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Effect of mass ratio for a flexible flapping wing during forward flight[1] HAOXIANG LUO, Vanderbilt University, FANG-BAO TIAN, XI-YUN LU, University of Science and Technology of China — During flight, insect wings typically deform under a combined aerodynamic force and wing inertia, whichever is dominant depends on the properly scaled mass ratio between the wing and air. To study the differences that the wing inertia makes in the aerodynamic performance of the deformable wing, a two- dimensional numerical study is applied to simulate the flow–structure interaction of a flapping wing during forward flight. The wing section is modeled as an elastic plate that may experience nonlinear deformations while flapping. The effect of the wing inertia on lift, thrust, and power is studied for a range of wing rigidity and kinematic parameters such as the stroke plane angle and advance angle. It is found that the wing flexibility can dramatically increase the thrust without significantly losing lift or increasing the power input. Furthermore, the wings with low mass ratios could have much better efficiency than the wings with high mass ratios. The implication of the findings on insect flight will be discussed.

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