Chicago Botanic Garden

Plant Biology and Conservation Internships Program

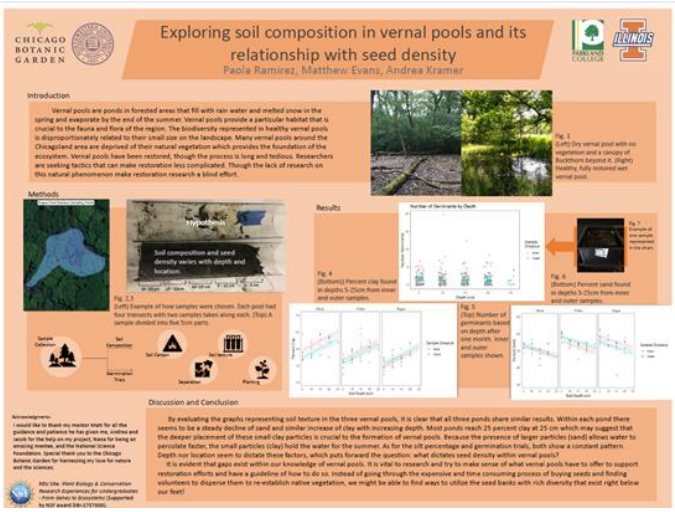
Plant Biology & Conservation: From Genes to Ecosystems

Poster Symposium

August 15, 2019

1) **Paola Ramirez** is majoring in Natural Resources and Environmental Science with dual enrollment at Parkland Colland and the University of Illinois at Urbana-Champaign and is expecting to graduate in 2022

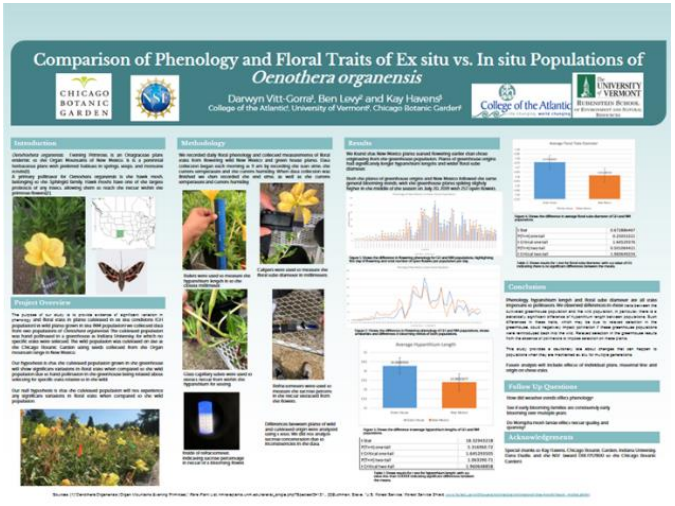
Title: Exploring soil composition in vernal pools and its relationship with seed density



Abstract: Vernal pools are small temporary wetlands that form in wooded areas and are created by melted snow and rain. These pools of water come together in the spring and evaporate by the end of the summer. Vernal pools provide a particular ecosystem that is crucial to the fauna and flora of the environment. The biodiversity represented in healthy vernal pools is disproportionate to their small size on the landscape. Though, many vernal pools, even in remnant woods, are not growing any vegetation. The lack of research on vernal pools has resulted in complicated attempts of restoration. In this experiment, our goal was to identify the location and any significant patterns of soil composition (sand, silt, and clay). Germination trials were also conducted to determine differences of seed density with depth. The results presented communicate that neither depth nor location seem to dictate these factors, which puts forward the question: what dictates seed density within vernal pools? Further research may direct its focus on this question. Noticing that varying depth and soil composition does not affect seed density, identifying the species would be key in understanding the success of the germinants.

2) **Darwyn Vitt-Gorra** majored in Human Ecology and Animal Behavior from the University of the Atlantic and graduated in 2019. **Ben Levy** is majoring in Environmental Science (Conservation Biology and Biodiversity) from the University of Vermont and is expected to graduate in 2021.

Title: Comparison of Phenology and Floral Traits of Ex Situ vs In Situ Populations of *Oenothera organensis*

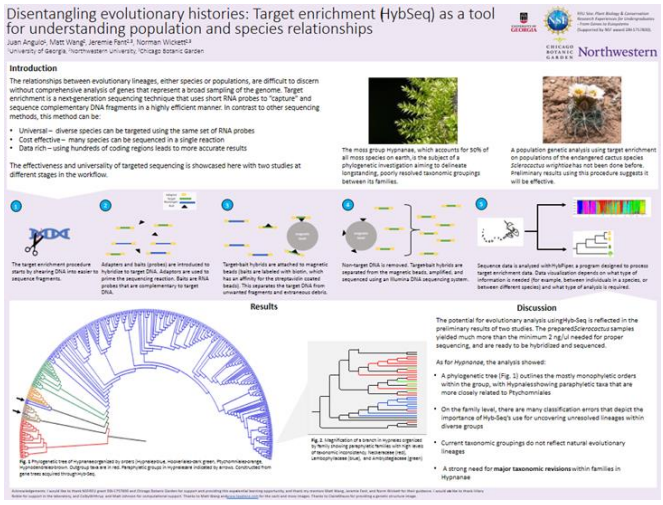


Abstract: Work with ex situ populations of threatened and/or endangered species is important to determine whether populations cultivated in controlled environments will be successful when reintroduced to the wild. The goal of this study is to determine whether a species cultivated in a greenhouse has similar enough phenology and floral traits to its wild counterpart to ensure a successful pollination process. This would mean if the species were to be reintroduced, the reintroduction has a greater chance to be a successful one. Our project was to compare one wild population and one cultivated greenhouse population of *Oenothera organensis,* Evening Primrose, to see if there were significant variations in phenology and floral traits. Phenology was recorded every day from June 25, 2019 to August 12, 2019. Measurements of hypanthium length and floral tube diameter were taken every week day when weather permitted, and sucrose percent in the nectar was taken when outside factors permitted but was inconsistent so was not considered in the final results of this project. Our hypothesis was that the cultivated population would exhibit significant variations in these floral traits as compared to the wild population, while our null hypothesis was that the cultivated population would exhibit no variation in these floral traits at all. The results of our analysis of our data were that there were differences in phenology, hypanthium length and floral tube diameter between the cultivated population grown in the greenhouse and the wild New Mexico population. Hypanthium length in particular had statistically significant differences between the populations. This may be due to the relaxed selection of traits in the greenhouse as pollination was done by hand. These differences in phenology and floral traits could negatively impact pollination of cultivated populations if reintroduced into the wild, and could result in an unsuccessful reintroduction all together. This study provides a cautionary tale about the changes that can occur to ex situ populations when they are maintained for multiple generations and further analysis of the effect of individual plant, maternal line and origin is needed.

3) **Juan Angulo** is majoring in Plant Biology at the University of Georgia and is expected to graduate in 2020

Title: Disentangling evolutionary histories: Target enrichment (HybSeq) as a tool for understanding population and species relationships

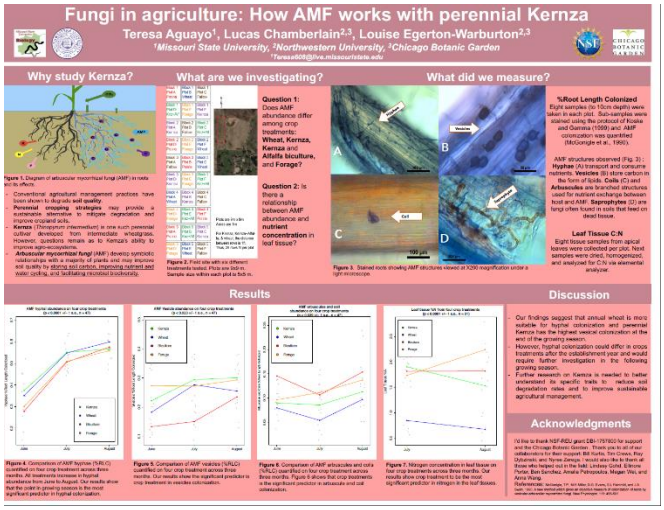
Abstract: The generation and analysis of DNA sequences that represent as much of the genome as possible is essential to make conclusions about relationships between organisms. Sequencing hundreds of nuclear genes in an efficient and cost-effective manner is particularly difficult for non-model plants. Furthermore, it can be difficult to interpret conflicting signal from these genes when groups have experienced periods of rapid speciation in the past. HybSeq, a relatively new method of next-generation DNA sequencing, has been productive in untangling these evolutionary relationships among plants with more certainty than other sequencing methods. It does so by producing complementary sequence reads from coding regions of DNA using short RNA probes that together represent the targeted genes. The efficacy and universality of the technique allows researchers to extend phylogenomic methods to diverse organisms from deep to shallow levels of evolutionary time. For example, we can study the genetic structure between populations of Sclerocactus wrightiae (recent time), or focus on the relationships of Hypnanae, a hyper-diverse lineage of mosses that underwent a rapid burst of speciation approximately 160 million years ago. Preliminary results show the suitability of HybSeq for Sclerocactus population genetics and offer a promising result for future sequencing efforts. For Hypnanae, we used 802 nuclear genes to reconstruct a phylogenetic tree that depicts relationships with varying levels of confidence, and reflects how the current taxonomy of the group does not align with natural evolutionary groups.



4) **Teresa Aguayo** is majoring in Biology and Environmental Plant Science (Horticulture) with a minor in Sustainability at the Missouri State University- Springfield and is expected to graduate in 2021

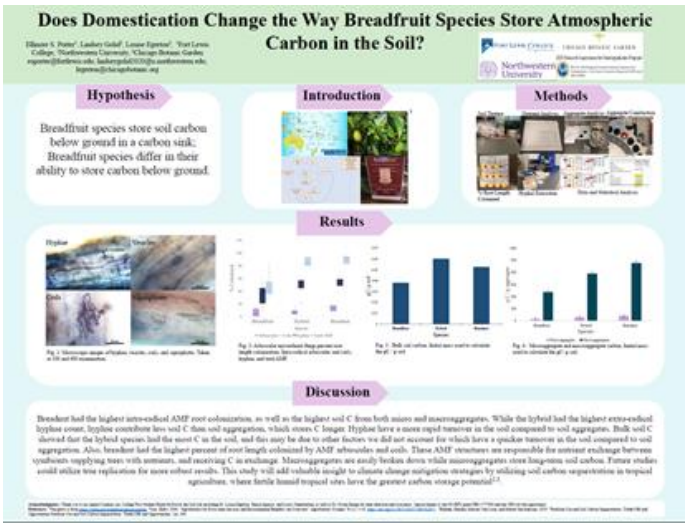
Title: Fungi in agriculture: How AMF works with perennial Kernza.

Abstract: Agroecosystems depend on suitable environments with healthy soil quality to produce food for the growing global population. However, current land mismanagement and the rate of soil degradation must improve to ensure food and ecosystem security. Wheat is a staple crop grown around the world that disrupts the soil after every annual harvest. Kernza (*Thinopyrum intermedium)* is a perennial intermediate wheatgrass that has been selected as a potential sustainable alternative to conventual agricultural management. Kernza is gaining attention for its potential to reduce soil degradation, sequester carbon, increase microbial diversity, and prevent erosion. However, questions remain about Kernza's effect on soil quality in comparison to annual crops. Arbuscular mycorrhizal fungal (AMF) abundance is a soil quality indicator because of its symbiotic relationship with terrestrial plants and its ability to improve soil health. My proposed research will observe relationships between AMF abundance from the sampled plots (Kernza, Kernza and alfalfa biculture, wheat, and forage) and the carbon/nitrogen ratio collected from each plots leaf tissue over the course of three months. This data will gain insight on the production of perennial intermediate wheatgrass and improving sustainable agricultural systems.



5) **Ellinore Porter** is majoring in Biology with a minor in Native American and Indigenous Studies at Fort Lewis College and is expected to graduate in 2020

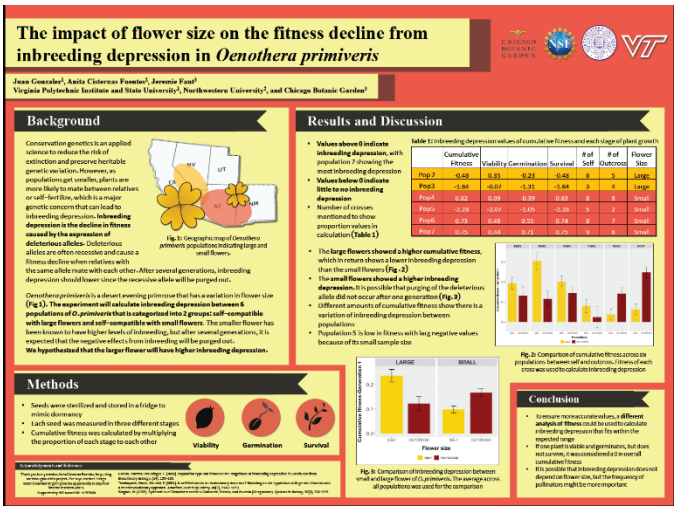
Title: Does Domestication Change the Way Breadfruit Species Store Atmospheric Carbon in the Soil?



Abstract: Breadfruit (*Artocarpus altilis*) is an important staple food crop throughout the Pacific Islands and tropical climates. Breadnut (*Artocarpus camansi*) is the wild relative, and a hybrid *A. altilis* x *A. mariannensis* was also studied. Pacific Islanders have traditionally grown breadfruit in permanent agroforestry systems within the Micronesian and Melanesian islands. Today, breadfruit is still being grown in agroforestry throughout Oceania and in particular Hawaii. As sustainable alternatives to agricultural practices grow in popularity, many are looking to agroforestry systems that utilize perennial crops such as breadfruit. Perennial crops have greater potential, in contrast to annual counterparts, to storing carbon in the soil for longer periods of time and mitigating carbon emissions in the atmosphere. The most prominent method that breadfruit utilizes to store atmospheric carbon as soil organic carbon is the arbuscular mycorrhizal fungi. It is thought that breeding practices such as asexual propagation have selected for crops that are less mycorrhizal-dependent, and thus less effective at storing carbon in the soil. This research's hypothesis was that breadfruit species differ in their ability to store carbon below ground. Results show that the breadnut had the highest intra-radical hyphae counts, as well as highest soil C in both the micro and macroaggregates. Whereas, the hybrid had the highest extra-radical hyphae counts. Future studies are warranted to better understand the divergent and complex abilities of breadfruit species in their carbon sequestration. The hope is to create a more robust profile on which trees store soil C the best, and to be able to combine that knowledge with other studies that focus on which trees provide the best nutrients, creating a multi-faceted solution to both the climate crisis and world hunger.

6) **Juan Gonzalez** is majoring in Environmental Horticulture and Plant Genetics/Breeding at Virginia Polytechnic Institute and State University and is expected to graduate in 2021

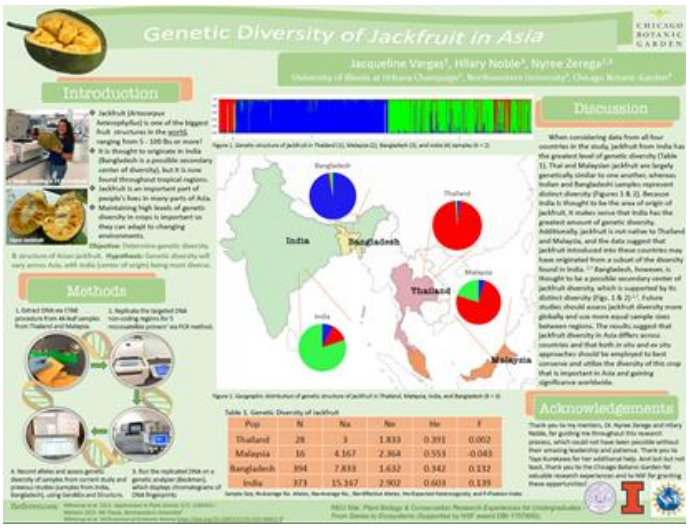
Title: The impact of flower size on the fitness decline from inbreeding depression in *Oenorthera primiveris*



Abstract: Genetic diversity is important to maintain genes within a population and will ensure those genes are passed onto the next generation. However, as populations get smaller, plants are more likely to mate between relatives or self-fertilize, which is a major genetic concern that can lead to inbreeding depression caused by the expression of recessive deleterious alleles. However, it is expected that after several generations, inbreeding depression should decrease because the deleterious allele will be purged out. The experiment compared the amount of inbreeding depression between the small and large flowers of self-compatible *Oenorthera primiveris* to see if flower size has an effect on plant fitness. To calculate inbreeding depression, the cumulative fitness of each population was measured in three different stages: viability, germination, and survival. Small flowers showed a higher level of inbreeding depression and the large flower showed a lower level of inbreeding depression. It is possible that the purging of the recessive deleterious allele was ineffective after one generation. For future studies, a different analysis of fitness could be used for better representation of plant fitness. Also, the experiment will need to be done throughout several generations to fully visualize the effect of flower size on inbreeding depression.

7) **Jaqueline Vargas** is majoring in Molecular and Cellular Biology at the University of Illinois at Urbana Champaign and is expecting to graduate in 2022

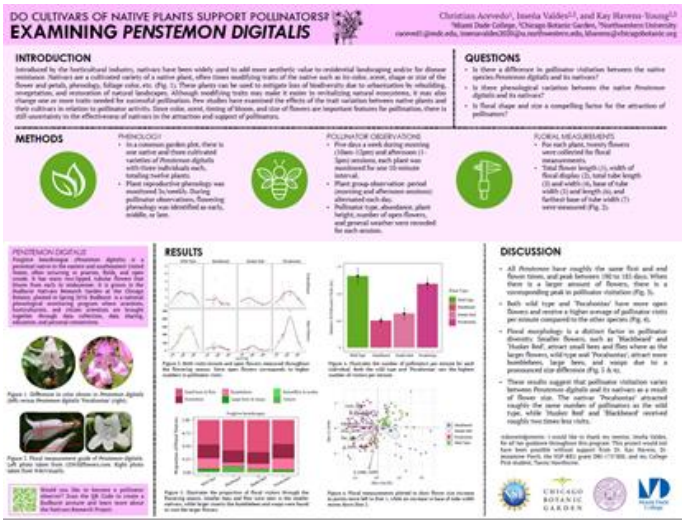
Title: Genetic Diversity of Jackfruit in Asia



Abstract: Jackfruit (*Artocarpus heterophyllus*), one of the largest fruit structures in the world, has become a big part of people's everyday lives in Asia. From jackfruit tacos to jackfruit flour, it has become commercialized around the globe through its' multiple uses. This experiment aims to measure the genetic diversity of jackfruit in Asia, more specifically, Thailand, Malaysia, India, and Bangladesh. By using 44 samples from Thailand and Malaysia, along with 767 other samples from India and Bangladesh that were collected from past data, 5 different microsatellite primers were used in order to assess genetic diversity. The data supports the hypothesis that Jackfruit first originated in India, due to its high level of genetic diversity, and because jackfruit is not native to Thailand or Malaysia, the data suggests that a small subset was brought from India into those countries. The data shows that the Thai and Malaysian jackfruit are largely genetically similar to one another, whereas the Indian and Bangladeshi samples represent distinct diversity. Bangladesh, however, is thought to be a possible secondary source of jackfruit diversity, which is also supported by its distinct diversity. In the future, studies should assess the genetic diversity of jackfruit in a more global perspective, taking into account equal sample sizes between regions.

8) **Christian Acevedo** is majoring in Environmental Science at Miami Dade College and is expected to graduate in 2021

Title: Do cultivars of native plants support pollinators? Examining *Penstemon digitalis*

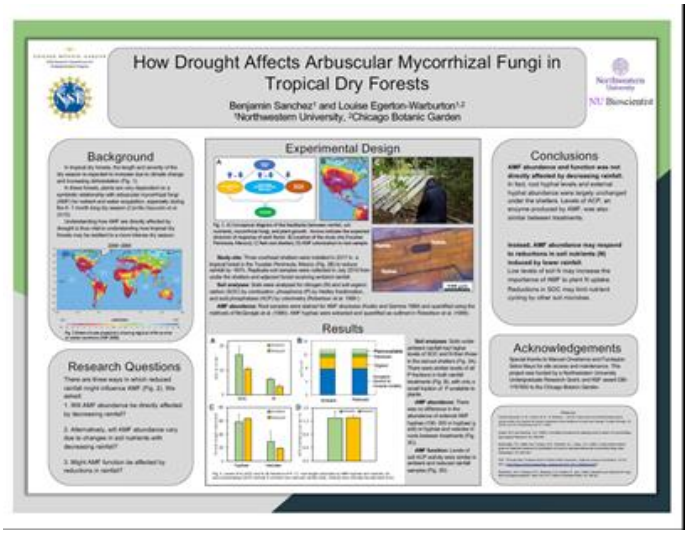


Abstract: Introduced by the horticultural industry, nativars have been widely used to add more aesthetic value to residential landscaping and/or for disease resistance. Nativars are a cultivated variety of a native plant, often times modifying traits of the native such as its color, scent, shape or size of the flower and petals, phenology, foliage color, etc. Although modifying traits may make it easier in revitalizing natural ecosystems, it may also change one or more traits needed for successful pollination. Few studies have examined the effects of the trait variation between native plants and their cultivars in relation to pollinator activity. In Spring 2018, foxglove beardtongue (*Penstemon digitalis*) was planted in the Budburst Nativars Research Garden at the Chicago Botanic Garden. We examined one native and three nativars of *P. digitalis* throughout the flowering season to observe any differences in pollinator visitation and phenological variation between individuals. Floral shape and size were also assessed as possible compelling factors for pollinator attraction. We found that all *Penstemon* had roughly the same first and end flower times. Both the wild type and the nativar 'Pocahontas' experienced more and larger open flowers with the highest numbers of pollinator visits. Floral morphology was a distinct factor in pollinator diversity, whereas smaller bees and flies were seen in the smaller nativars, while larger insects like bumblebees and wasps were found to visit the larger flowers. These results suggest that pollinator visitation varies between *Penstemon digitalis* and its nativars as a result of flower size.

9) **Benjamin Sanchez** is majoring in Chemistry at Northwestern University and is expected to graduate in 2022

Title: How drought affects arbuscular mycorrhizal fungi in tropical dry forests

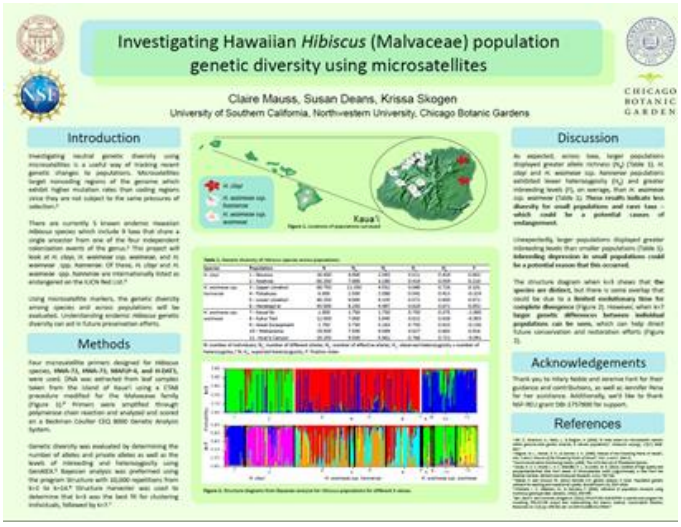
Abstract: In tropical dry forests, soil quality is very poor and plant life is very dependent on a symbiotic relationship with arbuscular mycorrhizal fungi (AMF). These ecosystems experience a 5-6 month dry season which is expected to intensify with continuing global climate change. The tropical dry forests of Mexico's Yucatan peninsula are projected to experience the most dramatic change. This change could put a strain on the AMF symbiosis and could result in plantlife terminating the symbiosis in order to preserve resources for itself. This would put the ecosystem in danger as the plant life needs the AMF to survive. Soil samples were collected from a field site in the Yucatan where overhead shelters were placed in order to simulate an intense drought. Nutrient analysis and the quantification of fungal structures was performed in order to study the abundance and performance of AMF in the soil. The data showed little difference between the sheltered samples and the control. This lack of difference implies that the symbiosis was maintained despite the more severe conditions and suggests that plant life would be less susceptible to more severe droughts.



10) **Claire Mauss** is majoring in Environmental Science and Health with a minor in Spanish at the University of Southern California and is expected to graduate in 2020

Title: Investigating Hawaiian *Hibiscus* (Malvaceae) population genetic diversity using microsatellites

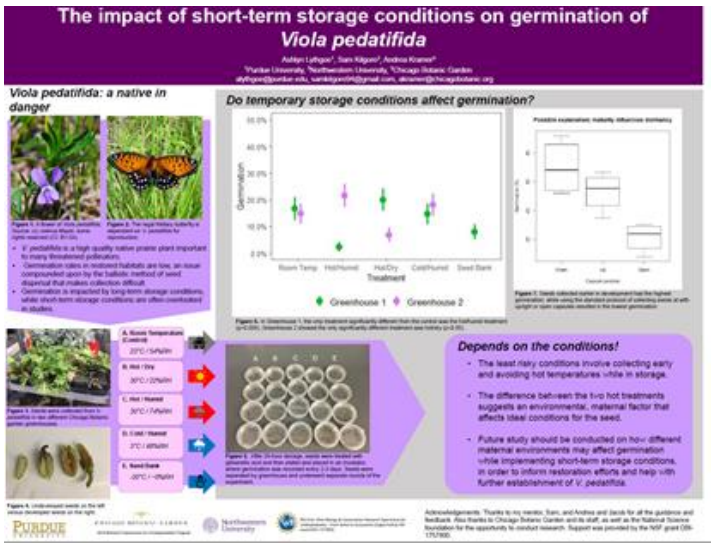
Abstract: The neutral genetic diversity of eleven populations of three Hawaiian *Hibiscus* taxa was evaluated using four microsatellite primers, HWA-72, HWA-73, MAFLP-4, and H-DAT1. *Hibiscus clayi*, *H. waimeae* ssp. *waimeae*, and *H. waimeae* spp. *Hannerae* are all single-island endemics found only on Kaua'i, with around 200 to a few thousand individuals remaining in the wild. As expected, across taxa, larger populations displayed greater allelic richness. H. clayi and H. waimeae ssp. hannerae populations exhibited lower heterozygosity and greater inbreeding levels, on average, than H. waimeae ssp. waimeae. These results indicate less diversity for smaller populations and rarer taxa – which could be a potential causes of endangerment. Larger populations displayed greater inbreeding levels than smaller populations. Inbreeding depression in small populations could be a potential reason that this occurred. Based on Structure diagrams created from the microsatellite data, it was determined that k=3 was the best fit for clustering individuals, followed by k=7. The structure diagram when k=3 shows that the species are distinct, but there is some overlap that could be due to a limited evolutionary time for complete divergence. However, when k=7 larger genetic differences between individual populations can be seen. This data can help inform and direct future conservation and restoration efforts.



11) **Ashyln Lythgoe** is majoring in Ecology, Evolution and Environmental Biology with a minor in Music Theory/ History at Purdue University and is expected to graduate in 2020

Title: The impact of short-term storage conditions on germination of Viola pedatifida

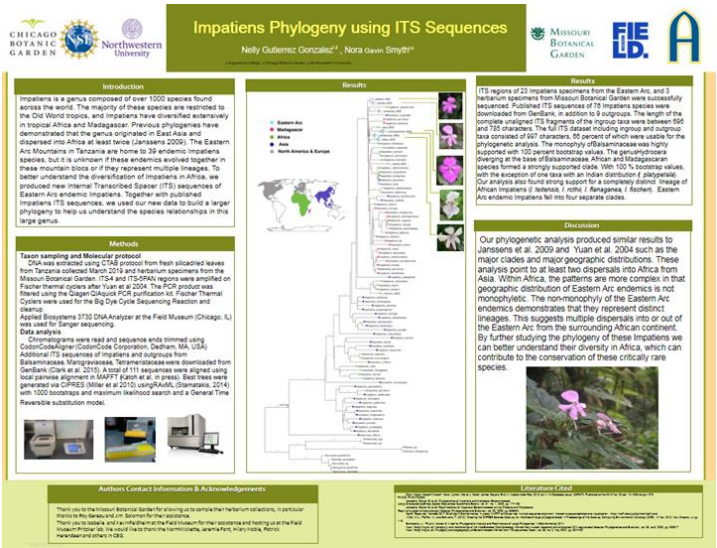
Abstract: Viola pedatifida, also known as the prairie violet, is a high-quality native that is important to tallgrass prairie restoration within the Midwest. Due to the difficulty of working with this species, particularly with the environmental sensitivity of this violet, efforts to introduce V. pedatifida into restored natural areas often result in low establishment. One factor that has been documented to affect the germination and establishment of many species are the conditions in which seeds are stored. Many studies have implemented storage durations of months or longer, but little research is available on conditions that seed is kept under for short periods of time. This experiment studied the impacts of short-term storage conditions on seed germination, with the expectation that germination would not be significantly affected. Seeds were collected and stored under varying temperatures and humidities for one day, then incubated and checked for germination for three weeks, with two separate rounds of treatment- one for each greenhouse seeds were collected from. Our results indicated that short-term storage was found to impact germination. The first round showed that the only treatment with significantly lower germination than the room temperature control was the hot/humid treatment. For the second round, only the hot/dry treatment resulted in significantly lower germination. Environmental conditions of the maternal plant in each greenhouse or the presence/absence of chaff during storage are possible factors for the differing suboptimal storage conditions found in the two treatments. Further research should be conducted on the maternal conditions that might lead to higher germination in one environment over another, as well as short-term storage of seeds in general.



12) **Nelly Gutierrez-Gonzalez** is Majoring in Biology with minors in Environmental Studies and French at Augustana College- Rock Island and is expected to graduate in 2020

Title: Impatiens Phylogeny Using ITS Sequences

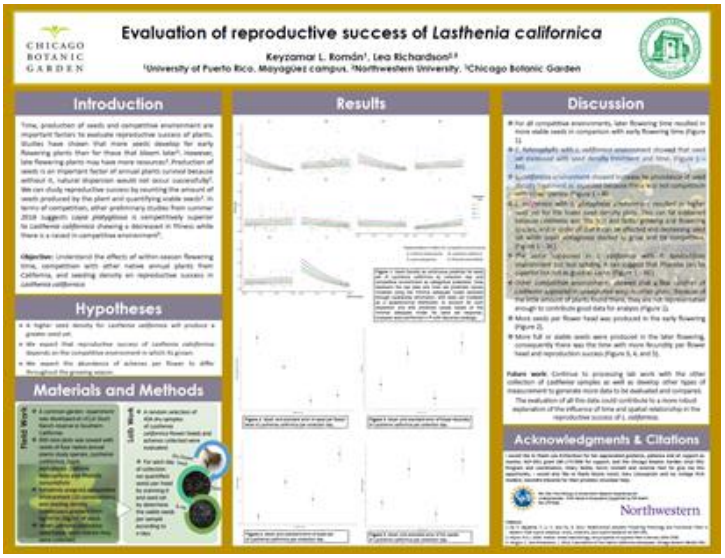
Abstract: This project studies some of the 39 named species of Impatiens that are endemic to the Eastern Arc Mountains, a region known to hold lot of biodiversity and endemism. To further understand these rare plants we produced ITS sequences, which we used to build a phylogeny. Our results showed that these Impatiens are not monophyletic. This means that they originate from different lineages.



13) **Keyzamar Román** is majoring in Industrial Microbiology at the University of Puerto Rico- Mayagüez and is expected to graduate in 2020

Title: Evaluation of reproductive success of *Lasthenia californica*

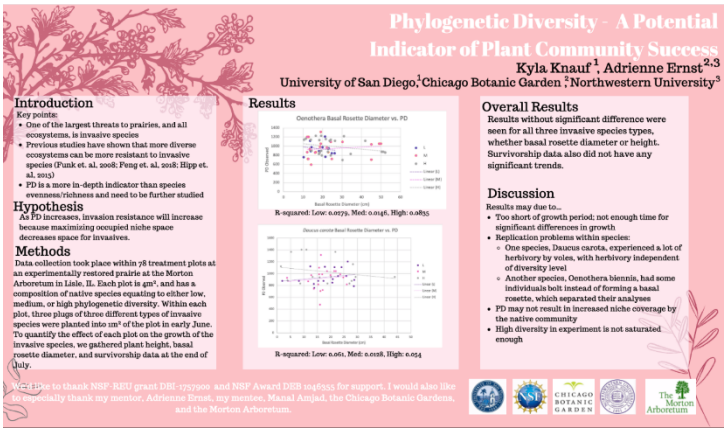
Abstract: Previous studies have showed how time, production of seeds and competitive environment are meaningful factors in evaluating reproductive success of plants. Plant production of seeds is an important factor for annual plants survival because without it, natural dispersion would not occur successfully. But there is a lack of studies have shed light on how seeds promote native biodiversity. Therefore, to better understand how reproductive success, or seed set, in California-native *Lasthenia californica* depends on within-season flowering time, competition with other native annual plants from California, and seeding density, we evaluated dry samples of *L. californica* flower heads and achenes grown in an experimental plot from four different collection days and quantified seeds per head and seed set. As expected, reproductive success of *L. calnifornica* increased with higher seed density treatment but depends on the competitive environment in which its grown. Also, we found that if there is less abundance of achenes per flower head in the later day of collection, then more viable seeds would be produced. Future work includes obtaining more data by counting more seeds, measuring biomass and counting the number of flowers produced by collection day. The evaluation of all this data could contribute to a more robust explanation of the influence of time and spatial relationship in the reproductive success of *L. californica.*



14) **Kyla Knauf** is majoring in Biology and Environmental and Ocean Sciences with a minor in Music at the University of San Diego and is expected to graduate in 2021

Title: Phylogenetic diversity: A potential indictor of plant community success

Abstract: In Illinois, less than one-tenth percent of its tallgrass prairie still remains. This major loss makes restoration efficiency increasingly important. A large threat towards restorations is invasive species. While studies traditionally count species (species richness) to characterize native communities and subsequent invasive species resistance, this does not consider the specific species characteristics present. My project aims to assess lesser-studied phylogenetic diversity (PD) of native species and its effect on invasive species success. PD measures the evolutionary history represented, which approximates the niche space occupied by the native community. My hypothesis is that as PD increases, invasion resistance will increase because maximizing occupied niche space decreases space for invasives. To test this, we used experimentally restored prairie plots with three levels of PD. Three different invasive species were planted in each plot in early June, and basal rosette diameter or height and survivorship were measured in late July as metrics of invasive success. In the end, the analyzed data demonstrated no significant difference within invasive species success between the three levels of PD. This may be because the niche was not saturated enough, the growing season was too short, or because there was too low of replication due to high death.



PROGRAM INFORMATION:
The Chicago Botanic Garden has hosted a Research Experiences for Undergraduates (REU) Site, supported in-part by NSF, for 14 years. This year 24 students participated in our ten-week summer undergraduate research experience, which is one of only a few programs in the country that offers undergraduate students an opportunity to explore a diverse array of scientific fields related to plant biology and conservation. Student are mentored by faculty and graduate students from the joint Chicago Botanic Garden–Northwestern University Graduate Program in Plant Biology and Conservation and other graduate programs. Their research projects are based at the Daniel F. and Ada L. Rice Plant Conservation Science Center, and they receive training in all aspects of the research process, from hypothesis formulation through experimental design, data collection, analysis, and ultimately presentation of results through this public research symposium. REU interns also serve as research mentors for high school students participating in the Garden's College First program, assist with teaching a topic related to their research as a part of Camp CBG, and participate in field trips, workshops, and professional development activities. Additionally, students and their mentors often pursue opportunities to present at national scientific meetings or publish findings in peer-reviewed journals following completion of the program.

REU Coordinators: Jeremie Fant, Norm Wickett, Hilary Noble

BIG THANKS TO:
Mentors: This science training program would not be possible without your dedication. We appreciate all the time and effort you have put into these students and hope that it is been as rewarding for you as it was for the students.

College First and Camp CBG programs: Your partnership allowed for a richer growth of our students through mentorship and science communication.

Funders: This summer program was supported in part by NSF-REU DBI-1757800 (Kramer, Fant) and the Charles and Margery Barancik Foundation.

Poster Judges: Nina Antonetti (Associate Vice President, Corporate and Foundation Relations at the Chicago Botanic Garden), **Rebecca Ammann** (Manager, Teacher and Student Programs at the Chicago Botanic Garden), **Pamela Geddes** (Professor and Research Scientist in the Biology Department at Northeastern Illinois University)