Mosquitoes have a mutual symbiotic relationship with malaria-causing pathogen

November 19 2021

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Cornelius Vanderbilt Professor of Biological Sciences Laurence J. Zwiebel is part of a team of researchers at Vanderbilt and the Johns Hopkins Malaria Research Institute who are working to understand how

Plasmodium falciparium—the pathogen that causes malaria in humans—affects the mosquitoes that spread the disease. The research was spearheaded by Ann Carr, a current visiting scholar and former postdoctoral fellow in the Zwiebel Lab.

Through comparative analysis of mRNA between uninfected and infected mosquitoes old enough to transmit malaria, the researchers concluded that infected mosquitoes' sense of smell was significantly enhanced, thus improving their ability to find hosts, Zwiebel said. This suggests that infection with the parasite provides the mosquito an advantage that promotes reproduction and disease transmission.

Beyond a more sensitive olfactory response, the researchers noted that the mRNA transcript profile of infected mosquitoes resembled that of much younger insects. "Infected mosquitoes revealed a physiology that had all the hallmarks of younger animals: more focused on reproduction, more robust immunologically and generally fitter than their uninfected middle-aged control siblings," Zwiebel said. "This suggests there is broad generalized adaptive advantage to keeping malaria pathogens in the population. That, in part, explains the global persistence of malaria."

The research team conducted their study within the challenging context of real-world infections that occur at very low levels. "We took enormous pains to conduct this study using very low intensity infections that align with the natural levels of infection seen in Africa," Zwiebel said.

The research was published in *Scientific Reports*.

Why it matters

Through taking the time and effort to replicate natural conditions to get these results, the researchers aim to demonstrate the feasibility and

underscore the need to conduct malaria infection studies within natural parameters.

"This research should also provide a new understanding that while P. falciparium is a deadly parasitic pathogen to humans and other mammals, it is most definitely not a pathogen to the mosquitoes," Zwiebel said. "In fact, our data strongly suggests there is a mutual symbiotic relationship between the Anopheles mosquito genus and P. falciparium."

What's next

These data will inform future studies of Anopheles mosquitoes and P. falciparium and the global effort to reduce and eradicate human malaria. The Zwiebel Lab will begin unraveling the molecular and cellular mechanisms responsible for the increased olfactory sensitivity in malaria -carrying mosquitoes.

More information: Ann L. Carr et al, Transcriptome profiles of Anopheles gambiae harboring natural low-level Plasmodium infection reveal adaptive advantages for the mosquito, *Scientific Reports* (2021). DOI: 10.1038/s41598-021-01842-x

Provided by Vanderbilt University