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The bending and breaking of bacteria

A research team involving the University of Bayreuth has investigated the locomotion of filamentous cyanobacteria - one of the oldest life forms on earth. The results provide important approaches for the use of cyanobacteria in biotechnology.

What for?

Cyanobacteria are one of the most important forms of life on earth: they have been instrumental in generating oxygen in the atmosphere and bind significant amounts of atmospheric carbon dioxide. They use sunlight as an energy source and therefore offer promising approaches for biotechnology. Due to their thread-like structure with a similar thickness to a carbon fiber, they could be used, for example, in adaptive biomaterials in which the shape can be changed by light. A better understanding of their movement properties thus contributes to the technological use of cyanobacteria.

Some species of cyanobacteria form long filaments composed of a few to more than 1,000 individual cells. The bacteria can move around in this form. Researchers from the Max Planck Institute for Dynamics and Self-Organization, the University of Göttingen and the University of Bayreuth have now investigated the principles of this locomotion. The team led by Prof. Dr. Oliver Bäumchen from the Chair of Experimental Physics V at the University of Bayreuth was also involved in the study, which was recently published in eLife.

The Bayreuth researchers guided two types of filamentous cyanobacteria into channels consisting of individual columns in the micrometer range. To measure the bending behavior, they used so-called "micropipette force spectroscopy", for which Bäumchen's laboratory is also internationally renowned. In this experimental approach, the researchers manipulate the cyanobacteria with a wafer-thin glass needle so that the bacterial filaments are pressed between two columns of a channel. The glass needle can simultaneously measure the acting forces with very high precision. "We discovered that the species Oscillatoria lutea is less flexible than the species Kamptonema animale, which has important implications for its potential use in biotechnology," says Bäumchen.

In another experiment, the filamentous cyanobacteria finally encountered an obstacle within the tiny channels. Bacterial filaments over a length of around 150 micrometers bent, while shorter filaments remained straight. "Interestingly, the length of most cyanobacteria is also in this range," reports Stefan Karpitschka, group leader at the Max Planck Institute for Dynamics and Self-Organization. He continues: "This means that slight changes in the length of a population change its movement. This indicates a natural tipping point at which the bacteria adapt their behavior to external conditions."

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Quantifying gliding forces of filamentous cyanobacteria by self-buckling. Maximilian Kurjahn, Antaran Deka, Antoine Girot, Leila Abbaspour, Stefan Klumpp, Maike Lorenz, Oliver Bäumchen, Stefan Karpitschka. eLife (2024)
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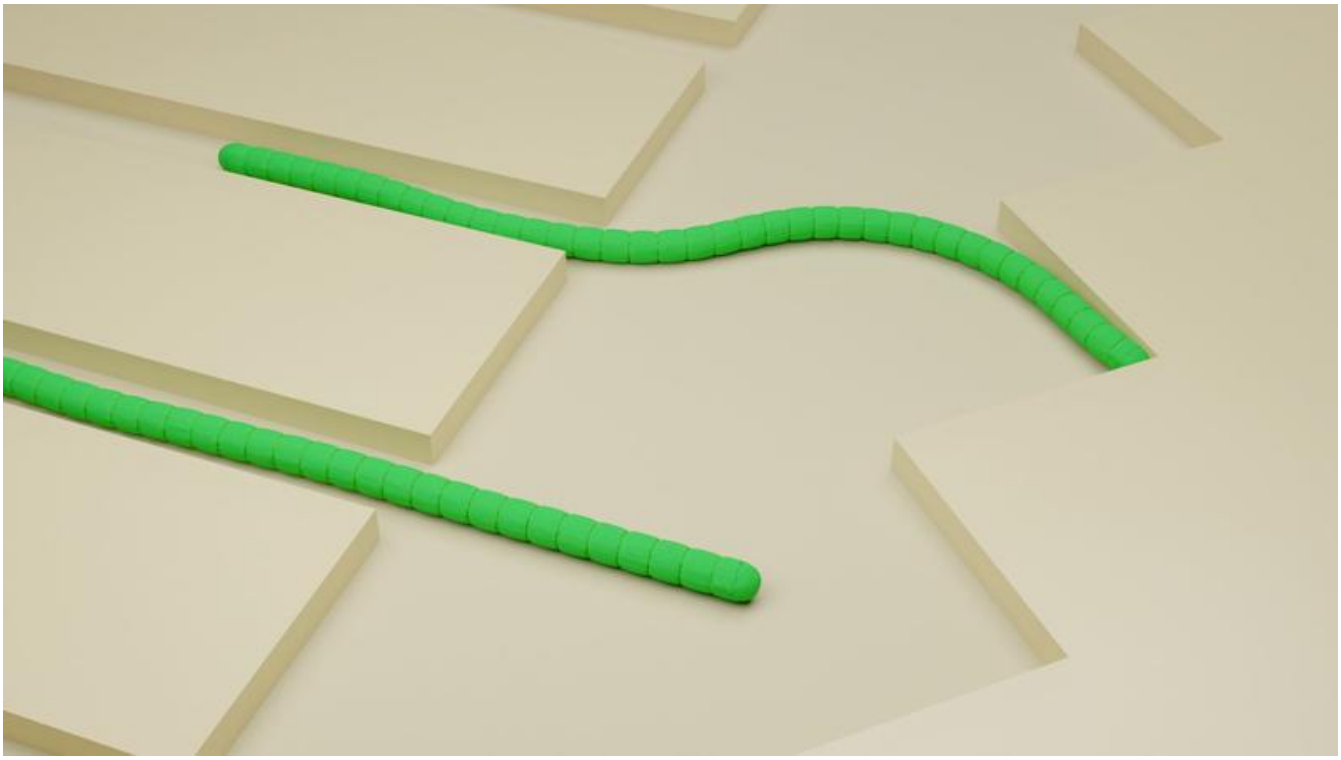

From a length of about 150 micrometers, filamentous cyanobacteria begin to bend when they encounter an obstacle.
MPI-DS, Kurjahn