnotiform propulsion, we investigated the hydrodynamics of a model ribbon-fin of an adult black ghost knifefish using high-resolution numerical experiments. We found that the principal mechanism of thrust generation is a central jet imparting momentum to the fluid with associated vortex rings near the free edge of the fin. The high-fidelity simulations also reveal secondary vortex rings potentially useful in rapid sideways maneuvers. We obtained the scaling of thrust with respect to the traveling wave kinematic parameters. Using a fin-plate model for a fish, we also discuss improvements to Lighthill's inviscid theory for gymnotiform and balistiform modes in terms of thrust magnitude, viscous drag on the body, and momentum enhancement.

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