During steamy summers, itchy bites remind us that female mosquitoes are remarkably adept at tracking us down. To add insult to injury, mosquitoes urinate on us while they greedily gorge on our blood. As Geoff Coast explains, feeding mosquitoes swell up to twice their size, and to make sure that they can still take off after their feast, the insects urgently need to pump out all the unwanted water and salts from their blood meal. In the 1980s, Klaus Beyenbach and his colleagues reported that mosquitoes solve this problem by flushing out copious amounts of sodium-rich urine. They found that the insects release a peptide that triggers sodium-rich urine production, and they dubbed this hormone mosquito natriuretic peptide, or MNP. For years, MNP’s chemical identity remained elusive. Now, Coast and his colleagues reveal that MNP is a calcitonin-like diuretic hormone (p. 3281).

Coast explains that MNP acts on mosquitoes’ Malpighian tubules, the insect equivalent of a kidney. When MNP binds to its unique receptor on the membranes of the Malpighian tubules’ principal cells, it triggers the production of cyclic AMP, an intracellular messenger that causes sodium channels in the cell membrane to open, flushing sodium out of the insect’s body. ‘There were two likely candidates for MNP’s chemical identity’, Coast says; MNP was either a corticotropin releasing factor (CRF)-related peptide or a calcitonin (CT)-like peptide, because both are recognised diuretic hormones in fruit flies, and both produce cyclic AMP as their messenger.

First, Coast and his colleagues confirmed that mosquitoes are able to produce these two peptides. David Schooley scoured the genome of the malaria mosquito (Anopheles gambiae) for sequences that match the known fruit fly sequences for the CRF-related and CT-like peptides. Sure enough, he found the two candidate peptides in the mosquito genome, synthesised them and sent them off to Coast.

The team was now ready to test the effect of the two peptides on mosquitoes’ Malpighian tubules. They carefully dissected out insects’ tubules and moved them to a microscopic droplet of bathing fluid held under liquid paraffin, where the tubules continued to exude urine. Would either of the two candidate peptides have a diuretic effect, just as MNP does? Disappointingly, when the team added the CRF-related peptide to the bathing fluid, the tubules’ secretion rates only increased a little. But when they added the CT-like peptide, the secretion rates shot up 10-fold, exactly as you would expect from a diuretic hormone. So far, the CT-like peptide was the most likely suspect in the search for MNP’s identity.

But the defining feature of MNP is that it helps mosquitoes pump out sodium ions, so the real test was still to come; the team needed to show that the CT-like peptide also triggers increased sodium ion transport. Sure enough, when the team bathed mosquito tubules in the CT-like peptide and examined ion concentrations in the tubules’ secretions, they saw a dramatic increase in sodium ion transport. But they didn’t see a change in sodium ion transport when they bathed tubules in the CRF-related peptide. Clearly, only the CT-like peptide acts as a sodium-expelling hormone. As a finishing touch, the team showed that the CT-like peptide, but not the CRF-related peptide, mimics the effects of MNP on tubule electrophysiology. The CT-like peptide had passed all the tests with flying colours; the team concluded that MNP is a CT-like peptide. Now they just need to show that mosquitoes actually release the CT-like peptide into their bloodstream when they feed, which is easier said than done when you’re working on such diminutive creatures!

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Harbour porpoises roam the cold, murky waters of the Northern hemisphere, where it can be hard to spot tasty schools of fish. To locate its dinner, a porpoise sends out high-frequency clicks and carefully listens out for the echoes bouncing off any prey lingering in the hunter’s transmission beam. By locking their sonar onto inanimate objects like nearby rocks, porpoises also gain an intimate knowledge of their underwater surroundings, which is especially useful in dark, murky waters. But do porpoises also use echolocation to work out where they are? Although it’s assumed that porpoises use sonar for spatial awareness, nobody has shown conclusively that the marine creatures use echolocation as a navigational tool. While investigating the swimming and echolocation behaviour of two harbour porpoises, Ursula Verfuß, Lee Miller and Hans-Ulrich Schnitzler discovered that porpoises really do rely on sonar to navigate, even though the animals they studied were swimming through familiar territory (p. 3385).

‘Researchers interested in echolocation behaviour usually give dolphins or porpoises a target object to find, like a fish hanging in the water’, Verfuß explains. As a result, we have plenty of evidence that these toothed whales use echolocation to track down their prey. But to provide clear evidence that porpoises also use echolocation for spatial orientation, Verfuß needed to show that porpoises use echolocation when there are no target fish in the water.

Teaming up with Miller and Schnitzler, Verfuß travelled to Kerteminde in Denmark to find out whether porpoises use echolocation while swimming across a familiar pool. The team studied two captive harbour porpoises in an outdoor pool supplied with a flow of seawater from the Great Belt and Kerteminde Fjord. They decided to see if porpoises use sonar while performing a simple task – swimming in a familiar pool containing relatively clear water, which meant that the animals should be able to see where they are going. The team soon trained the porpoises to swim from one side of the pool to the other and used two surveillance cameras suspended above the water to film the porpoises as the animals swam across the empty pool. At the same time, they recorded the porpoises’ high-frequency clicks using hydrophones placed underwater at each end of the pool.

Would the porpoises still emit clicks, despite the fact that there were no fish to lock their sonar beam onto? Since the animals were swimming in a familiar pool containing clear water, the team suspected that the porpoises would mainly rely on their eyesight to make their way across the pool. But to their surprise, they recorded a continuous stream of clicks from the porpoises as the animals swam across the pool. What’s more, they noticed that the time interval between clicks decreased as the porpoises approached the end of the pool. Verfuß explains that a decreasing click interval as a porpoise approaches an object reveals that the animal has locked its sonar onto that specific object. In other words, as they made their way across the pool, the porpoises appeared to be locking onto specific landmarks at the other end of the pool. The team concludes that, even when harbour porpoises swim along a familiar and visible route, these small whales use echolocation to make sure that they know where they’re headed.

Some expert jumpers, like tiny tree frogs, use a mechanical trick to boost their jumps: instead of relying on sheer muscle power to take off, they store and release elastic energy to provide extra power during a jump. Havalee Henry, David Ellerby and Richard Marsh now report that helmeted guinea fowl use a similar elastic storage mechanism to help them get airborne (p. 3293).

Guinea fowl are reluctant flyers; they spend most of their time scurrying around on the ground. But in desperate situations, the birds resort to a rapid takeoff by leaping into the air. Marsh and his team examined how the birds power their jumps. The obliging birds were happy to launch themselves off a force plate, encouraged by the prospect of a juicy cricket after each successful jump, while the team captured the birds’ leaps on high-speed video. To calculate the power produced by the birds’ leg muscles, the team tracked the position of each bird’s centre of mass by painting markers onto the birds and analysing the markers’ positions in successive video frames. They confirmed these calculations using the forces recorded by the force plate as the birds took off.

Marsh’s team measured peak power outputs of nearly 800 W kg⁻¹ of leg muscle during the birds’ jumps, which is far beyond what a bird’s muscles can deliver; the team calculated that a jumping guinea fowl’s leg muscles produce 330 W kg⁻¹. Yet, clearly, the birds still managed to leap enthusiastically off the force plate. The team concludes that guinea fowl store elastic energy in their tendons, which is released during a jump to help the birds get off to a flying start.


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