PhD Project: Fluid mechanics and nutrient uptake by microorganisms

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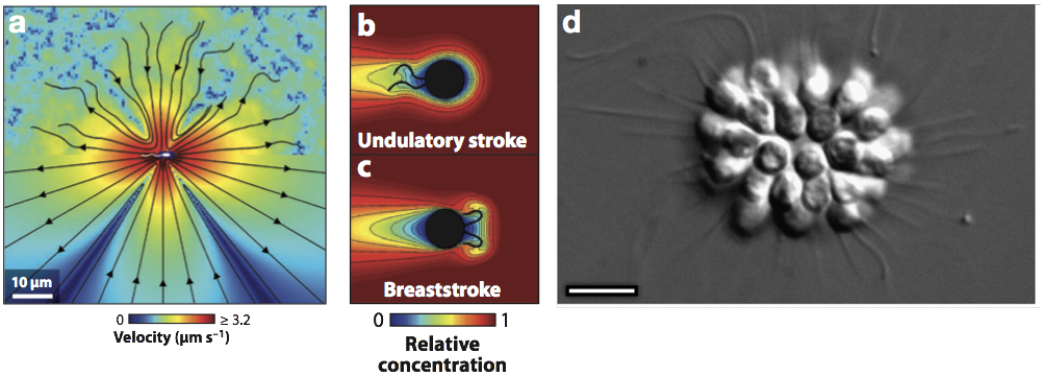

Figure 1: (a) Flow field produced by a swimming bacteria. (b) and (c) Predicted concentration of nutrients (normalized to 1) around a swimming algae, depending on the swimming stroke of the algae. (d) Aggregate of choanoflagellates: could multicellularity mean more food for everyone? Scale bar: 5 μm. Figures (a)-(c) taken from the review by Guasto et al. [1]. Figure (d) taken from [2]

One of the most basic needs of any living organism is to find enough nutrient in its environment to survive, and swimming microorganisms such as bacteria or algae are no exception. The ability of these microorganisms to move is crucial for foraging for food, but their motion can also serve a major role in enhancing their nutrient uptake by generating a flow, thereby mixing the surrounding medium and allowing food particles to reach the cell faster than by pure diffusion. Indeed, efficiently moving to more favorable environments is evolutionarily beneficial, but being able to mix the surrounding medium and take up more nutrients is not an advantage to dismiss, especially in environments sparse with food such as large regions of the ocean [1, 3].

The aim of the PhD project is to determine how nutrient uptake of microorganisms is influenced by the organisms' morphologies and the presence of flows.

The candidate will use droplet-microfluidics tools developed in the group to monitor nutrient uptake by thousands of individual microorganisms. She/he will link the efficiency of nutrient uptake to the flows created by the microorganisms, and compare the obtained experimental results to existing theories. Then, several questions can be asked, depending on the interests of the candidate. One possibility is to study the influence of the ever-present outer flows on nutrient uptake by a single cell. Another possibility is to study the impact of collective effects on nutrient uptake: could enhanced nutrient uptake be at the root of the transition from unicellular to multicellular organisms?

This PhD. will combine experiments and theory. Potential candidates should have a strong taste for experimental work and quantitative data analysis. Should the candidate be interested, theoretical work is also an option, in collaboration with other researchers at LadHyX. A background in fluid mechanics and an experience in experimental research work would be an asset.

References

[1] J. S. Guasto, R. Rusconi, and R. Stocker. *Annual Review of Fluid Mechanics*, 44(1):373, 2012

[2] M. J. Dayel and N. King. *PLoS ONE*, 9(5):1, 2014

[3] L. Karp-Boss, E. Boss, and P. Jumars. *Oceanography and Marine Biology*, 34:71, 1996