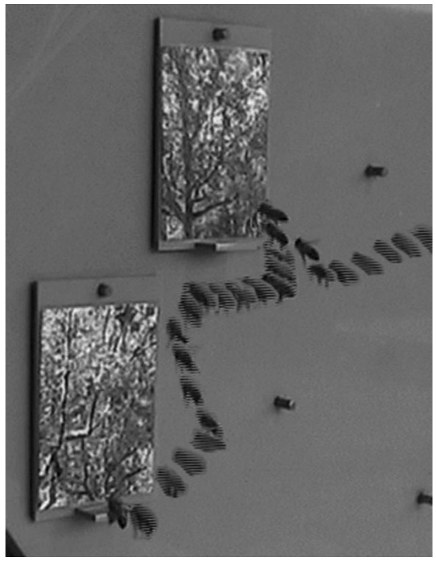
Inside JEB is a twice monthly feature, which highlights the key developments in the *Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

Inside JEB

SEEING THE TREE FROM THE WOODS



When Adrian Dyer, Christa Neumeyer and Lars Chittka found that bees could recognise human faces in 2005 (*J. Exp. Biol*. vol. 208, pp. 4709-4714), they were truly astonished. How could such tiny brains process something as complex as a human face? And why? Was this some cute party trick, or are bees genuinely able to recognise complex images as part of their daily chores? After all, foraging honey bees have to negotiate cluttered fields and forests while searching for nectar. Can they use this remarkable visual talent to pick out and recognise one tree (as a landmark) from a forest of thousands: in other words 'can they see the trees from the wood?' asks Dyer. Curious to know if bees have the ability to learn to recognise a complex tree shape, Dyer and his colleagues, Marcello Rosa and David Reser, set the bees a biologically relevant challenge: could they learn to recognise and distinguish between tree photographs (p. 1180)?

First Dyer set out to see if bees could learn to discriminate between a tree photograph they had been trained to recognise and a photograph they had been trained to avoid. Enticing a bee to land on a spoonful of sucrose, Dyer carried the insect over to a screen where he could show them two different tree pictures, each with a small landing platform for the insect to alight on. Eventually the bees learned to head to the screen on their own, and when Dyer was convinced that the bee was taking genuine interest in the images, he began training them to recognise one of the pictures by rewarding them with a nectar treat, but training them to avoid the other by presenting them with a bitter quinine drink.

After 120 training visits, Dyer took away the sucrose and quinine, forcing the insect to rely on their eyes to find the image they had been trained to recognise. Moving the images around, Dyer was delighted to see that the bees homed in on the image they had been trained to recognise. And when he presented the bees with the choice between the image they had been trained to recognise and a second novel tree picture, the insects continued returning to the tree image they recognised. Not only could the insects discriminate between tree images, but they could recognise the image from another similar picture.

So the bees seem to be capable of learning to recognise complex natural shapes. But it took an entire day to train the insects to recognise one tree image. Can they really learn to recognise complex shapes during their routine activities when they have to learn the positions of several sites during a day? This time Dyer replaced the quinine drink with water and reduced the number of training sessions from 120 to 40. Amazingly, this new group of bees correctly learned which tree to recognise, despite the milder training regime.

Having shown that bees can discriminate between, and recognise, complex natural images such as trees, Dyer is keen to see if they can do it for real in the field. But given the challenges of training and tracking insects in the natural environment, he suspects that this could take some time.

10.1242/jeb.018473

Dyer, A. G., Rosa, M. G. P. and Reser, D. H. (2008). Honeybees can recognise images of complex natural scenes for use as potential landmarks. *J. Exp. Biol.* **211**, 1180-1186.

COLONIES ACCEPT QUEEN IF HYDROCARBON COAT IS RIGHT

A multilane highway of ants marching across your kitchen floor is the last thing you want in your home, but this is the situation faced by many Californians and southern Europeans since the Argentine ant invaded. According to Jules Silverman, from North Carolina State University, these ants are far less problematic in their native environment. But when they arrived in the northern hemisphere, something changed; the ants' genetic diversity declined, they became less aggressive towards neighbours and formed massive supercolonies, wiping out native ant species. Curious to know how the Argentine ant has been so successful, Silverman wondered why the invaders' colonies were so much larger than in their native environment. Could individual Argentine ant colonies have fused to form supercolonies by adopting

Picture by Gissella Vásquez

queen and worker ants from elsewhere (p. 1249)?

But, according to Silverman, ant colonies don't usually accept outsiders. Each individual is coated with a blend of hydrocarbon compounds, unique to their home colony, which they use to distinguish between colonymates and strangers. But what if individual colonies were closely related and their hydrocarbon cocktails were similar, could the colonies accept each other and fuse to form a supercolony? Teaming up with Gissella Vásquez and Coby Schal, Silverman decided to test out whether invasive Argentine ant colonies accept visitors from other colonies if their hydrocarbon signatures are similar.

Fortunately for Silverman, the Argentinian invaders that have made it as far as North Carolina have retained their genetic diversity with varying degrees of aggression towards other colonies. So Vásquez collected workers and queens from 4 colonies at different locations in the state before teaming up with entomologist Schal to analyse their hydrocarbon cocktail. Having already established the relative aggression levels of each colony, Vásquez found that the hydrocarbon cocktails of queens that were accepted into a colony were very similar to the adopting colony's own cocktail; while hydrocarbon mixtures of the queens which were attacked differed most from the new colony's mixture. So queens can be adopted by a new colony, but only if their hydrocarbon signatures are similar to their new colony's signature.

Having identified the colonies that would accept queens from elsewhere, Vásquez tested whether an adopted queen's hydrocarbon cocktail changed after she had been accepted into another colony, and found that after two weeks it had changed slightly to resemble the cocktail of her new home. The team suspect that the insects could have modified how they synthesise the hydrocarbons, but add that the queens could have picked up hydrocarbons from their new nestmates.

Finally, Vásquez confirmed that the colony uses the hydrocarbon cocktail to recognise impostors by replacing a queen's hydrocarbon coating with that of a colony that her nestmates respond to aggressively. Having returned the queen to her nestmates, Vásquez saw the workers attack her aggressively; they no longer recognised her thanks to her new coating. The queen's hydrocarbon cocktail was essential for recognition.

Having found that it is possible for Argentine ant colonies to accept outsiders if their hydrocarbon signatures are similar enough, Silverman suspects that colonies could fuse and suggests that this could explain in part how Argentine ant gigantic supercolonies have developed.

10.1242/jeb.018465

Vásquez, G. M., Schal, C. and Silverman, J. (2008). Cuticular hydrocarbons as queen adoption cues in the invasive Argentine ant. *J. Exp. Biol.* **211**, 1249-1256.

SWINGERS DON'T SHARE FORCES

Picture by Tom Roberts

Most of us take our bodies for granted; that is until something goes wrong. Pull the wrong muscle and you can be hobbling for months. Frank Nelson explains that most joints are flexed and extended by several muscles, which poses the question how much each muscle contributes to a joint's movement. According to Nelson, some thought that all muscles associated with a joint contribute equally to its movement, while others suggested that a muscle's contribution was proportional to its cross sectional area. However no one had directly measured individual muscles' contributions to a joint's swinging movement, and none of the few measurements that had been made on limbs in contact with the ground came down hard for any of the hypotheses. Curious to find out how muscles work together, Nelson and his team leader, Tom Roberts, decided to test muscles around the turkey ankle joint to find out how they share the load (p. 1211).

According to Nelson, the turkey's ankle joint is ideal for such a study. Firstly the bird is a biped, like us, and the ankle joint has three major muscles to extend the joint, one of which doesn't contribute while the leg is being swung forward. Only the remaining lateral and medial gastrocnemius muscles extend the ankle during swinging. What is more, the muscles' tendons are calcified; ideal for fitting strain gauges. Even then, Nelson admits that successfully fitting four strain gauges to the tendons in each bird's ankle was challenging, but eventually he had three birds ready to set running to see how the muscles divided their force.

Filming the birds as they ran on a treadmill at speeds ranging from 1 to 3.5 m s^{-1}, Nelson also increased the force on the bird's ankles by fitting 30 g and 60 g weights to see how the muscles responded. Analysing the movies, Nelson was able to calculate the forces exerted on each bird's foot as it swung forward and to see how they matched up with the strains generated in the muscle tendons. If the muscles were sharing the load equally, then the strains on each tendon would be 50% of the forces acting on the foot.

Focusing on the stance phase of the stride, when the bird's foot was in contact with the treadmill, the strains that the team measured in both muscle tendons were equal. It seems that the force is shared equally when the foot is in contact with the ground.

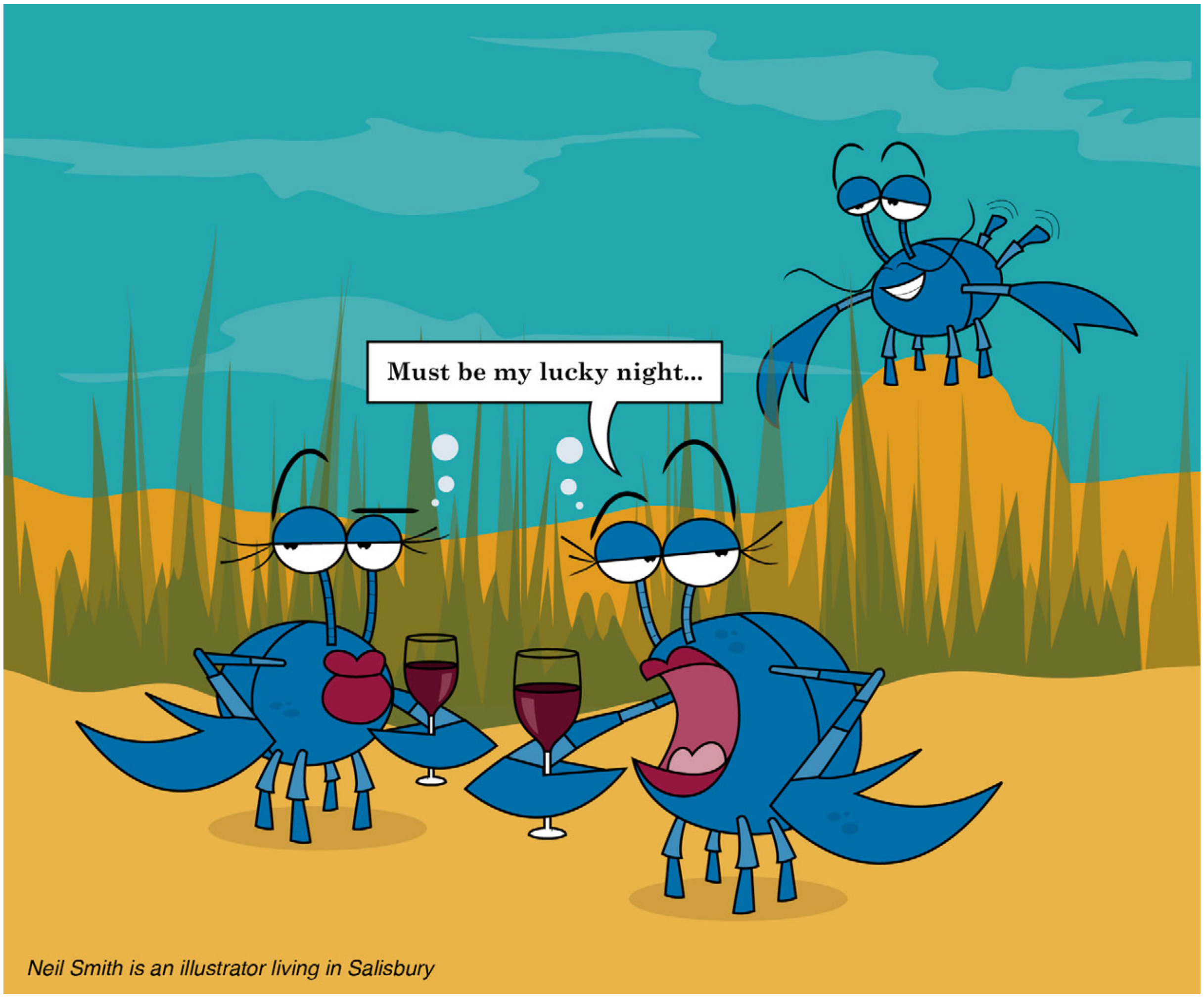
But Nelson and Roberts were in for a shock when they looked at the forces generated during each stride's swing phase. Far from contributing equally, only the lateral gastrocnemius muscle supplied the force during the second half of the swing. 'This was quite spectacular' says Nelson, and adds that no work has been done on the forces involved in limb swinging, so no one had thought that force sharing would break down.

Nelson suspects that that the failure of force sharing during the swing phase could be a general phenomenon applying to all non-weight bearing limb movements. He adds that it could help us to understand how we swing our arms, as well as explaining why a single strain can be such a pain.

10.1242/jeb.018457

Nelson, F. E. and Roberts, T. J. (2008). Task-dependent force sharing between muscle synergists during locomotion in turkeys. *J. Exp. Biol.* **211**, 1211-1220.

HOW WAVING MALES ATTRACT THE LADIES



When a courting male blue crab gets a whiff of a lady, he stands up high and starts waving his paddle-shaped swimming legs. But why male blue crabs indulge in such an ostentatious mating display wasn't clear: no other swimming crabs are known to go to these lengths; putting on a show increases the risk of attracting hungry predators; and the females, which prefer to stay hidden in clumps of smooth cord-grass, are unlikely to see the display anyway. So why bother? Which made Michiya Kamio, Matthew Reidenbach and Charles Derby wonder whether the waving males were sending more than a visual message (p. 1243).

When the team monitored the crabs' courting behaviour in the lab, they realised that the males rarely resorted to waving, and then only when the female was out of reach behind a plastic mesh. And when they visualised fluid flows around a crab with a thin plane of laser light, the team saw that the waving male generated a strong jet of water with his paddle-shaped legs. Kamio and his colleagues suspect that having located a female hidden in a clump of grass, the male entices her out of her hidey-hole with a pheromone message carried on the jet of water generated by his waving legs.

10.1242/jeb.018481

Kamio, M., Reidenbach, M. A. and Derby, C. D. (2008). To paddle or not: context dependent courtship display by male blue crabs, *Callinectes sapidus. J. Exp. Biol.* **211**, 1243-1248.

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