Undulatory swimming of a sandfish lizard in granular media

DANIEL GOLDMAN, RYAN MALADEN, CHEN LI, YANG DING, Georgia Tech

— We study the locomotion of the desert dwelling sandfish lizard (Scincus scincus) as it dives into and swims beneath the surface of sand (300$\mu$m glass beads). Above the surface, the animal uses a diagonal gait to move rapidly across the sand. High speed x-ray imaging reveals that once subsurface the animal no longer uses limbs for propulsion but instead folds the limbs against the body and generates thrust using a large amplitude undulatory motion consisting of a traveling wave with frequency $f$ that propagates down the body with one wave period. The forward swimming speed $v$ (maximum 10 cm/sec) increases with increasing $f$. We measure $v$ versus $f$ as a function of packing fraction of the material $\phi$. To predict $v$ as a function of $f$ and $\phi$, we model the animal as a series of elements, each which produces thrust and experiences drag along its surface. We measure thrust and drag coefficients by performing drag measurements on a small stainless steel rod (grain-rod friction comparable to the animal’s skin) as a function of rod angle, rod speed, and $\phi$. Integrating the drag law over a sinusoidal wave form accurately predicts the $v - f$ relationship of the animal in loose and close packed granular media.

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Daniel Goldman
Georgia Tech

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