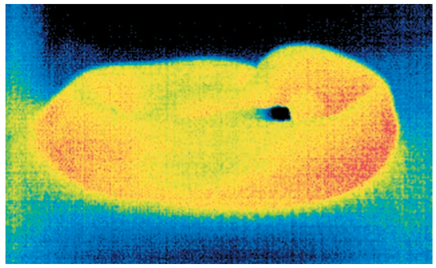
Inside JEB is a twice monthly feature, which highlights the key developments in the *Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

Inside JEB

SNAKES GET THE HOTS FOR BREAKFAST



For most of us, settling down to digest a hearty breakfast isn't the most eventful part of the day. But for many snakes, every meal is breakfast, and digesting unchewed mouthfuls is probably the most energetic thing they do; their metabolic rates rocket. Knowing that a digesting snake has a souped-up metabolic rate, Glenn Tattersall wondered whether digestively active snakes warm up too? After all snakes are not endothermic; they don't normally generate inner warmth. Heading south to Brazil with an infrared camera, Tattersall decided to put well-fed snakes on the spot, and ask them whether they warmed when fed (p. 579).

But when Tattersall arrived at Augusto Abe and Denis Andrade's Rio Claro lab, he didn't find a colony of good-natured snakes waiting to work with him. Instead, he had the pick of a colony of *Crotalus durissus*, South American rattlesnakes, with bad attitudes.

Unphased by the prospect of working with the venomous reptiles, Tattersall set about preparing small and large mouse meals ready to feed the snakes; but he hadn't banked on the reptile's contrary character. Some of the snakes tucked into their mice, while others didn't finish their portion, or simply ignored them. But after a day, enough snakes had satisfied their hunger for Tattersall to begin tracking the reptile's body temperatures while they patiently digested their snacks.

Over the first few hours, Tattersall didn't see much change through the lens of his infrared camera; the snakes blended in well with the thermal background. But after half a day, the snakes began to glow, and after 24 hours, they were clearly 1.5°C warmer then the background temperature. And when he tested the heat given off by a dead mouse after the same time, the mammal's corpse was stone cold. Tattersall wasn't seeing heat produced by a decaying mouse's body; this was a real increase in the reptile's body temperature, entirely due to the rise in their metabolic rate. Once, he even saw discrete hot spots on a snake's body, perfectly matching the number of mice that the reptile had swallowed the day before.

Delighted that the infrared camera had picked up the snake's postprandial hotspots, Tattersall began looking to see if the snakes had any other curious thermal habits. Noticing that the animals always rattled their tails vigorously whenever Simone Brito walked into their room, Tattersall trained the camera on the snake's tails. The shaker muscle lit up with warmth, while the air filled rattle stayed cool.

Having found that rattlesnakes warm after a mouthful of mouse, Tattersall and Brito are keen to see whether pythons do too. They explain that when a rattlesnake swallows its prey, the venom that killed the hapless victim often contributes to the snake's digestive task, breaking the rodent down from the inside. Pythons on the other hand, rely entirely on their gastric juices to digest their breakfasts. But as Tattersall had to return to his lab in Canada, Brito has been left wondering whether the python's extra internal effort might raise the snake's temperature even higher.

10.1242/jeb.00830

Tattersall, G. J., Milsom, W. K., Abe, A. S., Brito, S. P. and Andrade, D. V. (2004). The thermogenesis of digestion in rattlesnakes. *J. Exp. Biol.* **207**, 579-585.

PROTEASE GIVES EGGS THE SLIP

Picture provided by Oleg Gusev

On just a few nights every year, mother estuarine crabs rush down to the beach from their shore-side homes, ready to launch their young on their way. After carrying their precious cargo on tiny abdominal hairs and releasing them into the water, only the abandoned egg cases are left clinging to the mothers' ovigerious hairs. Soon after, the tightly attached cases loosen their grip, leaving the hairs free for the next clutch of eggs. But how the firmly attached cases are shed was a complete mystery, until Masayuki Saigusa began testing the water as the mothers cast their young out into the world. The water seemed to contain a protein that had the power to release the redundant egg cases from the female's body. But what was this mysterious polypeptide? Saigusa and his team set about isolating and cloning the protein to reveal its identity (p. 621).

Knowing that they could only collect the protein from egg-laden females, the team headed off to a roadside beach ready to trap the sea-bound mothers. Oleg Gusev remembers that the crabs were not particularly happy when intercepted, nipping at their captor before he could collect the case-detaching essence.

Back in the lab, the team separated the solutes from the water, testing each fraction on egg laden crab hairs to see which sample would loosen the bound cases. Sure enough, Saigusa found a sample from the water that dislodged the cases, and when he separated the protein components on an SDS-polyacrilamide gel, he discovered two protein chains. Sequencing short sections of the smaller 25 kDa peptide, Saigusa's team was able to get enough information on the short protein to clone it, and discover the protein's identity. It was a serine protease, making it a member of a well-known family of enzymes involved in processing other proteins.

But the team was in for a surprise. The serine protease gene that Gusev cloned seemed to code for a much larger protein than the 25 kDa serine protease that the team had isolated from the water. According to the gene, the egg detaching protein should weigh 54 kDa. What was going on? Why make a large protein when just a fragment seemed able to strip the abandoned cases from the hairs.

Gusev suspects that although the full-length protein contains the serine protease, the protease is only activated after the protein is cut in two. Gusev adds that he is also intrigued by the protein's remarkable environmental tolerance. He explains that most serine proteases are finely tuned, and only function under tightly regulated physiological conditions. But the crab's egg case-dislodging serine protease functions perfectly well, even when it's released into salty estuarine water.

The team is also curious to find which of the crab's tissues produce the protease. Gusev explains that both the mother and her young seem to produce the full length protein well before the youngsters hatch, so it's not clear whether the final dose of case clearing protease is delivered by the mother or her progeny. Either way, Saigusa and his team have their work cut out clearing up the case of the crab's self-cleaning protease.

10.1242/jeb.00828

Gusev, O., Ikeda, H., Okochi, T., Lee, J. M., Hatakeyama, M., Kobayashi, C., Agata, K., Yamada, H. and Saigusa, M. (2004). Purification and cDNA cloning of the ovigerous-hair stripping substance (OHSS) contained in the hatch water of an estuarine crab *Sesarma haematocheir*. *J. Exp. Biol.* **207**, 621-632.

WALKING'S TOUGHER FOR TINY TOTS

Picture provided by Bénédicte Schepens

At the rate that most kids rush around, even watching them is exhausting. But kids don't burn energy just for the sake of it; it takes much more effort for a child to walk and run than an adult. Patrick Willems is fascinated by human locomotion and wondered why children use so much more energy when walking than their parents. Were children's strides using energy less efficiently than their elders, or were they simply using more energy because they were doing more mechanical work while they walked? Measuring the mechanical work done by 3 to 12 year old's as they sauntered along, Willems and his team discovered that children are every bit as efficient as their elders; it's their smaller statures that cost them dear (p. 587).

Despite the old acting adage, Willems remembers that his child subjects were extremely cooperative little walkers, except when he asked them to speed up. Then their competitive sides came out. Some of the youngsters tried 'beating the record', instead of walking slightly faster; which wasn't exactly what he wanted. But once he'd overcome the child psychology, Willems and his team were able to track both children's, and adult's, movements with LEDs tapped to their skin as they strode across a force platform. After recording more then 1000 short walks at various speeds, the team converted the LED's movements into moving 'stick people' before Bénédicte Schepens and Guillaume Bastien began investigating individual strides.

First the team analysed each stride's energetic components. Calculating the amount of energy used by both young and old to swing their legs and move their weight forward, Bastien, Schepens and Norman Heglund also added another component to the work done during a stride; the mechanical work done while both feet were planted on the ground, pushing against each other. Willems remembers that he was pleased when he realised that less than 10% of each stride's energy was wasted while the feet opposed each other on the ground. Willems explains that although this energetic component had been measured before, he'd been anxious that it would take a larger fraction of the young walker's efforts and make a child's stride more costly than an adult's. But adult and children's strides used energy in the same way. So what was causing the children's costly gait?

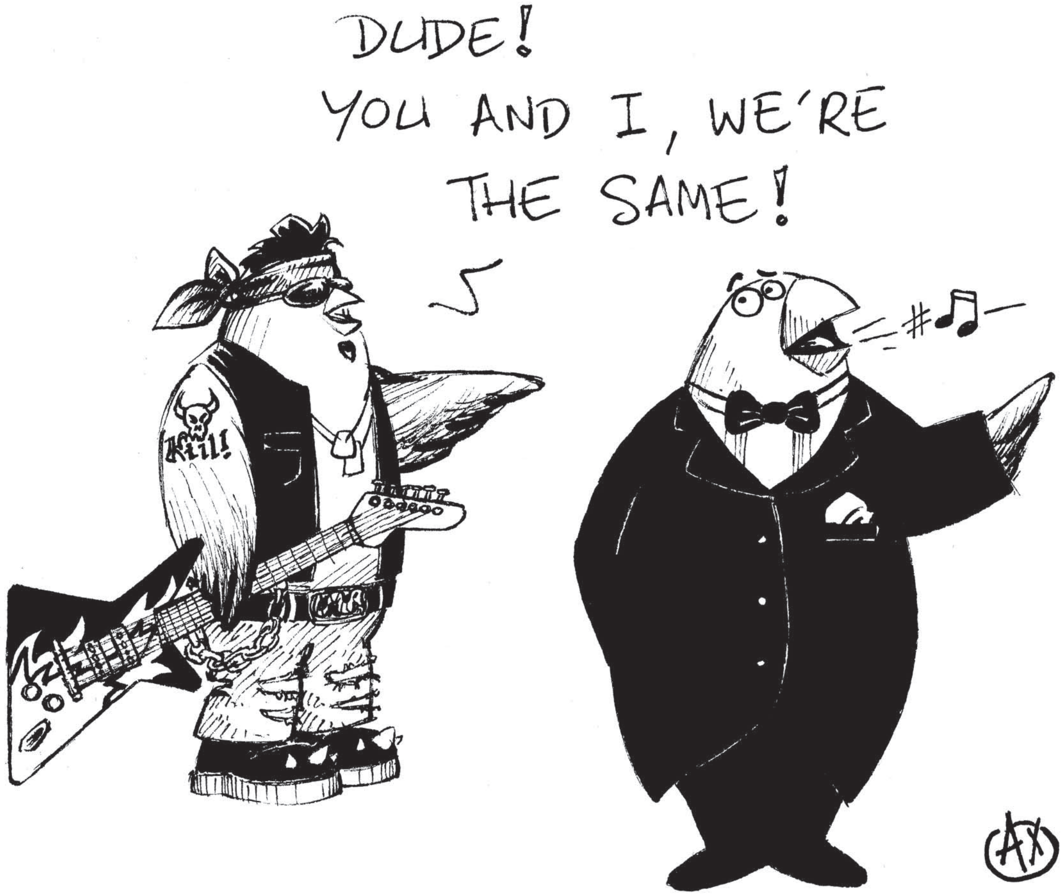
The team decided to see whether the children were using more energy, simply because they were smaller, by 'scaling' them up to the size of adults. Surprisingly the children's scaled up bodies used the same amount of mechanical energy as the adults! It was simply the children's smaller stature that made them use more energy. Willems explains that children's limbs are like short pendulums, which use more energy to swing than longer pendulums. So the children must do more work swinging their short legs, than adults use with their longer limbs.

But size didn't explain all of the differences for the really young children. The scaled up three year olds were using significantly more energy than adults of the same size, '[which] is probably due to an immature muscular pattern of walking' explains Willems.

10.1242/jeb.00829

Schepens, B., Bastien, G. J., Heglund, N. C. and Willems, P. A. (2004). Mechanical work and muscular efficiency in walking children. *J. Exp. Biol.* **207**, 587-596.

FINCHES' BIG BEAKS TRIM TRILLS



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Although the beaks of Darwin's finches have been credited with inspiring the theory of natural selection, it took Darwin almost a year to realise that the tiny birds were all members of the same family and that their intriguingly shaped beaks had evolved in response to their island's ecology. But how do these bird's diverse beak morphologies affect the songs they sing? Jeffrey Podos, Joel Southall and Marcos Rossi-Santos wondered whether the finches adjusted their beak gapes while singing, to adjust the pitch of their whistles, regardless of their beak's build (p. 607).

Filming seven finch species as they serenaded on the Galápagos Islands, Podos and his colleagues analysed the opening beaks, and looked for a correlation with the frequency of the bird's trills. The team found that as the birds hit high notes they threw their beaks wider than when chirruping a low note, regardless of whether they had dainty insect plucking beaks or thickset nut crushers. They add that as birds with larger beaks cannot open them as fast as daintier beaked species, birds with large beaks have evolved songs that trill at a relatively low rate to produce less complex songs, to match their beak's reduced agility. So no matter what their shape, Darwin's finch's all use their beaks in the same ways to enhance their tones.

10.1242/jeb.00827

Podos, J., Southall, J. A. and Rossi-Santos, M. R. (2004). Vocal mechanics in Darwin's finches: correlation of beak gape and song frequency. *J. Exp. Biol.* **207**, 607-619.

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