Researchers show that the mosquito smells, before it sees, a host

July 16 2015

Aedes aegypti mosquito feeds. Only the females feed on blood. Credit: James Gathany/CDC

The itchy marks left by the punctured bite of a mosquito are more than pesky, unwelcomed mementos of a day at the lake.

These aggravating bites can also be conduits for hitchhiking pathogens to worm their way into our bodies. Mosquitoes spread malaria, dengue, yellow fever and West Nile virus, among others. As the bloodsucking insects evolve to resist our best pesticides, mosquito control may shift more to understanding how the mosquitoes find a tasty—and unsuspecting—human host.

A team of biologists from the University of Washington and the California Institute of Technology has cracked the cues mosquitoes use to find us. As they report in a paper published July 16 in *Current Biology*, the minute insects employ a razor-sharp sense of smell to tip them off that a warm-blooded meal is nearby, and then use vision and other senses to hone in on the feast.

"Very little was known about what a host looks like to the mosquito and how a mosquito decides where to land and begin to feed," said UW biologist Jeff Riffell, co-author on the paper and one of three professors collaborating on these efforts.

Experiments by other scientists implied that the mosquito sense of smell might activate other senses in the quest for a host. But Riffell and his colleagues wanted to understand what those triggers are, and which sensory pathways are most critical for finding a meal. They used wind tunnels to observe mosquitoes, placing them in an enclosed environment where they could record and track their behavior.

"What's great about this wind tunnel is that it provided a nice control of wind conditions and the environment these mosquitoes are flying around in," said Riffell. "We can really test different cues and the mosquito's response to them."

The wind tunnels were mostly featureless, with the exception of a small dark dot on the floor. To test the role scent played in mosquito behavior,

the researchers released a plume of carbon dioxide—the gas we exhale with each breath—into the wind tunnel and observed how mosquito behavior changed. It turned out that carbon dioxide triggered a strong response in the mosquitoes.

"When we gave them the odor stimulus, all of the sudden they were attracted to this black dot," said Riffell. "It's almost like the carbon dioxide gas turned on the visual stimulus for the mosquitoes to go to this black dot."

Riffell believes the mosquitoes went to the black dot—a high-contrast spot in an otherwise featureless environment—thinking that a warm-blooded host was nearby. These results might mean that mosquitoes control or "gate" their sensory systems. They may not seek a host until they smell one—in this case, due to the scent of our exhaled breath. If this theory is correct, the scents picked up by the mosquito's nose may determine whether or not it engages other sensory sensory systems in the search, especially vision.

Adding heat or water vapor to the black dot increased the mosquitoes' affinity for the dot after carbon dioxide was released into the wind tunnel. Riffell and his colleagues plan to study how other scents might affect mosquito behavior.

"Carbon dioxide is the best signal for a warm-blooded animal, and they can sense that from up to 30 feet away—quite a distance," said Riffell. "And then they start using vision and other body odors to discriminate whether we're a dog or a deer or a cow or a human. That may be how they discriminate among potential blood hosts."

If so, the experiments Riffell and his collaborators are doing now may prove this theory. They are recording how the nerve cells in specific regions of the mosquito brain respond to other odors, which may

indicate which scents are most important for attracting mosquitoes to feed. They may also identify odors that repel mosquitoes rather than attract them.

Riffell and his colleagues hope these nerve cell recording experiments will help them understand how insects integrate and interpret different signals from their environment and use this information to make decisions. This information could someday be used to help control mosquitoes, particularly the species that spread dangerous pathogens.

"A lot of papers have been trying to find these odor sources that could repel or attract mosquitoes," said Riffell. "What our research shows is that it's not one kind of odor or stimulus that's attracting mosquitoes, it's a real combination of cues."

Provided by University of Washington