Anterior–posterior gradient in Ca^{2+} sensitivity of axoneme studied using detergent-extracted *Volvox* "model"

Noriko Ueki[1] and Ken-ichi Wakabayashi[1]

1. Laboratory for Chemistry and Life Science, Institute of Innovative Research, Tokyo Institute of Technology

Abstract

Volvox rousseletii, a multicellular spheroidal green alga containing ~5,000 cells, shows remarkable photobehavior without any known intercellular communication. Its ~10,000 flagella beat with an asymmetrical/ciliary-type waveform toward the posterior pole with a slight tilt from the anterior–posterior axis of the spheroid (Mast, 1926). The direction of flagellar beating changes upon light perception from posteriorward to anteriorward while retaining the ciliary waveform (Ueki et al., 2010). This flagellar response is called "ciliary reversal". Importantly, the sensitivity or the magnitude of this response has a gradient along the anterior–posterior axis, in that the response is more conspicuous near the anterior pole of the spheroid and rarely observed near the posterior pole (Ueki et al., 2010). In this study, to examine its flagellar properties in vitro, we developed a method for detergent-extraction of *V. rousseletii* and reactivation of its flagellar motility, while its spheroidal shape is retained. Upon addition of ATP, the demembranated flagella (axonemes) in the spheroids actively beat and the whole spheroids swam as if they were alive. Furthermore, we examined effects of Ca^{2+} on the motility of reactivated axonemes. Under Ca^{2+}-free conditions, the axonemes showed planar and asymmetrical waveforms beating toward the posterior pole, as in live spheroids swimming without light stimulation. In contrast, in the presence of 10^{-6} M Ca^{2+}, they beat somewhat three-dimensionally and toward the anterior pole, like the flagellar beating in photo-stimulated live spheroids. Intriguingly, this Ca^{2+}-dependent change in flagellar beating direction was more conspicuous near the anterior pole of the spheroid and not observed near the posterior pole. We propose that the anterior–posterior gradient of flagellar Ca^{2+} sensitivity underlies the gradient of photosensitivity of flagellar response in *V. rousseletii*.

References

Mast SO: Reactions to light in *Volvox*, with special reference to the process of orientation. Zeitschrift für vergleichende Physiologie. 1926, 4(5): 637–658.

Ueki N, Matsunaga S, Inouye I, Hallmann A: How 5000 independent rowers coordinate their strokes in order to row into the sunlight: phototaxis in the multicellular green alga *Volvox*. BMC biology. 2010, 8: 103.