Mushrooms as an Indicator of Soil pH, Phosphorus, and Nitrogen Content in Northern New Jersey

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Abstract:

Mushrooms are a crucial component to maintain an efficient and successful ecosystem in which plant life thrives. Due to their ability to absorb and release nutrients, mushrooms can serve as indicators of environmental factors, such as soil pH, nitrogen, and phosphorus content. The objective of this Urban Barcoding Project was to identify species of fungi, specifically saprophytic mushrooms, commonly found on lawns. We collected 20 samples of saprophytic mushrooms and their surrounding soil from 4 separate locations. Using LaMotte Nitrate, Phosphate, and pH soil kits, we tested our collected soil samples, and concluded that nutrient concentration and soil pH are directly equated with the DNA of the mushrooms extracted from the PCR tests. This project was an effective way to further enhance knowledge regarding mushrooms' impact on the environment and their role in determining the contents and habitational abilities of soil in Northern New Jersey.

Introduction & Goals:

Mushrooms are a crucial component to maintain an efficient and successful ecosystem.

- Mushrooms are heterotrophs with a mycelium that is responsible for obtaining nutrients. Plants then absorb these nutrients — potassium, phosphorus, and nitrogen — to carry out life functions.
- Mushrooms can exist within three categories: parasitic, saprophytism, and mycorrhiza.
  - The mushrooms we collected are saprophytes, which have a purpose of decomposing organic matter and returning it back into the soil.
  - 787 mushroom species recorded in New Jersey.

Soil pH affects the growth of the plants and the availability of fungi.

- The pH can affect the availability of these nutrients due to the direct effect pH levels have on phosphorus levels. Phosphorus tends to be more present when the pH of the soil is neutral, between 6 and 7.

Although wild mushrooms growing on lawns have a negative connotation, we sought to defy this standard and prove the correlation between healthy soil and mushrooms. We collected samples of mushrooms and the surrounding soil to test for the species, soil pH, phosphorus and nitrogen. We sought insight into mushrooms biodiversity and their impact on an ecosystem.

Materials and Methods:

Collection:

- 20 samples, 4 locations in Tenafly, New Jersey.
  - 5 samples from each location.
  - 1 area directly next to a small stream, 2 lawns, and 1 area covered in moss.

Fig 1 - Map of the locations we collected our samples from in Tenafly, New Jersey.

Soil Analysis:

- Tested pH, phosphorus, and nitrogen levels (LaMotte Soil Testing Kits).

DNA extraction:

- Extracted piece of sample from fungal tissue within the fruiting body.
- Placed tissue in tube with Chelex solution.
- Submerged the Chelex and sample mixture in hot water.

Identification:

- DNA samples sent out for PCR
- Sent to commercial lab for sequencing
- Data analysis complete on DNA Subway

Materials:

- Plastic tubes
  - pH — pH Indicator and soil determined pH.
  - Phosphorus — Phosphorus Extracting Solution and soil determined phosphorus levels.
  - Nitrogen — Nitrogen Extracting Solution and soil determined nitrogen levels.
  - Chelex — Extraction of DNA from samples.
  - Hot water in mug — Heat lysed cell and organelle membranes, released DNA.

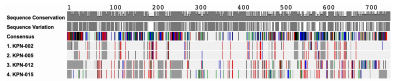

Fig 3 - DNA sequences observed on BLAST on DNAsubway.

Results:

Species	pH	Nitrogen	Phosphorus	Picture
Hebeloma crustuliniforme [1]	7.0	Low (0-15ppm)	Medium (25-50ppm)	
Tricholoma caligatum [1]	5.0	Low (0-15ppm)	n/d	
Amanita muscaria var. Guessowii [1]	6.0	Low (0-15ppm)	Low (0-15ppm)	
Marasmius cohaerens [2]	6.0	Medium (15-30ppm)	Trace	

1 -- specified from DNA
2 -- specified from observation

Fig 4 - Determined species of mushroom samples with corresponding pH, phosphorous, and nitrogen contents.

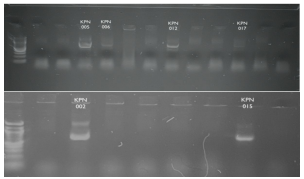

Fig 2 - Gel electrophoresis results after using Fungi-ITS primer.

Discussion:

After determining the species of our samples through DNAsubway and observing the appearances of the faulty sequences, we concluded that saprophytic mushrooms do serve as indicators of soil pH 5.0-7.0. The soil we collected and studied from the sites was proven to contain healthy levels of phosphorus and nitrogen. Mushrooms and nitrogen have a loose correlation, therefore explaining the low levels found in 3 out of the 4 sample sites. Furthemore, we confirmed the relationship between pH and phosphorus levels. The phosphorus levels were most prevalent at pH 7.0, minimal at pH 6.0, and not trackable at pH 5.0. In conclusion, mushrooms do serve as an indicator of soil pH, nitrogen, and phosphorus and of healthy soil environments, which plant life thrives in.

Fig 5 - Cluster of Hebeloma crustuliniforme mushrooms at sampling location 1.

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