Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Flagella-Driven Flows Circumvent Diffusive Bottlenecks that Inhibit Metabolite Exchange[1] MARTIN SHORT, CRISTIAN SOLARI, SUJOY GANGULY, JOHN KESSLER, RAYMOND GOLDSTEIN, University of Arizona, THOMAS POWERS, Brown University — The evolution of single cells to large and multicellular organisms requires matching the organisms' needs to the rate of exchange of metabolites with the environment. This logistic problem can be a severe constraint on development. For organisms with a body plan that approximates a spherical shell, such as colonies of the volvocine green algae, the required current of metabolites grows quadratically with colony radius whereas the rate at which diffusion can exchange metabolites grows only linearly with radius. Hence, there is a bottleneck radius beyond which the diffusive current cannot keep up with metabolic demands. Using *Volvox carteri* as a model organism, we examine experimentally and theoretically the role that advection of fluid by surface-mounted flagella plays in enhancing nutrient uptake. We show that fluid flow driven by the coordinated beating of flagella produces a convective boundary layer in the concentration of a diffusing solute which in turn renders the metabolite exchange rate quadratic in the colony radius. This enhanced transport circumvents the diffusive bottleneck, allowing increase in size and thus evolutionary transitions to multicellularity in the Volvocales.

[1]Supported by NSF Grants DEB-0075296, PHY-0551742 and CMS-0093658

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Date submitted: 30 Nov 2005

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