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HOW FLUID RHEOLOGY SHAPES MICORORGANISM SWIMMING GAIT IN VISCOELASTIC FLUIDS

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Many important biological functions depend on microorganisms' ability to move in viscoelastic fluids such as mucus and wet soil. The effects of fluid elasticity on motility remain poorly understood, partly because, the swimmer strokes depend on the properties of the fluid medium, which obfuscates the mechanisms responsible for observed behavioral changes. Gait adaptation is essential for biological function. For example, mammalian sperm swim in a variety of different fluids as they navigate the female reproductive tract. It is well known that sperm modulate their swimming gait in response to changes in their environment, but how they adapt their gait and the significance of these changes for biological function are not known.

We use computational and mathematical modeling to (1) disentangle these affects by changing the gait and fluid rhology independently and to (2) examine how the swimmer gait emerges from the properties of the environment. Specifically, we develop computational models that use experimental data from the undulatory motions of C. elegans [1] and mammalian sperm as well as the breast stroke motion of the algae C.reinhardtii [2] to explain experimental observations and to explore the effects of fluid elasticity on swimming. We show how characteristics of the gait and the body mechanics interact with fluid elasticity to alter swimming speed. Further we extend exiting models of flagellar mechanics [3]in complex fluids to examine how the flagellar beat emerges from the coordination of the mechanics of the flagella, the interactions with the external fluid environment, and the mechano-chemical feedback of the molecular motors.

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