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How to walk on water

Water snails crawl along under the water surface on ripples of slime.

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Some water snails have an extraordinary way of getting around: they crawl upside down at the water's surface. A team of US researchers may now have figured out how they do it.

At face value, the snails' motion seems almost impossible: how can they drag themselves across a fluid surface that they can't actually grip? But Eric Lauga of the University of California, San Diego and his colleagues say that, by creating little ripples in the surface, water snails transform it into one that does effectively offer a 'foothold'.

Gripping stuff: snails grab ripples of slime to hang onto the surface.

NHPA/ IMAGE QUEST 3-D

The question of how snails move has been studied for at least a century, but only relatively recently has an understanding emerged. For land snails, the secret's in the slime: the trail of mucus is sticky, but flows like a liquid if stressed beyond a certain level. So as the snail's 'foot' presses on it, the mucus offers an adhesive grip for some parts of the foot while lubricating the movement of other parts.

But this mechanism needs a solid surface to which the snail can stick. It won't work in water. Nonetheless, some freshwater and marine snails crawl 'hanging' from the water surface while secreting a trail of mucus. How do they do it?

Making waves

Lauga and colleagues studied the common freshwater snail Sorbeoconcha physidae, which can crawl at a respectable speed (in snail terms) of 0.2 cm per second. The snails stay buoyant by trapping some air inside their shells.

The snail's foot wrinkles into little rippling waves with a wavelength of about a millimetre and this produces corresponding waves in the mucus layer that it secretes between the foot and the air. But because surface tension constrains the deformation of the mucus, the shape of its top surface (in contact with air) doesn't exactly mirror that of the bottom surface (in contact with the foot). In effect, parts of the mucus film get squeezed, and parts get stretched, creating a pressure difference that pushes the foot forwards.

The researchers think their theory, described in a paper soon to be published in the journal

Physics of Fluids [1], offers only the beginnings of a full answer. It may also depend on the complex ways in which the mucus flows when squeezed, for example.

Sticky problem

Not all water snails move this way, says Lauga's colleague Anette Hosoi, of the Massachusetts Institute of Technology in Cambridge, Massachusetts. Many propel themselves using arrays of tiny hair-like appendages called cilia. Others simply swim underwater, or crawl along the bottom.

The researchers suspect that, as well as elucidating a biological puzzle, the findings might point to a new method of propulsion. Hosoi and her co-workers have already copied the adhesive/lubricating propulsive method of land snails to drive a robotic device [2]. Now it might be feasible to build similar devices that walk on water, although Hosoi says that this will require tricky mastery of buoyancy to keep them floating right at the water surface.

That earlier ‘artificial snail’ was built for sheer curiosity. But Hosoi says that once she and her colleagues reported it, "suddenly people were coming out of the woodwork": the researchers were approached by people in the oil industry and in medical research, among others.

So she suspects that, if they succeed with a synthetic water snail, "we may be hearing from industry again".

References
(1) Lee, S. et al., Phys. Fluids (in press, 2008).
(2) Chan, B. et al. Phys. Fluids 17, 113101 (2005).