Mother Nature to provide an environmentally friendly method for reducing mosquitoes

July 21 2010

A scientific breakthrough might assist in the fight against mosquitoes. New research carried out at the University of Haifa in collaboration with researchers from other universities has chemically identified, for the first time, compounds released by mosquitoes' natural aquatic predators that function as warning signals for egg laying mosquitoes. Introducing these natural chemicals into mosquito breeding sites will cause the mosquitoes to sense risk of predation to their progeny and avoid laying their eggs there. These findings will soon be published in the prestigious journal *Ecology Letters*.

Ecologists and evolutionary biologists have known for a long time that many prey species can detect predators chemically and, upon detection, take various actions to avoid being eaten or avoid having their progeny eaten. Yet, the chemical identity of the predator-released chemicals has remained elusive. Knowing the chemical identity of these compounds would greatly facilitate scientists' understanding of predator-prey relationships and the importance of these compounds in affecting ecological communities. They may also provide an eco-friendly alternative for mosquito control.

The new breakthrough research, funded by the Israel Science Foundation, was developed in Prof. Leon Blaustein's laboratory at the University of Haifa. Prof. Blaustein's research partners comprised a multi-disciplinary group: Alon Silberbush, a doctoral student, Dr. Shai Markman, a chemical ecologist from University of Haifa-Oranim, Dr. Efraim Lewinsohn and Einat Bar, chemists at the Newe Yaar Research

Center, and Prof. Joel E. Cohen, a mathematical and population biologist at Rockefeller and Columbia Universities.

Previous research from Blaustein's lab demonstrated that the mosquito, *Culiseta longiareolata*, chemically detects a voracious predator of its progeny in the water, the backswimmer, *Notonecta maculata*, and avoids laying eggs where the predator is detected. However, until recently, the chemical identity of these predator-released compounds was not known. By screening and comparing the chemicals released by *N. maculata* with those released by Anax imperator, another aquatic predator that does not elicit a chemical response by the mosquito, they were able to narrow down the potential chemicals that elicited the mosquito's behavioral response. Blaustein's group then conducted outdoor experiments on potential chemicals and determined that two of these *N. maculata*-released chemicals, n-tricosane and n-heneicosane, repelled these mosquitoes from laying eggs. The two compounds together had an additive effect.

Applying such synthetic compounds to mosquito breeding sites would not only result in much fewer mosquitoes in the immediate area but probably reduce mosquito populations overall. Increased searching by pregnant mosquitoes for a breeding site that is perceived as predator-free increases greatly the probability of dying before egg laying; mosquitoes, on average, incur a 20 percent probability of mortality per day. Moreover, mosquitoes, by concentrating their eggs in considerably fewer breeding sites perceived as predation-risk free, would increase competition among the mosquito larvae resulting in fewer and weaker emerging adults.

Prof. Blaustein explains that in the fight against mosquitoes, there are essentially three lines of defense. The first and preferred line of defense is to prevent emergence of adult mosquitoes from aquatic breeding sites. When this has not been done effectively, mosquito control workers

resort to trying to kill the adults that have spread to residential areas. This is much more difficult, more expensive, and usually involves chemical pesticides of environmental and health concerns. When these two lines of defense fail, the burden falls on the public to prevent mosquitoes in search of a blood meal from biting them, such as staying indoors and using mosquito repellents applied to the human skin. Prof. Blaustein points out that options for all three lines of defense are often chemicals that negatively affect the environment and are of health concerns to humans. Moreover, mosquitoes often develop resistance to chemical pesticides so there is always a need to find new weapons against mosquitoes. A bacterial pesticide, *Bacillus thuringiensis israeIensis*, can be very effective in killing mosquito larvae in breeding habitats while having relatively minor non-target effects, but it is rather expensive and is not effective in highly organic-polluted water.

This research group's new findings of chemical identification of predator-released egg-laying repellants can be a breakthrough in providing a natural, environmentally friendly and inexpensive option to the arsenal in the first line of defense.

Blaustein adds, "While we see this as a potentially large breakthrough in developing another weapon against mosquitoes, the work, is not over. We hope this breakthrough will spur further research to chemically determine other effective predator-released chemicals, particularly ones that are long lasting and then tested for their efficacy."

Provided by University of Haifa