Proposal: Addressing mosquito population dynamics in South Florida with geographic distribution and genomic variation analysis using a community-based mosquito surveillance program.

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Introduction

- Populations of *Aedes aegypti* are expanding throughout Florida due to the state's tropical and subtropical climate. *Ae. aegypti* can transmit dengue virus, ZIKV, Chikungunya, and yellow fever.
- Insecticide use is typically used and required as the first line of defense in mosquito control programs. In Florida, the exposure of insecticides is not evenly distributed through every county, so genetic diversity may exist in target populations.
- One aim of this proposal includes the sequencing of *Ae. aegypti* populations throughout south Florida using genome-wide sequencing in order to determine the level of genetic variance in Florida in response to insecticide-resistance.
- Bioinformatics tools and data analyses to process *Ae. aegypti* genetic diversity will be used in order to generate a final genetic map of population variance in South Florida. Mapping *Ae. aegypti* genetic diversity in relation to insecticide-resistance will allow us to link environmental conditions to genetic variation.

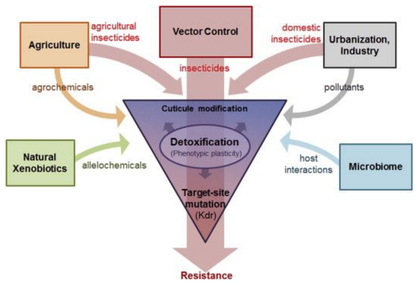

Figure 1. Environmental factors potentially affecting pyrethroid resistance mechanisms in mosquitoes

- The distribution, development, and survival of *Ae. aegypti* mosquitoes strongly depends on meteorological factors such as temperature, humidity, and precipitation. Due to this dependency, it is possible that mosquito population spatial and temporal patterns are controlled by environmental factors that can be remotely observed.
- The resulting information of my research can provide vector control management programs with knowledge on the population subdivisions within South Florida Ae. aegypti mosquitoes that would reveal the population structure based on potential genome-wide differentiation amongst genetic clusters.
- Landscape surface features such as vegetation and hydrology could also potentially be used to visualize and investigate gene flow and genetic differentiation for South Florida Ae. aegypti mosquitoes in order to calculate vector capacity.

FCE 4.2 Proposal Questions

- How will global climate change alter regional climate variability and extremes and therefore potentially alter mosquito distribution and expansion throughout South Florida?
- How does geomorphological influence on water pulses and therefore vegetation succession affect mosquito infestation throughout South Florida?

Materials and Methods

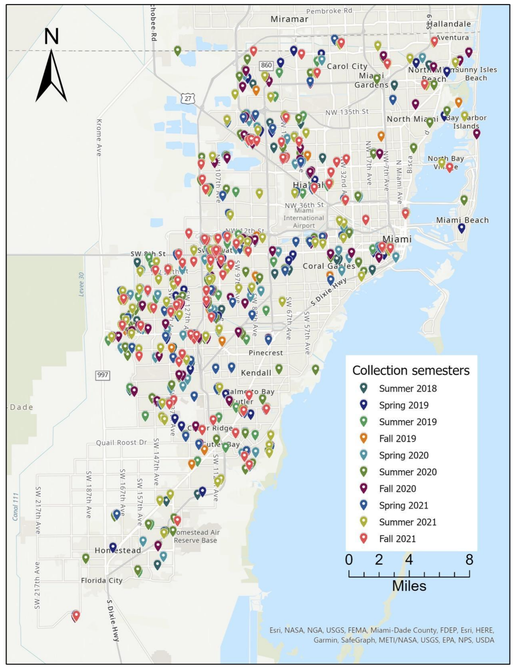

Figure 2. Map of 671 collection sites in Miami-Dade County.

Traps and Egg Paper Kits

Figure 3. Volunteers set up provided traps outside of their place of residence in a shaded area with no wind. Every week, volunteers are given a new bagged kit. The traps simulate still-water conditions and provide laying grounds for gravid female mosquitoes in the area.

Figure 4. An egg paper positive for *A. aegypti* eggs. The paper is marked positive and placed in a pan with water to hatch. Only positive egg papers are kept to be processed.

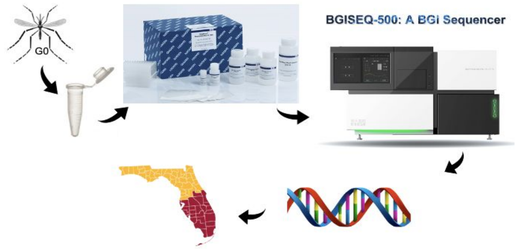

Figure 5. After egg collection, mosquitoes are placed in 1.5mL tubes filled with absolute ethanol for preservation and later, mosquitoes chosen for DNA extraction are sent to BGI genome sequencing center for whole genome re-sequencing.

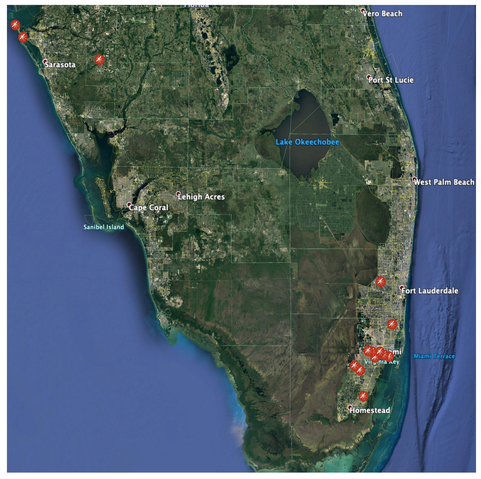

Figure 6. This map displays collection sites corresponding to sequenced mosquitoes. Sites include collections from student-volunteers and collaborators.

Preliminary Results

	Positive.Site	Ovitrap	EDI	TER
TrueRandomGeneratedNumbers	1.1	0.4	0.5	1.1
Distance.to.a.park.meters	6.1	4.4	2.3	5.1
Distance.to.a.Landfil	3	1.1	7.1	1.2
Distance.to.a.dump.site	1	0.2	1.1	2.9
Distance.to.a.cemetery..meters.	6	11.3	6.6	11.4
collections.done	15.8	1.4	0.4	10.8
Building.area	0.7	0.4	0.2	1
AveLST	58.9	66.5	52.7	50.9
AveEVI	8.4	14.2	29.2	16.6

Figure 7. The relative influence of predictors from several boosted regression trees for different indices including: "Positive.Site" representing if a site was ever positive, "Ovitrap" representing the percentage of positive traps within a location, Egg Density Index ("EDI") representing the average egg count per location, and Total Eggs Recovered ("TER") for the location.

Future Directions

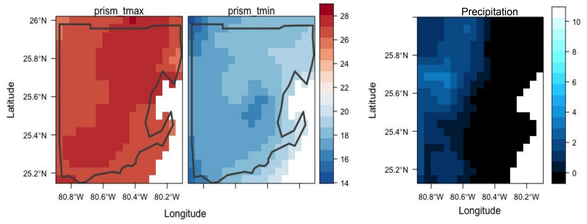

Figure 8. PRISM dataset for the mean maximum and minimum temperature and precipitation within Miami-Dade County for summer 2019.

- Explore how genomic variant distribution and density vary across different regions of South Florida.
- Understand what is driving the spatial variation in mosquito infestation in Miami-Dade County after looking at other environmental variables such as vegetation, elevation, temperature, and precipitation.
- Identify potential sites of infestation based on spatial variation in environmental and anthropogenic factors in order to model mosquito distribution and expansion throughout South Florida.

Contact and CV:

Community Outreach:

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References: