Justin P. Shaffer

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PhD Candidate
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I. Chronology of education

2012–present **Ph.D., Plant Pathology & Microbiology, University of Arizona, Tucson.**
Dissertation title: Endohyphal bacteria of tropical plant-associated fungi: diversity, evolutionary relationships, and ecology. Dissertation advisors: A. Elizabeth Arnold and David A. Baltrus.

2011 **Oregon State University, Corvallis.**

2010 **B.A., Environmental Studies, with Honors, University of California, Santa Cruz (*summa cum laude*)**
Thesis title: Antifungal activity of lichen extracts: exploring the potential for indirect protection of woody plants from pathogenic fungi. Thesis advisor: Dr. Gregory S. Gilbert.

2007 **A.A., Liberal Arts & Sciences, Moorpark Community College, CA.**

II. Honors and awards

2015 Graduate and Professional Students Club Research Award, University of Arizona
2015 Graduate and Professional Students Club Travel Award, University of Arizona
2015 School of Plant Sciences Graduate Student Travel Award, University of Arizona
2014 Forest Fungal Ecology Award, Mycological Society of America
2013 School of Plant Sciences Merit Award, University of Arizona
2013 Short-term Fellowship, Smithsonian Tropical Research Institute
2013 National Science Foundation Integrative Graduate Education and Research Traineeships Fellowship, University of Arizona
2013 Mentor Student Travel Award, Mycological Society of America
2013 Graduate and Professional Students Club Travel Grant, University of Arizona
2012 Pierson Graduate Fellowship, School of Plant Sciences, University of Arizona
2012 Graduate Student Travel Grant, Department of Botany and Plant Pathology, Oregon State University
2011 Provost's Distinguished Fellowship, Oregon State University
2010 Environmental Studies Undergraduate Senior Thesis Honors, University of California, Santa Cruz
2009–2010 Campus Merit Sage Scholarship, University of California, Santa Cruz *(each year)*
2008–2010 Cal Grant Award, University of California, Santa Cruz *(each year)*
2008–2010 Dean's Honors, University of California, Santa Cruz *(every quarter each year)*
2006–2007 Dean's List, Moorpark Community College *(three semesters)*

III. Refereed publications

3. **Shaffer, J.P.**, C. Sarmiento, P.-C. Zalamea, R. Gallery, A. Davis, D. Baltrus, A.E. Arnold. 2016. Diversity, specificity, and phylogenetic relationships of endohyphal bacteria in fungi that inhabit tropical seeds and leaves. *Frontiers in Ecology and Evolution* 4:116. doi: 10.3389/fevo.2016.00116

2. **Shaffer, J.P.**, D. Baltrus, A.E. Arnold. An endohyphal bacterium (*Chitinophaga*, Bacteroidetes) alters carbon-source use by *Fusarium keratoplasticum* (*F. solani* species complex, Nectriaceae). *Frontiers in Microbiology* 8:350. doi: 10.3389/fmicb.2017.00350

1. Carter, B., E. Kraichak, **J.P. Shaffer**, G.S. Gilbert. Co-occurring epiphytic bryophytes and lichens function as separate metacommunities. In revision at *Journal of Vegetation Science.*

IV. Technical writing

1. **Shaffer, J.P.**, J.L. Parke. 2013. Germination of *Phytophthora ramorum* chlamydospores: a comparison of separation method and chlamydospore age. *Proceedings of the Sudden Oak Death Fifth Science Symposium*. Gen. Tech. Rep. PSW-GTR-243. Albany, CA: USDA-FS, PSW Research Station. pp. 160-163.

V. Contributed presentations *(extramural only)*

2016 Mycological Society of America Annual Meeting, Berkeley, CA, USA. **Shaffer, J.P.**, D. Baltrus, A.E. Arnold. Endohyphal bacterium (*Chitinophaga* sp.) influences broad-spectrum substrate use by its host fungus (*Fusarium keratoplasticum*). (Oral presentation)

2015 Mycological Society of America Joint Meeting with the Botanical Society of America, Edmonton, Alberta, Canada. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Endohyphal bacteria of tropical, plant-associated Sordariomycetes. (Oral presentation)

2015 Fungal Genetics Meeting, Asilomar, CA, USA. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Endohyphal bacteria of tropical Sordariomycetes: community structure and relationships with other functional groups of bacteria in a lowland tropical rainforest. (Poster presentation)

2014 Smithsonian Tropical Research Institute, Bambi Seminar Series, BCI, Panama. Carter, B., E. Kraichak, **J.P. Shaffer**, G.S. Gilbert. Relationships among epiphytic-bryophytes, -lichens, and woody plants: metacommunity dynamics in a temperate, mixed-evergreen forest. (Oral presentation)

2014 Smithsonian Tropical Research Institute, Guide Training Course, BCI, Panama. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Bacteria that inhabit fungi that infect seeds: diversity, evolutionary relationships, and ecological impacts of endohyphal bacteria of tropical seed-associated fungi – *an update*. (Oral presentation)

2014 Smithsonian Tropical Research Institute, Bambi Seminar Series, BCI, Panama. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Bacteria that inhabit fungi that infect seeds: diversity, evolutionary relationships, and ecological impacts of endohyphal bacteria of tropical seed-associated fungi – *an update*. (Oral presentation)

2014 Deep Genomics, UA-NSF-IGERT International Meeting, Tucson, AZ, USA. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Phylogenetic relationships and diversity of bacteria associated with fungi, seeds, and soil from Barro Colorado Island, Panama. (Poster presentation)

2013 Mycological Society of America, Austin, TX, USA. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Phylogenetic relationships and diversity of endohyphal bacteria of plant-associated fungi. (Poster presentation)

2013 Smithsonian Tropical Research Institute Bambi Seminar Series, BCI, Panama. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Bacteria that inhabit fungi that infect seeds: diversity, evolutionary relationships, and ecological impacts of endohyphal bacteria of tropical seed-associated fungi. (Oral presentation)

2013 American Society for Microbiology General Meeting, Denver, CO, USA. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Phylogenetic relationships and diversity of endohyphal bacteria in tropical, seed-associated fungi. (Poster presentation)

2012 Sudden Oak Death 5 Symposium, Petaluma, CA, USA. **Shaffer, J.P.**, J.L. Parke. Germination of *Phytophthora ramorum* chlamydospores: a comparison of separation method and chlamydospore age. (Poster presentation)

2012 Botanical Society of America Meeting, Columbus, OH, USA. Carter, B., E. Kraichak, **J.P. Shaffer**, G.S. Gilbert. Host species and size affect epiphytic cryptogam communities in a mixed-evergreen forest. (Oral presentation)

2011 Northern California Botanists Symposium, Chico, CA, USA. **Shaffer, J.P.** Antifungal Activity of Lichen Secondary Metabolites (Oral and poster presentations)

VI. Other/intramural presentations

2017 University of Arizona, Graduate and Professional Student Council, Student Showcase, Tucson, AZ. **Shaffer, J.P.**, J. U'Ren, R. Gallery, D. Baltrus, A.E. Arnold. Endohyphal bacterium (*Chitinophaga* sp.) influences carbon source use by its host fungus (*Fusarium keratoplasticum*, Nectriaceae). (Poster presentation)

2016 University of Arizona, School of Plant Sciences Seminar Series, Tucson, AZ. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Endohyphal bacteria of tropical seed-associated fungi: diversity and influence on seed-fungus interactions. (Oral presentation)

2015 University of Arizona School of Plant Sciences Retreat, Tucson, AZ. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Phylogenetic relationships and diversity of endohyphal bacteria of plant-associated fungi. (Poster presentation)

2013 University of Arizona Microbial Genetics Symposia, Tucson, AZ. **Shaffer, J.P.** DNA sequence analysis of *Pseudomonas* sp. UB246 *umuC* and *umuD* loci encoding DNA polymerase V and its LexA-like transcriptional repressor. (Poster presentation)

2013 University of Arizona, School of Plant Sciences Seminar Series, Tucson, AZ. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Phylogenetic relationships and diversity of endohyphal bacteria in tropical, seed-associated fungi. (Oral presentation)

2013 University of Arizona School of Plant Sciences Retreat, Tucson, AZ. **Shaffer, J.P.**, R. Gallery, D. Baltrus, A.E. Arnold. Diversity and phylogenetic relationships of endohyphal bacteria of seed-associated fungi. (Poster presentation)

2012 University of Arizona NSF-IGERT Course Symposium, Tucson, AZ. **Shaffer, J.P.**, R. Ruboyianes. Fungal chimeras in public databases and their influence over diversity and phylogenetic analyses. (Poster presentation)

2012 University of Arizona, Fall Semester Microlunch Seminar Series, Tucson, AZ. Carter, B., E. Kraichak, **J.P. Shaffer**, G.S. Gilbert. Host species and size affect epiphytic cryptogam communities in a mixed-evergreen forest. (Oral presentation)

2010 Environmental Studies Undergraduate Research Symposium, Santa Cruz, CA. **Shaffer, J.P.** Antifungal Activity of Lichen Secondary Metabolites (Poster presentation)

VII. Invited scholarly presentations

2016 Maricopa County Master Gardener Fungus Workshop, Phoenix, AZ. **Shaffer, J.P.**, J. Meyers, and A. E. Arnold. An introduction to fungi and mycological herbaria. (Oral presentation)

2011 Henry Cowell Redwoods State Park Docent Training, Santa Cruz, CA. **Shaffer, J.P.** An introduction to lichens. (Oral presentation)

2011 University of California, Santa Cruz, Natural History of Santa Cruz (ENVS15) Guest Lecture, CA. **Shaffer, J.P.** An introduction to lichens. (Oral presentation)

VIII. Relevant graduate coursework

Advanced Mycology*, Plant Microbiology*, Plant Pathology*, Advanced Forest Pathology*, Advanced Community Ecology*, Species Diversity[§], Fundamentals of Ecology*, Fundamentals of Evolution*, Plant Population Ecology*, Plant Evolutionary Genetics*, Evolutionary and Functional Genomics, Evolutionary and Functional Genomics Computational Lab*, Population Genetics*, Microbial Genetics*, Community Structure and Analysis*, Molecular Fungal Systematics*, Phylogenetics*, Forest Insect and Disease Management*, Principles of Research*, Grant Writing[§], Methods of Data Analysis*

* = A in course. § = not graded.

IX. Relevant undergraduate coursework

Plant Ecology and Field Methods*, Plant Disease Ecology*, Plant Physiological Ecology*, Tropical Ecology*, Evolution*, Biostatistics*, Soils and Plant Nutrition*, Ecology and Society, General Biology*, Genetics*, General Chemistry*, Organic Chemistry*, Biochemistry*

* = A in course.

X. Research and professional experience

2012–present Ph.D. Student (with Drs. A. Elizabeth Arnold and David Baltrus, University of Arizona, Tucson; Candidacy achieved May 2014)

Research questions address the evolutionary relationships among– and ecological importance of bacterial endosymbionts of plant-associated fungi. Methods include culturing fungi, fluorescence microscopy, PCR-based detection of bacteria in fungal cultures, classification of sequences via public databases, OTU clustering, phylogenetic reconstruction of fungal and bacterial relationships, and phylogenetic community analyses. Also, cured fungi of–, and infected them with bacteria in order to conduct field– and lab experiments, to determine effects of the bacteria on fungal phenotypes and plant-fungus interactions.

2014 Graduate Researcher (Smithsonian Tropical Research Institute, Panama)

Dissertation work. Research questions address the role of endohyphal bacteria in plant-fungus interactions. Conducted inoculation, seed germination, and leaf-extract media growth experiments on Barro Colorado Island. Focused on seed-associated and foliar endophytic strains of *Fusarium* and *Xylaria.* Found bacteria to significantly influence colonization of seeds and growth on leaf-extract media by fungi, as well as the germination of infected seeds.

2014 Intern (with Drs. Camilo Zalamea and James Dalling, Smithsonian Tropical Research Institute, Panama)

In parallel to dissertation work. Research questions address tropical fungal community ecology. Assisted with a long-term seed-fate experiment on Barro Colorado Island, Panama. Investigated phenology of fruiting, and phylogenetic relationships with known endophytic strains, among saprotrophic *Xylaria*. Examined fungal community composition across the ontogeny of *Jacaranda copaia*. Sampled foliar fungal communities from infected and healthy populations of *Tachigali versicolor* to identify fungi associated with a novel disease epidemic.

2013–2014 Graduate Fellow (with the University of Arizona's NSF IGERT Program, Tucson)

Dissertation work. Research training in genomics, evolutionary biology, and computational biology. Participated in lecture and lab courses focused on integrating evolutionary, functional, and computational aspects of genomics, as well as a research course addressing problems in genomics. Contributed to biweekly discussion groups and helped to organize an international symposium on deep genomics.

2013 Graduate Fellow (with Drs. S. Joseph Wright and Egbert G. Leigh Jr., Smithsonian Tropical Research Institute, Panama)

Dissertation work. Research questions address the role of endohyphal bacteria in seed-fungus interactions. Conducted inoculation and seed germination experiments to explore effects of endohyphal bacteria of seed-associated fungi on fungal phenotypes important for interactions with seeds, and seed traits following fungal infection. Sampled and isolated bacterial communities from soil and conducted phylogenetic analyses to determine relationships with co-occurring endohyphal bacteria.

2013 Intern (with Drs. Camilo Zalamea and James Dalling, Smithsonian Tropical Research Institute, Panama)

In parallel to dissertation work. Assisted with a long-term seed-fate experiment on Barro Colorado Island, Panama. Collected, cleaned, and sorted seeds for field burial studies. Recovered and processed buried seeds for isolation of fungi and bacteria and analysis of seed traits such as germinability and viability. Identified invertebrate seed predators recovered from pitfall traps.

2012 Graduate Student (with Drs. Priscila Chaverri, Gregory Mueller, and Andrew Miller, Organization for Tropical Studies; Costa Rica)

A graduate level, research-based course focused on tropical forest mycology. (1) Examined the diversity, distribution, and substrate specificity of saprobic Sordariomycetes and Dothidiomycetes at montane and low elevation sites. Found elevation and substrate to drive most of the variation in fungal community composition across sites. (2) Examined the morphological diversity of epifoliar Ascomycota among native and non-native Palmae at Las Cruces. Addressed the hypothesis that exotic plants would harbor relatively unique and diverse fungal communities compared to native plants. Found that host species, rather than native vs. non-native, was a stronger driver of fungal community composition.

2011–2012 Ph.D. Student (with Dr. Jennifer L. Parke, Oregon State University; Corvallis)

Research questions addressing the physiological tolerances of the Oomycete plant pathogen, *Phytophthora ramorum*. Examined reproduction under anaerobic and saline conditions, and the tolerances of chlamydospores and sporangia to salinity, desiccation, and rehydration. Found anaerobic and saline conditions to significantly reduce production of sporangia, and salinity and desiccation to significantly reduce sporangial differentiation and chlamydospore germination. Assisted in analysis of root colonization of *Sorghum bicolor* (Poaceae) by arbuscular mycorrhizal fungi using staining and microscopy.

2011 Laboratory Technician (with Dr. Gregory S. Gilbert, University of California, Santa Cruz)

Lab and field research focused on plant and fungal community ecology. (1) *Rare species advantage:* Addressed patterns of foliar disease among exotic vs. native plants; assessed plant species composition within studied plots, sampled, scanned, and analyzed leaves to determine % disease. Project ongoing. (2) *6-ha. moss & lichen survey:* Collaborative research with UC Berkeley focused on the relationships between communities of epiphytic cryptogams and woody plants; exhaustive survey of epiphytic bryophyte and lichen species abundances and distributions on the Santa Cruz forest dynamics plot (CTFS-ForestGEO; http://ferp.ucsc.edu/). Found host species and size to be significant explanatory variables with regard to cryptogam community composition. (3) *Big Creek Lichens:* Independent research on the biogeography of lichen species at the Landels-Hill Big Creek Reserve in Big Sur, CA. (4) Managed wet-lab organization, fungal culture collections, hazardous waste, greenhouse projects, maintained the Santa Cruz forest dynamics plot, and mentored students to perform the above tasks and develop research projects focused on plant and fungal biology.

2011 Plant Disease Ecology Course Assistant (with Dr. Gregory S. Gilbert, University of California, Santa Cruz)

Teaching assistant for an upper division, undergraduate lecture and lab course in plant disease ecology, in the Environmental Studies Department. Lecture topics ranged from basic pathogen biology to management practices. Lab included basic methods in plant pathology and microbiology and a strong research component investigating fungal pathogens of Pacific

madrone (*Arbutus menziesii*, Ericaceae). Responsible for lab organization, grading, and assisting students with technique.

2009–2010 Undergraduate Researcher (with Dr. Gregory S. Gilbert, University of California, Santa Cruz)

Senior thesis project focusing on the local lichen flora. Research questions focused on the potential for locally abundant macrolichens to protect their host plants from pathogens. Assessed lichen species composition and accessioned specimens at the UCSC Herbarium. Compiled a database in order to construct an online, synoptic key of the local lichen flora (http://ferp.ucsc.edu/search/lichen/bytraits/), including taxonomical, chemical, morphological, photo- and micrographical information for each of 62 identified species. Extracted and tested the potential of six lichen species to suppress the growth of three cosmopolitan fungal plant pathogens in a series of bioassays. All extracts but those from one species were found to significantly inhibit growth and reproduction of all fungi.

2009–2010 Undergraduate Researcher (with Dr. Rebecca Braslau, University of California, Santa Cruz)

Senior thesis work. I extracted lichen secondary metabolites using standard organic chemistry techniques. The main focus of this work was natural products extraction.

2009–2010 Undergraduate Assistant (with Dr. Gregory S. Gilbert, University of California, Santa Cruz)

In parallel to senior thesis work. Lab and field research focused on plant and fungal community ecology. Maintained ongoing field research in the Santa Cruz forest dynamics plot and responsible for DNA extraction, PCR (fungal ITS), sequence editing, media preparation, culturing, plant vouchering, and accessioning vouchers into herbaria. Participated in the topographical mapping of waterways, an assessment of Sudden Oak Death severity on individuals of *Notholithocarpus densiflorus* (Fagaceae), the temporal mapping of changes in soil moisture, and the creation of a culture collection of endophytic fungi from leaves of all species of woody plants on the plot.

2008–2009 Undergraduate Researcher (with Dr. Joji Muramoto, University of California, Santa Cruz)

Long-term research in an agricultural soils lab investigating the effects of environmentally friendly alternatives to methyl bromide as a pesticide in agricultural settings. Anaerobic soil disinfestation methods were applied against natural populations of *Verticillium dahliae* to reduce microsclerotia abundance in agricultural soils, with a focus on strawberry production. Responsible for setting up field and growth chamber experiments involving environmental monitoring systems (CR1000 data loggers with Eh, temperature, and moisture sensors), and preparing post-treatment soils and plant matter for analyses using standard pedological techniques.

2010 Undergraduate Researcher (with Drs. William Sullivan and Laura Serbus, University of California, Santa Cruz**)**

Volunteer on a *Drosophila* cell screening project aimed at curing elephantiasis and river blindness caused by parasitic bacteria in the genus *Wolbachia*, using natural products extracted from environmentally sampled microbes. Responsible for maintaining lines of *Drosophila* cells infected with or cured of *Wolbachia*, and for performing cell screens using high throughput, automated robotics for plate treatment and photomicroscopy.

XI. Service and outreach

EXTRAMURAL SERVICE

1. Local/state service and outreach

2015, 2016 Mentor, NSF BLAST Outreach program for high school students, AZ
2013–2015 Judge, Tucson Magnet High School, Honors Student Science Fair, AZ
2013 Contributor, The Art of Science, *Arizona Daily Star* Special Section, Dec. 1, 2013
2012 Invited speaker, Oregon State University KBVR Radio Science Interview Series

2. National/international service and outreach

2014 Coordinator, Smithsonian Tropical Research Institute, Barro Colorado Island Reading Group, Panama
2014 Co-coordinator, Smithsonian Tropical Research Institute, Bambi Seminar Series, Panama

INTRAMURAL SERVICE

1. University service and outreach

2012–present President, School of Plant Sciences Graduate Student Club
2013 Volunteer, School of Plant Sciences "Family Fun Night"
2012 Volunteer, Oregon State University Discovery Days K-12 Science Program
2012 Volunteer, Oregon State University Winter Wonderings

2. Professional society membership

Mycological Society of America, Ecological Society of America, American Bryological and Lichenological Society, Golden Key International Honor Society**,** California Lichen Society

XII. Teaching

1. Undergraduate teaching

Semester	Course	Instructor	Credits	Enrollment
2016–17 Spring	Microbial Genetics Lab (UA PLP 428L/528L)	Baltrus	3	24
2016–17 Fall	Introductory Microbiology Lab (UA MIC 205L)	Wilbur	1	46
2015–16 Spring	Microbial Genetics Lab (UA PLP 428L/528L)	Baltrus	3	23
2015–16 Fall	Introductory Microbiology (UA MIC 205)	Xiong	3	370
2014–15 Spring	Plant & Animal Genetics (UA PLS 312)	Ray	3	144
2012–13 Fall	Introductory Microbiology Lab (UA MIC 205L)	Johansen	1	74
2010–11 Spring	Plant Disease Ecology Lab (UCSC ENVS 163L)	Gilbert	2	15

2. Undergraduate mentoring

Year	Name	Major	Topic
2017	Jasmin Pratt	Microbiology	Mycology/Microbiology
2016–17	Brenna Hall	Ecology & Evolutionary Biology	Mycology/Plant Science
2015	Thinh Tran	Biomedical Sciences	Microbiology
2013–2014	Kayla Garcia	Microbiology	Mycology/Microbiology
2013–2014	James DeVore	Ecology & Evolutionary Biology	Mycology/Microbiology
2013	Francis Lennartz	Microbiology	Frontiers in mycology
2013	Caitlin Smith	Veterinary Sciences	Frontiers in mycology
2013	Theodore Smith	Microbiology	Frontiers in mycology

XIII. References

Dr. A. Elizabeth Arnold
Professor and Curator, RLG Mycological Herbarium
School of Plant Sciences, University of Arizona
Department of Ecology and Evolutionary Biology
Email: Arnold@ag.arizona.edu
Phone: (520) 621-7212

Dr. Gregory S. Gilbert
Professor and Pepper-Gilberson Chair
Department of Environmental Studies, University of California, Santa Cruz
Email: ggilbert@ucsc.edu
Phone: (831) 459-5002

Dr. David A. Baltrus
Associate Professor
School of Plant Sciences, University of Arizona
Division of Plant Pathology and Microbiology

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Dr. Priscila Chaverri
Associate Professor
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