Sidewalk Samplers

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Abstract

The aim of this project was to determine the diversity of sidewalk plant life in New York City in relation to proximity to Central Park. With this information, we compared the diversity using Simpson's biodiversity index, report on the phylogenetic relationship of the species found, further our understanding of the phenological responses to the environment, and create a "livability score" based on the factors affecting formation and germination in each habitat, such as temperature, sidewalk pavement design and suitability for life, foot traffic, sunlight exposure (or lack thereof), time of day, and season.

Introduction

Although sidewalk plants appear to be a nuisance to all gardeners, the truth behind these bothersome weeds takes us back to a time before modernity. These "spontaneous urban plants" (SUPs) demonstrate how nature can take root and continue to survive and germinate despite the unrelenting expansion of cities. Spontaneous urban ecology offers a tool for understanding how cities have evolved and for assessing current environmental conditions. Urban ecologist and landscape designer David Seiter has argued that rather than assuming that invasive species are harmful and trying to exert control over new urban ecologies, we should try to understand them and their significance to urban ecologies (Seiter, David).

It is imperative to understand the numerous mechanisms behind plant distribution, namely seed dispersal. Passive dispersal methods - such as wind, water (usually not as common in an environment like New York City), animal, and attachment - lead to random habitat selection (Cheptou et al. 2008). This form of habitat selection is dependent on the potential of finding a suitable environment, which is directly correlated with the number of suitable sites in the area. In urban environments, where there are less liveable environments present, there will be fewer seeds surviving once dispersed. With this being said, the limited survival of dispersed seeds could lead to natural selection. In the plants that disperse more frequently, adaptations could form that curb dispersal, because they will not survive outside of a particular environment.

Understanding the role of phenological responses to the environment through phylogeny is important because spontaneous urban plants have biological responses that enable survival in difficult habitats. This aspect ties into our goal of measuring biodiversity, because understanding life in a suboptimal environment through the idea of 'phylogenetic conservatism,' that closely related plants share similar ecological and biological attributes, could demonstrate that through plant lineage we can further understand the phenological responses of spontaneous urban plants to abiotic cues. It has been shown that responses to abiotic cues (phenological responses) are what is conserved between closely related plants. This idea that plants hold on to these biological responses to environmental cues and utilize them during phenological events (defined moments in a plant's life cycle) may aid the discussion of our results, and it can provide clarity to how and why spontaneous urban plants have the ability to live in the irregular and ever-changing New York City (Davies, T. J., et al.).

We predicted that as we get farther from Central Park or other plots of natural plant growth, the number of SUPs would gradually decrease and the diversity of the SUPs that we find will also decrease. Urban environments such as New York City make SUP survival challenging, we believe that Central Park is more conducive to natural plant growth than sidewalks are; the further away from Central Park we travel, the more challenging the environment will be due to the presence of concrete, foot traffic, limited access to water, etc. Therefore, the less likely SUPs will be to survive and thrive. We also believe that we will see decreased diversity, because in order to survive, the SUPs will have adapted similarly and their phenological responses to the suboptimal habitat will reflect these shared traits.

Materials & Methods

At each site we spent fifteen minutes observing a ten-by-ten meter plot, collecting SUPs. When new samples were found, we recorded the plant species and number of individuals in the plot. Along with this, we took images of all locations as well as the sample, which were uploaded to the Sidewalk Samplers group on iNaturalist. We also recorded temperature, sidewalk pavement design and suitability for life, foot traffic, sunlight exposure (or lack thereof), time of day, season, and any other particularities about specific environments. Using this data, we provided each location with a 'livability score' with the purpose of providing a quantitative value influenced by various qualitative factors that we find extremely noteworthy and integral for discussing the results. The purpose of this score is to assign a quantitative value influenced by various qualitative factors for the discussion of results. The samples were stored in the freezer at The Browning School in individual, clearly labeled test tubes and bags. In order to confirm the identity of the samples collected, we used the DNA Learning Center DNA Barcoding protocol (DNA Learning Center. 2014). We used the ready-to-go PCR bead amplification method, and our primer of choice was rbcL. We sent our samples to Genewiz for sequencing. We expected sequences between 500-1000bp.

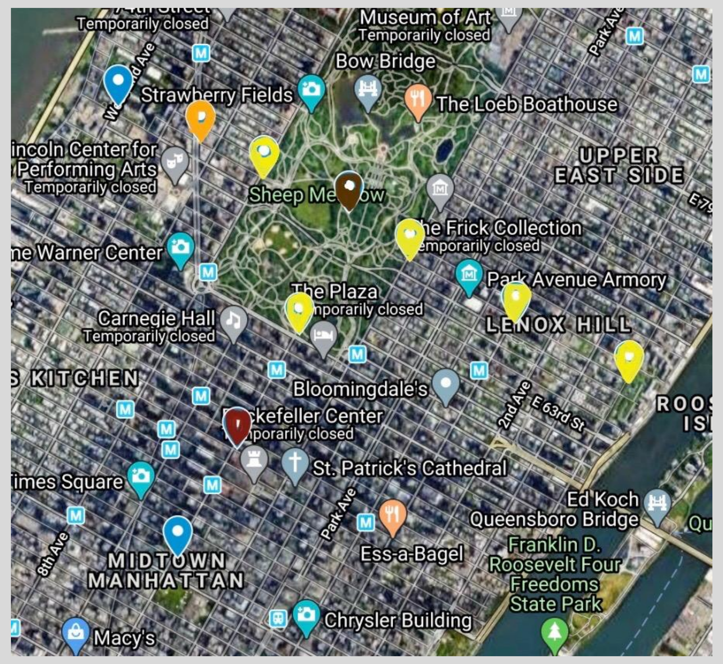

Figure 1: Here is a map that displays the plots we visited and collected samples. We traversed across the Manhattan on 67th street, and South. Our center plot was at Sheep's Meadow.

Figure 2: This image was taken at our plot on Broadway as seen on the sign just behind the tree. It depicts the the spirit and playful nature of our group, and was also the Stimpson family Christmas Card.

Results

At each different site we were faced with different challenges as some of the sites were totally barren, completely sealed off from the earth by concrete. At other sites, we were able to find a plethora of life, ranging from procumbent pearlwort to prostrate knotweed. All of these samples helped us to build up our collection of specimen to test. This method of physically testing the samples and going to specific sites was helpful and more informative than just looking at iNaturalist because it also gave us a good idea of what conditions would help them grow more or make the environment more difficult for life to thrive in, and we recorded the details of the site in the chart below.

FTable 1: The table below presents the different species we noted, and their defining characteristics. Also the date, time and location where they were located.

Sample Name (Species)	Date	Time	Location	Description
Prostrate Knotweeed	11/13/19	1:26 PM - 1:39 PM	Sheep's Meadow	Central vein, round leaves, green, no flowers; 1 specimen found
Dandelion	11/13/19	1:26 PM - 1:39 PM	Sheep's Meadow	Central vein, round leaves, green, no flowers; 1 specimen found
Crisped Pincushion	11/21/19	4:25 PM - 4:45 PM	S1 - 59th St & 6th Ave NE Corner	Moist, dark green color, fills up crack in pavement; 6 specimens found
Broadleaf Plaintain	11/21/19	4:25 PM - 4:45 PM	S1 - 59th St & 6th Ave NE Corner	Round leaves, leaflets connect at center base, one vein in the middle, green; 4 specimens found.
True Mosses	11/23/19	11:33 AM - 11:47 AM	E3 - 67th & York SE Corner	Dark green, fills crack next to subway grate, squishy/soft to the touch; 1 specimen found.
Dandelion	11/23/19	11:55 AM - 12:17 PM	E2 - 67th & 3rd SE Corner	Central vein, round leaves, green, no flowers; 1 specimen found
Broadleaf Plantain	11/23/19	11:55 AM - 12:17 PM	E2 - 67th & 3rd SE Corner	Broken off leaves, covered in dirt, irregular coloration; 2 specimin found
Yellow woodsorrel	11/23/19	11:55 AM - 12:17 PM	E2 - 67th & 3rd SE Corner	Single leaf, dark green, redish central vein; 2 specimin
True Mosses	11/23/19	12:26 PM - 12:41 PM	E1 - 67th & 5th NW Corner	Dark green, fills crack next to subway grate, squishy/soft to the touch; 1 specimen found.
Fringed Rush	11/23/19	12:26 PM - 12:41 PM	E1 - 67th & 5th NW Corner	Found in cobblestone, lack of color (yellowish-brown), shorter blades
Procumbant Pearlwort	11/26/19	2:40 PM - 3:05 PM	W1 - 67th & CPW SE Corner	Squashed, brown spots, poor color; 2 specimens found.
Common Dandelion	11/26/19	2:40 PM - 3:05 PM	W1 - 67th & CPW SE Corner	Light yellowish color, dry, broken leaves; 1 specimens found.
Procumbant Pearlwort	11/26/19	3:18 PM - 3:37 PM	W2 - 67th & Broadway NE Corner	Moist, good coloration, not squashed, found in between crack filler; 1 specimen found.

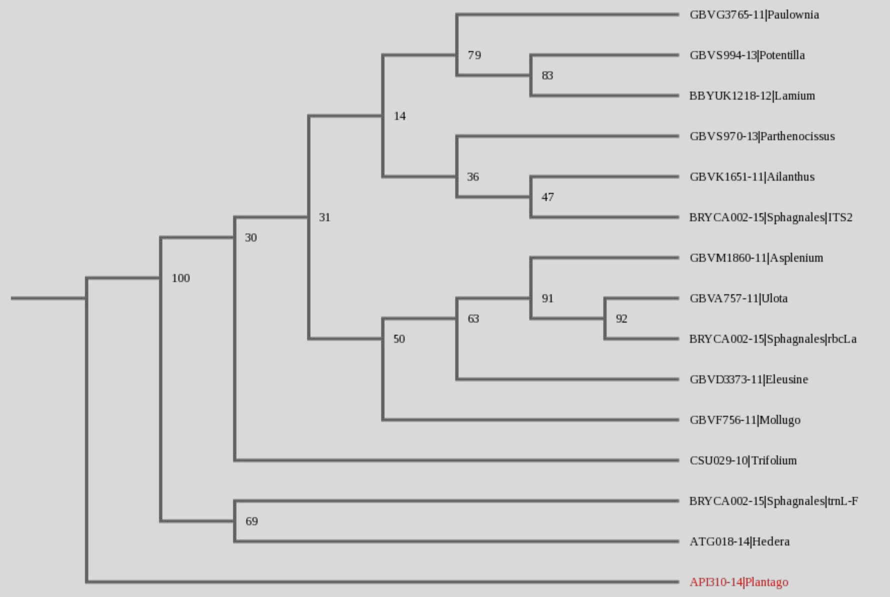

Figure 3: This is our phylogenetic tree. It was done using DNA Subway and maps out the similarity of the species we found. They all seemed to survive in a number of similar harsh conditions, and use similar agents for seed dispersal.

Discussion

all of these species originate in different places while they all hold the ability to thrive in harsh, unusual circumstances. At the start of our research, we thought that a majority of our samples would be closely related and share very recent ancestors which led them to be successful in living where they live, but in reality the plants that we looked at were all diverse in their origin. During the onset of our project, we had lots of difficulties collecting samples whether it be due to frigid weather in New York on our sampling days or simply because there were no viable samples on our testing sites.

Using these iNaturalist samples also allowed us to use pre-existing data on the internet to upload into DNA subway and compile all of our genetic sequences rather than sending all of them to a lab. Using this method to collect our data also helped us to leap over the giant hurdle that is the COVID-19 Pandemic that prevented us from doing our lab work ourselves. Even though we had to slightly alter the aim of our project and move in a more phylogenetic direction rather than a study based on plant life and diversity related to the distance between the Central Park and the sampling sites, we were able to produce a great phylogenetic tree that displayed our findings.

Hopefully this research and our inputting of the genetic sequences can provide preliminary groundwork for creating a DNA database for plant life similar to the CO1 database for animals. As well as hopefully contributing to a plant DNA database, this project can also provide additional resources similar to David Seiter's work about how these Spontaneous Urban Plants live and thrive in cities and hopefully help people to understand that these plants are not all bad and can actually contribute to the ecosystem of urban centers not just in New York City but around the world.

References

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