Microbial species interactions control litter decomposition

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Abstract

A complex community of microorganisms decompose plant litter (dead organic material), releasing carbon (C) from the soil to the atmosphere in one of the most important steps in the global C cycle. However, it is poorly understood how biological interactions among microorganisms affect the process of decomposition and microbial carbon utilization. In this study, we characterized plant litter mass during interactions among pairs of model decomposer fungi and bacteria. Ten species of fungi and five species of bacteria were cultured together on plant litter in laboratory microcosms over four weeks. Decay rate of litter (as percent mass loss) was measured using standard protocols. Fungal-bacterial interactions slowed litter decay rates while fungal-fungal interactions stimulated litter decay. This work aids our understanding of decomposition at a microbial level and the role of species’ interactions in carbon cycling.

Background

• Fungi and bacteria are a part of a complex community of interacting microbes in the soil that decompose plant litter
• How decomposition occurs and the effect of microbial interactions on decay are not well understood
• Fungal-fungal interactions may stimulate or hinder decay because of interspecies competition for resources
• e.g. fungi may expand their territory to sequester resources from their competitors
• Interactions among microbes of different types (e.g. bacteria and fungi) may stimulate or hinder decay because of strong antagonism among the competing microbes
• e.g. fungi and bacteria may produce antimicrobial compounds
• Though incredibly diverse, decomposer fungi and bacteria have evolved to be as efficient as possible at inducing decay (and obtaining C resources) across species
• OBJECTIVE: Determine if microbial interactions among decomposer fungi and bacteria affect rate of plant litter decomposition

Hypotheses

1. Fungal species compete for resources $\rightarrow$ increased plant litter mass loss
   bacteria negatively affect fungal growth $\rightarrow$ decreased plant litter mass loss
2. Interaction type is the primary determinant of decomposition rate over species $\rightarrow$ different species decompose litter in similar ways regarding interaction type

Methods

Study System
• 10 species of model decomposer fungi
• 5 species of co-occurring bacteria
• Arabidopsis thaliana plant litter

Experimental Design
• Petri dishes with Modified Melin Norkrans (MMN) media
• Species inoculated in co-culture and monoculture (N=490)
• Harvested after 30-35 days

Litter Mass Loss
• Comparison of litter dry weights before and after harvest

Results

Hypothesis 1: The presence of bacteria hinders plant litter decay by fungi

![Graph showing the effect of bacterial presence on fungal litter decay]

Interestingly, fungal-fungal competition did not significantly promote litter decay

Hypothesis 2: Interaction type determines litter mass loss in fungal species

![Graph showing the effect of interaction type on fungal litter decay]

Discussion and Conclusion

• Bacterial competitors hindered litter decay, suggesting that the bacteria reduce fungal growth and ability to decompose the litter
• Alone and in competition, fungi tended to galvanize litter decay, suggesting that fungi drive the decay process, not bacteria
• Competition type rather than species-specific interactions determined plant litter mass loss
• Future Research Questions:
  • What are the mechanisms by which interaction type affects decomposition?
  • How much microbial biomass accumulates on litter in these scenarios?

References


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