Ant-Ticipating Diversity

By: Ian Cheung[1], Noah Levine[1], Luke Singer[1]
Mentors: Nim Lee[1], Howard Waldman[1]
[1]Ethical Culture Fieldston School

Funded By the Thompson Family Foundation

Abstract

This paper investigates the diversity and habitat distribution of ant species on Randall's Island, New York, hypothesizing that the urbanization of Randall's Island would limit speciation. The objective was to determine the species and diversity of ants on Randall's Island within a deciduous forest and a salt marsh. It was also hypothesized that the forest would have a higher diversity than the salt marsh. Ants were then identified through morphological features followed by DNA sequencing. Twenty samples were collected with seven species of ants identified. From the salt marsh, the only species identified was *Tapinoma sessile*, while the deciduous forest contained seven species. A deciduous forest environment likely fosters higher ant diversity than a salt marsh. All species identified have been previously identified in New York State (Guénard, 2017). The proximity of Randall's Island to the mainland and urbanization have led to no speciation of ant species.

Introduction

Ants are among the most successful insects on the planet, colonizing nearly every habitat except Antarctica, Greenland, Iceland, and a few islands. There are approximately 20 quadrillion ants on Earth, with only 12,000 known species, while scientists estimate another 20,000 unknown species. Our research focuses on common ant species found in New York City. Randall's Island, situated between Manhattan, Queens, and the Bronx, was urbanized in 1916 with bridges connecting it to these boroughs. This connection enabled various species, including ants, to cross the East River and establish themselves on Randall's Island, which contains diverse biomes such as grassland, deciduous forest, and salt marsh.

Our study aimed to investigate and compare the diversity of ant species within the salt marsh and deciduous forest environments on Randall's Island. We hypothesized that the deciduous forest would have higher diversity compared to the salt marsh due to its complex vegetation structure and abundant resources. Additionally, we examined whether Randall's Island hosts any unique ant species or if its species composition mirrors that of the rest of New York City. Given the urbanization and the challenges of morphological identification, DNA sequencing was employed as the most precise method for identifying specific ant species.

Materials & Methods

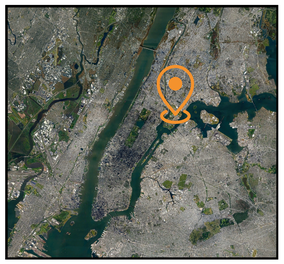


Figure 1: Map of Manhattan and its surrounding area, with Randall's Island, the sampling location, shown by the orange pin

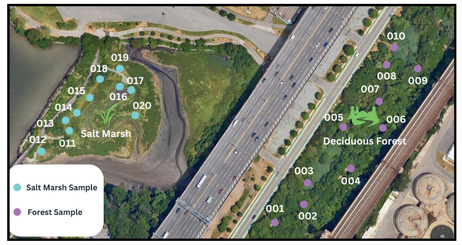


Figure 2: Map of the section of Randall's Island indicating locations of the deciduous forest, salt marsh, and the location in which the samples were collected. On the left is the salt marsh, and on the right is the deciduous forest. Each dot represents a site where a sample was collected, with the sample ID next to the site.

Sample Collection
- Locate sites within forest and salt marsh
- Collect samples using forceps and place in tubes
- Fill tubes with ethanol to preserve ants

Morphological ID
- Look at ants under microscope
- Identify ant species through features
- Record species identified through morphological identification

DNA Isolation
- Isolate DNA from cells with lysis
- Capture DNA using silica resin
- Remove DNA from silica resin by adding ITS primer.

PCR
- Denature DNA strands at 94-95°C.
- Use ITS primer to anneal strands at 55-72°C.
- Extend DNA strands at 72°C.

DNA Analysis
- Import and trim DNA sequences
- Pair DNA sequences
- Use the BLASTN tool to identify species.

Results

Sample ID	Species Identified	Bit Score
001	*Tapinoma sessile*	1141
002	*Tapinoma sessile*	1139
003	*Lasius claviger*	1108
004	*Nylanderia*	969
005	*Nylanderia*	978
006	*Nylanderia*	1145
007	*Nylanderia parvula*	893
008	*Lasius interjectus*	1162
009	*Prenolepis imparis*	1173
010	*Tetramorium caespitum/immigrans*	980

Table 1: Deciduous forest ant identification; bit scores of >800 are considered reliable.

Sample ID	Species Identified	Bit Score
011	*Tapinoma sessile*	1088
012	*Tapinoma sessile*	1144
013	*Tapinoma sessile*	1139
014	*Tapinoma sessile*	1139
015	*Tapinoma sessile*	1062
016	*Tapinoma sessile*	1139
017	*Tapinoma sessile*	1137
018	*Tapinoma sessile*	1131
019	*Tapinoma sessile*	1139
020	*Tapinoma sessile*	1180

Table 2: Salt marsh ant identification; bit scores of >800 are considered reliable.

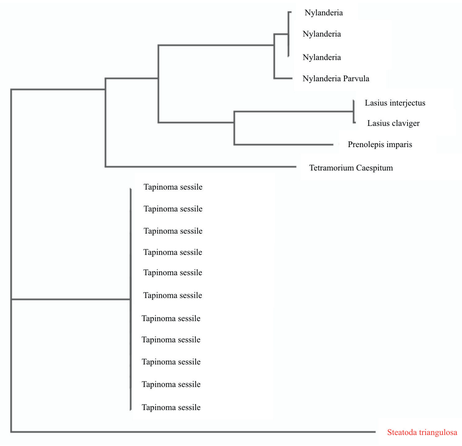


Figure 3: Maximum likelihood phylogenetic tree displaying the evolutionary relationships between the identified species. Steatoda triangulosa, a spider, was used as the least relative species. The latter branches show that Tapinoma sessile is least related to other ant species sampled. It can also be seen that the genus Prenolepis is closely related to the genus Lasius.

	Salt Marsh	Deciduous Forest
# of species	1	7
Simpson's Index	1.00	0.17

Table 3: Table displaying Simpon's Index for the Salt Marsh and Deciduous Forest. Results of the test indicate no diversity in the salt marsh and high diversity in the Deciduous Forest. Was calculated by setting each sample as 1 individual ant since each sample contained roughly the same number of ants

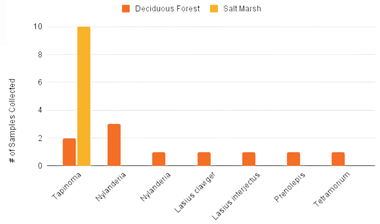
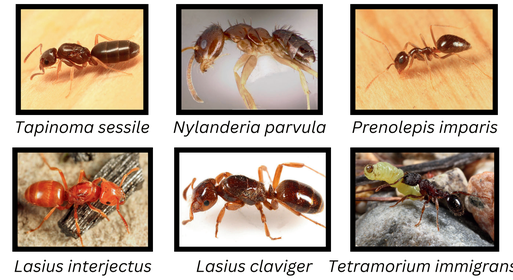


Figure 4: Bar graph displaying Amount of species sampled within the two habitats

Discussion

- Out of 20 Samples, all 20 were sequenced and identified
- 17 samples were identified to genus species, while 3 samples were identified to genus only
- In the deciduous forest, 7 species were identified: *Tapinoma sessile, Lasius interjectus, Lasius claviger, Nylanderia parvula, Nylanderia, and Tetramorium caespitum/immigrans.*
- The results support the hypothesis that the urbanization of Randall's Island correlates with high levels of species immigration.
- For sample CRJ-010, barcoding couldn't conclusively differentiate between *T. caespitum* and *T. immigrans*.
  - *T. caespitum* has never been documented in North America; likely species is *Tetramorium immigrans*.
- GABI confirmed that the ant species sampled at Randall's Island are present in wider New York State.
- Six species identified are native to North America; *T. immigrans* is nonnative, introduced by human activity.
- Results indicate species migration of ants to Randall's Island, with established populations of the identified species.
- Results also support hypothesis that deciduous forests have higher ant diversity than salt marshes.
  - Only species in salt marsh, *Tapinoma sessile,* is extremely adaptable to different conditions
- Simpson's Index was 1.00 for salt marsh and 0.17 for deciduous forest, indicating higher biodiversity in the forest.
- Future experiments could increase sample size, use different seasons, and employ varied collection methods.
- Findings highlight the importance of preserving varied habitats within urban areas to support biodiversity and guide urban planning and conservation efforts.



Tapinoma sessile *Nylanderia parvula* *Prenolepis imparis*

Lasius interjectus *Lasius claviger* *Tetramorium immigrans*

Photos by Tom Murray

Figure 5: Photos of species collected

Acknowledgments

Thank you to Nim Lee, Howard Waldman, and to the Randall's Island Park Alliance for helping us collect ant samples on Randall's Island. Thank you to Nim Lee for helping us edit the report as well. We would also like to thank our Science Research class for their support.

Select References

(n.d.). AntWiki. Retrieved May 20, 2024, from http://www.antwiki.org
Ammann, O. H. (n.d.). Randalls and Wards Islands. Wikipedia. Retrieved May 19, 2024, from https://en.wikipedia.org/wiki/Randalls_and_Wards_Islands

Goswami, A. (2020). Diversity of ants species in different habitat mosaics of Acharya Jagadish Chandra Bose Indian Botanical Garden. https://doi.org/10.38059/biodiversity.698157

Guénard, B., Weiser, M., Gomez, K., Narnula, N., & Economo, E. P. (2017). The Global Ant Biodiversity Informatics (GABI) database:. Myrmecological News, 24, 83-89. abc

Leicht, A. M. (2017, November 7). Randall's Island – History of New York City. TLTC Blogs. Retrieved May 19, 2024, from https://blogs.shu.edu/nyc-history/2017/11/07/randalls-island/#_ftn13

Libre Texts Biology. (n.d.). Wikipedia. Retrieved May 19, 2024, from https://bio.libretexts.org/Courses/Thompson_Rivers_University/Principles_of_Biology_II_OL_ed/04%3A_Ecology/4.04%3A_Ecosystems_and_the_Biosphere/4.4.03%3A_Terrestrial_Biomes

Price, J., & Morgan, J. (2008, April 10). Woody plant encroachment reduces species richness of herb-rich woodlands in southern Australia. https://doi.org/10.1111/j.1442-9993.2007.01815.x

Salt Marsh Guide. (n.d.). Ecological Setting. Salt Marsh Guide. Retrieved May 19, 2024, from https://www.saltmarshguide.org/guide/ecological-setting/

Tews, J. (2004). Animal species diversity driven by habitatheterogeneity/diversity: the importance of keystone structures. https://doi.org/10.1046/j.0305-0270.2003.00994.x

Wang, C. (2001, October 01). Association Between Ants (Hymenoptera: Formicidae) and Habitat Characteristics in Oak-Dominated Mixed Forests. https://doi.org/10.1603/0046-225X-30.5.842