The Effect of Natural Bait Type on Mosquito Oviposition in Central Virginia

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Abstract

In Central Virginia, where there is a humid, subtropical climate and substantive annual rainfall, mosquitoes are quite prevalent. As the climate warms, it is reasonable to expect increased temperatures, as well as precipitation, providing increased opportunities for mosquito oviposition. This study investigates how certain natural bait types commonly found in Virginia attract mosquitoes and impact the number of larvae. The study site was a well-shaded and undisturbed backyard in Henrico County, Virginia. Three large black buckets served as traps, and pine needles, tall fescue grass, and white clover were each placed in one trap. The traps each had a large rock at the bottom, three liters of water, and a flat, wooden ruler in order to accommodate species that don't oviposit on the water's surface. The larvae were systematically counted from each trap at ten to twelve days, depending on larvae development. At the conclusion of each trial, mosquito habitats were eliminated so as not to exacerbate issues adult mosquito cause. The traps were reset for the following trial. Findings revealed that the white clover trap had the greatest number of larvae present, but the pine needle trap was a close second. The data is included in a NASA dataset. For additional research, more trials should be conducted and other natural baits could be involved, such as different types of pine needles.

Keywords: oviposition, pine needles, tall fescue grass, white clover, larvae count

Research Question

Mosquitoes are capable of spreading diseases among humans, such as West Nile Virus in the US. By understanding what types of vegetation provide nutrients that encourage and facilitate mosquito oviposition, the public could be better guided to limit and reduce disease spread through direct action. What natural baits in Central Virginia result in the greatest levels of mosquito oviposition?

Introduction

Across the globe, there are about 3,500 species of mosquitoes, but only a small percentage spread anthropogenically-significant disease. More specifically, The Commonwealth of Virginia hosts fifty distinct species of mosquitoes, many of which have frequent interactions with humans (*Mosquitoes of Virginia*, n.d.). Virginia's most common mosquito is the Asian tiger mosquito, which is also an invasive species responsible for most bites (Virginia Department of Health, n.d.). Due to the widespread nature of mosquito populations in Virginia and across the country, it is important to understand what factors attract them to reproduce in a given area.

In Central Virginia, the climate and land cover tend to lend themselves well to aiding in mosquito oviposition. There is plenty of shade provided by tree cover. Many residential areas have quiet, dark containers that can hold standing water for females to lay eggs in. Creeks and streams with deeper water are quite prevalent and undisturbed. Additionally, it is established that in general, mosquitoes tend to prefer larger containers. The reason for which might be that a larger container reduces the risks and effects associated with the competition that comes with more densely populated containers. Yet another reason for the differences in where mosquitoes lay eggs is the idea that closed-canopy areas are favored because of the increased nutrients present in such areas (Parker et al., 2020). Central Virginia also has a wide variety of vegetation dispersed throughout the area that could make their way into potential mosquito habitats. By better understanding what vegetative factors contribute to local mosquito populations, communities and individual citizens can become better informed and take action to address said problem. Specifically, minimizing opportunity for mosquito oviposition can reduce West Nile Virus cases.

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Research Methods

To investigate these questions, this experiment was conducted in a well-covered and isolated backyard in Henrico County, Virginia, where the climate is humid and sub-tropical, featuring muggy, hot summer days and much rainfall. The study site specifically was in a well-shaded and undisturbed backyard, where three black buckets served as ovitraps, each with ~7.08 grams (0.25 ounces) of a specific natural bait type, either tall fescue grass, white clover, or pine needles. Each trap had a rock placed at the bottom to prevent disturbance during the study, as well as three liters of water with a smooth, wooden ruler to accommodate any species that oviposit on such material instead of the water's surface. The main objective was to investigate the effect of different natural bait types on the amount of mosquito larvae present in the corresponding trap. Data was collected using the GLOBE Observer app Mosquito Habitat Mapper Tool from 8:00 a.m. to 11:00 a.m. ten to twelve days from initial set up, in order to account for any disruptions, as well as to ensure that the larvae were not given the opportunity to fully mature into adults. Mosquito larvae typically hatch three to seven days from an egg. Sample collection and measurement were conducted nearby the site. Three trials were conducted for the purposes of this study.

Data collection occurred by systematically counting larvae from each trap by pulling samples in a separate container repeatedly and totaling the number of larvae for each bait type. The larvae count was uploaded to Mosquito Habitat Mapper on GLOBE Observer from ten to twelve days after the traps being initially set up, depending on maturity levels of larvae. Larvae that were particularly intriguing were evaluated under a microscope and identified. Lastly, the traps and larvae were dumped after data collection, so as not to worsen mosquito control efforts locally.

West

North

South

East

Date/Time (UTC): **07/05/2021 14:30:00**

Data Source: **GLOBE Observer App**

Latitude/Longitude: **37.6639, -77.5543 (37° 39' 50.04", -77° 33' 15.48")**

Organization: **United States of America Citizen Science**

Site: **18STG747716**

Water Source Type: **Container: Artificial**

Water Source: **Ovitrap**

Larvae Count: **610**

Mosquito Eggs: **Yes**

Mosquito Pupae: **No**

Mosquito Adults: **No**

Breeding Ground Eliminated: **Yes**

GLOBE Badges

Be a **Data Scientist** fits my project because of the implementation of original data from my field work, as well as outside research to corroborate my results and West Nile Virus data from the CDC to exemplify the importance of studies like this. This project freely acknowledges limitations and suggests strategies to address them in future research. Additionally, this work details the importance of such experiments as the climate warms and provides increased opportunities for mosquito oviposition to take place.

Be a **STEM Storyteller** also represents my project well because I have written a blog post for the GLOBE Observer website about my experiences, with an emphasis on the excitement of discovering two *Toxorhynchites* cannibal mosquitoes during my first ever mosquito trap trial.

Results

White clover was the most successful in terms of larvae count, but pine needles were a close second and tall fescue grass did not do very well in comparison. Between Trial 1 and Trial 2, pine needles and white clover saw increases in larvae counts. From Trial 2 to Trial 3, all three bait types experienced a decrease in larvae counts. In terms of egg rafts, white clover had many more than any other bait type across all trials. Additionally, there was a large rain event during Trial 2 and excessive heat during Trial 3.

Figure 1. The Effect of Natural Bait Type on Average Larvae Count

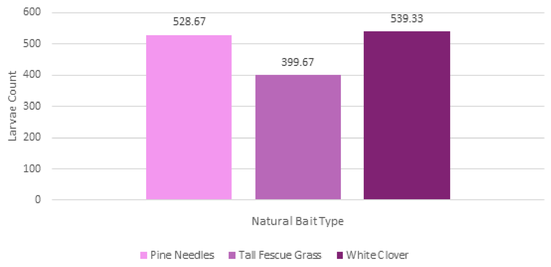


Figure 2. The Effect of Natural Bait Type on Larvae Count

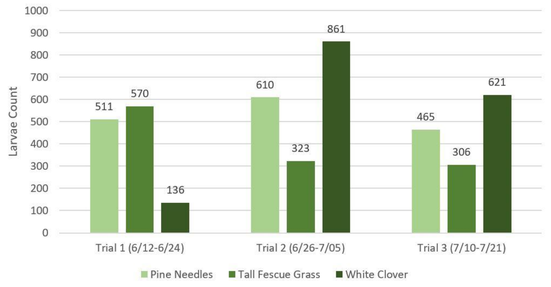
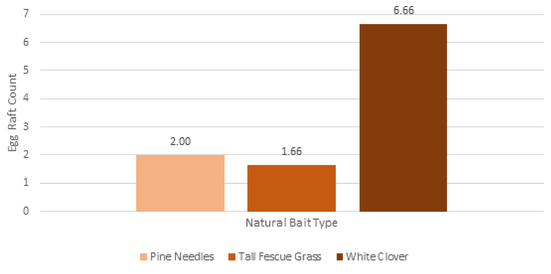


Figure 3. The Effect of Natural Bait Type on Average Egg Raft Counts

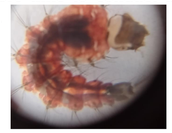


Discussion

The white clover seemed to decompose the fastest of all three baits, potentially explaining why it was the most successful bait. If a material breaks down quickly, the mosquitoes may be attracted to the more readily available nutrients. As for why pine needles were so successful as a bait, *Aedes* mosquitoes have been shown to have sensitive antennas that attract them to baits with chemical compounds limonene and pinene present, which are both found in pine needles (Zimmer, 2015). For these reasons, the hypothesis of grass being most effective and pine needles being least was not supported. To address the increase in larvae numbers from Trial 1 to 2 for pine needles and white clover, studies show that mosquitoes are more active after a rain event because of the compound geosmin, which is microbial by nature. The olfactory system aids mosquitoes in the detection of geosmin, which can attract them to the area (Melo et al., 2019).

One potential influence to results is the fact that during Trial 1 in the pine needle trap, two *Toxorhynchites* cannibal mosquitoes were present. These mosquitoes, pictured below, eat fellow larvae, so the larvae count for pine needles in Trial 1 could actually have been much higher.

The importance of this research lies in the idea of increasing knowledge of mosquito preferences in order to guide public behavior and ideally prevent negative mosquito-to-human-interaction, such as the transmission of West Nile Virus. Limitations include the presence of only three trials. More time to conduct additional trials to gather more data would be ideal.



Conclusions

The results suggest that white clover and pine needles are very effective in attracting female mosquitoes to lay eggs due to the high corresponding larvae counts in both traps. To improve methods, more trials should be run in order to verify and validate results. In the future, additional natural baits could be tested to investigate whether or not there are even more attractive nutrient sources for mosquitoes. Similarly, different types of pine needles could be manipulated as a variable in order to determine whether varying concentrations of limonene and pinene make a significant difference in terms of larvae count. Mosquito Habitat Mapper would be best suited for such studies. Lastly, this experience of working with such qualified and committed mentors has eased the research process into something incredibly enjoyable and memorable.

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