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Effect of aspect ratio on the hydrodynamics of a self-propelled elliptic foil XING ZHANG, SAIZHEN NI, SHIZHAO WANG, GUOWEI HE, LNM, Institute of Mechanics, Chinese Academy of Sciences — Flapping wings or fins are commonly used by birds, insects, fishes and some Micro Air Vehicles to generate propulsive force. In most of the studies on flapping wings, the foil is placed in a steady stream and the motion in the horizontal direction is constrained. However, the condition in these studies is completely different from that in real self-propelled locomotion. Alben and Shelly (PNAS, 102, 11163-11166 (2005)) have performed a pioneering study on fundamental hydrodynamics of a self-propelled flapping foil. In this study, we investigate the effect of geometrical shape on the hydrodynamics by varying the aspect ratio of the elliptical foil. Three different dynamic modes of the foil have been identified with the increase of aspect ratio, i.e. fore-aft symmetry, non-periodic motion and unidirectional motion with periodic velocity oscillation. It is observed that the dynamics of the body are closely related to various vortical patterns around the foil. The formation of the vortices during the starting procedure and their subsequent disposition in the wake will be described. The implication of the current study on the optimization of the foil shape in obtaining locomotion is given.

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