Documenting Mycorrhizal Infection of Plant Species at Atqasuk, Alaska

Jenna Boelkins & Robert Hollister Grand Valley State University, USA

Abstract

Mycorrhizal networks are integral to nutrient transport in nearly every terrestrial ecosystem and the warming climate may heavily impact their role, diversity, and abundance[3]. Baseline studies of mycorrhizal abundance are needed in the Arctic because the region is experiencing rapid climate warming[1]. Arctic plants tend to be nutrient-limited and have low mycorrhizal specificity and concentrated root systems leading to high mycorrhizal activity[4]. Arbuscular mycorrhizal, ectomycorrhizal, and other types of fungi have been noted in several species of *Salix* and *Betula* in various Arctic territories, however they have yet to be studied at Atqasuk, Alaska[8]. This study assesses the current presence and abundance of various fungal types in the roots of *Betula nana*, *Salix pulchra*, *Salix polaris*, and *Salix phelbophylla*. These species were chosen because they are abundant and have a high likelihood of arbuscular mycorrhizal (AM) and ectomycorrhizal (EM) fungi presence due to their woody structure. Roots of these species were collected from various ecological community types and shipped to Allendale, Michigan where they were cut, cleared, and stained for analysis under a dissecting scope. Percent infection of each type of mycorrhizae was determined using a grid line method[5]. The end product of this investigation is a baseline dataset that will be submitted to the TRY Plant Trait Database.

Methods

Collection

During July 2023, root samples of *Betula nana*, *Salix phlebophylla*, *Salix polaris*, and *Salix pulchra* were collected throughout the Arctic System Science (ARCSS) Grid located at Atqasuk, Alaska. Twelve samples of each species were preserved in 70% ethanol and shipped to Allendale, Michigan.

Preservation and Staining

Samples were cut into ~1 cm pieces, cleared, and stained.

The clearing process consisted of a 15-minute autoclaving in a 10% KOH solution and a 10-minute sit in Hydrogen Peroxide. For the staining of the roots, a 2% Acetic Acid solution was used to acidify samples followed by a 10-minute sit in 0.1% Trypan Blue stain[4].

Between every chemical bath, several DI water rinses were conducted.

Scoring Infection

A modified grid line method was conducted to count the percent infection of various mycorrhizal types[4]. Approximately 55-85cm of root for each sample were placed in a 100 mm petri dish with a 5mmx5mm grid taped to the bottom. The samples were suspended in DI water and evenly distributed throughout the dish. The dish was then placed under a dissecting microscope where mycorrhizal infection was analyzed for each root segment at a grid intersection.

Results

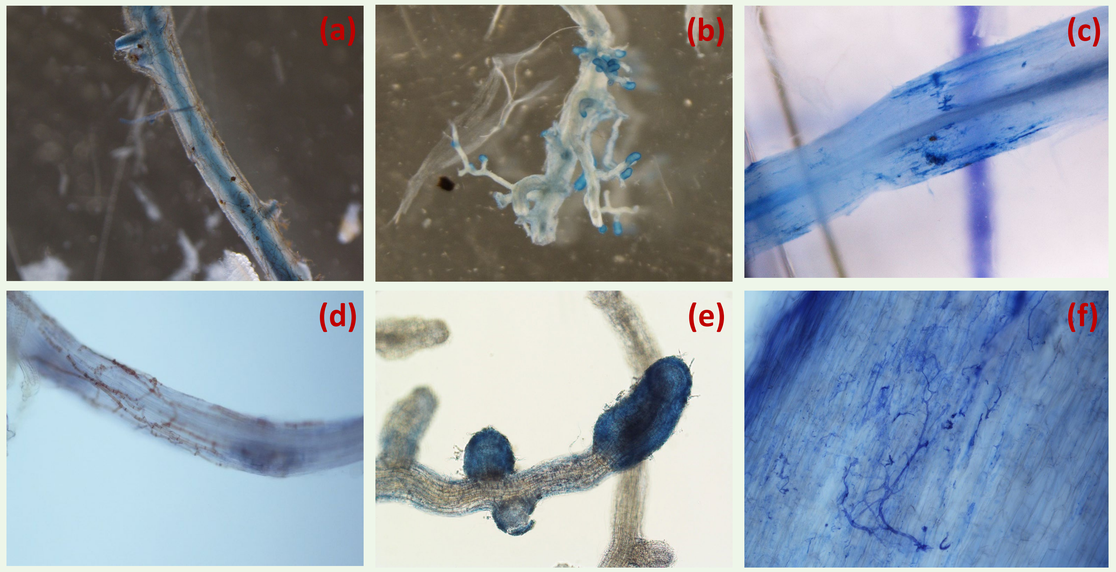
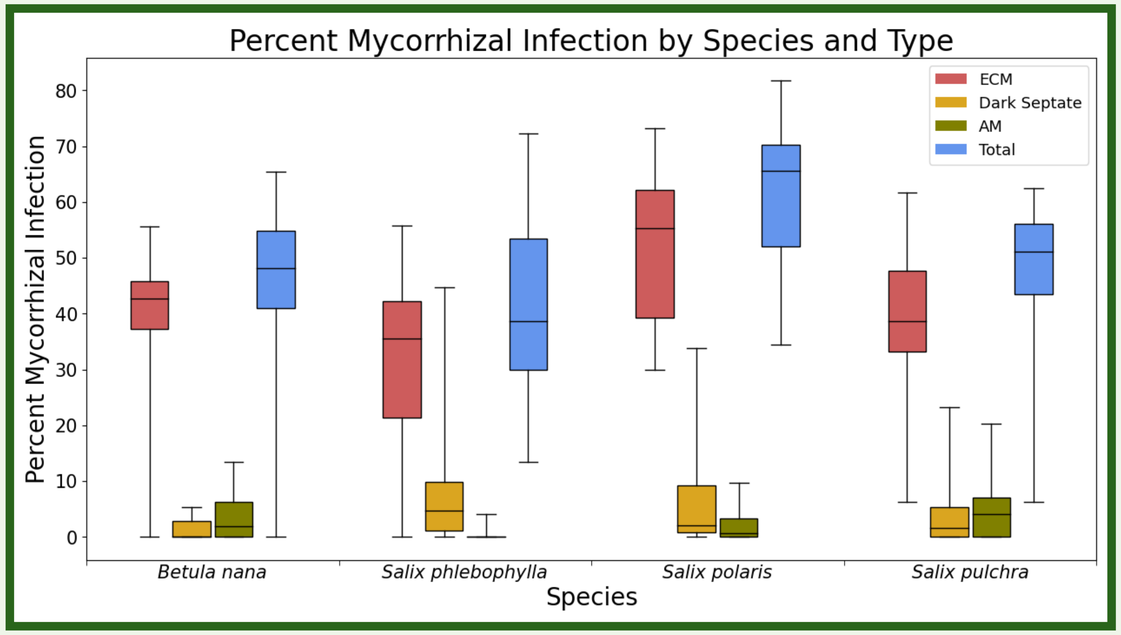


Figure 1. (a) Dark septate fungi in *Betula nana* under a dissecting microscope. (b) Ectomycorrhizal fungi in *Salix phlebophylla* under a dissecting scope. (c) Arbuscular mycorrhizal fungi in *Salix polaris* under a dissecting scope. (d) Dark septate fungi in *Salix polaris* under a compound microscope. (e) Ectomycorrhizal fungi in *Salix phelbophylla* under a compound microscope. (f) Arbuscular mycorrhizal fungi *in Betula nana* under a compound microscope.

Species	Ectomycorrhizal	Dark Septate	Arbuscular Mycorrhizal	Total Infection
Betula nana	39.54%	1.36%	3.57%	44.47%
Salix phlebophylla	31.52%	9.08%	0.52%	41.11%
Salix polaris	52.18%	7.32%	2.01%	61.51%
Salix pulchra	38.61%	4.23%	5.14%	47.98%
Overall	40.46%	5.50%	2.81%	48.77%

Table 1. Average mycorrhizal infection by mycorrhizae type and plant species



Graph 1. Box plots of the percent mycorrhizal infection by species and mycorrhizal type (n=12).

Discussion

Main Points

- Ectomycorrhizal fungi were the most abundant mycorrhizal type throughout the four shrub species investigated.
- *Salix polaris* had both the highest ectomycorrhizal infection and total fungal infection.
- Dark septate and arbuscular mycorrhizal fungi were present in all four species, though at a much lower level than ectomycorrhizal fungi. Additionally, we found the most outliers within the dark septate and arbuscular mycorrhizal infection data.
- A previous study conducted at Utqiaġvik, Alaska noted that *Salix rotundifolia* had a total mycorrhizal infection rate of 20.7% which is significantly lower than the total infection we found for other species within the *Salix* genus[6].

Relevance

- Documenting mycorrhizal infection is important as one of the most anticipated shifts is towards deciduous shrubs, with their size and hardiness out-competing other herbaceous species[7].
- Shifts in both nutrient availability and flora community composition may lead to changes in the community structure both above and below ground[2].
- Changes in climate has the potential to complicate the physiology of plants, the energy balance of the ecosystem, and the overall composition of the region.

Archival

- These data will be archived with other ecosystem changes as part of the ITEX-AON contribution to the Arctic Data center.
- They will also be submitted to the TRY Plant Trait Database.

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