

ELI DAVID HORNSTEIN

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CURRENT POSITION: PhD Candidate, North Carolina State University

I am a sixth year Plant Biology PhD candidate in Heike Sederoff's Plant Systems Engineering group. I am also an NSF-NRT fellow in the Agricultural Biotechnology in our Evolving Food, Energy and Water Systems program housed at NC State University. My primary research goal is to find new ways of improving crop sustainability and diversity through biotechnology. I am currently working with transgenic Brassicaceae plants carrying the mycorrhizal symbiosis-requisite transcription factor *IPD3*. Brassicaceae have evolutionarily lost mycorrhizae, and by restoring them I aim to improve water and nutrient efficiency of the many crops belonging to this family. I have also carried out work on projects for development of new plant protein crops and in improved methods of plant genetic transformation.

EDUCATION

Harvard Business School (2016): HBS Online Credential of Readiness, summer 2016 cohort
Duke University (2014): High Distinction in Biology

Cross-morph mate preference within a divergent, polymorphic population of poison frogs.
Thesis advisor Dr. Manuel Leal. Biology course GPA 3.7.

University of North Carolina at Chapel Hill (2014): B.A. Linguistics with Honors, GPA 3.4
Philological analysis of Old Mongolian: consonant-vowel harmony was not universally enforced. Thesis advisor Dr. Jennifer L. Smith. Linguistics course GPA 3.6.

Robertson Scholar, 2010-2014: A full merit scholarship with simultaneous enrollment at UNC and Duke. I received my degree in Linguistics from UNC and concurrently completed the Biology curriculum at Duke with a concentration in Evolutionary Biology.

High school: North Carolina School of Science and Math, Durham, NC (2009) GPA 5.0

Languages: Native: English; Fluent: Spanish and Swahili; Conversant: Mongolian and Mandarin

Tests: GRE General Test (2014): Verbal: 170/170 Quantitative: 160/170 Writing: 6/6
GRE Subject Test (2014): Biology: 880/990 (96th percentile)
North American Computational Linguistics Olympiad (2008): 8th in North America

GRANTS AND FELLOWSHIPS

NSF NRT Fellowship (2019-2021): \$97,000 (approximate) 2-year full fellowship to an interdisciplinary PhD cohort on agricultural biotechnology at NCSU titled 'Agricultural Biotechnology in our Evolving Food, Energy, and Water Systems' (AgBioFEWS).

NSF CCE-STEM Fellowship (2017): \$3,000 summer fellowship for training in research ethics of biotechnology conducted by the Genetic Engineering and Society Center.

Provost's Doctoral Fellowship (2016-2017): \$26,000 yearlong fellowship awarded by NC State University to support doctoral studies. Supplemented by a University Graduate Fellowship and a departmental RAship from the Department of Plant and Microbial Biology.

Fulbright Fellowship (Mongolia 2014-2015): \$20,000 yearlong fellowship awarded by the US Department of State, designed to foster international academic cooperation.

Foreign Language and Area Studies (FLAS) Fellow (2013): \$7,500 US government award supporting intensive study of advanced Swahili at the National Museum of Kenya.

Kenan-Biddle Grant (2013-2014): \$5,000 for a Duke-UNC collaborative project to develop a mobile app to report and receive biodiversity information for users' GPS coordinates.

EMPLOYMENT

- 2017 – 2018 **Teaching Assistant, NC State Biotechnology program:** responsible for laboratory instruction of 3, 6-hour-per-week laboratory sections per year of ‘BIT 410/510: Introduction to Manipulation of Recombinant DNA’
- 2016 **Associate in Research, Duke University Department of Biology:** in Dr. Tom Mitchell-Olds’ lab studying *Boechera*. Responsible for plant care, data collection and DNA extraction for multiple population genetic projects.
- 2014 – 2015 **Fulbright researcher, National University of Mongolia Department of Biology** independent research in conservation strategy, seed germination, and environmental restoration technology. Research supervisor Dr. B. Boldgiv.
- 2014 **Associate in Research, Duke University Department of Biology:** in Dr. Kathleen Donohue’s lab studying *Arabidopsis* germination and flowering in response to changing climate conditions. Responsible for fieldwork, germination assay preparation, germination data collection, and plant crosses.
- 2013 summer **Work Study, UN Environment Programme:** I worked on policy analysis for wildlife trade and food waste reduction at UNEP headquarters in Nairobi, Kenya.
- 2012 summer **Short Term Fellow, Smithsonian Tropical Research Institute:** STRI fellowship for independent field research on sexual selection in poison dart frogs in Panama.
- 2010 **Intern, International Criminal Tribunal for Rwanda:** Responsibilities included court reporting and production of case documents and outreach materials related to the aftermath of Rwanda’s genocide. At ICTR headquarters in Arusha, Tanzania.
- 2010 **Guide, Ranario de Monteverde:** I worked as a bilingual guide at the *Ranario*, a large facility dedicated to native frog breeding and ecotourism in Costa Rica.
- 2010 **Research Assistant, Organization for Tropical Studies:** I collected frogs and lizards for a study of sex differences at La Selva Biological Station in Costa Rica.

RESEARCH PROJECTS

- Induction of arbuscular mycorrhizal symbiosis in brassicas (present):** My thesis project is a systems biology-based transgenic experiment to restore arbuscular mycorrhizal symbiosis to members of the Brassicaceae, which previously lost this trait. I used evolutionary information to identify a key missing gene *IPD3*, which I have inserted back into model plants. I am currently screening and evaluating transgenic lines through transcriptomics.
- Improved transformation of diverse plant species (2019-2021, preliminary):** I am exploring the use of rationally designed, modified plant growth regulating proteins to improve transformation and regeneration efficiency of difficult-to-transform plants. My goal is to create a tool to improve the speed of iteration in plant biotechnology, and promote crop diversity through application of biotech improvements to a wider range of species.
- Evaluation of lupin for genetic modification as a protein source (2019-2020, preliminary):** I conducted preliminary greenhouse and field trials, and bioinformatic analysis, of wild and domestic *Lupinus* species to identify new sources of germplasm and target traits for gene editing to improve the attractiveness of this crop for the growing demand for plant protein.
- CRISPR editing of 4 genes in *Camelina* (2016-17):** I was part of a team working on a DOE BETO grant with Yield10, a private company. We targeted yield-related genes in *Camelina* with CRISPR and team members are continuing with work on identifying and phenotyping edited lines. I worked on a novel HRM genotyping method for this study.

Mongolian native plant germination study (2014-15): I performed the first known laboratory analysis of germination response to light and temperature levels in seeds of eight Gobi plant species that have been identified as targets for use in restoration of mining sites.

Bactrian camel population survey, Zoological Society of London (2014): I was on the field team for a ZSL study to assess population levels of this critically endangered species found only in Mongolia's Great Gobi Strictly Protected Area.

Evolution and sensory biology of sexual selection in dart frogs (2012-2014): My undergraduate thesis in biology used mate choice and spectrophotometry data collected during my Smithsonian Short-Term Fellowship in Panama. I used the data to determine that there is unequal sexual selection on the warning color trait of male frogs. My conclusions went into a broader body of literature explaining how a population of mixed aposematic coloration can exist when predator selection is expected to be stabilizing or directional for that trait. I was one of four students in the 2014 Duke Biology class to be awarded High Distinction for my research work. My advisor was Professor Manuel Leal.

African Blackwood Conservation Project (2010): I assisted ABCP founder Sebastian Chuwa with creation of a GPS-mapped database of sites in Tanzania supporting 1.5 million replanted ebony trees at that time. ABCP-planted trees have since exceeded 2 million.

PRESENTATIONS & PUBLICATIONS

Inter-American Development Bank (2020): *Biotechnology and GMOs: their development, intrinsic properties, and relationship to the public interest.* Expert talk delivered virtually to the Inter-American Development Bank in La Paz, Bolivia. Given in Spanish.

Plant Biology/ASPB Annual Meeting (2020): Attended a weeklong virtual science conference.

Genetic Engineering and Society Center (2020): COVID-19 Global Impact: interdisciplinary perspectives. Member of an expert panel discussing unconventional applications of biotechnology and rapid manufacturing to the early coronavirus response. Virtual.

NCSU Graduate Research Symposium (2019): *Re-engineering mycorrhizal symbiosis into non-mycorrhizal plants for better yield.* Poster Presentation.

Plant Biology/ASPB Annual Meeting (2018): *Evaluating components of the Common Symbiosis Pathway in nonmycorrhizal plants.* Poster presentation.

Guest Lectures (2018): *Mycorrhizal nutrient relations* and *Mycorrhizal accommodation signaling.* Advanced Plant Physiology, NCSU course PB751.

NCSU Plant and Microbial Biology Graduate Student Research Symposium (2018): *Re-engineering a lost symbiosis.* Talk awarded first prize by a panel of professors.

Genetic Engineering and Society Center Colloquium (2017): *Genetically engineering a multi-organism relationship.* Presented to an interdisciplinary biology/social science audience.

NCSU Biolunch seminar (2017): *Re-engineering a lost symbiosis.* Presented to an interdisciplinary science and engineering audience.

Patent no. 62/522,917 (2017): Inventor of patent "Re-engineering of mycorrhizal symbiosis in plants", filed June 21, 2017.

Ecological Society of America Conference (2015): *Germination timing in response to light and temperature in five Gobi plant species.* Poster presentation.

American Center for Mongolian Studies Lecture Series (2015): *Cooperation for conservation: international and interdisciplinary opportunities in Mongolia.* (in English and Mongolian)

Ecological Society of Mongolia Seminar Series (2015): *Seed germination rates of some plants of Mongolia's Southern Gobi.* (given in Mongolian)

Duke Expert Environmentalist (2014): *You Are A Genetic Engineer.* Invited talk at a Duke

symposium on environmental issues. I spoke about genetic consequences of human influence on other organisms and potential uses of biotechnology in conservation.

UNC Celebration of Undergraduate Research (2014): *Deciphering irregularity in the ancient Mongolian sound system.* This was a podium presentation of my thesis research.

TEDxUNC Student Speaker Finalist (2013): *Connected Environment.* Talk given to an audience of about 700 on adaptations of biotechnology techniques for conservation.

State of NC Undergraduate Research & Creativity Symposium (2012): *Interaction of natural and sexual selection to drive divergence in a poison frog.* Podium talk on STRI research.

OUTREACH & LEADERSHIP

Genetic Engineering for Sustainability Course (2020): I helped develop, teach, and serve as a peer mentor for a new interdisciplinary course on agricultural biotechnology created for the AgBioFEWS program. NCSU course GES591.

Spanish-language Biotechnology Workshop (2019): With a small team from 2 labs at NCSU, I conducted a 40-hour workshop on practical biotechnology at the National University of San Agustín in Arequipa, Perú. The workshop included lectures and hands-on molecular biology labs; I taught both of these components entirely in Spanish.

Swahili-language Scientific Interpretation (2019): At the request of the North Carolina Science and Engineering Fair, I served as a Swahili-English interpreter for high school students from Burundi and Tanzania at the Winston-Salem ESL Academy who had limited English ability but wished to present their project at the statewide science fair.

Mentorship (2018-2019): I mentored a student from the NC School of Science and Math on an independent research project based in our lab. The project included lab experiments on root exudates, and development of a Python tool to aid in genomic promoter studies.

Bugfest (2010-2019): Since 2016 I have been a coordinator of an exhibit at the Bugfest event held by the NC Museum of Natural Science. I train high school students to share entomology exhibits with up to 30,000 visitors. Prior to 2016 I was a regular volunteer.

Biotechnology Focus Groups (2017): Conducted 4 focus groups on responsible research priorities for academic and industry members of the biotechnology community. Data was analyzed by Professor Jennifer Kuzma (NCSU) for further use.

U.S. Army training exercises (2015): Biology and language instructor for U.S. Army officers and cadets in Mongolia for the Khaan Quest 2015 United Nations peacekeeping exercises.

'Let's Talk About America' US Embassy lecture series (2015): *Ecoregions of North America*

Volunteer Coordinator, Ulaanbaatar Disabled People's English Club (2014-15): I recruited and scheduled volunteer English teachers for physically disabled Mongolian students.

Carolina Priceless Gems (2014): *Rebellious Learning.* One of six graduating students selected to address members of the freshman class at UNC with advice for success as undergraduates.

President of UnderLing (2013-14): UnderLing is UNC's undergraduate linguistics club that sponsors guest speakers, career events, study nights and annual conference speakers.

Coach, Chapel Hill High Computational Linguistics Team (2012-14): I mentored a small group of high school students competing in the North American Computational Linguistics Olympiad (NACLO), some of whom advanced to international competition.

Coach, NCSSM Debate Team (2011-13): I helped coach high school students in Lincoln-Douglas debate and speaking events, including the 2013 state champion.

Course Designer and Instructor (2011): I designed and ran a travelling summer science class in rural Kentucky under the Robertson program, supported by \$2,500 in additional funding.

PROFESSIONAL SKILLS

Biology specialties and skills: *Agrobacterium* transformation; CRISPR; qPCR and HRM; plant and fungal microscopy; plant genetics; plant phenotyping; evolution and speciation; flowering assays; germination assays; plant crosses; ecology field methods; plant and amphibian taxonomy; animal behavior tests; CLC, R, JMP, Mesquite, Arlequin, CLAN, and MEGA 5.1 analysis tools

Other lab skills: Python programming, electronics, 3D design and 3D printing

Spanish: Fluent, 13 years experience including literature, professional and academic work

Swahili: Fluent, 6 years experience including literature, immersion, and professional work

Mongolian: Advanced Conversational, 2 years coursework plus 18 months of immersion. Also familiar with Mongolian formal linguistics and 4 classical writing systems of the Mongol Empire.

Mandarin Chinese: Conversational, 3 years experience including immersion and coursework

Linguistic specialties and skills: phonology; morphology; syntax; computational linguistics; diachronic methods; writing systems; acquisition and evolution of language, Praat; LaTeX

OTHER INTERESTS

●**Glassblowing:** Prior to entering university I studied artistic glassblowing at the Penland School of Crafts (North Carolina, concentration in flameworking) and the Pilchuck Glass School (Washington State, introductory furnaceworking).

●**Calligraphy and translation:** in parallel with my undergraduate thesis research on ancient Mongolian writing systems, I developed an interest in modern Chinese and Mongolian artistic calligraphy. I continue to work remotely with Mongolian friends on translations of poems and calligraphic pieces, as well as the occasional ecology paper.

●**Long-distance hiking** includes completion of the Appalachian Trail on the East coast of the US, Hadrian's Wall Path across England, and Mt. Kilimanjaro.

COLLABORATORS AND OTHER AFFILIATIONS

Name	Affiliation	Association
Heike Sederoff	NCSU	Advisor
Fred Gould	NCSU	Committee member/ AgBioFEWS NRT Fellowship director
Rossangela Sozzani	NCSU	Committee member
Marc Cubeta	NCSU	Committee member
Tom Mitchell-Olds	Duke	Principal Investigator
Bazartserengiin Boldgiv	National Univ. of Mongolia	Fulbright research sponsor/ department head
Lkhagvagiin Ariuntsetseg	National Univ. of Mongolia	Collaborator
Kathleen Donohue	Duke	Principal Investigator
Jennifer L. Smith	U. North Carolina	Undergraduate thesis advisor
David Mora-Marin	U. North Carolina	Undergraduate committee member
Elliott Moreton	U. North Carolina	Undergraduate committee member
Manuel Leal	Duke	Undergraduate thesis advisor