

Role of Mycorrhizal Fungi in Forest Ecosystem Restoration

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INTRODUCTION/BACKGROUND

Background – Ecology

- Mycorrhizal fungi are an important part of every forest ecosystem because they strengthen plants' ability to resist stresses coming from biotic and abiotic factors as well as enhance seedling survival, establishment, and growth (Asmelash, *et al.* 2016).
- Mycorrhizal fungal networks bolster plant productivity and ecosystem biodiversity (Van der Heijden, *et al.* 1998).
- Restoring degraded lands is often unsuccessful, or not as successful as possible, when not paired with symbiotic mycorrhizal fungi, so it is essential that native mycorrhizal fungi are utilized to promote the successful establishment of native plant species to degraded lands (Ryszka, P., & Turnau, K. 2007).
- Mycorrhizal fungi and plants have a reciprocal relationship in which the presence of one supports the development of the other (Sun, *et al.* 2017).
- While mycorrhizal fungi and plants have mutually beneficial relationships, the success of establishing healthy ecosystems from degraded lands also depends upon complex interactions between the soil microbiome and nutrients available such as phosphorus and nitrogen (Hoeksema, *et al.* 2010).

Major Problem #1

- Human development is rapidly destroying forests across the globe.
- Forests are essential hotspots of biodiversity and ecosystem complexity.

Major Problem #2

- Climate change is threatening the natural world as well as our human societies in myriad ways and forests keep vast amounts of carbon out of the atmosphere when they aren't being burned.
- Regenerating old-growth forests is a vital step towards restoring biodiversity to important ecosystems as well as keeping carbon out of the atmosphere.

METHODS

Experimental Design:

- This study is a manipulative field experiment and will assess the extent native mycorrhizal fungi support healthy forest stand regeneration by analyzing 5 control forest plots and 5 experimental forest plots over a 20-year time span.
- The only variable being manipulated is whether each plot is inoculated with native mycorrhizal fungi.
- The control plots will consist of land which has been cleared for human use (ie: logging, mining, farming), are near a remaining old-growth forest, and are no longer being used in any industrial or agricultural capacity.
- The experimental plots will consist of similar plots of land to the control plots but will be inoculated with native mycorrhizal fungi samples taken from the parent old-growth forest to support the experimental plots regenerating to a similar ecosystem composition as the parent forest.
- Over the span of the experiment, beta diversity, as well as species richness and plant productivity of each plot will be recorded and compared.
- It is important that soil nitrogen and phosphorus levels, as well as the presence and composition of mycorrhizal fungi over time are recorded to assess the extent to which these may impact the results.

Analysis:

- A regression analysis will be used to determine any correlation or causation between the presence of native mycorrhizal fungi in experimental plots and the biodiversity and productivity of experimental plots over time.
- Aside from the species compositions of each plot which is categorical data, the beta diversity, productivity, and soil nutrient levels are all continuous data.

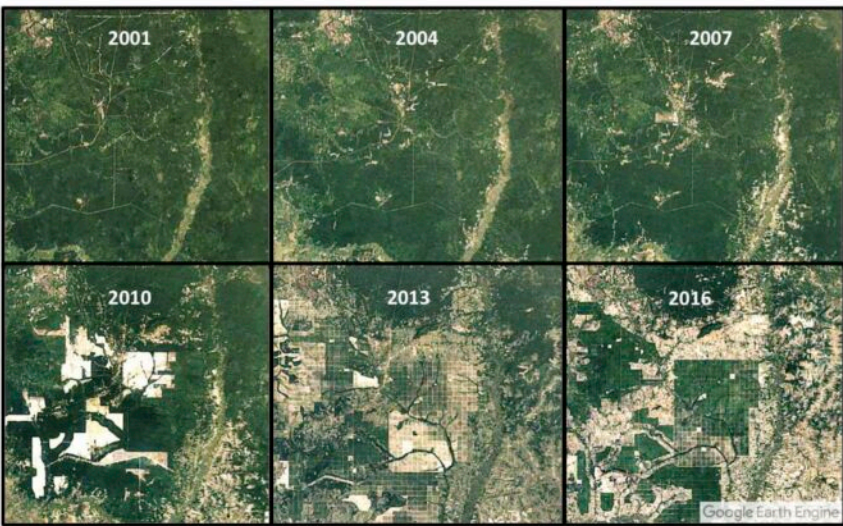


Figure 1. Satellite view of deforestation in Cambodia from 2001 to 2016. (Google Earth Engine)

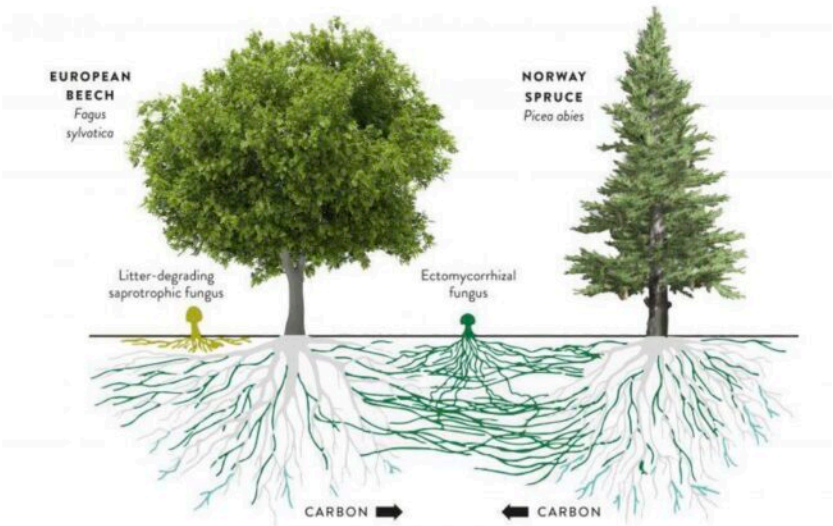


Figure 2. Shows interactions between trees and mycorrhizal fungi in the soil. (New Zealand Geographics)

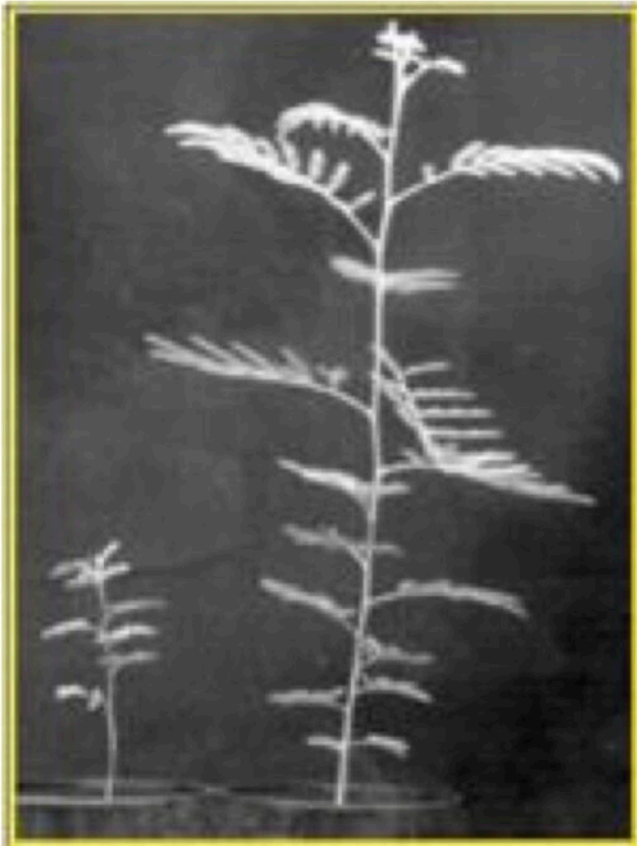


Figure 3. Specimen on the right was inoculated with mycorrhizal fungi while the specimen on the left was not (Miyasaka, *et al.* 2003).

OBJECTIVES

Objectives:

- Assess the extent to which native mycorrhizal fungi promote biodiversity and plant production in recovering forest plots.
- Compare the plant development, species richness, and species diversity between experimental and control plots.

Hypotheses:

- Null Hypothesis: presence of native mycorrhizal fungi has no impact on forest stand regeneration.
- Hypothesis: Native mycorrhizal fungi promote development and biodiversity in regenerating forest stands.

MANAGEMENT IMPLICATIONS

- The results from my study will provide useful information which can be generalized outside of my study to an extent.
- Limitations to the applicability of my results stem from the complex nature of each unique ecosystem and the myriad ways different plots may respond to the same experimental assessment.

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