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Optimal flexibility in flapping appendages¹

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When oscillated in a fluid, appendages such as insect wings and fish fins can produce large thrust forces while undergoing considerable bending. Can we understand these bending patterns by comparing them with the patterns which produce maximum thrust, or a given thrust at maximum efficiency? We present a general model for how flexible surfaces produce vorticity and bend actively and passively in a fluid. We solve the model numerically, and discuss results for moderate deflections (relevant for large thrust), and for small deflections (relevant for high efficiency). We'll then consider how a fish-fin-like structure might be designed for optimal performance.

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