Mosquitoes are tuned to seek out temperatures that match warm-blooded hosts

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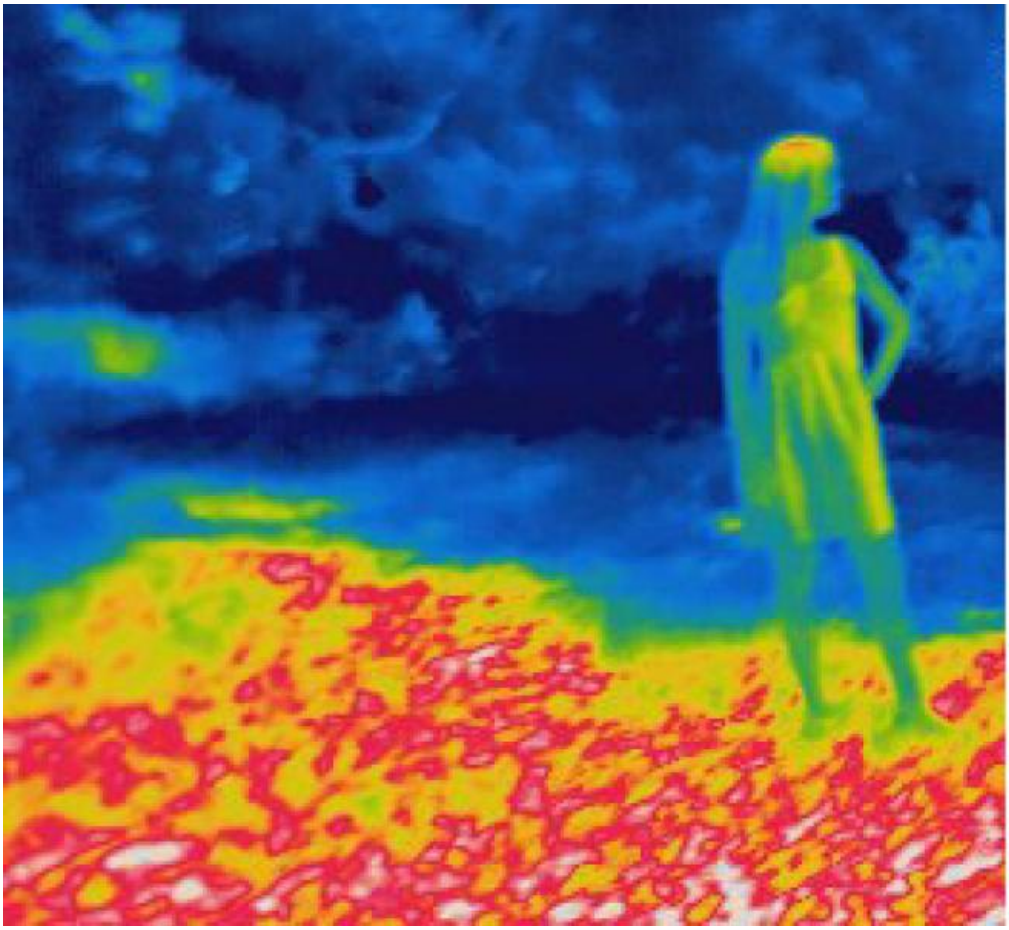

Mosquitos seek out heat to help them find blood. Researchers are examining the molecular mechanisms behind this behavior. Above, a thermal image from a sunlit patch of grass in Central Park in New York City. Credit: Laboratory of Neurogenetics and Behavior at The Rockefeller University

Many animals gravitate towards heat, most often to regulate their own body temperatures. In rare cases, certain species—ticks, bedbugs, and some species of mosquitoes—seek out heat for food. For female mosquitoes, finding heat is essential for survival, as they need to feast on warm-blooded prey to produce eggs. At the same time, mosquitoes have to know when something is too hot, so they won't get scorched on an over-heated blacktop, for instance.

Researchers at Rockefeller University have demonstrated that mosquitoes are exquisitely tuned to find heat sources that match the temperature of warm-blooded hosts, including humans. What's more, they uncovered part of the molecular mechanism the insects use to fine-tune their behavior; when a specific gene was blocked, mosquitoes lost the ability to distinguish between different temperatures.

"This paper is the beginning of the unraveling of the genes and behaviors underlying mosquitoes' heat-seeking behavior," says Roman Corfas, a graduate fellow in the lab of lead author Leslie Vosshall, Robin Chemers Neustein Professor at Rockefeller University. Hopefully, one day researchers can use this information to help control mosquito populations that transmit deadly diseases such as yellow fever, he adds. "Understanding this process and the molecular mechanisms behind it will provide strategies for designing better repellants, traps, and other ways to control mosquitoes."

A sensitive thermometer

In one experiment, described December 15 in the journal *eLife*, Corfas and Vosshall placed Aedes aegypti mosquitoes—carriers of yellow fever, dengue virus, and other diseases—inside a box lined with metal plates that could be heated up to specific temperatures. Opposite the plates, the researchers placed a tiny camera that captured how many mosquitoes were present on each plate at any given time. The results were obvious,

Corfas notes. "The hotter a plate became, the more mosquitoes were attracted to it. But it got to the point when the plate became so hot, most mosquitoes began to avoid it."

The upper limit? Approximately 40 degrees Celsius (104 degrees Fahrenheit), close to the maximum temperature of birds—which are one of the hottest food sources for mosquitoes—and a few degrees warmer than the human body. Once the plates got hotter than that, the mosquitoes avoided them. Given the choice between a plate at 40 degrees and one at 50, the mosquitoes clearly preferred the 40 degrees surface. "The animals could even distinguish between temperature differences as small as 2.5 degrees," notes Corfas.

Next, Corfas and Vosshall wanted to learn more about how mosquitoes fine-tune their temperature sensitivity. They blocked a gene called TRPA1, which is known to help other species seek out appropriate temperatures. Not surprisingly, mosquitoes that didn't express the TRPA1 gene spent equal amounts of time on plates that were either 40 or 50 degrees—in other words, they were unable to fine-tune their ability to seek out the ideal temperature.

Possibilities to control mosquito-borne disease

Understanding how mosquitoes target temperatures might enable researchers to design better traps. "Just learning how mosquitoes seek out temperatures that resemble hosts, and characterizing this heat-seeking behavior, lets us develop new traps that will capture disease-carrying vectors," Corfas notes.

Mosquitoes use more than just heat to find hosts. They are also attracted to the carbon dioxide we breathe out, as well as body odor and some visual cues. "Hopefully, we'll be able to use this information to bring all cues together synergistically to create the next generation of traps," says

Corfas.

Provided by Rockefeller University

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