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Flexibility, stroke, and dimensionless parameters: the importance of telling the whole story for swimming micro-organisms in complex fluids BECCA THOMASES, ROBERT GUY, University of California, Davis — The question of how fluid elasticity affects the swimming performance of micro-organisms is complicated and has been the subject of many recent experimental and theoretical studies. The Deborah number, $De = \lambda\omega$, is typically used to characterize the strength of the fluid elasticity in these studies, and for swimmers is expressed as the product of the elastic relaxation time and the frequency of the swimmer stroke. In simulations of undulatory flexible swimmers in an Oldroyd-B-type fluid, we find that varying the frequency of the stroke and varying the relaxation time separately results in a significantly different dependence of swimming speed for the same De. Thus the elastic effects on swimming cannot be characterized by a single dimensionless number. The Weissenberg number, defined as the product of elastic relaxation time and characteristic strain rate ($Wi = \lambda\dot{\gamma}$), is another dimensionless parameter useful for describing complex fluids. For a fixed swimmer frequency, varying the relaxation time will also vary the Weissenberg number. We conjecture that the different behavior is a consequence of a Weissenberg-number transition in the fluid, which additionally depends on the amplitude of the swimmer stroke.

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