The lotus's clever way of staying dry (w/ Video)

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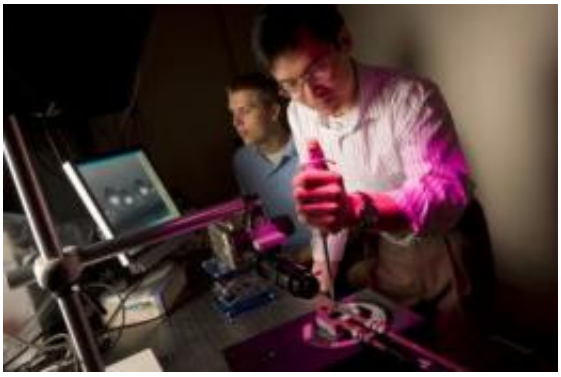

These are Duke University researchers Jonathan Boreyko, left, and Chuan-Hua Chen. Credit: Duke University Photography

An ancient Confucian philosopher once said, "I love the lotus because while growing from mud, it is unstained."

Now, almost one thousand years since Zhou Dunyi wrote these lines in China, scientists finally understand how the plant keeps itself clean and dry. It took an ultra high speed camera, a powerful microscope and an audio speaker to unlock a secret that has puzzled scientists for ages.

The process of solving this biological problem inspired Duke University engineers to make use of man-made surfaces resembling the lotus to improve the efficiency of modern engineering systems, such as power plants or electronic equipment, which must be cooled by removing heat

through water evaporation and condensation.

For the first time, scientists were able to observe water as it condensed on the leaf's surface, and more importantly, how the water condensate left the leaf.

The trick lies in the surface of the plant's large leaves, and the subtle vibrations of nature. The leaves are covered with tiny irregular bumps spiked with even tinier hairs projecting upward. When a water droplet lands on this type of surface, it only touches the ends of the tiny hairs. The droplet is buoyed by air pockets below and ultimately is repelled off the leaf.

"We faced a tricky problem - water droplets that fall on the leaf easily roll off, while condensate that grows from within the leaf's nooks and crannies is sticky and remains trapped," said Jonathan Boreyko, a third-year graduate student at Duke's Pratt School of Engineering, who works in the laboratory of assistant professor Chuan-Hua Chen. The results of the team's experiments were published early on-line in the journal *Physics Review Letters*.

"Scientists and engineers have long wondered how these sticky drops are eventually repelled from the leaf after their impalement into the tiny projections," Boreyko said. "After bringing lotus leaves into the lab and watching the condensation as it formed, we were able to see how the sticky drops became unsticky."

The key was videotaping the process while the lotus leaf rested on top of the woofer portion of a stereo speaker at low frequency. Condensation was created by cooling the leaf. It turned out that after being gently vibrated for a fraction of a second, the sticky droplets gradually unstuck themselves and jumped off the leaf.

Voila, a dry leaf.

"This solves a long-standing puzzle in the field," Chen said. "People have observed that condensation forms every night on the lotus leaf. When they come back in the morning the water is gone and the leaf is dry. The speaker reproduced in the lab what happens every day in nature, which is full of subtle vibrations, especially for the lotus, which has large leaves atop long and slender stems."

The results of these experiments, as well as earlier ones showing for the first time that water droplets spontaneously "jump" off a highly water-repellent, or superhydrophobic, surface, will allow engineers to employ man-made surfaces much like the lotus leaf in settings where the removal of condensation and the transfer of heat are necessary.

We have revealed the physics behind anti-dew superhydrophobicity, a vital property for water-repellent materials to be deployed in the real world," Chen said. "These materials will be used in humid or cold environments where condensation will naturally occur. Our findings point to a new direction to develop water-repellent materials that would survive in demanding natural environments, and have strong implications for a variety of engineering applications including non-sticking textiles, self-cleaning optics and drag-reducing hulls."

Source: Duke University (news : web)