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From *The 69th Meeting of The American Physical Society – Division of Fluid Dynamics*

Cat Tongues Are Even 'Handier' Than You Imagined

Lessons learned from the flexible, sharp spines on cats' tongues have implications for the development of soft robotics

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Washington, D. C., November 21, 2016—Have you ever taken a good look at a cat's tongue? If so, you may have noticed the tiny, sharp "spines" on its surface.

Watching her cat lick a thick, microfiber blanket and immediately become stuck – tongue out – was all it took to inspire Alexis Noel, a Ph.D. candidate in mechanical engineering, working in the Hu Biolocomotion Lab at Georgia Tech, to explore the odd "spines" she noticed while helping to disentangle her cat.

If you've never looked closely at a cat's tongue, imagine that it's covered in tiny Velcro-like hooks and as it glides over fur, these hooks catch tangles and snags. "When the cat's tongue hits a snag, it pulls on the hooks, which rotate to penetrate the snag even further. Like a heat-seeking missile for snags, the hook's mobility allows the cat to better tease tangles apart," said Noel.

During the 69th Annual Meeting of the American Physical Society's Division of Fluid Dynamics (DFD), being held November 20-22, in Portland, Oregon, Noel will describe this concept, which she likens to using stiff vs. soft hairbrushes, and what it might enable.

"A typical hairbrush has spines that stick straight out. When hair collects on the brush it forms a thick mat that must be removed by hand," Noel explained. "In comparison, the cat's flexible spines make it easier to clean. When not in use, the spines on a cat tongue lie nearly flat against its surface, like overlapping shingles. This configuration provides openings in a single direction, enabling the mat of hair around the bristles to be removed with a single finger swipe. These openings face the cat's throat and is also why cats swallow their hair and end up with hairballs."

Taking the concept to the lab and using macro- and high-speed videography equipment, Noel and colleagues were able to zoom in and observe the unique shape and flexibility of the tongue spines during grooming. "In terms of shape and sharpness, it reminds me of cat claws. And this opens yet another question of why all claws are shaped so similarly," Noel said.

To help explore their theories, the researchers became the first group to 3D print a cat tongue mimic – at 400% scale.

What did they learn? "Both the cat tongue and mimic are very good at cleaning and removing tangles in fur samples," she said. "We also discovered that the cat tongue is self-cleaning—it's easy to remove hair beneath the spines by simply brushing the tongue from tip to end."

This may have important implications for the world of soft robotics, in which researchers are still struggling to find ways for soft materials to grip surfaces. “The cat tongue is flexible, but it can pull apart tangles in fur,” Noel said. “So we’re trying to develop a cat tongue-inspired surface based on our 3D-printed mimic. The flexibility of cats’ tongue spines may have broad-reaching applications from an easy-to-clean hairbrush to wound cleaning within the medical field.”

Next, the group plans to explore how the spacing of cat tongue spines affects frictional resistance. “With this knowledge, we can develop a hairbrush suitable for human grooming,” said Noel. “We’d also like to study the tongues of tigers, lions, and other large cats to understand how tongue spines scale across the cat family.”

In the meantime, Noel and colleagues are planning to develop the cat tongue mimic technology through the Innovation Corps at Georgia Tech and talk to consumers, beauty specialists, and medical device specialists around the U.S. about application opportunities. “We’ve already submitted a technology disclosure form and intend to file a patent within the next year,” she added.

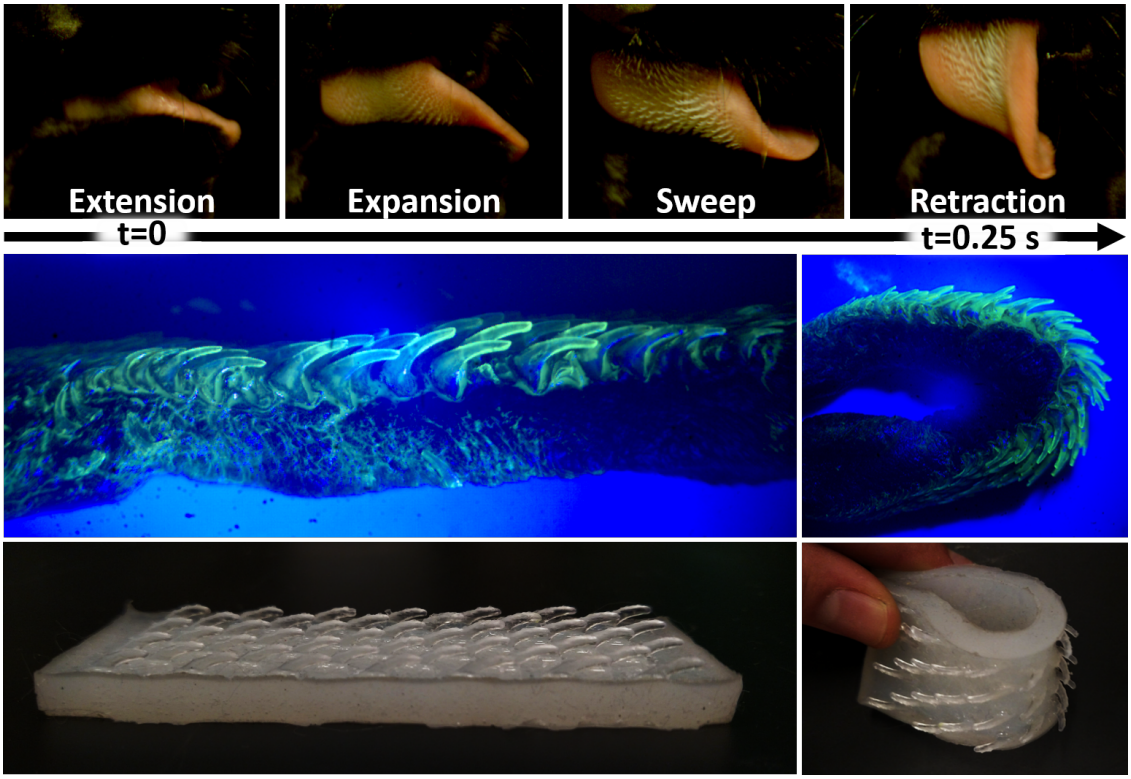

Figure 1. The cat tongue. (A) The four phases of cat grooming: tongue extension, tongue lateral expansion, sweeping of the tongue through fur and lastly retraction of the tongue in a V-shape curl. (B) (top) Cat tongue spines when tissue is straight and curled, (bottom) cat tongue mimic when silicone substrate is straight and curled.

Video B: Cat tongue papillae rotating with tissue stretch. Papillae coated in UV dye for enhanced videography.

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Abstract: L1.00008 : "Cat tongue Velcro," by Alexis Noel, Andrea Martinez, Hyewon Jung, Ting-Wen Tsai and David Hu is at 6:01-6:14pm PST, November 21, 2016 in Room A105

For more information about the APS DFD 2016 meeting, visit: http://apsdfd2016pdx.org/

MORE MEETING INFORMATION

USEFUL LINKS
Main meeting website: http://apsdfd2016pdx.org/
Technical program: http://meetings.aps.org/Meeting/DFD16/Content/3199
Meeting/Hotel site: http://apsdfd2016pdx.org/?page_id=30
Press Room: http://www.aps.org/newsroom/index.cfm

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We will grant free registration to credentialed journalists and professional freelance journalists. If you are a reporter and would like to attend, contact Julia Majors (jmajors@aip.org, 301-209-3103) who can also help with setting up interviews and obtaining images, sound clips, or background information.

LIVE MEDIA WEBCAST
A press briefing featuring a selection of newsworthy research will be webcast live from the conference on Monday, November 21st. The first briefing at 2:00pm (EST) is about the forensic analysis of blood spatter and how changing the position of your fingers can help you swim faster. The second one at 4:00pm (EST) is about cat's Velcro-like tongues and bubbles. More information can be found at the following link: https://www.aps.org/units/dfd/pressroom/

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