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.

## HOW GECKOS COPE WITH WET FEET


Edward A. Ramirez

Geckos are remarkable little creatures, clinging to almost any dry surface, and Alyssa Stark, from the University of Akron, USA, explains that they appear to be equally happy scampering through tropical rainforest canopies as they are in urban settings. 'A lot of work is done on geckos that looks at the very small adhesive structures on their toes to really understand how the system works at the most basic level', says Stark. She adds that the animals grip surfaces with microscopic hairs on the soles of their feet that make close enough contact to be attracted to the surface by the minute van der Waals forces between atoms. However, she and her colleagues Timothy Sullivan and Peter Niewiarowski were curious about how the lizards cope on surfaces in their natural habitat.

Explaining that previous studies had focused on the reptiles clinging to artificial dry surfaces, Stark says 'We know they are in tropical environments that probably have a lot of rain and it's not like the geckos fall out of the trees when it's wet'. Yet, the animals do seem to have trouble getting a grip on smooth wet surfaces, sliding down wet vertical glass after a several steps even though minute patches of the animal's adhesive structures do not slip under humid conditions on moist glass. The team decided to find out how Tokay geckos with wet feet cope on wet and dry surfaces (p. 3080), but first they had to find out how well their geckos clung to glass with dry feet.

Fitting a tiny harness around the lizard's pelvis and gently lowering the animal onto a plate of smooth glass, Stark and Sullivan allowed the animal to become well attached before connecting the harness to a tiny motor and gently pull the lizard until it came unstuck. The geckos hung on tenaciously, and only came unstuck at forces of around 20 N, which is about 20 times their own body weight. 'The gecko attachment system is over-designed', says Stark.

Next, the trio sprayed the glass plate with a mist of water and retested the lizards, but this time the animals had problems holding tight: the attachment force varied each time they took a step. The droplets were interfering with the lizards' attachment mechanism, but it wasn't clear how. And when the team immersed the geckos in a bath of room temperature water with a smooth glass bottom, the animals were completely unable to anchor themselves to the smooth surface. 'The toes are superhydrophobic [water repellent]', explains Stark, who could see a silvery bubble of air around their toes, but they were unable to displace the water surrounding their feet to make the tight van der Waals contacts that usually keep the geckos in place.

Then, the team tested the lizard's adhesive forces on the dry surface when their feet had been soaking for 90 min and found that the lizards could barely hold on, detaching when they were pulled with a force roughly equalling their own weight. 'That might be the sliding behaviour that we see when the geckos climb vertically up misted glass', says Stark. So, geckos climbing on wet surfaces with damp feet are constantly on the verge of slipping and Stark adds that when the soggy lizards were faced with the misted and immersed horizontal surfaces, they slipped as soon as the rig started pulling.

Therefore geckos can walk on wet surfaces, so long as their feet are reasonably dry. However, as soon as their feet get wet, they are barely able to hang on and the team is keen to understand how long it takes geckos to recover from a drenching.

10.1242/jeb.078246

**Stark, A. Y., Sullivan, T. W. and Niewiarowski, P. H.** (2012). The effect of surface water and wetting on gecko adhesion. *J. Exp. Biol.* **215**, 3080-3086.

**Kathryn Knight**

## LOGGERHEAD TURTLES HAVE LOW FREQUENCY HEARING

When Kelly Martin decided to map out the underwater hearing ability of a loggerhead turtle using behavioural hearing tests, she soon discovered why it had never been done before. When you're training a turtle, she says, 'you need tremendous patience'. She should know; it took 2 years to train a captive loggerhead turtle at the Mote Marine Laboratory & Aquarium in Sarasota, Florida. But Martin persevered, and was able to show that behavioural hearing tests provide strikingly similar results to physiological testing methods (p. 3001).

We currently know little about turtle hearing, explains Martin, and what is


known is based on electrophysiological tests, in which electrodes measure voltages generated by the brain in response to sounds. While these tests are quick and relatively simple, they don't provide a direct measure of hearing ability. But if Martin could show that the results of electrophysiological tests correlate well with behavioural hearing tests, it would provide reassurance that electrophysiological tests are accurate.

Undeterred by the scant success of previous attempts to train reptiles, Martin set to work training a 31 year old loggerhead turtle to respond to sounds. With the turtle positioned in front of a training platform, Martin activated an LED light suspended from the platform to signal the start of a trial. During a 'go' trial, Martin played a sound through an underwater transducer. To indicate that she had heard the sound, the turtle had to swim to a plastic response paddle suspended in the water and press it with her beak. During a 'no-go' trial, no sound was played, and the turtle had to indicate that she couldn't hear anything by not pressing the response paddle after the LED light was switched on. If the turtle got it right, she was rewarded with food; if she didn't, Martin briefly switched off the overhead lights. But the turtle's erratic behaviour proved to be problematic, especially when she lost her appetite in the months before the nesting season. 'It was a frustrating period', Martin recalls. 'It took months to develop behavioural consistency.'

Eventually, Martin was ready to test how sensitive the turtle's hearing really was. By playing sounds of varying frequencies and incrementally decreasing or increasing the volume between trials, she found that the turtle was able to hear sounds between 50 and 800 Hz. This is fairly low frequency hearing compared with humans, who can typically hear between 20 and 20,000 Hz. But would electrophysiological tests produce the same results? To find out, Martin inserted electrodes under the turtle's skin just above the brain, played sounds at different frequencies, and recorded the signals from the electrodes. To her astonishment, the results correlated closely with the range established during the behavioural tests. Given the difficulties training the turtle, Martin says, 'It was a big surprise that the results aligned so well'.

Martin concludes that electrophysiological methods can be used to conduct simple and fast hearing tests for wild or untrained marine turtles. She acknowledges that other loggerhead turtles will need to be tested to confirm this conclusion. But, she says, 'This is a first step towards a better understanding of marine turtle hearing abilities'.

10.1242/jeb.078220

**Martin, K. J., Alessi, S. C., Gaspard, J. C., Tucker, A. D., Bauer, G. B. and Mann, D. A.** (2012). Underwater hearing in the loggerhead turtle (*Caretta caretta*): a comparison of behavioral and auditory evoked potential audiograms. *J. Exp. Biol.* **215**, 3001-3009.

**Yfke Hager**

## CANARIES CAN'T CHEAT ON SEXY A SYLLABLES


Male birds have many features in their arsenal to attract healthy female mates, including ostentatious plumage, complex dances and elaborate vocal performances. However, Roderick Suthers, from Indiana University, USA, and Eric Vallet and Michel Kreutzer, both from the Université Paris Ouest Nanterre La Defense, France, explain that it is unclear exactly how a male bird's vocal performance communicates his fitness. According to the team, female domestic canaries are particularly willing to mate with males that incorporate a specific wide bandwidth two-note syllable – the so-called 'sexy' A syllable, executed at a high 15 syllables $s^{-1}$ repetition rate – into their repertoire. So, Suthers and his colleagues decided to analyse the males' vocal tract gymnastics to find out how difficult the syllable's trills are to coordinate and how they convey information about male fitness (p. 2950).

Explaining that the two sides of the bird's syrinx are capable of producing sound independently – with the left side producing low frequency notes while the right side produces high frequency sounds – Suthers and his colleagues surgically implanted two thermistors, one in each side of the male canary's syrinx, to measure airflow through the organ and to determine which side of the syrinx produced the pair of characteristic sexy syllable notes. The team also inserted a cannula into one of the bird's airsacs to determine the airflow direction. Repeating the surgery on two other birds, the team then recorded the birds' songs and determined which side of the syrinx produced each note.

Having identified seven sexy syllables in the birds' recitals and analysed the airflow producing them, the team found that each sexy syllable was produced as the birds pulsed their breath while exhaling. Also, each syllable was separated by minibreaths – when the birds inhale swiftly after a syllable to replace the exhaled air – allowing the bird to sustain a lengthy recital. The team says, 'The combination of these two respiratory strategies permits high note repetition rates', allowing the males to hit the 15 syllables $s^{-1}$ repetition rate required for a syllable to be deemed 'sexy' by the female. In addition, Suthers and his colleagues found that despite repeating the syllables at an extremely high rate, each syllable still had a wide frequency bandwidth, which is a key feature of sexy syllables, achieved by sequentially alternating two notes, one from either side of the syrinx.

The team explains that as each half of the syrinx is controlled by one brain hemisphere, it is the ability of the males to coordinate the two brain hemispheres (bilateral coordination) to alternate the pair of sexy syllable high and low frequency notes – resulting in a wide bandwidth spectrum – that allows the female to assess her suitor's coordination and quality. They also suggest that listening for two-note sexy syllables allows females to rule out cheats with poor bilateral coordination that could produce similar effects by only using one half of the syrinx.

So, it appears that females have evolved a preference for sexy syllables because they reveal how well coordinated males are. The team says, 'Females who prefer these traits should have a higher probability of choosing a male with excellent bilateral coordination than females that choose based on only one or a few of these traits'.

10.1242/jeb.078253

**Suthers, R. A., Vallet, E. and Kreutzer, M.** (2012). Bilateral coordination and the motor basis of female preference for sexual signals in canary song. *J. Exp. Biol.* **215**, 2950-2959.

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## APPROACHING BATS REDUCE VOLUME EXPONENTIALLY


All echolocating animals face an acoustic challenge. Only a tiny fraction of each echolocation cry returns as a faint reflection: most of the initial call is dispersed through the air. But, as an animal approaches its target, the volume of reflected cries can increase dramatically as the acoustic losses decline. Ulrik Nørum, Signe Brinkløv and Annemarie Surlykke explain that the intensity of a returning echo can increase by four orders of magnitude as a bat closes in from 5 m to 5 cm. However, to overcome the challenge of interpreting the reflections, bats dramatically reduce the volume of their echolocation cries during the final approach, and the pattern that was thought to best match this decline was a logarithmic decrease. However, the trio point out that the logarithmic model fails to accurately predict the bat's volume during the early stages of an approach, suggesting that remote bats produce cries that are much louder than is physically possible. So, Nørum and his colleagues developed another equation – where the volume starts from a maximum and decreases exponentially during an approach – to predict how inbound echolocating animals modulate their echolocation volume and tested the new equation's accuracy by comparing it with the precisely recorded echolocation cries of five species of bat exiting their roosts and hunting (p. 3045).

Successfully recording 53 echolocation sequences, the team found that the reduction in the bats' volume was better matched by the new exponential equation than by the earlier logarithmic model. In addition, the new equation also allows scientists to predict the animal's top volume and the point at which they begin to reduce the volume of echolocation calls as they approach an object. The team suggests that their new model could help us to understand how animals modulate their volume while communicating over a wide range of distances.

10.1242/jeb.078212

**Nørum, U., Brinkløv, S. and Surlykke, A.** (2012). New model for gain control of signal intensity to object distance in echolocating bats. *J. Exp. Biol.* **215**, 3045-3054.

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