Inside JEB 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

LEAPING TAILLESS LIZARDS TOPPLE

Picture by Lauren Bonvini

If you've ever tried capturing a lizard, you'll know how difficult it is. But if you do manage to corner one, many have the ultimate emergency quick release system for escape. They simply drop their tails, leaving the twitching appendage to distract the predator as they scamper to safety. According to Gary Gillis from Mount Holyoke College, USA, up to 50% of some lizard populations seem to have traded some part of their tails in exchange for escape. This made Gillis wonder how this loss may impact on a lizard's mobility and ability to survive. Specifically, how do branch hopping, tree dwelling lizards cope with their loss? Teaming up with undergraduate student Lauren Bonvini, the pair began encouraging lizard leaps to see how well the reptiles coped without their tails (p. 604).

Constructing a jumping arena from boxes and fine sandpaper, the duo gently encouraged arboreal *Anolis carolinensis* (anole) lizards to launch themselves from an 11 cm high platform as they filmed the animals' jumps. The animals performed well, launching themselves by pushing off with their back feet and landing gracefully, covering distances ranging from 14.9 to 29.9 cm.

But how well would the animals perform without their tails? Encouraging the lizards to drop their tails by holding them, just like a hungry predator would, Bonvini then persuaded the tailless reptiles to jump while Gillis filmed them. As soon as the first animal took to the air, Gillis knew something was different. 'It looked weird,' says Gillis, 'the animals became blurred as they jumped. I called Lauren over and said, "you're not going to believe this".' Replaying the animal's jump in slow motion, the team could see that the animals were tumbling backwards uncontrollably as their tail stump flailed around. Filming other tailless anoles, three more backflipped out of control, although two others seemed to manage their trajectories better.

Teaming up with Duncan Irschick to analyse the reptiles' leaps, the team could see that everything about the tailless lizards' take off was exactly the same as it had been before they lost the appendage. Things only started to go wrong as they left the jump stage. The lizards began flipping back by more than 30 deg.; some tumbled so far that they landed on their backs. The team also realised that as the animals with tails took off, they raised the base of the tail while the rest of the appendage trailed along the ground, as if it was somehow stabilising the take off.

'If jumping and landing are important for lizards, they are really compromised,' says Gillis. 'Coordinated landing on a branch is out of the question when spinning backwards,' he adds. Escaping lizards probably pay a significant ecological cost for their life saving quick release system.

So how do the animals use their tails to ensure a safe touch down? Gillis isn't sure whether the lizards push down with their tails at take off to prevent themselves from spinning, or whether the trailing tail passively stabilises the animal's departure. He is also keen to find out more about how the animals adjust to life without their tails, and after they have grown back.

10.1242/jeb.029710

Gillis, G. B., Bonvini, L. A. and Irschick, D. J. (2009). Losing stability: tail loss and jumping in the arboreal lizard *Anolis carolinensis. J. Exp. Biol.* **212**, 604-609.

EARLY ALARM BELL FOR HEAT STRESS

When physiologist Markus Frederich decided to shift his research focus from Antarctic crustaceans to mammalian energy metabolism, he didn't anticipate that his disparate research interests would neatly dovetail to lead him into uncharted scientific territory. As a postdoctoral researcher at Harvard Medical School, Frederich was introduced to AMP-activated protein kinase (AMPK), which acts as a metabolic 'master switch' to stimulate production of ATP, the cell's main energy source. He explains that while AMPK is well studied in mammals, the existence of this key energy regulator is virtually unexplored in the invertebrate world. From his earlier research, Frederich knew that rising temperatures lead to plummeting energy levels in Antarctic crustaceans. Given that low energy levels trigger AMPK in mammals, he wondered whether heat stress might activate AMPK in crustaceans (p. 722).

To test this, Frederich and his colleagues Michaela O'Rourke, Nathan Furey and Jennifer Jost set out to compare AMPK activity levels in heat-stressed crabs with levels of a traditional heat stress marker, heat shock protein 70 (HSP70). A friendly local lobster fisherman supplied rock crabs to Frederich's lab at the University of New England in Maine. The team first investigated how the crabs coped at high temperatures by settling the animals into tanks kept at a comfortable 12°C, then quickly ramped the heat up to 30°C. To identify the first behavioural warning signs of heat stress, they tested the crabs' reaction times at different temperatures by flipping the crabs upside down and timing how long it took for the creatures to right themselves. 'Above 18°C, the crabs were noticeably slower than at lower temperatures, suggesting that they were starting to struggle,' says Frederich. The team also assessed the rock crabs' critical temperature – the temperature at which the animals switch to anaerobic metabolism due to heat stress – by measuring the crabs' heart rates and lactate accumulation, and found that it was 26°C.

But would any of these behavioural and physiological findings correlate with molecular markers of heat stress? To find out, the team measured AMPK activity and AMPK and HSP70 protein levels at 2°C increments. Levels of HSP70, the traditional heat stress marker, only started to increase at 28°C – around the crabs' critical temperature. But to Frederich's delight, AMPK activity steadily increased above 18°C, revealing that the crabs were already heat stressed at this lower temperature. Importantly, the threshold indicated by rising AMPK activity corresponded to the animals' behavioural threshold – the temperature at which the crabs struggled to flip themselves over. 'Long before crabs reach the temperature at which HSP70 reveals heat stress, other processes indicate that the animals are struggling to cope. AMPK seems to be an earlier, more sensitive heat stress indicator,' says Frederich.

Just to make sure that AMPK and HSP70 produced similar responses in a more traditional prolonged heat stress test, the team also tested crabs sweltering at a continuous 26°C. Sure enough, both HSP70 and AMPK mRNA levels increased constantly over 6 h, showing that rock crabs also have slower but longer-term mechanisms to survive soaring temperatures.

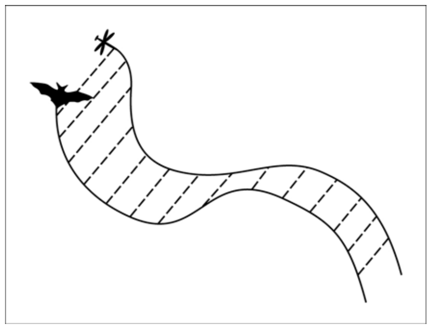
Frederich anticipates potential applications of his team's findings in models to assess how animals will cope with global warming. 'AMPK activity could allow us to assess more accurately whether animals are heat stressed,' he concludes.

10.1242/jeb.029728

Frederich, M., O'Rourke, M. R., Furey, N. B. and Jost, J. A. (2009). AMP-activated protein kinase (AMPK) in the rock crab, *Cancer irroratus*: an early indicator of temperature stress. *J. Exp. Biol.* **212**, 722-730.

Yfke Hager

BATS TRACK DIVING MANTISES WITH PARALLEL NAVIGATION



Manoeuvring through the air that is firing off ultrasound to track your every move seems daunting, but the praying mantis has evolved an impressive acrobatic trick to evade their big brown bat predators. Employing its single ear, tuned to the bat's frequency, the mantis performs a sudden rapid dive in mid-flight when the ultrasound hits its body. Scientists have studied this defence technique for some time but they knew nothing about the counter-attacks that big brown bats might launch to catch up with the escape artists. To find out more about the bat's response to the insect's evasive action, Kaushik Ghose, then a graduate student at the University of Maryland, and his colleagues Cynthia Moss and Kari Bohn teamed up with insect escape experts Jeffrey Triblehorn and David Yager to film and record big brown bats pursuing diving praying mantises (p. 693).

Capturing the aerial dogfight in a laboratory flight room equipped with high-speed infrared video cameras and ultrasonic microphones, Ghose recalls that 'it was tricky to get both animals into the air at the same time'. However, once a chase was established, the big brown bats emitted a characteristic ultrasound pattern that the researchers used to identify pursuit sequences and analyse the animals' movements.

In previous experiments with deafened mantises that could not dive, Ghose had discovered that big brown bats use a 'parallel navigation' strategy where lines drawn between the bat's and insect's positions are always parallel, regardless of the animals' individual trajectories. Ghose explains that this strategy allows the bat to constantly adjust its own movements to those of the mantis. He adds that this is the same strategy used by guided missiles and allows the bat to minimise the time it needs to catch up with unpredictably moving targets. 'We still don't know how the bat does it, but we think it locks its sonar beam to the target and then keeps its head steady in relation to the mantis,' Ghose explains.

So what happened when the mantises dived suddenly? The team found that a quarter of the bats did not manage to follow the insect into the dive and changed their ultrasound emissions to a pattern suggesting they were no longer interested in the mantis. They had given up completely.

However, in the remaining cases the bats dived too, closely tracking the mantis, although none of them managed to successfully catch their prey. When plotting lines between the animals as they both plummeted, the researchers found that the lines drawn between the two animals also remained parallel during the dive, suggesting that the diving bats use the same parallel navigation strategy that they appear to use during dive-free pursuits.

Despite the lab bats' lack of success, Ghose suspects that bats in the wild would eventually be able to catch the mantis. He attributes the lab bats' failure to intercept the diving insects to the constraints of the experiment: 'the flight room is not very high and the mantis often ended up on the ground so the bat pulled up to avoid smashing itself on the floor,' he explains. But out in the open, with more height, a bat that managed to follow the mantis into the dive may well have better luck.

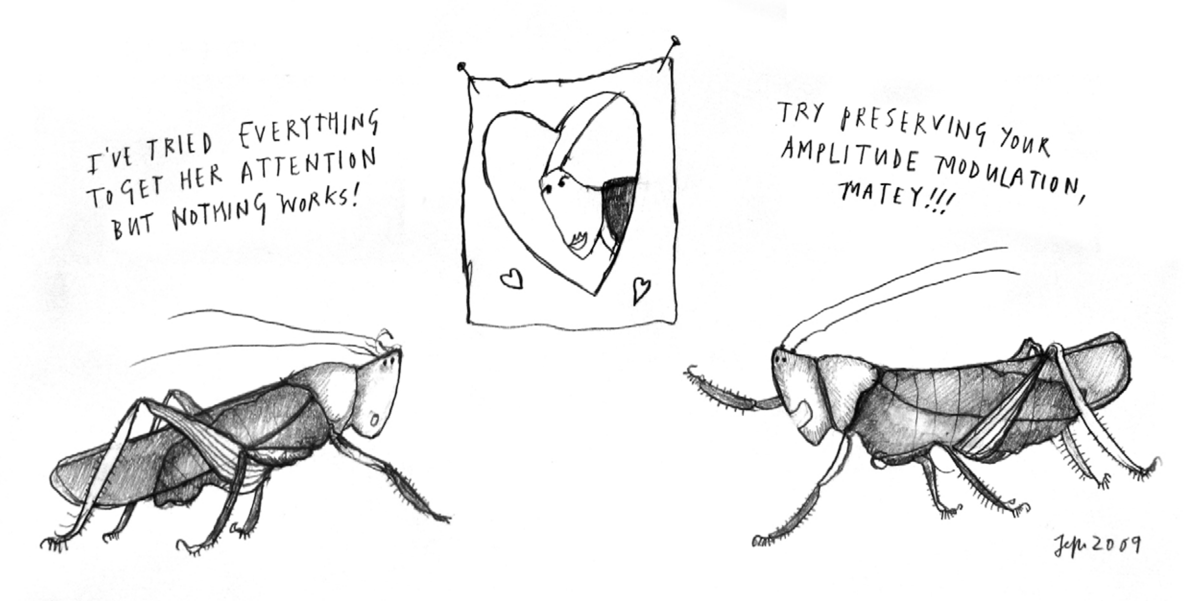
10.1242/jeb.029694

Ghose, K., Triblehorn, J. D., Bohn, K., Yager, D. D. and Moss, C. F. (2009). Behavioral responses of big brown bats to dives by praying mantises. *J. Exp. Biol.* **212**, 693-703.

Nora Schultz

CHIRRUP SHAPE GETS GIRL'S ATTENTION

Pete Jeffs is an illustrator living in Paris



When *Neoconocephalus affinis* males want to get a girl's attention, they don't turn up with flowers and chocolates: they chirrup. But it wasn't clear which aspect of their songs made a girl take note. Sarah Bush, Oliver Beckers and Johannes Schul from the University of Missouri decided to find out which components of the male's calls were essential and how the females tune in to the serenade (p. 648).

Recording males' serenades, the team placed a female *N. affinis* on a spherical treadmill in a darkened room, and measured the female's movements in response to the males' songs. Then they modified various aspects of the males' calls to see how the females reacted. Analysing the females' responses, the team realised that the females reacted most strongly to a 12.8 Hz component in the song's amplitude modulation by a neuronal membrane resonance mechanism. However, the 12.8 Hz component was not sufficient to get the females' attention. According to Bush, the overall shape of the chirrup was significant too.

10.1242/jeb.029702

Bush, S. L., Beckers, O. M. and Schul, J. (2009). A complex mechanism of call recognition in the katydid *Neoconocephalus affinis* (Orthoptera: Tettigoniidae). *J. Exp. Biol.* **212**, 648-655.

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