The Effect of Fungi Biodiversity on Tree Density (trees/m^2) in Northern New Jersey Forests

Amit Yogev[1], Ella Zviran[1]

Menor: Alan Brandstaedter[1]

[1]Tenafly High School

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Abstract

Fungi are non-vascular eukaryotic organisms that obtain nutrients primarily through saprophytic means[4]. In our research, we focus on their interactions with their host trees. We collected fungi samples found on trees and analyzed them in order to discern their effects on trees. Areas of lower tree densities, tended to demonstrate lower biodiversity of fungi. Our findings point to a positive correlation between higher fungi biodiversity and tree density and thus refute our previous hypothesis. Through our DNA analysis and upon collection of samples, our data pointed towards a direct correlation between fungi biodiversity and tree density due to the substantial amount of symbiotic relationships between fungi and trees when compared to the amount of parasitic relationships.

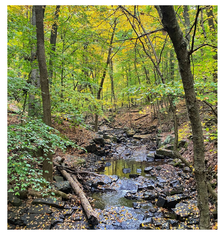


Fig 1, Fig 2. Flat Rock Brook Trailhead

Introduction

Approximately 144,000 species of fungi have been identified[5] and over 110 fungi species are common to New Jersey[6]. Research indicates that forests with diverse and abundant mycorrhizal fungi often support higher tree densities, as these fungi can aid and enhance nutrient uptake, water absorption, and disease resistance in trees. Through their improvement of root surface as well sharing nutrients such as nitrogen and phosphorus in exchange for sugar from the tree[1]. Further, fungi have been shown to play a crucial role in tree productivity as diverse, functional fungi can enhance nutrient cycling/availability, which directly influences tree growth and therefore, density[2].

On the other hand, fungi biodiversity can also lead to an increased susceptibility to fungal pathogens which can negatively impact tree health and survival rates[3]. Although fungi can form parasitic relationships with trees, our research demonstrated that the relationships between the two are predominantly symbiotic as fungi allow trees access to growth-limiting soil resources, nurturing their growth[7].

Aim: Analyze the effects of fungi biodiversity on tree density in Northern New Jersey forests.

Hypothesis: Higher fungal biodiversity negatively impacts tree density (tree/m^2) due to an increased likelihood of encountering predominantly parasitic fungi.

Materials and Methods

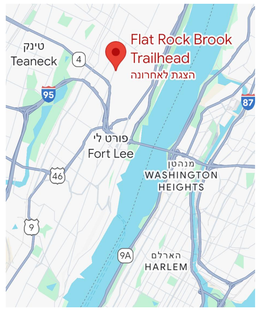


Fig 3. Collection Site

Fig 4. Isolating DNA extract

Sampling

Measure out two 20x20 meter area of low and high tree density → Collect 5 samples of fungi from low and high tree density areas → Identify species of fungi via "Seek" and calculate biodiversity Index

DNA Extraction

Use lysis to extract DNA from fungi cells → Incubate, centrifuge, and add silica resin to the transferred supernatant → Incubate, centrifuge, remove supernatant, wash buffer, centrifuge, remove supernatant → Remove DNA from silica resin and add ITS primer

PCR

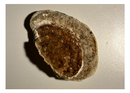
Add extracted DNA and PCR reagent to a tube → Denaturation of DNA strands (94-95 °C) → ITS primer cutting DNA strands → annealing of primers (55-72 °C) → Amplification of DNA strands → extension (72 °C)

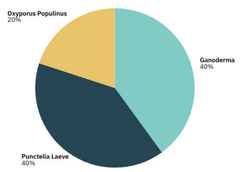
Bioinformatic - DNA Subway

Edit and pair the F/R rbcL sequences for each sample → BLAST to search for closest rbcL match→ identify samples → Incubate, centrifuge, remove supernatant, wash buffer, centrifuge, remove supernatant → Remove NA from silica resin and add ITS primer

Results

Table 1. Scientific names and images of collected specimens - identified by DNA barcoding

Low tree density (29 trees)	High tree density (55 trees)
Ganoderma 	Ascomycota 
Punctelia 	Cylindrobasidium Laeve 
Oxyporus Populinus 	Lecanoromycetes 
Punctelia 	Punctelia 
Ganoderma 	Phlebia cf. 



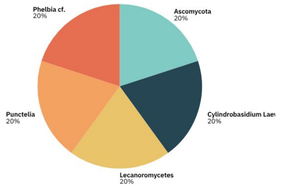


Fig 7, 8. Fungi Type and Frequency in Low Tree Density (top) and High Tree Density (bottom)

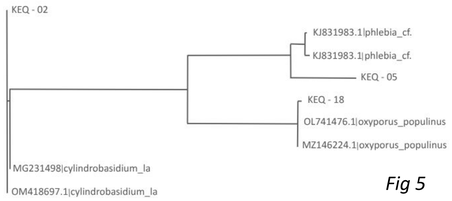


Fig 5

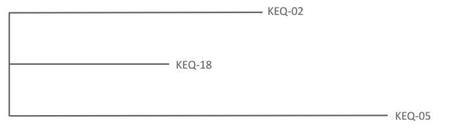


Fig 6

Fig 5, 6. Phylogenetic Tree of Maximum Likelihood - in Relation to rbcL in Database and to One Another

	Simpson's Diversity Index - Fungi Biodiversity Indication (only fungi identified through DNA Barcoding)	Simpson's Diversity Index - Fungi Biodiversity Indication (all fungi identified)
High Tree Density (55 trees/20m^2)	D=0.5	D=1
Low Tree Density (29 trees/20m^2)	D=0	D=0.8
% Difference	200%	22.22%

Table 2. Biodiversity of Fungi in Low and High Tree Density Areas - All Fungi vs. Only DNA Barcode Identified Fungi

Discussion

- Our research and experimentation refuted our original hypothesis, denoting a symbiotic relationship between fungi and trees through their sharing[7] of resources and warning of potential threats.
- In both cases, when using only DNA barcode identified fungi or all fungi, we have found that a higher fungi biodiversity is present in the higher tree density area, according to Simpson's Diversity Index.
- Fungi aid in increasing tree density as they can enhance nutrient uptake, water absorption, and disease resistance via mutualism[1].
- Fungi can enhance the nutrient cycling/availability which positively influences tree growth which augments tree density[2,7].
- Although fungi biodiversity can lead to increased susceptibility of fungal pathogens (which negatively affect tree density)[3], this effect is shown to be outperformed by the symbiotic relationship between fungi and trees.
- This study faced key limitations, including a small sample size and uncontrolled environmental variables, which may have affected our ability to assess the relationship between fungi biodiversity and trees.
- Future research endeavours should prioritize expanding sample collection and incorporate additional environmental factors for more accurate results.
- The study provides a foundation for future research on this topic, emphasizing the importance of understanding how fungi biodiversity influences tree density–an increasingly relevant issue in the context of global warming.

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