The Effect of Urbanization on Ant Biodiversity in a Suburb in Northern New Jersey

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Abstract

In the suburban town of Tenafly, located in Northern New Jersey, many ecological niches with different levels of urbanization exist. In these ecological niches many different species of ants thrive, allowing for a large variety of ants. Our research investigated the correlation between urbanization and the variation of ant species. We collected 15 ant samples from three locations: Tenafly Nature Center, Roosevelt Commons, and West Clinton Avenue. Utilizing the Chelex solution, we determined the specifics of our samples. Although we found that the Tenafly Nature had a wider variety of ants as compared to the other locations; the results showed that urbanization did in fact lessen the variety of ant species in a location. However due to the limited amount of successful analyzed samples, there is no strong correlation that urbanization will lessen the diversity of ant species, and potentially other organisms as well.

Introduction

There exists thousands of different species of ants filling different ecological niches. There are more than 12,000 individual species of ants that inhabit planet Earth,1 and some of them, including the Carpenter ant (Camponotus) and Citronella ants (Acanthomyops), can be found in New Jersey.2 Ants are key factors in seed dispersal, as ant colonies carry large amounts of plant seeds into burrows they have built underground. Along with this, many ant species aerate soil, allowing water, oxygen, and nutrients to reach the roots of plants.3 This is especially essential for the environment of Northern New Jersey, as its proximity to New York City makes the area prone to acid rain, which drains nutrients from the soil important to the plants living in the area.4 The aeration of the soil by organisms such as ants support the plant ecosystem so that they can continue to obtain the nutrients they need in order to survive. This suggests that an abundance of ants would prove to be beneficial to areas located in proximity to large urban areas.

It is well known that the urbanization of areas by humans negatively affects the biodiversity of the native species. Urbanization creates an intensely uniform environment that is often highly disparate from the undeveloped area they lived in, forcing the native species to adapt to overwhelming change. As a result, ant species that may rely on the environment they live in to provide them with the necessary shelter and nutrients to survive are unable to adapt fast enough to accommodate the rapid change brought upon by urbanization. Even in areas that retain a substantial amount of local vegetation, any land development and disturbance of about 30-40% has been shown to be the level in which the biodiversity of ants begins to decline.5

Ants in Northern New Jersey, unlike those in tropical climates, are inactive in the winter months and go into dormancy known as diapause in order to survive the cold temperatures. Ants re-emerge from their nests in the spring, and become most active during the summer months.6 During their active season, ants go through a four-step life cycle, which takes around six to twelve weeks.7

Tenafly is a suburban neighborhood located in Northern New Jersey. Tenafly contains 7 recreational parks, including the Roosevelt Commons, located in the downtown area of Tenafly. Tenafly also boasts a 52-acre nature center, the Tenafly Nature Center, that preserves the area's biodiversity and water resources.8 This urban barcoding project may assist in determining the ant biodiversity of suburban towns similar to Tenafly.

Our project focuses on determining what is the correlation between urbanization and variance in ants' population? We collected ants from three different locations and tested our hypothesis that urbanization has some effect towards the variance in ants in specific areas.

Materials & Methods

We collected 15 samples of ants from 3 different locations in Tenafly, collecting 5 samples from each location: Tenafly Nature Center, Roosevelt Common, and West Clinton Avenue. We chose these locations because each of them had different levels of urbanization. Tenafly Nature Center is all woodlands, West Clinton Avenue is downtown therefore it is the most urbanized out of the three locations, and Roosevelt Common is a park; a mix between woodlands and suburbs. We captured the ants using bait traps, and attracted the ants using pecan sandies. We placed the cookies on a white piece of paper and waited a few hours for ants to come to the bait. From the 5 samples we collected from each of 3 different locations in Tenafly, we accurately documented each sample with dates, location the ants were found, along with pictures. After collecting the 15 ant samples we euthanized them by putting them in a freezer for several hours. Once the ants were euthanized we began to isolate the DNA.

First, we preserved the ants at -20°C in 95%+ EtOH. Next, we gently tapped the 10% Chelex solution tube on a hard surface to ensure the solution was at the bottom and placed the ant sample into the tube with sample identification numbers. We then twisted a clean plastic pestle against the inner surface of the Chelex tube to forcefully grind the tissue for at least 2 minutes, and grinded the ant sample into fine particles.

After securely closing the tube's cap, we filled a mug nearly to the top with boiling water and covered it with aluminum foil. Next, we secured the lid using a cap lock to the rim of the tube. We made sure that both the tube rim and cap were held within the cap lock so that steam couldn't force the cap open. We placed the tube through the foil using small punched guide holes, so that the Chelex and sample mixture was fully submerged, but did not submerge the top of the tube. We used a water bath to incubate tubes at 95°C for 10 minutes. After, we discarded the water from the mug and returned the tubes in foil to the mug and allowed Chelex to settle for an additional 10 minutes. Finally, we carefully transferred ~30 µL of supernatant from the Chelex tube, avoiding the Chelex, into a clean 1.5mL microcentrifuge tube labeled with the sample identification number. We were careful not to transfer any of the white Chelex resin. We stored this tube at 4° C temporarily until ready to amplify the DNA using a primer.

Next, we amplified DNA using a primer. First, we added 23 µL of the COI primer set and added 2 µL of our DNA collected into the PCR tube. We then placed the PCR tube into the thermal cycle that had been programmed with the correct PCR protocol. After PCR, we stored the amplified DNA at -20° C.

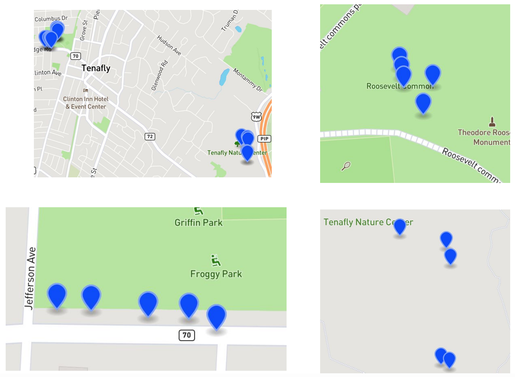
Finally, we analyzed the PCR products by gel electrophoresis. First, we sealed the ends of the gel-casting tray with masking tape and poured 2% agarose solution into the tray to a depth covering about one-third in height. Then we let the 2% agarose solution solidify for about 20 minutes, and added 5 µL of PCR product and 2 µL of SYBR Green. Finally, we ran the gel through electrophorese and viewed the gel using UV transillumination.

After completing the gel electrophoresis, we then sent the sample to be sequenced. Once the samples were sequenced, we used the website, DNAsubway.org, to compare and analyze our sample sequences with their database. Utilizing the UniGene database allowed us to search for genes and compare similarity to our ants' samples DNA sequence, therefore assisting us in identifying the type of ant. This helped us determine the biodiversity of the ants at each of the three locations and determine the correlation between ant biodiversity and urbanization in different parts of the Northern New Jersey suburb.

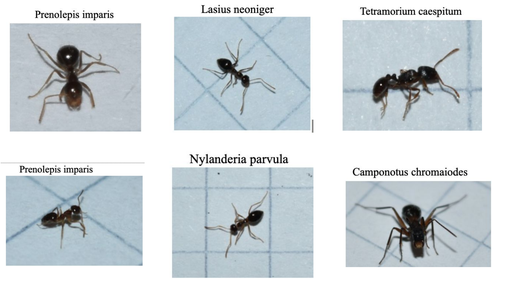
Results

Out of the fifteen samples we collected, only nine samples were analyzed successfully. We compiled our results in forms of a phylogenetic tree along with a table that identifies each species in each of the three locations.

In Location 1, three out of the five samples from these locations were analyzed. In Location 2, only two out of the five samples from these locations were successfully analyzed. Finally in Location 3, four out of the five samples were successfully analyzed.



Location 1	Location 2	Location 3
QSR-01: Prenolepis imparis	QSR-06: Tetramorium caespitum	QSR-12: Prenolepis imparis
QSR-02: Lasius neoniger	QSR-10: Lasius neoniger	QSR-13: Nylanderia parvula
QSR-05: Lasius neoniger		QSR-14: Prenolepis imparis
		QSR-15: Camponotus chromaiodes



Discussion

From these results, there seems to be a correlation between urbanization and the variance of the ants' population.

Looking at both Locations 1, the species we identified were similar to each other. In Location 1, although only three out of the five samples were successful, lasius neoniger was the identified species for two out of the three successful analyzed samples.

In contrast, the one other remaining sample is analyzed and identified as prenolepis imparis. From these results in Location 1, Location 1 is a recreational park behind the school and is located at Roosevelt Commons. This location exhibits both suburban and natural characteristics. Thus we concluded at the beginning that urbanization does create some uniform environment where the native species had to adapt to overwhelming change, leading to the prevalence of the lasius neoniger species; these ant species were probably best able to adapt in Location 1.

In Location 2, the analyzed samples and their data are much more obscure. Location 2 is on the busiest intersection, right next to Jefferson Avenue. Only two out of the five samples were successfully analyzed and identified. Looking at the samples, both QSR-06 and QSR-10 are different species; QSR-06 is identified as tetramorium caespitum while QSR-10 is identified as lasius neoniger. This data does not support our hypothesis because of how restricted and limited the data is. We concluded that the limited information from Location 2 did not significantly help prove our hypothesis that there was a correlation between urbanization and variance in ants' population.

Finally, Location 3 has the most natural characteristic out of all the locations. Location 3 is a woodland located in a nature center. Location 3 has four out of the five samples successfully analyzed. In addition, 3 samples exhibited the greatest diversity. With each sample being a different species. Such as QSR-12 is prenolepis imparis, QSR-13 is nylanderia parvula, QSR-14 is prenolepis imparis, and QSR-15 is camponotus chromaiodes. Each of these species varied in size and color. When comparing samples QSR-12 and QSR-15, QSR-12 was the smallest ant while QSR-15 was the largest ant with a tinted hue. The data from Location 3 demonstrated that it has the greatest diversity out of all three locations. This supports our hypothesis that there is a correlation between urbanization and ant variety where the less urbanized locations exhibit a great variety of ant species.

However, due to the limited amount of data and successfully analyzed samples we received, this correlation between urbanization and the variety of ants is weak. One of our mistakes when analyzing the samples was the transportation method. After we analyzed the samples at home using the Chelex solution, we shipped the samples in a UPS truck under blistering conditions from the heat. This may have affected our results. Therefore, although we saw a correlation between the urbanization and ant variety when comparing Location 1 to Location 3, we cannot accurately conclude there is a definite correlation between the two due to the limited amount of data.

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