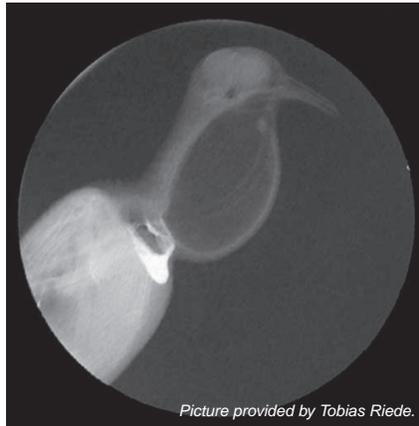


Inside JEB is a twice monthly feature, which highlights the key developments in the *Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

Inside JEB

COO FILTERING



Picture provided by Tobias Riede.

When some creatures want to get a message across there's no substitute for opening the mouth and calling. But not all: a few animals manage to vocalise, even with closed mouths. Tobias Riede explains that some birds, frogs and even primates project their mating calls through inflated air spaces, but how these animals communicate without using their mouths to modulate sounds puzzled him. Thanks to Gabriël Beckers and Roderick Suthers in Bloomington, Indiana, Riede already knew that the sounds emitted from the syrinx of the dove, which inflates its throat as it coos, were acoustically filtered to remove overtones and produce a sound with an almost pure single tone. But which structures in the throat act as acoustic filters and how they function wasn't clear. Riede and his colleagues decided to get inside a dove's skin, to find out how they call-filter (p. 4025).

Watch a cooing dove, and the first thing you'll see is the bird's throat swell with air, but Riede needed to know which internal organs became inflated during the serenade. The only way to view the throat's internal workings was to persuade a bird to sing in front of an X-ray camera. Contacting William Blevins at Purdue University, Riede asked if he could use the veterinary college's state-of-the-art X-ray equipment to collect X-ray movies of a bird's performance.

Riede remembers that once the birds had settled down in front of the camera, getting them to coo was straightforward; they started as soon as they heard another male's voice or saw a nearby female. And the movies were spectacular; the team could clearly see an enormous air bubble forming in the upper cervical oesophagus. However, the crop region of the

oesophagus never inflated, suggesting that it featured little in dove sound production.

Knowing which regions of the throat became inflated as the bird cooed, the team inserted tiny tubes into the bird's trachea and oesophagus to record the coo's spectrum as it progressed through the throat. Comparing spectra from both regions of the throat with the sound recorded outside the bird's body, Riede realised that the trachea first damped some of the syrinx's overtones, while the oesophagus seemed to filter out the remaining harmonics.

Combining these results with a mathematical model that Riede and Neville Fletcher had derived previously, the team suspects that the trachea and oesophagus work together as acoustic filters, stripping the overtones while amplifying the coo's main tone. Riede suspects that the trachea may behave as a tube resonator that is closed at one end and tuned to the main tone's frequency by a variable sized opening at the top. This partially damps the overtones, before the sound is transmitted to the inflated oesophagus where the oesophagus outer wall and skin resonate at the main tone's frequency, further damping the overtones and transmitting the pure call as doves coo their piece.

10.1242/jeb.01325

Riede, T., Beckers, G. J. L., Blevins, W. and Suthers, R. A. (2004). Inflation of the esophagus and vocal tract filtering in ring doves. *J. Exp. Biol.* **207**, 4025-4036.

TURKEYS PUT THEIR HIPS AND ANKLES INTO IT

It's a long time since humans had to rely on two feet for a speedy get-away, but for most creatures, a good sprint take off can make all the difference to life and death. Tom Roberts explains that acceleration during an escape is an essential aspect of natural selection. Yet the biomechanics of acceleration is barely understood, probably for good reason; getting an animal to accelerate reliably is notoriously difficult. But this didn't deter Roberts and his research assistant, Jeffrey Scales. They boldly set about startling turkeys into a trot to investigate which leg joints contribute to the bird's accelerating sprint, and found that the hip and ankle are key players in the bird's acceleration (p. 4165).

According to Roberts, working with running turkeys over the years had its moments. The males just have a 'bad

Picture provided by Tom Roberts.



attitude'; you can never be sure when they'll turn on you! Fortunately the females are relatively cooperative, so when Roberts needed to film the surly birds accelerating across a force plate, Scales landed the job of startling the female sprinters. But even the females' psychology was contrary, and despite adjusting their startle tactics to each bird's temperament, Scales and Roberts could only use 10% of the 500 sprint sequences they filmed to investigate the bird's acceleration biomechanics.

Digitising the position of the bird's hip, knee, ankle and tarsometatarsal-phalangeal joints as they strode across the force plate, Scales and Roberts were able to calculate the work done at each joint as the birds accelerated, and found that surprisingly, the ankle and hip were the only joints that produced the work required to accelerate the birds. The knee and tarsometatarsal-phalangeal joints didn't contribute at all to the bird's acceleration.

Intrigued, Roberts and Scales wondered how the muscles attached to the working joints powered the bird's acceleration. Were they contracting with more force, or were they contracting over a longer distance? Roberts knew that if he analysed the distance swung by each joint as the bird's accelerated, he could distinguish between both types of contraction to find out how the birds power a get-away. Analysing each joint's trajectory, Roberts and Scales realised that the muscles in the hip and ankle increased the length they shortened by as the birds sped up.

But Roberts was puzzled. How could the ankle produce so much mechanical work, when the large muscles joined to the joint were attached through springy tendons? Surely the muscle's work would simply be soaked up by the elastic tendon, rather than contributing to the bird's acceleration.

Roberts decided to 'think about the problem in another way'. He explains that when an animal trots at a constant speed,

the limb muscles do no net mechanical work; the leg muscles store work in tendons during the first half of the step, recovering the stored work when the muscle stops contracting in the second half of the step as the body moves forward. Roberts suspects that the accelerating birds also use energy stored in the tendon by muscular contraction. In this case, he suggests that the muscle continues contracting, after storing elastic energy in the tendon during the first half of the step. He believes that by combining the work stored in the tendon with the contracting muscle's work in the later stage of the step cycle, sprinters get off to a flying start.

10.1242/jeb.01323

Roberts, T. J. and Scales, J. A. (2004). Adjusting muscle function to demand: joint work during acceleration in wild turkeys. *J. Exp. Biol.* **207**, 4165-4174.

PENGUINS RISING



Picture provided by K. Sato.

If your favourite snack is fish or octopus, then most animals only have one choice; hold your breath and dive. And with only a lungfull of air to get you through the excursion, it would seem to make sense to get back to the surface quickly. But when Katsufumi Sato began monitoring the diving behaviour of foraging penguins, he realised that instead of returning vertically to the surface, the birds took a more leisurely route; they returned along a gentler incline. Intrigued by this unexpected finding, Sato decided to investigate the bird's underwater behaviour, to find out why macaroni penguins ascend gently (p. 4057).

Travelling to Kerguelen Island in the South Indian Ocean, Sato teamed up with his French collaborator, Jean-Benoît Charrassin, ready to tag macaroni penguins and track their dives. But the duo had to find volunteers to accompany them to the penguin's nesting site before their base research facility would allow them to venture into the wilderness alone. Fortunately Amélie Lescroel, Laurent Mely

and Florent Colin were free to accompany them to Cape Cotter Colony.

Setting up camp near the beach, Sato attached tiny data loggers to the penguins. Luckily the birds were unphased by the scientists, and didn't seem to notice the data loggers once secured on their backs. It was Sato who was in for a stressful time, waiting for the intrepid voyagers to return from their two week round trip. Would the data loggers remain attached? Would they collect good data? The team kept a round-the-clock watch on the penguins' nests ready to retrieve the data loggers when the birds returned. And two weeks latter, their patience was rewarded when all eight penguins returned their data loggers safely, packed full of acceleration and depth recordings from their foraging dives.

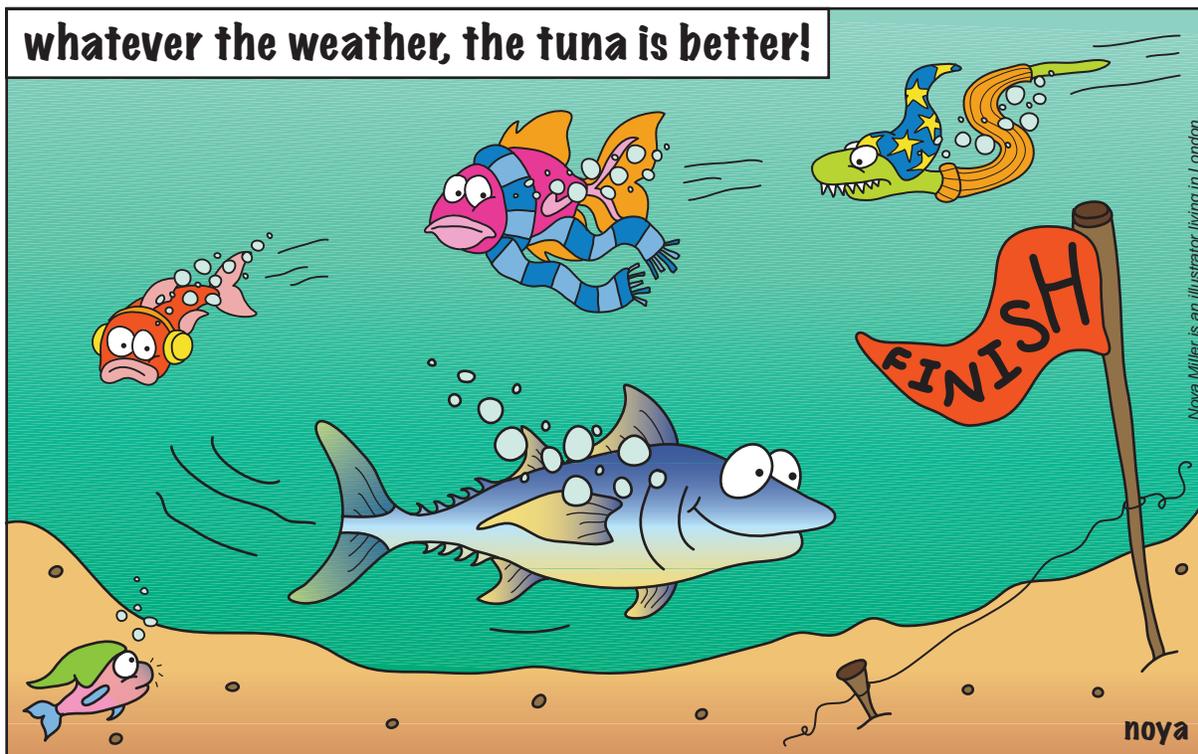
Undaunted by the amount of data from almost 7000 dives, Sato calculated the bird's angles of ascent and descent from the acceleration records. Surprisingly, the birds seemed to use different diving strategies depending on how long they remained at depth. When the birds dived and spent only a brief time at depth, they returned to the surface at a shallow angle, and followed with another dive also at a shallow body angle. But when the penguins spent a lengthy period at depth, their surfacing angle was much steeper, and subsequent redives were also steep. Sato also analysed the birds' wing beat pattern as they swam and found that, just like other penguins, the macaronis swam hard during the descent phase of the dive, and later during the first half of their ascent. However, while the birds were at depth, they glided along without swimming, and also allowed their natural buoyancy to complete their return to the surface without taking a stroke.

But why use different dive strategies depending on the amount of time spent at depth? Sato suspects that the birds use shallow angled dives when the pickings are meagre and they need to cover greater distances to find a decent meal. But when they happen upon a tasty shoal, they use steeper ascents to get back to the surface quickly, before plunging steeply again to make the most of the awaiting feast.

10.1242/jeb.01324

Sato, K., Charrassin, J.-B., Bost, C.-A., and Naito, Y. (2004). Why do macaroni penguins choose shallow body angles that result in longer descent and ascent durations? *J. Exp. Biol.* **207**, 4057-4065.

WHY TUNA ARE TOPS



During the last 3000 years, man and the tuna have had a close association; many early civilisations based around the Mediterranean Sea trapped the fish as part of their diets. More recently, man’s attention has been caught by the tunas’ extraordinary physiology, which allows them to exploit environmental niches closed to other fish. In a Commentary published in this issue of the JEB, Jeffrey Graham and Kathryn Dickson explain that ‘comparative physiologists seek to understand the mechanism and biological significance of physiological adaptation, and tunas satisfy all criteria essential for this’ (p. 4015).

Describing the tunas’ unique swimming style and body shape, Graham and Dickson also explain many advantages of this group’s ability to retain body heat through countercurrent heat exchange tissue, retina mirabilia, which help to maintain the fish’s extreme performance levels even when venturing into icy northern waters. The team also discuss the fish’s elevated aerobic scope and standard metabolic rate, which coupled with their specialised oxygen transport system allow them to achieve levels of performance beyond the physiological capacities of other fish.

But while many questions about tuna

physiology have recently been resolved, many remain outstanding, and will continue to intrigue comparative physiologists for decades to come.

10.1242/jeb.01322

Graham, J. B. and Dickson, K. A. (2004). Tuna comparative physiology. *J. Exp. Biol.* **207**, 4015-4024.

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