The effect of the wake symmetry in biomimetic propulsion

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We address here the understanding of how animal propulsion is related to flow physics in biomimetic locomotion. It is known that the wake pattern observed in a cross-section behind swimming or flying animals is typically characterized by the presence of periodical vortex shedding. However, depending on species, propulsive wakes are distinguished by their spatial ordering : symmetric (squid-like) or asymmetric (fish-like), with respect to the motion axis. We conducted a very precise experiment to analyse the role of the wake topology in propulsion generation. Self-propulsion is achieved by the flapping motion of two identical pitching rigid foils, separated by a distance d. By keeping the momentum input unchanged, we compared both symmetric and asymmetric flapping modes. For the entire parameters range, the symmetric squid-like mode proves to be more efficient for thrust generation than the fish-like asymmetrical one. We show that this difference is due to a pressure effect related to the ability of each wake to produce, or not, significant mixing in the near wake region.