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Research interests and summary

My research merges the fields of microbial and functional ecology. As part of my doctoral thesis, I developed a new theoretical framework—the “symbiosis-to-saprotrophy continuum” (Aguilar-Trigueros et al., 2014)—to understand how changes in fungal phenotypes determine the role of fungi in their environment. I have helped develop new fungal trait databases for ecologists (Zanne et al., 2020), adapted trait-based approaches used in animal and plant ecology to mycelia and spore-size variation (Aguilar-Trigueros et al., 2017; Aguilar-Trigueros et al., 2019), and identified network morphology as a potential new functional trait for fungi (Aguilar-Trigueros et al., 2022). I currently work as a Humboldt Fellow using fungal functional traits to understand how urbanization and drought impact microbial diversity, and how the impact of this combination affects plant communities in Finland and in Australia.

Education and degrees

Doctor of Natural Sciences (summa cum laude) (11 May 2015)

Freie Universität Berlin; Berlin, Germany

Division of Biology, Chemistry, & Pharmacy

Dissertation title: “Understanding the ecological role of root-infecting fungi through phenomenological and trait-based approaches”

Dissertation grade: magna cum laude

Disputation grade: summa cum laude

Overall doctorate grade: magna cum laude

Advisor: Professor Matthias Rillig, Institute of Biology and the Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB).

Licenciatura in Biology

Universidad de El Salvador, San Salvador, El Salvador (25 September 2009)

Languages

- Spanish (native language)
- English (C2 level)
- German: (C1 level)

Research experience

Feodor Lynen Humboldt Fellowship International Visiting Fellow 2021–2023

I was awarded a two-year fellowship from the Alexander von Humboldt Foundation, which enables highly qualified scientists and scholars from Germany who are just embarking on their academic careers and who completed their doctorates less than four years ago¹ to spend extended periods of research (6-24 months) abroad.

Research locations and lab affiliations:

- Professor Otso Ovaskainen and Dr. Nerea Abrego (University of Jyväskylä, Finland)
- Professor Jeff Powell, Western Sydney University (Australia)

Project work: “Understanding mycorrhizal phenotypes using functional traits”

Postdoctoral Researcher, Freie Universität Berlin; Berlin, Germany 2016–2021

Institute of Biology, Berlin-Brandenburg Institute of Advanced Biodiversity Research

I was a postdoc working on synthesizing the research produced by the “Bridging in Biodiversity Science” (BIBS) project, which was funded by the BMBF (the German Federal Ministry of Education and Research). The BMBF also funded the creation of the Berlin-Brandenburg Institute of Advanced Biodiversity Research (BIBIB), an institute that brings together all the major universities and most of the research institutes working on biodiversity research in the Berlin-Brandenburg area.

Specifically, in this role, I

- synthesized fungal functional trait data used to predict how drought changes soil fungi interaction with plants
- developed new theoretical frameworks to understand the ecological meaning of phenotype variation among fungal species
- linked the experimental work on how drought and microplastics impacts root-associated fungi (done in Professor Matthias Rillig’s lab at the Freie-Universität Berlin) to the work of other researchers in BIBS
- communicated the results of our research to local residents and stakeholders in the Uckermark (a region of the state of Brandenburg), such as how the root-associated fungi of wild and agricultural plants grown in the region are affected by drought, as part of public outreach on the project

Visiting Scientist, University of Oxford; Oxford, United Kingdom 2019

Professor Mark Fricker, Department of Plant Sciences

My interest in applying network science to fungi led to a collaboration funded by the Berlin-Oxford Research Partnership with Professor Mark Fricker at Oxford, where I learned network theory, microscopy and image-processing algorithms. Our paper on network morphology as a new functional trait for fungi is the first of several planned publications. This new trait is the foundation for my future research.

PhD Candidate, Freie Universität Berlin; Berlin, Germany 2011–2015

Professor Matthias Rillig

During my PhD program I measured the effect of the widespread but understudied phenomenon of root fungal endophytes and how they affect plant community structure. In my research, I was able to identify distinct effects of different fungal species on the evenness of plant communities, yet could not *predict* these effects. I therefore identified the information that would be needed to make these

predictions. First, by looking at how traits have been used to identify a major axis of variation in resource allocation in the plant kingdom (such as the leaf economic spectrum), I proposed using traits to allocate root-endophytic fungi along a “symbiosis-to-saprotrophy continuum,” reflecting differences in resource-acquisition adaptation. Second, after reviewing several applications of trait information on macro-organisms, I proposed roadmaps of microbial traits to understand other resource-allocation patterns and community assembly and diversity-ecosystem functioning relationships. My objective with this synthesis work was to help fill the conceptual gap in trait information in microbial ecology.

Current projects

My current projects use fungal functional traits to understand how urbanization and drought impact microbial diversity, and how this feedback affects plant communities in Finland and in Australia.

Awards, grants, and funding

- Feodor Lynen Humboldt Fellowship (Humboldt Foundation) (2021–2023)
Two years of funding for research collaborations and projects in Germany, Finland, Australia
- Oxford-Berlin Seed Funding (Berlin-Oxford Research Partnership) (2019–2022)
Funding for lab visits to study fungal network morphology using microscopy and image-processing algorithms
- Australia-Germany Joint Research Cooperation Scheme (DAAD [German Academic Exchange Service]/Western Sydney University) (2019–2020)
Funded project for continued work with Professor Jeff Powell at Western Sydney University
- FU-Berlin Research Alumni Program Award (Freie Universität Berlin) (2016)
Funded project to continue learning language programming and statistics skills at Professor Jeff Powell’s lab at Western Sydney University
- Doctoral Fellowship (DAAD [German Academic Exchange Service]) (2010–2014)
- ADELANTE fellowships (Smithsonian Tropical Research Institute) (2009–2010)

Research supervision and leadership experience

- Co-doctoral supervisor for Milos Bielčik (Freie Universität Berlin), who was awarded his PhD in ecology magna cum laude. (2016 to 2022)
- Co-supervisor of five bachelor’s students’ thesis projects and two master’s students’ thesis projects at the Freie Universität Berlin, each of whom successfully completed the projects (2014–2022)

Teaching and training experience

Co-lecturer of three bachelor’s courses at the Freie Universität Berlin:

- Aufbaumodul 1: Organismische Biologie (Organismal Biology) (2015)
- Basismodul 5: Ökologie (Basic Ecology) (2015)
- Einführung in R für statistische Anwendungen (Introduction to R for statistical use) (2015)

Invited lecturer for the master’s course Fungal Biology and Ecology (2014–2018; 2020–2021) at the Freie Universität Berlin.

Awards and honors

- New Phytologist Symposium Grants Award (2014), selected speaker. Title: “Ecological understanding of root-infecting fungi using trait-based approaches,” 33rd New Phytologist Symposium, Zurich (Switzerland)

Key academic merits

- Opponent of two doctoral dissertations at the Freie Universität Berlin (2016) and Universidad Nacional de Colombia (2022).
- Refereed for the following journals: *Nature Communications*, *Microbial Ecology*, *Ecological Modelling*, *FEMS Microbial Ecology*, *Ecography*, *Functional Ecology*, *Plant and Soil*, *New Phytologist*, *Soil Biology and Biochemistry*, *Pedobiologia*
- Co-organizer of the workshop “Measurement of fungal transport networks” (February 2020). Department of Plant Sciences, University of Oxford, United Kingdom.
- Co-organizer of the “Fungal traits database workshop” (August 2016 and March 2017), National Center for Ecological Analysis and Synthesis (NCEAS), Santa Barbara, CA (USA). (This workshop led to the creation of the FunToFun Database.)

Scientific and social impact

- While a postdoc at the Freie Universität Berlin, I travelled to and spoke with local farmers and other regional stakeholders in north Brandenburg (Germany) to explain our research in the region and the benefits we believe it will yield. As part of this outreach, I helped prepare a booklet, “Increasing droughts: Help comes from the soils” (2019) (Original title in German: Zunehmende Trockenperioden: Hilfe kommt aus dem Boden. In: *Vielvalt in der Uckermark*).
- Since 2018, I have served as a scientific advisor to the Salvadoran NGO Fundación Naturaleza (<http://fundacionnaturalezaelsalvador.org/>). My job is to help Salvadoran biology students pursue careers in science.
- In 2016, I published an essay about how I became a biologist and advocated for greater opportunities for students from developing countries who want to pursue careers in science: Aguilar-Trigueros CA. (2016). “The questions that opened doors.” *Science*. 353 (6295): 190–190.

Publications

Peer-reviewed scientific articles

Lozano, Y.M., Aguilar-Trigueros, C.A., Ospina, J.M. and Rillig, M.C. (2022), Drought legacy effects on root morphological traits and plant biomass via soil biota feedback. *New Phytol*, 236: 222-234. <https://doi.org/10.1111/nph.18327>

Camenzind, T., Weimershaus, P., Lehmann, A., Aguilar-Trigueros, C.A. and Rillig, M.C. (2022), Soil fungi invest into asexual sporulation under resource scarcity, but trait spaces of individual isolates are unique. *Environ Microbiol*, 24: 2962-2978. <https://doi.org/10.1111/1462-2920.16012>

Aguilar-Trigueros, C.A., Boddy, L., Rillig, M.C. et al. (2022). Network traits predict ecological strategies in fungi. *ISME C 2*. <https://doi.org/10.1038/s43705-021-00085-1>

Chaudhary VB, Aguilar-Trigueros CA, Mansour I, Rillig MC. (2022), Fungal Dispersal Across Spatial Scales. *Annual Review of Ecology, Evolution, and Systematics* 2022 53:1

- Heger T, Aguilar-Trigueros CA, Bartram I, Braga RR, Dietl GP, Enders E, Gibson DJ, Gómez-Aparicio L, Gras P, Jax K, Lokatis S, Lortie CJ, Mupepele AC, Schindler S, Starrfelt J, Synodinos AD, Jeschke JM (2021). The Hierarchy-of-Hypotheses Approach: A Synthesis Method for Enhancing Theory Development in Ecology and Evolution, *BioScience*, 71(4) 337–349. <https://doi.org/10.1093/biosci/biaa130>
- Lozano, Y.M., Aguilar-Trigueros, C.A., Roy, J. and Rillig, M.C. (2021), Drought induces shifts in soil fungal communities that can be linked to root traits across 24 plant species. *New Phytol*, 232: 1917-1929. <https://doi.org/10.1111/nph.17707>.
- Lozano, YM, Aguilar-Trigueros, CA, Onandia, G, Maaß, S, Zhao, T, Rillig, MC. Effects of microplastics and drought on soil ecosystem functions and multifunctionality. *J Appl Ecol*. 2021; 00: 1– 9. <https://doi.org/10.1111/1365-2664.13839>
- Lozano, YM, Aguilar-Trigueros CA, Flaig, IC, Rillig, MC. Root trait responses to drought are more heterogeneous than leaf trait responses. *Funct Ecol*. 2020; 34: 2224– 2235. <https://doi.org/10.1111/1365-2435.13656>.
- Zanne, A. E., Abarenkov, K., Afkhami, M. E., Aguilar-Trigueros, C. A., Bates, S., Bhatnagar, J. M., ... & Flores-Moreno, H. (2020). Fungal functional ecology: bringing a trait-based approach to plant-associated fungi. *Biological Reviews*, 95(2), 409-433.
- Rillig, M. C., Aguilar-Trigueros, C. A., Anderson, I. C., Antonovics, J., Ballhausen, M. B., Bergmann, J., ... & Hempel, S. (2020). Myristate and the ecology of AM fungi: significance, opportunities, applications and challenges. *New Phytologist*. doi:10.1111/nph.16527.
- Bielčík, M., Aguilar-Trigueros, C. A., Lakovic, M., Jeltsch, F., & Rillig, M. C. (2019). The role of active movement in fungal ecology and community assembly. *Movement Ecology*, 7(1), 36.
- Rillig, M. C., Ryo, M., Lehmann, A., Aguilar-Trigueros, C. A., Buchert, S., Wulf, A., ... & Yang, G. (2019). The role of multiple global change factors in driving soil functions and microbial biodiversity. *Science*, 366(6467), 886-890.
- Ryo, M., Aguilar-Trigueros, C. A., Pinek, L., Muller, L. A., & Rillig, M. C. (2019). Basic principles of temporal dynamics. *Trends in ecology & evolution*, 34(8), 723-733.
- Rillig, M. C., Aguilar-Trigueros, C. A., Camenzind, T., Cavagnaro, T. R., Degrune, F., Hohmann, P., ... & Yang, G. (2019). Why farmers should manage the arbuscular mycorrhizal symbiosis. *New Phytologist*, 222(3), 1171-1175.
- Aguilar-Trigueros, C. A., Hempel, S., Powell, J. R., Cornwell, W. K., & Rillig, M. C. (2019). Bridging reproductive and microbial ecology: a case study in arbuscular mycorrhizal fungi. *The ISME Journal*, 13(4), 873-884.
- Aguilar-Trigueros, C. A.; Rillig, Matthias C; Ballhausen, Max-Bernhard. 2017. Environmental Filtering Is a Relic: A Response to Cadotte and Tucker. *Trends in Ecology & Evolution*. 32 (12):882-884.
- Aguilar-Trigueros, C. A.; Rillig, Matthias C; Crowther, Thomas W. 2017. Applying allometric theory to fungi. *The ISME Journal*. 11 (10): 2175-2180.
- Rillig, Matthias C; Lehmann, Anika; Aguilar-Trigueros, C. A.; Antonovics, Janis; Caruso, Tancredi; Hempel, Stefan; Lehmann, Johannes; Valyi, Kriszta; Verbruggen, Erik; Veresoglou, Stavros D; 2016. Soil microbes and community coalescence. *Pedobiologia* 59 (1): 37-40.
- Rillig, Matthias C; Sosa-Hernández, Moisés A; Roy, Julien; Aguilar-Trigueros, C. A.; Vályi, Kriszta; Lehmann, Anika. 2016. Towards an integrated mycorrhizal technology: harnessing mycorrhiza for sustainable intensification in agriculture. *Frontiers in plant science*. 7: 16-25.
- Aguilar-Trigueros, C. A.; Rillig, Matthias C. 2016. Effect of different root endophytic fungi on plant community structure in experimental microcosms. *Ecology and evolution*. 6 (22): 8149-8158.

Rillig, Matthias C; Aguilar-Trigueros, C. A.; Bergmann, Joana; Verbruggen, Erik; Veresoglou, Stavros D; Lehmann, Anika. 2015. Plant root and mycorrhizal fungal traits for understanding soil aggregation. *New Phytologist*. 205 (4): 1385-1388.

Aguilar-Trigueros, C. A.; Hempel, Stefan; Powell, Jeff R; Anderson, Ian C; Antonovics, Janis; Bergmann, Joana; Cavagnaro, Timothy R; Chen, Baodong; Hart, Miranda M; Klironomos, John. 2015. Branching out: towards a trait-based understanding of fungal ecology. *Fungal Biology Reviews*. 29 (1): 34-41.

Veresoglou, Stavros D; Aguilar-Trigueros, C. A.; Rillig, Matthias C. 2015. Self-DNA: A blessing in disguise? *New Phytologist*. 207 (3): 488-490.

Aguilar-Trigueros, C. A.; Powell, Jeff R; Anderson, Ian C; Antonovics, Janis; Rillig, Matthias C. 2014. Ecological understanding of root-infecting fungi using trait-based approaches. *Trends in plant science*. 19 (7): 432-438.

Non-refereed scientific articles

Aguilar-Trigueros, Carlos A. (2016). The questions that opened doors. *Science*. 353 (6295): 190-190

Aguilar-Trigueros CA, Lozano Y. (2019). Zunehmende Trockenperioden: Hilfe kommt aus dem Boden. In: Vielvalt in der Uckermark. This was a bulletin given local stakeholders in north Brandenburg (Germany) on the research activities taking place in that region. Our contribution, in English is: "Increasing droughts: Help comes from the soils."