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Simple asymptotic results for the role of flexibility in flapping propulsion MATTHEW N.J. MOORE, Courant Institute of Mathematical Sciences — Wing or fin flexibility in flapping propulsion is important to our understanding of bio-locomotion and may be used to engineer devices based on similar principles. Laboratory experiments and numerical simulations have been used extensively to examine effects of wing flexibility, but useful analytical results seem to be lacking. Here we use a small-amplitude calculation to determine the forces produced by a thin wing flapping in an inviscid, 2D fluid and shedding a vortex-sheet wake. We represent flexibility in a simple way by considering a torsional spring located at the root of a rigid wing. The wing moves according to an imposed heaving motion and pitches passively in response to the fluid and spring forces. Remarkably, closed-form expressions are obtained for the kinematics and thrust produced by the wing. Though limited to small amplitude, the results capture a variety of behaviors that are consistent with previous experimental and numerical observations. For small frequencies, thrust is enhanced by torsional compliance and peaks at a resonant frequency, while for larger frequencies the compliant wing underperforms when compared to a clamped, rigid wing. The wing can even produce negative thrust, i.e. drag, if the wing's mass is sufficiently large.

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