Fruit flies' courtship song may hold key to controlling mosquitoes

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How fruit flies mate may hold a key to limiting the spread of diseases by mosquitoes.

In a new study, University of Iowa researchers found a gene that orchestrates the antenna movements of female fruit flies, which is central for them to detect the unique sound produced by prospective male mates. That gene, the Iowa researchers say, is present in mosquitoes and can be silenced, which in theory would lessen the chances of mating, and thus limit mosquitoes' population growth.

Mosquitoes are well-known vectors for a host of diseases that affect human health. In the United States, those diseases include West Nile virus, Eastern equine encephalitis, and Zika. Female mosquitoes spread those diseases among animals and humans when biting them, extracting blood contaminated with a disease germ that then can be transmitted to others in subsequent bites.

"Mosquitoes actually have a very similar mechanism to fruit flies of a type of active tuning, which could have implications for deterring the spread of so many diseases," says Daniel Eberl, professor in the Department of Biology at Iowa and the study's corresponding author. "So, understanding how fruit flies and mosquitoes not only mate but also how they hear could have important considerations for human health."

The researchers used tiny microphones to pick up sound when a species of male fruit fly flaps its wings. It's those vibrations, or pulses, in the air from the beating of the wings that are picked up by the antennae of the female fruit flies, signaling that a male mate is present. You can think of a female fruit fly's antenna as a sensory organ, which "hears" the vibrations similarly to the human ear.

What is interesting is that not every courtship song is the same.

"I think a key point for us is that the songs that they sing are a little bit different in closely related species," Eberl says. "The spacing between the pulses is distinct for each species. And that's why it's important, because they want to mate with a mate from their own species. So, the song helps them give that recognition of the same species."

Biologists have known female flies tune their antennae to a frequency similar to the range of sound emanating from a male of a similar species. What they didn't know is how exactly that fine-tuning took place, and specifically where.

The Iowa researchers examined the hearing in Drosophila melanogaster, a well-known and long-studied species of fruit fly. In particular, they studied the fly's Johnston's organ, located in the antenna, and the place where sound is detected. Within the Johnston's organ, they found and studied a pathway called a potassium ion channel, which energizes neurons involved in the fly's hearing. Investigating further, they learned that a gene, called Shal, is the gatekeeper of sorts for the ion channel, dictating when outside sounds or movements are converted to electrical signals that are then passed along between neurons. That cascade of events, managed by the Shal gene, seemed essential for the fly to hear.

The researchers then canceled the Shal gene to confirm its role in a female fly's antenna tuning, and thus, its hearing.

"Without the Shal gene, it loses that ability to tune," says Eli Gregory, an undergraduate human physiology major from Cedar Rapids who carried out the gene-canceling experiments. "The female loses its ability to tune that antenna to that frequency. And so, you get this lower response in mating from that female."

Mosquitoes employ a similar method in their courtship rituals.

That means "we could conceivably knock out that gene or that potassium channel and prevent mosquitoes from being able to mate as effectively as they do, which could mean fewer mosquitoes; therefore, fewer problems for human health," Eberl says.

The study, "The voltage-gated potassium channel Shal (Kv4) contributes to active hearing in Drosophila," was published online Dec. 17 in *eNeuro*, an open access journal of the Society for Neuroscience.

More information: Eli S. Gregory et al, The Voltage-Gated Potassium ChannelShal(Kv4) Contributes to Active Hearing inDrosophila, *eneuro* (2024). DOI: 10.1523/ENEURO.0083-24.2024

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