**Plant-Fungal Interactions as Mediators of Invasive Plant Competition**

Invasive plant species pose worldwide ecological and economic risks[1] by altering nutrient dynamics, community structure and species interactions in an ecosystem, and reducing biodiversity by displacing native species[2]. Annually, they cost the United States alone billions of dollars in crop, pasture, and recreational land damage[3]. Despite substantial public and scientific interest, little is known about the mechanisms that allow exotic plants to transition from relatively benign competitors in their native environments to aggressive invaders in others. Many non-mutually exclusive hypotheses have been postulated to explain this phenomenon, including release of the invasive from enemies, evolution of novel traits, allelopathy, and interactions with soil biota, including **arbuscular mycorrhizal fungi (AMF)**[4].

AMF are obligate plant symbionts that form mutualistic associations with most land plants. They colonize roots and can increase the accessibility of water and nutrients to their host plant, and in return receive carbon from the host in the form of fixed photosynthates[5]. Due to their ability to increase resource uptake, AMF presence may indirectly influence the competitive ability of a plant and thus alter plant species composition and interactions in an ecosystem[4,6]. Although AMF have been hypothesized to underlie competitive success in invasive plants, direct tests are rare owing to the complexity of plant-AMF associations. For example, different AMF species differentially provide benefit to their host depending on host and fungal taxa. Additionally, AMF are not restricted to their primary host plant; their mycelia can extend from one plant's roots to another and establish **common mycelial networks (CMNs)** that can transfer nutrients, metabolites, and even defense signals between connected plants[7]. Due to the nutrient transport properties of CMNs, it is possible that their formation could alter competitive outcome and either add to or alleviate intensity of belowground competition. My research will directly test the role of AMF/CMNs in invasive success by answering the following questions: **1) Does AMF presence and species composition influence the enhanced competitive abilities exhibited by invasive plants? 2) Can CMN formation alter belowground competitive intensity?**

**Proposed research:** I will study *Brachypodium sylvaticum* (slender false brome), a newly invasive grass currently undergoing rapid range expansion in Oregon. As its competitor I will use *Elymus glaucus* (blue wildrye), a native grass commonly found co-occurring with *B. sylvaticum* in field populations. Both grasses are facultatively mycotrophic, perennial, and have similar growth rates in the field and greenhouse (pers. obs.).

**Experiment 1:** To determine the contribution of AMF to invasive plant competitive success, I will measure growth, survivorship and fecundity in competing plant species while varying AMF presence and AMF species composition. I hypothesize that the invasive plant will outcompete the native regardless of AMF treatment; however, the competitive inequality between the two species will be lessened with the addition of AMF. In addition, AMF communities from different sources will differentially influence plant competitive success, and should provide more benefit to the plant species associated with the AMF source. These results will indicate the degree of specificity of AMF-host interactions.

*Methods*: *B. sylvaticum* and *E. glaucus* will be grown from seed in intra- and interspecific competitive pairs in a greenhouse setting. These three pairings will be planted in a 1:1 sand soil mixture with a sterile control (autoclaved soil), soil with fungicide, and soil taken from two ranges in Corvallis, Oregon: one dominated by *B. sylvaticum* to represent an invaded range (B-AMF), and one with only *E. glaucus* to represent an uninvaded range (E-AMF). The twelve treatments will be replicated 10 times, with each block containing two maternal families from

each species to exclude competition from the same genotypes in intraspecific pairings. Competitive ability will be determined by three metrics: growth, survivorship, and fecundity. Upon harvest, roots and shoots will be separated, dried, and weighed, and a section of the roots will be removed to assess the level of mycorrhizal colonization (following McGonigle et al[8]).
*Expected results:* AMF are thought to mediate plant coexistence and relax competition by favoring the inferior competitor[9]. Therefore, disruption of the AMF-host mutualism could be beneficial for an invader. Some invasive plants are suspected to have developed a decreased reliance on the AMF mutualism, and their competitive success has been attributed in part to their ability to disturb the well-established relationship between AMF and native plant species[10]. If this mutualism-degradation hypothesis is supported by my results, the invasive will be most competitively successful when grown without AMF. Results from this experiment will lay the groundwork for exploring the effects of single species AMF isolates in future experiments. DNA sequencing will allow me to identify individual AMF species and characterize them according to host benefit.
**Experiment 2:** To test the effects of CMN formation on invasive competitive success, I will isolate CMN influence and assess plant fitness as described above. I hypothesize that CMN formation will homogenize nutrient distribution and favor the inferior native competitor.
*Methods*: *B. sylvaticum* and *E. glaucus* will be grown in mixture and monoculture, with or without AMF, in pots either containing a solid divider, fine mesh screen, or no divider. The solid divider will serve to block root interactions as well as CMN formation and eliminate belowground competition. The mesh screen will allow for CMN formation but no root interactions. Competitive ability will be measured in the same manner as in experiment one.
*Expected results*: CMNs are suspected to favor inferior competitors by transferring nutrients and carbon down a concentration gradient established by the asymmetric uptake of nutrients between connected competitors[9]. In this manner, CMN formation is expected to reduce belowground competition by homogenizing nutrient distribution. I therefore predict that competitive intensity of both species will be lowest in treatments that allow for CMN formation only, even more so than in treatments eliminating belowground competition.

**Broader impacts:** Only by understanding how plants become invasive can their spread be prevented and controlled[2]. My research will contribute to the growing body of knowledge on the role of AMF/CMNs in mediating invasive plant competition, and allow me to influence the implementation of new policies regarding the control of invasive plant range expansion. For example, if AMF/CMNs relax plant competition, AMF inoculum could be applied to threatened ranges to strengthen native plant communities and prevent invasive spread. In addition to my research, I will establish outreach programs with local schools and public forums to discuss the implications and importance of my work for conservation of native habitats, as well as mentoring undergraduates recruited from McNair Scholars and similar programs to help them develop their own research projects related to the plant-fungal associations and biotic interactions of invasive plant species.

**References:** **1.** Booth et al 2010. CAB International, Oxfordshire, UK. **2.** Luken and Thieret, 1997. Springer-Verlag New York, Inc. **3**. Pimental et al, 2000. *BioScience* 50(1):53-65. **4.** Mitchell et al, 2006. *Ecology Letters* 9:716-740. **5.** Smith and Read, 2008. Associated Press. **6.** Scheublin et al, 2007. *J. of Ecology* 95(4): 631-638. **7.** Song et al, 2010. *PLoS ONE* 5(10): e13324. 8. McGonigle et al, 1990. *New Phytologist* 115:3 (495-501) **9.** Hart et al, 2003. *Trends in Eco*. & Evo 18(8): 418-423. **10.** Vogelsang and Bever, 2009. *Ecology*, 90(2): 399–407.
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