A Biodiversity Study of Lichens in Central Park-NYC and Tenafly Nature Center

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Funded by the Thompson Family Foundation

Abstract

Lichens are sensitive bioindicators of nitrogen oxides, common air pollutants in urbanized areas. Crustose lichens are found in polluted areas, while foliose lichens are more common in less polluted areas. Our purpose was to observe how levels of nitrogen oxides affect the biodiversity of lichen in Tenafly Nature Center and Central Park, a low pollution suburban nature preserve and a highly polluted urban center, respectively. Through the collection of lichen samples in both locations, extraction and sequencing of the lichen DNA, and a bioinformatic analysis of the results, we found that *Punctelia rudecta* was a recurring lichen species in both locations. Contrary to our expectations, the only crustose lichens were present in the Tenafly Nature Center, while all of the Central Park lichen species were foliose. These results show that although crustose lichens are known to be the most pollution-tolerant growth form, foliose lichens are also effective in tolerating air pollutants and occupying pollution-dense areas, such as Central Park.

Introduction

- Oxides of nitrogen (NOx): nitrogen dioxide, nitric oxide, nitrous oxide[1]
  - Released from fuel combustion
  - Forms smog, acid rain, and fine particles
- Lichen: a symbiotic association between algae and fungi[2]
  - Lack a vascular system and a waxy outer cuticle
  - Absorb nutrients through cortex
  - Have a high surface area to mass area
- Three main growth forms of lichens[3]
  - Crustose: indicate highly-polluted air
  - Foliose: indicate small amount of air pollution
  - Fruticose: indicate clean air

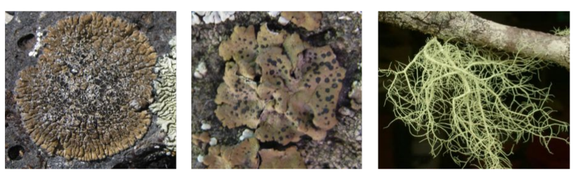

Figure 1. Crustose (left), foliose (middle), fruticose (right)

Objectives

- Purpose:
  - To examine the effect of nitrogen oxides on biodiversity of lichens
    - Number and type of species
    - Growth forms
  - To find a correlation between the identified lichen species and the associated level of nitrogen oxide
- Hypothesis
  - The exposure of nitrogen oxides will reduce the biodiversity of the lichens in Central Park, while Tenafly Nature Center will harbor a more diverse set of species.

Methodology

Sample Collection

- 17 samples from Tenafly Nature Center (40°55′29″ N 73° 56′42″ W)
- 12 samples from Central Park (40°46′0″ N 73°58′17″ W)

- 1-2 cm in diameter
- Collected in late November and December
- Taken from tree branches, trunks, and rocks
- Washed with acetone and preserved in a refrigerator

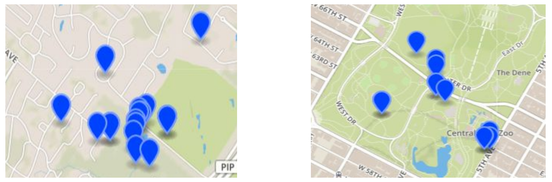

Figure 2. Tenafly Nature Center and Central Park Sample Locations

Isolating the DNA (at Harlem DNA Lab)

- Defective samples were removed. (8 fungal species found)
- A lysis solution was used and each sample was mechanically ground.
- Each sample was centrifuged to obtain the supernatant.
- The supernatant and silica resin were mixed and incubated to isolate the DNA.
- The primer ITS mix and supernatant were placed in a thermal cycler to amplify DNA.
- Samples were analyzed through gel electrophoresis.
- Usable samples were sent to Genewiz to obtain DNA sequences.

Bioinformatics

- Samples were identified and analyzed using the DNA Subway bioinformatics platform.
- The DNA sequences were trimmed and paired to create consensus sequences.
- The BLAST and BOLD databases were used to match the DNA sequences to lichen species.
- We observed the phylogenetic trees to find similarities between samples.

Results

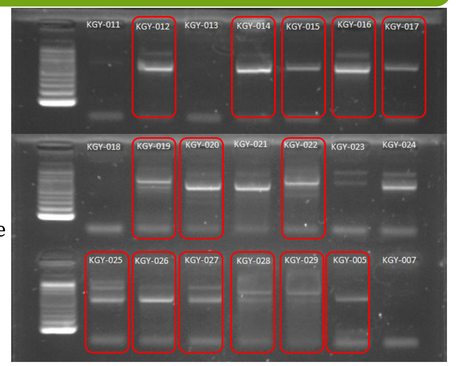

Figure 3. Gel electrophoresis results (Red outlines indicate analyzed samples.)

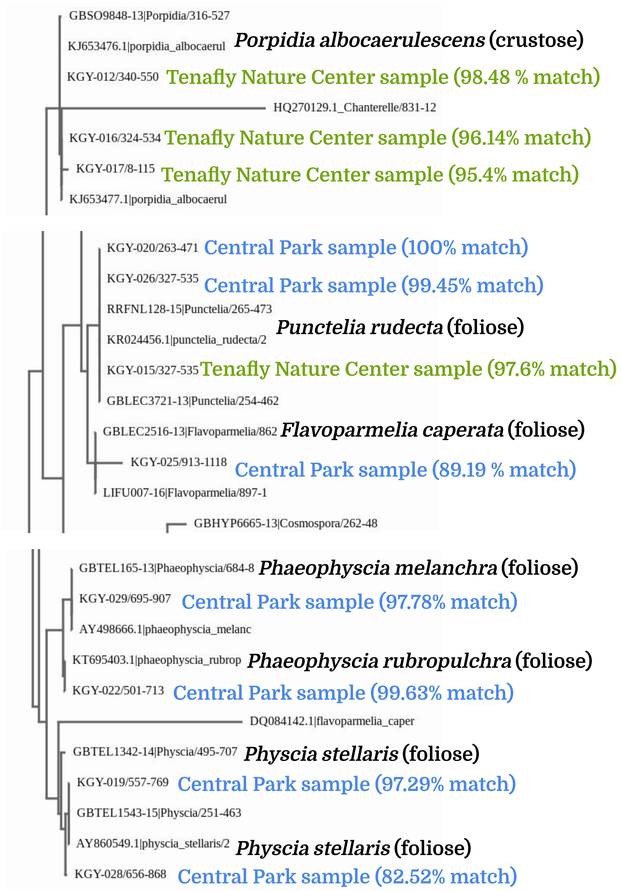

Figure 4. Phylogenetic tree of our samples, given by DNA Subway

Results (cont.)

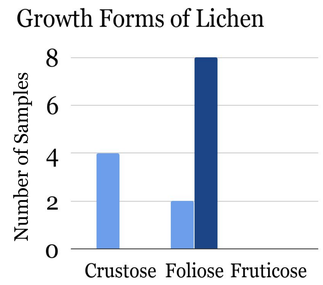

Figure 5. Growth forms of lichens identified in Tenafly Nature Center (light blue) and Central Park (navy)

Conclusion

Results did not support our hypothesis and predictions

- No clear correlation between the identified lichen species and the associated level of nitrogen oxide
- Foliose lichens were identified in Central Park.
- Crustose lichens were identified in Tenafly Nature Center.
  - Most tolerant of air pollution - expected in Central Park, not Tenafly Nature Center

Future Work

- If continued, we
  - will take a measurement of NO_x and considering other pollutants
    - To find a clear distinction between levels of pollutants in Central Park and Tenafly Nature Center
  - will consider soil and water quality
  - wil have a larger sample pool
  - will consider a more diverse set of places
  - will improve accuracy in collected samples (no fungal species)

References

[1] Icopal Ltd. *Nitrogen Oxide (NOx) Pollution.* Retrieved October 5, 2018, from http://www.icopal-noxite.co.uk/nox-problem/nox-pollution.aspx

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[3] APIS (2016) *Impacts of air pollution on Lichens and Bryophytes (mosses and liverworts).* Retrieved October 10, 2018, from http://www.apis.ac.uk/impacts-air-pollution-lichens-and-bryophytes-mosses-and-liverworts

Acknowledgements

We would like to thank our teacher, Mrs. A. Firnberg, for her continuous support. We would also like to thank Dr. C. Marizzi and Dr. A. Cucco of the Cold Spring Harbor Laboratory for their assistance with our project.