Abstract Submitted
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The role of resonance in propulsion of an elastic pitching wing with or without inertia[1] YANG ZHANG, Vanderbilt University, CHUNHUA ZHOU, Nanjing University of Aeronautics and Astronautics, HAOXIANG LUO, Vanderbilt University, LUO TEAM, ZHOU TEAM — Flapping wings of insects and undulating fins of fish both experience significant elastic deformations during propulsion, and it has been shown that in both cases, the deformations are beneficial to force enhancement and power efficiency. In fish swimming, the inertia of the fin structure is negligible and the hydrodynamic force is solely responsible for the deformation. However, in insect flight, both the wing inertia and aerodynamic force can be important factors leading to wing deformation. This difference raises the question about the role of the system (fluid-structure) resonance in the performance of propulsion. In this study, we use a 2D pitching foil as a model wing and vary its bending rigidity, pitching frequency, and mass ratio to investigate the fluid-structure interaction near resonance. The results show that at low mass ratios, i.e., a scenario of swimming, the system resonance greatly enhances thrust production and power efficiency, which is consistent with previous experimental results. However, at high mass ratios, i.e., a scenario of flying, the system resonance leads to overly large deformation that actually does not bring benefit any more. This conclusion thus suggests that resonance plays different roles in flying and in swimming.

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