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

WHISPERING BATS ARE SHRIEKING


Picture by Signe Brinkløv

Annemarie Surlykke from the University of Southern Denmark is fascinated by echolocation. She really wants to know how it works. Surlykke equates the ultrasound cries that bats use for echolocation with the beam of light from a torch: you won't see much with the light from a small bulb but you could see several hundred metres with a powerful beam. Surlykke explains that it's the same with echolocating bats. Some have big powerful calls for perception over a long range, while others are said to whisper; which puzzled Surlykke. How could 'whispering' bats echolocate with puny 70 dB cries that barely carry at all? Teaming up with her long time collaborator Elizabeth Kalko from the Smithsonian Tropical Research Institute and student Signe Brinkløv, Surlykke decided to measure the volume of a pair of whispering bat species' calls to find out how loud the whisperers are (p. 11).

Travelling to the Smithsonian Research Institute's Barro Colorado Island in Panama, Surlykke decided to focus on two whispering members of the Phyllostomidae family: *Artibeus jamaicensis* and *Macrophyllum macrophyllum*. According to Surlykke, the Phyllostomidae family of bats are unique because of their remarkably diverse lifestyles and diets. Some feed on fast moving insects while others feast on fruit hidden in trees, making them an ideal family to study to find out how echolocation works.

But measuring the volume of the bat's echolocation calls was extremely challenging. If Surlykke was going to get true volume measurements from hunting bats on the wing, she would have to be certain that the bats were facing head on and that she could measure their distance from the microphone so that she could correct for the volume lost as the call travelled to the microphone. Setting up an array of four microphones, the team recorded 460 cries, which Surlykke eventually whittled down to 31 calls for *M. macrophyllum* and 19 for *A. jamaicensis* that she could use.

Correcting the volume measurements, Surlykke was delighted to find that far from whispering, the bats were shrieking. The tiny insectivore *M. macrophyllum* registered a top volume of 105 dB, while fruit feeding *A. jamaicensis* broke the record at 110 dB, a remarkable 100 times louder than a 70 dB bat whisper and almost twice as loud as *A. jamaicensis*.

Surlykke suspects that she can explain the differences in the animals' volumes by their different lifestyles. She explains that the relatively large *A. jamaicensis* feeds on fruit, which it probably locates through a combination of senses, including smell and short-range echolocation whispers. But the bats have to search over large areas to find fruiting trees, and Surlykke suspects that the bat uses its high volume, well-carrying shrieks for orientation in their complex forest environment.

However, tiny *M. macrophyllum*'s lifestyle is completely different. They hunt for insects over water, scooping them up with their tail. Surlykke says that she suspected that *M. macrophyllum* would be louder because she couldn't see how the animals could locate moving insects with a low intensity echolocation call, but admits that she was amazed that they were so much louder and that they could also adjust the volume to match their prey.

10.1242/jeb.027656

Brinkløv, S., Kalko, E. K. V. and Surlykke, A. (2009). Intense echolocation calls from two 'whispering' bats, *Artibeus jamaicensis* and *Macrophyllum macrophyllum* (Phyllostomidae). *J. Exp. Biol.* **212**, 11-20.

COST OF HATCHLING TURTLES' DASH FOR FREEDOM

A newly hatched sea turtle's first swim is the most critical of its life. Having run the gauntlet of air and land predators to make it to the sea, the tiny voyager must also evade hungry fish patrolling the beaches in its bid for freedom. For youngsters hatching on the Great Barrier Reef's coral cays the risks are high: as many as 30% perish as they head for safe deep waters. But how much does this headlong dash through the waves cost the intrepid hatchlings? Curious to know, David Booth from the University of Queensland decided to measure hatchling turtles' oxygen consumption rates as they swam for safety (p. 50).

Travelling north to the university's research station on Heron Island, Booth was fortunate enough to have a laboratory within metres of a green turtle nesting beach. Visiting the beach as the mothers-to-


Picture by Nick Holmes

be lumbered up on to the sand, Booth was able to collect several clutches of eggs and move them to the edge of the nesting site for safety from other egg-laying mothers. Returning to the site several months later as the eggs were about to hatch, Booth intercepted several youngsters before they reached the sea. Transporting them 100 m up the beach to the research station, he fitted each hatchling with a lycra swim suit with a chord attached to a force transducer, before setting the youngster free in a seawater aquarium. As soon as they entered the water, the youngsters began swimming frantically with their large front flippers, pulling against the force transducer as if they were swimming out to sea. Meanwhile, Booth measured the youngsters' oxygen consumption as they swam for 18 h to find out how hard they were working.

Watching the youngsters' swimming style, Booth could see that initially the animals swam very hard using their front flippers with their heads down, only switching to a 'doggy paddle' as they came up for air before returning to frenzied front-flipper swimming. But as time drew on, the youngsters' activity slowed. They spent more time doggy paddling and less time pulling with their front flippers until they eventually began taking the odd break after about 12 h.

The youngsters' progress was also reflected in the force with which they tugged on the force transducer. Setting off with a thrust of 45 mN, the swimmers' thrust rapidly dropped to 35 mN during the first half hour, continuing to fall more gradually over the next 10 h before levelling off at 20 mN about 12 h after embarking.

Analysing the hatchlings' oxygen consumption, Booth found the same trend with oxygen consumption falling rapidly during the first half hour, before declining more slowly and eventually levelling off after 12 h. So what does this mean for a young turtle as it thrashes to safety?

Calculating the amount of energy that the hatchlings consumed during their 18 h swim (4.79 kJ), Booth realised that the turtles carry almost 10 times as much energy in their yolk remnants as they needed to reach safety. So the youngsters aren't at risk of running out of energy before reaching deep water, and Booth suspect that they can probably survive 14 days in the open ocean before finding food.

10.1242/jeb.027623

Booth, D. T. (2009). Swimming for your life: locomotor effort and oxygen consumption during the green turtle (*Chelonia mydas*) hatchling frenzy. *J. Exp. Biol.* **212**, 50-55.

GILLS SWITCH ATPASE DOMAIN TO SWITCH PUMP DIRECTION


Picture by Steffen S. Madsen

Anyone who's spent too long in the bath knows that too much time in water isn't good. But fish spend their entire lives immersed in fluid, and for fish that migrate from freshwater to saltwater, the problem is even more complex. They have to maintain a stable body salt concentration (~320 mmol l^{-1}), regardless of the external salt concentration. Steffen Madsen from the University of Southern Denmark explains that salmon, which spend part of their lives in rivers, have to continually reabsorb lost ions while in fresh water. But as soon as they relocate to the sea, they have to start pumping ions out of their bodies as they seep in. According to Madsen, fish excrete or absorb salts through specialised cells in their gills, and one of the key proteins involved in ion transport is the Na^+,K^+-ATPase. Madsen explains that Na^+,K^+-ATPases power the majority of ion movement by consuming ATP to pump sodium out of ion-transporting cells to establish a sodium gradient that ultimately powers other ion transporters. Wondering how the gill reverses its pumps as a fish moves from fresh to salt water, Madsen began monitoring the expression levels of key Na^+,K^+-ATPase components to find out how the pump responds to freshwater and saltwater conditions (p. 78).

Transferring young salmon from freshwater to seawater, Pia Kiilerich took samples of the fish's gills until the animals had adjusted to the new conditions 7 days later. Monitoring the Na^+,K^+-ATPase activity, Madsen could see that the enzyme's activity increased significantly as the fish became acclimated to the salty conditions. The fish needed to pump more ions in the salty conditions.

Next, Madsen began investigating changes in the enzyme's composition in response to the environmental change. According to Madsen, the intact Na^+,K^+-ATPase protein is composed of two subunits (α and β) and the α subunit can be expressed in different forms (isoforms) in the gill. Knowing that the gill seems to switch expression of the α isoforms in response to salinity changes, Madsen decided to quantify the amount of each isoform's mRNA in the fish's gill. Measuring the mRNA levels, Madsen and Christian Tipsmark realised that two of the α subunit isoforms dominated the transcription pattern and that the fish seemed to switch from α_{1a} transcription in freshwater to α_{1b} in seawater.

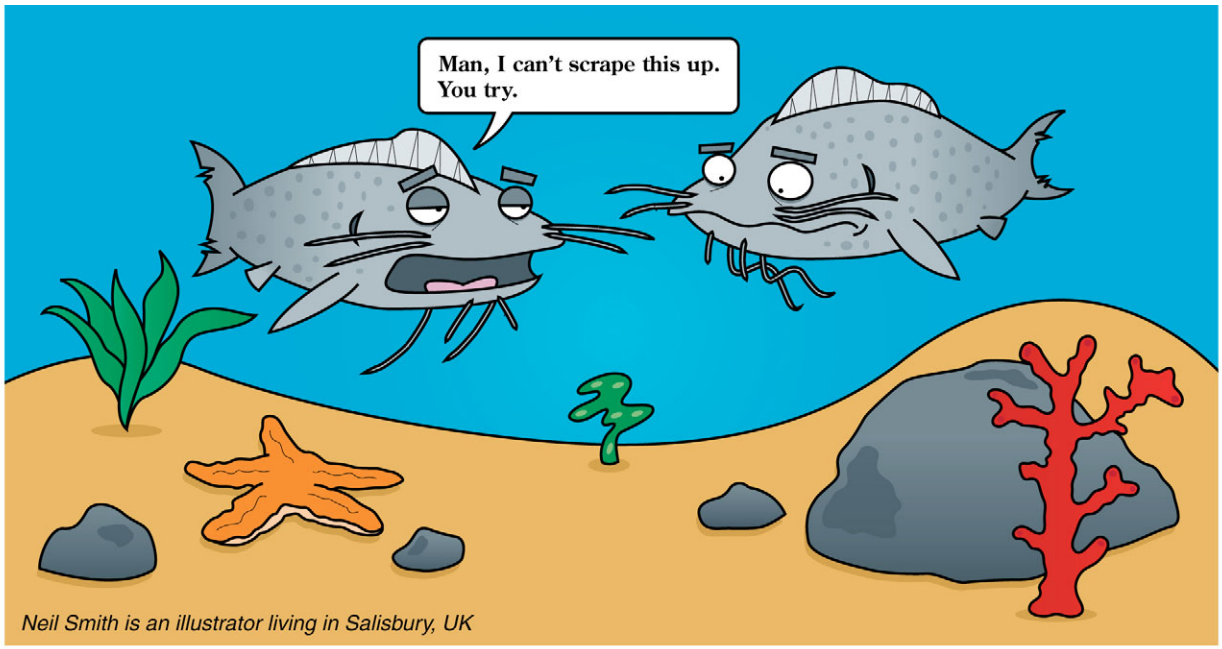
But where did these changes happen in the fish's gill? Tracking the location of α subunit expression in the fish gills in freshwater, Madsen found high levels of α_{1a} mRNA in the lamellae and filament. However, when the fish adjusted to their new saltwater home, the α_{1a} transcript retreated to deep within the filament while the previously restricted α_{1b} spread throughout the filament.

Madsen is very excited that the gill switches between the α subunits in response to the environmental change. He explains that the osmotic gradient between the fish's tissues and its surroundings is 20 times greater in freshwater than in saltwater. Suspecting that the α_{1a} subunit consumes significantly more ATP per pumped sodium ion than the α_{1b} subunit, Madsen suggests that this allows α_{1a}-rich gill cells to maintain a greater sodium gradient than cells packed with the α_{1b} subunit. The steeper sodium gradient could then power ion transport into the fish's blood from dilute freshwater, while the shallower sodium gradient generated by the α_{1b} subunit could be sufficient to rid salmon of ions that seeped into their blood from seawater.

10.1242/jeb.027631

Madsen, S. S., Kiilerich, P. and Tipsmark, C. K. (2009). Multiplicity of expression of Na^+,K^+–ATPase α-subunit isoforms in the gill of Atlantic salmon (*Salmo salar*): cellular localisation and absolute quantification in response to salinity change. *J. Exp. Biol.* **212**, 78-88.

WHAT TURNS A SLURPER INTO A SCRAPER?



Neil Smith is an illustrator living in Salisbury, UK

Catfish have opted for one of two different ways to feed. They either slurp up whatever takes their fancy, or scrape it off surfaces with their mouths. How scrapers evolved from slurpers intrigues a team of Belgian scientists led by Peter Aerts at the Universiteit Antwerpen. Sam Van Wassenbergh explains that the first thing you have to do if you want to understand how slurpers become scrapers is to understand how slurping relatives of modern scrapers feed now; they may have some of the attributes necessary to make the transition from slurping to scraping (p. 116). So, Van Wassenbergh and his colleagues filmed and analysed the feeding techniques of an African and a South-American bottom-feeding slurper, both of which are closely related to modern scraping feeders, and compared them with a more distantly related slurper. The team found that the bottom feeders' brain cases barely rotated at all while they were feeding, just like their scraping cousins. They also suggest that catfish with deep and narrow heads may be able to get closer to the ground when slurping food up, and this feature could have allowed the scraper's suction-feeding ancestors to make the lifestyle change.

10.1242/jeb.027664

Van Wassenbergh, S., Lieben, T., Herrel, A., Huysentruyt, F., Geerinckx, T., Adriaens, D. and Aerts, P. (2009). Kinematics of benthic suction feeding in Callichthyidae and Mochokidae, with functional implications for the evolution of food scraping in catfishes. *J. Exp. Biol.* **212**, 116-125.

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