Comparison of Invasiveness in Plant and Insect Species in Forest Park

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Abstract

IInvasive species are defined as species that are non-native to a particular ecosystem and that, upon introduction to said ecosystem, could potentially be dangerous to the native inhabitants of the ecosystem. Forest Park encompasses an agricultural, green space in the urban environment of Forest Hills, Queens, NY. Our team endeavored to compare the prevalence of invasive plants versus invasive insect species in Queens, NY. However, it is important to note that, in Forest Park, it was difficult for our team to find and collect ant samples; the ant samples collected did not live long after being stored. Due to this, for the purposes of this project, our team mainly focused on exploring the degree of prevalence of invasive plant species in Forest Park and how/if that impacts the surrounding environment. In order to detect the presence of invasive plant species, sixteen plant samples were collected from Forest Park. The samples' DNA was extracted and amplified using an rbcl primer and was subsequently sequenced. Using BLAST, GenBank, the USDA Invasive/Noxious species list, and PHYLIP-NJ, four samples were identified to be *Lolium Arundinaceum*, *Plantago Lanceolata*, *Stellaria species*, and *Zinnia violacea*. Out of our four positively identified samples, three samples constitute as invasive species. Our identification of these invasive species could prove to be useful in removing or managing such species in the future and, thus, aid in maintaining and improving their impact on our ecosystem in order to protect the surrounding environment.

Introduction

Invasive species are generally not indigenous to the ecosystem in which they live. For species to be considered invasive, they are typically destructive and harmful to the surrounding environment. Invasive species can travel on a multitude of different surfaces and via a variety of different pathways. People may accidentally release pets or houseplants, only for them to inadvertently become invasive.A non-native species becomes invasive when competing with native species for food, spreading rapidly and invading the growing space of other species, absorbing vital nutrients and adapting to the environment. This poses a threat to the native species inhabiting the given ecosystem. Invasive species can be in any type of environment. Thus, the presence of invasive species would not be unlikely.

Some common invasive plant species in New York City include Acer platanoides (Norway Maple), Aegopodium podagraria (Goutweed), and Alliaria petiolata (Garlic Mustard). Some common invasive insect species in New York City are Anoplophora glabripennis (Asian longhorned beetle), Agrilus planipennis (Emerald ash borer), and Sirex noctilio (Sirex woodwasp).

DNA barcoding was used to identify the plant species in Forest Park and to determine if the plant species are invasive to the community. Various plants found within Forest Park were sampled, and their DNA was compared to those of invasive species using BLAST (BLAST: Basic Local Alignment Search Tool), the USDA Invasive/Noxious Species list, and GenBank (National Library of Medicine). In this paper, we identify the number of invasive insect and plant species in Forest Park and compare those two numbers to give us an idea of the degree of prevalence in each category, which better equips us to find a solution to the problem of invasive species critically harming the biodiversity of New York City.

Methodology

1- Sample collection
2- DNA Extraction
3- PCR
4- Gel electrophoresis
5- DNA Sequencing
6- BLAST
7- Creation of phylogenetic trees
8- Crosscheck with USDA Invasive Species List

Results

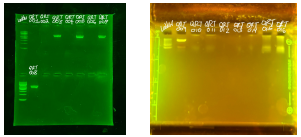

Figure 1: Gel data. Among the 16 samples, only QRT-003, QRT-005, QRT-007, and QRT-008 were positive.

Sample #	Species Name	Date Collected	Is It Invasive to New York City?	Where is It Native
QRT-003	*Stellaria species*	11/01/22	Yes	Europe
QRT-005	*Lolium Arundinaceum*	11/01/22	Yes	Europe
QRT-007	*Plantago Lanceolata*	11/01/22	Yes	Eurasia
QRT-008	*Zinnia violacea*	11/01/22	No Non-Invasive	Mexico and Central America

Table 1. Species name identified from BLAST and whether or not it is invasive to New York City and where it is native

QRT 003, 005, 007, and 008 were successfully amplified and sequenced (Figure 1) and sequenced.Using phylogenetic trees generated through PHYLIP-NJ in DNA Subway as well as BLAST, we were able to identify the closest possible alignment between our sequences and other known plant sequences.

Results (cont')

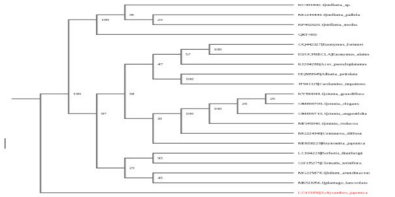

***Figure 2**. Phylogenetic tree for QRT-003.*

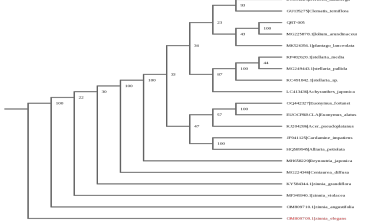

***Figure 3:** Phylogenetic tree for QRT-005.*

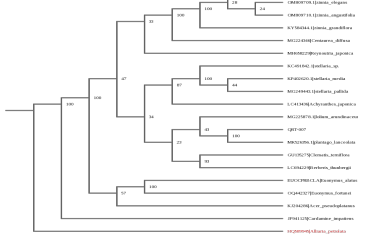

***Figure 4:** Phylogenetic tree for QRT-007.*

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Discussion

Data we collected from BLAST and PHYLIP-NJ was analyzed using numerous different indicators which allows us to determine the quality of the match between our sequences and other sequences that were showing to potentially be similar in nature to our sequences. Primarily, we looked at the e-values, number of mis-matches, bit score, and alignment length. Although it is impossible to determine the matches between sequences with absolute certainty, our matches indicated high bit score alignment length value, which indicates high degrees of similarity, as well as low e-values and mis-matches. The combination of the two indicates that our matches are likely very close and accurate. Almost all of our sequences indicated zero mis-matches with our sequence, increasing the accuracy in confirming their identity

Through the use of PHYLIP-NJ in DNA Subway, we created phylogenetic trees, containing our sequence, the likely matches from our BLAST results, as well as common invasive species from the USDA Invasive/Noxious Species list for NY and GenBank (National Library of Medicine). The bootstrap values and demonstrated evolutionary relationships depicted in the phylogenetic trees indicated to us the degree of likelihood that there was once a clear evolutionary relationship between our sequence and another species. In phylogenetic trees, bootstrap values indicate the amount of time a generated relationship was repeated each time the tree was generated. For sample QRT-003, our phylogenetic tree indicated a close evolutionary relationship with the *Stellaria* genus. Although it is difficult to determine which exact species of *Stellaria* is most closely related to, the bootstrap value of 100 demonstrates that in 100% of generations of the phylogenetic tree, sample QRT-003 was identified as having close evolutionary ties to the *Stellaria*, giving us a high degree of likelihood that QRT-003 may be identified as a *Stellaria* species, an invasive weed. For sample QRT-005 we received a bootstrap value of 100 between our sample QRT-005 and the *Lolium arundinaceum* species. This would again indicate that in every trial of our phylogenetic trees, our sample was identified as having a very close evolutionary relationship with *Lolium arundinacium* species, giving us a reasonable degree of certainty that sample QRT-005 can be identified with *Lolium arundinaceum*, another invasive species. Moreover, sample QRT-007, the phylogenetic tree we generated again yielded a bootstrap value of 100. Our tree indicates a close evolutionary relationship with *Plantago lanceolata* giving us a reasonable degree of certainty that our sample QRT-007 can identify with *Plantago lanceolata*, an invasive plantain species.

The main challenge faced in this project was getting proper samples that would effectively show the number of invasive species since many of the plants at Forest Park were placed there intentionally and were imported from other countries. Because of the deliberate placement of many of these plants, it was somewhat difficult to figure out which species were truly "invasive" and which ones were there because people put them there

A separate challenge we encountered during the beginning portion of our project was sample collections and storage of ants. Initially, the goal of this project was to compare the prevalence of invasive plants in Forest Park to the prevalence of invasive insect species in Forest Park.

The invasive species we identified provide a lens into the notion that there are potential environmental dangers locally in our neighborhood. The identification of such species allows us to understand the prevalence of such species in New York as a whole. Species such as *Stellaria*, for instance, are dangerous, invasive weeds whose rapid growth invades the space of native plants and prevents native species from accessing proper nutrients. By identifying the properties of such invasive species, we are able to potentially find solutions to stop the spread of such species in the future and consequently improve the health ability to thrive of our native species.

Selected Reference

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