Does mycorrhizal symbiosis determine the climate niche for *Populus* as a bioenergy feedstock?

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Project Goals: This research project uses a native North American tree with strong biofuel potential – *Populus* – to answer fundamental questions about the role of climate, soil environment, and mycorrhizal interactions in determining growth and competition in plant communities. The experiments we are carrying out will provide important basic insights into the way beneficial interactions shape the natural world, but will also have a direct impact on predicting the suitability of particular sites for bioenergy projects in light of climate change, and predicting how above- and below-ground carbon allocation might change with climate.

While microbes have long been viewed as agents of disease, recent explorations of the microbiome have led biologists to recognize that beneficial microbes play an equally vital role in maintaining the health of plants and animals. Perhaps the most ubiquitous form of beneficial interaction in terrestrial ecosystems occurs between fungi and plant roots. These fungus-root, or "mycorrhizal", symbioses involve the reciprocal exchange of plant sugars for soil nutrients obtained by the fungus, such as nitrogen and phosphorous, which are critical for plant growth. It is known that mycorrhizal associations are widespread, occurring in over 90% of plants, and diverse, with single plants associating with over 100 species of fungi. Despite this, the ecological factors that control the distribution and abundance of mycorrhizal symbioses are still poorly known, making it challenging to predict how mycorrhizal symbioses may change in future climate conditions or how these fungal communities might be manipulated to improve agriculture or forestry.

This research project uses a native North American tree with strong biofuel potential – *Populus* – to answer fundamental questions about the role of climate, soil environment, and mycorrhizal interactions in determining growth and competition in plant communities. *Populus* provides a unique opportunity for ecologically relevant experiments because of its widespread distribution across North America and its natural variability in mycorrhizal association types. The first component of this project will use a global forest database to map and model the distribution of different mycorrhizal associations with respect to climate. After establishing this baseline laboratory experiments will then be used to measure the precise ways in which beneficial interactions with mycorrhizal fungi shape the environmental niche dimensions of *Populus*, and how variation in mycorrhizal associations determine the balance of competition with co-occurring tree species across its natural range. Finally, we will use we will use isotope labeling to track changes in carbon flow from *Populus* to mycorrhizal fungi and other soil microbes in different environmental conditions. These experiments will provide important basic insights into the way beneficial interactions shape the natural world, but will also have a direct impact on predicting the suitability of particular sites for bioenergy projects in light of climate change, and predicting how above- and below-ground carbon allocation might change with climate.

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