Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Pumping at low Reynolds numbers - the leucon sponge pump[1]
JENS HONORE WALTHER, SAYED SAEED ASADZADEH, POUL SCHEEL LARSEN, Technical University of Denmark, HANS ULRIK RIISGRD, University of Southern Denmark — Leuconoid sponges are filter-feeders with a complex system of branching inhalant and exhalant canals leading to and from the close-packed choanocyte chambers. Each of these choanocyte chambers holds many choanocytes that act as pumping units delivering the relatively high pressure rise needed to overcome the system pressure losses in canals and constrictions. We study these pumping units by solving the Navier-Stokes equations using computational fluid dynamics simulations. We find that each choanocyte operates as a leaky, positive displacement-type pump owing to the interaction between its beating flagellar vane and the collar, open at the base for inflow but sealed above. The leaking backflow is caused by small gaps between the vaned flagellum and the collar. The choanocyte pumps act in parallel, each delivering the same high pressure, because low-pressure and high-pressure zones in the choanocyte chamber are separated by a seal – secondary reticulum. The mechanical pump power expended by the beating flagellum is compared with the useful (reversible) pumping power received by the water flow to arrive at a typical mechanical pump efficiency of about 70 %.

[1]This work was supported by a research grant no. (9278) from VILLUM FONDEN.

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No Company Provided

Date submitted: 19 Jul 2019 Electronic form version 1.4