Investigation of Epiphytic Mosses as Bioindicators of Air Pollution in Westchester County, NY

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Abstract

Moss, a spore-bearing, nonvascular plant, plays a pivotal role in the maintenance of a thriving environment. Moss' absorbent qualities help water retention levels in the soil and serve as a bioindicator of atmospheric pollution. Atmospheric, or air pollution, in overwhelming quantities, may reduce moss biodiversity in moss populations sensitive to pollution levels. This study set out to prove the hypothesis, claiming an inverse relationship between levels of atmospheric pollution in a given area and moss biodiversity, via using moss samples from an area as a bioindicator. The 27 samples of mosses were initially identified using iNaturalist and a field guide. Once identified and photographed using a stereoscope and microscope, the samples were DNA sequenced with the goal to barcode them later with DNA Subway and BLAST. Results from DNA barcoding did not prove the hypothesis correct due to an invasive species in the Teatown Lake Reservation. In addition to this species, another factor that may have influenced results was the Bronx River Parkway's attempt to revive native species. Over the past few years, the Bronx River Parkway has planted many native species to help create equilibrium and restore the environment.

Introduction

Does pollution cause less biodiversity in moss?
Moss is a significant component of global biodiversity because its absorbent sponge-like qualities allow mosses to serve as a bioindicator of atmospheric pollution. Moss is essential to many environments because it contributes to the environment by regulating water levels, providing temperature control, and facilitating ecological succession.

Problem Statements

• Moss, a keystone species in a majority of environments, is becoming concerningly less abundant as atmospheric pollutants from high-traffic areas inhibit bryophyte biodiversity.

• There is a lack of data on the effect of air pollution on epiphytic moss biodiversity in the lower Hudson Valley region.

Goal/Hypothesis

Areas with high levels of atmospheric pollution will inversely contain less epiphytic bryophyte biodiversity.

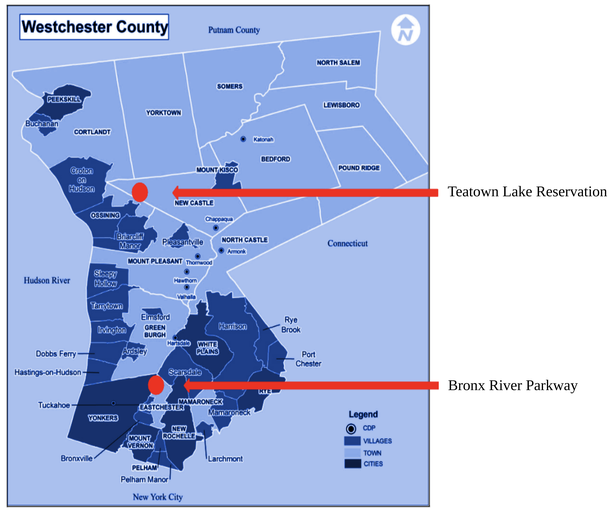
Materials & Methods

- A total of 27 moss samples were collected in December of 2023 from Teatown Lake Reservation and the Bronx River Parkway Area.
- Photographs of moss samples in natural habitat uploaded to iNaturalist.
- Samples were also identified using a field guide.
- Samples photographed under stereoscope and microscope (40x magnification).
- DNA extraction using silica resin method.
- ITS primer used in PCR procedure.
- Amplified DNA mixed with loading dye and placed into gel electrophoresis chamber.
- Sequence analysis and logging using DNAsubway.org and BLAST.
- Comparison of identification results from iNaturalist, field guide (McKnight et al. 2013), DNA Subway, and BLAST.

Comparison of iNaturalist and Paper Field Guide with DNA Barcoding Results:

• Identification from BLAST was prioritized over results from iNaturalist and the field guide.

Figure 1: Map of Westchester County



Results

Biodiversity in the Bronx River Parkway area (9 different moss species) was about the same as biodiversity at the Teatown Lake Reservation (10 different moss species). The comparatively high level of biodiversity in Bronx is the most likely a result of the planting of many native species to combat pollution done by an organization called The Bronx River Alliance.

Interestingly, that out of 22 DNA barcoded species, five species were identified as *Orthotrichum consobrinum*.

This species was initially thought to be native of Eurasia, with recent breakthrough data which showed its presence in Connecticut, USA (Fragmeier et al., 2021). We reported this species to be found in state of New York in our UBP paper and poster last year (Jennings, O'Sullivan et al., 2023). If confirmed, that would be first sighing of this species in state of New York.

Figure 2: Sample Abundancy Comparison Chart

Teatown Lake Reservation	Bronx River Parkway
Orthotrichum consobrinum	Orthotrichum callistomum
Ulota crispula	Leskea obtusa
Hypnum lindbergii	Frullania appalachiana
Callicladium haldanianum	Frullania solanderiana
Platygyrium repens	Amblystegium fluviatile
Orthotrichum stellatum	Platygyrium repens
Dicranella heteromalla	Allium sativum
Kindbergia praelonga	Leskea polycarpa
Entodon seductrix	Orthotrichum columbicum
Climacium americanum	

Discussion

Findings:
•The Teatown Lake Reservation showed about the same level of biodiversity than did Bronx River Parkway Area.
• We suggest that the explanation of our results could be in the fact that authorities plant more plant species in the Bronx River Parkway area in improve quality of the air, and that could increase biodiversity.

Limitations:
•The four methods used to identify the collected samples rarely yielded consistent results.
• The iNaturalist software is not programmed to identify species from photographs taken from microscopes, resulting in incorrect identification results.

Future Research

• Results encourage continued monitoring and research to track moss species in Westchester county to see trends and patterns of the effects of air pollution in our protected territories and other areas.
• Tracking pollution levels in our green spaces are crucial to determining a course to correct the adverse results of atmospheric pollution, resulting in a greener future.

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