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Evolved to fail: Bacteria induce flagellar buckling to reorient KWANGMIN SON, JEFFREY S. GUASTO, ROMAN STOCKER, MIT — Many marine bacteria swim with a single helical flagellum connected to a rotary motor via a 100 nm long universal joint called the "hook." While these bacteria have seemingly just one degree of freedom, allowing them to swim only back and forth, they in fact exhibit large angular reorientations mediated by off-axis "flicks" of their flagellum. High-speed video microscopy revealed the mechanism underpinning this turning behavior: the buckling of the hook during the exceedingly brief (10 ms) forward run that follows a reversal. Direct measurements of the hook's mechanical properties corroborated this result, as the hook's structural stability is governed by the Sperm number, which compares the compressive load from propulsion to the elastic restoring force of the hook. Upon decreasing the Sperm number below a critical value by reducing the swimming speed, the frequency of flicks diminishes sharply, consistent with the criticality of buckling. This elegant, under-actuated turning mechanism appears widespread among marine bacteria and may provide a novel design concept in micro-robotics.

Kwangmin Son
MIT

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