Ants in Our Parks: Ants as a Bioindicator of Land Pollution Near Grumman

Authors: Molly Byrne[1, 2], Alexa Maraboli[1, 2]
Mentor: Pamela Shanley[1,2]
[1]Saint Dominic High School; [2]Cold Spring Harbor Laboratory DNA Learning Center

Figure 5. Prenolepis Imparis CTN-002

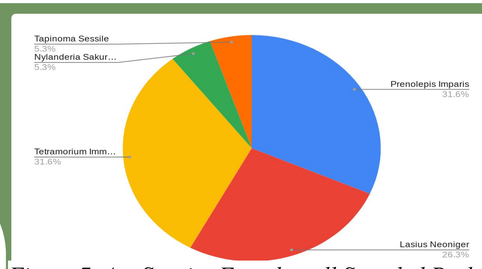

Figure 7. Ant Species Found at all Sampled Parks

Figure 3. Map of Ant Collection at Theodore Roosevelt Park (Google Earth 2024)

Figure 2. Bethpage Community Park collection sites (Google Earth 2024)

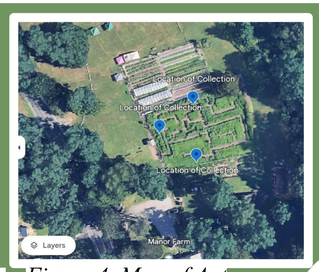

Figure 4. Map of Ant Collection at Manor Farm Park (Google Earth 2024)

Figure 6. Prenolepis Imparis CTN-001

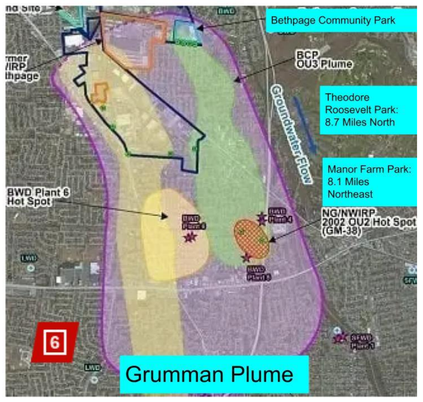

Figure 1. Park locations and Grumman plume (Goldberg 2024)

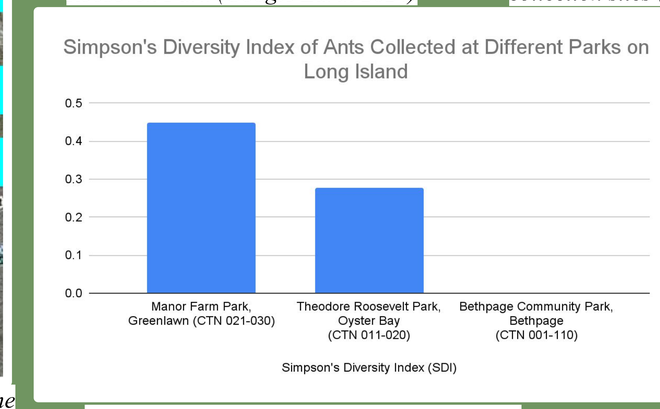

Figure 8. Simpson's Diversity Index for Parks

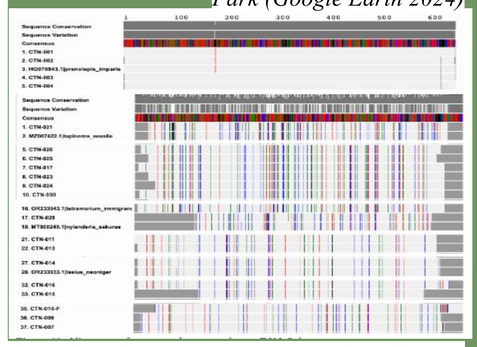

Figure 9. Alignment of samples on DNA Subway

Abstract

In the 1930s, Northrop Grumman's research generated volatile organic wastes in Bethpage. Soil tests administered there detected carcinogens (Admin 2017). We hypothesized ant diversity may be lower at Bethpage Community Park compared to two other parks farther north away from the plume. DNA was extracted from ants using chelex or silica, and PCR was used to amplify the COI region and samples were sent out for sequencing. Simpson's Diversity Index was used to determine the biodiversity at each park. Bethpage Community Park had a lower diversity index, which supported our hypothesis. *Prenolepis imparis,* a species not known for pollutant tolerance, was the only species found at Bethpage Community Park. A larger sample size and different locations of the parks could be used to analyze the relationship between pollution and biodiversity in ants more accurately.

Introduction

In the 1930s, Northrop Grumman occupied lands in Bethpage conducting research, testing, design engineering, and assembly of various military aircraft and spacecraft (Health Consultation 2022). This produced mass amounts of inorganic and volatile organic wastes discarded directly to surface impoundments and liquid waste handling systems on the current grounds of Bethpage Community Park. Figure 1 represents the plume caused by the toxins. Pollution has been found to have varying effects on ant biodiversity, abundance, community structure, and colony size (Skaldina 2018). Because of this, we predicted that Bethpage Community Park will have a lower species diversity.

Materials and Methods

30 ants were collected from Bethpage Community Park in Bethpage, Theodore Roosevelt Memorial Park in Oyster Bay, and Manor Farm Park in Huntington (Figures 2, 3, and 4). Two of the ants collected are shown in Figures 5 and 6. Ants were placed into a 1.5 mL tube with ethanol. Each sample was identified using an Audubon insect field guide and the Seek app, photographed, and uploaded to the DNALC sample database.

DNA was isolated from the samples with the silica protocol. PCR was performed amplifying the COI region. Successful gels were sent to GeneWiz for sequencing and each sequence was analyzed using BLAST to confirm if the initial phenotypic species identification was accurate.

Results

One distinct species was identified at Bethpage Community Park (*Prenolepis imparis)*, two distinct species were identified at Theodore Roosevelt Park, and 3 species were identified at Manor Farm Park. All of the species found is represented in Figure 7. Using the Simpson's Diversity Index (SDI) equation (D=1-(n(n-1)/ N(N-1))) , Bethpage Community Park was found to have the lowest ant diversity index, 0, as shown in Figure 8. Theodore Roosevelt Park had a diversity index of .278 and Manor Farm Park had a diversity index of .451 (Figure 8). Sequence alignment for identified species can be seen in Figure 9.

Discussion

Our hypothesis was supported as Bethpage Community Park had the lowest SDI. The data suggests that ant diversity may be lowered from chemicals present in the soil. If this is the case, the species that rely on the ants that are no longer able to live in the polluted area could be poorly affected which causes a domino effect on the entire ecosystem (Cho 2019).

This experiment did not account for the possibility of a hump-shaped relationship between pollution and diversity, where most diversity would be found between polluted and unpolluted zones (Belskaya 2019). To examine this relationship, the first location must be in the polluted area, the second must be on the edge of the polluted area, and the third must be far away from the plume. Increased sample size would also produce more reliable results.

Acknowledgements

Thank you to Cold Spring Harbor Laboratory DNALC specifically Kelly Eames, Jeffry Petracca, Keith Bannerman, and Dr. Cristina Fernandez-Marco for guiding us. Thank you to Daniel Ballato, the facility manager associated with the Town of Oyster Bay, Laurie, with the Town of Huntington, and Gregory M. Mangino with the Town of Bethpage, for allowing us to use the parks for sampling. Most importantly, thank you to our mentor, Mrs. Shanley, for your countless hours of hard work, guidance, and dedication throughout this process.

REFERENCES

Admin. 2017 Aug 11. Nassau Residents at Risk from Radioactive Toxic Waste. New York League of Conservation Voters. [accessed 2024 May 23]. https://nylcv.org/news/nassau-residents-risk-radioactive-toxic-waste/.

Belskaya E, Gilev A, Trubina M, Belskii E, editors. 2019 June 26. Diversity of ants (Hymenoptera, Formicidae) along a heavy metal pollution gradient: Evidence of a hump-shaped effect. Science Direct . [accessed 2024 May 27]. https://www.sciencedirect.com/science/article/abs/pii/S1470160X19304297#:~:text=The%20pollution%20with%20heavy%20metals,diversity%20along%20the%20pollution%20gradients.

Cho R. 2019 Mar 26. Why Endangered Species Matter. State of the Planet. [accessed 2024 May 27] https://news.climate.columbia.edu/2019/03/26/endangered-species-matter/.

Google Earth. 2024. Googlecom. [accessed 2024 May 28]. https://earth.google.com

Health Consultation. [accessed 2023 October 10]. https://www.health.ny.gov/environmental/investigations/northrop_grumman/docs/health_consultation.pdf.

Skaldina O, Peräniemi S, Sorvari J. 2018. Ants and their nests as indicators for industrial heavy metal contamination. Environmental Pollution. doi:https://doi.org/10.1016/j.envpol.2018.04. 134. [accessed 2024 May 27].