A. Project Title

Identifying genotypic variation in loss of blight resistance under drought in hybrid American chestnuts to inform restoration

B. Project Summary

Resistance to plant pathogens is known to vary based on environmental conditions both generally and specifically in *Castanea spp* resistance to *Cryphonectria parasitica*. How blight resistance in hybrid chestnut genotypes will change under environmentally stressful conditions like drought is unknown. Testing BC3F3 hybrid genotypes under droughted and nondroughted conditions will show if and how much resistance to blight is lost under stress. Genotypes or families of genotypes that maintain resistance under drought will help TACF identify hybrids that could be useful for reintroduction to particularly xeric sites or identify genotypes that have consistent blight resistance under stressful environmental conditions.

C. Principal investigators and affiliations

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D. Duration of the project

Project will last from February 2019 to February 2020. The project will run concurrently with the annual progeny testing of hybrid chestnut genotypes at Meadowview and sample processing will occur at Ohio University in the fall of 2019.

E. Total amount requested

A total amount of $~~9472.40~~ is requested for the entirety of the projects. $7,500 approved, SBowers

F. Short and long-term goals

The long-term goal of our research is to assess how biotic and abiotic factors affects carbon assimilation, carbon dynamics and growth of American and hybrid chestnuts. We have established permanent plots at OU where we monitor the seasonal physiology of American chestnuts. We have also assessed the response of American and hybrid chestnut seedlings to simulated climate change (elevated CO2 and Temperature). Here we propose to study the response of hybrid chestnuts to abiotic and biotic stresses simultaneously. The short-term goal of this proposal is to 1) determine how drought changes hybrid chestnut resistance to chestnut blight and 2) identify genotypes that maintain resistance to blight when drought stressed. In the future, we intend to further study the most and least resistant genotypes under drought to resolve the mechanism that confer enhanced blight resistance under drought stress.

G. Narrative

The restoration of American chestnut (*Castanea dentata* (Marsh.) Borkh.) as a canopy dominant tree is important for ecological, economic and aesthetic reasons. As an ecological foundation species, it is likely to affect population, community and ecosystem processes in eastern American forests (Ellison et al. 2005, Jacobs et al. 2013, Gustafson et al. 2018). Chestnuts also provide a rich food source for wildlife. In addition to providing tangible ecosystem services, it is a versatile tree for wood production and other agricultural products. Historically, it was valued for its large decay resistant timbers and its nuts were an important agricultural commodity. Chestnut bark was also valued for its tannins, which are a critical natural component of leather processing. Finally, its popularity with the public also adds less tangible but equally important esthetic and recreational values to the forest. Within 50 years of its introduction in 1904, Chestnut blight (*Cryphonectria parasitica* (Murrill) Barr) had virtually eliminated American chestnut from North American forests.

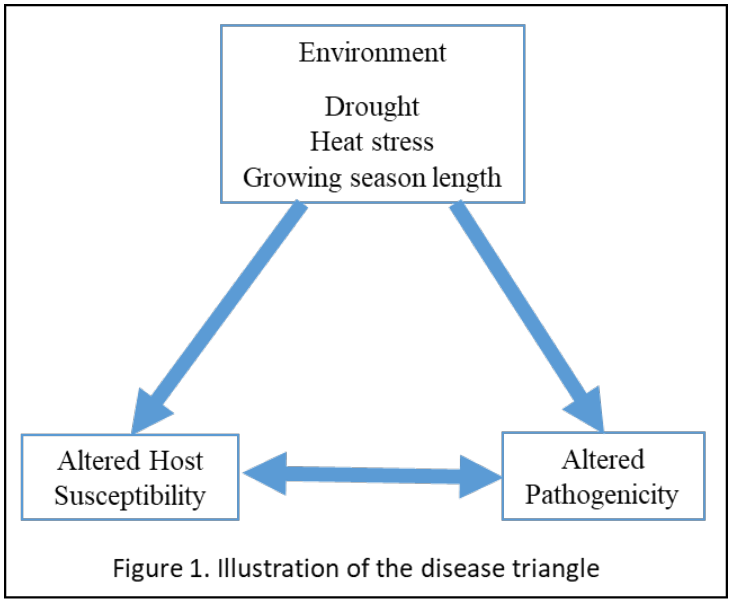

Figure 1. Illustration of the disease triangle

Many environmental factors influence plant diseases like *Cryphonectria parasitica*; changes in temperature, moisture, and soil can all alter the formation and progression of disease (Manion, 1991; Blanchette and Biggs, 2013). The disease triangle (Figure 1) is a conceptual model that represents the idea that the host, pathogen, and environment must all be conducive for a disease to persist and spread through a population. The host must be susceptible to the disease and in high enough numbers to spread it, the pathogen must present in the ecosystem and sufficiently virulent in the host, and the environment must be suitable for infection to progress. The environment is the most variable factor and the most likely to change under future climates. In fact, changing climate is predicted to facilitate more diseases by either expanding the range of pathogens or increasing the susceptibility of host by other stresses. Abiotic stresses in particular are known to interact with forest diseases resulting in reduced resistance and increased mortality (Suzuki *et al*, 2014; Senthil-Kumar, 2017), making it more important that researchers and foresters understand how these stresses can influence disease (Sukumar Chakraborty, 2008; Sturrock *et al.*, 2011; Pautasso *et al.*, 2012).

It is generally understood that an abiotic stress (i.e. drought) combined with a biotic stress (i.e fungal pathogen) will result in increased mortality but the nuances of plant responses to combined stresses are poorly understood. Plant responses to multiple stresses are not always a sum of the responses to individual stresses and have been shown to involve unique genetic pathways. For instance, a study in *Arabidopsis thaliana* showed that 776 unique genes were differentially regulated under a drought-pathogen combined stress compared to either drought or pathogen stress alone (Prasch and Sonnewald, 2013). While the specific genes and mechanisms

of resistance are not known in American chestnut, blight resistant BC3F3 hybrid genotypes exhibit a spectrum of resistance implying multiple resistance loci exist (Jared Westbrook pers. comm.).

While the resistance varies from genotype to genotype, TACF has historically tested for resistance under optimal conditions (greenhouses and managed orchards). Based on the disease triangle in figure 1, only testing under optimal conditions ignores the potential effect of environmental variation on the resistance of the hybrids. Therefore, it is possible that the most resistant hybrid genotypes may not maintain their resistance under a stress, like drought, and/or hybrids that have moderate to limited resistance may show little change in resistance under drought. Either way, this project proposes to quantify how much resistance is lost in BC3F3 genotypes under drought stress and identify genotypes most prone to losing resistance and genotypes that are able to maintain resistance under drought.

Loss of disease resistance under a co-occurring stressor like drought is widely observed in trees. Several species in the *Castanea* genus have exhibited interactions of abiotic stress with *Cryphonectria parasitica* infections. For instance, Chinese chestnut (*Castanea molissima*) has shown increase canker size under cold stress (Jon*es et al*, 1980). Japanese chestnut (*Castanea crenata*), European chestnut (*Castanea sativa*), and pure American chestnut (*Castanea dentata*) have all shown increased canker size and/or increased mortality under drought (Uchida, 1977; Anagnostakis, 2001; Waldboth and Oberhuber, 2009). However, there is limited evidence for a widely observed mechanism for lower pathogen resistance under drought. It is has been theorized that pathogen resistance is lower because of a decline in non-structural carbohydrates (NSCs), largely because drought lowers photosynthesis (McDowell, 2011; Oliva *et al.*, 2014; Stenlid and Oliva, 2016). Since trees respond to necrotrophic pathogens like *C. parasitica* partly by shunting carbon to thicken cell walls to prevent further infection, the carbon costs of fighting necrotrophs is amplified under drought. Therefore, hybrid genotypes with larger NSC pools should be more resistant under a drought-blight combination than other genotypes.

This proposal will test three hypotheses: 1) hybrid chestnuts will exhibit significant variation for drought tolerance, 2) drought will limit the blight resistance in hybrids regardless of the genetics involved and 3) hybrid genotypes will differ in their response to the combination of drought and blight. We predict that the most pathogen resistant genotypes under drought will have greater carbon assimilation, larger NSC pools or both, when compared to the least resistant genotypes.

Approach

The overarching goal of this project is to assess genotypic variation in hybrid response to concurrent drought and blight stress. Every year a selection of BC3F3 hybrids from TACF's breeding program are tested for blight tolerance to determine which genotypes have inherited resistance. During this progeny testing, we will use a subsample of the genotypes being tested by TACF and subject them to a drought. Keeping the droughted seedling in the same environment as the progeny test will allow us to use the progeny test seedlings as non-droughted, infected, controls. Genotypes will be selected with guidance from Jared Westbrook (TACF) and will represent families that have some level of known blight resistance. Forty individuals of 20 BC3F3 genotypes will be selected with previous familial resistance being used to classify genotypes as tentatively high and low resistance to ensure a range of resistance is captured

(Table 1). Twenty pure American chestnut, Chinese chestnut, and F1 hybrids will also be used for comparison to the hybrids.

Table 1 – Experimental design and sample sizes for each family and treatment

Populations	Families	Drought	Infected	Drought + Infected	Control	Total
American Chestnuts	1	20	40	40	20	120
Chinese Chestnuts	1	20	40	40	20	120
F1 Hybrids	1	20	40	40	20	120
BC3F3 Hybrids	20	20	40	40	20	2400
Total	23	80	160	160	80	2760

The goal will be to have ten highly resistant and ten low resistance BC3F3 genotypes in each treatment. Treatments will consist of a droughted treatment, infected treatment (progeny test), drought and infection treatment, and non-droughted non-infected controls (progeny test). More individuals are included in the infection treatments (n=40) compared to non-infected treatments (n=20) to account for variation in canker phenotypes and ensure enough successful inoculations will occur.

Seeds will be planted according to TACF protocol in February 2019 (Jared Westbrook pers. comm). We will travel to TACF facilities to assist in planting and experimental set up in February. However, drought treatments will not start until May when inoculations occur. Droughts will be applied by withholding water until 50% of individuals within a given family wilt or show other signs of drought stress (e.g. excessive dieback). At this point, the days until wilting will be recorded for a given family and that family will be rehydrated to full turgor. We will stay onsite until each family has wilted once for the first drought cycle in May to determine the days until wilting for each family. As individuals are planted in small containers, we do not expect more than a week of withholding water being needed to see wilting within all families. To ensure each family does experience the same water stress, withholding water until wilted on a familial basis is needed to account for differences in size and morphology.

The days until wilting will be communicated with staff maintaining the plants at Meadowview facilities who will use it as an interval to water droughted genotypes. For example, if genotype A is observed to wilt within 4 days, it will be watered every 4 days in the droughted treatments. These droughts will mimic relatively prolonged periods without rainfall punctuated by short burst of precipitation the most common droughts predicted by climate models that the hybrids will see when reintroduced (Hubbart *et al*, 2016). Plant height, seed mass, and basal diameter will be measured prior to treatment initiation to use as covariates. Nondroughted plants are normally watered every day according to TACF protocol. We will be on site regularly to assist with planting, small stem assays, monitor treatments and to conduct measurement campaigns (see below) during the course of the experiment.

Blight determinations

The small stem assay (SSA) was developed by The American Chestnut Foundation for rapid progeny testing of blight resistance. While it has not been used to quantify loss of resistance under stressful conditions, it has shown to be strong enough to quantify variance in canker size between field and glasshouse conditions (Sara Fitzsimmons, pers. comm.). The assay uses seedlings that are >3mm diameter which seedlings can reach by their first year (used for progeny testing). The protocol entails making an incision in the stem while marking the size and location of the wound. A small plug of agar media containing actively growing *Cryphonectria parasitica* mycelia is then pressed against the wound. The media is then sealed against the wound with parafilm for two weeks allowing the mycelia to infect the stem. The parafilm is then removed and the infection allowed to progress for 15-18 weeks. The strain of *Cryphonectria parasitica*, Ep155, has been shown to cause the greatest difference in canker size. It is the most common strain of blight used in the progeny testing, though few others have been tested. Canker size in the drought treatments will be measured concurrently with those of the control treatments. This will occur in weeks 6, 12, and 18 after inoculation. Differences in canker size and time to wilting after inoculation will be used to quantify resistance and treatment effects.

Average canker size, approximated by length and width of the canker, will be calculated for each genotype in both normal watering (progeny tests) and droughted treatments. Percent loss of resistance will by calculated by percentage differences in average canker size for each genotype

$$\frac{Canker\ size\ in\ progeny\ test - Canker\ size\ in\ drought}{Canker\ size\ in\ progeny\ test} \times 100 = Loss\ of\ resistance\ (\%)$$

In addition to canker size, mortality, basal diameter, and height will be recorded for each individual to track changes in resistance and the effect of treatments on plant growth. Initial height, seed mass, and basal diameter of plants should be recorded at planting to be used as covariates.

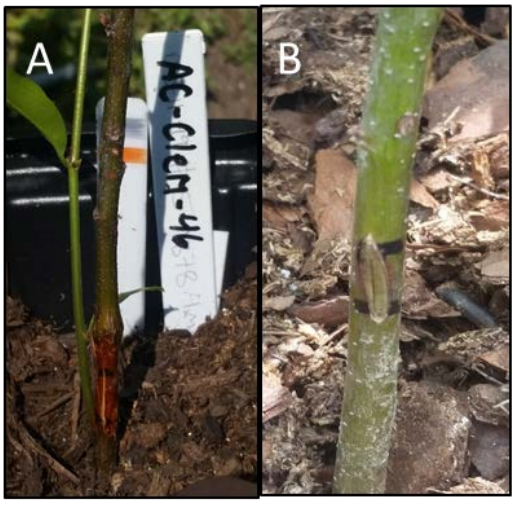

Figure 3. American (A) and Chinese (B) chestnut subjected to blight at Ohio University summer 2018.

We maintain a culture of *Cryphonectria parasitica*, (strain Ep155 provided by TACF), at Ohio University, which Brett Fredericksen is currently using in a pilot study to ensure proficiency at conducting the SSA and to test how drought changes blight resistance in an initial common garden experiment at Ohio University. We have confirmed that we are proficient at conducting the SSA (Figure 3) with ~75% of inoculated individuals showing signs of infection. The pilot study includes pathogen and drought pathogen treatments on Americans, hybrids and Chinese chestnuts (n=6) for each species. While the study is ongoing it will provide proof of concept that chestnuts (Americans, Chinese, and hybrids) have larger cankers and increased rates of mortality under a drought-blight combination.

Physiological Measurements

To assess the physiological impact of drought, point measurements of photosynthesis (A) and stomatal conductance (g_s) will be taken during 4 trips May – August 2019. These measurements will use a randomly selected sub-sample of six individuals from each genotype and family of each treatment. Measurements will be completed over three days during each visit. Data will be collected from 8 am – 12 pm to avoid confounding typical midday stomatal closure with treatment effects. Midday leaf water potential (Ψ_{md}) measurements will also be completed on the six plants randomly selected for gas exchange measurements using a Scholander pressure chamber (Scholander *et al*, 1965). These measurements will take place after the gas exchange measurements are conducted (i.e. 12 – 4 pm) the time of day when plants exhibit the highest water stress.

Nonstructural carbohydrate content (NSC) of woody and foliar tissue will be measured using a standardized method (Chow and Landhäusser 2004, Quentin et al. 2015) on 10 randomly selected individuals in each genotype in each treatment. Sampling will occur near the end of the summer and into the fall when treatment effects should be the largest. Tissue must be frozen in liquid N immediately after sampling to prevent temporal variation in NSC content and must remain frozen until assayed. Additionally, similarly frozen tissue samples can be used to estimate water potential at turgor loss point as well as osmotic potential which have been shown to be important drought tolerance traits (Bartlett et al. 2012). Samples will be transported back to Ohio University in liquid nitrogen and will remain frozen until analysis.

Measurements of stomatal conductance and the midday leaf water potential data during the experiment will confirm that droughted plants are experiencing more water stress compared to the controls. Nonstructural carbohydrate analyses at the end of the experiment represent the integrated effect of several drought cycles on carbon stores. Associations of physiological variables or NSCs with variation in canker size will reveal physiological mechanisms associated with variation in resistance.

Data Analysis

All data analyses and visualizations will be performed in the R Statistical Software (R Core Team, 2015). Two-way ANOVAs will be used to test the effect to genotypes and treatment on average photosynthesis, conductance, midday leaf water potentials, NSCs, tugor loss points and canker size (loss of resistance). Initial seed size, height, and basal diameter (prior to drought treatment) will be included as covariates. To estimate the influence of genetic identity on trait differentiation, variation among the 20 genotypes will be assessed by partitioning total phenotypic variance within and among genotypes with restricted maximum likelihood (REML). For traits with a significant genotype effect, genetic variation for each will then be determined by partitioning variance to genotype (V_G), replication plot (V_E), and residual variation (V_R). Broad-sense heritability (H^2) can be calculated as $H^2 = V_G/(V_G + V_E/n + V_R)$, where V_E is divided by n to account for the n replicate plots in the experimental design.

H. Timeline for the project

	Feb 2019	May 2019	June 2019	July 2019	Aug 2019	Oct 2019	Nov 2019 – Jan 2020
Planting							
Inoculation & Drought Set-up							
Gas Exchange & Water Potentials							
NSC sampling & processing							
Harvesting							
Data analysis and writing							

I. How results will be measured and reported

We will detect genotype by treatment interactions revealing which genotypes differ with respect to the combined effect of drought and pathogens. No genotypes should show a positive interaction (i.e. an increase in resistance under drought). We expect a disproportionately negative response with genotypes that are not very resistant under control treatments (i.e. showing much greater infection under drought). Genotypes that do show an interaction will likely have the largest percent losses of resistance and will represent genotypes that did not inherit resistance that is robust against environmental change. Lastly, genotypes that do not show an interaction with treatment should show minimal percent losses of resistance under drought and would be identified as promising stress tolerant genotypes. The results from these experiments will be presented at the TACF annual meeting, written up for publication in peer reviewed literature (i.e. Tree Physiology, New Forests). All the datasets will made available to TACF.

J. Budget

Expense	Item Provider	Quantity	Item Cost	Total Cost	When Funds will be used
Travel					
Car	IRS mileage estimate	6 trips x 530 miles	$0.545 / mile	$1733.10	Feb, May – Oct 2019
Hotel	Country inn and Suites by Radisson, Abingdon	1 room (2 beds)	$86 per night	$516	Feb & Oct 2019
Dorm Room	Emory and Henry College	1 room (2 beds)	$20 per night	$380	May – Aug 2019
TACF 2019 Annual meeting	Hotel & Registration	1 graduate student	$500	$500	Oct – Nov 2019
Personnel					

Undergraduate Assistant	Stipend	20 hrs/wk 24weeks	$8.15 per hour	$3912	May– Oct 2019
	Workers comp			$29	
Materials and Equipment					
10L Liquid nitrogen dewar	Cole-Parmer	1		$740	August – October 2019
Liquid Nitrogen	Ohio University	As needed		$150	August – October 2019
Nitrogen Gas	Pallini Industries	As needed		$85	May – Oct 2019
Gas exchange consumables	LI-COR Bioscience	As needed		$600	June – August 2019
Reagents and standard for NSC analyses				$827.30	August– December 2019
Total				**$9472.40**	

Budget Justifications

Travel

Gas costs are determined from the distance from Ohio University to Meadowview, VA and on the IRS recommended cost per mile ($0.543). A personal vehicle will be used for all trips. The hotel cost is based on pricing from 8/14/2018 for a two adult, two bed room at the Country Inn and Suites by Radisson in Abingdon. 940 E Main St, Abingdon, VA 24210. The hotel stay is necessary for visits during the school year where the dorms will be unavailable. During visits in the summer we will stay in dorms at Emory and Henry College which provide a much cheaper rate. Travel and Hotel to TACF meeting in 2019 to present results from the experiment is an estimate ($500) because we don't have exact details on timing and location. Rosenthal lab will cover any additional travel expenses incurred during the experiment or to attend the meeting.

Personnel

Funds for a part-time undergraduate assistant are requested to help in measurement taking during the trips and sample processing. As multiple types of measurements will be taken on each trip, another set of hands is imperative to assure all data is collected efficiently. The undergraduate will also assist in processing NSC samples in lab. The 480 hours requested at $8.15 per hour is comparable to other undergraduate research programs at Ohio University.

Materials and Equipment

Liquid nitrogen and 10L liquid nitrogen dewar

For the Nonstructural carbohydrate analysis, samples must be frozen immediately after collection in liquid nitrogen. The dewar is needed to keep samples frozen after collection, during transit to Ohio University and until samples are analyzed. Liquid N is available in the Plant Biology Department on pay per use basis.

Nitrogen Gas

Nitrogen gas is used in pressure chambers to determine leaf water potentials. This cost includes both tank rentals fees ($60) and refill costs ($25).

Gas exchange consumables

The LI-COR 6400s requires uses chemicals and gaskets that need to be replaced after each measurement campaign. The consumables are sold in a couple of packages totaling $475. This package includes CO2 Cylinders (12 g) packs (25/pack), Drierite (10-20 mesh, 1 lb. each) for humidity control, and two bottles of soda lime (Wet Type, 6-12 mesh, 450 g each). Chamber gasket kits are sold separately. Lastly, we require calibration gases ($125) to routinely "zero" infrared gas analyzers in the LI-COR 6400 to ensure precision and accuracy of gas exchange measurements.

Nonstructural carbohydrate Assay and Solute Standard

Funds for this assay include reagents for a sugar extraction and quantification detailed in Chow and Landhäusser, 2004. This reaction requires the purchasing of alpha-amylase ($12.50), amyloglucosidase ($93.90), sodium acetate buffer ($52.40), glacial acetic acid ($4.50), Lugol's solution ($52.50), sulfuric acid ($81.00), phenol ($84.40), ethanol ($91.00), glucose standards ($44.80), and starch standards ($40.30). Solute standards are also needed for calibrating our vapor pressure osmometer and dew point hygrometer which are both used in determining aspects of water potential and drought stress ($270).

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K. Curriculum Vitae

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Professional Preparation:
Ph.D. Plant Biology, 2004 – University of Georgia, Athens, GA. ; M.S. Botany, 1999 – University of Wyoming, Laramie, WY; B.S. Biology, 1993 – George Mason University, Fairfax, VA.

Appointments:
2013 – Present Assistant Professor of Environmental and Plant Biology, Ohio University
2007 – 2012 Plant Physiologist USDA Global Change and Photosynthesis Research Unit
2005 – 2007 Research Faculty – Portland State University.

Publications last 4 years:
Tomeo, NJ and David M Rosenthal. (2018). Photorespiration differs among *Arabidopsis thaliana* ecotypes and is correlated with photosynthesis. *Journal of Experimental Botany*, in press: https://doi.org/10.1093/jxb/ery274

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decreases in photosynthetic stimulation of soybean (*Glycine max*) at elevated [CO_2] and temperatures under fully open air field conditions, *Plant Science*, 226 136–146

Grants Received:

The American Chestnut Foundation : "Predicting growth and carbon uptake of American chestnut in current and future climates." PI. Funded ($2826; 2016-2018;).

Ohio University Research Council: "Parameterizing photosynthesis models in American chestnuts and hybrids to inform restoration in the context of climate change. PI. Funded ($7960; 2016-2017)

Ohio University Research Council: "Does drought alter phloem loading in deciduous trees. PI. Funded ($7955; 2018-2019)

Synergistic activities:

Professional Service, Activities and Memberships: 2018-2018 Chair, and 2016-2017, Vice Chair of the Midwestern Section American Society of Plant Biologists (ASPB). I work to maintain an active and vibrant subsection of ASPB, work with the committee to plan annual meeting locations and help organize the annual meeting with Chair, Select and invite plenary and Keynote speakers, coordinate advertising and organizing and facilitate judging of student oral and poster presentations.

Member: American Society of Plant Biologists; Crop Science Society of America; Ecological Society of America; International Society for Photosynthesis Research; Sigma Xi. Board Member: Ohio University Environmental Studies Advisory Board (Voinovich School of Leadership and Public Affairs). Ad hoc reviewer last four years: Bioenergy Research, BMC Plant Biology, Forest Ecology and Management, International Journal of Plant Sciences, Global Change Biology, New Phytologist, Plant Biology, Plant Cell and Environment, Photosynthesis Research, Plant Functional Biology, Science of the Total Environment, PLOS one, The Plant Phenome Journal,

Current Graduate Advising: Doctoral Students: Nick Tomeo (2017), Kelsey Bryant (2021), Brett Fredricksen (2022); MS students Abby Singletary (2017); Jen Hastings (2018) Allison Pigliucci (2020). Doctoral advisory committee (current) Ann Sternberger, Kathleen Gabler. MS Thesis (NUTR) Shun Dai.

Undergraduate Mentoring: Honors College Tutorial (Susan Eiben, Rachel Martin); Program to Aid Career Exploration (2018, Sam Kukor; 2016, Jordan Francisco, Luke Welch; 2015 Andrew Fox); Undergraduate research credit (2016 Morgan Varner, Bailey Erickson; 2017 Susan Eiben, Jeremy Oehlenschlager)

Outreach: 2017 Morrison Gordon Elementary School Garden Club; Environmental Defense fund panelist, Athens Ohio; 2016 South-East Regional State Science Fair Judge, Ohio University Student Expo Judge; 2013,15,16,17 Ohio University Student Expo Judge; 2014 Mentor/Speaker, High School Science Students, Logan High School, Logan OH; 2013 Ohio South-East Regional State Science Fair Judge; American Chestnut Foundation Ohio Chapter, Volunteer tree planting. 2012: Speaker Ohio Corn Growers Group, Champaign-Urbana People's Garden community garden project to provide fresh produce to families in need 2010; University of Illinois Agronomy Day 2010.

K. Curriculum Vitae (cont.)

Brett Fredericksen

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Academic Background

Ph.D. 2021(anticipated) – Department of Environmental and Plant Biology
Ohio University – 2016-2021 (anticipated)
Advisor – Dr. David Rosenthal

Bachelor of Science, Plant Biology - May 2016
College of Biological Sciences: Department of Plant Biology
University of Minnesota - Twin Cities

Academic Appointments

2016 to current	Teaching Assistant – Ohio university Department of Environmental Science and Plant biology
	Interactive effects of Chestnut Blight and Drought
Summer 2015 and 2016	Field technician– Cedar Creek Ecosystem Science Reserve Dimensions of Biodiversity Project – University of Minnesota
2015	Undergraduate Researcher – Directed Research Program
	Dimensions of Biodiversity Project – University of Minnesota
2014	Undergraduate Researcher – Undergraduate Research Opportunities Program
	Oaks of the Americas Project – University of Minnesota

Research in Progress

Dissertation:
Interaction of Drought and Chestnut blight on the resistance of Blight resistant hybrids
Rosenthal, D., Fredericksen, B., "American Chestnut response to Elevated CO2 and Temperature"
Rosenthal, D., Bryant, K., Fredericksen, B., "Application of Vc_{max} – Temperature response model to chestnut"

Grants

Original Work Grant – Fall 2017 – Ohio University Graduate Student Senate
Drought tolerance in American chestnut and hybrids - $750
Original Work Grant – Fall 2016 – Ohio University Graduate Student Senate
Effects of Climate Change on Phytophthora Infection in American Chestnut - $750

Presentations

Brett Fredericksen, Susan Eiben, Jeremy Oehlenschlager, David M. Rosenthal, "Genotypic differences and seed size prove more influential on first year growth than simulated climate change in American chestnut and blight resistant hybrids." ESA Annual meeting. (New Orleans – 2017)

Brett Fredericksen, Susan Eiben, Jeremy Oehlenschlager, David M. Rosenthal, "Seed size, not simulated climate change, explain biomass differences of American chestnut and hybrids after one season." TACF Annual Meeting. (Portland – 2017)

Luke Welch, **Brett Fredericksen**, and David Rosenthal, "Early Growth Response to Elevated CO2 and Temperature in both Hybrid and Native American Chestnuts (*Castanea dentata*)." Student Research and Creativity Expo. (Ohio University – 2016)

Brett Fredericksen, Matthew Kaproth, Jeannine Cavender-Bares, "Drought Tolerance Trait Conservation in Oaks of the Americas." Undergraduate Summer Research Symposium, (University of Minnesota – 2014)

Training and Workshops:

Li-Cor Photosynthesis Training – May 2017
Intensive Training course in the use of the Li-6400XT Portable Photosynthesis System.

Teaching Experience

2018 BIOL1010 Principles of Biology – Ohio University
PBIO 3260/5230 Ecophysiology Teaching assistant- Ohio University
Graduate Assistant for University Greenhouse – Ohio University

2017 PBIO 2090 Plant Ecology Teaching assistant– Ohio University
PBIO 4120 Plant Pathology Teaching assistant – Ohio University
PBIO 3260/5230 Ecophysiology Teaching assistant- Ohio University
Graduate Assistant for University Greenhouse – Ohio University

Society Affiliations

Ecological Society of American – Since 2017
American Society of Plant Biologist – Midwest Chapter – Since 2017
The American Chestnut Society – Ohio Chapter – Since 2017

Outreach & Involvement

2017&2018: Guest Presenter - Camp Oty'okwa and Good Works
2017: Co-representative for Graduate Student Senate for PBIO Department Ohio University
2017: Member of University Research Council – Ohio University
2017: Volunteer at Techsavvy 2017, Ohio University hosted by AAUW,
2017: Co-Organizer for Invasive Garlic Mustard removal effort, Ohio University's PGSA
2017: Grant Reviewer for Original Work Grant given by the Graduate Student Senate.