Faculty & Student Research
2016-2017

MATTHAEI BOTANICAL GARDENS
AND NICHOLS ARBORETUM
UNIVERSITY OF MICHIGAN

caring for nature,
enriching life

Matthaei Bottanical Gardens
1800 N. Dixboro Rd.
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Nichols Arboretum
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Ann Arbor 48109

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On the cover: (foreground) Ines Ibanez, Associate Professor, University of Michigan School for Environment and Sustainability; (back) undergraduate student Leslie Hamar.

The Key Role of Research at Matthaei-Nichols

We are delighted to share this catalog of recent scholarship at or with Matthaei Botanical Gardens and Nichols Arboretum with you. Supporting research and creative work has been central to our mission since our founding in 1907, and we serve as a unique bridge between the University's academic community and the general public.

As you will see from the entries, current scholarship reflects wide-ranging themes including more traditional work in plant biology and plant-environment interactions to applications in sustainable systems and ecological restoration/ management. We also delight in providing venues for testing and showcasing creative ideas in architectural construction and musical or theatrical production. This year, we have been working collaboratively with other units at the University of Michigan (the Biostation, School for Environment and Sustainability, E.S. George Reserve) to create a common digital platform for recording work (both historic and current) on our properties, and you'll likely hear more about that in the near future.

We also delight in sharing research findings with the general public through free lectures with many of our partner community-based organizations, through public workshops, or through displays and special exhibits.

This guide shares a mere sampling of research and creative work conducted during 2016-2017. I hope you enjoy reading about these projects as much as I have. We want to thank all the scholars who have worked with us this past year and look forward to working with any of you who'd like to contact us about work in the future.

Robert E. Grese, Director

Robert E. Grese

Our Mission:

Developing leaders and inspiring people to care about nature and enrich life on earth.

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Research Projects

Project Title: Aquaponics Basic Research, Extension, and Demonstration (AquaBREAD).

Investigator: Jose Alfaro, Assistant Professor of Practice, School for Environment and Sustainability.

Abstract: This project will determine the sustainability and productivity of aquaponic systems focusing on the water and carbon footprints of food produced. The project will also create and demonstrate an outreach product for rural and peri-urban stakeholders.

Project Title: Michigan Aquaponics Beta Prototype Project.

Investigator: Michigan Aquaponics.

Faculty Advisor: Jose Alfaro, Assistant Professor of Practice, School for Environment and Sustainability.

Abstract: Michigan Aquaponics has been working in Greenhouse 4 of the Matthaei Botanical Gardens for over a year in constructing and beginning to cycle our largest aquaponics system to date: the Beta Prototype. Aquaponics is a sustainable agricultural method where aquatic species and plants are grown together in a recirculating water system. No soil is used in aquaponics; instead waste products from the aquatic animals in the fish tank are converted by natural bacterial cycles into usable nutrients for the plants to consume. The plants in turn, filter out these waste products and the water is recycled back into the fish tank where the process begins again.

Michigan Aquaponics has constructed a floating raft aquaponics system to explore the potential of aquaponics further. The system features a converted IBC tank into a 220-gallon fish tank where the organization plans to rear 30-35 Blue Tilapia. The system then flows into a 20-gallon mechanical particulate filter and a 1520-gallon bio-filter where bio-balls are used to increase livable surface area for bacteria. Finally, water flows into the plant bed, where water of depth 8-12 inches is maintained, growing 67 plants. Our initial plan is to grow iceberg lettuce. The system is built in a

way that it could be expanded, adding an additional plant bed and fish tank. For now, however, research will be conducted on the system at the current size.

The organization plans to conduct research in three main areas all while tracking the environmental footprint of the system. First, is it possible to grow plants in the system by artificially adding ammonia without fish, in a modified hydroponics setup? Second, how the Blue Tilapia grows in compared to literature when fed a protein rich bug, specifically the Black Soldier Fly Larvae? Third, can the organization make measurements essential to aquaponics using only remote sensors without the need for a manual labor force making these measurements?

As Michigan Aquaponics is currently pursuing a sight designation for our site under the ACUO Protocols, this is going to take some time. So until then, we plan on researching how our system can grow lettuce without the fish present. Instead, we will put 2 teaspoons of liquid ammonia into the fish tank every day to simulate the waste product of the fish. Then, we will observe and collect necessary data on the system when growing the plants. We will thus run the system as a fishless cycling aquaponics system until we are approved to rear fish in Matthaei Botanical Gardens.

Once we are approved to raise fish in our system, we will order fingerlings from White Brook Tilapia Farm and start to feed them the Black Soldier Fly Larvae. We hope to research the effects of this protein and fat rich aquaculture feed on the growth and health of the tilapia. The Black Soldier Fly Larvae that we will feed to the tilapia will come from the company Kulisha. Kulisha, a U of M startup, works at the Botanical Gardens, so we hope to have more than enough feed for the tilapia to live a happy and healthy life.

Throughout this entire process, some of the engineers on our team will be designing, developing, and testing a prototype to automatically record relevant data from the system and send that data to our data tracking files, most likely housed on our organization's Google Drive folder. Conclusions drawn from these three investigations will hopefully lead to greater success in future endeavors for MAqua.

Research Projects

Project Title: Spatial genetics of an agricultural weed: Use of next generation sequencing to explore levels of population connectivity in common morning glory (*Ipomoea purpurea*).

Investigator: Diego F. Alvarado-Serrano, Postdoctoral Researcher Fellow, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Faculty Advisor: Regina S. Baucom, Assistant Professor, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: The spread of herbicide resistance is an increasing concern for agriculture, yet its underlying causes remain inadequately understood. In particular, how population connectivity contributes to the spread and evolution of resistance remains an open question. The main goal of this project is to address this question by assessing patterns of inter-population migration via pollen and seed movement through the combination of GIS and genetic analyses. The project is focused on the common morning glory, a problematic crop weed of economic importance, which offers excellent opportunities to study the interaction between evolutionary forces, landscape features, and agricultural management practices.

Project Title: Investigating species-specific hydraulic traits using stable water isotopes.

Investigator: Phoebe Aron, Graduate Student Research Assistant and Graduate Student Instructor, Department of Earth and Environmental Sciences, College of Literature, Science, and the Arts.

Faculty Advisor: Chris Poulsen, Professor, Department of Earth and Environmental Sciences, College of Literature, Science, and the Arts and Department of Climate and Space Sciences and Engineering, College of Engineering.

Research Projects

Abstract: Stable water isotopes are useful tracers of physical hydrologic processes since phase changes preferentially partition mole cules with the heavy isotopes of water (18O and 2H or D) into the liquid phase and molecules with the light isotopes of water (16O and 1H) into the vapor phase. In this way, the isotopic composition of water contains a record of water transport through time. We use stable water isotopes to study hydraulic strategies along the soil-plant-atmosphere continuum to understand how different plants use water. Specifically, we measure the isotopic composition of transpired vapor and soil, stem, and leaf waters. At MGBNA we characterize diurnal hydrologic cycling of *Citrus paradisi.* The methods and insights gained from this initial study will be used to guide a large-scale project characterizing species-specific hydraulic strategies of dominant trees at the University of Michigan Biologi cal Station in northern lower Michigan.

Project Title: Population genetics of native Michigan snakes along an urban-rural gradient.

Investigator: Jeff Bartman, MS Student, Biology Department, Eastern Michigan University.

Faculty Advisor: Katy Greenwald, Associate Professor, Biology Department, Eastern Michigan University.

Abstract: The goal of our study is to investigate the effect that urbanization has on the demography and population genetic structure of native snake species in Michigan. In the modern world, urbanization is always on the rise and wildlife is constantly having to confront these changes. However, few studies have addressed the affects that urbanized environments have on wildlife, and none to our knowledge have studied how urbanization affects snakes. Snakes are integral parts of ecosystems because of the predatory function they play within their habitats, but often are left understudied because of their cryptic and reclusive behavior. Also, snakes and herpetofauna, in general, are considered to be at high risk of extinction which makes their study of paramount concern. Washt

enaw County provides an excellent study system for this research. Matthaei Botanical Gardens would be an excellent area for sampling snake populations along an urban-rural gradient. In addition, within Ann Arbor and the surrounding areas there are plenty of urban and rural areas where the same species can be sampled (see map below) to compare populations along an urban-rural gradient. Methods: To study urbanization and snake population structure we plan to place artificial cover objects (ACOs) such as plywood or sheets of tin in areas considered to be optimal snake habitat in urban and rural environments. We plan to check all ACOs at least once a week. Snakes encountered at ACOs will be captured for data collection. Data collection will include species determination, sexing snakes, measuring length and weight, estimating age, swabbing snakes for snake fungal disease, and collection of a genetic sample. Genetic samples will either be in the form of approximately 200-400 µl of blood drawn from the caudal vein or a scale clipping when necessary. All snakes will be permanently marked with a Passive Integrated Transponder (PIT) tag for individual identification. PIT tags are injected using a standard 12-gauge syringe. All data collection will occur at snake capture location, and all snakes will be released immediately thereafter. With this data we will be able to conduct assignment tests that allow us to detect any possible population clustering or isolation along our urban-rural gradient. This will allow us to determine whether urbanization is having a negative impact on native snake species in Southeast Michigan.

Project Title: The evolution of herbicide resistance in the common morning glory.

Investigator: Regina S. Baucom, Assistant Professor, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: The repeated evolution of herbicide resistance among separate populations of a weed provides both a unique opportunity to address the mechanisms of evolutionary repeatability as well as a significant challenge to weed control efforts. To determine if the re-

peated evolution of resistance is a result of genomic constraints or a response to similar regimes of selection, it is crucial that the genetic basis of resistance, the potential for contemporary gene flow between populations, and the influence of local adaptation of resis -tant lineages be examined in concert. Such information is also vital for designing useful control regimes. Here, we propose to empirically assess the genetic and ecological mechanisms underlying the repeated evolution of RoundUp resistance across populations of the noxious crop weed *Ipomoea purpurea* (common morning glory). In light of our focus, this work is directly applicable to the 'Controlling Weedy and Invasive Plant Species' program area priority.
The specific objectives outlined in this proposal are to: 1) Utilize the tools of landscape genetics to visualize and interpret contemporary and historical gene flow between populations of this species located in the southeastern and Midwest US, 2) Assess the genetic basis of resistance across widely separate populations using a QTL mapping and candidate locus approach, and 3) Examine the extent of local adaptation of resistant lineages by performing a reciprocal transplant study. The complementary aims proposed herein address the long-standing and important evolutionary debate about the predictability of the evolutionary process while simultaneously providing crucial information for applied control efforts.

Project Title: Leaf shape variation in sweet potatoes and *Ipomoea purpurea*, a diploid relative.

Investigator: Regina S. Baucom, Assistant Professor, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: Leaf shape, a highly dynamic and variable plant trait, has captured the interest of botanists and evolutionary biologists alike for more than a hundred years. Although its functional significance is unknown, data from many species support the idea that leaf shape variation may be an adaptation to water supply trade-offs. Varieties of sweet potato (*Ipomoea batatas*) exhibit remarkable and as-yet relatively unexplored variation in leaf shape, with accessions ranging from highly lobed to circular with no lobing. Recently dis

covered relationships between leaf shape traits and tuber biomass suggests that selective breeding for leaf shape could provide a novel path to sweet potato improvement, especially since key eco-physiological parameters likewise vary with yield and are themselves directly related to leaf shape traits. In this project, the Co-PIs will investigate both the genomic basis of leaf shape traits in sweet potato and the influence of leaf shape variation on crop yield and quality across variable environments. The research involves three interrelated components: (1) the identification of eco-physiological, phenotypic, nutrient-related, and associated transcriptomic differences underlying leaf shape variation in sweet potato accessions along with an assessment of how these relationships change across variable common gardens; (2) QTL mapping of the genetic basis of leaf shape in the closely related diploid *I. trifida*; and (3) the development of an Associative Transcriptomics pipeline and a series of comparative analyses with the diploid relative to associate leaf shape phenotypes in sweet potato with their genomic basis.

Project Title: *Ipomoea trifida* crosses.

Investigator: Regina S. Baucom, Assistant Professor, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: Leaf shape varies dramatically in *Ipomoea batatas*, or the sweet potato. There is currently very little known about the functional influence of leaf shape on sweet potato yield. As such, we are developing the sweet potato's progenitor, *Ipomoea trifida*, as a model organism to understand the genetics of leaf shape variation.

Project Title: How does soil structure and microclimate affect earthworm abundance?

Investigators: Sindhu Bharadwaj, Yuanqiu Feng, and Taylor Landeryou, MS Students, School of Natural Resources and Environment.

Research Projects

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: We will be going to the site of a previous experiment conducted over the summer (map on page 3) and assessing different weed control methods on the campus farm. Of the six total plots, we have selected the three that had the fewest weeds, along with a control, to conduct our experiment. We will be measuring earthworm abundance and diversity at three points on each of the four plots in order to understand the long-term impacts of different microclimates and soil structure in the area.

Project Title: Identifying functional traits of summer cover crops that predict ecosystem services on farms.

Investigators: Jennifer Blesh, Assistant Professor, School for Environment and Sustainability.

Jeremy Moghtader, Campus Farm Program Manager, Matthaei Botanical Gardens and Nichols Arboretum.

Abstract: In vegetable crop rotations, summer cover crops are often an economically feasible option for farmers to increase plant diversity within agroecosystems. This project will be led by Jennifer Blesh, and involves project collaborator, Jeremy Moghtader, one PitE honor's thesis student, and an SNRE PhD student to address questions about plant functional trait diversity of summer cover crops.

The research will focus on ecosystem services important to farmers such as biological nitrogen fixation by legumes, nitrogen retention, weed suppression, and pollination. Summer cover crop treatments will be planted in a randomized complete block design of mixtures and monocultures. We will identify above- and below-ground plant functional traits, and interspecific interactions in mixtures, that predict particular ecosystem functions. Legume cover crops will include cowpea, chickling vetch, and sunn hemp, and these species will be mixed with other plant functional types

like grasses (e.g., oat) and an herbaceous species (buckwheat), which is one of the most common summer cover crops in Michigan. A common Michigan fall vegetable crop, such as broccoli, kale or chard will follow the summer cover crop so we can test impacts of the different cover crop treatments on crop yield, nutrient content, weed suppression,and nitrogen cycling processes. Soil samples were collected in late April, and soil preparation will start early May. This experiment will be planted by June 15, 2017, with cover crop termi nation August 1st - 15th, followed by fall vegetable crop planting August 15th - 30th, with crop harvest mid-October 2017.

Project Title: A comparative study on seasonal bird feeder use: Urban vs natural environments.

Investigator: Genevieve Brown, B.S. Student, Department of Ecol ogy and Evolutionary Biology and Anthropology, College of Literature, Science, and the Arts.

Faculty Advisor: Lynn Carpenter, Lecturer IV, Department of Ecology and Evolutionary Biology and Department of Molecular, Cellular, and Developmental Biology, College of Literature, Science, and the Arts.

Abstract: Two sites will be used to investigate the proposed topic. One off campus site in Nichol's Arboretum and one on campus site; each will have three bird feeders. The feeders will be refilled with seed every other day, and observations will be made at each site once per week.

Project Title: Solar dehydrator testing.

Investigator: Megan Bushlow, Research Assistant, Department of Civil and Environmental Engineering at U of M.

Faculty Advisor: Steven Skerlos, Associate Professor, Department of Civil and Environmental Engineering.

Research Projects

Abstract: The BLUElab Hagley Gap team works with community members and a non-profit organization in Hagley Gap, Jamaica to design and implement sustainable technologies for the community. Over the past several months, our team has developed a design for a solar dehydrator that can be used to preserve fruits. The need for this technology was identified during a trip to the community during August of 2014, when the travelers learned of the large surplus of fruits such as mangoes that go to waste each year. The solar dehydrator includes a chute component that intakes and heats air and an enclosed tower component through which the air is directed to dry pieces of fruit. The majority of the structure is composed of plywood, but the bottom of the chute component is covered in aluminum to absorb sunlight and the top of the chute is plexiglass. Airflow is primarily driven by natural convection. The air is directed through the chute by wooden baffles to increase the heating time of each parcel of air. The air then flows into the bottom of the tower through three PVC pipes and rises to the top of the tower, passing over trays of fruit, as it exits the tower through ventilation holes. In order to successfully dry the fruit, the tower component must reach a temperature of about 120°F. If this temperature is reached, a single batch of mangoes can be dried over the course of a day. The purpose of the prototype testing is to determine whether or not the current design achieves the required internal temperature and desired airflow. Testing will be conducted by placing mangoes in the dehydrator and leaving the device with the absorption panel facing the sun. Temperature measurements will be taken inside the chute and tower at regular time intervals. Additionally, the percent moisture removal from the mangoes will be measured after one batch is completed.

Project Title: 509 Independent Project.

Investigator: Stephanie Campbell, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Research Projects

Abstract: I will be comparing insect abundance and diversity be tween standing and downed logs by removing a small piece of bark from each sample (~20 samples) over one afternoon.

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Project Title: Do the wood chips contain invasive seeds?

Investigators: Yu-Han Cheng, Ho Hsieh, MS Students, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: Test if the wood chips contain significant amount of invasive seeds. We expect that the differences of percentage cover of invasive plants of near and of far from the wood chips road would be higher than where it doesn't use wood chips.

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Project Title: 462 Final Project for Instrumentation for Atmospheric and Space Sciences (AOSS 462).

Investigator: Nathaniel Clark, BS Student, Department of Climate and Space Sciences Engineering, College of Engineering.

Faculty Advisor: Roger De Roo, Associate Research Scientist and Lecturer IV, Department of Climate and Space Sciences Engineering, College of Engineering.

Abstract: This project will use 10 model DS1921G iButtons to measure temperatures at different outdoor elevations in the botanical gardens. The purpose of these measurements is to measure the temperature gradient with elevation over the course of two days. This will help determine lapse rates, the presence of nighttime temperature inversions, and atmospheric stability in Ann Arbor.

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Research Projects

Project Title: Investigating intraindividual variation and mutation in an apple tree.

Investigator: James Cohen, Assistant Professor, Department of Applied Biology, Kettering University.

Abstract: In plants, genetic diversity can arise because the same type of organ can develop independently and at different times during the lifetime of a plant due to the modular nature of plant growth. This intraindividual genetic variation can influence 1) the diversity of gametes (sperm and egg) and offspring (seeds and spores) from a plant, 2) herbivore and pathogen resistance within a plant, and 3) environmental adaptation in different parts of a plant. Despite the utility in crop production and selection, genomic intraindividual variation within a single plant has yet to be quantified. Therefore, the proposed project is an investigation of intraindividual variation within an apple tree through deep sequencing across the genome and the development of a statistical model of cell mutation accumulation throughout the organism. DNA from leaves and from flowers will be isolated and then sequenced using Genotyping-by- Sequencing to identify single nucleotide polymorphisms throughout the apple tree. Additionally, pollen viability will be assessed to investigate fitness as it relates to mutation accumulation, and cell divisions throughout the tree will be estimated through examination of anatomical sections of branches. This data will be used to develop a model of intraindividual evolution throughout tree growth. From the proposed project, two manuscripts and con ference presentations will be produced based on quantitative and model-based aspects of intraindividual variation within a plant, and external funding will be sought for further studies on genetic variation and mutation rate within plants.

Research Projects

Project Title: Is ecological displacement a driving force in the evolution of root morphologies of invasive weed species? (Field Experiment)

Investigator: Sara M. Colom, Ph.D. Candidate, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Faculty Advisor: Regina S. Baucom, Assistant, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: Invasive plants disrupt natural community dynamics and threaten local biodiversity and have been estimated to cause over 36 billion dollars in economic losses in the United States per year. Thus, understanding the mechanisms that underlie their ability to adapt and thrive in new areas is key to developing strategies for invasive plant control. Here we will explore the concept of character displacement of root traits as a potential mechanism for explaining co-existence and geographic distribution of *Ipomoea hederacea* (native) and its close relative and weed species, *I. purpurea* (invader). The study will consist of a field experiment where fifteen maternal lines of *I. hederacea* and *I. purpurea*, respectively, will be planted 'alone' (control) or in pairs (competition), and each treatment replicated six times for an approximately total of 1500 plants. Plant measurements such as height, leaf number, flower number, seed set, and biomass will be recorded for all individuals. And two weeks after flowering, a subset of individuals growing 'alone' and in 'competition' will be excavated to collect and phenotype their root traits. Mixed model ANOVA will be performed to determine how root traits vary between species and maternal line within species and a linear regression will be performed between root trait similarity of competing individuals and fitness measurement (e.g. flower number, seed set, biomass). Root traits that vary significantly in their maternal line indicate that those root traits are heritable and may thus undergo character displacement, and a negative relation ship between phenotypic similarity between competing plants and fitness would suggest that selection favors individuals bearing more divergent root traits than their competitor suggesting that character

displacement may represent an important force of natural selection in the root traits in this morning glory weed system.

Project Title: Is ecological displacement a driving force in the evo lution of root morphologies of invasive weed species? (Greenhouse Experiment)

Investigator: Sara M. Colom, Ph.D. Candidate, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Faculty Advisor: Regina S. Baucom, Assistant, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: Invasive plants disrupt natural community dynamics and threaten local biodiversity and have been estimated to cause over 36 billion dollars in economic losses in the United States per year. Thus, understanding the mechanisms that underlie their ability to adapt and thrive in new areas is key to developing strategies for invasive plant control. Here we will explore the concept of ecological displacement of root traits as a potential mechanism for explaining co-existence and geographic distribution of Ipomea hederecea (native) and its close relative and weed species, *I. purpurea* (invader). Our study will consist of a greenhouse rhizotron assay, where individual seeds of *I. hederecea* and *I. purpurea*, from ten maternal lines per species from a total of ten populations, will be grown in rhizotrons for both *I. hederecea* and *I. purpurea*. Then root growth will be monitored, recorded, analyzed and compared to address whether or not there is evidence that root traits have evolved in populations where these two species occur together versus popula tions where they grow alone.

Project Title: How does forest type effect fungi diversity and abundance?

Research Projects

Investigators: Nicolas Curotto and Chuying Lu, MS Students, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: If fungi diversity and abundance is dependent on multiple variables like substrate acidity, nutrient availability, and moisture and light availability, then the abundance of fungi fruiting bodies and the number of species of fungi in oak-hickory dominated forest will be higher than in hemlock dominating and white pine dominating forest.

Project Title: Investigation of the effects of plasma treatment of soybean seed's physiology and development.

Investigators: Kenneth Engeling, Ph.D. Student, Graduate Student Research Assistant, Department of Nuclear Engineering and Radiological Science, College of Engineering.

Victoria Fritz, B.S. Student, Department of Cellular and Molecular Biology, College of Literature, Science, and the Arts.

Faculty Advisors: John Foster, Professor, Department of Nuclear Engineering and Radiological Sciences, College of Engineering.

Cora MacAlister, Assistant Professor, Department of Molecular, Cellular and Developmental Biology, College of Literature, Science, and the Arts.

Abstract: Up until recently ROS and RNS in plants were thought to be exclusively harmful and result in impeding effects on plant's growth and development. More recent findings however, have found that ROS plays a beneficial role in somatic embryogenesis (development and proliferation of new body cells), organism response to wounding, programmed cell death, pathogen defense, and root gravitropism.

Research Projects

Plants generate ROS through metabolic processes (Oxidative phosphorylation, Beta oxidation of fatty acids, Citric Acid Cycle, and Glyoxylate Cycle to name a few important ones). The accumulation of these ROS have recently been linked to playing a role in shifting dormant seeds to non-dormant. Dormant seeds have low levels of ROS that appears to be correlated with higher levels of Abscisic Acid, a plant hormone that is present during seed dormancy. In contrast, non-dormant seeds have higher levels of ROS and appear to contain more of the plant hormone Gibberellin, a hormone involved in plant germination. This is one example of the influence of ROS on plant cellular signaling. Additionally, ROS are only recently being recognized as influencing regulatory mechanisms of up and down regulation of RNA transcripts. Cellular signaling controls this regulation and the regulation of more or less transcripts being produced for a particular gene, results in differential protein production and ultimately organisms that have different physical characteristics. In addition to up and down regulation there is evidence in the model organism *Arabadopsis* that cellular signaling plays a role in alternative splicing which adds to multiple transcripts from the same gene. Effects of modification to regulatory transcripts would be carried throughout the development and life time of the organism. This is because if you change transcripts you change the protein produced, and ultimately, the protein's function.

Our plasma treatment would be an abiotic stress resulting in the message being picked up by receptors on the cell's surface and inducing an intrinsic signaling cascade. It is possible that a correlation between densities of species produced in a plasma reactor could eventually be correlated to a predicted phenotypic outcome (what the plant will look like). If this is true, it is relatable to the defined influences of specific ROS becoming more and more documented. Based on the understanding of the effects on up and down regulation of transcription factors and ROS being known to be associated to gene expression, research should be performed on the hypothesis that differential transcript concentrations will be pre senting parts of the treated organism that have a differing physiological appearance when compared to the control organism.

Research Projects

Project Title: Survivorship of food producing trees as a function of distance from pre-existing trees.

Investigator: Julia Entwistle, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: An analysis of the survivorship of food-producing trees within an agroforestry system paired with their distance from pre-existing, mature tree species of the Campus Food Forest.

Project Title: Impact of edge proximity on micro-agriculture yields.

Investigator: Zach Friedman, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: We are examining the impact of a crop's proximity to a field edge on the yield of said crop. We will segment bean rows into quadrants using flags and harvest the beans to analyze differences in weight for each quadrant.

Project Title: Effects of multiple urban stressors (sedimentation and zinc) on benthic macroinvertebrates under different groundwater/hyporheic upwelling conditions.

Investigator: Anna Harrison, Ph.D. Candidate, School of Natural Resources and Environment.

Faculty Advisor: Allen Burton, Professor, School for Environment and Sustainability, and Professor, Department of Earth and Environmental Science.

Abstract: Zinc toxicity in sediments is well documented. However, little research has examined the role of groundwater and hyporheic flows on the effects of metals to benthic macroinvertebrates, particularly in a controlled mesocosm experiment. This research assesses the effects of zinc contaminated sediments on invertebrate (Daph nia magna and Hyalella azteca) survival, growth and reproduction under two hyporheic conditions (upwelling vs. limited hyporheic flows). The implications of this research could be particularly useful for assessments of streams impacted by mining operations (Nimick et al. 2005, Crouch et al. 2013) and in urban streams that receive large amounts of stormwater runoff, which is often highly dissolved zinc (Kayhanian et al. 2008). This study will help to better understand how hyporheic flows influence metal toxicity, which is often dependent on the redox conditions of the sediments and thus likely influenced by interactions with hyporheic flows (Benner et al. 1995, Gandy et al. 2007). The experimental flume mesocosms provide both improved determination of fine-scale exposure-effect relationships, and control of both surface and pore water dynamics. The flume experiments are designed in triplicate, with three replicated flume experiments per treatment combination (12 flume mesocosms total). The first factor, hyporheic flow, has two treatments: upwelling and limited hyporheic flow. The second factor to assess is the presence of metal contaminated sediments (collected from field-contaminated sites). Contaminated sediments are contained within mesh baskets, surrounded by reference sediments and con tained within the flume mesocosms (Burton et al. 2005). Test organisms will be exposed during seven to ten day long experiments. To complement the flume experiments, I will also deploy both field zinc-contaminated sediments from Little Black Creek (43.185836 N, -86.245764 W) and reference sediments into Fleming Creek (42.298757 N, -83.660428 W), adjacent to the flume experiments, in contained baskets to minimize zinc exposure to natural Fleming Creek sediments. Stream sites will be selected that have variable hyporheic flow conditions (established during Fall 2014 experiments), assess impacts of hyporheic upwelling on benthic macroinvertebrate colonization. Colonization trays will be deployed to

assess impacts to benthic invertebrate community composition (Nguyen et al. 2010, Costello et al. 2011). Sediment deployment will last 4 weeks, at which time I will assess the community composition of the sediment baskets and characterize the sediment.

Project Title: Time series of Michigan squamate microbiomes.

Investigator: Iris Holmes, Ph.D. Candidate, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Faculty Advisors: Alison Davis Rabosky, Assistant Professor and Assistant Curator, Department of Ecology and Evolutionary Biology and Museum of Zoology, College of Literature, Science, and the Arts.

Dan Rabosky: Assistant Professor and Assistant Curator, Department of Ecology and Evolutionary Biology and Museum of Zoolo gy, College of Literature, Science, and the Arts.

Abstract: I am looking at the gut microbiome of squamate reptiles across a range of sites. One of the central problems with microbiome studies is that the abundances of microbial taxa can vary widely throughout an individual's life. In order to understand the magnitude of this variability and the ontogeny of the squamate microbiome, it is very necessary to track individual squamates and repeatedly sample their microbiota.

Project Title: Investigating the effects of galling on goldenrod.

Investigator: Mike Ilardi, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Joe Arvai, Max McGraw Professor of Sustainable Enterprise, School for Environment and Sustainability.

Research Projects

Abstract: I will explore the effects that galling (via gallflies) has on prairie goldenrod by measuring the heights and assessing the biomasses of infected and noninfected plants.

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Project Title: The difference of insect abundance between urban areas and forested areas.

Investigators: Lingzi Liu and Emily Nummer, MS Students, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: According to the number of herbivory types and damage area per leaf on different leaves collected from two conditions, we can know which area supported more insects.

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Project Title: Land Plant Phylogeny.

Investigator: Yin-Long Qiu, Associate Professor, Department of Ecology and Evolutionary Biology and Associate Curator, Herbarium, College of Literature, Science, and the Arts.

Abstract: We attempt to establish a temporal evolutionary framework of land plants through conducting a maximum likelihood phylogenetic analysis and a set of fossil-calibrated molecular clock analyses of two data sets. One includes 616 species, covering 70% of all 675 families of land plants, and five gene genes (cp-atpB, cp-rbcL, mt-atp1, mt-nad5, and nu-18S). The other samples nearly all 136 orders and most of the genes in both chloroplast and mitochondrial genomes. In the molecular clock analyses, different topological arrangements of basal land plant lineages, basal monilophyte lineages, angiosperm-gymnosperm relationships, and mesangiosperm lineages will be experimented. Furthermore, vari ous combinations of rate, substitution, and speciation models will be explored. Finally, different sets of fossil calibration points will be

used. All these experiments will allow assessment of robustness of the results, which have been difficult to obtain in molecular clock studies because of uncertainty in data quality and methodological limitations. Establishment of a robust temporal evolutionary framework of land plants will help integrate molecular systematics, paleobotany, morphology, and evolutionary genomics and developmental biology and help us gain a profound understanding of evolutionary history of land plants. Most of the DNA samples needed for this project are already available in our lab, but new materials for rare plant families, especially those from South Africa, have been acquired recently or are still being acquired. They are all grown at the Matthaei Botanical Garden.

Project Title: Robotic Exoskeletons for Gait Rehabilitation.

Investigators: Mhairi K. MacLean, BSE Student, Department of Biomedical Engineering, College of Engineering.

Faculty Advisors: Daniel Ferris, Professor, School of Kinesiology and Department of Biomedical Engineering, College of Engineering.

Research Engineer: Bryan Schlink, Research Technician, Department of Biomedical Engineering, College of Engineering.

Abstract: In recent years, there has been an increasing interest in the development of robotic exoskeletons for both gait augmentation and rehabilitation. The goal of many of these devices is to make walking easier, which is often characterized by a decrease in the metabolic cost of walking. The K-SRD™ (by b-temia) is one such human augmentation device. We aim to determine whether, and to what extent, the use of this device reduces the energetic cost of different gait conditions with and without a 40lb backpack. We will also evaluate the effect of the device on the muscular activity of the lower limbs. We will find the rate of Oxygen consumption for each condition to determine the effect on energy cost. Trials will include treadmill walking, incline walking, stair climbing, and outdoor walking. Conditions will include wearing the exoskeleton, not

wearing the exoskeleton, wearing the exoskeleton with a 40lb backpack, and wearing a 40lb backpack but no exoskeleton.

Project Title: Communicating from below: Can microbial symbionts below ground alter plant smells above ground?

Investigator: Amanda Meier, Ph.D. Candidate, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Faculty Advisor: Mark Hunter, Earl E. Werner Distinguished University Professor, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: Belowground microbes can have far-reaching effects on aboveground multitrophic interactions. Microbial symbionts that associate with roots belowground, such as arbuscular mycorrhizal fungi (AMF), are ubiquitous in terrestrial ecosystems and associate with the majority of plants. By improving plant nutrient uptake and interacting with plant signaling pathways, AMF can alter plant defensive traits, affecting interactions among plants, herbivores, and their natural enemies. For example, AMF can alter the volatile organic compounds (VOCs) constitutively emitted by plants and induced by herbivores, influencing the ability of herbivores to locate host plants and natural enemies to find herbivores. Despite the prevalence of AMF-plant symbioses belowground, little research has addressed how AMF may shape aboveground multitrophic species interactions through altering plant volatile profiles. Therefore, I propose to analyze how AMF communities may indirectly influence insect herbivores and their natural enemies by altering plant VOC emissions. Using two North American milkweed species, their specialist aphid herbivore, and a community of ubiquitous AMF species, I will test the hypothesis that AMF differentially alter the concentration and blend of VOCs produced constitutively and in response to aphid feeding across plant species. I will correlate specific AMF-mediated changes in VOC emissions with rates of aphid colonization and natural enemy recruitment that I recorded

in the field at the Matthaei Botanical Gardens in the summer of 2015. This proposed research will help elucidate the mechanisms by which microbial symbionts belowground may shape multi-trophic interactions aboveground. Also, because most plants are colonized by AMF, this work will also add to a more comprehensive theory of plant defense. In addition, my proposed research has applications in agriculture and forestry. For instance, we may be able to account for and manipulate the presence of particular AMF taxa to improve pest management, while increasing nutrient uptake and stress tolerance of crop plants.

Project Title: Linking functional traits in the redwood family: past and present.

Investigator: Molly Ng, Ph.D. Student, Department of Earth and Environmental Sciences, College of Literature, Science, and the Arts.

Faculty Advisor: Selena Y. Smith, Assistant Professor, Department of Earth and Environmental Sciences and Program in the Environment, College of Literature, Science, and the Arts.

Abstract: Cupressaceae (the cypress and redwood family) are the largest, most diverse conifer group today, found in a wide range of habitats from the arctic to hot, arid regions, and highly valued as ornamentals. The fossil record of Cupressaceae extends back to ca. 200 million years (Ma) ago. 1) And shows species distributions have expanded and contracted through time. 2) As climate changed over the Cenozoic (the last 66 Ma) from a warm, wet world to relatively cooler and drier climate, physiological shifts in drought tolerance are thought to have been a key adaptation in Cupressaceae as climates cooled and species shifted into new biomes. Three species have adapted to new biomes over time, and while their morphology has not changed, it is unclear how physiological and anatomical (PA) traits have responded to these ecological shifts. In order to understand the link between PA traits and environment, understanding variation within living species is necessary.

Research Projects

This research aims to determine how functional traits vary within and between Sequoia sempervirens and *Taxodium* ditichum (Cupressaceae) with respect to environmental gradients. With precipitation forecasted to increase in some areas and become drier in others as the global temperature warms, 4) connecting physiologi cal data from these species of Cupressaceae to their respective environments is more important than ever in order to understand their potential response and conservation concern. Data collected can then be used to understand how these species will respond to projected changes in precipitation and temperature. These species are hypothesized to have varying anatomy and physiology in response to an environmental gradient.

Project Title: Started from the bottom: Measuring herbivory on different farming techniques.

Investigator: Priscila Papias, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: We are completing a class research project that investigates the amount of herbivory that particular crops face. We intend on collecting this data by measuring the herbivory on the leaves of different crops. Our research team is made of three people and we will all be collecting data on herbivory.

Project Title: Comparing herbivory on interplanted crop rows.

Investigators: Michael Reiner and Danielle Wilkins, MS Students, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Research Projects

Abstract: We are comparing the herbivory between the rows of kale and broccoli. We will be looking at number of leaves that experience herbivory as well as average percent leaf herbivory.

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Project Title: Pollinator loyalty: A comparison of domesticated and native bees.

Investigator: April Richards, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: I will be comparing pollinator loyalty of domesticated honey bees and native bees. This is determined by observing the flower choice of individual bees.

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Project Title: Does density of honeysuckle affect herbivory levels?

Investigator: Syne Salem, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: We wish to test the resource concentration hypothesis, which states that the more of a particular resource in an area, the higher the levels of herbivory on it. We will specifically be looking at 5x5 meter ranges of plants in the Arboretum, estimating the amount of honeysuckle, and measuring herbivory levels on them.

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Project Title: Prioritizing plant selection of green roofs for meeting unique community needs.

Research Projects

Investigator: Lino Sanchez Siegel, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Tony Reames, Assistant Professor, School for Environment and Sustainability.

Abstract: The benefits of green roofs are commonly known, and have proven to be helpful in keeping buildings cool in the summer and warm in the winter, reducing storm water runoff, and providing habitat for local fauna. However, green roofs are generally communicated as a one size-fits-all solution to each of these issues, which disregards the unique properties of plants to carry out different services at various levels of effectiveness. There is little literature on the specific effects of individual plant selection and their unique strengths and weaknesses towards addressing certain building and environmental issues. For instance, one community might need a green roof to solve flooding issues, while another community might seek a green roof to address energy justice issues concerning heating and cooling expenditure. While a single type of green roof can produce multiple ecosystem services, there may be tradeoffs that compromise a building's potential to maximize the service that is most needed. A certain type of grass might be excellent for retaining storm water, yet unimpressive in terms of attracting needed pollinators. This paper argues that green roof plant selection be based on an evaluation of which specific ecosystem services a community is most in need of. Since research has previously been conducted to measure the effectiveness of various types of plants for reducing storm water, insulating buildings, and providing habitat, this paper adds to the literature by methodically breaking down how communities should prioritize green roof plant selection to meet their own unique needs.

Project Title: How does topography – Aspect and Elevation (Direction of slope and elevation) of the Arb affect the nutrient content of the soil?

Research Projects

Investigators: Samhita Shiledar, Anita Lin, Yili Luo, MS Students, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: If topography influences plant communities, then as elevation increases, plant abundance and % area covered per quadrate will decrease. These parameters will also change depending on the aspect of the slope i.e. whether it's north facing or south facing.

Project Title: When do floral additions cease to affect pollinator diversity in urban landscapes?

Investigator: Maria Carolina Simao, Ph.D. Candidate, School of Natural Resources and Environment.

Faculty Advisor: Ivette Perfecto, George Willis Pack Professor, School for Environment and Sustainability.

Abstract: It is well known that flowers provide essential food resources for pollinators, and their availability is a fundamental requirement for sustaining pollinator populations. Studies in agricultural settings indicate that only large plantings of flowers effectively enhance pollinator diversity in an area, but the number, size and effectiveness of flower additions in urban landscapes is poorly studied. To date two studies have addressed this question, with one finding floral additions to be ineffective and the other finding floral additions to be very effective in increasing pollinators in urban landscapes. This study explores a hypothesis that in urban landscapes, floral additions increase pollinator diversity until a saturation point, after which additional flowers no longer affect pollinator populations. To test this, levels of flower additions will be experimentally manipulated in an urban landscape to assess effects on urban pollinator abundance, richness, and diversity. This work is critical for bee conservation in urban contexts, as floral additions remain a primary recommendation for pollinator conservation, but little direct evidence exists on the parameters of its effectiveness in urbanized landscapes.

Research Projects

Project Title: Independent Research: Correlation between plant diversity and insect diversity and abundance.

Investigator: Param Singh, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: Specialist insects prefer to consume specific plants, which means that if there are more types of plants then there will be more types of insects. If this is true, then insect diversity will increase or decrease in direct relationship with plant diversity. Our research will work to check the credibility of the above assertion and/or work to find reasons for deviation, if any.

Project Title: Leaf economic traits in monocots.

Investigator: Selena Smith, Assistant Professor, Department of Earth and Environmental Sciences, and Program in the Environment, College of Literature, Science, and the Arts.

Abstract: Leaf economic traits reflect the function of leaves and various trade-offs between physiology, ecology, and evolution. Leaf economics of monocot flowering plants are understudied and it is not known whether they show the same relationships between traits as dicot flowering plants, which have been extensively stud -ied, or are different.

Project Title: Establishing a long-term study plot within the Nichols Arboretum to assess forest performance under global change.

Research Projects

Investigator: Shaquan Smith, B.S. Student, Program in the Environment, College of Literature, Science, and the Arts.

Faculty Advisors: David Michener, Associate Curator, Matthaei Botanical Gardens and Nichols Arboretum.

Michael Kost, Assistant Curator, Matthaei Botanical Gardens and Nichols Arboretum.

Abstract: We examined tree species composition within a forest stand at Nichols Arboretum to determine the best location to conduct future studies on the full community dynamics of forest performance under global change. The Shannon-Weiner Diversity Index in combination with GIS analysis was used to determine the best location for 100 m x 100 m, long-term forested research plot. Assessments of tree composition within the research plot indicate that if current trends continue, shade-tolerant species such as red maple and Norway maple could replace several native oak species in the future.

Project Title: Seedling emergence and seedling growth test – OECD 208.

Investigator: Max LaBonte, NSF International.

Abstract: The objective of this research is to test plastic material to requirements as set forth in the ASTM Standard D6868-17 and D6400-12. This research determines the phytotoxic effect that compost from plastic decomposition have upon terrestrial seedling germination and growth when compared to compost without any addition of plastic material. A compost derived from plastic decomposition is distributed into growing flats with three replicates of 100 seeds per species. Two seedling species are planted for this Phytotoxicity test: Barley (Hordeum vulgare) and Soybean (Glycine max). A thin layer of potting soil is sprinkled over the top of the flats.

The flats are kept in a temperature controlled greenhouse. They are lightly watered twice daily and rotated once weekly to

ensure equal sun exposure. After two weeks in the greenhouse, final seedling emergence is tallied, mortality is documented, and biomass is measured on a wet/dry basis.

Project Title: Effects of environmental factors on monarch wing shape, symmetry, and flight ability.

Investigator: Abrianna Soule, B.S. Student, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Faculty Advisors: Mark Hunter, Earl E. Werner Distinguished University Professor, Department of Ecology and Evolutionary Biology, College of Literature, Science, and the Arts.

Abstract: Throughout life's history, flight has evolved separately and in various forms on different organisms. The repeated and independent evolution of flight indicates that flying generally increases organism fitness. In fact, flight ability has been shown to positively influence factors such as dispersal, migration and predator avoidance. Flight ability is particularly important in the case of monarch butterflies, which complete an incredible annual migration from southern parts of Canada to central Mexico. Many environmental factors have been shown to affect flight ability, including but not limited to injury, parasitism, food quality, climate, and weather. Food quality in monarchs largely depends on the concentration of cardenolides, toxic steroids, present in their host plant milkweed. Monarchs sequester cardenolides, because they act both as a cardiac-active poison to vertebrate predators and a natural antibiotic to parasitic infection. The monarchs in the study will be fed milkweed species of varying cardenolide concentrations- Asclepias incarnata (low), A. syriaca (med), and A. curassavica (high). This study will enhance our understanding of the separate and interactive effects of cardenolide concentration and other food quality measures on monarch flight ability and, potentially, general fitness.

Research Projects

Project Title: Testing impacts of crop diversification on soil fertility and crop nutritional quality.

Investigators: Anne Elise Stratton, Ph.D. student and NSF Gradu-ate Research Fellow, School of Natural Resources and Environment.

Jennifer Blesh, Assistant Professor, School for Environment and Sustainability.

Abstract: We will study the impacts of intercropping on soil fertility, crop yields, and food crop nutritional quality at the University of Michigan (UM) Campus Farm at the Matthaei Bottanical Gardens. Intercropping offers increased crop diversity and ecological complexity compared to conventional monocultures. Legume inter crops, specifically, have the potential to impact both soil fertility status and crop nutrient content due to their ability to convert or "fix" nitrogen (N) from the atmosphere into a biologically available form in soil. Another mechanism by which agroecological practices such as intercropping could improve soil fertility, plant health, and allocation of nutrients to edible crops is through increased coloni zation of plant roots by symbiotic arbuscular mycorrhizal fungi, which increase availability of phosphorus (P) and other soil nutrients for associated crops. We will plant lettuce (Latuca sativa) and black beans (Phaseolus vulgaris) in mid-June 2017, both alone and in the same rows (the intercrop, or "multi-crop" treatment), and will analyze the treatments for yield, N, C, potassium (K), P, micronutrient (Fe, Mg), and phytochemical (e.g., antioxidant compounds, vitamins A and C) contents. We expect that greater mycorrhizal colonization in the intercrop will increase yield of both crops, as well as phytochemical concentration of key nutritional compounds ("nutritional quality") in lettuce leaves and black beans. This project will advance ecological understanding of the potential for legume based diversification through intercropping to provide 37 multiple ecosystem services including more varied and nutritious produce for human consumption.

Research Projects

Project Title: Insect galls impact on goldenrod growth.

Investigators: Kaitlyn Teppert and Muyao Li, MS Students, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: If hosting insect galls requires more resources from a host goldenrod, then goldenrods with insect galls will not grow as much as goldenrods without. Essentially, we are trying to determine if insect galls impact a goldenrod's rate of growth and poten tially trying to figure out by how much.

Project Title: Difference in macroinvertebrate diversity, abundance, and water quality above and below a constructed wetland as an assessment of its effectiveness and ecological functions.

Investigators: Kesiree Thiamkeelakul and Malavika Sahai, MS students, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: As part of our NRE 509 coursework, we are to conduct independent projects. My partner and I are interested in studying the effectiveness of constructed wetlands by comparing macroinvertebrate diversity, abundance, and water quality above and below a constructed wetland. Our findings could help assess the effectiveness and functionality of artificial wetlands compared to their natural counterparts.

Project Title: 2017 Research on Exotic Forest Pests in Michigan.

Investigator: Andrew Tluczek, Research Technologist, Department

of Entomology, College of Agriculture and Natural Resources, Michigan State University.

Faculty Advisor: Deborah McCullough, Professor, Department of Entomology and Department of Forestry, College of Agriculture and Natural Resources, Michigan State University.

Abstract: Our primary objective is to collect insects from sites that may be at relatively high risk of exotic forest pest introduction and establishment. We will use a variety of traps baited with artificial lures designed to attract and capture exotic insects. Insect samples collected from traps will be sorted and screened. All long-horned beetles (Cerambycidae), metallic wood-boring beetles (Buprestidae), horntail wasps (Siricidae), bark beetles (e.g., walnut twig-beetle) and other defoliators (e.g., *Lymantria monacha* moths) will be identified to species. If any suspect pests of significance are captured, specimens will be forwarded to federal regulatory officials for confirmation.

Project Title: Understanding and conserving genetic diversity of historic and wild herbaceous peonies (*Paeonia* - Paeoniaceae) in public garden reference collections.

Investigators: Nastassia Vlasava, Ph.D., Leading Researcher, Department of Plant Biochemistry and Biotechnology, The Central Botanical Gardens of the National Academy of Sciences of Belarus, Minsk, Belarus.

David Michener, Ph.D., Associate Curator, Matthaei Botanical Gardens and Nichols Arboretum

Abstract: The major public peony collections in North American and Belarus together hold over 1,150 herbaceous cultivars introduced between the 1820s and modern times, as well as species of the genus Paeonia – many of which are globally endangered. Many of these historic cultivars are commercially extinct – the one to few specimens in living collections are the sole survivors. In this multi-year project, key issues being addressed using a series of molecular

markers (i.e. multilocus fingerprinting with RAPD, ISSR, SRAP and SSR systems) include: identifying unique molecular profiles of authentic cultivars; defining the relationships of the cultivars among themselves and with the ancestral species in the absence of breeding records; resolving the identity of unknown or incorrectly named specimens, and; finding correlation of specific phenotypes / important breeding traits (e.g., pathogen resistance, stem strength, and aesthetic diversity with the minimal number of plant specimens, while defining and maintaining critical redundancy across etc.) with genetic parentage. A long-term outcome is a new model of historic cultivar conservation that maximizes genetic, cultural, multiple institutions. This model will be useful not only for the institutional partners, but in other living-collection contexts worldwide. This project is being conducted under a Memorandum of Understanding between the two botanical gardens. The project is supported by a grant from the University of Michigan Matthaei Botanical Gardens and Nichols Arboretum and the Belarusian Republican Foundation for Basic Research (No Б15МС-035, for the period 2015-2017).

Project Title: Comparing soil composition variability between turf grass and forest in the Arboretum meadow.

Investigator: Katie Williamson, MS Student, School of Natural Resources and Environment.

Faculty Advisor: Sheila Schueller, Lecturer and Academic Program Specialist, Lecturer and Academic Program Specialist, School for Environment and Sustainability.

Abstract: We would like to take 10 soil samples from the Arboretum in order to analyze them for pH, compaction, and soil horizons to inform us more about how soil composition differs in more or less disturbed/trafficked sites.

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