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Optimal number of waves for ribbon fin propulsion RAHUL BALE, AMNEET P.S. BHALLA, MALCOLM A. MACIVER, NEELESH A. PATANKAR, Northwestern University — Many species of fish, such as *rajiform, diodontiform, amiiform, gymnotiform* and *balistiform* swimmers, use a ribbon fin as their primary mode of propulsion. It has been observed that each fish species, depending on its size, uses a specific number of waves on its ribbon fin. For example, the black ghost knifefish (10×1cm fin) typically uses 2-2.5 waves while a giant oarfish (3×0.1m fin) uses 6-8 waves. In this work we investigate whether this leads to optimal axial thrust. The axial thrust generated depends on the efficiency with which fin waves transport the fluid backward. We find that there are two competing mechanisms. On the one hand, an increase in wavelength (at fixed amplitude and frequency of the wave), and therefore the wave velocity, leads to an increased ability to transport the fluid backward. This leads to more thrust. On the other hand, longer wavelength leads to shallower waves. This reduces the efficacy to transport the fluid backward and reduces the thrust. The optimal wavelength, and therefore the optimal number of waves, is a result of a balance between the two competing mechanisms. We do our analysis in terms of specific wavelength, which is the wavelength non-dimensionalized by the wave amplitude. We find that the value of the specific wavelength at which the axial thrust is maximized is universal for ribbon fins and it is in agreement with biological data.

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