Bulletproof?
Multiple pesticide resistance mutations can work together to make a tougher mosquito.

Credit: Nil Rahola/IRD

Two Resistance Genes for the Price of One

By Elsa Youngsteadt
*Science*NOW Daily News
8 April 2008

It seems like a no-brainer, even for mosquitoes: Why be resistant to one pesticide when you can be resistant to two? In practice, however, such adaptations weaken insects in other ways, so more might not be a good thing. A new study brings the argument full circle, suggesting that two resistance genes are indeed better--or at least no more costly--than one.

Chemical warfare on insects and other arthropods has bred for pesticide resistance in more than 500 species. From an insect's perspective, this resistance comes at a cost. Mutations that save a bug's life during a pesticide onslaught may work to its disadvantage in a clean environment by making its metabolism or nervous system less efficient. Evolutionary biologists therefore expect the resistance to decline when pesticides are not used. But no one knew quite what to expect from insects that have two resistance alleles at once. Would the costs of each mutation add up? Would they multiply or perhaps cancel out?

To find out, medical entomologist Vincent Corbel of the Institut de Recherche pour le Développement in Montpellier, France, and a team of researchers compared four strains of *Culex quinquefasciatus* mosquitoes in the lab. The strains differed in their resistance to two classes of insecticides used on everything from bed nets to agricultural fields: one strain was resistant to pyrethroids, one to organophosphates, one to both, and one to neither.

As expected, when the researchers raised the four strains of larvae in the lab sans insecticide, the nonresistant mosquitoes survived the best. Those with the pyrethroid resistance mutation had a slightly lower survival rate, and those with the mutation for organophosphate resistance did the worst, with nearly 15% lower survival than nonresistant insects. The surprise came from the mosquitoes that had both mutations. They did just as well as the insects resistant only to pyrethroids, the team reports online today in *BMC Evolutionary Biology*.

Although the mechanism for this effect is unknown, Philip Agnew, an evolutionary biologist at Génétique et Evolution des Maladies Infectieuses in Montpellier and an author of the study, says one resistance mutation may partially compensate for the other. One of the mutations makes for "a bit of a twitchy mosquito," Agnew says, whereas the other makes the nervous system more sluggish. "It's possible that between them they're balancing each other out," he says. And that could mean that the resistance genes stick around for longer than expected in a population, even when no poison is present.

The supermosquitoes were not, however, invincible. Although the adults could resist each poison by itself, a mixture of the two killed them with a lower dose. In practice, the two classes of insecticides are rarely combined. But Corbel says that if the effect translates from lab to field, mixing the pesticides could offer a tool to help manage supermosquitoes.

Entomologist Jeffrey Scott of Cornell University says the study is "a very positive step" toward understanding the complicated costs of multiple resistance mutations. He hopes researchers will carry on the studies with other resistance mutations and in different insects, predicting that similar mechanisms may be at work in many agricultural and household pests.