Linking microbial enzyme genes with community responses to drought and nitrogen

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Project design

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![Diagram of project design](image)

- **Genome**
  - Taxonomic markers (16S/18S/ITS)
  - Functional genes
  - Env. response genes

- **Community**
  - Abundance changes with treatment

- **Expressed Traits**
  - Enz1
  - Enz2
  - Enz3
  - $k_1$, $k_2$, $k_3$

- **Function**
  - Decay rate

- **Time**
  - Resilience
Project goals

1. Determine how microbial communities and function respond to environmental change
2. Determine the distribution of enzyme genes among taxa
3. Predict enzyme function and carbon cycling under environmental change
4. Test if microbial communities are resilient to environmental change
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1. Determine how microbial communities and function respond to environmental change.

- Nitrogen, Drought
  - Direct
  - Indirect
- Physiological change
  - Direct
  - Indirect
- Microbial community change
- Plant community change
- Function (litter decay)

Prediction: drought reduces litter decay; nitrogen increases litter decay.
Litter mass remaining: Drought

- More mass remaining in drought plots (6 months)
- Drought-derived microbes leave more mass remaining (6-12 months)
Fungi increase with drought (3-6 months)
Drought suppresses bacteria directly and indirectly

Plot Effect (P=0.000)

Litter Origin (P=0.000)
Drought increases activities of all hydrolytic enzymes except peptidase.

Plot Effect (P=0.000)

Cellobiohydrolase

Leucine aminopeptidase

Control

Drought
More labile constituents remaining in drought plots (3-6 months)
Drought response summary

- **Drought**
  - **Physiology**
  - **Microbial community change**
  - **Plant community change**
  - **Function** (litter decay)

- **Chemical changes**
  - +Fung. biomass
  - –Bact. biomass

- **Enzymes**

- **Reduction**
  - Chemical changes during decomp
N addition to plots slightly increases decomposition at 6 months.
Microbes decompose litter faster in their native N plots (home-field advantage)
N-derived litter has more bacteria (6 months)
N-derived litter has more peptidase
Nitrogen response summary

Nitrogen

Physiology

+ Glycine uptake

indirect

Plant community

Plant community change

+ Bact. biomass

indirect

+ Peptidase

indirect

– Chitosan uptake

Function (litter decay)

Increase

Chemical changes during decomp
Data summary

• Both direct and indirect effects are evident
• Reduced water favors fungi over bacteria, slows decomposition, and allows enzymes and labile substrates to accumulate
• Bacteria may drive protein turnover
2. Determine the distribution of enzyme genes among taxa

- Fosmid screening for extracellular enzyme genes
- Eoin Brodie, Mari Nyyssonen, LBL
3. Predict enzyme function and carbon cycling under environmental change

• Incorporate disturbance responses and gene distributions into trait-based model (Allison in press)

• Predict response of litter decomposition to treatments

• Validate model with reciprocal transplant results
Conclusions

• Strong microbial and functional responses to drought
  • Both direct and indirect effects

• Mostly indirect responses to nitrogen (plant and microbial community changes)
  • Two manuscripts in progress: Litter transplant, mass loss and enzymes led by me; enzymes and microbial biomass led by Charlotte Alster (former REU student)

• Encouraging rates of gene discovery

• Use model to synthesize empirical findings and predict community responses
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Microbial Communities and Carbon Cycling

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