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Ectomycorrhizal colonization & diversity on red oaks are reduced in response to garlic mustard density & extracts

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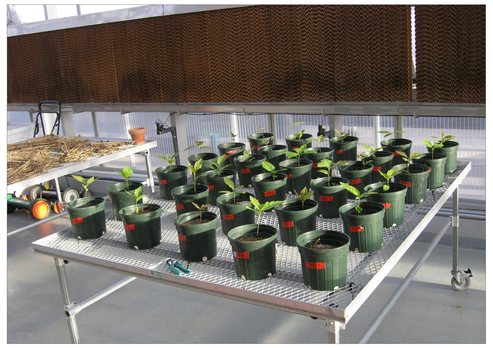
Background & Design

Allelopathy associated with the invasive exotic herb, Garlic mustard (GM, *Alliaria petiolata*), has been found to affect ectomycorrhizal (ECM) host colonization, though density related allelopathic affects on ECM are less clear. To better understand how ECM fungi are affected by GM density & allelopathy, I examined: (1) ECM colonization & community structure from Northern red oak (NRO, *Quercus rubra*) trees growing amidst low-high GM densities *in situ*, (2) ECM colonization & community structure from NRO seedlings inoculated with soils removed below NRO trees growing amidst a range of GM densities, and (3) ECM colonization & community structure from NRO seedlings inoculated with soils removed beneath NRO trees growing amidst no GM, but treated with GM extracts.



NRO seedlings growing in soils removed from beneath NRO trees. The oak trees were growing among garlic mustard "thickets" of lower and higher density.

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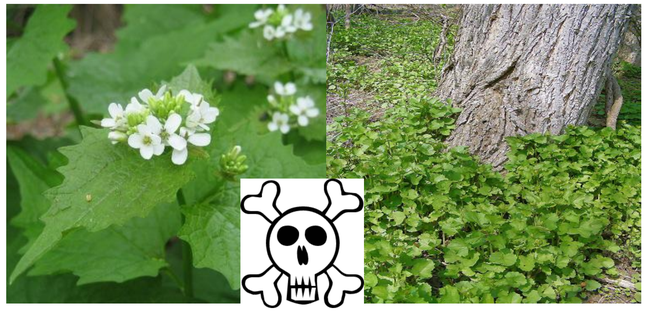
Study Site & Methods

- Red oak-beech dominated forest in the Robert L. Gordon Natural Area - East Goshen, PA
- High level of garlic mustard encroachment across NA



Typical second year garlic mustard plant in flower (left) & high density of first year GM under oak tree (right)

Field Study

- Soil cores extracted beneath NRO growing amidst high (> 10 GM stems m^2), low ((1-5 stems m^2), or no GM (control)
- Roots examined for ECM morphotypes, colonization, & community properties (i.e. richness & H)

Seedling x GM Density - Pot Study 1

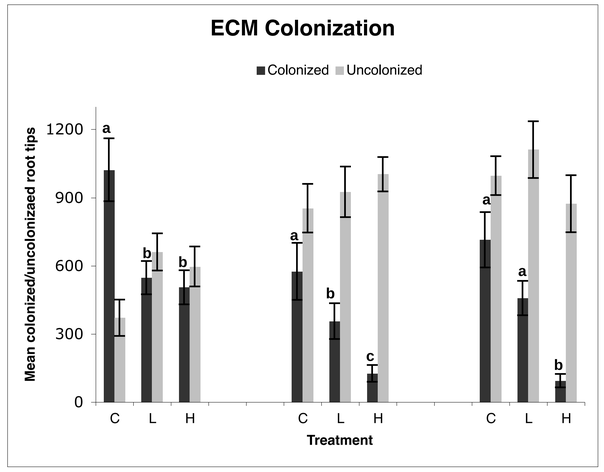
- Cores extracted as w/ Field Study, but sown with acorns to grow as seedlings in soils serving as an inoculum source
- Grown in greenhouse for 8 weeks
- ECM parameters examined as before

Seedling x GM Extract - Pot Study 2

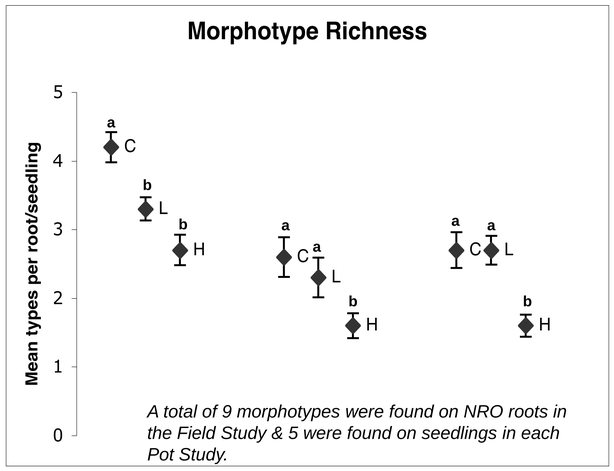
- Cores extracted from control oaks used in prior studies
- Sown w/ acorns & grown for 8 weeks in greenhouse
- Seedlings watered w/ no, low, or high GM extracts (low = 250 g dry mass/10L water; high = 1000 g dry mass/10L water) as per the (high) as per the methods of Roberts & Anderson, 2001 (American Midland Naturalist 146: 146-152)

Two ECM morphotypes from Study 1: Copper (left) & orange (right)

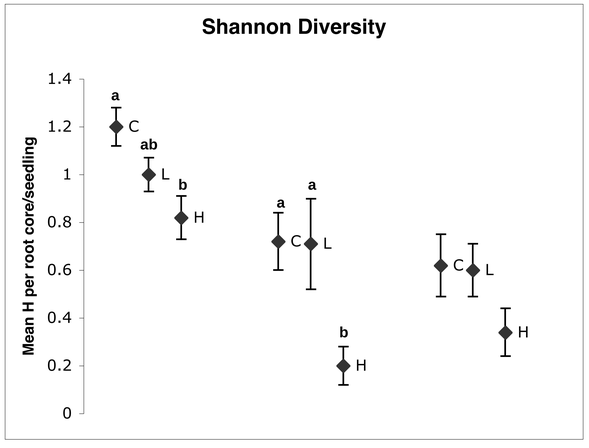
Results *(For each graph, data for the Field Study, Pot Study 1 & Pot Study 2 are portrayed in the left, middle, & right of each graph, respectively. C = control; L = low & H = high GM density/extract)*



Mean colonized & uncolonized root tips per root core/seedling



Mean morphotype richness per root core



Mean Shannon diversity (H) per root core

Variable	F	P
Field Study*		
Colonized tips/core	8.029	**0.002**
Uncolonized tips/core	3.342	0.052
Richness/core	12.585	**0.000**
Diversity/core	5.394	**0.012**
Pot Study 2*		
Colonized tips/seedling	6.622	**0.006**
Uncolonized tips/seedling	0.643	0.535
Richness/seedling	4.416	**0.024**
Diversity/seedling	5.518	**0.011**
Pot Study 2		
Colonized tips/seedling	13.634	**0.000**
Uncolonized tips/seedling	1.109	0.344
Richness/seedling	8.643	**0.001**
Diversity/seedling	1.900	0.169

Bold P values denote a significant difference ($p < 0.05$.)

Summary of two-way ANOVAs on the effect of GM density* & extract** on ECM colonization, R & H

Findings Summary

- ECM colonization & richness were significantly > on NRO roots from control compared to low & high GM density soils
- Shannon diversity was significantly > on roots from control compared to high GM density soils
- Colonization was significantly > on oak seedlings grown in control compared to low & high GM density soils
- Richness & diversity were significantly > on seedlings grown in control & low compared to high GM density soils
- Colonization & richness were significantly > on seedlings exposed to no & [low] compared to [high] GM extract
- Uncolonized root tip #s did not significantly differ b/w soils in any study
- **Results found that GM reduces (1) ECM colonization, richness, & diversity on NRO roots *in situ* & (2) reduces ECM colonization & diversity on seedlings grown in field inoculated soils. Further, GM extracts reduced colonization & richness on seedlings. This suite of findings suggests that high densities of GM & associated allelopathic compounds affect ECM colonization & community properties, which may result in reduced benefits to host plants & in reduced ECM fungal diversity in forests with high GM densities.**

Acknowledgements

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