

**Breedlove, Dennis Fund
Awards for Student Botanical Field Experiences**

Fiscal years 2018, 2019, and 2020 [partial]

**Report prepared by the University of Tennessee – Knoxville Herbarium (TENN)
Margaret Oliver and Jessica Budke**



Jessica Budke and undergraduate student Anna Raney examine *Isoetes tennesseensis* growing in the Hiwassee River (Polk County, TN) on 28 September 2019.

Contents

Fiscal Year 2018 Awards.....	3
Graduate Students	3
Amanda Benoit.....	3
Jonathan Dickey	4
Jayne Lampley	5
Chloe Lash.....	6
Undergraduate Students.....	7
Vanessa ‘Rosy’ Harpe and Jackson Turner	7
Isabella ‘Bella’ Ritchie	8
Fiscal Year 2019 Awards.....	9
Graduate Students	9
Mali Hubert.....	9
Jacob Moutouama.....	10
Undergraduate Student	11
Jordan Reed	11
Fiscal Year 2020 Awards.....	12
Graduate Students	12
Alessandra ‘Alex’ Aromin.....	12
Ongoing Projects in FY20	13
Graduate Students	13
Eric Shershen	13
Rachel Swenie.....	13
Sophia Turner	13
Undergraduate Students.....	14
Joanna Huntoon	14
Nathan Pace.....	14
Herbarium Excursions	15
Rock Island State Park.....	15
Big South Fork National River and Recreation Area	16
Hiwassee River	17

Fiscal Year 2018 Awards

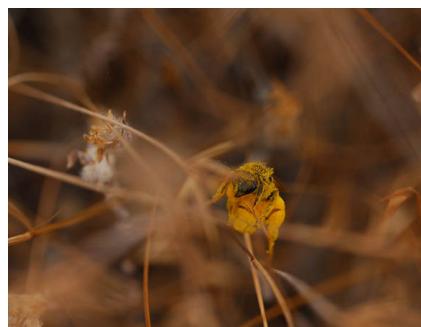
Graduate Students

Amanda Benoit

2nd year PhD student in EEB

Summary:

- Objective: Determine how crab spiders affect plant-pollinator interactions, plant reproduction, and phenotypic selection on floral traits of the emblematic west coast endemic *Calochortus luteus* (Liliaceae).
- Conducted pollinator observations of 90 paired plants randomly assigned to a crab spider present or absent treatment.
- Found that pollinators avoided flowers which harbored crab spiders. Plants in the crab spider present treatment received 60% fewer pollinator visits than crab spider-free control plants.
- Pollinators that did visit flowers, which harbored crab spiders, reduced their visit duration by 61%.
- Despite reduced pollinator visitation, plants that harbored crab spiders produced more seeds than crab spider-free plants. This increase in seed set despite reduced frequency and duration of pollinator visits, suggests that crab spiders may mediate self-pollination of *C. luteus* flowers.
- In the field I observed crab spiders with pollen grains on their legs and bodies as well as crab spiders moving across plant stigmas as they hunted. If crab spiders mediate self-pollination, they could cause inbreeding depression and affect plant population genetics.
- I am currently working on a follow-up greenhouse experiment to determine if offspring from crab spider-harboring plants are more inbred and less fit than offspring of crab spider-free plants.
- This award helped fund the collection of data that will contribute to three chapters of my dissertation, which will be published in peer-reviewed journals.
- These data were also included in the following presentation:
Benoit, A., and S. Kalisz. 2019. Indirect effects of predators on plant-pollinator interactions, plant reproduction, and phenotypic selection. Ecological Society of America, Louisville, KY.



Jonathan Dickey

1st year PhD student in EEB

Summary:

- Initial research addressed how belowground nutrient based microbiome interactions with *Salvia lyrata* can affect aboveground higher trophic mutualisms, like the association with pollinators, and the plant fitness consequences that may follow.
- Objective: How does soil microbial community dissimilarity associated with *S. lyrata* correlate with population level variation in floral morphology (flower abundance, inflorescence biomass, corolla tube length) and phenology? How does bacterial community richness and abundance correlate with plant fitness?
- Rhizosphere sampling occurred from May-June 2018 in the Cherokee National Forest in Eastern Tennessee.
- Currently analyzing results; however, it's expected that lower microbial functional diversity in the soil rhizosphere will reduce protection from pathogens and limit the availability of vital nutrients causing a negative feedback on aboveground plant fitness and flower phenology.
- Anticipate that with lower concentrations of nitrogen in the form of ammonia or ammonium, available carbon, and potassium in the soil, that a more functionally redundant microbiome community will coexist with *S. lyrata*.
- This research has led to other inquiries regarding the spatial structure of bacterial and fungal richness within the rhizosphere of *S. lyrata*.
- This data supported a poster presentation on the spatial structure of *S. lyrata* at the 2019 Ecological Society of American annual meeting.
- This data is supporting a manuscript titled "Bacterial communities of the rhizosphere explained by spatial structure and sampling grain," which is in review for publication.



Jayne Lampley

4th year PhD Candidate in EEB

Summary:

- Made several field trips over two spring seasons in order to complete the sampling necessary to finish a portion of my study on the phylogenetic relationships and spatial distribution of populations of *Trillium lancifolium* among multiple watersheds of the southeastern US.
 - Included trips in Tennessee, Mississippi, Alabama, and Georgia (Montgomery, AL, Tullahoma, TN, Chattanooga, TN, Hardin Co., TN, S. Pittsburg, TN, Rising Fawn, GA, and Hoover, AL).
- Collected *T. lancifolium* vouchers and made DNA extractions from enough populations of every watershed in which the species occurs in order to make population-level analyses and to compare population relationships among watersheds.
- Collected vouchers of other plant species at *Trillium* population sites both to add to the herbarium and to make record of *Trillium* associates.
- Collected from more *T. cuneatum* populations to enhance the analysis in that part of the study
- Was able to use some of the fresh samples collected during field work to perform microscopic studies to look for clear morphological differences which could be used as field characteristics to separate new species.
- Currently working on manuscripts and finishing up analyses in these projects.
- This award helped support the collection of 67 new herbarium specimens deposited in the TENN herbarium.
- These data were included in the following publications and presentations:
Missouri Botanical Garden Annual Fall Symposium, October 13, 2018, St. Louis, MO – Jayne Lampley – A phylogenetic and population study of *Trillium lancifolium* (Melanthiaceae) and allies using chloroplast DNA to explore species diversification among watersheds of the southeastern US (Poster).
Botany 2018, Rochester, MN – Jayne Lampley – Role of river watersheds on diversification and endemism in native plant species: A phylogeographic study of *Trillium lancifolium* (Melanthiaceae) (Talk).



Chloe Lash

3rd year PhD student in EEB

Summary:

- Focuses on the incorporation of microbes into myrmecochory (ant seed dispersal), which has traditionally been viewed as a simple pairwise mutualism.
- Objectives: 1) identify the microbial community of seed-dispersing ant nests; 2) identify changes conferred to the microbial community of seed coats by seed-dispersing ants.
- Collected soil and decaying woody debris samples from active ant nests and control substrate one meter away.
- Extracted DNA from the samples and with the assistance of the UTK Genomics Core, prepared them for Illumina MiSeq sequencing.
- Have found that the fungal communities in ant nests are primarily driven by substrate type (soil or decaying woody debris) and that ant activity influences the pathogenic fungal community turnover in the nest, particularly animal pathogens.
- I utilized funds to investigate effects of ant handling on the microbial community on seed coats.
- I collected seeds from 16 of both Bloodroot (*Sanguinaria canadensis*) and Wild Ginger (*Asarum canadense*) fruiting plants and divided seeds into 3 treatments of 0.5 grams of seeds each.
- Treatments included: control seeds with elaiosomes (fleshy seed coat derived appendage), control seeds without elaiosomes (which were steriley manually removed), and ant handled seeds (ants were allowed to interact with seeds for 4 days). I am currently processing the data.
- This award helped fund the collection of data that will contribute to two chapters of my dissertation, which will be published in peer-reviewed journals.
- These data were also included in the following publications and presentations:
Lash, C.L., and C. Kwit. 2019. Ants, Plants, and Pathogens: Ant nest provide a safe location with different plant pathogen communities for dispersed seeds. In prep for *Oecologia*.
Lash, C.L., M. Cregger, and C. Kwit. 2019. Ants alter the seed coat microbiome. In prep for TBD.
Lash, C.L., and Kwit, C. 2019. Ants, plants and fungi: Active ant nests remain low in plant pathogenic fungi throughout the myrmecochore fruiting season. Entomological Society of America Annual Meeting.
Lash, C.L., M. Cregger, and C. Kwit. 2020. Ants alter the seed coat microbiome. Ecological Society of America 2020, planned for 2-7 August 2020.



Undergraduate Students

Vanessa 'Rosy' Harpe and Jackson Turner

V. Harpe graduated spring 2019, Biology major – EEB concentration

J. Turner anticipated graduation spring 2021, Biology major – EEB concentration

Summary:

- Surveyed the root-associated fungal communities of five host plants in each of twenty locations in the Great Smoky Mountain National Park (GSMNP) and surrounding urbanized areas in Gatlinburg, TN.
 - Locations ranged in burn severity following the 2016 Chimney Tops II fire, from severely burned to unburned.
- Overall, decomposer fungal abundance in soils decreased as a function of burn severity, with the highest burn severity sites have fewer decomposers than unburned sites.
- Similarly, symbiotic fungal abundance decreased in abundance within plant roots.
- Plant composition shifted following fire and symbiotic fungal abundance varied among plant hosts.
- Symbiotic fungi are likely to respond to fire indirectly via shifts in the abundance of their plant hosts while decomposer fungi are likely to be directly affected by fire decreasing available substrates in the soil.
- This work is of public importance for several reasons: 1) Symbiotic fungi were sensitive to fire suggesting that ecosystem nutrient flows may be disrupted following fires in southeastern temperate forests. 2) Decomposer fungi declined following fire. The decline in abundance of decomposer fungi following fire may lead to lower decomposition rates and thus a higher accumulation of litter to fuel future fires.



Isabella 'Bella' Ritchie

Biology major – EEB concentration
Graduated fall 2019

Summary:

- Surveyed native and non-native plant species of Fort Dickerson (91-acre historical park in Knoxville).
 - Made 12 collecting trips during the spring, summer, and fall of 2018
- Collected 223 specimens, which have been pressed and will be deposited at TENN once the full project is complete.
- Documented new species for Knox County (*Alliaria petiolata*, *Ligustrum quihoui*) as well as non-native species that are considered invasives (*Albizia julibrissi*, *Euonymus fortunei*, *Hedera helix*, *Ligustrum sinense*, *Lonicera maackii*, *Paulownia tomentosa*, *Pueraria montana*).
- Participated in all aspects of the project: field collection, identification of specimens using dichotomous keys, and pressing plants for voucher specimens.
- This award helped fund the collection of data that will be published in a peer-reviewed journal on the flora of Fort Dickerson.



Fiscal Year 2019 Awards

Graduate Students

Mali Hubert

2nd year PhD student in EEB

Joint award with undergraduate student:

Kaitlyn Meadows

Biology major – EEB concentration

Anticipated graduation: Spring 2022

Summary:

- Objective: address the knowledge gap between the combined effect of urbanization and wildfire on plant communities in the wildland-urban interface [area where houses meet or intermingle with undeveloped vegetation].
 - Particularly the native plant communities across a fire gradient (from low to high severity), in both exurban (Gatlinburg) and natural (Great Smoky Mountains National Park) conditions.
- Addressed the following hypotheses:
 - Hyp. 1) The plant communities after the fire disturbance will have higher plant diversity among lower fire severities and in the natural site locations.
 - Hyp. 2) The fire disturbance generates more diverse patterns of species composition in relationship with lower fire severity in the wildland-urban interface.
 - Hyp. 3) Plant species diversity increases through time across the fire gradient and among the natural and exurban locations.
- Identified a total of 223 species over the 20 sites sampled across a two-year period
- Results suggest that plant community composition and diversity is changing in relation to fire severity and urbanization within the wildland-urban interface.
 - Plant communities are more diverse in areas with low/medium fire severity and in exurban locations, supporting the first portion of Hyp. 1; (ii) plant type is mostly evenly distributed throughout the fire gradient and between the locations, but is variable among the two sampling years, thus rejecting part of Hyp 2; and (iii) plant richness and abundance have been negatively affected through time by the fire severity, supporting Hyp. 3.



Jacob Moutouama

1st year PhD student in EEB

Summary:

- Objective: understand center periphery population dynamics using *Thunbergia atacorensis* (Acanthaceae), an endemic and very rare West-African plant, as a study species.
 - The center periphery population theory assumes that species reach their higher abundance in the center of their range and then decrease in abundance at the periphery.
- Identified 12 natural populations across the distribution of the species.
- Randomly installed five 5x5m plots in every population, collected the species densities, and demographic data.
- Found that densities of *T. atacorensis* were higher at the center of its distribution but also higher at the periphery.
 - *T. atacorensis* does not display the center periphery population dynamics.
 - Species density decreases with an elevation gradient.



Undergraduate Student

Jordan Reed

Biology major – EEB concentration

Anticipated graduation: 2020

Summary:

- Objective: investigate the relative importance of fire disturbance on plant functional plant traits in the *Solidago* species.
- Wildfire that began in the GSMNP in November 2016 presented a rare opportunity to examine how fire affects plant structure and function along a burn gradient in the southeastern U.S., from no fire, to low/medium to high burn severity.
- This study yielded significant differences across sites
 - Unburned site revealed to have the greatest rates of herbivory at 41.4%, when compared to low/medium burn (29.3%) or high burn (27.7%) sites.
 - Low/medium burn site exhibited a 13.7% increase in specific leaf area – a means to estimate growth rates - when compared the unburned and high burn sites, however, leaves collected at the high burn site showed a 40% increase in weight.
- Fire may reduce rates of herbivory, as well as increase aspects of plant growth in the years after fire.



Fiscal Year 2020 Awards

Graduate Students

Alessandra 'Alex' Aromin

Masters in EEB

Anticipated graduation: Summer 2020

Summary:

- Objective: examine the tradeoff in structural maternal investments to better understand how different moss species have evolved to protect their offspring using the calyptra (a protective structure that originates from the maternal plant and its main function is to protect the offspring from environmental stress like dehydration).
 - The calyptra is covered in a cuticle, which impacts the overall survival and fitness of the offspring. Therefore, a way to quantify maternal investment is by measuring cuticle thickness.
 - We predict that species with smooth calyptra will have a relatively thick cuticle and species with hairy calyptra will have a relatively thin cuticle.
- Collected species around east Tennessee as well as out of state.
 - Located and collected species that produce shorter offspring, *Orthotrichum anomalum* and *Orthotrichum pusillum* (Cropseyville, New York) and taller offspring, *Polytrichum alpinum* and *Atrichum angustatum* (east Tennessee).
- This award helped support the collection of 8 new non-vascular herbarium specimens and 10 other specimens that will be deposited in the TENN herbarium.
- This award helped fund the collection of data that will contribute to my thesis, which will be published in peer-reviewed journals.
- These data will be included in a presentation at Botany 2020 being held in Anchorage, Alaska from July 18th to 22nd, 2020.



Ongoing Projects in FY20

These projects have been funded and are ongoing.

Graduate Students

Eric Shershen

1st year PhD student in EEB

Final report due: October 2020

Summary: Eric will be visiting the Great Smoky Mountains National Park during the summer of 2020 to revisit plots from previous studies in order to examine how the species composition of bryophytes in spruce-fir forests may have changed over time. He will be collecting bryophyte voucher specimens and depositing them in the TENN herbarium.

Rachel Swenie

3rd year PhD student in EEB

Final report due: January 2021

Summary: Rachel will be constructing a phylogeny of the fungal order Cantharellales, which is a highly diverse but understudied group of corticioid fungi. Since the majority of the specimens in the TENN herbarium are older than 30 years and this is a group of organisms that often requires DNA barcoding to identify to species she will be visiting 12 field sites through the southern Appalachians to collect specimens for future molecular work. She will be depositing these specimens in the TENN herbarium.

Sophia Turner

1st year PhD student in EEB

Final report due: August 2020

Summary: Sophia will be examining the role of direct and indirect multi-species interactions on plant performance by testing how soil microbial communities, pollinators, and herbivore interactions impact plant function of native and invasive species. She will be conducting field surveys of *Cirsium vulgare* in the Oak Ridge National Laboratory's protected area, Freels Bend. She will be collecting voucher specimens of the plant community and depositing these in the TENN herbarium.

Undergraduate Students

Joanna Huntoon

Biology major – EEB concentration

Anticipated graduation: Spring 2021

Final report due: June 2020

Summary: Joanna has deployed seed traps in Knoxville's urban wilderness near the winter-fruiting invasive shrubs *Rhamnus davurica* and *Ligustrum sinense*. She is collecting bird fecal samples from the traps and will be examining the dispersal of seeds from these species. She has already collected several voucher specimens of *R. davurica* and *L. sinense*, which have been deposited in the TENN herbarium.

Nathan Pace

Biology major – EEB concentration

Anticipated graduation: Spring 2021

Final report due: August 2020

Summary: Nathan is examining the morphologically reduced bryophyte species *Bryocrumia vivicolor*, which has a highly disjunct distribution with populations in Africa, Asia, and the United States. He will be conducting his field work in May 2020 to collect specimens from the southeast United States for future molecular analyses. These specimens will be deposited in the TENN herbarium.

Herbarium Excursions

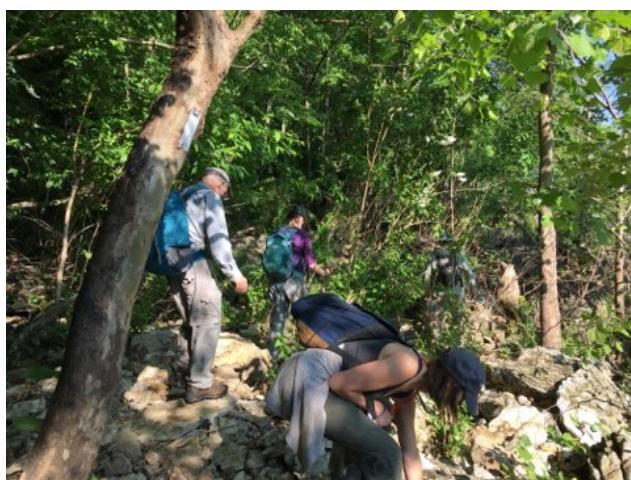
Rock Island State Park

Warren County, TN

18 May 2019

Summary:

- *Palamocladium leskeoides* (Hook.) E. Britton is a moss on Tennessee's Rare Plant List (https://www.tn.gov/content/dam/tn/environment/documents/na_rare-plant-list-2016.pdf)
- The last known collection in the state was made by D.K. Smith in 1992 from Savage Garden in Anderson County, TN and this species has not been collected from Rock Island State Park in Warren County since 1979.
 - Todd Crabtree, TN state botanist, relocated a potential population of *P. leskeoides* at Rock Island State Park in 2009, but was unable to confirm the identification in the field.
- Herbarium Director Jessica Budke, Collections Manager Margaret Oliver, and Emeritus Lecturer Ken McFarland accompanied undergraduate student Rosy Harpe and state botanist Todd Crabtree on a trip to Rock Island State Park on May 18, 2019 to relocate the population and collect a couple voucher specimens, if possible.
- We successfully located a single extant population of *P. leskeoides* among large, shaded boulders along the southern edge of the Caney Fork.
 - Ken McFarland confirmed the identification under a microscope at the herbarium.
 - Two voucher specimens from this trip have been deposited in TENN.
- We observed large patches of the invasive plants *Deutzia scabra* and *Euonymus fortunei* growing over boulder surfaces that could otherwise be suitable habitat for *P. leskeoides* and are planning a future collaboration with the state park to assist in removal of these invasive species.
- Jessica Budke gave an oral presentation about our trips and preliminary findings at the annual meeting for the TN Plant Conservation Alliance (TPCA) held in Nashville on 11 February 2020.
- Although field work originally planned for April of 2020 has been postponed due to COVID-19, we still plan to visit two more likely sites for *P. leskeoides*: Savage Gardens near Lake City, TN in Anderson County and along the Sequatchie River in Marion County.



Big South Fork National River and Recreation Area

Rugby, Morgan County and Burnt Mill Bridge, Scott County, TN
22 June 2019

Summary:

- *Boldia* is a genus of freshwater red algae that is primarily found in the southeast United States.
- Amanda Benoit, the herbarium graduate RA for the spring 2019 semester, worked on curating and databasing the TENN macroalgae collection that had gone unused in a taped-shut herbarium cabinet for many years.
- Emeritus professor Ray Holton semi-regularly checks for the occurrence of *Boldia* by the Burnt Mill Bridge in Scott County, TN but has not collected any in a few years.
- Collections Manager Margaret Oliver with undergraduate students Rebecca Atkins, Joanna Huntoon, and Ryan Vichich, graduate student Amanda Benoit, and UTK staff member Daniel Siksay visited Rugby and Burnt Mill Bridge, TN on 22 June 2019 to search for, and potentially collect, *Boldia* from the Clear Fork inside Big South Fork National River and Recreation Area.
- Due to heavy rainfall over the previous days the river ended up being too high to find any of the algae, but we did get a chance to hike several trails and to botanize widely in the field.



Hiwassee River

Reliance, Polk County, TN

15-17 August and 28 September 2019

Summary:

- *Isoetes tennesseensis* (Tennessee or Hiwassee quillwort) is a 'fern ally' that is listed as endangered in the state of Tennessee and has a historic distribution that includes the Little Tennessee, Monroe Co. and Hiwassee River, Polk Co.
 - It has not been observed in the Little Tennessee River since the Tellico Dam was finished in 1979.
 - The last known collections were from the type locality in the Hiwassee River near Reliance, TN in 2001.
- Two trips to Reliance, TN were made towards the end of the summer of 2019:
 - 15-17 August – Herbarium Director Jessica Budke, Collections Manager Margaret Oliver, undergraduate students Joanna Huntoon and Helen Law, and herbarium volunteer Lynne Davis.
 - 28 September – Jessica Budke, Margaret Oliver, and undergraduate students Anna Raney and Ryan Vichich.
- Over both trips we surveyed almost five miles of the Hiwassee River and found 87 individuals of *I. tennesseensis* at various life stages.
 - We collected two voucher specimens, which are now deposited at TENN.
- We made a brief trip to the historical sites in the Little Tennessee River:
 - One is no longer easily accessible due to the construction of a gated community and a boat would be necessary to access the site.
 - The second location is near a public boat ramp, but the water now appears to be too deep due to the impoundment of the Tellico Lake.
- Plans are being made to visit a potential site on the Little Tennessee River again at the end of the summer of 2020.

