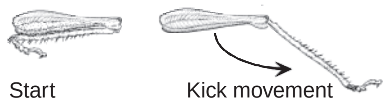



## Kick Like a Locust (p. 3471)

The secret behind the flea's extraordinary jump was discovered in 1967 when Henry Bennet-Clark realised that the tiny athlete was launched by a spring, not muscle. Later, he found that locusts use similar systems to project themselves into the air, but the mechanical details remained obscure until Malcolm Burrows focused a high-speed camera on the left leg of a locust.

Using lower resolution 1970s technology, Bennet-Clark had shown that some of the energy that goes into the locust's kick is stored in the external cuticle and a tendon. A couple of shield-like structures in the hinge joint, called the semi-lunar processes, also store energy, but how that energy was released into the kick wasn't clear.

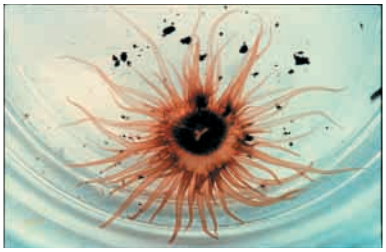
Filming jumping locusts isn't easy, but if you hold them on their backs and tickle their feet, you can get some pretty vigorous kicks out of them. Genevieve Morris filmed the hinge joint moving, at 1000 frames per second. She captured deformations in the semi-lunar processes as they stored the energy before it was released in the explosive kick that lasts just 5-6 ms!

Morris's film showed that the kick begins up to a full second before the leg swings forward. The first stage of the kick, when the leg retracts, charges the spring structures by bending the semi-lunar processes ready to power the kick. She saw that the semi-lunar processes don't release their energy as the leg begins to move, but stay locked in place until the leg has swung about 50 °. At this point Burrows and Morris heard a loud clicking sound, accompanied by the semi-lunar processes unfurling suddenly to unleash their stored energy.

Malcolm Burrows wasn't just interested in the mechanics of the kick but also in the nerve signals that trigger it. Working together, Burrows and Morris were able to watch each stage of the kick and relate it to the nervous impulses that fired off at each stage of the kicking movement. The key to the kick's force is the number of nerve spikes received by the extensor muscle. As the number of nerve spikes to the extensor muscle increased, the semi-lunar processes became more deformed. Burrows already knew that the locust's fastest kicks came when the semi-lunar processes were most deformed, so he realised that the extensor muscle nerve was the kick's main control.

But all this energy has to be dissipated somehow, otherwise the locust is in danger of dislocating its leg with every kick. Burrows and Morris watched the tibia as it reached the end of the swinging arc and saw that it bent up to 35 ° once the hinge was fully extended. They believe that the tibia is behaving like a shock absorber, dissipating the energy when the leg oscillates at the end of the kick.

Although the semi-lunar processes aren't the only players in the locust's kick, they do deliver the coup de grace. And Bennet-Clark is pleased to see that his 1975 analysis has stood the test of time; he says that Burrows' work is 'a considerable refinement!'



## Coral's Colour Comes Unstuck (p. 3443)

Images of bleached coral in the press are a grim reminder of some of the ecological perils that face the planet at the turn of the 21st century. The effects on Australia's Barrier reef of 1998's El Niño suggest that variations in sea temperature pose the biggest threat to the planet's reefs. Work by Sara Sawyer and Leonard Muscatine provides some of the first evidence that temperature-triggered cellular processes may be letting our coral reefs fade.

Corals are symbiotic life forms, whose vivid colours come from the algae that reside inside microscopic animal host cells. Bleached corals have lost their algal lodgers, leaving a dull scaffold behind. It had been thought that the algae were being lost from the animal host cells, but it became apparent that the coral was also shedding host cells, algae and all, and that was how the majority of the damage happened. Understanding the mechanics of coral cell adhesion would go a long way to explaining how coral bleaching happens.

Changes in cellular calcium levels play a strong role in cell adhesion, so Sawyer reasoned that something similar might be happening in the coral cells. She set about looking for a calcium-induced effect using a variety of pharmacological agents that block calcium activity. The hope was that if she could produce bleaching using a compound which she knew disrupted calcium pathways, it might give a clue to how heat-shock causes corals to bleach. Focusing her attention on a sea anemone and a coral from temperate Hawaiian waters, Sawyer began testing. Which meant a lot of time staring down a microscope. Her patience was finally rewarded when caffeine produced the symptoms of coral bleaching. But when she looked to see if there was any change in intracellular calcium levels, she didn't find any.

Caffeine interacts with several other cellular pathways and she knew that caffeine regulates protein phosphorylation in the cell. Having ruled calcium out of the equation, she looked to see if caffeine was regulating cell adhesion through a phosphorylation pathway.

By modifying the activity of different enzymes involved in regulating protein phosphorylation, she was able to produce the bleaching effects that she had seen with caffeine. But the best direct evidence that phosphorylation, and not calcium, was the main culprit, came from comparing the phosphorylation patterns of bleached and unbleached corals.

This doesn't mean that calcium is not involved in bleaching in other corals, but it seems likely that it plays a minor role in these Hawaiian species. Rising levels of UV radiation are another factor that causes coral bleaching by modifying the activity of some of phosporylation mechanisms. Which makes protein phosphorylation an attractive offender, because both environmental triggers could be linked through one common mechanism.

## Flirting Finches (p. 3497)

Heather Williams thinks that courting zebra finches communicate as much by their dance as they do with their song. So imagine the scene, a glance across a crowded branch. Their eyes lock, he bursts into a song and dance routine. Is this the latest smash hit musical from the film studios of Bombay? No, it's 'boy meets girl' zebra finch style.

Each male has his own unique mating song that he learns when he's a fledgling, but once testosterone kicks in, the song is fixed, and he never learns another note. Which could be a problem for our zebra finch love story if his song doesn't catch the girls. By watching these courtship rituals, Williams realised that certain dance movements encouraged the females to respond, even if they couldn't hear his chattering song. Was his feather puffing posturing dance hard wired along with the song?

She chose 10 male performers, and watched how they serenaded, recording their entire dance more than 100 times. She broke each dance down into two types of moves: opening and closing the beak, and general body movements. Then she averaged together the 100 dances she recorded per bird to see whether each one had a specific pattern of movements that corresponded to the syllables of his song.

First she watched their beaks dancing. For each bird she found certain beak movements were tightly tied to syllables of the song, but at other notes, they just moved their beak differently every time they performed. Each bird had his own beak-dance, and some stuck to their routine more rigidly then others.

But what happened with the body dance? Untangling the different dance steps that the bird uses is a much more complex task than deciding whether he moves his beak, so she lumped together all the jerky body movements and looked to see if the birds always jiggled about at the same points in the song. This wasn't as clear-cut as the beak-dance, as only a few syllables had a strongly tied dance movement.

Knowing that a few parts of the dance seemed to be intrinsic to the song, she looked to see how a father's song compared to his son's. She noticed that the youngsters had added and dropped the odd syllable, but the songs were almost identical. And when she compared dance steps, syllable-by-syllable, the related birds used almost identical dance moves. The dance had been passed from father to son!

Williams explains that there could be two reasons for the dance inheritance. The son could learn the bobbing dance from his father, which would be an advantage because he knows that the father's dance 'works'. Or else, the bird's breathing could affect when it can move. Some syllables might let it move freely, while it might be more difficult to bob to others. If the song and dance are physically linked, a song learned from a father will come complete with a set of dance steps.

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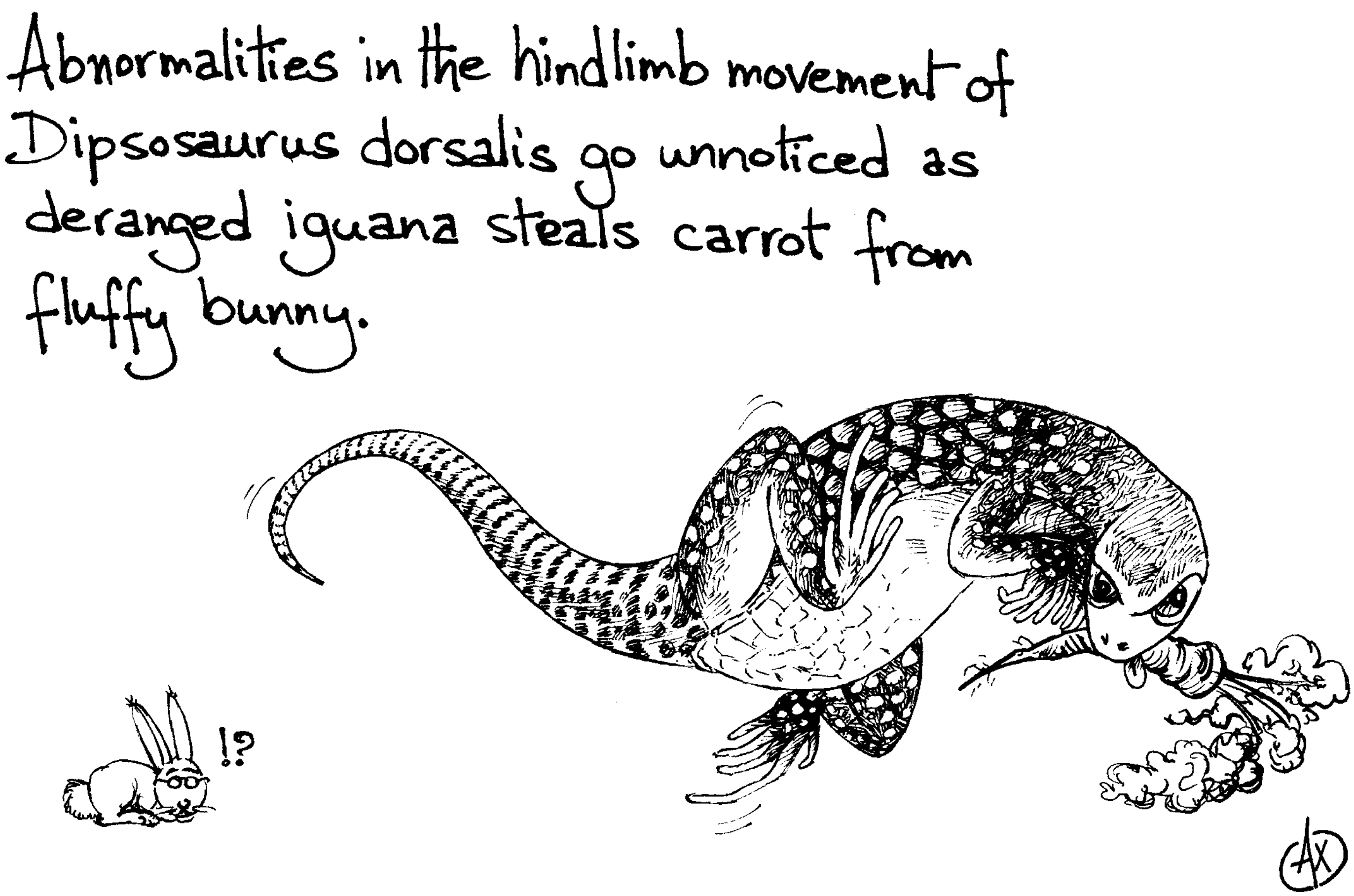


**Nelson, F. E. and Jayne, B. C.** (2001). The effects of speed on the *in vivo* activity and length of a limb muscle during the locomotion of an iguanian lizard, *Dipsosaurus dorsalis*. *J. Exp. Biol.* **204,** 3507-3522.