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Biomemetic pumping by gill plate arrays: Reynolds number effects in mayfly nymphs ANDREW SENSENIG, JEFFREY SHULTZ, Dept. of Entomology, KEN KIGER, Dept. of Mech. Engr., University of Maryland — Mayfly nymphs are entirely aquatic and must alter behavior and metabolism to accommodate changes in ambient dissolved oxygen levels. Many species can generate a ventilation current to compensate for low oxygen levels by beating two linear arrays of plate-like gills that line the lateral edge of the abdomen. The characteristic Reynolds number associated with the gill motion changes with animal size, varying over a span of Re = 5 to 100 depending on age and species. Thus mayflies provide a novel system model for studying ontological changes in pumping mechanisms associated with transitions from a viscous- to inertia-dominated flow. Indeed, observation of other animals and theoretical analysis[1] indicate that a bifurcation should exist for inertial thrust generation by a reciprocal flapper for Reynolds numbers on the order of 10-20. In the ongoing work, the gill kinematics and resulting fluid motion is recorded experimentally through the use of high-speed stereo imaging and cinematographic planar PIV. Results show that the gills transition from a strongly asymmetric motion at Re=5 to a more reciprocal motion by Re=21. Details of the hydrodynamic mechanisms and pumping effectiveness will be discussed.
[1] Childress, S. & Dudley, R. (2004), *J. Fluid Mech.* **498**, 257–288.

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