Austen Apigo - Dissertation Abstract

Life in the leaves: diversity, distribution and function in foliar fungal endophytes

A common goal in ecology is to identify the factors that shape patterns of biodiversity. Macroecology, the study of broad-scale patterns in species diversity and distribution, has been historically studied in the context of plants and animals but whether microorganisms play by the same rules remains unclear. In particular, understanding whether microbes display latitudinal patterns in species diversity - the widely documented pattern in many plants and animals where species richness increases towards the equator - remains elusive.

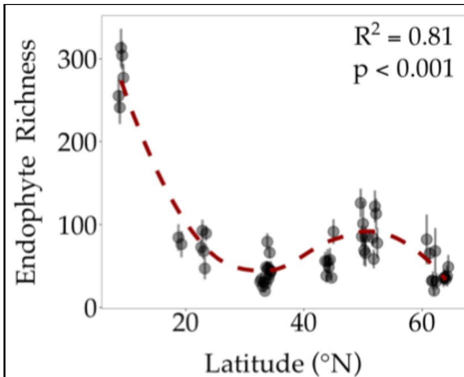

Figure 1. Latitudinal patterns of endophyte species richness. Each point represents a sampling quadrat with bars that refer to standard error.

I have focused my research on the ecology of foliar fungal **endophytes**, a guild of microfungi that live in the photosynthetic tissues of plants. Endophytes are especially useful to study patterns in species diversity along latitudinal gradients because they occur in all terrestrial ecosystems that support plant life and associate with all major plant lineages. I have sampled across a North American latitudinal gradient from Alaska to Panama (n = 20 sites; range: 9°N - 64°N) to understand how climate and the host community shape endophyte **diversity**. At each site, I sampled 10 leaves from one individual of every co-occurring plant species within five randomly distributed 50 m^2 quadrats (n = 1917 plant samples) and characterized the endophyte community with high-throughput sequencing. **I found that endophyte diversity tended to increase towards the equator consistent with patterns in plants and animals but was hump-shaped at high latitudes** (50°N; Figure 1). Conifer forests at 50°N received high precipitation that was only second to tropical forests at 9°N. This could explain the hump-shaped diversity pattern at high latitudes because mean annual precipitation was positively correlated with endophyte species richness.

Another factor that may influence endophyte diversity patterns is their **distribution** across host species. I developed a quantitative method that standardized metrics of endophyte distribution to null expectations of endophyte-plant associations and **found that the same endophytes were consistently found among abundant host species but not rare host species** (Apigo and Oono 2021). I am currently using the framework I developed to describe how endophyte distribution varies with plant diversity and climate to further investigate the hump-shaped diversity pattern at high latitudes that is also observed in other fungal guilds.

In addition to research on the diversity and distribution of endophytes, I have investigated how endophytes **function** as decomposers of decaying plants, causing plant litter to lose mass. Endophytes are hypothesized to occur within the tissues of every land plant on Earth but many basic questions that concern how much, how fast and what plant compounds endophytes decompose remain unanswered. To address this, I conducted a year-long lab incubation study in collaboration with two undergraduates and **found that endophytes decomposed pine litter at a rate similar to soil fungi** that was controlled by the abundance of sugars in decomposing litter. I am continuing to follow up on this work by testing the associations between specific carbon compounds and enzyme activity to gain a more mechanistic understanding of how endophytes cause litter to lose mass.

My proposed work under the guidance of Professor Treseder will leverage expertise from my past work to understand how endophyte communities respond to global change - a distinct and novel research avenue. Support from the NSF Postdoctoral Fellowship will provide me the opportunity to learn new skills related to metatranscriptome assembly and FTIR spectroscopy using established methods in the Treseder, Vázquez-Lobo and Chávez-Vergara labs that will prepare me as a future faculty member that intends to work at the interface of fungal diversity, distribution and function.