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Inside JEB

CALCULATING CRABS COPE WITH HILLS

Fiddler crabs appear to use simple navigational skills as they scurry around their burrows on mudflats in Beaufort, North Carolina. Yet these unassuming creatures have hidden talents, as Michael Walls and John Layne of the University of Cincinnati, Ohio, recently discovered.

Walls and Layne wanted to know whether fiddler crabs foraging away from their burrows are as adept at finding their way home as desert ants (p. 3236). Ants negotiating sand dunes in Africa make a beeline for home undeterred by the three-dimensional nature of their journeys. They do this using a sensory neural mechanism known as path integration: from the moment they leave home, they tally up the directions and distances of all their movements into a single big arrow pointing the way home. Walls and Layne already knew that fiddler crabs are capable of path integration on flat surfaces, but were unsure whether the tiny crustaceans would be flummoxed by hills.

To test the crabs' ability to cope with hills, Walls and Layne designed an inflatable hill using a sand-covered balloon attached to a wooden frame. They planned to move crabs so that their homeward path would pass over the artificial hill, and see if the crabs would compensate for the extra distance travelled over the hill on their return journey.

First, Walls and Layne checked whether crabs uprooted to a new location will make their way home – or at least, where they *think* home is – without realising they've been moved. Unlike ants, fiddler crabs don't take kindly to being transported, so the pair took a surreptitious approach. They set up a camera on a mudflat in Beaufort and waited for crabs to leave their burrows. And waited… 'We needed the crabs to travel at least 30 cm from their burrows,' Layne says. 'We spent a long time waiting for adventurous crabs. Some days we'd pack up the cameras without having filmed anything.' When some bold crabs finally emerged, the pair waited for them to step onto a mud-covered plastic square, then carefully pulled a fishing line attached to the square to stealthily move the crabs to the far side of the (still deflated) hill. Then they startled the crabs, prompting them to run for shelter. Sure enough, the crabs ran the correct distance and direction and stopped exactly where their burrow should have been, at their new 'fictive' burrow location.

Walls and Layne were now ready to set the crabs a three-dimensional challenge. This time, they moved crabs behind the inflated hill. When startled, would the crabs simply run the same distance that they had run on a flat surface on their outbound trip? If they failed to take into account the extra distance travelled over the brow of the hill on their return journey, they should stop short by a predictable distance. Surprisingly, the crabs weren't confused. 'They ran farther by exactly the right amount to compensate for the hill,' Layne says. 'We weren't expecting them to be able to do this. It turns out that they are cleverer than we thought!'

Even more intriguing, when the location of a 'fictive' burrow happened to end up on the hillside, crabs traversing the hill would stop abruptly on inclines as steep as 40–50 deg. and search frantically for their burrow – despite having dug their real burrow on flat ground. 'They don't take anything else into account,' Layne says. 'Their home vector is not just their primary navigational tool – it's all they've got. This makes fiddler crabs a clean model system to study spatial navigation.'

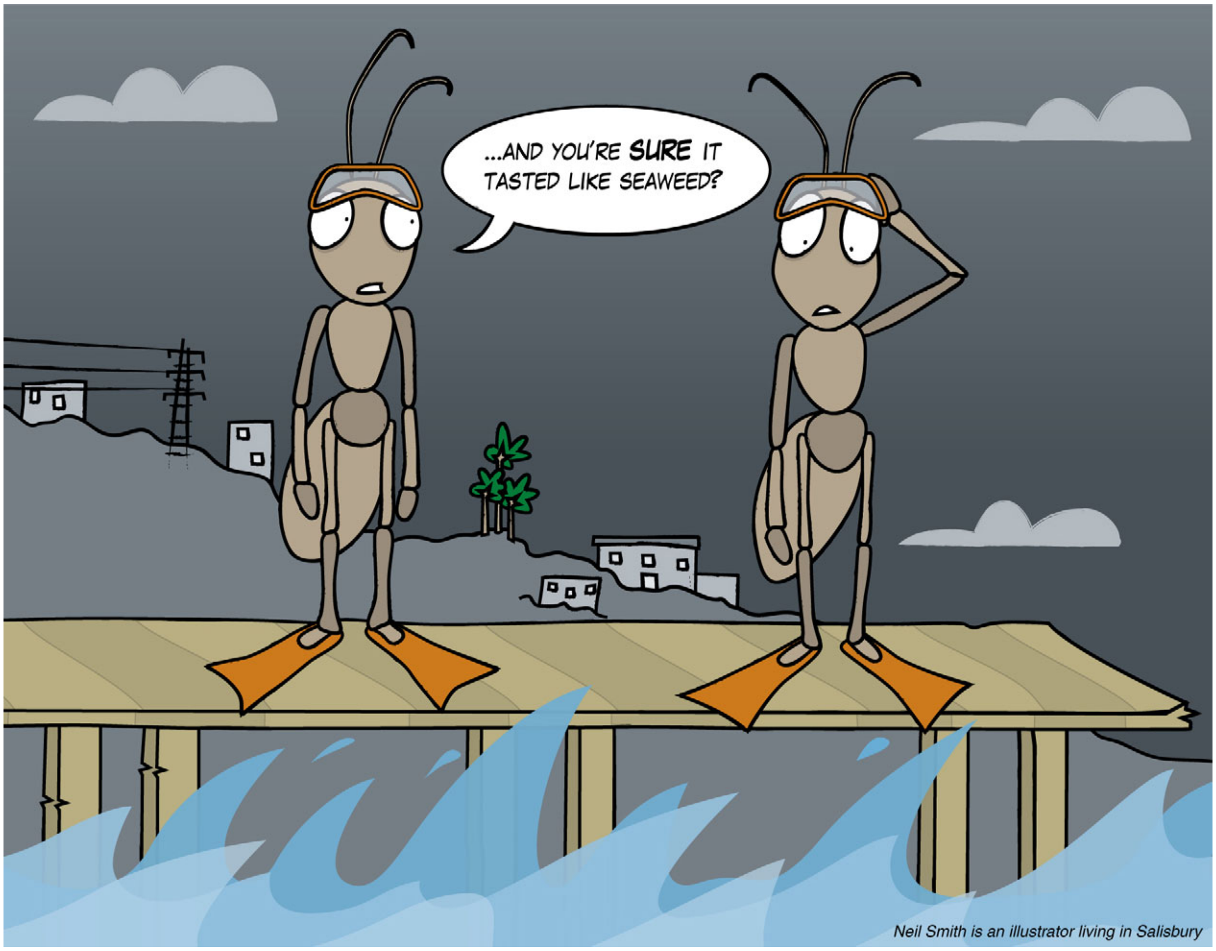
While it's too early to say exactly how the crabs accomplish their navigational feat, Layne suspects that they continuously measure their body tilt as they travel up- and downhill, and use that to compute where they are relative to the horizontal as they run. 'They're effectively doing high school trigonometry,' he says. Not bad for a crustacean.

Yfke Hager

10.1242/jeb.038554

Walls, M. L. and Layne, J. E. (2009). Fiddler crabs accurately measure two-dimensional distance over three-dimensional terrain. *J. Exp. Biol.* **212**, 3236-3240.

ANTS LEARN SCENTS FROM TASTE



Ants navigate the world through a rainbow of scents: the scents of their nest, nest mates and tempting food. However, when a forager follows a plume of scent to a tasty snack, it may not have learned to recognise and respond to the food's odour: it may simply be following its nose because it likes the smell. Knowing that foragers carry nectar for the colony in their crops and transfer it to hungry nest mates — they look as if they are kissing as they sip from each other — Yael Provecho and Roxana Josens from the Universidad de Buenos Aires, Argentina, wondered whether ants could learn to recognise food flavours picked up when sipping from a nest mate's mouth and then follow the flavour's odour in search of more of the same (p. 3221).

The duo decided to test their theory by seeing whether an ant could follow an odour in a maze after tasting the scent in sucrose supplied by a foraging nest mate. Having identified (and marked) an ant that they knew was empty and would feed from a full forager, the team paired the empty ant with a forager and released the forager into an arena supplied with tea tree flavoured sucrose solution. They allowed the forager to fill up on the tea tree flavoured sucrose and returned it to its empty nest mate so that the empty ant could take a sip of the sucrose from the forager's mouth. Then they asked the ant that had just taken a sip to choose between a tea tree scented channel and a channel scented with rose (that it had not encountered before) in a Y shaped maze.

The ant successfully chose the tea tree scent. And when the team repeated the test with other pairs of ants and different scent combinations, the insects that sipped flavoured sucrose solution from another's mouth were able to follow the flavour's scent in favour of an unfamiliar scent.

So rather than simply following tempting odours to tasty treats, ants can learn to recognise scents associated with food that have been brought to the nest, allowing new foragers to follow the scrumptious scent and forage for more.

10.1242/jeb.038562

Provecho, Y. and Josens, R. (2009). Olfactory memory established during trophallaxis affects food search behaviour in ants. *J. Exp. Biol.* **212**, 3221-3227.

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