Researchers discover ultrathin lipid coating covering snakeskin

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Credit: Western Pacific Tropical Research Center

(Phys.org)—A combined team of researchers from the U.S. and Germany has discovered a very thin layer of fat covering the scales of a single species of snake. In their paper published in *Journal of the Royal Society Interface*, the team describes how they studied the snakeskin and their views on what benefits the snake gets from the fatty outer scale layer.

Snakes move around by slithering—as their bodies undulate against a surface below their bellies, friction is applied that pushes the snake forward, but the molecular mechanism by which this occurs has never been fully understood. To learn more, the researchers obtained samples of the shedded skins of several California kingsnakes and studied them using sum frequency generation spectra and near-edge X-ray absorption fine structure imagery, which essentially involved firing lasers at the skin and then measuring how the light was reflected and scattered.

The scanning revealed an extremely thin lipid layer, just nanometers thick, coating the scales that covered both the top and bottom parts of the snake, though there were differences between the lipid layer on the two body parts. The lipids on the belly were made of ordered pairs that provide a very slick surface, one that also offered, the researchers believe, some degree of protection to the scales—sliding across surfaces would otherwise cause the scales to wear away. A lipid outer layer would help explain why snakes are able to slither so effortlessly across a multitude of surfaces, the team notes.

The reason that the lipid coating has not been noticed before by people handling the non-venomous snake, is because the lipid does not come off, it adheres to the snake body, providing a constant slick surface. The researchers suggest that because the kind of snake they studied was common, they believe the lipid coating likely exists on the scales of other snakes as well, though it likely comes in different forms suited to the environment in which the snake lives. They also believe their findings might help researchers working to make robots that simulate snakes, or those looking to create next generation paints or lubricants.

More information: Evidence of a molecular boundary lubricant at snakeskin surfaces, *Journal of the Royal Society Interface*, Published 9 December 2015. DOI: 10.1098/rsif.2015.0817 , rsif.royalsocietypublishing.or … tent/12/113/20150817

Abstract

During slithering locomotion the ventral scales at a snake's belly are in direct mechanical interaction with the environment, while the dorsal scales provide optical camouflage and thermoregulation. Recent work has demonstrated that compared to dorsal scales, ventral scales provide improved lubrication and wear protection. While biomechanic adaption of snake motion is of growing interest in the fields of material science and robotics, the mechanism for how ventral scales influence the friction between the snake and substrate, at the molecular level, is unknown. In this study, we characterize the outermost surface of snake scales using sum frequency generation (SFG) spectra and near-edge X-ray absorption fine structure (NEXAFS) images collected from recently shed California kingsnake (Lampropeltis californiae) epidermis. SFG's nonlinear optical selection rules provide information about the outermost surface of materials; NEXAFS takes advantage of the shallow escape depth of the electrons to probe the molecular structure of surfaces. Our analysis of the data revealed the existence of a previously unknown lipid coating on both the ventral and dorsal scales. Additionally, the molecular structure of this lipid coating closely aligns to the biological function: lipids on ventral scales form a highly ordered layer which provides both lubrication and wear protection at the snake's ventral surface.