A Trial Run of a Bacterium Robot with a Flagellum

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The helical axis of a flagellar filament does not coincide with the output axis of a flagellar motor in bacteria (Fig. 1, left panel). We consider that this "rotational asymmetry" plays a role in establishing the biased random walk in their chemotaxis. The asymmetry results in a kind of mechanical instability, which causes a cell to change its swimming trajectory when the motor changes the rotational direction, especially in a cell with a single polar flagellum. The asymmetry can be related to the mechanism of flicking at which the swimming trajectory changes are as large as 90˚. Though buckling of a hook has been proposed to occur during the flicking, it might not be a simple buckling; rather it can easily take place because of the off-axis configuration of the flagellar filament.

It is difficult to experimentally confirm the above idea using real bacteria, because the possibility to find a mutant with a rotationally symmetric flagellar filament that can be a control is just about zero. Trial to investigate the above point by making a bacterium robot will be presented. The swimming manners of the robot with an asymmetric or a symmetric helical screw propeller are compared (Fig. 1). Rotationally asymmetric screw propeller that seems to be an imperfect structure in the field of artificial machines is shown to work well in bacteria.

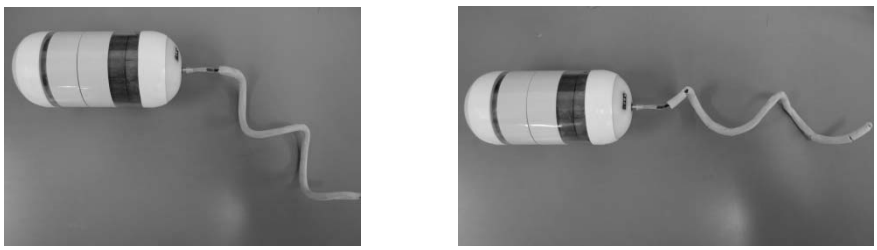

Fig. 1 Images of a bacterium robot. Left one is with a rotationally asymmetric flagellar propeller, and right one is with a rotationally symmetric propeller. The cell body was equipped with a microcomputer, a geared motor, a battery, and a light sensor.