Merritt Khaipho-Burch

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LinkedIn Profile
Google Scholar Profile

SUMMARY STATEMENT

I am a geneticist with a broad range of experiences in quantitative genetics, classical transmission genetics, molecular biology, plant breeding, and bioinformatics using the model organism *Zea mays*. I have a passion for designing and implementing models to understand the genetic basis and regulation of complex quantitative traits.

EDUCATION

2023 Ph.D. Cornell University, Plant Genetics, minor Genomics
2018 M.S. South Dakota State University, Biological Sciences
2016 B.S. University of Hawaii at Hilo, Biology (Cell and Molecular Biology Track)

RESEARCH EXPERIENCE

Cornell University | Graduate Research Assistant | Aug 2018 – Nov 2023 (expected)

Advisor: Edward Buckler

Topics: Elucidating the patterns of pleiotropy and its biological relevance in maize AND Regulatory Adaptation of Transposable Elements and Their Effect on Gene Expression in Maize and the Andropogoneae

Delivered: With association mapping techniques I curated and mapped 120,549 traits across two diverse maize populations to uncover the patterns of pleiotropy. Using this data, I created multiple machine learning models (random forest, gradient boosting) to describe how these pleiotropic loci were biologically regulated. Currently, in my second project, I have developed a novel gene expression quantification pipeline suited towards the highly diverse maize genome to test how >1 million transposable element insertion polymorphisms impact gene expression across four tissues. Lastly, I have led a highly collaborative team with the world's leading molecular biologists and plant breeders to write a perspective on why genomic prediction will be the solution to increasing intrinsic crop yield rather than single genes. **Over the course of my PhD, I am the first and corresponding author on 2 publications, am co-author on 5 papers, and was awarded a USDA NIFA AFRI predoctoral fellowship for $180,000.**

South Dakota State University | Graduate Research Assistant | July 2016 – May 2018

Advisor: Donald Auger

Topics: Identification of QTL Modifying the Activity of The *Tcb1-S* Locus AND Characterization and Sequencing of Two Plutonium-Beryllium Induced Reduced Gametophyte Transmission Mutants in Maize

Delivered: Used QTL mapping to identify modifiers of the *teosinte crossing barrier 1* locus in maize using the Intermated B73 x Mo17 population and identified numerous candidate loci. For my second project, I sequenced and assembled the genomes of two male gametophyte mutants and identified candidate causal loci for pollen development. **From these projects I am a co-corresponding author on 1 publication and presented my research on posters in 5 national and international conferences.**

USDA ARS PBARC | Research Student Assistant | 2015-2016

Advisor: Scott Geib

Topic: Investigating axis formation in Mediterranean fruit flies.

Delivered: Designed and analyzed experimental data for a time series gene expression experiment on fruit-fly eggs. Additionally, I validated numerous RNAi experiments through gene expression assays.

Hilo Core Genetics Facility | Laboratory Assistant | 2015

Advisor: Anne Veillet

Delivered: Taught two workshops on DNA extraction for the non-science community (East Hawaii 4-H club, UH Hilo outreach day). I also ran and taught core facility users how to perform DNA extractions, design RT-PCR experiments, set up IonTorret sequencing libraries and runs, and use facility instruments.

University of Hawaii at Hilo | Molecular Laboratory Assistant | 2014-2015

Advisor: Elizabeth Stacy

Delivered: Using DNA extraction, PCR, and Sanger sequencing I amplified genetic markers to create and deliver phylogeographic trees of *Metrosideros polymorpha* to understand the speciation process of these trees across the Hawaiian Islands.

South Dakota State University | REU Research Scholar | Summer 2014

Advisor: Heike Bucking

Topic: Plant microbe interactions affect the biomass production of *Spartina pectinata*, a potential bioenergy crop.

Delivered: Collected and analyzed data on phosphorous content in roots and shoots, arbuscular mycorrhizae prevalence, as well as harvested tissue for RNA sequencing. Over this summer internship I generated one written report, presented a poster at two scientific conferences, and presented a talk to other REU students and department faculty.

LEADERSHIP

2022-2023 – **Co-chair** of the Synapsis Professional Development Committee. Responsible for organizing four events that invite alumni of Cornell's Plant Breeding and Genetics Section to answer questions about their research programs, career path, and job activities, as well as provide guidance for current students.

2021-2022 – **Co-chair** of the Synapsis Invited Speaker Committee. Responsible for soliciting speaker nominations from students, inviting the speakers, and organizing two seminars.

2020-2021 – **President** of Synapsis, the academic and social organization of the faculty, graduate students, and alumni of the Section of Plant Breeding and Genetics at Cornell University.

2019-2020 – **Committee Chair** for 9th Annual Cornell University Graduate Student Plant Breeding Symposium titled "Bringing Back Biodiversity" held virtually. Applied and awarded a $6,000 grant from Corteva Agriscience to host this symposium. I lead a team of four volunteers who obtained 500 registered participants that tuned into listen to our five invited speakers and two student speakers.

2018-2019 – **Committee Member** for the 8th Annual Cornell University Graduate Student Plant Breeding Symposium titled "Common Plants for Uncommon Goals." Responsible for organizing speaker travel, accommodations, and day-of logistics.

GRANTS AND FUNDING

2022-2025 – **USDA NIFA AFRI Predoctoral Fellowship** for "*Regulatory Adaptation of Transposable Elements and Their Effect on Gene Expression in Maize and the Andropogoneae.*" Award amount: **$180,000**.

2017 – Helen Roberti Native American Scholarship, South Dakota State University

2017 – South Dakota EPSCoR travel award to the 2017 American Indian Science and Engineering Leadership Summit, Chandler, AZ.

2016 - Maize Genetics Network Enhancement via Travel (MaGNET) travel award to the 58th Annual Maize Genetics Conference, Jacksonville, FL.

HONORS AND AWARDS

2022 – **David L. Call Award** from the American Indian and Indigenous Studies Program. Given to one Indigenous graduate or professional student per year who displays outstanding leadership, service, and commitment in pursuit of a graduate degree.

2021 – **Best PhD Poster Video** at the 6th International Conference of Quantitative Genetics.

PUBLICATIONS (*CORRESPONDING AUTHOR, **JOINT CORRESPONDING)

Khaipho-Burch, M.**, Cooper, M., Crossa, J., de Leon N., Holland, J., Lewis, R., McCouch, S., Murray, S., Rabbi, I., Ronald, P., Ross-Ibarra, J., Weigel, D., Yan, J., Buckler, E. S.** (2022). The perils and promise of single-gene solutions to crop yield: extraordinary claims require extraordinary evidence. Submitted to Nature.

Khaipho-Burch, M.*, Ferebee, T., Giri, A., Ramstein, G., Monier, B., Yi, E., Cinta Romay, M., & Buckler, E. S. (2022). Elucidating the patterns of pleiotropy and its biological relevance in maize. In bioRxiv (p. 2022.07.20.500810). https://doi.org/10.1101/2022.07.20.500810

Maharjan, N., **Khaipho-Burch, M.****, Awale, P., Gyawali, A., Shrestha, V.**, Wu, Y., & Auger, D. L. (2022). Genomic mapping of the modifiers of teosinte crossing barrier 1 (Tcb1). In bioRxiv (p. 2022.07.18.500501). https://doi.org/10.1101/2022.07.18.500501

Bekkering C, Breitzman M, Cook T, **Khaipho-Burch M**, Finegan C, Kyanam AN, et al. Virtual symposia drive student professional development around the world. CSA News. 2022. doi:10.1002/csan.20732

Gage JL, Mali S, McLoughlin F, **Khaipho-Burch M**, Monier B, Bailey-Serres J, et al. Variation in upstream open reading frames contributes to allelic diversity in maize protein abundance. Proc Natl Acad Sci U S A. 2022;119: e2112516119. doi:10.1073/pnas.2112516119

Giri A, **Khaipho-Burch M**, Buckler ES, Ramstein GP. Haplotype associated RNA expression (HARE) improves prediction of complex traits in maize. PLoS Genet. 2021;17: e1009568. doi:10.1371/journal.pgen.1009568

Song, B., Buckler, E. S., Wang, H., Wu, Y., Rees, E., Kellogg, E. A., Gates, D. J., **Khaipho-Burch, M.,** Bradbury, P. J., Ross-Ibarra, J., Hufford, M. B., & Romay, M. C. (2021). Conserved noncoding sequences provide insights into regulatory sequence and loss of gene expression in maize. Genome Research. https://doi.org/10.1101/gr.266528.120

Washburn JD, **Burch MB**, Franco JAV. Predictive breeding for maize: Making use of molecular phenotypes, machine learning, and physiological crop models. Crop Sci. 2020;60: 622–638. doi:10.1002/csc2.20052

SKILLS

Communication: Communication of plant breeding and genetics to the community from grades 3-12 at appropriate National State Science Standard levels. Have interacted with plant breeders, molecular biologists, computational biologists, programmers, and geneticists for various collaborative projects.

Quantitative Genetics, Statistics, Association Mapping and Population Structure Analysis Experience: QTL mapping, association mapping (using mixed linear models, general linear models, and matrix eQTL), genomic prediction (SNPs, RNA expression, metabolite), RNA and DNA sequence analysis (skim, genome assembly), and imputation (Beagle, Practical Haplotype Graph).

Cloud-based Computing: Google Colab, and Cornell High Performance Computing Services (accessed through R Studio Server, Jupyter Notebooks, and the command line).

Bioinformatic Experience: R, bash/shell.

Computational Tools: Windows, Linux, Mac.

Molecular Experience: DNA and RNA extraction, quantitative real time PCR, DNA sequencing library preparation for the Ion Torrent platform, PCR, gel electrophoresis, primer design, dsRNA design and preparation for use in RNAi experiments, RNAi injection into fruit fly eggs, microscopy, phosphorous profiling in roots and shoots, and arbuscular mycorrhizae phenotyping.

Phenotyping and field: Measurement of maize flowering time and numerous other plant architecture phenotypes, designing and planting maize field layouts, and maize and Arabidopsis pollinations.

Management and Mentoring: Mentored two undergraduate students (Emily Yi and Busha Hika). Certified in a course called "*Building Mentoring Skills for Academic Careers*" sponsored by the Future Faculty and Academic Careers office of the Cornell Graduate School.

PRESENTATIONS

The perils and promise of single-gene solutions to crop yield: extraordinary claims require extraordinary evidence.
Authors: **Khaipho-Burch, M.****, Cooper, M., Crossa, J., de Leon N., Lewis, R., McCouch, S., Murray, S., Rabbi, I., Ronald, P., Ross-Ibarra, J., Weigel, D., Yan, J., Buckler, E. S.****

- Virtual talk presented at North Carolina State University's Initiative for Translational, Integrative and Synthetic Plant Biology group. March 10, 2023.
- Virtual talk presented at Zeavolution. November 16, 2022.

Limited contribution of transposable elements to regulatory adaptation in maize inbreds and hybrids.
Authors: **Khaipho-Burch, M. B.,** Ferebee, T., Stitzer, M, Buckler, E. S.

- Poster presented at the Plant and Animal Genome Conference, San Diego, CA. January 13-18, 2023.
- Poster presented at the Cold Spring Harbor Transposable Element Meeting, Syosset, NY. October 11-15, 2022.
- Poster presented at the National Diversity in STEM Meeting hosted by the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), San Juan, Puerto Rico. October 27-29, 2022.

Elucidating the extent of pleiotropy in maize and its relevance towards trait prediction.
Authors: Khaipho-Burch, M. B., Ferebee, T., Giri, A., Ramstein, G., Monier, B., Yi, E., Romay, M. C., Buckler, E. S.

- Poster presented at the Population, Evolutionary, and Quantitative Genetics Conference, Pacific Grove, CA. June 7-10, 2022.
- Talk presented at the Plant Breeding and Genetics Student Seminar Series, Cornell University, Ithaca, NY. YouTube: https://youtu.be/Mdk_iRLQdFw. March 14, 2022.
- Talk presented at the Plant Breeding and Genetics Student Seminar Series, Cornell University, Ithaca, NY. April 13, 2021.
- Talk presented at the Plant Breeding and Genetics Student Seminar Series, Cornell University, Ithaca, NY. April 28, 2020.
- Virtual poster presented at the 62nd Annual Maize Genetics Conference. June 25-26, 2021.
- Poster video presented at the 6th International Congress on Quantitative Genetics. YouTube: https://youtu.be/9lwoF-2EXDc. November 2-12, 2020. **Awarded Best PhD Poster Video.**

Estimation of the divergence between maize and sorghum using the Andropogoneae.
Authors: **Burch, M. B.**, Song, B., Romay, M. C., Kellogg, E., Buckler, E. S.,

- Poster presented at the 61st Annual Maize Genetics Conference, St. Louis, MO. March 14-17, 2019.

Mapping Loci that Modify the Efficacy of Teosinte crossing barrier 1.
Authors: **Burch, M. B.**, & Auger, D.

- Poster presented at the 60th Annual Maize Genetics Conference, Saint Malo, France. March 22-25, 2018.
- Poster presented at the 59th Annual Maize Genetics Conference, St. Louis, MO. March 9-12, 2017.

TEACHING AND OUTREACH

2022 – **Taught two workshops** as part of the Research and Education Activities for Community Teachers (REACT) program to 25-30 elementary to high school teachers from across New York State titled:

"Cabbages and their cousins: the dogs of the plant world" and "Plant domestication and adaptation, a seed dispersal game."

2022 – **Taught four in-person classes** as part of the GRASSHOPR program to 15 students at the Southern Cayuga Junior/High school. The four classes were named "a-MAIZE-ing diversity: How plant breeders make your favorite foods even better." Taught students about natural versus artificial selection with various hands-on activities ranging from DNA extraction using strawberries, generating, and testing hypotheses on what grains 'pop', creating and domesticating wild seeds, and identifying shared plant morphology between wild and domesticated plants.

2022 - **Taught three in-person workshops** at the one day Expanding Your Horizons conference titled 'Plant Domestication and Adaptation: A Seed Dispersal Game" to 40 middle school students and parents.

2021- **Graduate Teaching Assistant** for Plant Genetics. The assistantship entailed teaching two lab sections to a total of 20 students, creating lab materials (quizzes, lab lectures, slides, pre-lab videos), grading exams, and running various experiments with students.

2021 - **Taught two virtual workshops** at Expanding Your Horizons titled 'Plant Domestication and Adaptation: A Seed Dispersal Game" at appropriate NY State Science Standards levels for elementary and middle school students.

PROFESSIONAL AFFILIATIONS

2017 - Present – American Indian Science and Engineering Society

2020 – Present – Society for Advancing Chicanos/Hispanics and Native Americans in Science

REFERENCES

Edward S. Buckler
Research Geneticist
USDA-ARS and Cornell University
esb33@cornell.edu
Ph.D. thesis advisor at Cornell University.

Heike Buecking
Division Director and Professor
University of Missouri College of Agriculture, Food & Natural Resources
heike.buecking@missouri.edu
REU advisor at South Dakota State University, also on Master's thesis committee.

Donald Auger (deceased January 2021)
Professor
South Dakota State University
Master's thesis advisor at South Dakota State University. Please contact Dr. Buckler or Dr. Buecking for the letter of reference from Dr. Auger.