

Four shakes a second

Why are animals so keen to get rid of water in their fur? *Andrew Robinson* on the physics behind beastly behaviour

FURRY LOGIC

by *Matin Durrani*
and *Liz Kalaugher*



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In China, the appearance of panicky rats is an officially designated earthquake precursor. According to a scientific report, in 1974, a housewife in Yunnan province found rats running about her house from May 5. On the night of May 10, they were so noisy she got up to hit them. Then she recalled a visit to a government exhibition on earthquakes and evacuated her family. The following morning, a magnitude-7.1 earthquake destroyed the house.

Assuming these events were not coincidence – and there are numerous reports of animal sensitivity before earthquakes, dating back to a prescient rabbit in Sparta circa 464 BC – exactly what had the Chinese rats detected? And how might this particular biophysics work? Unfortunately, no scientist has more than the slightest reliable evidence. To quote some honest introductory words in *Furry Logic: the Physics of Animal Life*, “If biology’s your bag, the key

thing to remember about physics is that it’s much easier than biology.” Still, given the mind-boggling ingenuity of animals with mechanics, sound, electricity and so many other aspects of physics that is so winningly documented by the book’s authors – Matin Durrani, editor of *Physics World*, and Liz Kalaugher, a science writer with a PhD in materials science – I am inclined to think that rats could be genuine seismic detectors.

Furry Logic offers six chapters on six subjects of traditional importance in physics – heat, forces, fluids, sound, electricity and magnetism, and light – and their revelation in animal behaviour. But little knowledge of physics and not much of biology is assumed, although plenty of numbers are on show with minimal mathematics. Rather, the book is an appealing mix of familiar animals such as dogs, squirrels, bees and mosquitoes, exotics such as the elephant, rattlesnake, electric eel and giant squid, and the life stories and weird research techniques of physicists and biologists, past and current, famous and unknown.

Insight and entertainment go hand in hand, despite too many puns: some apt and funny (“time to squidaddle”), others merely puny (“to bee or not to bee”).

Consider how animals, unlike humans, dry their wet skin by shaking themselves in order to prevent loss of body heat by evaporation of the water. Researchers in the United States have experimented by soaking 16 species, ranging from a baby mouse and a poodle to a tiger and a brown bear, and then filming the animals spinning themselves dry with cameras running at up to 1,000 frames per second, about 40 times faster than television. The smallest are seen to oscillate fastest and the largest slowest. A mouse completes about 31 shake cycles per second, a domestic cat nine and a brown bear four. A 30kg labrador, with 500g of water in its fur, uses about 100 joules of energy



to shake itself dry, as against 480 kilojoules, almost 5,000 times more energy, if it dries without shaking. The latter figure equates to roughly 110 food calories, compared with the dog’s daily intake of about 800 food calories. “That’s about a third of a can of dog food, which no mutt’s keen to waste on staying at the same temperature.”

However, size is no indicator of strength. One amazingly powerful little crustacean, the harlequin mantis shrimp, is only 10cm in length and 60g in weight but it can knock holes in a crab’s shell to get at its dinner, and smash its way through the glass of an aquarium, with a club-like dactyl that exerts a peak force more than 2,500 times the shrimp’s weight. It manages this feat with two techniques: storing energy from its muscles in its stiff exoskeleton

by compressing it; and striking so fast that the water molecules separate from each other, creating a “cavitation” bubble that implodes with an enormous release of energy. To survive the recoil, the dactyl contains a layered structure of nanoscale cracks that deflect and dissipate the shock; moreover, the exoskeleton replaces itself every three to four months.

In addition, the shrimp’s bulbous eyes contain 16 visual pigments, compared with just three in humans and two in dogs. How on earth did natural selection design such an improbable creature? This question arises incessantly while enjoying *Furry Logic*. Researchers have few answers. After all, rats are likelier to survive a seismic convulsion than cows. Yet cows wired with seismic sensors remain placid even during an earthquake – let alone before.

