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

HEAT HELPS DOVES KEEP THEIR COOL

Picture provided by Paul Berquist.

When the going gets hot, most creatures head for shade. But not white-winged doves. They spend the summer in the Sonoran desert where they are perfectly content perched on saguaro cacti, even when the mercury tops 50°C. As Andrew McKechnie explains, there's only one-way to stay cool in those conditions; by evaporation, and white-winged doves are particularly good at it. Most animals manage to keep their temperature down either by evaporating water across the skin, or by panting as the temperatures soar. But McKechnie and Blair Wolf wondered how good the birds are at adjusting to rapid temperature changes. Could they modify their water loss mechanisms quickly when the temperature rose? Acclimating the birds to hot and cool environments, McKechnie tested how well they fared as he turned up the heat, and found that the birds are champions of the cool (p. 203).

McKechnie headed into the sweltering desert where he had no problems netting 14 doves ready to return to the lab. Back in Albuquerque, he segregated the birds, placing half in a temperate room at 21°C, while the remaining birds were released into a searingly hot room where the temperature topped 43°C every day. After three weeks, McKechnie began testing the doves' heat tolerance in a respirometer, where he could track both their water losses and metabolic rates over temperatures ranging from 35°C to 45°C.

As the temperature in the respirometer rose the differences between the birds were instantly clear. The cool-acclimated birds had to work much harder to stay cool, resorting to panting to keep their temperature down, while the hot-acclimated birds seemed relatively untroubled as the temperature hit 45°C. And when he measured the amounts of water that the two groups lost across their skins, almost 80% of the hot-acclimated birds' total evaporative water loss was across their skin, while the birds that had acclimated to the lower temperature only lost 53% of their water across the skin. The hot-acclimated birds had made their skin more permeable to lose water and keep cool.

Measuring their metabolic rates as the temperatures rose, McKechnie also realised that it took much less effort for the hot-acclimated doves to keep their temperature down, than it did for the birds used to cooler climes; which wasn't too surprising. The cool-acclimated birds had resorted to panting as the conditions got stickier, and so their metabolic rate rose much more then the birds that were used to the heat.

McKechnie admits that he is surprised that the hot-acclimated birds were able to increase their ability to lose water across the skin so quickly. Not only would they need to increase their peripheral blood pressure to squeeze fluid out of the blood and across the skin, but they'd also have to alter the skin's permeability by altering the lipid content. He adds that staying cool might not be quite so straight forward back in the desert, where the humidity is very variable, but McKechnie is confident that the bird's fantastic adaptability lies at the heart of their unconventional choice of summer home.

10.1242/jeb.00799

McKechnie, A. E. and Wolf, B. O. (2004). Partitioning of evaporative water loss in white-winged doves: plasticity in response to short-term thermal acclimation. *J. Exp. Biol.* **207**, 203-210.

TROUT HEARTS DON'T ALWAYS SUCK

A trip to the doctor is enough to set most hearts racing; it's hard staying calm when you're having your blood pressure taken. And maybe fish aren't so different. When they're having their blood pressure taken, their heart rates rocket. But when Michael Axelsson and Jordi Altimiras monitored trout heart rates as they rested peacefully in a tank, their pulse rates were quite low. Could fish's racing hearts affect their cardiac performance and blood pressure? All pressure measurements taken on fish's hearts in the past had been done in perfused hearts where the heart rates were much higher than if they were resting peacefully. These measurements from the fast rate hearts suggested that the pressure in the first chamber of the fish's heart, the sinus venosus, was negative; their hearts appeared to suck blood around the body as the ventricle contracted. But no one had actually measured the pressure in the beating heart's sinus venosus directly. Altimiras wondered whether the pressure in the fish heart's first chamber would be negative if he could drop their heart rate to a more realistic rate (p. 195)? But this was easier said than done.

Altimiras realised that if the fish wouldn't do it on their own, he'd have to help them. Remembering that rat heart rates could be reduced with a dose of zatebradine, Altimiras tested the drug on trout; their heart rate fell to the resting rates he'd seen in the untroubled fish. After checking that the drug didn't alter any other aspects of their cardiovascular function, he decided to measure the pressure in the sinus venosus.

But no one had ever directly measured the pressure in the chamber, and Axelsson and Altimiras knew this was a technically challenging problem. Working together they learned how to gently cannulate the sinus venosus, ready to measure the pressure in the chamber. Finally, they were ready to test how the fish's cardiac pressure varied as they gently slowed the trout's beating heart.

Not surprisingly, as they began the experiment when the fish's heart rate was high, the pressure in the sinus was low, just as Altimiras expected. But as the team increased the dose of zatebradine and the fish's pulse rate fell, the pressure in the chamber began increasing until it became positive as the fish's heart rate approached the resting fish's pace. At the low heart rates that resting fish experience, the heart was behaving almost like a mammal's, producing a positive pressure in the sinus venosus and filling the heart.

Altimiras explains that although this increase in cardiac pressure had never been measured before, it wasn't unexpected. As the heart slows and the length of time between each heart beat increases, the ventricle has longer to fill and stretch the muscle, ready to pump the blood out with an increased pressure. If the heart rate fell low enough, it would eventually be able to generate a high enough flow to maintain a positive pressure in the sinus venosus throughout a heart beat cycle. So it seems that the trout heart's function depends on the fish's level of activity, switching from low to high pressure in the sinus venosus as it settles down for a rest.

10.1242/jeb.00800

Altimiras, J. and Axelsson, M. (2004). Intrinsic autoregulation of cardiac output in rainbow trout (*Oncorhynchus mykiss*) at different heart rates. *J. Exp. Biol.* **207**, 195-201.

HILLS CATCH WALLABIES ON THE HOP

Picture provided by Craig McGowan

Getting around can be tough; but thanks to specialised muscle–tendon units in their limbs, most creatures cope well, no matter how rough or hilly the terrain. Many limb muscles are long and involved in moving joints, while some muscles are so short it seems unlikely that they can contribute to joint movements. Instead, these short muscles are thought to act as dampers, cancelling out unwanted vibrations with the help of the long elastic energy-storing tendons that they attach to. But is that all there is to these small muscles, or can they contribute to the increased demands when an animal changes gear; for example when speeding up or climbing hills? Although some animals can use these muscles for extra power it was not clear whether super-efficient wallabies rely on these muscles for this purpose as they hop around the outback. In an international collaboration that spanned the Pacific Ocean, Andrew Biewener and his colleagues tested whether tammar wallabies use two short lower leg muscle groups either to contribute power in the animal's legs, or for economical force generation and vibration damping (p. 211).

Biewener hopped off to Adelaide University in Australia to train four wallabies to bounce on treadmills, either on the flat or up a moderate incline. According to Biewener, the wallabies were extremely cooperative, resting quietly between experiments in pouch-like bags. Once the animals were happy on the treadmill, the team fitted them with instruments to record contraction forces and length changes in the lateral gastrocnemius and the plantaris muscles, as well as measuring the muscles' electrical activities. But there was no difference in the muscle lengths or the amount of work done as the animals hopped along the flat or uphill. So the muscles weren't contributing to the increased work of hopping uphill, but were sticking to their main job of minimising work and the cost of force production by elastic energy-savings in their tendons. Biewener suspects that there is a 'division of labour' between the muscles in the upper and lower portions of the leg. He suggests the upper muscles are responsible for the increasing work output as the animal ascends a hill or accelerates, while the shorter lower leg muscles are responsible solely for energy-savings. Although wallabies appear not to use their short muscles to power themselves uphill, other creatures, such as running turkeys, may be able to adjust their short muscle–long tendon units to contribute power over tougher terrains. Biewener is keen to put more species through their paces to find out whether the tammar wallaby is unique in this respect.

But the mystery of the wallaby's efficient hop is not entirely solved. Biewener explains that the secret of their low-energy bounce must depend on the muscle–tendon unit's design, but other animals have also evolved similar highly specialised designs that do not result in the same energy savings. So, it's still unclear exactly how the wallabies can operate so efficiently, but Biewener intends to continue his wallaby studies with the hope of understanding how different creatures have adapted their legs to bounce, hop and run across varying terrains.

10.1242/jeb.00802

Biewener, A. A., McGowan, C., Card, G. M. and Baudinette, R. V. (2004). Dynamics of leg muscle function in tammar wallabies (*M. eugenii*) during level *versus* incline hopping. *J. Exp. Biol.* **207**, 211-223.

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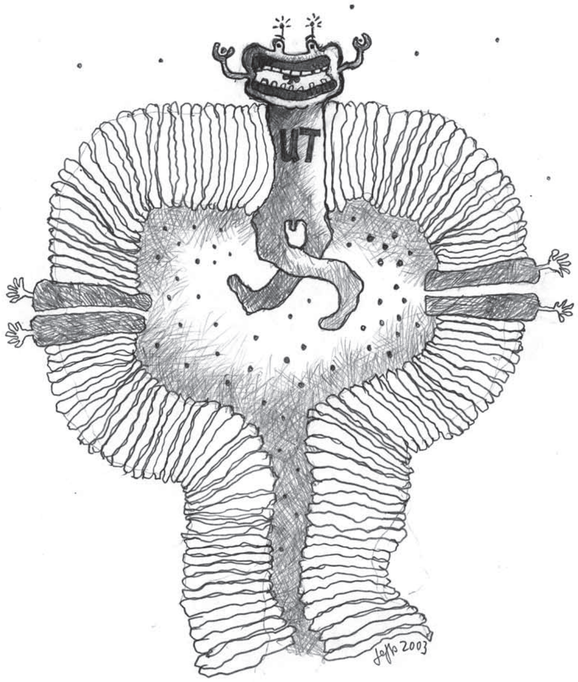
FACILITATING WASTE RECYCLING

THE UREA TRANSPORTERS' SONG



WELL WE LIVE UPON A LOBULE, NOT A BRINDLE, NOR A GLOBULE
PUMPING UREA AGAINST ITS WISHES UP THE SPOUT...
IN THE PAST ITS BEEN SO DIFFICULT TO FIND US, IN THAT LABYRINTHINE SINUS,
THAT DIVERS DEFINITIONS OF OUR LOCATION FLOAT ABOUT...

BUT ONCE YOU'VE CUT THE KIDNEY INTO SLICES WITH YOUR MICROSCOPIC KNIFE
THE LATERAL BUNDLE FROM THE MESIAL FALLS AWAY –
YOU THEN UNDO THE NEPHRITIC HOOPS WHERE SEVERAL TWISTS TURN INTO LOOPS
YOU'LL FIND A TUBULAR SEGMENTED REGION ON DISPLAY...

THE ELASMOBRANCH DEPENDS UPON OUR EFFORTS AMIDST THESE BENDS
FOR ISO-OSMOTIC IN THEIR HABITAT THEY MUST BE –
SHOULD WE CALL A STRIKE – THEY'D SIMPLY END UP – "UP THE DYKE,"
A FISHY TALE OF MARINE EXTINCTION BENEATH THE SEA!

Pete Jeffs is an artist living in Paris, France.

Most creatures need to excrete urea, or suffer their waste product's toxic effects. But a little urea isn't a bad thing for many, and for elasmobranchs, it's positively beneficial, so they recycle as much urea as possible, pumping urea out of their urine back into their urea saturated bodies. But how wasn't clear. Although several teams had suggested ways that elasmobranchs could reabsorb urea, no one had come up with conclusive evidence for the mechanisms that allow the dogfish to pump urea back into its body against a concentration gradient. Knowing that a urea transporter protein had been identified in a spiny dogfish's kidney, Susumu Hyodo and colleagues from the University of Tokyo began searching for a similar protein in the kidney of a close relative, *Triakis scyllia* (p. 347).

Using the spiny dogfish's urea transporter, the team were able to identify a urea transporter protein in *Triakis*' kidney, and then make a specific antibody to the new protein, ready to probe the protein's distribution through the kidney. The transporter was found exclusively in the kidney's collecting tubule, which is surrounded by a complex arrangement of countercurrent tubules that produce a low urea environment around the collecting tubule, confirming that urea reuptake in the dogfish's kidney is by facilitative diffusion.

10.1242/jeb.00801

Hyodo, S., Katoh, F., Kaneko, T. and Takei, Y. (2004). A facilitative urea transporter is localized in the renal collecting tubule of the dogfish *Triakis scyllia*. *J. Exp. Biol.* **207**, 347-356.

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