Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

The hydrodynamic principle for the caudal fin shape of small aquatic animals JEONGSU LEE, Department of Mechanical and Aerospace Engineering, Seoul Natl Univ, YONG-JAI PARK, Department of Mechanical Engineering, Sunmoon Univ, KYU-JIN CHO, HO-YOUNG KIM, Department of Mechanical and Aerospace Engineering, Seoul Natl Univ — The shape of caudal fins of small aquatic animals is completely different from that of large cruising animals like dolphin and tuna which have high aspect-ratio lunate tail. To unveil the physical principle behind natural selection of caudal fins of small aquatic animals, here we investigate the hydrodynamics of an angularly reciprocating plate as a model for the caudal fin oscillation. We find that the thrust production of a reciprocating plate at high Strouhal numbers is dominated by generation of two distinct vortical structures associated with the acceleration and deceleration of the plate regardless of their shape. Based on our observations, we construct a scaling law to predict the thrust of the flapping plate, which agrees well with the experimental data. We then seek the optimal aspect ratio to maximize thrust and efficiency of a flapping plate for fixed flapping frequency and amplitude. Thrust is maximized for the aspect ratio of approximately 0.7. We also theoretically explain the power law behaviors of the thrust and efficiency as a function of the aspect ratio.

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Date submitted: 01 Aug 2014 Electronic form version 1.4