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The Anti-Icing Tricks of Penguins

A combination of nano-sized pores and the use of a special coating called preen oil makes Antarctic penguin feathers ultra-water-repelling, which keeps them ice-free

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WASHINGTON, D.C., November 22, 2015 -- Antarctic penguins live in a bitterly cold place, where the air temperature can drop to -40 degrees Celsius and the winds can hurtle at speeds of 40 meters per second. Although these birds routinely hop in and out of the water in sub-freezing temperatures, they manage to keep ice from coating their feathers.

Now researchers have examined penguin feathers in extreme detail and think they know the penguins' anti-icing trick: a combination of nanostructures and a special oil make Antarctic penguin feathers ultra-water-repelling, or superhydrophobic. Droplets of water on the feathers bead up so much that's it's difficult for heat to flow out of the droplet, and the water will roll off before it has time to freeze.

The researchers will present their findings at the annual meeting of the American Physical Society's Division of Fluid Dynamics, held Nov. 22-24 in Boston.

Pirouz Kavehpour, a professor in the Department of Mechanical and Aerospace Engineering at UCLA, first got interested in penguin feathers while watching a nature documentary on the famous black and white birds. "I noticed the penguins were coming out of very cold water, and sitting in very cold temperatures, and it was curious that no ice formed on their feathers," he said.

Kavehpour got in touch with Judy St. Leger, a world expert on penguins, who confirmed that indeed no one had ever observed ice on the feather coat of healthy penguins. To find out what the penguins' anti-icing secret was, the two scientists and their colleagues studied penguin feathers, donated by San Diego SeaWorld, using Scanning Electron Microscopy.

They discovered that the feathers had tiny pores that trap air and make the surface hydrophobic. In addition, the penguins apply an oil, which is produced by a gland near the base of their tail, to their feathers. The combination of the nano-sized pits and the preen oil makes the feathers superhydrophobic.

On superhydrophobic surfaces, water droplets bead up and sit on the surface almost like spheres. Kavehpour and his colleagues propose that it's the sphere-like geometry that delays ice formation, since heat has a hard time flowing out of the water droplet if the droplet does not make much contact with the surface.

"Heat flow could be compared to traffic. If you have a freeway that turns into a tiny, two-lane road, the traffic will back up. Similarly, heat does not flow well from the large cross-section of the middle of the drop to the small cross-section where the drop makes contact with the feather," Kavehpour said.

The scientists looked most extensively at the feathers of the gentoo penguin, which lives in Antarctica and the southern-most parts of South America. They also compared the gentoo feathers to feathers from the Magellanic penguin, which lives in warmer climates farther north in Chile, Argentina and even Brazil. They found that the warmer weather penguins lacked the small pores on their feathers, and that the birds also produced a different type of preen oil that was not as hydrophobic.

Penguin's anti-icing solutions could help humans solve some of our own problems with ice. For example, ice on an airplane's wings, flaps and rudder can alter the aerodynamic properties of the plane and even cause it to crash. Airlines spend lots of time and money applying chemical de-icers to planes that fly in winter weather. Superhydrophobic surfaces inspired by penguins might be cheaper, longer-lasting and more environmentally friendly.

"It's a little ironic that a bird that doesn't fly could one day help airplane fly more safely," Kavehpour said.

Presentation #E36.00006, "Ice Formation Delay on Penguin Feathers," is authored by Elaheh Alizadehbirjandi, Faryar Tavakoli-Dastjerdi, Judy St. Leger, Stephen H. Davis, Jonathan P. Rothstein and H. Pirouz Kavehpour. It will be at 5:55 p.m. on Sunday, Nov. 22, 2015 in Ballroom C of the Hynes Convention Center in Boston.
ABSTRACT: http://meetings.aps.org/Meeting/DFD15/Session/E36.6

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MEETING INFORMATION

The 68th Annual Division of Fluid Dynamics Meeting will be held at Hynes Convention Center in Boston from Nov. 22-24, 2015. More meeting information: https://apsdfd2015.mit.edu/

REGISTERING AS PRESS

Any journalist, full-time or freelance, may attend the conference free of charge. Please email: <jbardi@aip.org> and <dfdmedia@aps.org> and include "DFD Press Registration" in the subject line.

ON-SITE AND ONLINE PRESS ROOMS

Workspace will be provided on-site during the meeting. The week before the meeting, news, videos and graphics will be made available on the Virtual Press Room: http://www.aps.org/units/dfd/pressroom

LIVE MEDIA EVENT

A press briefing featuring a selection of newsworthy research talks will be streamed live from the conference at 1:00 p.m. ET on Monday, Nov. 23. For more information, email jbardi@aip.org.

ABOUT THE APS DIVISION OF FLUID DYNAMICS

The Division of Fluid Dynamics (DFD) of the American Physical Society (APS) exists for the advancement and diffusion of knowledge of the physics of fluids with special emphasis on the dynamical theories of the liquid, plastic and gaseous states of matter under all conditions of temperature and pressure. DFD Website:
http://www.aps.org/units/dfd/index.cfm

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Image caption: Pirouz Kavehpour, a professor at UCLA, poses with a penguin. He and his colleagues studied the feathers of penguins to learn their anti-icing tricks.
Image credit: Pirouz Kavehpour/UCLA