Planet of the Apes: Furry mammals evolved a tuned spin dry

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When a wet dog shakes himself dry, he does something amazing. He hits just the right rhythm to maximize the drying effect with minimal effort. The seemingly casual jiggle imparts enough centrifugal force to expel 70 percent of the water in his coat in a fraction of a second.

This fact comes courtesy of experiments by David Hu, a professor of mechanical engineering and biology at Georgia Tech. He and his students found that the highly tuned drying ability is shared by 30 other furry mammals.

Hu thinks engineers can learn from some of the remarkable features that evolution has built into living things. He envisions harnessing this ability for devices that can dry or clean themselves, something like a Mars rover programmed to jiggle the dust off its solar panels.

He was initially inspired to study wet mammals by a toy poodle named Jerry, who was a gift to his current fiancee from her former boyfriend. Jerry ended up in Hu's lab, where high-speed cameras recorded and measured the rhythm by which he shook his coat dry.

Before Jerry, Hu had been interested in the way animals interact with water, but his focus had been on the insect world. Thanks to the surface tension of water, many insects can easily get stuck in a puddle or pond once they get wet. Predatory bugs called water striders - the subject of Hu's doctoral thesis - get around this with hairy feet that barely touch the water's surface.

The adaptation allows striders to make dinner out of less water-adapted insects.

Hu realized that surface tension also trapped water on mammals, and shaking was a common adaptation that helped them deal with it. The project expanded from Jerry to guinea pigs, lab mice, and a house cat.

In search of more mammals, Hu sent one of his graduate students to the Atlanta Zoo to spritz water on lions, tigers and bears, and record their drying techniques.

Fur, said Hu, is great for keeping animals insulated in cold air. It's not so good when it rains or when a furry animal falls into a frigid lake. Then, the fur can hold in cold water next to an animal's skin. A thoroughly wet 60-pound Labrador retriever, for example, holds about a pound of water.

Letting it dry by evaporation would sap energy equal to 20 percent of the dog's daily calories.

If an animal needs to get rid of the water to stay warm, then it's much more efficient to shake. Hu's study showed that most of the mammals that were observed did it. He watched shaking mice, rats, cats, goats, sheep, lions, tigers, bears, and giant pandas, to name a few. But the big surprise was that there was a predictable pattern across all these species - all imparted about the same amount of centrifugal force to expel water.

The force depends on the size of the animal and the frequency of the shake, Hu said, so to get the same force, little animals shake faster than big ones. Bigger dogs shake about three or four times a second; mice, about 30 times.

The water-expelling force also depends on how big the shakes are - their amplitude - said Hu, and most of the animals studied added oomph to

each shake by having loose skin.

A dog, for example, shakes his spine through an angle of about 30 degrees, but his floppy skin swings through a full 90-degree angle. This, they measured by putting stickers on the dogs' backs and watching their motion.

Hu said he hasn't figured out a good way to get stickers on the backs of the lions and tigers - at least not yet.

Hu and his students Andrew Dickerson and Zachary Mills published their results in the *Journal of the Royal Society Interface*, which specializes in work that combines biology and engineering.

Shaking is a useful adaptation, but did it show up in some ancestral mammal millions of years ago, or did it evolve independently in different lines? That's hard to say, said evolutionary biologist Frank Fish of West Chester University. Fish said mammals probably co-opted the ability to shake, which originated far back in the evolutionary tree. Sharks, for example, do some fast twisting to help them tear up their prey.

"We can see the ability to twist all the way back to the first vertebrate."

Since evolution is basically a descent by modification, he said, mammals probably inherited the ability to shake from distant ancestors, and then modified it as a way to get dry.

And shaking with a definite rhythm isn't such a surprise, he said, since it happens all over the animal world. Dogs pant with a regular frequency, he said, tuned to help them get maximum cooling with minimum energy expenditure.

One mammal that doesn't seem too well-equipped to shake dry is the human being. Hu said he tried it once after a shower when he forgot to take a towel.

"It didn't work very well," he said. Humans don't have fur, so perhaps our ancestors lost the ability somewhere along the evolutionary line. There's also one type of hairless guinea pig that doesn't shake off water, he said. "They just sit there and shiver."

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