Tongue Power! (p. 3621)

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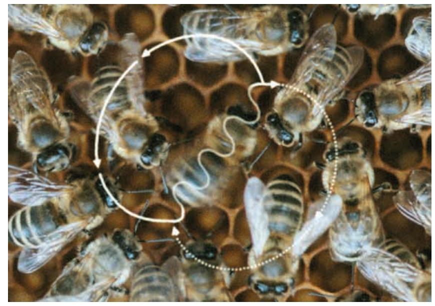
Listening to Anthony Herrel list his favourite beast's talents, you'd be hard pressed to think of a superhero with half as many powers. Everyone knows that chameleons change colour for camouflage and communication, but not many of us know about the unique tongue that the lizards use for hunting. Chameleons are not your run-of-the-mill hunters. They just sit in a tree waiting for some tasty prey to wander past. Once dinner has appeared, the hungry lizard fires out its tongue, sometimes extending it by more than twice its own body length! This is an astounding feat in itself, but the story doesn't end there. Having captured its prey, the lizard has to drag the meal back to the branch it's sitting on. But how does a muscle that has stretched to more than a thousand times it original length contract, yet keep pulling? Herrel and his colleagues have revealed the structural properties that give the tongue its exceptional supercontractile powers.

He set up a game of Tug of War between a tethered cricket and a chameleon to see just how hard they could pull. No matter how often he offered the chameleon a cricket, the lizard tried to tug it back, sometimes hard enough to tear the cricket apart! He measured the force several chameleons exerted over a range of distances. Remarkably the chameleons were able to produce forces up to almost 0.8 N over a range of distances from as little as 20 cm to twice their own body length!

Muscle fibres are built up from two types of protein filaments. Myosin is the major protein in thick filaments, and thin filaments are made up of actin. At a microscopic level, Z disks link adjacent thin filaments to form a lattice. The thick filaments lie within the lattice, and the thick and thin filaments are cross-bridged by tiny myosin levers. When normal muscle contracts the myosin levers rotate and the thin filaments slide along the adjacent thick filaments. The movement stops when the Z disks crash into the end of the thick filament, so it is the Z disks that limit muscle contraction. Herrel realised that the chameleon had found some way around this restriction.

Having proved that the muscle could contract forcefully over an unprecedented range of distances, Herrel took a close look at the muscle's microscopic structure. He found that conventional muscle and the chameleon's supercontracting tongue muscle only differed in the Z disks. The chameleon Z disk structures were not solid: they were perforated. The Z disks wouldn't limit contraction, because the thick filaments could pass through allowing the tongue muscle to contract beyond the range of normal muscle.

Although a few other lizards have this remarkable capacity none of them are close relatives to the chameleon, 'suggesting that this is a recent adaptation' says Herrel. He believes that the supercontractile adaptation is coupled to the lizard's life style. If dinner is sitting on an adjacent branch, the chameleon doesn't have the choice to walk to it. The only choice is to drag dinner over by shear tongue power alone!



Waggle Wobbles Wax (p. 3737)

Humans are not the only creatures that live in massive colonies. Bees have well developed social structures, and communication underpins the hive's delicate social structure. The waggle dance is probably the best-understood example of bee communication. Once a forager has located a flower full of nectar, he returns to the hive and dances, transmitting crucial details about the find to the followers back home. But the message only gets through if the dancer can catch the follower's attention. Jürgen Tautz and his colleagues have taken a closer look at the dancing bees and found something that could explain how bees alert each other. The dance vibrations are transmitted through the honeycomb in a way that amplifies the signal, so even remote bees know to attend the dance.

The waggle dance is a series of vibrating moves. The bee straddles a honeycomb cell, and grips the wax walls while it vibrates its body, at frequencies up to 300 Hz. As long ago as 1967, Karl von Frisch suggested that comb vibrations could be involved in bee communication, because the hive is too dark for the bees to rely on visual communication. But von Frisch lacked the sensitive methods needed to prove that the bees were reacting to tiny vibrations in the wax.

In the mid 1990s, Tautz and his co-workers began looking at the acoustic properties of the wax dance floor. The breakthrough came when Tautz was able to measure the tiny displacements generated by the dancing bees using two laser vibrometers.

More recently, Tautz has investigated how the vibrations travel through the comb. While analysing the way the waves spread across the dance floor, he noticed a curious effect: as the wave travelled through the walls of the honeycomb, it suddenly changed phase over the width of a single cell, so that the walls were moving in opposite directions, amplifying the vibration. Tautz says 'this finding took us by surprise' but he didn't know if the bees would respond to it.

Tautz repeated the experiments with the bees playing the roles of vibrator and detector. Knowing which cell walls would vibrate with the phase reversal effect, he looked to see if bees straddling those cells responded more strongly than bees at other points on the dance floor. They did. Phase reversal amplified the signal enough to catch the attention of remote dance followers, and attract them to the centre of the dance floor.

For Tautz, the next stage is to identify the neurological basis for how the bees sense the vibrations. But he points out that this work is also of interest to architects and engineers. He says 'Honeycombs have evolved over 50 million years, so you can assume…. that bees have found the optimal solutions for all sorts of problems.' Tautz's analysis of waggle dance vibrations could help to explain how waves travel through massive buildings, as well as directing bees to the best source of nectar.

Running the Blockade (p 3779)

Iron's role in respiration gives it pride of place among the major nutrients that all organisms must absorb for survival. Most animals consume iron in the ferric (Fe^{3+}) state, but they absorb it through the gut wall as soluble ferrous iron (Fe^{2+}). Terrestrial organisms

have an acidic gut environment that reduces ferric iron to soluble ferrous iron that can be absorbed easily. However, marine fish that have adapted to life in a saline environment have a basic gut, which is believed to be one of the fish's adaptations to keep it in osmotic balance with the dehydrating environment. But Fe^{2+} is insoluble at a high pH. Wouldn't a basic gut compromise the fish's ability to absorb divalent iron cations? In this issue of J. Exp. Biol. Nic Bury reports that marine fish can absorb iron as Fe^{2+}, despite the unfavourable conditions.

Working in Denmark, Bury had access to flounders trawled from the Baltic Sea. Despite the sea's unusually low salinity levels, the fish still had a basic gut environment, so Bury set out to see whether Fe^{2+} was the preferred form for iron transport, and if it was, to find out how the divalent cation was crossing into the blood stream.

Bury used radiolabelled iron to test whether Fe^{2+} or Fe^{3+} entered the fish's blood stream. Having established that the bulk of iron transport was in the reduced Fe^{2+} state, he divided the gut into short sections to see if he could localise the region that transported the most iron. All regions of the gut showed some Fe^{2+} uptake, but Bury found that the majority of absorption took place at the posterior end of the gut. This is in stark contrast to iron uptake in mammals, where the majority of divalent cation transport occurs in the first loop of the intestine. Bury admits that this was a surprise, and it isn't clear why fish have moved iron transport so far along the intestine.

Bury says 'we know so little about iron uptake in fish, that we need to hurry it along a bit'. But he's clearly had a good start and there are plenty of lines of enquiry still open, such as identifying an iron specific divalent cation transporter gene and figuring out what it is that keeps iron reduced in the first place. There's still a lot of physiology to do before he can explain the mystery of iron transport in marine fish.

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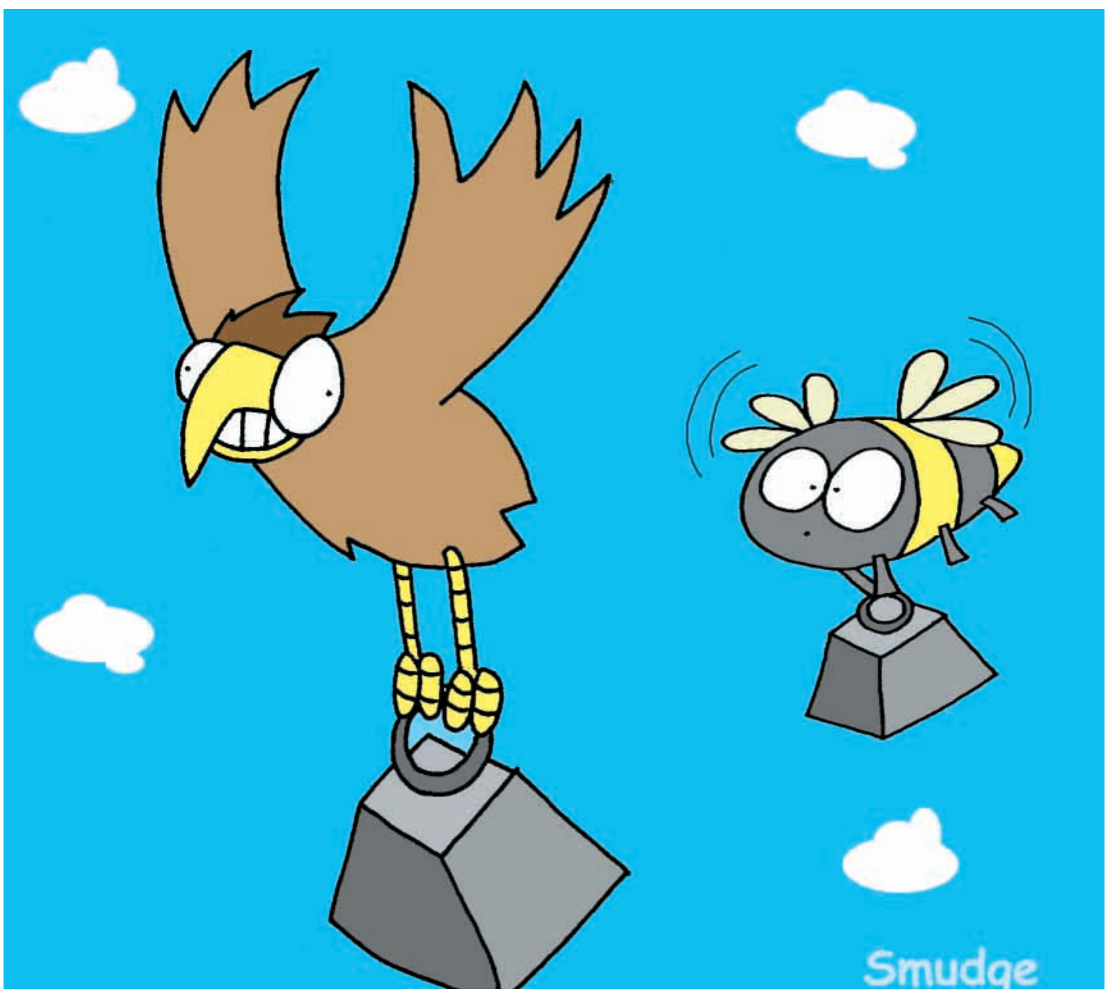
The Journal of Experimental Biology 204, i-ii (2001)



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