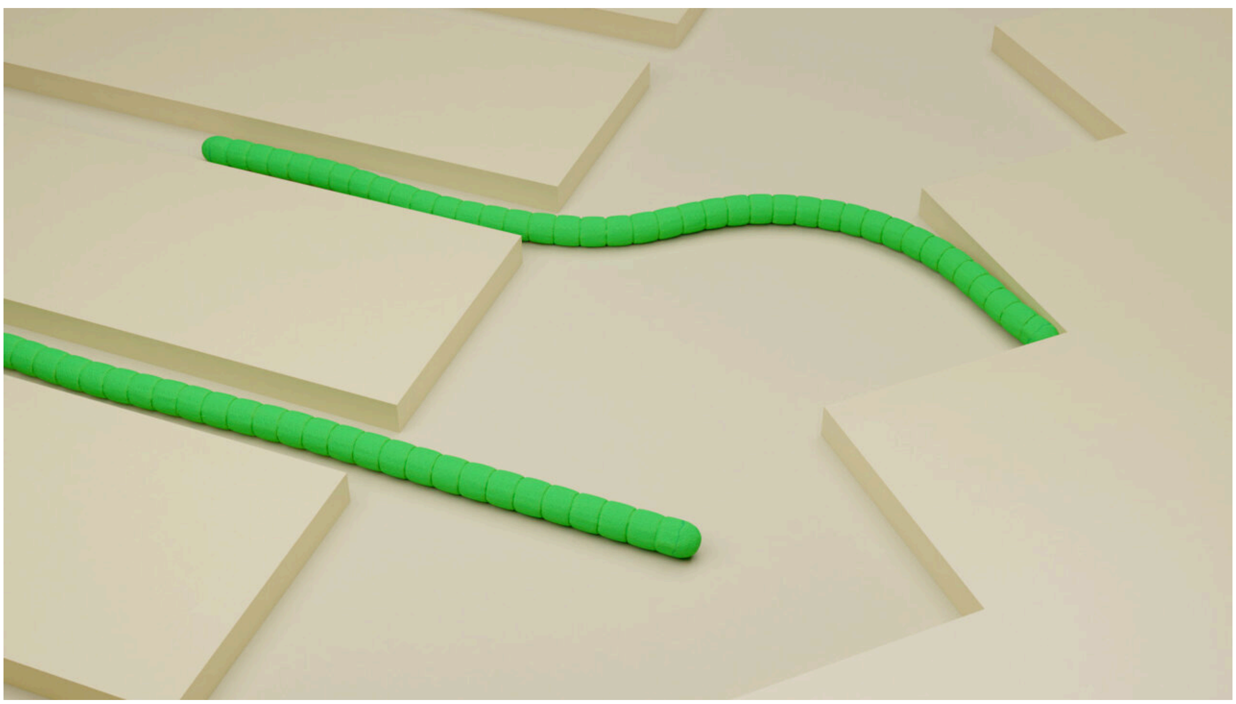
When bacteria are buckling: Study supports propulsion based on adhesion forces rather than slime extrusion

June 17 2024



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

Filamentous cyanobacteria buckle at a certain length when they encounter an obstacle. This was discovered by the research group of Stefan Karpitschka, group leader at the Max Planck Institute for Dynamics and Self-Organization and professor at the University of Konstanz. The results, appearing in *eLife*, provide an important basis for the use of cyanobacteria in modern biotechnology.

Cyanobacteria are one of the oldest and most important life forms in the world—for example, they played an essential part in producing the oxygen in our atmosphere. Some types form long filaments composed of a few to more than 1,000 individual cells. In this form, the filamentous bacteria can move around.

The principles of this locomotion have now been investigated by a research team led by Stefan Karpitschka, group leader at the MPI-DS and professor at the University of Konstanz, in collaboration with the University of Bayreuth and the University of Göttingen.

"We measured the force during locomotion on individual filamentous bacteria," says first author Maximilian Kurjahn, describing the approach. "We found that they start to bend when force is applied above a certain length, while shorter filaments remain straight," Kurjahn continues.

To do this, the researchers used a special microfluidic chip in which the bacteria were directed into channels and finally hit an obstacle. This bending test revealed that the threads start to kink and buckle at a length of around 150 micrometers.

Critical length enables flexibility of the system

"Interestingly, the length of most cyanobacteria is also in this range," reports Karpitschka. "This means that slight changes in the length of a population change its movement. This indicates a natural tipping point with which the bacteria adapt their behavior to external conditions."

The bacteria appear to move by adhesion to the surface, as they have no cilia or other external propellers, and higher forces generate higher friction.

Cyanobacteria use sunlight as an energy source and therefore offer promising applications in biotechnology. As bio-solar collectors, for example, they can be used to produce biofuel.

Due to their filamentous structure with a similar thickness to a carbon fiber, they could also be used in adaptive biomaterials in which the shape can be changed by light. A better understanding of their movement properties therefore contributes to the technological use of cyanobacteria .

More information: Maximilian Kurjahn et al, Quantifying gliding forces of filamentous cyanobacteria by self-buckling, *eLife* (2024). DOI: 10.7554/eLife.87450.3

Provided by Max Planck Society