Double trouble with insecticide-resistant mosquitoes

April 8 2008

Mosquitoes harbouring two insecticide-resistance genes have been found to survive unexpectedly well in an insecticide-free environment where carrying such genes would normally expected to be a burden. As outlined in research published by the open access journal *BMC Evolutionary Biology*, this results from the genes interacting with one another to the advantage of the host Culex quinquefasciatus mosquitoes and to the detriment of pest management strategies affecting human health.

The research team, led by Dr Vincent Corbel and colleagues from the Université Montpellier II, Genetics and Evolution of Infectious Diseases and The Research Institute for Development (IRD) in France compared the survival rates or evolutionary fitness of one strain of the mosquito that carried two resistance genes (ace-1R and KdrR) for two different insecticides to mosquitoes that only had one insecticide-resistance gene, a French research team discovered that the survival cost of having both genes was far lower than the cost of having just ace-1R.

“We know from evolutionary theory that mutations such as these are likely to be costly to their owners in environments where they have not been selected for” explained Dr Corbel. “We’ve found that in C. quinquefasciatus the cost of having the ace-1R mutation in the absence of insecticides is counterbalanced when the mosquito also has the KdrR mutation. Mosquitoes with both mutations will also be harder to control as they are resistant to two different types of insecticide.”

The authors also found evidence that resistance alleles interact with one

another in the presence of insecticides. For instance, synergism (that is, a more than an additive effect) in toxicity was observed when a pyrethroid insecticide and a carbamate insecticide were applied simultaneously to the strain sharing both mutations (the insecticide had a greater activity and more of the mosquitoes died), whereas antagonism (that is, a less than an additive effect) was noted with Culex mosquitoes carrying only ace-1R.

Resistance to so-called xenobiotics (antibiotics, insecticides and herbicides) is a problem affecting the control of organisms of medical or economic importance. In C. quinquefasciatus insecticide resistance mutations interacted to positively and negatively influence the mosquitoes' fitness. Costs were associated with both resistance genes in an insecticide-free environment. The KdrR form of the gene, or allele, however, compensated for the costs associated with the ace-1R allele, suggesting that mosquitoes with both genes in the wild could be more prevalent. Females with both alleles were more likely to mature than those with just the ace-1R mutation."

"It is important to identify genetic interactions such as this and how they influence the fitness of multiply resistant organisms in order to better structure management strategies" says Dr Corbel. "We have found in this case that resistance genes do interact and even compensate. We will have to be very careful in how we use insecticides in future as our results have major implications for pest and health management."

Source: BioMed Central