

PENNSTATE



College of Agricultural Sciences

L.W. SCHATZ CENTER FOR TREE MOLECULAR GENETICS

ANNUAL REPORT

July 2020 – June 2021

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The Schatz Center over the years:



L.W. SCHATZ CENTER FOR TREE MOLECULAR GENETICS ANNUAL REPORT, FOR FISCAL YEAR 2020-2021

Since 2003, The Louis W. Schatz Center for Tree Molecular Genetics at Penn State has flourished from its founding from the estate gift of Dr. Schatz and through continued interactions with the Schatz family and colleagues around the world. The Schatz Center endowments at University Park have supported a wide array of research advancements through support for post-doctoral fellows, visiting scholars, undergraduate and graduate students, staff, field trips, travel, equipment, and research supplies. The Schatz Center endowments at the Mont Alto campus have also been highly impactful through sponsorship of local and national colloquia and by enabling students to enhance their training through hands-on projects. We are pleased to provide this update on activities and accomplishments in The Schatz Center for the 2020-2021 academic year, and to welcome Dr. Jill Hamilton as the new Director of The Schatz Center for Tree Molecular Genetics at the University Park campus beginning August 1, 2021.

UNIVERSITY PARK CAMPUS ENDOWMENTS

THE LOUIS W. SCHATZ CENTER FOR TREE MOLECULAR GENETICS ENDOWMENT:

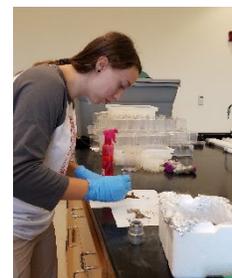
This endowment supported ongoing research activities in the Schatz Center at the University Park campus, including wages for undergraduate student researchers, wages for technical staff, salary for the visiting scientist, publication costs, field support staff, travel expenses, external and internal research services, and research supplies. Expenses supported the completion of projects under the outgoing Schatz Center Director, J.E. Carlson, in addition to projects sponsored by two major grants which extended into the next fiscal year, as explained in the research progress update below.

Undergraduate Research: One undergraduate research student, **Joshua Gershey**, was awarded a Schatz student assistantship in the 2020/2021 academic year. Josh conducted research on the combined effects of climate change and competition on black walnut growth, which was conducted with Schatz Center Associate Faculty member Laura Leites, Associate Research Professor of Quantitative Forest Ecology in the Department of Ecosystem Science & Management. Joshua received a first-place award at the Penn State Undergraduate Research Exposition for a poster presentation on his research in black walnut. Josh's research was also supported by an undergraduate research award from the Penn State College of Agricultural Sciences.



Joshua Gershey

Technical Research Staff: The endowment supported the Schatz Center's lab manager, **Maureen Mainlander**, who served on a part-time basis. Ms. Mainlander trained for 2 years as an undergraduate assistant in the Schatz Center until her graduation with a BS degree from the Horticulture Program at Penn State in December 2019. Since January 2020, Maureen has provided administrative and research support to the Center's Director and the Visiting Scholar, including arrangements for travel, safety training, lab inspections, ordering supplies, shipping, inventory and research assistance. Maureen also helped supervise undergraduate research assistants and she managed the Schatz Center's extensive greenhouse and field trial



Maureen Mainlander

plantings, including the collection of phenotypic (growth) data and vegetation management. Stephen Hoy, staff member with The American Chestnut Foundation's research group at Penn State, was also supported one month per calendar year to assist us in larger-scale field work such as tractor mowing, herbicide and pesticide applications, harvesting plants from the field sites, and tilling.

Visiting Scientist: The endowment supported Associate Research Professor **Tatyana Zhebentyayeva** for a third year. Dr. Zhebentyayeva's high productivity continued, with the publication of 6 peer-reviewed research papers, virtual conference presentations, and submissions of grant proposals with colleagues at Penn State and beyond. Tatyana's research on tree genomes and genes for important traits such as disease resistance and dormancy, included projects on peach, plum, apricots, and chestnut. Over the past 3 years, Dr. Zhebentyayeva's contributions were important to maintaining the high profile and productivity of the Schatz Center during Director John Carlson's transition through part-time service and into retirement on June 30, 2021. Dr. Zhebentyayeva will continue to work with the new Director of the Schatz Center, Dr. Jill Hamilton, in the 2021-2022 fiscal year.



Dr. Zhebentyayeva

Plans for the 2021-2022 fiscal year: Approximately half of the endowment funds available at the beginning of this fiscal year were carried over to the next (2021/22) fiscal year. This surplus was primarily the result of reduced research capacity during the covid pandemic. Travel plans to collect samples and gather data were curtailed, while research activities were slowed by interruptions in the delivery of supplies and temporary closures of core facilities providing research services such as DNA sequencing. In addition, the current director conserved funds to assist the new director with a smooth transition period and support for quick initiation of new larger scale research programs. The new Schatz Center Director, Dr. Jill Hamilton, is scheduled to assume responsibility for the fund on August 1, 2021.

SCHATZ FACULTY TRAVEL FUND:

The Louis and Merry Schatz Faculty Travel Fund was not used in the 2020-2021 fiscal year due to out-of-state travel being banned due to the covid-19 pandemic. Participation in conferences and research meetings this past year was achieved virtually. **The 2020/21 university fiscal year** will see a transition of the Directorship of the Schatz Center at the University Park campus from Dr. Carlson, who retired June 2021, to Dr. Jill Hamilton who arrives August 1, 2021. With the recent relaxation of travel restrictions, it is anticipated that the new Director will be able to attend conferences and visit colleagues in PA and across the US as initial steps in developing new research directions for the Schatz Center. The remaining balance of \$4,828 was applied back to the principal of the Schatz Faculty Travel Fund, which will increase the total amount of travel support available for the new Director and other faculty in future years.

SCHATZ STUDENT FIELD TRIP FUND:

The biennial field trip of Schatz Center faculty and students to visit Gordon and Karen Schatz and The L.W. Schatz Demonstration Tree Farm at Humboldt State University in California was originally planned for May 2020, but delayed due to the covid pandemic. The field trip date was re-scheduled for August 2020, and then May 2021. However, travel restrictions were still in place. The balance of \$12,724 from fiscal year 2020/2021 plus estimated new revenues of \$4,000 should

provide app. \$16,725 for a student field trip to visit the Schatz's and Humboldt CA, in 2022. The fund will then be large enough to support participation by several faculty and several students from both the University Park and Mont Alto campuses participate in the biennial field trip. **In the 2020/21 university fiscal year**, Dr. Carlson, who is retired and serving now as Professor Emeritus, and Craig Houghton at the Mont Alto campus, who plans to retire in June 2022, will be able to introduce to the Schatz family to both the new Director of The Center on the University Park campus, Dr. Hamilton, and to Mont Alto campus faculty member Kimberly Bohn who serves as co-Director of Schatz endowment activities at Mont Alto. In addition, we plan to also include in the field trip Dr. Jesse Kreye, Assistant Research Professor of Fire and Natural Resources Management in the ESM department at Penn State, who graduated from Humboldt State University. Dr. Kreye volunteered to introduce the new Schatz Center Co-directors and students to faculty and students at Humboldt State, with whom he still collaborates.

SCHATZ TREE GENETICS COLLOQUIUM FUND, MONT ALTO CAMPUS

The Schatz Center's Tree Genetics Colloquium Fund is based at the Mont Alto campus, which will provide a complete report for the 2020-2021 fiscal year. Plans for holding The Schatz Tree Genetics Colloquium at Penn State in 2021 did not materialize due to scheduling issues arising from the covid pandemic. Instead, the Schatz Colloquium Fund became a major sponsor of the 36th Southern Forest Tree Improvement Conference (SFTIC) hosted by the Warnell School of Forestry at the University of Georgia, but convened virtually from June 7 to 9, 2021. The Schatz Colloquium Fund provided support for speaker honoraria, conference organization expenses, awards to 5 presenters to supplement their research projects, and partial coverage of publication charges for presenters wishing to publish their presentations as peer-reviewed papers in a special issue of the journal *Forests* edited by Dr. Carlson, Dr. Bohn, and Dr. Abbott at the University of Kentucky. Finally, the closing session of the SFTIC conference was dedicated to the Schatz Center, which featured a talk by the center's new director, Dr. Hamilton.

For the 2021/22 fiscal year, the Schatz Tree Genetics Colloquium fund is planning to partially support the first meeting of the North American Forest Genetics Society at the Asilomar, CA, conference center in June, 2022. It is hoped that the Asilomar meeting and the Schatz Center's student field trip to Humboldt, CA, can be held in tandem as one extended trip.

SCHATZ CENTER RESEARCH PROGRESS UPDATE FOR 2019-2020

The Schatz Center made substantial progress during the past year, despite continuing issues related to safety requirements during the covid pandemic. With colleagues, from July 2020 to June 2021, we published 10 peer-reviewed journal articles, 2 peer-reviewed proceedings, and submitted 3 manuscripts that are currently under review. The grant received by Carlson, Steiner and Zhebentyayeva from the USDA's McIntire-Stennis program, which concludes September 2021, has resulted in the completion and analysis of the first reference genomes for Northern Red Oak and Green Ash. We have completed a manuscript describing the 23 chromosomes of green ash, all of the gene sequences in ash including candidates for EAB-resistance, and comparisons of the structure of the green ash genome to the genomes of other angiosperm trees and other plants within the Asterids. We also used the new reference genome as a platform to assemble whole-chromosome versions of the genomes of 27 other *Fraxinus* species and to provide an assessment of DNA sequence variation and population structure across the former natural range of green ash in North America. The US Department of Energy's Joint Genome Institute (JGI) assisted us in the sequencing and assembly of the Northern Red Oak, which was completed early in 2021 and released to the world through the JGI's Phytozome website (<https://phytozome->

next.jgi.doe.gov/info/Quabra_v2_1). The preparation of a manuscript is now underway to describe the 12 chromosome pairs of Northern Red Oak, the gene content, and how the organization of genes and genome of *Quercus rubra* compares to other oak species and a range of angiosperm trees. For the manuscript we are also conducting analyzes of the genetic basis of important traits to elucidate a platform of genomic and genetic resources to encourage and facilitate future research projects and applied forest health and restoration initiatives.

During the 2020-2021 academic year, Dr. Carlson and Dr. Zhebentyayeva continued to publish scientific papers and present updates at conferences, on our continuing research projects with colleagues on peach, plum, alder, shrub willow, chestnut, peony, beech, and acacia trees:

Peer-reviewed publications:

1. Groppi A, Liu S, Cornille A, ..., **Zhebentyayeva T**, *et al*, 2021. Population genomics of apricots unravels domestication history and adaptive events. *Nature Communications* **12**, 3956 <https://doi.org/10.1038/s41467-021-24283-6>
2. Lazic D, Hipp AL, **Carlson JE**, Gailing O. 2021. Use of genomic resources to assess adaptive divergence and introgression in oaks. *Forests* **12**:690, <https://doi.org/10.3390/f12060690>, 18 pages.
3. Pina A, Irisarri P, Errea P, **Zhebentyayeva T**. 2021. Mapping Quantitative Trait Loci Associated with Graft (In) Compatibility in Apricot (*Prunus armeniaca* L.). *Frontiers in Plant Science*. **12**:45.
4. Callahan AM, **Zhebentyayeva TN**, Humann JL, Saski CA, Galimba KD, Georgi LL, Scorza R, Main D, Dardick CD. 2021. Defining the ‘HoneySweet’ insertion event utilizing NextGen sequencing and a de novo genome assembly of plum (*Prunus domestica*). *Horticulture research*. **8**(1):1-3.
5. Yu J, Bennett D, Dardick C, **Zhebentyayeva T**, Abbott AG, Liu Z, Staton ME. 2021. Genome-Wide Changes of Regulatory Non-Coding RNAs Reveal Pollen Development Initiated at Ecodormancy in Peach. *Frontiers in Molecular Biosciences*. **2021**:8.
6. Stanton BJ, Haiby K, Gantz G, Shuren R, Hall R, Johnson LJ, Weathers TC, Wu D, Islam-Faridi N; Best T, Stanish A, Staton M, **Carlson JE**. 2020. Inter-Specific Hybridization of *Alnus rubra* and *Alnus rhombifolia*: Preliminary Report of a New Taxon and DNA Marker Resources for Bioenergy Feedstock Production. *Tree Genetics & Genomes* **16**:70. <https://doi.org/10.1007/s11295-020-01457-9>, 13 pages.
7. Wang W, Carlson CH, Smart LB, **Carlson JE**. 2020. Transcriptome analysis of contrasting resistance to herbivory by *Empoasca fabae* in two shrub willow species and their hybrid progeny. *PLoS ONE* **15**(7): e0236586, (<https://doi.org/10.1371/journal.pone.0236586>) , 25 pages.
8. Staton ME, Addo-Quaye C, Cannon N, Yu J, **Zhebentyayeva T**, Huff M, Islam-Faridi N, Fan S, Georgi LL, Nelson CD, Bellis E, Fitzsimmons S, Henry N, Drautz-Moses D, Noorai RE, Ficklin S, Saski C, Mandal M, Wagner T, Zembower N, Bodénès C, Holliday J, Westbrook J, Lasky J, Hebard FV, Schuster SC, Abbott AG, **Carlson JE**. 2020. A reference genome assembly and adaptive trait analysis of *Castanea mollissima* 'Vanuxem', a source of resistance to chestnut blight in restoration breeding. *Tree Genetics and Genomes*, **16**:57 (<https://doi.org/10.1007/s11295-020-01454-y>) 23 pages.
9. Tchatchoua TD, Poethig RS, Doody E, Weathers TC, Swartz K, Mathieson I, Zembower N, **Zhebentyayeva T**, **Carlson JE**. 2020. Genetic diversity of *Faidherbia albida* populations in the Sudano Sahelian region of Cameroon, using SSR (Simple Sequence Repeat) markers. *African Journal of Biotechnology*, **19**(7): 415-425.
10. Guo L, Guo S, Xu J, He L, **Carlson JE**, Hou X. 2020. Phylogenetic analysis based on chloroplast genome uncover evolutionary relationship of all the nine species and six cultivars of tree peony. *Industrial Crops and Products*, **153**: p.112567, (<https://doi.org/10.1016/j.indcrop.2020.112567>), 10 pages.
11. **Carlson JE**, Staton ME, Addo-Quaye C, Cannon N, **Zhebentyayeva T**, Islam-Faridi N, Yu J, Huff M, Fan S, Conrad, AO, Schuster SC, Abbott AG, Westbrook J, Holliday J, Nelson CD, Georgi L, Hebard FV. 2020. An Improved Chinese Chestnut Genome, **In**: Proceedings of the Sixth International Workshop on the Genetics of Host-Parasite Interactions in Forestry—Tree Resistance to Insects and Diseases: Putting Promise into Practice, eds. Nelson, C. Dana; Koch, Jennifer L.; Sniezko, Richard A.,

Mt. Sterling, Ohio, USA, 5-10 August 2018. e-Gen. Tech. Rep. SRS–252. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 118 p.

12. **Carlson JE**, Čalić I, Koch J, Carey D, Addo-Quaye C, Shim D, Neale DB, 2020. Candidate Genes from GWAS was RNAseq for Beech Bark Disease Resistance in American Beech, **In**: Proceedings of the Sixth International Workshop on the Genetics of Host-Parasite Interactions in Forestry—Tree Resistance to Insects and Diseases: Putting Promise into Practice, eds. Nelson, C. Dana; Koch, Jennifer L.; Sniezko, Richard A., Mt. Sterling, Ohio, USA, 5-10 August 2018. e-Gen. Tech. Rep. SRS–252. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 42 p.

Manuscripts Submitted to journals for peer review:

1. Krystle A. Swartz, T. Casey Weathers, Nicole M. Zembower, Di Wu, John W. Wenzel, **John E. Carlson**, "Genetic Variation and Conservation Implications for the Rare and Imperiled Buffalo Nut (*Pyralaria pubera*)" *In revision*.
2. T. Casey Weathers, Matt A. Kulp, Jacob M. Rash, Aaron W. Aunins, Mike Eackles, Jesse R. Lasky, David C. Kazyak, **John E. Carlson**, "Riverscape Genetic Analyses Identify Biotic and Abiotic Factors that Shape Patterns of Genetic Structure in Appalachian Brook Trout Populations", *In revision*.
3. T. Casey Weathers, Matt A. Kulp, David C. Kazyak, Jacob Rash, **John E. Carlson**, "Implications of fine-scale genetic differentiation for the conservation of southern Appalachian brook trout (*Salvelinus fontinalis*)" *In revision*.

Preprints published

1. Perkins MT, **Zhebentyayeva T**, Sisco PH, Craddock JH. Genome-wide sequence-based genotyping supports a nonhybrid origin of *Castanea alabamensis*. bioRxiv. 2019 Jan 1:680371.

Presentations at scientific meetings

1. Pina A, Irisarri P, Errea P, **Zhebentyayeva T**. 2020. "Exploring the genetic control of graft incompatibility in apricot (*Prunus armeniaca* L.)." The 10th Rosaceae Genomics Conference", 9-18 December 2020, Barcelona, Spain (Virtual)
2. Sarto PS, **Zhebentyayeva T**, Errea P, Pina A, 2020, ""SELF- AND GRAFT- INCOMPATIBILITY ON A F1 APRICOT PROGENY" The 10th Rosaceae Genomics Conference", 9-18 December 2020, Barcelona, Spain (Virtual)