Priority effects of foliar fungal endophytes in leaf litter decomposition

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Introduction

Carbon, a fundamental element, permeates every aspect of our lives, from our physiology and sustenance to the foundations of our economies. Though essential for life, carbon also lies at the core of a major issue: climate change. Microbial communities significantly influence the movement of carbon within natural systems, affecting how quickly carbon is recycled back into the environment. How these communities interact and assemble are shaped by a combination of stochastic and deterministic processes [1]. Priority effects, a process where the order of species arrival in a local community can lead to competitive exclusion or facilitation, influencing community composition and functioning [2] (Fig. 1). To understand this phenomenon, leaf litter was used as a model system to investigate the priority effects of foliar endophytic fungi (FEF) in leaf litter communities (Fig. 2).

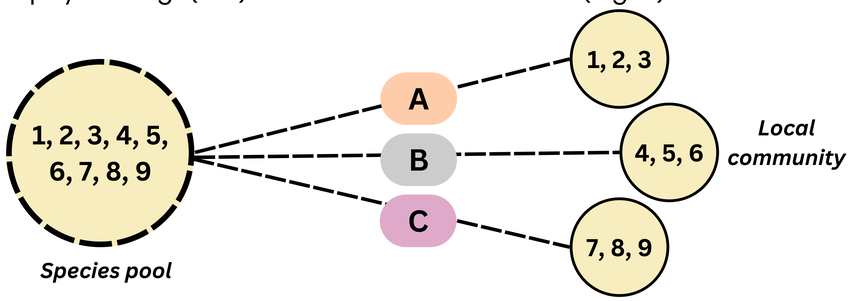

Figure 1. Hypothetical representation of historical contingencies: Numbers in the species pool represent hypothetical species that are able to colonize the local community. Lines extending from the species pool represent varied immigration histories leading to compositionally different local communities.

Leaf litter decomposition

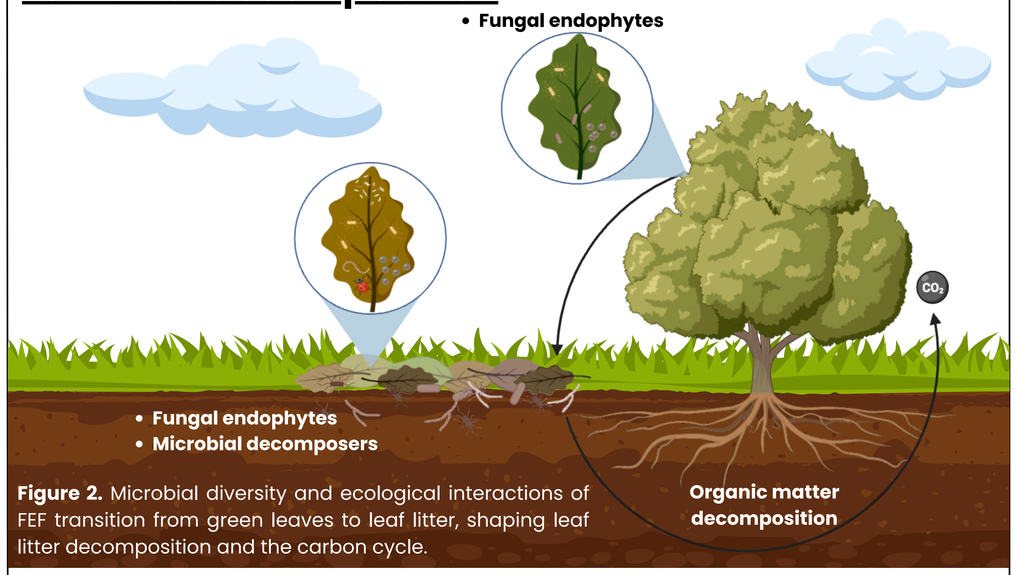

Figure 2. Microbial diversity and ecological interactions of FEF transition from green leaves to leaf litter, shaping leaf litter decomposition and the carbon cycle.

As deciduous trees shed their leaves in the fall, a layer of leaf litter forms. Many FEF live commensally in the leaves while they are still on the tree, gaining an early foothold in this litter. Research shows that FEF are present in both living leaves and leaf litter, suggesting they may act as early colonizers in the leaf litter community, causing a priority effect [3, 4]. This early colonization could impact the establishment of other fungal decomposers through competitive exclusion or facilitation, thereby influencing the rate at which carbon is cycled back into the atmosphere.

Specific aims

1. Priority effects of fungal endophytes
2. Dual lives of fungal endophytes
3. Efficiency of fungal endophytes as decomposers of leaf litter
4. Shifts in community composition over time across different sites and treatments as leaves decompose

Research question

Do fungal endophytes impose priority effects in leaf litter communites?

Methodology

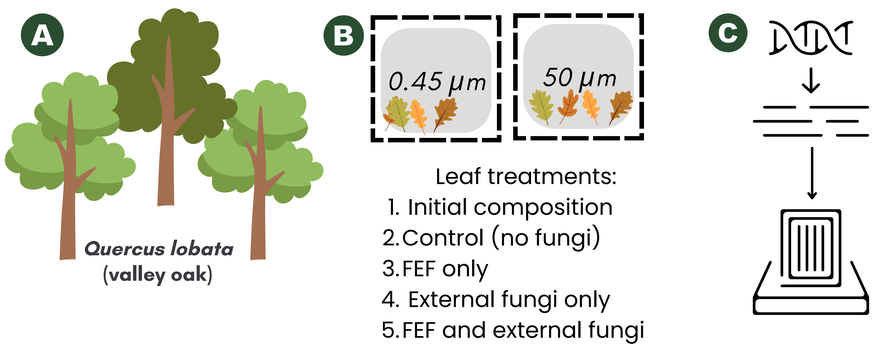

Figure 3. (A) Field experiments were conducted at Big Chico Creek Ecological Reserve (BCCER) using valley oak leaf packets at three different sites. (B) Leaves were assigned to 5 leaf treatments based on two types of nylon mesh: 50 µm pores to allow external fungal colonization and 0.45 µm pores to prevent colonization. Leaf packets from each site and treatment were returned to BCCER and collected at five different intervals to monitor leaf litter decomposition. **(C)** After collecting the leaf packets, plant DNA was extracted, the fungal internal transcriber region (ITS1) was amplified, and samples were pooled together for Illumina sequencing.

Results

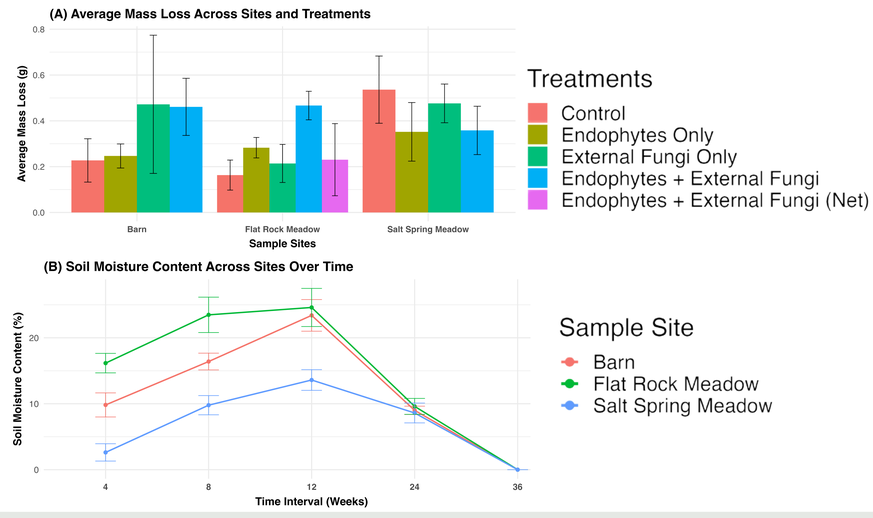

Figure 4. Mass loss and soil moisture content across treatments and sites. **(A)** Average mass loss (g) of leaf treatments (control, endophytes only, external fungi only, and endophytes + external fungi) across three sites (Barn, Flat Rock Meadow, and Salt Spring Meadow). Three-way ANOVA found no significant effects of treatment, site, time, or their interactions (all $p > 0.05$). **(B)** Soil moisture content (%) across sites was measured over five time points (Weeks 4, 8, 12, 24, 36). Two-way ANOVA showed significant effects of site, time, and their interaction (all $p < 0.001$), indicating site-specific influence on soil moisture dynamics.

Significance

- Research shows that the arrival order of species like fungi significantly impacts diversity and ecosystem functions such as carbon cycling in leaf litter decomposition [5].
- Gaining knowledge about these community assembly dynamics is essential for ecosystem management and for mitigating climate change.

Acknowledgements

- Committee members: Dr. Kristen Kaczynski & Dr. Robert Griffin-Nolan

More info