

Podcast Interview: Alexis Noel and David Hu

PNAS: Welcome to Science Sessions. I'm Paul Gabrielsen. It's well-known that cats are fastidious groomers. But the extent of the cat tongue's suitability for the task was not known. In a recent PNAS paper, Alexis Noel and David Hu of the Georgia Institute of Technology detailed the microstructures on a cat's tongue. These structures, called papillae, had long been thought to be shaped like solid cones. Noel and Hu found, however, that the papillae are instead hollow wicks with properties that make the cat tongue a prime instrument for preening. Their research has led to a bio-inspired brush. The full applications of this artificial cat tongue are still being explored.

Although Noel and Hu had been studying animal tongues for several years, their research into cat tongues began with Noel's cat, Murphy.

Noel: And I had gone back home for a small break and had observed this thing with Murphy's tongue where he jumped on my lap and started licking this microfiber blanket. He got his tongue stuck in one of those small loops of the blanket.

David and I had been talking about how cat tongues were like sandpaper, and by observing this, it looked a lot more like Velcro than sandpaper. So we'd gone back to the lab and took the cat tongue out of the freezer. We had about, what, 15 different tongues in that freezer at the time? And so we had taken this cat tongue out and stuck it under a microscope and that's really where our study began.

PNAS: The full extent of the papilla structure wasn't evident at first. Here's Hu.

Hu: These things are really small. You can barely see them with your eye, and you definitely can't see the scoops with your eye.

Noel: And they're transparent.

Hu: And transparent. We missed it ourselves for at least a year or two. I think Alexis only figured it out serendipitously, by accident.

Noel: We had actually started this study where I'd gotten a piece of pork from the supermarket and gotten one of those fresh dissected cat tongues, and I had literally taken a cat tongue and pulled it across the surface of the pork. And it did a really good job of shredding the meat but when I went to wash the tongue, it was dyed red, which was really strange, because typically blood doesn't dye biological tissues. And so, it was the little spines that were dyed red. Normally they're transparent. So I took one of the spines off of the cat tongue and stuck it under a microscope. And the meat actually lodged itself into this little cavity and illuminated it beautifully. So you could really see what that cavity looked like.

Imagine a cat claw. It's actually pretty much the same shape of a cat claw with the curvature. So, it's a cat claw that's really, really small, about the size of half a grain of

rice, 1-2 millimeters in height. And imagine the tip of the cat claw, rather than coming to a point, actually creates a little u-shaped cavity. Kind of like cutting a coffee straw in half. And so, the tip of the claw or the papilla is a u-shape and then as it goes down towards the base it flattens out and becomes a lot more shallow as it goes to the base. And then at the very bottom of the base there's actually another cavity that is used to attach the papilla to the tissue of the tongue.

PNAS: The cavities hold saliva and help move it down through the fur to the cat's skin.

Hu: In fact, that's the only way cats can keep themselves cool. They only have sweat glands on the bottom of their feet. So only by sort of panting and by covering themselves in saliva can they actually stay cool. They lick themselves about once per second. So, you can imagine, each time they lick it's only a tenth of an eyedropper drop that comes out of these papillae. But over a day, it can be almost 48 grams. That's about 3 tablespoons of cat saliva.

PNAS: Using CT scans of the papillae, Noel and Hu fabricated a brush that recreated many of the properties of the cat's tongue. It's called TIGR, an acronym for tongue-inspired grooming brush. The authors have filed a provisional patent of the brush technology.

Noel: We found some really interesting aspects of the cat tongue brush where if, when we had hairs tangle inside of the brush, all we had to do was wipe a single finger across the surface and all of the hair would come off in a single bundle. As opposed to, like, human hairbrushes where you have to pull all that loose hair out with tweezers or with scissors. It's really a big pain.

PNAS: The researchers are still exploring the applications of the brush, ranging from depositing cleaning solutions into deep carpets to applying medications directly to a cat's skin. The brush may also have applications for removing allergens from cat fur. Allergenic proteins in cat saliva are normally deposited throughout the fur during grooming.

Noel: And so we're thinking, well, why don't we try and reverse that process? They've shown that if you were to wash a cat, like, give a cat a bath - which is not a fun prospect - but, if you give a cat a bath, the allergens take about a week to replenish. So people with cat allergies actually don't have cat allergies with freshly washed cats. So, if we were to develop our TIGR brush to be able to distribute leave-in shampoo to dissolve away some of these proteins, it may provide respite to some people with cat allergies.

Hu: The idea is kind of like using the cats' own method of depositing saliva down to the depths of the hairs, using that same method to remove the saliva.

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