Evolution-proof insecticides may stall malaria forever (w/Video)

April 7 2009

Killing just the older mosquitoes would be a more sustainable way of controlling malaria, according to entomologists who add that the approach may lead to evolution-proof insecticides that never become obsolete.

Each year malaria -- spread through mosquito bites -- kills about a million people, but many of the chemicals used to kill the insects become ineffective. Repeated exposure to an insecticide breeds a new generation of mosquitoes that are resistant to that particular insecticide.

"Insecticides sprayed on house walls or bed nets are some of the most successful ways of controlling malaria," said Andrew Read, professor of biology and entomology, Penn State. "But they work by killing the insects or denying them the human blood they turn into eggs. This imposes an enormous selection in favor of insecticide-resistant mosquitoes."

Read and his colleagues Matthew Thomas, professor of entomology, Penn State, and Penelope Lynch, doctoral student, Open University, UK, argue that insecticides -- chemical or biological -- that kill only older mosquitoes are a more sustainable way to fight the deadly disease.

"If we killed only older mosquitoes we could control malaria and solve the problem of resistant mosquitoes," said Read. "This could be done by changing the way we use existing insecticides, even by simply diluting them," he added.

Aging mosquitoes are easier to kill with insecticides like DDT but new generation pesticides could do it too. Read and his colleagues are working with a biopesticide that kills older mosquitoes.

"It is one of the great ironies of malaria," explained Read, whose team's findings appear today (April 7) in *PLoS Biology*. "Most mosquitoes do not live long enough to transmit the disease. To stop malaria, we only need to kill the old mosquitoes."

Since most mosquitoes die before they become dangerous, late-acting insecticides will not have much impact on breeding, so there is much less pressure for the mosquitoes to evolve resistance, explained Read, who is also associated with the Penn State Center for Infectious Disease Dynamics. "This means that late-life insecticides will be useful for much, much longer -- maybe forever -- than conventional insecticides," he added. "Insects usually have to pay a price for resistance, and if only a few older mosquitoes gain the benefits, evolutionary economics can stop resistance from ever spreading."

"We are working on a fungal pesticide that kills mosquitoes late in life," said Thomas. "We could spray it onto walls or onto treated materials such as bed nets, from where the mosquito would get infected by the fungal spores."
The fungi take 10 to 12 days to kill the insects. This achieves the benefit of killing the old, dangerous mosquitoes, while dramatically reducing the selection for the evolution of resistance, Thomas explained.

To study the impact of late-acting insecticides on mosquito populations, the researchers constructed a mathematical model of malaria transmission using factors such as the egg laying cycle of the mosquito and the development of parasites within the insect.

Once malaria parasites infect a mosquito, they need at least 10 to 14

days -- or two to six cycles of egg production -- to mature and migrate to the insect's salivary glands. From there they can pass into humans when a mosquito bites.

Analyses of the model using data on mosquito lifespan and malaria development from hotspots in Africa and Papua New Guinea reveal that insecticides killing only mosquitoes that have completed at least four cycles of egg production reduce the number of infectious bites by about 95 percent.

Critically, the researchers also found that resistance to late-acting insecticides spreads much more slowly among mosquitoes, compared to conventional insecticides, and that in many cases, it never spreads at all.

Read says the development of biological or chemical insecticides that are more effective against older, malaria-infected mosquitoes could save the millions dollars that will have to be spent to endlessly find new insecticides to replace ones that have become ineffective.

"Insecticides that kill indiscriminately impose maximal selection for mosquitoes that render those insecticides useless. Late-life acting insecticides would avoid that fate," Read added. "Done right, a one-off investment could create a single insecticide that would solve the problem of mosquito resistance forever."

Source: Pennsylvania State University (news : web)