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Symmetry breaking for drag minimization MARCUS ROPER, Harvard Engineering and Applied Sciences, TODD M. SQUIRES, U.C. Santa Barbara Chemical Engineering, MICHAEL P. BRENNER, Harvard Engineering and Applied Sciences — For locomotion at high Reynolds numbers drag minimization favors fore-aft asymmetric slender shapes with blunt noses and sharp trailing edges. On the other hand, in an inertialess fluid the drag experienced by a body is independent of whether it travels forward or backward through the fluid, so there is no advantage to having a single preferred swimming direction. In fact numerically determined minimum drag shapes are known to exhibit almost no fore-aft asymmetry even at moderate Re. We show that asymmetry persists, albeit extremely weakly, down to vanishingly small Re, scaling asymptotically as Re^3. The need to minimize drag to maximize speed for a given propulsive capacity gives one possible mechanism for the increasing asymmetry in the body plans seen in nature, as organisms increase in size and swimming speed from bacteria like E-Coli up to pursuit predator fish such as tuna. If it is the dominant mechanism, then this signature scaling will be observed in the shapes of motile micro-organisms.

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