

## ESA - Plant Population Ecology Early Career Highlight January 2022

"Grant" Yu Liu (cc'd) is a PhD candidate with [Dr. Jean Burns](#) at Case Western Reserve University. His work is helping to unravel the complex interplay between plants and their associated soil microbial communities. In particular, he has taken a phylogenetic comparative approach, demonstrating that benefits of whole soil biota in the presence of disease are general across multiple clades in the Rhododendron. This work highlights the power of this study system for addressing broad questions: such as how has evolutionary history shaped plant costs and benefits of soil microbes for plants?

In the 2021 paper "[The soil biotic community protects Rhododendron spp. across multiple clades from the oomycete \*Phytophthora cinnamomi\* at a cost to plant growth](#)" Liu and coauthors asked whether soil biota from conspecific plants help alleviate the pathogenic effects of an oomycete, and whether the protective role of soil community interacts with plant functional traits. They found that plants infected with *Phytophthora* suffered substantially less damage when inoculated with a live soil microbial community, and that microbes also alter the allocation strategies of plant hosts. Their results support the value of Rhododendron as an ideal clade in which to study microbial controls over disease resistance in plants.



## Get to know Yu:

**Q: Tell us a bit about your overall dissertation research. In particular, why did you decide to focus on *Rhododendron* as a focal clade for questions about disease resistance in plants?**

A: My dissertation is to study the costs and benefits of plants from the soil microbial communities in phylogenetic analyses. I focused on the plant-soil microbial interactions and their role in influencing plant performance. For example, the aforementioned research of *Rhododendron* studied plant performance by measuring disease susceptibility. Another aspect of plant performance in my dissertation is the plant invasiveness in a meta-analysis (under review). The genus [\*Rhododendron\*](#) has more than 1000 species across multiple clades, which contain much information of evolutionary history when conducting a phylogenetic analysis. The *Rhododendron* species are strongly influenced by interactions with soil microbial communities. Their specific pathogen- [\*Phytophthora cinnamomi\*](#) can cause root rot disease.



One reason to use such a plant-pathogen system to conduct this study is that the *Rhododendron* and *Phytophthora* collections were from [Dr. Juliana Medeiros](#) and [Dr. Stephen Krebs](#) at Holden Arboretum (Kirtland, OH), which is convenient to obtain samples and manipulate the experimental treatments. Also, *Rhododendron* species show different *Phytophthora* susceptibility as detected in existing studies. This might put forward a question, whether the disease susceptibility replicates across multiple *Rhododendron* clades. This motivated us to conduct such a greenhouse experiment on 14 *Rhododendron* species across 4 sections.

**The research in the highlighted paper used soils from plants growing at the [Holden Arboretum](#). Can you tell us more about this arboretum? Are there any other types of ecological questions that you think would be ideal to address using the resources at arboretums in general?**

A: The Holden Arboretum has a Rhododendron Garden, where I usually work. There are many Rhododendron collections including hybrids. There is a canopy walk and an emergency tower, so it is convenient to measure leaves of trees and detect the forest canopy, studying things like the water potential stress, photosynthesis and thermal properties. The Holden Arboretum had a [Phys-Fest Workshop](#) when many student researchers cooperated in these intriguing research projects.

**What are your next steps for this work?**

A: In this work, we conducted a whole soil inoculum approach to apply soil microbial effects to plants, because we thought the soil community was highly complex like a "black-box". This means that the effects of soil microbial communities may be an emergent property of these communities, which cannot be reduced to the effects of a single taxa. However, a more mechanistic work could focus on the genetics in the soil microbial communities. We have another greenhouse experiment at Case Western Reserve University Farm with a basically similar experimental design to the aforementioned project. We anticipate conducting a High-Throughput Sequencing for the soil samples from each pot, collaborating with Dr. David Burke at Holden Arboretum.

**What has been your most unexpected pleasure in plant ecology research?**

A: When I was an undergraduate, I was doing micro-injections to *C.elegans* using CRISPR-Cas9. In the Principle of Ecology class (by Dr. Jean Burns) in my first semester at Case Western Reserve University, I felt interested in plant ecology and I decided to try it. I was starting with volunteering work in the lab. It was my first time to experience the pleasure of plant ecological research, like walking in the forest, planting trees and shoveling snow. I met other graduates and many outstanding undergraduates in the period. By researching plant ecology, I get used to the fact that sometimes I need a hand and so do others. Sharing and cooperating with others is a pleasant experience, in which I learn from others and improve my skills.