The Effects of Soil Composition on Ant Biodiversity

Nicholas Galvin Gusmano, Jaron Schachner, Noah Daher, Valentina Lopez

Mentor: Mr. Coleman

Abstract

This project analyzed ant biodiversity across these three environments using DNA barcoding. By using a soil composition test kit, soil pH, potassium, and phosphorus levels are determined. When comparing the soil conditions to the DNA of the ants, no significant correlation was found. This indicates that the ant species we analyzed has little biodiversity, and can adapt to different conditions by varying its gene expression. This supports previous studies, that have shown ant colonies queens can change the genetic expression of their ants to adapt.

Introduction

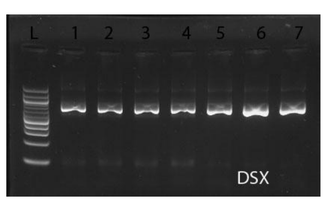
Ants are widely regarded as one of the most successful species groups in the world, with their roughly 10,000 species making up at least a third of all insect biomass—several times the biomass of all land vertebrates combined. Furthermore, ants play an axial role in nearly every ecosystem they inhabit and are commonly referred to as the soil engineers of an ecosystem (Poulsen, M., & Sapountzis, P.). Individual ant species differ in their tolerance for soil conditions, including pH and key nutrients such as potassium, nitrogen, and phosphorus. Because urban, suburban, and wooded soils exhibit different nutrient levels due to development and pollution, they frequently support completely distinct ant populations. Ultimately, this study analyzes these human-altered habitats to discover trends in species distribution and uncover how local ant communities adapt.

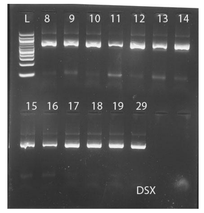
Materials & Methods

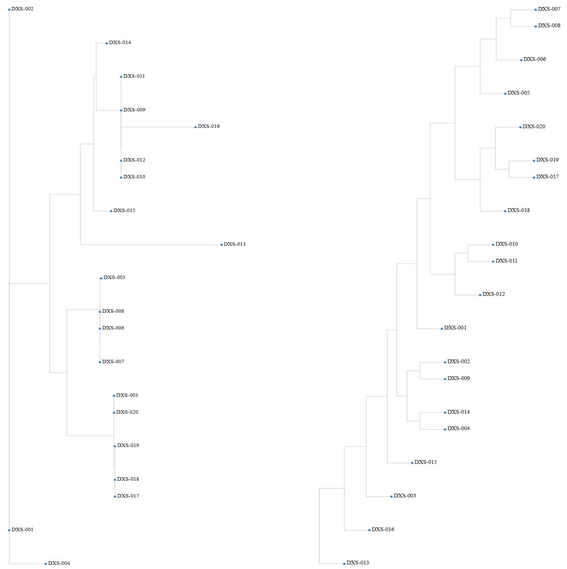
We collected ant and soil samples from three locations with different environments: urban (Udalls Cove, Queens), suburban (Portledge School in Locust Valley and East Norwich), and wooded (Oyster Bay Cove). Ants will be collected using non-harmful traps, while soil samples will be gathered from the same locations and analyzed for phosphorus, potassium, and pH using a soil test kit. Twenty ant samples will be selected, photographed, stored in a freezer, and identified with iNaturalist. DNA will be extracted from the ants using a Chelex solution, then amplified through PCR using the COI primer set. The amplified DNA will be sequenced using Sanger Sequencing to identify species and compare genetic information. Finally, gel electrophoresis will separate DNA fragments by size to confirm successful DNA amplification before sequencing.

Results

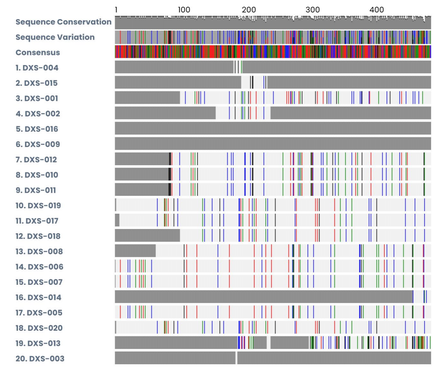
While high-density Queens and lower-density Long Island exhibited similar overall species richness, their specific species compositions varied significantly. This biodiversity shift corresponds directly to a stark demographic contrast—a population delta of over 1 million people and a density variance of roughly 17,000 people per square mile. Ultimately, these intense urban pressures do not lower absolute species counts, but instead fundamentally alter community structures by selecting for highly resilient species like Tapinoma sessile.

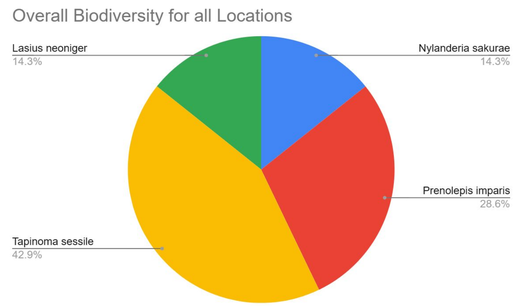


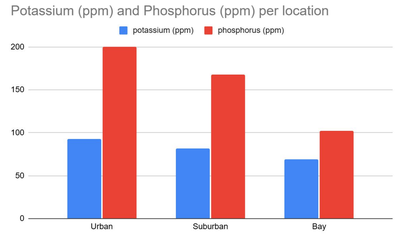


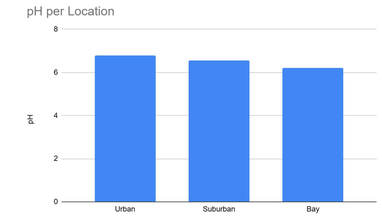


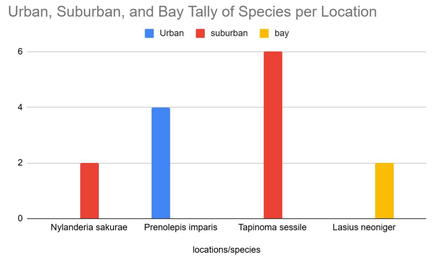
Data & Evidence











Discussion

Analysis of local soil chemical profiles (pH, Nitrogen, Phosphorus, and Potassium) revealed high uniformity across all collection sites, indicating that soil chemistry was not the primary driver of ant distribution. Instead, urbanization and human population density strongly influenced community dynamics, resulting in distinct shifts in species composition between wooded, suburban, and urban habitats. This ecological adaptability was highlighted by the widespread dominance of Tapinoma sessile (the odorous house ant) within human-altered landscapes, thriving despite varying levels of human disturbance. While total species richness remained comparable across the three habitat types, the generalizability of these findings is constrained by our localized geographic scope on Long Island and a limited sample size (N = 20), which included one PCR amplification failure due to visual clarity constraints and two non-target insect exclusions. To validate whether these trends hold true across broader ecosystems, future research should expand both the sample size and the geographic matrix of high- and low-density environments.

Acknowledgments and References

National Wildlife Federation. (n.d.). Ants. National Wildlife Federation. Retrieved December 9, 2025, from https://www.nwf.org/Educational-Resources/Wildlife-Guide/Invertebrates/Ants

Poulsen, M., & Sapountzis, P. (2012). Behind every great ant, there is a great gut. Molecular ecology, 21(9), 2054–2057. https://doi.org/10.1111/j.1365-294X.2012.05510.x