Adaptive motions in protozoan ciliates

Toshiyuki NAKAGAKI
Mathematical and Physical Ethology laboratory,
Research Institute for Electronic Science, Hokkaido University.
nakagaki@es.hokudai.ac.jp

Previous studies on adaptive behavior in single celled organisms have given hints at a basic algorithm for behavioral flexibility. Here we report a few instances of adaptive capacity in protozoan ciliates.

The first instance is that a ciliate *Tetrahymena* has the capacity to adapt the shape and size of its swimming space. Cells confined in a small water droplet for a short period were found to recapitulate circular swimming trajectories upon release. The diameter of the circular trajectories and their duration reflected the size of the droplet and the period of confinement. We suggest a possible mechanism for this adaptive behavior based on a simple mathematical model for gating dynamics of mechanosensitive Ca^{2+} channel as it is known that swimming motions of ciliate can be regulated by membrane potential. In our model, repeated collisions with the walls of a confining droplet result in a slow rise in intracellular calcium that leads to a long-term increase in the reversal frequency of the ciliary beat.

The other instance is that a ciliate *Paramecium* has the capacity to take a new course of actions when a conventional action does not lead to better situations. Cells confined in a dead-ended capillary repeated typical avoiding behavior (short-term backward swimming and a trial to turn) many times at the dead-end but could not turn due to small diameter of capillary. After experiencing many failures of trial to turn, they showed a different type of action: long-term backward swimming (ten times longer and more). We suggest a possible mechanism for this adaptive behavior based on a simple mathematical model for gating dynamics of channel.

Although a instance of adaptive behavior was found and accumulated, a general model that explains all instances is not proposed yet. To seek for this possibility, we will continue to consider a basic common model.

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