### Review of resistance in US mosquitoes

Jennifer A. Henke, M.S. Laboratory Manager Coachella Valley Mosquito and Vector Control District

*Global Mosquito Resistance Management Summit March 24, 2022* 

#### **US Agencies and Roles**

- US Environmental Protection Agency (US EPA)
  - Regulate pesticides and repellents
- Centers for Disease Control (CDC)
  - Provide information on insect-borne diseases
  - Respond to outbreaks, with local and state agencies





U.S. Department of Health and Human Services Centers for Disease Control and Prevention



### Vectors and Diseases of Focus

- Zika
- West Nile virus
- Malaria
- Encephalitis Eastern Equine, Japanese, St. Louis
- Yellow fever
- Dengue fever
- Chikungunya fever



#### Vectors and Diseases of Focus



Zika Yellow fever Dengue fever Chikungunya fever



West Nile virus Encephalitis – Eastern Equine, Japanese, St. Louis

\*Malaria – *Anopheles* \*Encephalitis – Eastern Equine - *Culiseta* 

### Potential Range of Aedes

Estimated Potential Range of Aedes aegypti in the United States, 2017

Estimated Potential Range of Aedes albopictus in the United States, 2017



https://www.cdc.gov/mosquitoes/mosquito-control/professionals/range.html





Gorris et al. 2021 Parasites & Vectors



#### Arthropod Pesticide Resistance Database

#### http://www.pesticideresistance.org





→ C	g/search.php :Clock Employee 🔇 PAHO/WHO Data 臏 Insect H	Heat Shock P N The Impact of COVI 🔇 MyPhoneNext 🗈 Answ	ver Battle Virtu	»   Ⅲ R
Welcome	Search Login Sign Up	de ase Contact		
Order: Select to Add V Family:	Select to Add V Genus: Select All	✓ Active Ingredient: All	V MOA Ab	br: All
Resistance Vear: All				~
				•
	Se	earch   Reset		
Parameters: Selecting multiple parameters	rameters from same catagory is treated a	s OR		
Order: [ diptera X ] Family: [ culicidae	e X ]			
Genus Species	Taxonomy (family - order)	Common Name(s)	# Cases	Grou
<u>aedes aegypti</u>	culicidae diptera	yellow fever mosquito	589	MED
aedes aegypti aedes albopictus	culicidae diptera culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito	589 259	MED MED
aedes aegypti aedes albopictus aedes atropalpus	culicidae diptera culicidae diptera culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito	589 259 1	MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis	culicidae diptera culicidae diptera culicidae diptera culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito	589 259 1 1	MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans	culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito	589 259 1 1 3	MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator	culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito	589 259 1 1 3 2	MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius	culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito	589 259 1 1 3 2 2 7	MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius aedes detritus	culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito	589 259 1 1 3 2 2 7 3	MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius aedes detritus aedes dorsalis	culicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito	589 259 1 1 3 2 2 7 3 3 3 3	MED MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius aedes detritus aedes dorsalis aedes fijiensis	culicidae dipteraculicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito	589 259 1 1 3 2 7 3 3 3 3 1	MED MED MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius aedes detritus aedes dorsalis aedes fijiensis aedes melanimon	culicidae dipteraculicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito medium-sized saltmarsh mosquito	589 259 1 1 3 2 7 7 3 3 3 3 1 8	MED MED MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius aedes detritus aedes dorsalis aedes fijiensis aedes melanimon aedes nigromaculis	culicidae dipteraculicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito medium-sized saltmarsh mosquito medium-sized pasture floodwater mosquito	589 259 1 1 3 3 2 7 3 3 3 3 1 8 8 20	MED MED MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius aedes detritus aedes dorsalis aedes fijiensis aedes melanimon aedes nigromaculis aedes polynesiensis	culicidae dipteraculicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito medium-sized saltmarsh mosquito medium-sized pasture floodwater mosquito	589 259 1 1 3 2 7 3 3 3 3 1 8 20 1	MED MED MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes cantans aedes cantator aedes caspius aedes detritus aedes detritus aedes dorsalis aedes fijiensis aedes melanimon aedes nigromaculis aedes polynesiensis aedes pseudoscutellaris	culicidae dipteraculicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito medium-sized saltmarsh mosquito medium-sized pasture floodwater mosquito	589 259 1 1 3 2 2 7 3 3 3 3 3 1 8 8 20 1 1 1 1	MED MED MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes canadensis aedes cantator aedes cantator aedes caspius aedes detritus aedes detritus aedes dorsalis aedes fijiensis aedes melanimon aedes melanimon aedes nigromaculis aedes polynesiensis aedes pseudoscutellaris aedes sierrensis	culicidae dipteraculicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito medium-sized saltmarsh mosquito medium-sized pasture floodwater mosquito western tree-hole mosquito	589 259 1 1 3 2 7 3 3 3 3 1 8 20 1 1 8 20 1 1 1 1 1	MED MED MED MED MED MED MED MED MED MED
aedes aegypti aedes albopictus aedes atropalpus aedes canadensis aedes canadensis aedes cantator aedes cantator aedes caspius aedes detritus aedes dorsalis aedes dorsalis aedes fijiensis aedes melanimon aedes nigromaculis aedes polynesiensis aedes pseudoscutellaris aedes sierrensis aedes sollicitans	culicidae dipteraculicidae diptera	yellow fever mosquito asian tiger mosquito, forest day mosquito rockpool mosquito woodland pool mosquito brown saltmarsh mosquito medium-sized semi-arid mosquito medium-sized saltmarsh mosquito medium-sized pasture floodwater mosquito western tree-hole mosquito floodwater/saltmarsh mosquito	589 259 1 1 3 2 7 3 3 3 3 1 8 20 1 8 20 1 1 1 1 1 1 6	MED MED MED MED MED MED MED MED MED MED

### **Global Records**

- Aedes aegypti 589
- Aedes albopictus 259
- Culex pipiens 74
- Cx. pipiens pipiens 161
- Cx. pipiens quinquefasciatus 71
- Cx. quinquefasciatus 299
- Cx. tarsalis 14
- Cx. tritaeniorhynchus 114





# *Culex tarsalis –* organochlorines



# *Culex tarsalis -* organochlorines



# *Culex pipiens/quinquefasciatus* – organochlorines



### **US Mosquito Control**

#### Organophosphates

- Chlorpyrifos
- Malathion
- Fenthion
- Fenitrothion
- Parathion
- Temephos

#### Pyrethroids

- Pyrethrins
- Cypermethrin
- Deltamethrin
- Etofenprox
- Lambda-cyhalothrin
- Permethrin
- Phenothrin
- Resmethrin



### Limitations of this review

- Very broad state level
- Relies on published information
- Relies on bottle bioassays or field data





# *Ae. aegypti –* organophosphates

# *Ae. aegypti –* pyrethroids





### *Culex tarsalis –* organophosphates



# *Culex tarsalis –* pyrethroids



### *Culex tarsalis –* summary



### *Culex pipiens/quinquefasciatus* – organophosphates



# *Culex pipiens/quinquefasciatus* – pyrethroids



# *Culex pipiens/quinquefasciatus* – summary





### Conclusions

- Resistance is an issue in mosquito control in the US
   Not all driven by mosquito control agencies
- More information is needed
  - CDC Centers of Excellence and Funding increasing this work
- Resistance is at a finer population-level than what was shown here
  - Agencies need to examine at local levels routinely



#### Selected References

Arthropod Pesticide Resistance Database: Mota-Sanchez, D. and J.C. Wise. 2022. The Arthropod Pesticide Resistance Database. Michigan State University. On-line at: <u>http://www.pesticideresistance.org</u>

Gorris, M. E., et al. 2021 Updated distribution maps of predominant *Culex* mosquitoes across the Americas. Parasites & Vectors 14: 547

Richards, S. L. et al. 2018. Insecticide susceptibility screening against *Culex* and *Aedes* (Diptera: Culicidae) Mosquitoes from the United States. J Medical Entomology 55(2): 398-407

### Thank you!

#### Jennifer Henke jhenke@cvmosquito.org

