Science & Technology

Why Butterfly Wings are Even Cooler Than You Think!

Science reveals how the insects' paper-thin wings withstand the heat of the sun.

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|
Apr. 21, 2020

Thermal images created by Nanfang Yu.

Butterflies are in a bit of a bind. Being cold-blooded, they must absorb thermal energy from the sun in order to boost their metabolism and have the strength to flutter from flower to flower. And yet their paper-thin wings are delicate. How can they withstand the heat of the sun’s rays?

A team of researchers led by Nanfang Yu, a Columbia applied physicist who studies the optical properties of biological materials, recently set out to find answers. In

collaboration with Naomi Pierce, a biologist who oversees the butterfly collection at Harvard's Museum of Comparative Zoology, Yu's team examined the physiology and behaviors of dozens of butterfly species, including the painted lady, pictured below, to determine how they regulate the temperature of their wings.

A painted lady (Vitalii Hulai / Shutterstock).

First, the scientists used a novel imaging technique developed in Yu's lab to analyze the colorful iridescent scales that cover butterfly wings. They found that some scales — specifically those atop wing sections that contain veins, nerves, and sensors for monitoring airflow — are shaped to deflect sunlight. Although they appear smooth, when viewed under the electron microscope the scales actually contain lots of cavities, crevices, and tunnels.

"This is a perfect design if you want a material to emit most of the thermal energy it receives from the sun rather than retain it," says Yu, who is an associate professor at Columbia Engineering.

The researchers then conducted a series of experiments on live butterflies, using heat lamps to mimic the effects of direct sunlight. They found that most butterfly species exhibit avoidance behaviors when subjected to intense heat, closing their wings and holding them parallel to the light source in order to minimize the impact.

Finally, Yu and his colleagues observed the neuronal activity happening inside butterfly wings. In doing so, they identified a network of heat-sensing cells that

biologists had never noticed before.

“Butterfly wings are often thought of as rather lifeless objects, but they are actually dynamic systems,” says Yu. “Among other things, they are highly sensitive light-detecting panels that enable the insects to swiftly determine the intensity and direction of sunlight without using their eyes or antennae.”

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