Biomonitoring: Lichens as Bioindicators of Air Pollution in Urban & Suburban Areas

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Introduction

Bioindicators species can reveal important qualitative environmental data. For example, using lichen as a bioindicator species allows scientists to evaluate the quality of the air in a given area. Lichens, a type of fungi who can be sensitive to polluted areas. The abundance of lichens indicates good air and environmental quality and therefore few or no pollutants, however, when lichen vegetation is scarce, it is a sign of poor air and environmental quality linked to the presence of atmospheric pollutants (NO2 and SO2) that cause disturbances to human health. Using lichen as a bioindicator is a quick and cost-effective tool for assessing environmental and health risks in ecosystems. The aim of this study is to investigate the distribution and abundance of lichens and relate that to air pollution and the climate. Specifically, we plan to randomly collect lichen from trees and gather air quality data (AQI) from three sites: *Site A, Queens NY, Site B, Darien, CT, and Site C, Rye, NY.*

Materials & Methods

Lichen collection from tree:

- Locate a tree where lichen is growing.
- Photograph specimen
- Before, extraction, wet the lichen and use a tweezer to collect 2 inch sample.

DNA isolation, PCR, Gel Electrophoresis & Sequencing:

- Genomic DNA was extraction using CSHL DNA barcoding protocol
- We amplified the Internal Transcribed Spacer (ITS) region of the lichen genome
- Sanger sequencing via Genewiz
- DNA sequences analyzed through BLAST and and MUSCLE

Results

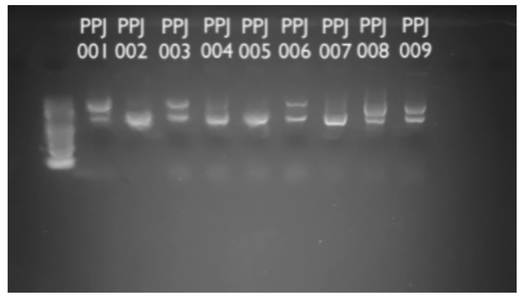

Table 2: PCR products were identified using Gel Electrophoresis (Average length ~500bp)

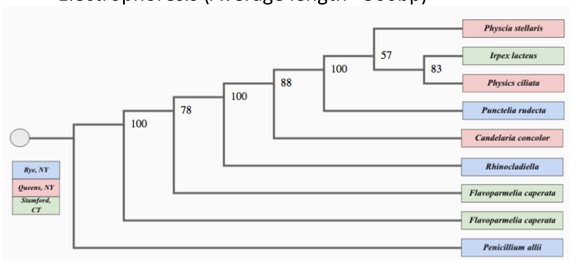

Table 3:Evolutionary relationship between lichen species (Phylogenetic tree analysis)

Table I: Lichen Identification, Pollutant (NO_2/SO_2) Sensitivity and Tolerance

Sample #	Location	AQI	Length (bp)	BLAST Identification	Sensitive to air pollution	Tolerant to air pollution
PPJ-001	Stamford, CT	25	646	Flavoparmelia caperata (common greenshield lichen)	Yes	No, would put the species in severe endangerment
PPJ-002	Stamford, CT	25	711	Irpex lacteus (mushroom)	No	Yes
PPJ-003	Stamford, CT	25	473	Flavoparmelia caperata (common greenshield lichen)	Yes	No, would put the species in severe endangerment
PPJ-004	Rye, NY	25	570	Rhinocladiella (lichen)		Pioneer species
PPJ-005	Rye, NY	25	566	Punctelia rudecta (Speckleback lichen)	No (except sulfur dioxide)	Yes (sensitive to Sulfur dioxide)
PPJ-006	Rye, NY	39	610	Penicillium allii (bacteria)	Unknown	Unknown
PPJ-007	Queens, NY	52	519	Candelaria concolor (candle flame lichen)	No	Thrive under high nitrogen-polluted air environments
PPJ-008	Queens, NY	52	518	Physcia stellaris (lichen)	No	Pioneer species. thrive under high nitrogen-polluted air environments
PPJ-009	Queens, NY	52	957	Physcia ciliata (lichen)	No	Thrive under high nitrogen-polluted air environments

Discussion

According to the data chart below, six (6) species of lichen, one (1) mushroom, and one (1) bacteria was identified using DNA barcoding. The six species of lichen from Stamford, CT, Rye, NY, and Queens NY are known to adapt to that specific environment. The samples collected from Rye yielded two lichens, and one unexpected species (bacteria): *Rhinocladiella* was found to be lichen/ pioneer species. *Punctelia rudecta* is a native species to North America and they do much better in climates on the East coast, and are very tolerant to air pollutants, with the exception of sulfur dioxide (SO2). They are commonly used as indicators of air quality, due to their great resistance to pollutants. Penicillium Alli, was found to be a type of mold and not lichen. The samples collected from Queens, NY: *Candelaria concolor, Physcia stellaris, Physcia ciliata* prefer high nitrogen environments such as roadsides, or agricultural areas. We would conclude from this specific finding that the air in the vicinity of LaGuardia Airport has an above-average concentration of nitrogen-containing compounds. The samples collected from Stamford, were *Irpex lacteus* and *Flavoparmelia caperata. Irpex lacteus* is a mushroom that is not any type of bioindicator. The *Flavoparmelia caperata* which is common across the world, is also known as the greenshield lichen and is mostly found on trees and shrubs in temperate forests. The lichen has been used in past studies of the effect of SO_2 on chlorophyll production and plant health in the past, making it a good indicator species.