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Good luck outsmarting a mosquito

The blood-sucking insects use their senses in sequence in a relentless search to find you

By Susan Milius 2:01pm, July 16, 2015



GOTCHA A mosquito's quest for a blood meal is so much more intricate than just flying toward an exhalation of carbon dioxide.

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Holding your breath all summer, even if possible, wouldn't keep mosquitoes from finding you. Nor would breath-holding plus invisibility. Studies of how mosquitoes find people to bite reveal tastes and tricks that are "annoyingly robust."

So says, literally, a report to be published in the Aug. 17 *Current Biology* on [mosquitoes' search strategies](#). The carbon dioxide exhaled by animals, the look of high-contrast objects and the warmth of bitable bodies all attract mosquitoes, but in interacting ways that make the system hard to beat. "The independent and iterative nature of the sensory-motor reflexes renders mosquitoes' host seeking strategy annoyingly robust," the study concludes.

Biologists have known that mosquitoes follow plumes of carbon dioxide wafting away from a breathing target. It doesn't take much. In other research published earlier this year, blood-hunting mosquitoes proved sensitive to the merest whiffs of carbon dioxide. In that study, chemical ecologist Ben Webster applied human odors to gauze pads by wearing them in his socks. (To keep from confounding the experiment, he couldn't use soaps with any scent during the course of his research.) He then placed the pads in a cage with *Anopheles gambiae* mosquitoes.

The odor that the pads picked up didn't attract many female mosquitoes to settle down as if preparing for a serious blood meal. But adding some extra carbon dioxide to the air blowing through the cage triggered considerable landing, Webster and his University of California, Riverside colleagues reported in the January *Journal of Chemical Ecology*.

Story continues below infographic



HOW THEY FIND YOU A mosquito (far left) mixes strategies and clues as it homes in on its next blood meal. *F. van Breugel et al/Current Biology 2015*

That makes sense for a species that lurks in human homes, says Webster, now at the University of Sheffield in England. The scent of a human is great for finding the right location for an ambush. But caution about landing and biting prevents wasting effort on trying to suck blood from sofas and socks. Breath betrays a living target, and boosting carbon dioxide by just 0.015 percent above regular air triggered mosquito landing on gauze, Webster says.

But following a carbon dioxide plume is not enough by itself to guide a mosquito to its target, reports Floris van Breugel of Caltech, coauthor of the *Current Biology* study. In the breezy outdoors, plumes break into scattered floating puffs. A lag in the insect's nervous system can cause it to fly through the puff before it can finish turning toward the source. Van Breugel's computer simulations of mosquitoes searching through a plume show that they get close to the source of the plume but not precisely there.

So in wind tunnel tests, van Breugel was not surprised to see mosquitoes fly out of perfectly good plumes of carbon dioxide to investigate other sensory clues. Tracking equipment let the researchers record the flight waverings and swoops of individual insects in the tunnel. The experiments were designed to look at how mosquito preferences interact.

Van Breugel and colleagues found that carbon dioxide triggers female *Aedes aegypti* mosquitoes to start exploring visual contrast. When there was no extra carbon dioxide in the tunnel air, females flew here and there but didn't pay special attention to contrasty objects on the floor. Adding an extra whiff of carbon dioxide to tunnel air inspired the mosquitoes' interest in features that stood out — plastic filters, glass squares or even spots of projected light that contrasted with the light or dark tunnel floorings.

Heating the clear glass squares attracted mosquitoes even when the lures blended in against the background. And the interest in warm objects didn't require the puff of carbon dioxide as a trigger, the researchers found.

The interactions of these clues mean that a mosquito catching just an exhalation of carbon dioxide can fumble along until some visually interesting or warm object invites closer scrutiny, the

researchers say.

Webster welcomes the new study because so much research has focused on carbon dioxide, odors and temperature. “Relatively little is known about how mosquitoes use visual cues,” he says.

Effective as vision and other search cues are, mosquitoes need another factor to become so annoyingly robust. The insects make mistakes, says neuroscientist Michael Dickinson of Caltech, coauthor of the more recent study. But when they fly to a rock instead of person, they pull back and try again. And again. “It’s the relentlessness that ensures success.”

Citations

F. van Breugel et al. Mosquitos use vision to associate odor plumes with thermal targets. *Current Biology*. Vol. 25, August 17, 2015, p. 1. doi: 10.1016/j.cub.2015.06.046.

B. Webster, E.S. Lacey and R.T. Cardé. Waiting with bated breath: Opportunistic orientation to human odor in the malaria mosquito, *Anopheles gambiae*, is modulated by minute changes in carbon dioxide concentration. *Journal of Chemical Ecology*. Vol. 41, January 2015, p. 59. doi: 10.1007/s10886-014-0542-x.

Further Reading

N. Seppa. Chikungunya is on the move. *Science News*. Vol. 187, No. 12, June 13, 2015, p. 16.

S. Milius. Sexual conflict in mosquitoes may have worsened spread of malaria. Science News Online, February 26, 2015.

H. Thompson. Mosquito bites might be foretold in genes. Science News Online, April 22, 2015.

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