

## Permethrin Resistance in *Culex pipiens*

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### INTRODUCTION

*Culex pipiens* is a vector of West Nile virus (WNV) that is broadly distributed in urban and suburban landscapes. Vector control agencies routinely employ insecticides to reduce the abundance of infected *Cx. pipiens*, and often use those with pyrethroid-based chemistries because of the relatively low residues and safety properties. We sought to employ the MVCAC Integrated Vector Management Committee's recommendations on testing *Cx. pipiens* that were collected in Alameda County for insecticide resistance by examining the activity of permethrin-metabolizing enzymes and the *kdr* loci of the *voltage gated sodium channel 1* (*vgsc-1*) gene using quantitative polymerase chain reaction (qPCR). Mutation of L1014F at the *kdr* loci of *vgsc-1* in *Cx. pipiens* contributes to pyrethroid resistance. A goal of the study was to determine the baseline of permethrin resistance in *Cx. pipiens* in Alameda County.

### METHODS

The activity of alpha-esterase (AE), beta-esterase (BE), oxidase (OX), glutathione-s-transferase (GST), acetylcholinesterase (AChE) and insensitive acetylcholinesterase (iAChE) were evaluated. Enzyme activity was normalized to protein content of mosquito homogenates.

### RESULTS

There was no significant difference in the activity level of AE, BE, OX, iAChE or AChE in adult *Cx. pipiens* that were collected near

a wastewater treatment facility (WWTF) and a large tidal lagoon (TL) in Alameda County relative to *Cx. pipiens* from a susceptible laboratory colony. GST activity was significantly reduced in *Cx. pipiens* that were collected at the tidal lagoon (TL) relative to the lab colony. A total of 80 field-caught *Cx. pipiens* were tested for the mutant allele in the *kdr* loci of *vgsc-1* that is associated with pyrethroid resistance. The majority (70%) were homozygous for the susceptible *kdr* allele, 26% were heterozygous, while 4% of the *Cx. pipiens* were homozygous for the resistant allele.

### DISCUSSION

This study was the first assessment of insecticide resistance markers for *Cx. pipiens* that were collected in Alameda County. While the activity of insecticide-metabolizing enzymes in the field-collected *Cx. pipiens* were similar to those from a susceptible lab colony, 30% of the mosquitoes that were collected in the field contained at least one copy of the *kdr* allele that is associated with resistance to pyrethroid insecticides. Because vector control agencies in Alameda County rarely apply pyrethroid insecticides to control mosquitoes (e.g. twice during the prior three years), the presence of resistant *kdr* alleles in mosquitoes suggests that structural or household insecticide use may contribute to insecticide resistance in these mosquitoes.