Magnolia Chapter
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Student Panhandle Research Grant

The mission of the Florida Native Plant Society (FNPS) is to promote the preservation, conservation and restoration of native plants and native plant communities of Florida. The FNPS Magnolia Chapter Panhandle Research Grant was established to support local undergraduate or graduate students in research related to the FNPS mission in the Florida panhandle, Coastal Plains and Big Bend Regions (defined as from Escambia eastward to Hamilton, Suwannee, Lafayette, and Dixie Counties in Florida).

Panhandle Research Grant Description:
Up to $500 is available to an actively enrolled, local undergraduate or graduate student of any institution of higher education to conduct research relating to the FNPS mission in the panhandle and Big Bend of Florida. The grant money is awarded on a reimbursable basis in increments not less than $100 by completing the reimbursement form. Applications will be reviewed by the Magnolia Chapter's review committee, as appointed by the president. The grant winner will be notified by May 1st. After the research is complete, the recipient is to provide the Chapter with a report describing the research to be published to the website and distributed in Ms. Magnolia and/or a short oral presentation at a Chapter program meeting or at the FNPS Annual Conference.

Application Requirements:

- Completed application form – may be filled out using Adobe Reader “Sign” tool and saved.
- Support letter - a recommendation from a professional or academic reference.
- Research plan and budget proposal – a two page maximum project description and a one page maximum budget proposal and project timeline.

Applications are announced on February 1st and are due by midnight on April 1st. Send all application materials together to: *magnoliaFNPS@gmail.com* and with “Panhandle Research Grant Application” in the subject field.

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Application Form Name: Brendan P. Scherer Date of Application: March 27th, 2020

E-mail: bps15c@my.fsu.edu Phone: 9202688041

Local Address: 3355 Cypress Cove Court
Tallahassee, FL 32310

College/University Name: Florida State University

Department: Biological Sciences

Field(s) of Study: Ecology and Evolution

Major Professor (if applicable): Dr. Austin Mast

Academic Status: Graduate student X Undergraduate _____

Expected Date of Degree: May 2021 Cumulative GPA: 3.902

Add pages to this application form including the following:

1. **Project Title**
2. **Project Narrative:** Describe the project in not more than 1000 words (2 pages single spaced @ 12 point font). Include project goals and objectives and state whether this is an on-going project. Describe coordination with other individuals, institutions or organizations.
3. **Budget Detail and Project Timeline:** (Not to exceed $500); with a break down that facilitates understanding of the project approach and goals. Include information of other funders, if applicable. Include expected timeframe for a presentation and or write-up.

Phylogeography and Propagule Bacterial Diversity Across the Florida Range of Red Mangroves (*Rhizophora mangle*; Rhizophoraceae)

Brendan P. Scherer

Florida State University

Department of Biological Science: Ecology and Evolution

Ph.D. Candidate: Fifth Year

Research Plan

Introduction

Mangrove ranges are expanding poleward, likely in response to a warming climate (Saintilan et al., 2014). Persistent and reproductive populations of Red Mangroves (*Rhizophora mangle*) have been documented across the Florida Panhandle in the St. Mark's Wildlife Refuge and the barrier islands between Panama City Beach and Panacea (Scherer Voucher Number 6, RKG). Red mangroves produce hardy, buoyant, viviparous propagules which can survive up to a year in seawater (Drexler, 2001). In these propagules, the embryo grows through both the seed coat and fruit wall prior to abscission from the parent plant (Figure 1). These adaptations to hydrochorous dispersal suggest that any range expansion in this species can be driven by both short and long-distance dispersal. This project will generate RADseq data to investigate phylogeographic relationships between *R. mangle* populations across Florida to infer the relative importance of short and long-distance dispersal in the ongoing range-expansion. Additionally, this project will use 16s rRNA sequencing and microbial community analysis to investigate patterns of endophytic bacterial diversity across genetic and geographic distance to determine how endophytic communities are affected by host phylogeny and geographic origin.

Endophytic microbes are increasingly recognized for their roles in the physiology of many multi-cellular organisms. Bacteria and fungi often play important roles in plants such as pathogen defense, nutrient acquisition, secondary metabolite production, and even resistance to abiotic threats (Berg et al., 2015, Turner et al., 2013). Despite recent advancements in microbial ecology, it is still unclear how microbiomes are assembled in plants, and in *R. mangle* specifically. As proposed in the Hologenome Theory of Evolution, symbiotic microbial communities may be largely inherited from an organism's parents, making them subject to natural selection and thus important for the evolution of the host itself (Zilber-Rosenberg and Rosenberg, 2008). In plants, such inheritance would likely take place through the seed or fruit tissues. If this is the case, one would expect to see conservation of microbial communities within a species, potentially even across large distances. Although preliminary data in red mangrove leaves suggest there are unique communities associated with different locations, the extent to which this pattern translates to other tissues is unclear (Scherer and Mast, 2019). Instead, if microbial communities are acquired from the environment, one would expect geographically distinct populations of plants to derive their endosymbionts from distinct environmental pools, and thus possess distinct endophytic bacterial communities. In this project I will address two sets of hypotheses:

$H1_o$: Populations of *R. mangle* along the panhandle coast of Florida are the result of short-distance dispersal from nearby populations found in northern peninsular Florida.

$H1_a$: Populations of *R. mangle* along the panhandle coast of Florida are the result of long-distance dispersal events from southern Florida.

$H2_0$: The propagule microbiome of *R. mangle* varies based on geographic origin, with each locality possessing a unique endophytic bacterial assembly.

$H2_a$: The propagule microbiome of *R. mangle* is composed of a reoccurring assemblage of bacterial taxa found across the Florida range of *R. mangle*.

Methods

I have collected 110 georeferenced *R. mangle* leaf samples from 11 localities in Florida (Figure 2). These samples will form the basis of my RADseq data pipeline and will allow me to generate novel genomic data. Each of these samples has a corresponding propagule sample (from the same individual) that will form the basis of the bacterial, 16S sequencing portion of this project. Each propagule sample consists of five propagules from one individual, collected in a sterile bag. All samples for bacterial sequencing are currently stored in the Mast Lab in FSU's Department of Biological Sciences.

I am currently performing my microbial DNA extractions through a collaboration with Dr. Prashant Singh's lab at FSU. I am also collaborating with Dr. Stuart McDaniel at the University of Florida for my RADseq extractions and library preparation. I intend to complete all sequencing through FSU's Bioanalytical and Molecular Core Facilities.

My RADseq data may be augmented with previously published data (Hodel et al., 2017), and will be used to investigate population structure and gene flow, especially among the establishing panhandle populations. My 16S data will be used to 1) identify patterns of diversity across localities and individuals, and 2) investigate the presence or absence of a "core community" of microbial taxa associated with red mangrove propagules.

The funds obtained from the Magnolia Chapter will cover the cost of the RADseq portion of this work, including DNA extractions and library preparation. The samples and microbial DNA extraction kits necessary to complete the proposed project are currently in my possession. Although my research has been supported by small grants from Florida State University's Department of Biological Sciences, additional funds are required for project completion.

Conclusions

This work will explore the phenomenon of long-distance dispersal in an ecologically and economically important plant species. Mangroves provide a host of ecosystem services yet have been decimated worldwide over the past hundred years (Alongi, 2008; Ellison, 2000; Rogers, 1990; Shelton and Richmond, 2016). Exploration of their dispersal and establishment may yield valuable insight into the natural regeneration of mangrove forests. Additionally, expanding our knowledge of the processes that structure endophytic bacterial communities may support further understanding of plant ecology and evolution. I intend to disseminate the results of this research through publication and presentation at the Florida Native Plant Society 2021 meeting or another conference. Continued support from the Magnolia Chapter would be invaluable in facilitating the exploration of bacterial community dynamics critical to the establishment and expansion of *R. Mangle* populations.

Budget

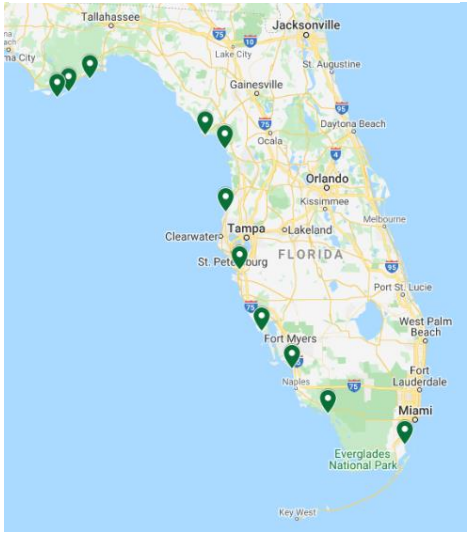
I was the grateful recipient of the Magnolia Chapter's Student Panhandle Research Grant in 2019. The funds supported sequencing of preliminary data which was presented at the Botany 2019 conference in Tucson, Arizona (see link below). I am also in the process of drafting a manuscript from this data, which I intend to submit for publication by early summer 2020. This early work enabled me to develop and refine a pipeline from sampling through data analysis. Since 2019, I have completed the field work necessary to support this project, and am currently completing my microbial DNA extractions. The RADseq portion of this work was originally scheduled for 2019, but due to laboratory delays it will be completed in 2020. The COVID-19 pandemic has further affected my ability to complete the RADseq components of the project, but I am working with Dr. McDaniel to ensure completion of this project remains a priority.

https://www.youtube.com/watch?v=6KH6N_cA8sQ

Item	Item Cost	Total Cost
RADseq reagents and supplies	$500	$500
Illumina Sequencing Lane at FSU Core Facilities	$1,400 per lane (1x)	$1,400
Total		$1,900
Total Already Covered		$1400
Total Requested from the Magnolia Chapter		**$500**

Figure 1

Figure 2



Project Timeline

The public health emergency created by the COVID-19 pandemic has resulted in the disruption of laboratory activities at Florida State University and the University of Florida. This timeline has been revised to facilitate the earliest possible completion of this work while prioritizing the health and safety of students and faculty members at both universities.

Mar. 2020	**Apr. 2020**	**May 2020**	**Jun. 2020**	**Jul. 2020**	**Aug. 2020**
Analyze Existing Data	Complete Analysis of Existing Data	Complete DNA extractions	Complete DNA sequencing	Begin Data Analysis and Manuscript preparation	Continue Data Analysis and Manuscript Preparation
Sept. 2020	**Oct. 2020**	**Nov. 2020**	**Dec. 2020**	**Jan. - April 2021**	**May 2021**
Continue Data Analysis and Manuscript Preparation	Continue Data Analysis and Manuscript Preparation	Submit Manuscript for Publication	Revise Manuscript	Revise Manuscript (as needed)	Present finished project at the annual FNPS conference Graduate with Ph.D.

Bibliography

Alongi, D. M. (2008). Mangrove forests: resilience, protection from tsunamis, and responses to global climate change. Estuarine, Coastal and Shelf Science, 76(1), 1-13.

Berg, G., Rybakova, D., Grube, M., & Köberl, M. (2016). The plant microbiome explored: Implications for experimental botany. Journal of Experimental Botany, 67(4), 995–1002. https://doi.org/10.1093/jxb/erv466

Drexler, J. Z. (2001). Maximum longevities of Rhizophora apiculata and R. mucronata propagules. Pacific Science, 55(1), 17-22.

Ellison, A. M. (2000). Mangrove restoration: do we know enough? Restoration Ecology, 8(3), 219-229.

Hodel, R. G. J., Chen, S., Payton, A. C., McDaniel, S. F., Soltis, P., & Soltis, D. E. (2017). Adding loci improves phylogeographic resolution in red mangroves despite increased missing data: Comparing microsatellites and RAD-Seq and investigating loci filtering. Scientific Reports, 7(1), 1–14. https://doi.org/10.1038/s41598-017-16810-7

Rogers, C. S. (1990). Responses of coral reefs and reef organisms to sedimentation. Marine Ecology Progress Series, 62, 185–202. https://doi.org/10.3354/meps062185

Saintilan, N., Wilson, N. C., Rogers, K., Rajkaran, A., & Krauss, K. W. (2014). Mangrove expansion and salt marsh decline at mangrove poleward limits. Global change biology, 20(1), 147-157.

Scherer, B. *Rhizophora mangle* Voucher Specimen. Collection number 6. Robert K. Godfrey Herbarium. November 3rd, 2017. https://herbarium.bio.fsu.edu/view-specimen.php?RecordID=100065

Scherer, B. and Mast, A. Oral Presentation: “Endophytic Bacterial Diversity Across the Florida Range of Red Mangroves (*Rhizophora mangle*; Rhizophoraceae).” Botany 2019, Tucson, AZ. July 30th, 2019.

Shelton, A. J., & Richmond, R. H. (2016). Watershed restoration as a tool for improving coral reef resilience against climate change and other human impacts. Estuarine, Coastal and Shelf Science, 183, 430-437.

Turner, T. R., James, E. K., & Poole, P. S. (2013). The plant microbiome. Genome biology, 14(6), 209.

Zilber-Rosenberg, I., & Rosenberg, E. (2008). Role of microorganisms in the evolution of animals and plants: the hologenome theory of evolution. FEMS microbiology reviews, 32(5), 723-735.