Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Transitions in low Re pumping by oscillating plate arrays of mayfly nymphs KEN KIGER, ANDREW SENSENIG, JEFFREY SHULTZ, University of Maryland — Mayfly nymphs are aquatic insects which alter behavior and metabolism to accommodate changes in ambient dissolved oxygen. 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 oscillation Reynolds number associated with the gill motion changes with animal size, varying over a span of Re = 2 to 50 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. Observation of the detailed 3-D kinematics of the gill motion of the species *Centroptilum triangulifer* reveal that the mayfly makes a marked transition in stroke motion when Re>5, with a corresponding shift in mean flow from the ventral to the dorsal direction. Results of the time-resolved flow within the inter-gill space shows that for Re>12 the plate motion generates a complex array of bound and shed vortices, which interact to produce an intermittent dorsally directed jet. For the Re<5, distinct bound vortices are still observed, but increased diffusive effects creates vortices which simultaneously envelope several gills, forcing a new flow pattern to emerge. Details of the flow mechanism and its implications will be discussed. This work is supported by NSF under grant CBET-0730907.

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Date submitted: 04 Aug 2008 Electronic form version 1.4