Mechanisms of *Paramecium* contact reaction

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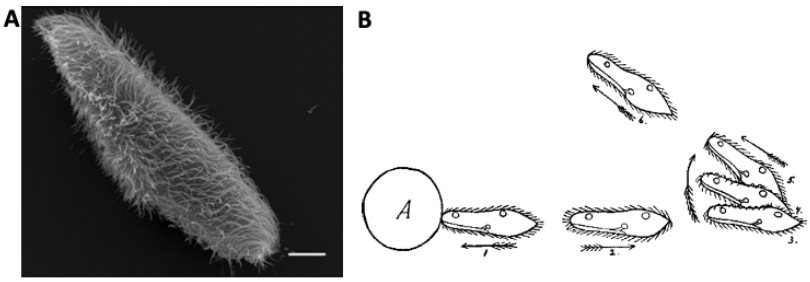
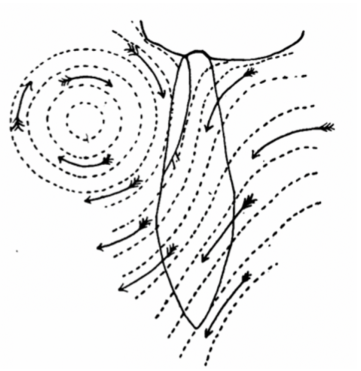
Paramecium is a unicellular organism that swims in fresh water by beating thousands of cilia. When it is stimulated (mechanically, chemically, optically, thermally…), it often swims backward then turns and swims forward again. This "avoiding reaction" is triggered by a calcium-based action potential. For this reason, some authors have called *Paramecium* a "swimming neuron" (Brette, 2021). This project belongs to a broader project aiming at developing integrative models of *Paramecium*, bridging physiology and behavior. This is a collaborative effort between the labs of Romain Brette (neuroscience, Vision Institute), Alexis Prevost et Laetitia Pontani (physics, Laboratoire Jean Perrin) and Eric Meyer (genetics, Ecole Normale Supérieure), in Paris. The team has already developed experimental techniques (behavior and electrophysiology), including a device to immobilize *Paramecium* for electrophysiology experiments (Kulkarni et al., 2020), and a basic biophysical model of the action potential and electromotor coupling.



A, Scanning electron microscopy image of Paramecium tetraurelia (scale bar: 10 µm) (Valentine et al., 2012). B, Avoiding reaction against an obstacle, as illustrated by Jennings (Jennings, 1906).

This project aims at understanding the basis of the *contact reaction* of *Paramecium*. When *Paramecium* encounters some fibrous material such as a decaying plant or a piece of cloth, it may stall (Jennings, 1897). This behavior has been termed *contact reaction* or *thigmotaxis*. The cilia in contact with the object are immobilized, and all the other cilia are quiet or quivering except the oral cilia, which beat strongly. In this situation, *Paramecium* may feed, for example on bacteria, yeast or algae.



Thigmotactic Paramecium resting against a fiber (Jennings, 1897). Arrows show water currents produced by oral cilia.

This behavior is never seen in electrophysiology experiments, but can be observed on culture tubes. The first question to address is therefore to understand what exactly triggers the contact reaction. Is it the type of material? (e.g. hydrophilic vs. hydrophobic) Does it depend on feeding or metabolic state? Does it depend on the extracellular medium? (e.g. culture medium vs. calcium-chloride solution)

Once this basic question has been solved, the student will examine whether the electrophysiological properties of *Paramecium* change during the contact reaction.

The project can be adapted to the duration of the project and the profile of the student.

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