Investigating Mosquito Habitat Preferences For Tree Canopy Or Building Shade In Urban Environments

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Abstract

The world's population continues to grow, with much of the growth occurring in urban areas. This increase in urban population growth is problematic as urban settings are ideal for the spread of mosquito-borne/vector diseases. Thus, it is vital to understand the habits underlying mosquito breeding to prevent or minimize the spread of disease. In this study, we examine whether mosquitoes, when ovipositing, prefer habitats in building shade or tree canopy shade. By setting our traps here, we also explore if mosquitoes prefer the hotter or cooler end of the heat spectrum in cities. The study consisted of setting up 4 or 6 mosquito larvae traps, made out of two liter soda bottles cut in half with black surfaces and grass clippings as bait, in various cities: Austin, Texas; Frisco, Texas; McLean, Virginia; Colorado Springs, Colorado; Edison, New Jersey; Alameda, California. Half of the traps were in building shade and the other half were in canopy shade. After three days, the traps were observed for data collection and if present, larvae were counted and logged via the GLOBE Observer app. We then utilized arcGIS and spreadsheets to visualize our data. The results suggest that there is a greater number of mosquitoes breeding in habitats under canopy shade rather than building shade. To further expand our knowledge regarding habitats preferred by mosquitoes, we could observe a greater number of locations to determine if other factors, rather than shade location, impact mosquito ovipositing. A supplementary study could be to investigate if the reason mosquitoes prefer tree canopies for oviposition is because they consume the foliage or sap.

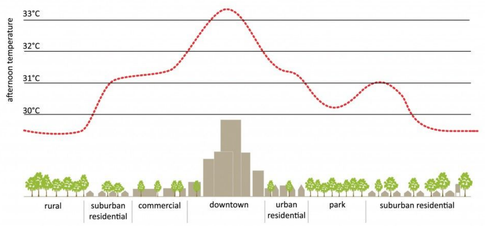
Research Question

1. Do mosquitoes have an oviposition preference for tree canopy or building shade in urban environments?
2. Does this preference vary by state?
3. Do disease carrying mosquitoes breed in urban environments?

Introduction

Vector-borne disease, which includes viruses transmitted by anthropods such as mosquitoes, poses a significant threat to society, especially with the increasing impact of both climate change and urbanization on the globe. Climate change and urbanization provide a common element impacting mosquito breeding: heat. The relationship between heat and mosquito transmitted disease is complicated since it varies vastly between species. In some genuses, higher temperatures suggest short incubation and high infection and transmission rates, but in the Aedes genus, low temperatures procure those results.

The project our group undertook investigates how heat produced by urban heat islands mosquito habitats.To better understand urban heat islands, envision a heat spectrum that represents the temperature range in a city; areas with more vegetation and less infrastructure such as city parks will have cooler temperatures as compared to areas congested with buildings, people, and pavement. We chose to investigate if mosquitoes prefer to oviposit under the shade of a tree canopy or a building in urban environments because these two locations are on different locations on the heat spectrum, while still providing the shade in which mosquitoes prefer to lay eggs.



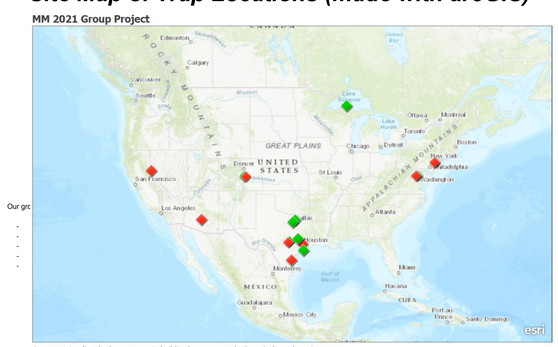
Picture credit: "Urban Heat Island." *Urban Green-Blue Grids for Resilient Cities*, EPA, UHI Basics, 2008, www.urbangreenbluegrids.com/uploads/Heatisland-naar-EPA-eng-950x476.jpg.

Research Methods

Our group had study sites in Austin, Texas; Frisco, Texas; McLean, Virginia; Colorado Springs, Colorado; Edison, New Jersey; Alameda, California; and Troy, Michigan.

- 4-6 mosquito larvae traps in urban areas in our respective cities
- Traps: 2 liter soda bottle cut in half and colored black with grass clipping as bait
- Half of these traps were under a leafy canopy cover (trees/bushes/etc), and the other half remained under the shadow of a building.
- Left for 3 days before counting larvae, pupae, and eggs and eliminating the traps
- Also accessed data from other SEES interns from the GLOBE Observer Mosquito Habitat Database to create sitemaps using arcGIS

Site Map of Trap Locations (made with arcGIS)



Be a Data Scientist

The data utilized in this research derived from our team members' experiments with mosquito traps in shaded regions as well as mosquito habitat mapper data from other SEES interns collected through the GLOBE Observer app. We gained experience in purposeful data collection and how to analyze it.

Make an Impact

Our members all reside in or near metropolitan areas, thus the environmental and health threats associated with the urban heat island effect impact our local communities. Knowing that mosquitoes prefer tree canopy shade over building shade affects the health of these cities' residents, as well as the billions of people that will move into urbanized areas as time progresses.

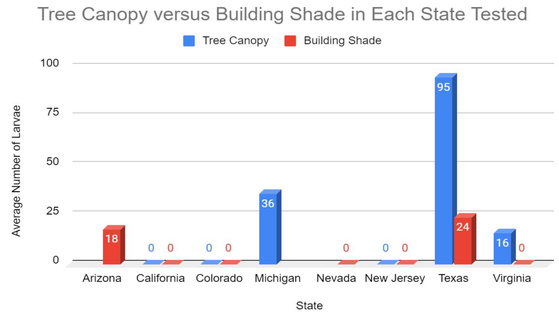
Results

Figure 1 data was collected during our experiment as well as additional traps set by other SEES interns during the Mosquito Mapping internship.
The numbers of larvae in each state are averages
The cells with "n/a" data mean there was no trap and therefore no data for those variables.
In Figure 2 the blue bars represent the average number of mosquito larvae found in traps under tree canopies and the red bars represent the average number of mosquito larvae found in traps within building shade.

Table Organizing Trap Data

State	Tree Canopy	Building Shade
Arizona	n/a	18
California	0	0
Colorado	0	0
Michigan	36	n/a
Nevada	n/a	0
New Jersey	0	0
Texas	95	24
Virginia	16	0

Graph Visualizing Differences



Credit: A. Dziaba

Credit: S. Khare

Discussion

Looking at figure 2, it appears that mosquitoes prefer tree canopy shade over building shade. This is not the result that was expected, as we theorized mosquitoes would oviposit in building shade more due to the fact that mosquitoes bearing vector borne diseases have recently increased in urban environments. This experiment is of importance to society as well as the scientific community. The result can alert those living in urban areas about the danger zones and what to avoid so as to protect oneself. This will then allow scientists to better understand mosquitoes in urban areas and create new ways to limit the spread of vector borne diseases. However, there are a wide variety of characteristics individual to a specific city. This alone can cause a discrepancy in the data collected as some cities are better suited for mosquitoes regardless of shade type.The overall results found during this experiment are inconclusive. Our group only set traps in 5 states which 3/5 had no comparable data as both trao locations yielded no mosquitoes. Also the experiment was held for a short period of time (3-6 days).

Conclusions

In all it was concluded that the experiment was unable to accurately answer the Research Question due to the lack of comparable data and the limitations placed on the experiment. While one of our mentors, Rusty, said zeros are data, zeros across most of the locations imply that the type of shade is negligible yet the data from Texas and Virginia proved otherwise. In the future, this experiment would be more accurate if performed in numerous locations over a greater time frame. Another improvement to the experiment would be to compare similar cities as all cities might not have the same effect on mosquito populations.

Bibliography

- "CDC - Malaria - about Malaria - History - Elimination of Malaria in the United States (1947-1951)." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 23 July 2018, www.cdc.gov/malaria/about/history/elimination_us.html.
- "Mosquitoes in the United States." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 5 Mar. 2020, www.cdc.gov/mosquitoes/about/mosquitoes-in-the-us.html.
- Franklinos, Lydia H, et al. "The Effect of Global Change on Mosquito-Borne Disease." *The Lancet Infectious Diseases*, vol. 19, no. 9, 2019, doi:10.1016/s1473-3099(19)30161-6.
- Luvall, J.C., Quattrochi, D.A., Rickman, D.L., Estes Jr., M.G., 2015. Urban Heat Islands. In: Gerald R. North (editor-inchief), John Pyle and Fuqing Zhang (editors). Encyclopedia of Atmospheric Sciences, 2nd edition, Vol 1, pp. 310–318. ISBN: 9780123822253.
- "68% Of the World Population Projected to Live in Urban Areas by 2050, Says UN | UN DESA Department of Economic and Social Affairs." *United Nations*, United Nations, 16 May 2018, www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html.
- GLOBE materials used: GLOBE observer app (mosquito habitats and landcover observations) on 07/22/2021

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