



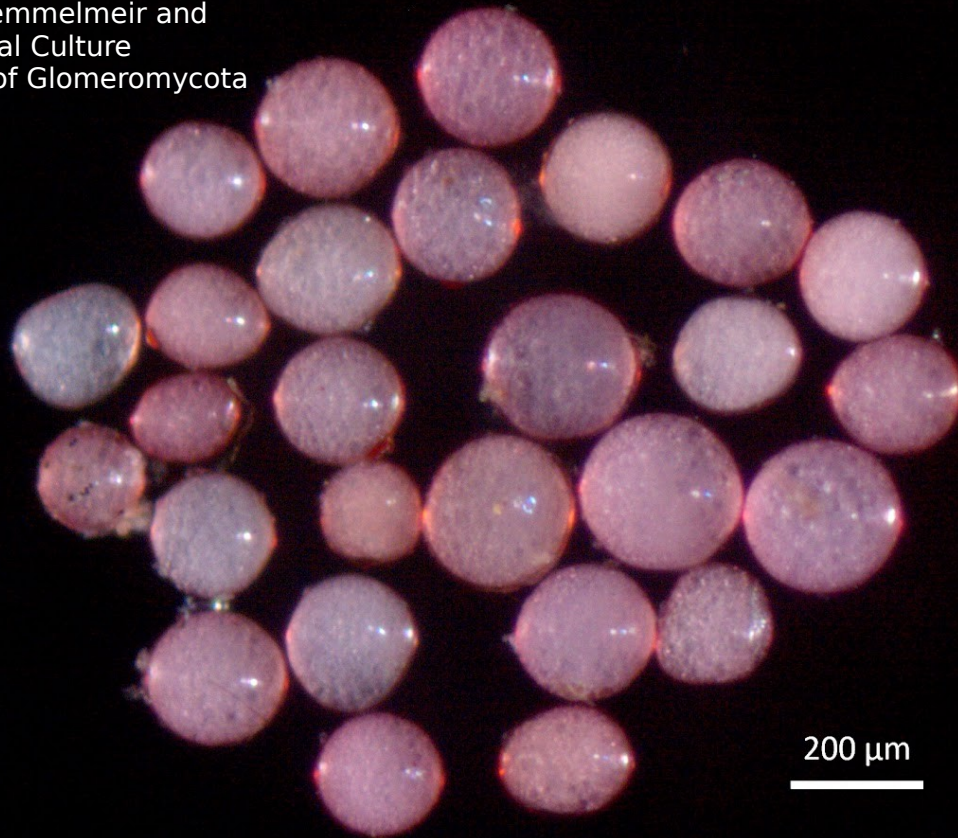
IMS Newsletter

Indexed in Latindex

The International Mycorrhiza Society quarterly e-newsletter

Scutellospora weresubiae

By: Karl Kemmelmeir and
International Culture
Collection of Glomeromycota



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Editorial: ICOM12 (Manchester, UK) approaching!

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As ICOM12 is approaching, in this Editorial of the 13th issue of the International Mycorrhiza Society (IMS) Newsletter, we want to reiterate some of the ICOM12 and IMS-related news that we announced in our last Editorial (Vol. 4, Issue 3; December 2023).

ICOM12 News – Registration is Open:

The 12th International Conference on Mycorrhiza (ICOM12) will take place in Manchester, United Kingdom, 4-9 August 2024. Please visit the ICOM12 website: <https://icom12.org/>. ICOM12 is being organized by Prof. David Johnson and his team. The ICOM12 Plenary Speakers are: Bala Chaudhary (Dartmouth College, United States), Giles Oldroyd (University of Cambridge, United Kingdom), Lingli Liu (Institute of Botany, Chinese Academy of Sciences, China), and Uta Paszkowski (University of Cambridge, United Kingdom). Please find the full list of speakers by theme, including plenary talks, keynote speakers, and rising stars here: <https://icom12.org/invited-speakers/>

Abstract submission is open until 11 March 2024:

<https://icom12.org/abstract-submission/>.

On this occasion, ICOM has many topics under which you can submit your Abstract: Mycorrhizas as Drivers of Interaction Networks, Managing Mycorrhizas for Sustainability & Food Security, Regulation and Transport in Mycorrhizal Networks, Functional Consequences of Mycorrhizal Diversity, Ecosystem Functioning, Omics

and Ecology, Environmental Change, Physiology, Evolution & Taxonomy, and Management & Applications.

Please remember to review our [Diversity and Inclusivity Statement](#) (page 12).

Call for award nominations to be given during ICOM12

The International Mycorrhiza Society offers four prestigious awards at the next meeting in Manchester, United Kingdom. These are the: 1) **Student Award for Excellence in Mycorrhiza Research Publication**, 2) the **Early Career Award for Excellence in Mycorrhiza Research Publication**, 3) the **Mid-Career Mycorrhiza Research Excellence Award** and 4) the **Eminent Mycorrhiza Researcher Award**. If you know a person which you feel deserves an award or if you like to nominate yourself because you feel you made a ground breaking discover, please check out the terms of reference here (bottom of the page):

<https://mycorrhizas.org/icom/icom-12/>

The deadline for nomination is 30 June 2024.

IMS News

Two elected board positions to be filled: After ICOM12, Justine Karst will become the new President of the International Mycorrhiza Society and Marcel van der Heijden will move to Past President. After four years of service, Ian

Dickie will leave the Board of Directors – we are very thankful to Ian for his great contributions to our Society. As such, at ICOM12 two positions need to be filled:

- New Vice President of the IMS (it can be someone from the current Board or from outside).

- New member of the Board of Directors.

If you are interested in filling/apply to any of these positions, please send your picture and a short bio-sketch to Justine Karst, IMS Vice President (karst@ualberta.ca), until 30 June of 2024. We will give further information about the voting procedure. The New Vice President and the new Board Members will be presented on the last day of ICOM12 in Manchester, United Kingdom.

IMS Seminars: Starting on April 2024, we will organize online regular seminars from an eminent researcher and from a rising star in mycorrhizal research. More information soon! The IMS seminars are also announced at our website:

<https://mycorrhizas.org/>

Call for ICOM14 proposals in 2028: If you are interested in organizing ICOM14 in 2028, please write to:

- Katarina Zachariasova,

zachariasova@associationhouse.cz

- IMS President Marcel van der Heijden,

marcel.vanderheijden@agroscope.admin.ch, &

- IMS Vice-President Justine Karst,

karst@ualberta.ca

So your proposal can be presented during ICOM12 in Manchester, United Kingdom, please submit your bid by June 30 of 2024. For the terms of reference, see p. 24 and/or the following link:

<https://mycorrhizas.org/wp-content/uploads/2024/02/ICOM14-bid.pdf>

IMS Newsletter news

IMS Newsletter indexed!

Our Newsletter has been indexed in the [database Latindex](#), and we are very happy about it! In practical terms this means that the short articles published in our Newsletter can be now deemed as “Indexed publications”.

Articles/interviews welcomed: If you want to highlight your recent mycorrhizal research/publications formally or informally, to give your expert opinion on any mycorrhizal topic of interest, or to present the 'behind-the-scenes' stories often not shown in publications, please reach out to us. There are two ways you can do this. First, you can write a short article (800-1200 words), which our Editorial Team will review (check all the articles over the last four years here: <https://southmycorrhizas.org/ims-newsletter/>). Second, we can program a YouTube interview through the South American Mycorrhizal Research Network channel (see our interviews here: <https://southmycorrhizas.org/reading/>). Please get in touch with IMS Newsletter Editor-in-Chief César Marín (cmarind@santotomas.cl) if interested!

Managing Editor position: We are looking for a Managing Editor of the IMS Newsletter who helps the Editor-in-Chief and Topic Editors produce the Newsletter every four months. Your tasks would include helping with the format design and graphic layout of the Newsletter, updating a list of events and job opportunities, checking reference formats of the articles, and sharing the Newsletter through social media. PhD students, postdocs, early career, and established mycorrhizal researchers are welcome to apply. Previous similar expertise helps your application, as well as a demonstration of editing, graphic, web design, and social media skills. Please contact IMS Newsletter Editor-in-Chief César Marín (cmarind@santotomas.cl) before 30 April 2024 if you are interested!

In this issue...

The Top 10 mycorrhizal research papers of the last four months (papers published between September and December 2023) include a *Nature Microbiology* article by Jana Sperschneider and co-authors (Rank 1). Using PacBio high-fidelity and Hi-C sequencing, the authors find that two co-existing genomes of arbuscular

mycorrhizal fungi heterokaryons, which are phylogenetically related but different in structure, content, and importantly, epigenetics. Interestingly, they found signatures of genetic exchanges indicative of past sexual reproduction in both types of genomes. The second-best paper – also published in *Nature Microbiology* – was by Stefanie Lutz and co-authors whom report an outstanding trial across 54 northern Switzerland corn fields. They found that the main predictors of a positive mycorrhizal growth response on corn were the initial soil fungal microbiome (particularly plant pathogens) and soil nutrients. Such positive responses were found in about a quarter of the fields, with the remaining 75% being not significantly different from the non-inoculated control, or even negative in some cases. This goes to show that soil microbe and nutrient context matter a lot when predicting plants' response to mycorrhizal inoculation! Please find a short article in our Newsletter describing the results and future research perspectives of this trial. The third rank corresponds to a *New Phytologist* article by Ziliang Zhang and co-authors, who found that ectomycorrhizal hyphae increased soil phosphorous bio-availability under nitrogen addition by stimulating mineralization of organic phosphorous and desorption/solubilization of secondary mineral phosphorous. Ectomycorrhizal hyphae increased phosphatase activity in the soil and the abundance of microbial genes involved with these processes (phosphorous mineralization and solubilization).

This 13th IMS Newsletter issue includes three short articles and three YouTube interviews. In addition to the above-mentioned article related to a large-scale inoculation trial in northern Switzerland, please find another short article by Cat Adams, who reports about her and co-authors recent *New Phytologist* article, exploring how large and old, genets of *Amanita phalloides* can be in their native European ecosystems, and as invasive

fungi in North America. At some places (California), a genet of this fungi can spread up to 10 m within the forest and live up to 10 years! Another short article by Chihiro Miura and co-authors *Plant Physiology* explores the molecular mechanisms of mycoheterotrophic germination in orchids, showing that orchids simultaneously coordinate seed germination and mycorrhizal symbiosis establishment, by co-opting signaling pathways of the arbuscular mycorrhizal symbiosis.

YouTube interviews ranged in varied topics, from core, functional (phosphorous cycling) microbiomes in the hyphosphere of arbuscular mycorrhizal fungi (Gu Feng interviewed by César Marín and Nancy Collins Johnson) to the (no) relationship between soil nutrients and the distribution of ectomycorrhizal tropical trees (José A. Medina-Vega interviewed by Justine Karst). Camille Delavaux became the first researcher to be interviewed twice in our YouTube channel, as C. Guillermo Bueno interviewed her about how mycorrhizal feedbacks influence global forest structure and diversity at a global scale. This work has just been published in *Communications Biology*. Please also find an appealing Webinar entitled “Threats to mycorrhizae” in the Global Soil Biodiversity Initiative seminar series (“GSBI Speaks”), moderated by Katie J. Field and with the interventions of César Marín, Nhu Nguyen, and Matthias Rillig (https://youtu.be/0uUAFy7T_ps?si=zAlZjDI2uoZ09qS7). As always, please find our Tools and Events sections at the end of our Newsletter.



Top 10 papers on mycorrhizal research*

- 1.** Sperschneider J, Yildirim G, Rizzi YS, *et al.* 2023. Arbuscular mycorrhizal fungi heterokaryons have two nuclear populations with distinct roles in host-plant interactions. *Nat Microbiol* 8:2142-2153. <https://doi.org/10.1038/s41564-023-01495-8>
- 2.** Lutz S, Bodenhausen N, Hess J, *et al.* 2023. Soil microbiome indicators can predict crop growth response to large-scale inoculation with arbuscular mycorrhizal fungi. *Nat Microbiol* 8:2277-2289. <https://doi.org/10.1038/s41564-023-01520-w>
- 3.** Zhang Z, Guo W, Wang J, Lambers H, Yin H. 2023. Extraradical hyphae alleviate nitrogen deposition-induced phosphorus deficiency in ectomycorrhiza-dominated forests. *New Phytol* 239:1651-1664. <https://doi.org/10.1111/nph.19078>
- 4.** Robinson DG, Ammer C, Polle A, *et al.* 2023. Mother trees, altruistic fungi, and the perils of plant personification. *Trends Plant Sci* 29:P20-P21. <https://doi.org/10.1016/j.tplants.2023.08.010>
- 5.** Větrovský T, Kolaříková Z, Lepinay C, *et al.* 2023. GlobalAMFungi: a global database of arbuscular mycorrhizal fungal occurrences from high-throughput sequencing metabarcoding studies. *New Phytol* 240:2151-2163. <https://doi.org/10.1111/nph.19283>
- 6.** Allsup C, Marquardt S, Lankau R. 2023. Mycorrhizal driven positive feedbacks and forest resilience to reduced rainfall. *Fungal Ecol* 65:101280. <https://doi.org/10.1016/j.funeco.2023.101280>
- 7.** Brearley FQ, Roy M, Vasco-Palacios AM. 2023. Dipterocarps, ectomycorrhizal fungi, and monodominant forests: not such a simple story?. *Trends Plant Sci* 28:P1333-P1334. <https://doi.org/10.1016/j.tplants.2023.08.015>
- 8.** Janoušková M, Remke M, Johnson NC, *et al.* 2023. Transferred communities of arbuscular mycorrhizal fungal persist in novel climates and soils. *Soil Biol Biochem* 187:109190. <https://doi.org/10.1016/j.soilbio.2023.109190>
- 9.** Jansson JK, McClure R, Egbert RG. 2023. Soil microbiome engineering for sustainability in a changing environment. *Nat Biotechnol* 41:1716-1728. <https://doi.org/10.1038/s41587-023-01932-3>
- 10.** Shao S, Wurzburger N, Sulman B, Pries CH. 2023. Ectomycorrhizal effects on decomposition are highly dependent on fungal traits, climate, and litter properties: A model-based assessment. *Soil Biol Biochem* 184:109073. <https://doi.org/10.1016/j.soilbio.2023.109073>

*Selected from 151 Web of Science articles published between *September – December*, 2023 by: Bala Chaudhary, Pedro M. Antunes, Francis M. Martin, Joseph Birch, Mark Anthony, Jeff Powell, Camille Truong, Justine Karst, Junling Zhang, Jan Jansa, Annegret Kohler, Judith Lundberg-Felten, and César Marín.

Research commentaries

To inoculate or not to inoculate? Predicting the effects of field inoculation with arbuscular mycorrhizal fungi on maize yield

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The intensification of agriculture in recent decades has led to significant increases in yields, but has also contributed to biodiversity loss, land degradation, soil pollution, greenhouse gas emissions, and water eutrophication. There is an urgent need for more sustainable methods of food production that use fewer agrochemicals (mineral fertilisers and pesticides). Soil ecological engineering is an important strategy to increase sustainability and reduce the need for external resources (Bender *et al.* 2016). Promoting beneficial soil biota is an integral part of this management practice and arbuscular mycorrhizal fungi (AMF) in particular have an enormous potential to play a pivotal role in sustainable agriculture.

The beneficial properties of AMF can be harnessed in two ways. First, native AMF communities can be supported through the adoption of favourable agricultural practices such as reduced tillage intensity, crop diversification, increased cover crops, and organic farming. Second, AMF can be deliberately introduced into the soil. Such inoculation is a particularly valuable strategy for restoring depleted soils characterized by low levels of native AMF or in soils with impaired AMF functioning (Martin and van der Heijden 2024). While greenhouse studies generally show positive effects of AMF on plant growth, the outcome of field applications of these

beneficial AM fungi is highly variable, ranging from beneficial to detrimental depending on the field (Lekberg and Koide 2005, Hoeksema *et al.* 2010, Rúa *et al.* 2016). Consequently, the *in situ* use of AMF to improve crop performance in agriculture is rather unpredictable, despite decades of research in the field.

For AMF inoculations to become an agronomically useful management practice, reliable predictions of the conditions under which AMF improve crop yields are urgently needed. In our recent publication in *Nature Microbiology* (Lutz *et al.* 2023), we have specifically investigated whether inoculation success can be predicted, and if so, based on which soil biomarkers. As a basis for our work, we conducted large-scale trials with AMF on 54 Swiss arable fields (comprising 864 individual plots, with 16 plots per field) and recorded their effect on maize growth. Maize plants were inoculated either with the AM fungus *Rhizoglyphus irregularis* SAF22 (Swiss arbuscular fungi collection isolate #22) or with a control carrier substrate without the fungus. The success of the inoculation was determined by the mycorrhizal growth response (MGR) (Köhl *et al.* 2016), a measure of the effect of AMF inoculation on crop yield.

As expected, the MGR was highly variable across the 54 fields, ranging from a decrease of -12% to an increase of +40% (Fig. 1). In one quarter of the fields, we observed significant growth improvements. In the remaining fields, however, the growth response was either neutral or, in two fields, even significantly negative (-12%). This disparity highlights the potential concerns for farmers when using AMF inoculants, as the benefits of AMF inoculation are highly context-dependent and the costs of inoculation in many cases are higher than the benefits.

To determine the context-dependency of inoculation success, we assessed 52 local soil chemical, physical, and biological parameters and the soil fungal microbiome using long-read sequencing at the beginning of the growing season (just before planting the crops). We used different modelling approaches to identify the key soil properties that could best explain the variation in MGR. Surprisingly, the composition of the native soil fungal microbiome was almost twice as important

in predicting inoculation success (53%) as chemical or physical soil properties (29%). Within the fungal microbiome, the abundance of fungal plant pathogens (e.g. *Fusarium*, *Olpidium*, *Myrothecium*) emerged as a strong predictor of high yield gains from inoculation with AMF (33% of variation in MGR explained). Overall, using a linear regression model, we were able to predict 86% of the variation in MGR: this means that we can successfully predict inoculation success in 5 out of 6 fields. Our model could be used as a decision tool for farmers to decide whether to inoculate or not.

We also examined the root microbiome at the end of the growing season and found that in fields with high MGR, the inoculated AMF significantly reduced the abundance of pathogenic fungi in the roots (Fig. 2). The ability of AMF to protect plant roots from soil-borne pathogen attack can be explained by several mechanisms, including enhanced uptake of plant nutrients and thus improved plant health, induced systemic resistance (plant

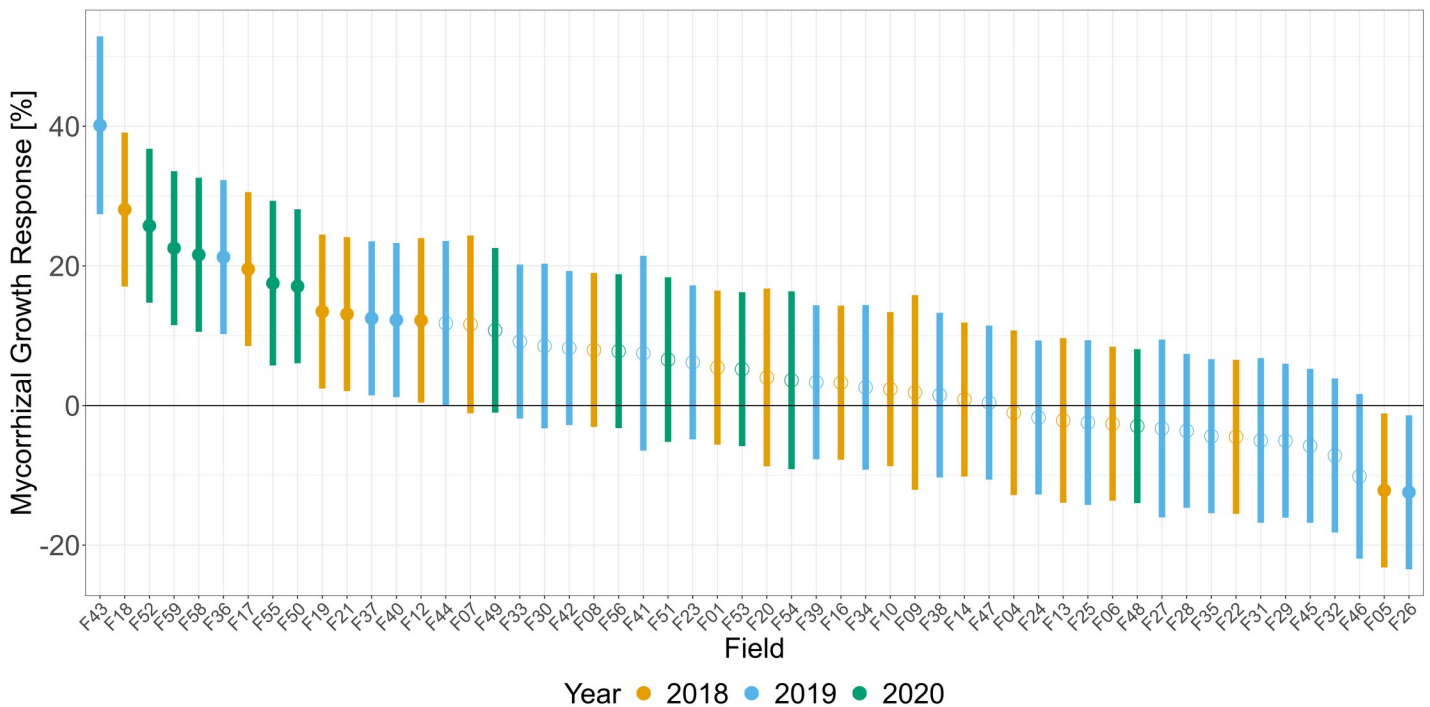


Figure 1. Variation in Mycorrhizal Growth Response in the 54 maize fields across northern Switzerland. The variation was large, ranging from a -12% yield reduction to a +40% yield increase. The graph shows the means (circles) and confidence interval for each field. Significant differences are indicated by solid circles.

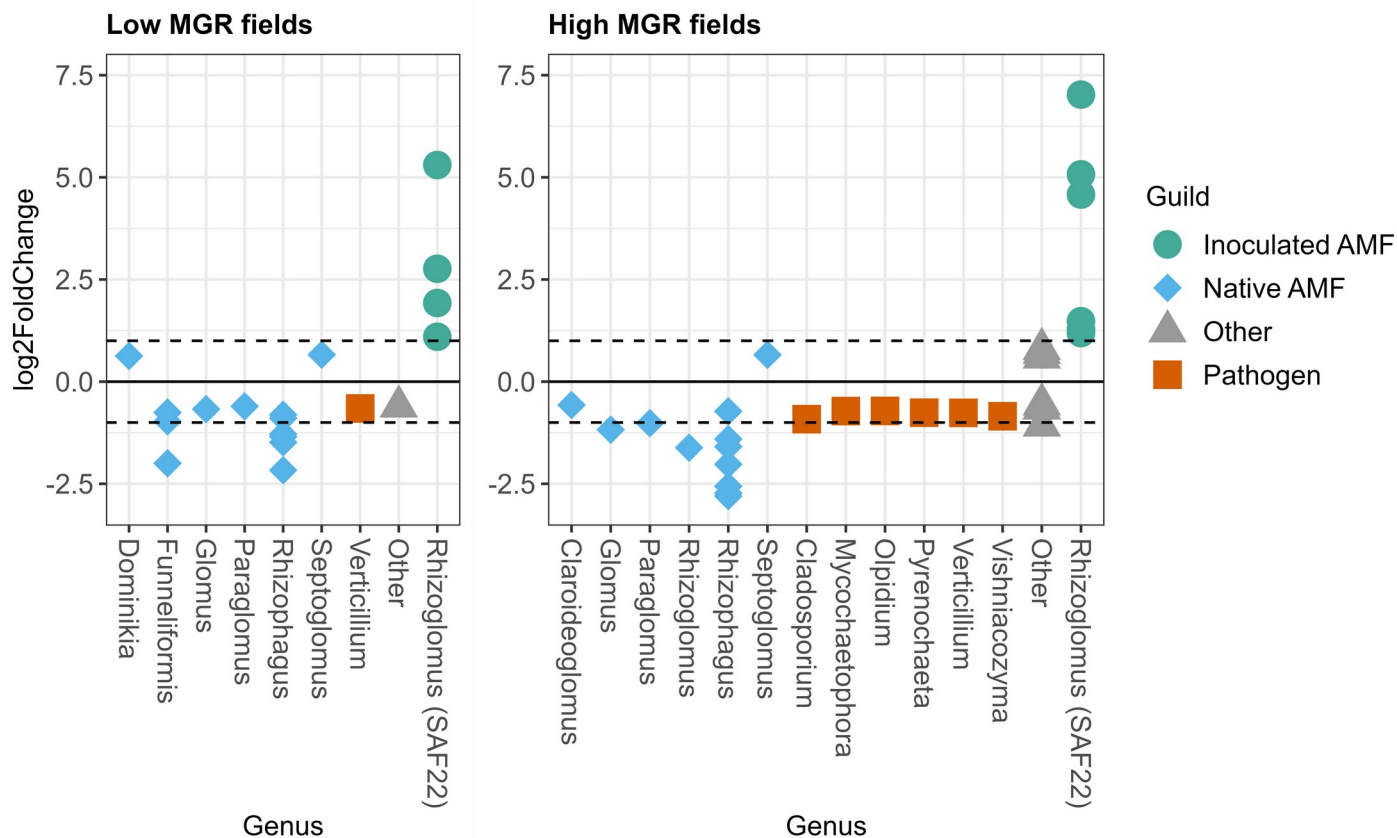


Figure 2. Comparison of differentially abundant root OTUs between control and inoculated samples for fields with low and high Mycorrhizal Growth Response (MGR). In fields with low MGR (left) the inoculated *Rhizoglossum irregulare* SAF22 (represented by several OTUs corresponding to rRNA variants) replaced the native AMF, whereas in fields with high MGR (right) not only the native AMF but also pathogenic fungi were replaced.

immune response analogous to inoculation in humans), and alteration of the root microbiome (Frew *et al.* 2024). Our data on the root microbiome suggest, in part, direct competition for root colonisation.

With this work we have resolved the context-dependency of mycorrhizal growth response for one maize variety in one geographical area and across three growing seasons. The approach presented here is easily transferable and further studies will include a wider range of crop varieties/species, soil types, growing seasons, AMF species (or species consortia), and climatic regions to extend the scope of the work. Using the analogy of 'personalised medicine', our aim is to lay the foundations for soil diagnostics to play a key role in what is known as 'precision farming'. This concept involves tailoring agronomic practices to specific soil characteristics. In addition, there is

still a need to evaluate the effectiveness of commercial AMF products because many products on the market do not contain viable propagules and do not colonize plants in field soils (Salomon *et al.* 2022). Our results suggests that under certain contexts (ie. depending on the initial soil microbiome and soil chemistry), AMF have great potential for commercial agriculture, not only as a tool to improve soil health and soil carbon storage, but also as a way to increase yields using natural processes. This study serves as a proof of concept, paving the way for the next step, where we will focus on the scalability and economic feasibility of integrating AMF into agricultural management practices. Ultimately, the targeted use of AMF can become a reliable and cost-effective alternative to conventional agrochemical use, contributing to more sustainable agriculture.

References

- Bender SF, Wagg C, Van der Heijden MGA. 2016. An underground revolution: biodiversity and soil ecological engineering for agricultural sustainability. *Trends Ecol Evol* 31:440-452. <https://doi.org/10.1016/j.tree.2016.02.016>
- Frew A, Weinberger N, Powell J, Watts-Williams SJ, Aguilar-Trigueros CA. 2024. Community assembly of root-colonising arbuscular mycorrhizal fungi: beyond carbon and into defence?. *ISME J*: wrae007. <https://doi.org/10.1093/ismejo/wrae007>
- Hoeksema JD, Chaudhary VB, Gehring CA, et al. 2010. A meta-analysis of context-dependency in plant response to inoculation with mycorrhizal fungi. *Ecology Lett* 13:394-407. <https://doi.org/10.1111/j.1461-0248.2009.01430.x>
- Köhl L, Lukasiewicz CE, Van der Heijden MGA. 2016. Establishment and effectiveness of inoculated arbuscular mycorrhizal fungi in agricultural soils. *Plant Cell Environ* 39:136-146. <https://doi.org/10.1111/pce.12600>
- Lekberg Y, Koide RT. 2005. Is plant performance limited by abundance of arbuscular mycorrhizal fungi? A meta-analysis of studies published between 1988 and 2003. *New Phytol* 168:189-204. <https://doi.org/10.1111/j.1469-8137.2005.01490.x>
- Lutz S, Bodenhausen N, Hess J, et al. 2023. Soil microbiome indicators can predict crop growth response to large-scale inoculation with arbuscular mycorrhizal fungi. *Nat Microbiol* 8:2277-2289. <https://doi.org/10.1038/s41564-023-01520-w>
- Martin FM, Van der Heijden MGA. 2024. The mycorrhizal symbiosis: research frontiers in genomics, ecology, and agricultural application. *New Phytol*. Early View. <https://doi.org/10.1111/nph.19541>
- Rúa MA, Antoninka A, Antunes PM, et al. 2016. Home-field advantage? Evidence of local adaptation among plants, soil, and arbuscular mycorrhizal fungi through meta-analysis. *BMC Evol Biol* 16:122. <https://doi.org/10.1186/s12862-016-0698-9>
- Salomon MJ, Demarmels R, Watts-Williams SJ, et al. 2022. Global evaluation of commercial arbuscular mycorrhizal inoculants under greenhouse and field conditions. *Appl Soil Ecol* 169:104225. <https://doi.org/10.1016/j.apsoil.2021.104225>

How large is an individual? Demographic dispatches from a toxic toadstool

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Just last year, Karst *et al.* (2023) called for more research illuminating common mycorrhizal networks and how they may or may not support the idea of a ‘Wood Wide Web’. They suggested that basic information, such as genet size, was needed to understand the structure of common mycorrhizal networks. In December, a new article in *New Phytologist* (Golan *et al.* 2023) furthered our understanding of one ectomycorrhizal (ECM) fungus, *Amanita phalloides*, or the death cap mushroom. Led by our fearless leader Anne Pringle, we spent many autumn days over the last 15 years mapping and sampling individual mushrooms of *Amanita phalloides* (**Fig. 1**). Across two continents, the team braved poison oak, lengthy permit processes, ticks, stormy weather, and more, to bring you the paper entitled “Death caps (*Amanita phalloides*) frequently establish from sexual spores, but individuals can grow large and live for up to a decade in invaded forests” (Golan *et al.* 2023).

Like many microbes, humans introduced death caps around the entire world before we even noticed we had done so. It is believed that death caps were first brought from Europe to California and the Northeast United States in the mid-20th century (Pringle *et al.* 2009). For reasons unknown, in the Northeast US death caps have remained in association with planted trees, but in California they are invasive in native forests (Wolfe *et al.* 2010). We define invasive as any species imported from elsewhere, found in the wild, and established as self-sustaining populations (Williamson and Fitter 1996).

Though it has been known that death caps are invasive in California for a number of years (Pringle and Velinga 2006), there is scarce research on its mode of reproduction and the persistence of individual genets, defined as genetically distinct individuals. Even less work has compared populations in the death caps’ invasive range to its native range in Europe. Here, by sampling across both of these ranges and performing genetic analyses on mapped sporocarps, we tested whether death caps spread underground through hyphae, or aboveground using sexual spores. Next, we tested whether genets are ephemeral or persistent.

Our first finding was that most genets, whether in Europe or California, are small (**Fig. 2**). In fact, the vast majority of genets consist of a single mushroom. This is in contrast with another invasive ECM fungus, *Amanita muscaria* or the Fly Agaric, which is invasive in Australia, New Zealand, and elsewhere, and is found primarily as large genets that can overlap (Sawyer *et al.* 2001; Bagley and Orlovich 2004). These notably different patterns suggest that invasive ECM fungi are capable of a myriad of life history strategies. I look forward to future research that describes genet size for other invasive ECM fungi.

What is perhaps more surprising to me, is that, for death caps, many small genets suggest frequent establishment from sexual spores. In other words, most death cap genets are small because they reproduce primarily sexually (Golan *et al.* 2023). I had personally hypothesized that death caps would consist of large genets,



Figure 1. **A.** Cat Adams ventures into the bushes to map a mushroom in 2014. **B.** Cat Adams poses with and among death caps while mapping in 2014. **C.** Lynne Boddy and Cat Adams mapping in 2014. **D.** Nick Harris (6' tall) poses with large death caps at Drake 3 (California, United States) in 2016.

due to their wielding potent amatoxins and phallotoxins. Such potent toxins could theoretically deter many organisms that stand in the way of large death cap genets, but, instead, death caps establish over and over again with sexual spores. Recent work has shown that the toxin genes are under strong selection (Drott *et al.* 2023), perhaps indicating they may still play an active role in the death cap's invasion success. More research on the ecological role of mushroom toxins is sorely needed.

But when it comes to life history strategies, death caps seem to hedge their bets: genets *can* grow quite large and persist over time. For example, at one site in California, 17 mushrooms collected in 2004, 2014, and 2015 represented a single genet, almost 10 meters wide at its maximum width (**Fig. 3**). Though the mushrooms we sampled in Europe resulted into much smaller genets than the large ones mapped in the US, our relatively limited sampling in Europe does not allow us to compare the relative sizes of genets

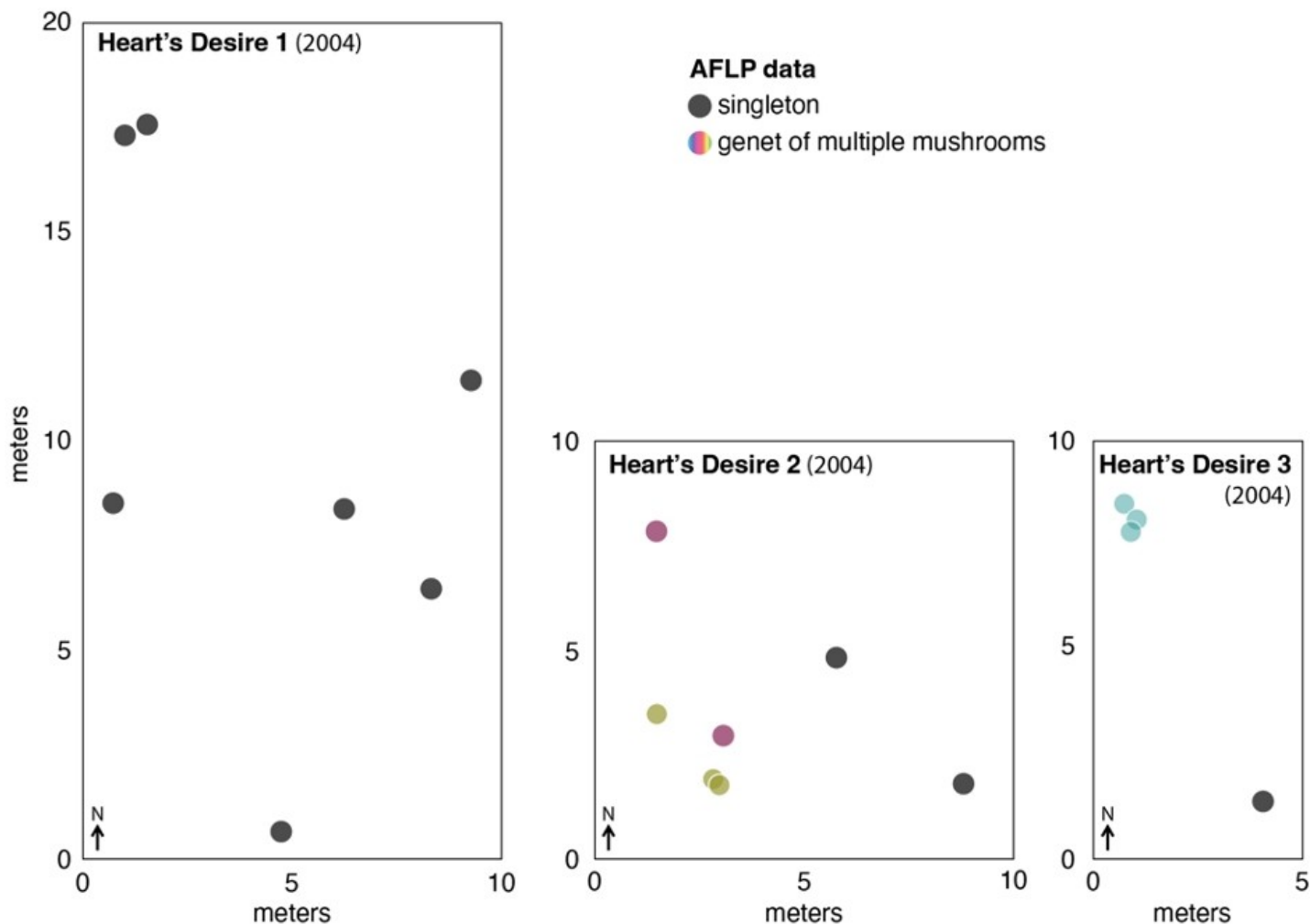


Figure 2. Reproduced from Golan *et al.* 2023: Sporocarp maps and genets identified at Tomales Bay State Park in California: Heart's Desire 1, Heart's Desire 2, and Heart's Desire 3 (2004). All collections genotyped using AFLP data. Genets made up of a single mushroom are in black, and genets made up of multiple mushrooms are each a different color. Some points jiggered for clarity. Gray shaded squares mark an area of 4 m², enabling comparisons across maps.

in death caps' invasive vs. native ranges. This cross-range genet size comparison will be a fascinating area of future study.

Lastly, some genets, at least in California, are perennial and can live for at least a decade. This finding suggests death caps can sexually reproduce repeatedly over relatively long timescales, in addition to their ability to grow vegetatively. Much like invasive English ivy, which can both grow vegetatively to cover huge swathes of native forest - in addition to producing seed-bearing fruit (Okerman 2000), a flexible life history strategy may be part of the reason for death caps' widespread invasion success in the western coast of the US.

Here we showed that, although most death cap genets are small, they *can* grow large and persist over decades. Large genets could be part of a common mycorrhizal network, potentially associating with multiple trees. However, whether death caps are a 'good' symbiont or a 'bad' symbiont remains to be established, let alone whether or not death caps can trade nutrients between their tree hosts. Many more studies will need to be performed to describe the interaction between death caps and their tree hosts, across their native and introduced ranges.

Read the full paper to learn more about average spore production per mushroom and genetic structure across sites!

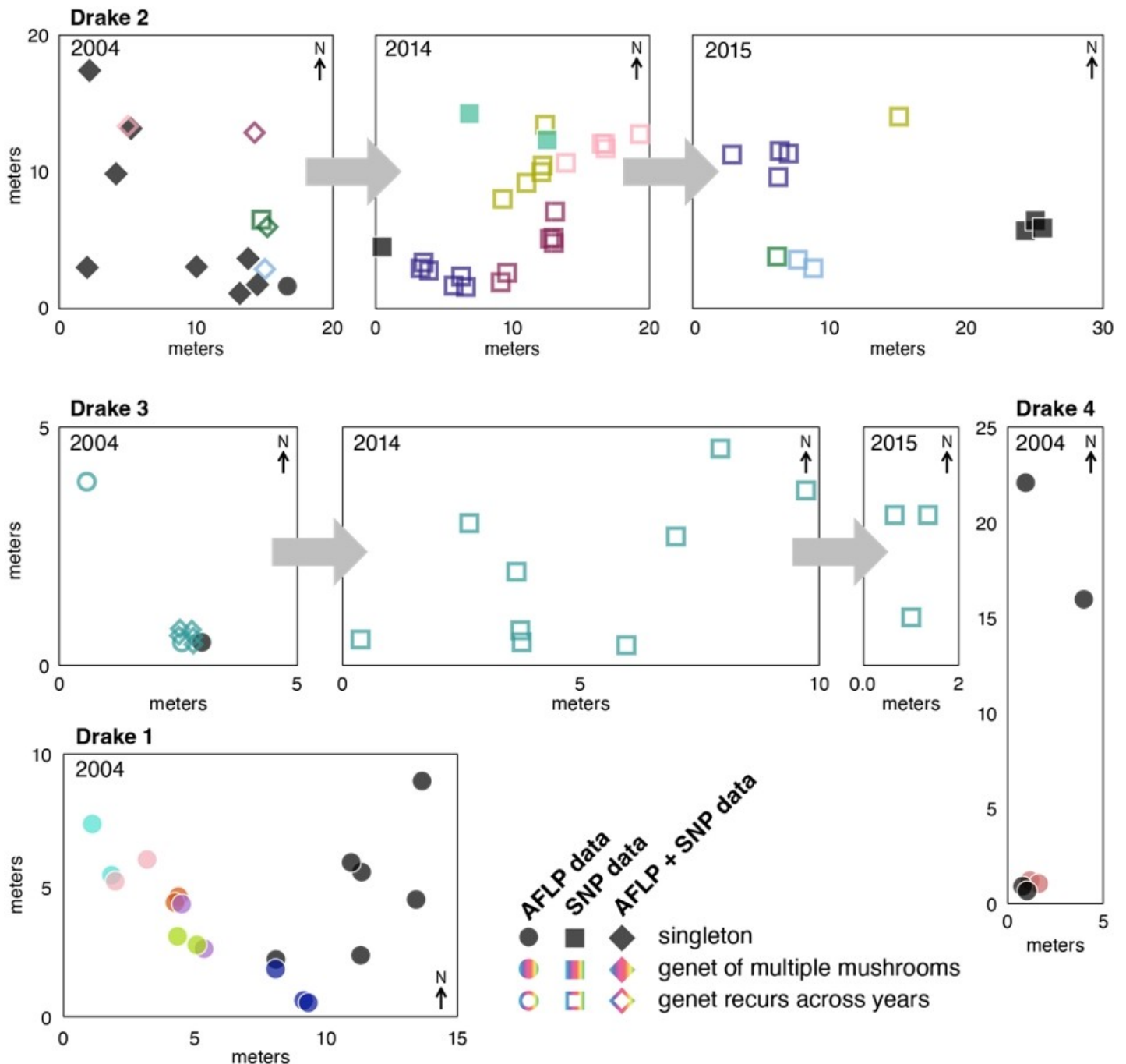


Figure 3. Reproduced from Golan *et al.* 2023: Sporocarp maps and genets identified along Limantour Road at Point Reyes National Seashore in California: Drake 1 (2004), Drake 2 (2004, 2014, 2015), Drake 3 (2004, 2014, 2015), and Drake 4 (2004). All 2004 collections genotyped using AFLP data; Drake 2 2004 and Drake 3 2004 also genotyped using SNP data; both 2014 and both 2015 collections genotyped using SNP data. Genets made up of a single mushroom are in black, as either a circle (AFLP data only), square (SNP data only), or diamond (both kinds of data). Genets made up of multiple mushrooms are each a different color, either circles (AFLP data), squares (SNP data only), or diamonds (both, relevant to Drake 2 2004 and Drake 3 2004 only). Hollow symbols mark genets found across years. In combination, a colored hollow symbol translates to a genet made up of multiple mushrooms also found across years. While Drake 2 mushrooms were collected from a single site, maps cannot be overlaid. The same is true for the Drake 3 maps. Some points jiggered for clarity. Gray shaded squares mark an area of 4 m², enabling comparisons across maps.

Acknowledgements

This short article newsletter author would like to emphatically thank the co-authors of the scientific publication for all their

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Benjamin Wolfe, and Anne Pringle. Thank you also to David Rust and Debbie Veiss of the Bay Area Mycological Society (BAMS) for hosting Justine Karst and enabling the conversation that led to this article.

References

- Bagley SJ, Orlovich DA. 2004. Genet size and distribution of *Amanita muscaria* in a suburban park, Dunedin, New Zealand. *New Zeal J Bot* 42:939-947.
<https://doi.org/10.1080/0028825X.2004.9512940>
- Drott MT, Park SC, Wang YW, Harrow L, Keller NP, Pringle A. 2023. Pangenomics of the death cap mushroom *Amanita phalloides*, and of Agaricales, reveals dynamic evolution of toxin genes in an invasive range. *ISME J* 17:1236-1246.
<https://doi.org/10.1038/s41396-023-01432-x>
- Golan J, Wang YW, Adams CA, et al. 2023. Death caps (*Amanita phalloides*) frequently establish from sexual spores, but individuals can grow large and live for more than a decade in invaded forests. *New Phytol*. Early View.
<https://doi.org/10.1111/nph.19483>
- Karst J, Jones MD, Hoeksema JD. 2023. Positive citation bias and overinterpreted results lead to misinformation on common mycorrhizal networks in forests. *Nat Ecol Evol* 7:501-511.
<https://doi.org/10.1038/s41559-023-01986-1>
- Okerman A. 2000. "Combating the "Ivy Desert": The Invasion of *Hedera helix* (English Ivy) in the Pacific Northwest United States." University of Minnesota, Department of Horticultural Science. Retrieved from the University of Minnesota Digital Conservancy. <https://hdl.handle.net/11299/59738>
- Pringle A, Vellinga EC. 2006. Last chance to know? Using literature to explore the biogeography and invasion biology of the death cap mushroom *Amanita phalloides* (Vaill. ex Fr.:Fr.) Link. *Biol Invasions* 8:1131-1144.
<https://doi.org/10.1007/s10530-005-3804-2>
- Pringle A, Adams RI, Cross HB, Bruns TD. 2009. The ectomycorrhizal fungus *Amanita phalloides* was introduced and is expanding its range on the west coast of North America. *Mol Ecol* 18:813-833.
<https://doi.org/10.1111/j.1365-294X.2008.04030.x>
- Sawyer NA, Chambers SM, Cairney JWG. 2003. Distribution of *Amanita* spp. genotypes under eastern Australian sclerophyll vegetation. *Mycol Res* 107:1157-1162.
<https://doi.org/10.1017/S0953756203008426>
- Williamson MH, Fitter A. 1996. The characters of successful invaders. *Biol Conserv* 78:163-170.
[https://doi.org/10.1016/0006-3207\(96\)00025-0](https://doi.org/10.1016/0006-3207(96)00025-0)
- Wolfe BE, Richard F, Cross HB, Pringle A. 2010. Distribution and abundance of the introduced ectomycorrhizal fungus *Amanita phalloides* in North America. *New Phytol* 185:803-816.
<https://doi.org/10.1111/j.1469-8137.2009.03097.x>

The mechanism of mycoheterotrophic germination in orchids and its application for the conservation of endangered species

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Orchids are sometimes called the “Queen of Flowers” because they exhibit beautiful flowers of various colors and shapes. They are not only valuable ornamental plants but are also used in traditional medicine. The family Orchidaceae, which includes approximately 30,000 species, is one of the largest groups of angiosperms (Christenhusz and Byng 2016). This hyperdiverse family has unique biological and evolutionary features, including a dependence on fungi for nutrients, deemed “mycoheterotrophy” (Leake 1994, Merckx 2013), and some orchids rely entirely on energy sourced from fungal partners throughout their life cycle. Such a lifestyle that they exploit fungi as soldiers is like that of the “Queen of Hearts” from Alice in Wonderland.

Recently, we found that orchids autoactivate mycorrhizal symbiosis pathways via inactivation of the plant hormone gibberellin (GA) during seed germination (Miura *et al.* 2024) (**Fig. 1**). Seed germination is an important process in the plant’s life cycle. It is generally known that GA stimulates seed germination in many plant species (Shu *et al.* 2016, Tuan *et al.* 2018). However, previous studies have shown that GA has either negative or no significant effects on symbiotically and non-symbiotically germinated seedlings of phylogenetically distant orchids (Hadley and Harvais 1968, Van Waes and Debergh 1986, Wilkinson *et al.* 1994, Miyoshi and Mii 1995, Chen *et al.* 2020).

All orchids are mycoheterotrophic, at least during seed germination, and fungal colonization begins at the early seedling development stage, occurring through the

suspensor end before rhizoid development (Richardson *et al.* 1992). Therefore, tiny orchid seeds with no endosperm can successfully germinate using nutrients obtained from symbiotic fungi. Because orchids require such unique germination conditions, it is difficult to grow many species artificially, which causes problems for orchid breeding and conservation. At present, there are still no efficient ways to conserve endangered wild orchids owing to their uncommon seed germination mechanisms.

We previously reported that mycoheterotrophic symbioses in orchids, at least in part, shares molecular mechanisms common to arbuscular mycorrhizal (AM) symbioses (Miura *et al.* 2018). Moreover, other studies have found that GA signaling negatively affects AM fungal colonization and development (Floss *et al.* 2013, Foo *et al.* 2013, Takeda *et al.* 2015). In the current study, we hypothesized that orchids have evolved to not use GA as a positive regulator of seed germination, but instead, inactivating GA contributes to the establishment and maintenance of symbiotic associations concurrent with seed germination. To elucidate the mechanisms that connect orchid seed germination and mycorrhizal symbiosis at the molecular level, we investigated the effects of GA on seed germination and mycorrhizal symbiosis using an established *in vitro* seed germination system for the terrestrial orchid *Bletilla striata*, which can germinate using either symbiotic or non-mycorrhizal (asymbiotic) methods (Yamamoto *et al.* 2017).

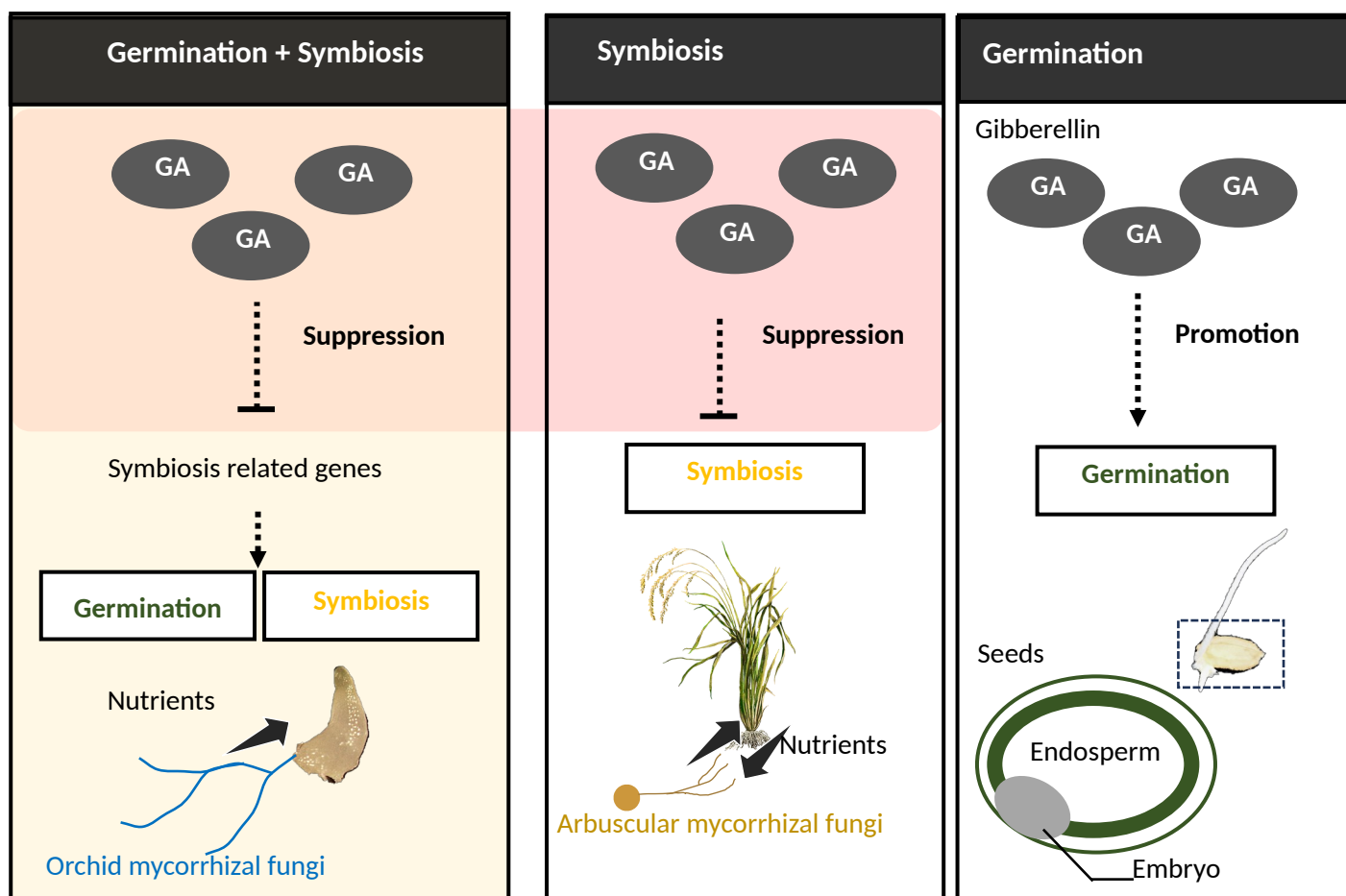
Bletilla striata (Orchidaceae)*Oryza sativa* (Poaceae)

Figure 1. A graphical summary of research published in a recent paper in *Plant Physiology*. Here, we show that gibberellin (GA) stimulates seed germination of arbuscular mycorrhizal (AM) in plants such as *Oryza sativa* (right panel). After root development, mutual relationships between plants and AM fungi are established in the roots (middle panel). In *Bletilla striata*, an orchid mycorrhizal (OM) plant, exogenous treatment with GA inhibits seed germination and fungal colonization via unknown mechanisms (left panel). When seed germination occurs, environmental factors—likely derived from OM fungi—indirectly stimulate symbiotic signaling even without living fungi.

Symbiotically and asymbiotically germinated *B. striata* seeds (hereafter SS and AS, respectively) were subjected to transcriptome analysis following RNA sequencing to determine whether these germination procedures share differentially expressed genes (DEGs). Our results showed that SS and AS shared more than half the total number of DEGs identified. Common upregulated DEGs included AM-specific marker homologs and GA metabolic genes. During seed germination, we observed an increase in the expression of GA 2-oxidase genes, which encode enzymes that convert bioactive GAs to their inactive forms, and direct

measurements confirmed that endogenous bioactive GA was actively converted to the inactive form. These results indicated that orchids autoactivate the mycorrhizal symbiosis pathway during seed germination even without mycorrhizal fungi via GA inactivation, suggesting that an adaptive mechanism coordinates seed germination and mycorrhizal symbiosis.

Next, we found that commercially accessible plant growth stimulators, comprising GA-biosynthesis inhibitors, promoted *B. striata* germination. One inhibitor, uniconazole-P, stimulated four other orchid species. These findings may

contribute to the development of conservation and restoration methods for orchids facing extinction (Swarts and Dixon 2009).

We began the conservation of wild orchids using the knowledge reported here. In Japan, approximately 300 orchid species inhabit temperate forests, grasslands, and wetlands (Inoue 1996). However, many orchids have been registered on the Red List of Species of Concern. For example, the orchid *Cephalanthera falcata* is endangered because of the illicit collection of wild populations and natural habitat loss caused by land development. In addition, this orchid faces a new threat from a seed-eating fly (Suetsugu *et al.* 2018). To promote seed propagation, we sowed GA-biosynthesis inhibitor-treated seeds in natural habitats and later returned to collect data on seed germination and growth.

Our results demonstrated that seeds treated with the GA-biosynthesis inhibitor were likely to show higher seed germination and subsequent growth relative to untreated controls (**Fig. 2**). This preliminary finding may provide evidence for the application of our laboratory work in wild orchid conservation.

Taken together, our findings imply that orchids coordinate two concurrent events, seed germination and mycorrhizal symbiosis, by co-opting for AM symbiotic signaling pathways in roots via GA-mediated seed germination. This co-option scenario may explain the possibility that the interaction between orchids and mycorrhizal fungi has driven the evolution of mycoheterotrophy. In addition, we hope that a germination strategy using GA-biosynthesis inhibitors can support the conservation of the Queen of Flowers.

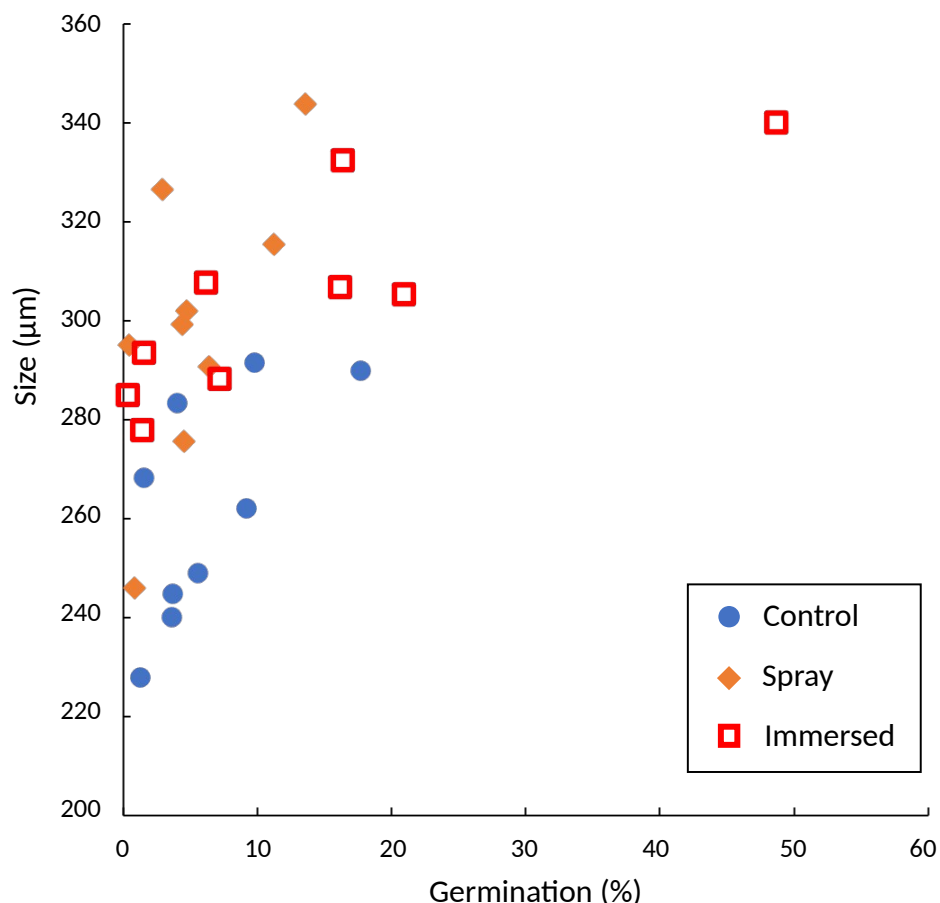


Figure 2. Preliminary data on seed germination and early growth of *Cephalanthera falcata* sown in natural habitats. Here, a seed germination experiment was conducted in a test field in Japan using the seed packet method (Rasmussen and Whigham 1993). Seeds were treated by spray with a spreading agent (Control) or a GA-biosynthesis inhibitor (Spray) or were immersed into a solution (Immersed).

References

- Chen J, Yan B, Tang Y, et al. 2020. Symbiotic and asymbiotic germination of *Dendrobium officinale* (Orchidaceae) respond differently to exogenous gibberellins. *Int J Mol Sci* 21:6104. <https://doi.org/10.3390/ijms21176104>
- Christenhusz MJM, Byng JW. 2016. The number of known plants species in the world and its annual increase. *Phytotaxa* 261:201-217. <https://doi.org/10.11646/phytotaxa.261.3.1>
- Floss DS, Levy JG, Lévesque-Tremblay V, et al. 2013. DELLA proteins regulate arbuscule formation in arbuscular mycorrhizal symbiosis. *Proc Natl Acad Sci USA* 110:E5025-E5034. <https://doi.org/10.1073/pnas.1308973110>
- Foo E, Ross JJ, Jones WT, Reid JB. 2013. Plant hormones in arbuscular mycorrhizal symbioses: An emerging role for gibberellins. *Ann Bot* 111:769-779. <https://doi.org/10.1093/aob/mct041>
- Hadley G, Harvais G. 1968. The effect of certain growth substances on asymbiotic germination and development of *Orchis purpurella*. *New Phytol* 67:441-445. <https://doi.org/10.1111/j.1469-8137.1968.tb06393.x>
- Inoue K. 1996. Current status and conservation of orchid plants in Japan. *Ecol Soc Japan* 1:115-129. https://doi.org/https://doi.org/10.18960/hozen.1.2-3_115
- Leake JR. 1994. The biology of myco-heterotrophic ('saprophytic') plants. *New Phytol* 127:171-216. <https://doi.org/10.1111/j.1469-8137.1994.tb04272.x>
- Merckx VSFT. 2013. Mycoheterotrophy: An Introduction. In: Merckx VSFT (Ed) *Mycoheterotrophy: The Biology of Plants Living on Fungi*. Springer, New York, United States. Pp. 1-17. https://doi.org/10.1007/978-1-4614-5209-6_1
- Miura C, Furui Y, Yamamoto T, et al. 2024. Autoactivation of mycorrhizal symbiosis signaling through gibberellin deactivation in orchid seed germination. *Plant Physiol* 194:546-563. <https://doi.org/10.1093/plphys/kiad517>
- Miura C, Yamaguchi K, Miyahara R, et al. 2018. The mycoheterotrophic symbiosis between orchids and mycorrhizal fungi possesses major components shared with mutualistic plant-mycorrhizal symbioses. *Mol Plant-Microbe Interact* 31:1032-1047. <https://doi.org/10.1094/MPMI-01-18-0029-R>
- Miyoshi K, Mii M. 1995. Phytohormone pre-treatment for the enhancement of seed germination and protocorm formation by the terrestrial orchid, *Calanthe discolor* (Orchidaceae), in asymbiotic culture. *Sci Hortic* 63:263-267. [https://doi.org/10.1016/0304-4238\(95\)00813-9](https://doi.org/10.1016/0304-4238(95)00813-9)
- Rasmussen HN, Whigham DF. 1993. Seed ecology of dust seeds in situ: a new technique and its application in terrestrial orchids. *Am J Bot* 80:1374-1378. <https://doi.org/10.1002/j.1537-2197.1993.tb15381.x>
- Richardson KA, Peterson RL, Currah RS. 1992. Seed reserves and early symbiotic protocorm development of *Platanthera hyperborea* (Orchidaceae). *Can J Bot* 70:291-300. <https://doi.org/10.1139/b92-040>
- Shu K, Liu XD, Xie Q, He ZH. 2016. Two faces of one seed: hormonal regulation of dormancy and germination. *Mol Plant* 9:34-45. <https://doi.org/10.1016/j.MOLP.2015.08.010>
- Suetsugu K, Fukushima S, Sueyoshi M. 2018. Substantial impact of seed-feeding fly on seed production of five endangered Japanese orchids. *Ecology* 99:2871-2873. <https://doi.org/10.1002/ecy.2471>
- Swarts ND, Dixon KW. 2009. Terrestrial orchid conservation in the age of extinction. *Ann Bot* 104:543-556. <https://doi.org/10.1093/aob/mcp025>
- Takeda N, Handa Y, Tsuzuki S, et al. 2015. Gibberellins interfere with symbiosis signaling and gene expression and alter colonization by arbuscular mycorrhizal fungi in *Lotus japonicus*. *Plant Physiol* 167:545-557. <https://doi.org/10.1104/pp.114.247700>
- Tuan PA, Kumar R, Rehal PK, et al. 2018. Molecular mechanisms underlying abscisic acid/gibberellin balance in the control of seed dormancy and germination in cereals. *Front Plant Sci* 9:668. <https://doi.org/10.3389/fpls.2018.00668>
- Van Waes JM, Debergh PC. 1986. *In vitro* germination of some Western European orchids. *Physiol Plant* 67:253-261. <https://doi.org/10.1111/j.1399-3054.1986.tb02452.x>
- Wilkinson KG, Dixon KW, Sivasithamparam K, Ghisalberti EL. 1994. Effect of IAA on symbiotic germination of an Australian orchid and its production by orchid-associated bacteria. *Plant Soil* 159:291-295. <https://doi.org/10.1007/BF00009292>
- Yamamoto T, Miura C, Fuji M, et al. 2017. Quantitative evaluation of protocorm growth and fungal colonization in *Bletilla striata* (Orchidaceae) reveals less-productive symbiosis with a non-native symbiotic fungus. *BMC Plant Biol* 17:50. <https://doi.org/10.1186/s12870-017-1002-x>

YouTube interviews*

- Gu Feng on core microbiomes of AMF hyphospheres

Prof. César Marín (Universidad Santo Tomás, Chile) and Prof. Nancy Collins Johnson (Northern Arizona University, United States), interview Prof. Gu Feng (China Agricultural University, China), about his team recent work on arbuscular mycorrhizal fungi (AMF) hyphospheres.

Interview: <https://southmycorrhizas.org/reading/january-2024/>

Study: Wang L, Zhang L, George TS, Feng G. 2023. A core microbiome in the hyphosphere of arbuscular mycorrhizal fungi has functional significance in organic phosphorus mineralization. *New Phytol* 238:859-873.

<https://doi.org/10.1111/nph.18642>

- Camille Delavaux on mycorrhizal feedbacks effects on global forests

C. Guillermo Bueno (Ramon y Cajal Researcher, CSIC, Spain) interviews Camille Delavaux (Lead Scientist, ETH Zurich, Switzerland) about her and co-authors' recent paper on whether ectomycorrhizal tree species exhibit weaker negative conspecific density dependence than arbuscular mycorrhizal tree species, at a global scale.

Interview: <https://southmycorrhizas.org/reading/february-2024/>

Study: Delavaux CS, LaManna JA, Myers JA, et al. 2023. Mycorrhizal feedbacks influence global forest structure and diversity. *Commun Biol* 6:1066. <https://doi.org/10.1038/s42003-023-05410-z>

- José A. Medina-Vega on the soil nutrients-independent distribution of ectomycorrhizal tropical trees

Assoc. Prof. Justine Karst (University of Alberta, Canada) interviews Postdoc José A. Medina-Vega (Smithsonian Tropical Research Institute, United States) about his (and co-authors) global-scale study on the (no) relationship between soil nutrients and ectomycorrhizal trees' distribution, at a global scale.

Interview: <https://southmycorrhizas.org/reading/february-ii-2024/>

Study: Medina-Vega JA, Zuleta D, Aguilar S, et al. 2024. Tropical tree ectomycorrhiza are distributed independently of soil nutrients. *Nat Ecol Evol*. Early View. <https://doi.org/10.1038/s41559-023-02298-0>

Section by: South American Mycorrhizal Research Network

Contact/Join us: <https://southmycorrhizas.org/join/>



GSBI Speaks: Threats to Mycorrhizae

Webinar No. 19 of the series “GSBI Speaks”, by the Global Soil Biodiversity Initiative (<https://www.globalsoilbiodiversity.org/>): Threats to Mycorrhizae.

“Soil mycorrhizae occur globally and are an important component of soil biodiversity. As soils and soil biodiversity in general face threats, it will be critical to evaluate and understand how mycorrhizae are impacted by these threats. Join us in this webinar with leading experts on mycorrhizae to learn more about how these threats impact mycorrhizae and potential solutions.

Moderated by Katie J. Field (University of Sheffield, UK), panelists Bala Chaudhary (Dartmouth College, USA), César Marín (Santo Tomas University, Chile), Nhu Nguyen (University of Hawai‘i at Mānoa, USA), and Matthias Rillig (Freie Universität Berlin, Germany).”

YouTube link: https://youtu.be/0uUAFy7T_ps?si=ysBAndfqW_ch_1D-

GSBI link: <https://www.globalsoilbiodiversity.org/webinar-19-threats-to-mycorrhizae>

“GSBI SPEAKS” FEBRUARY WEBINAR

**Threats to mycorrhizae - February 7th 2024, 4:00
HST, 7:00 MST, 9:00 EST, 11:00 GMT-3, 14:00 GMT,
15:00 CET, 16:00 MSK**



Tools

→ **Absolute qPCR to quantify root colonization by arbuscular mycorrhizal fungi (AMF)**

Root staining and microscopic quantification of AMF structures is time-consuming, and the results are very dependent on the observer. Corona Ramírez *et al.* (2023) developed a method based on quantitative polymerase chain reaction (qPCR) to quantify AMF root colonization, through two methods: relative quantification and absolute quantification. They observed a high correlation between microscopy and qPCR in three of the four plant species tested.

Study: Corona Ramírez A, Symanczik S, Gallusser T, Bodenhausen N. 2023. Quantification of arbuscular mycorrhizal fungi root colonization in wheat, tomato, and leek using absolute qPCR. *Mycorrhiza* 33:387-397. <https://doi.org/10.1007/s00572-023-01122-8>

→ **Cardiolipins as biomarkers for AMF?**

Řezanka *et al.* (2023) analyzed AMF lipids through shotgun lipidomics using a high-resolution hybrid mass spectrometer, for the detection of potential biomarkers among cardiolipins. Although further research is needed, the results obtained are very promising regarding the possibility to identify novel biochemical signatures particular to AMF in colonized roots.

Study: Řezanka T, Hršelová H, Kyselová L, Jansa J. 2023. Can cardiolipins be used as a biomarker for arbuscular mycorrhizal fungi?. *Mycorrhiza* 33:399-408. <https://doi.org/10.1007/s00572-023-01129-1>

→ **Split-root assays to study ectomycorrhizal symbioses in Pinus**

Rose *et al.* (2023) describe a hydroponics-based protocol to produce split-roots in *P. taeda*, which takes only eight weeks, with significant root elongation. The protocol was validated by measuring root biomass and inoculating the *P. taeda* seedlings with two ectomycorrhizal fungal species.

Study: Rose BD, Frank HE, Garcia K. 2023. Development of split-root assays for loblolly pine (*Pinus taeda* L.) seedlings to study ectomycorrhizal symbioses. *MethodsX* 10:102046. <https://doi.org/10.1016/j.mex.2023.102046>

Click for previous Tools: [Vol1_I1](#) (p. 11), [Vol1_I2](#) (p. 15), [Vol1_I3](#) (p. 16), [Vol2_I1](#) (p. 19), [Vol2_I2](#) (p. 15), [Vol2_I3](#) (p. 15), [Vol3_I1](#) (p. 16), [Vol3_I2](#) (p. 17), [Vol3_I3](#) (p. 26), [Vol4_I1](#) (p. 19), [Vol4_I2](#) (p. 23), and [Vol4_I3](#) (p. 34).

Events

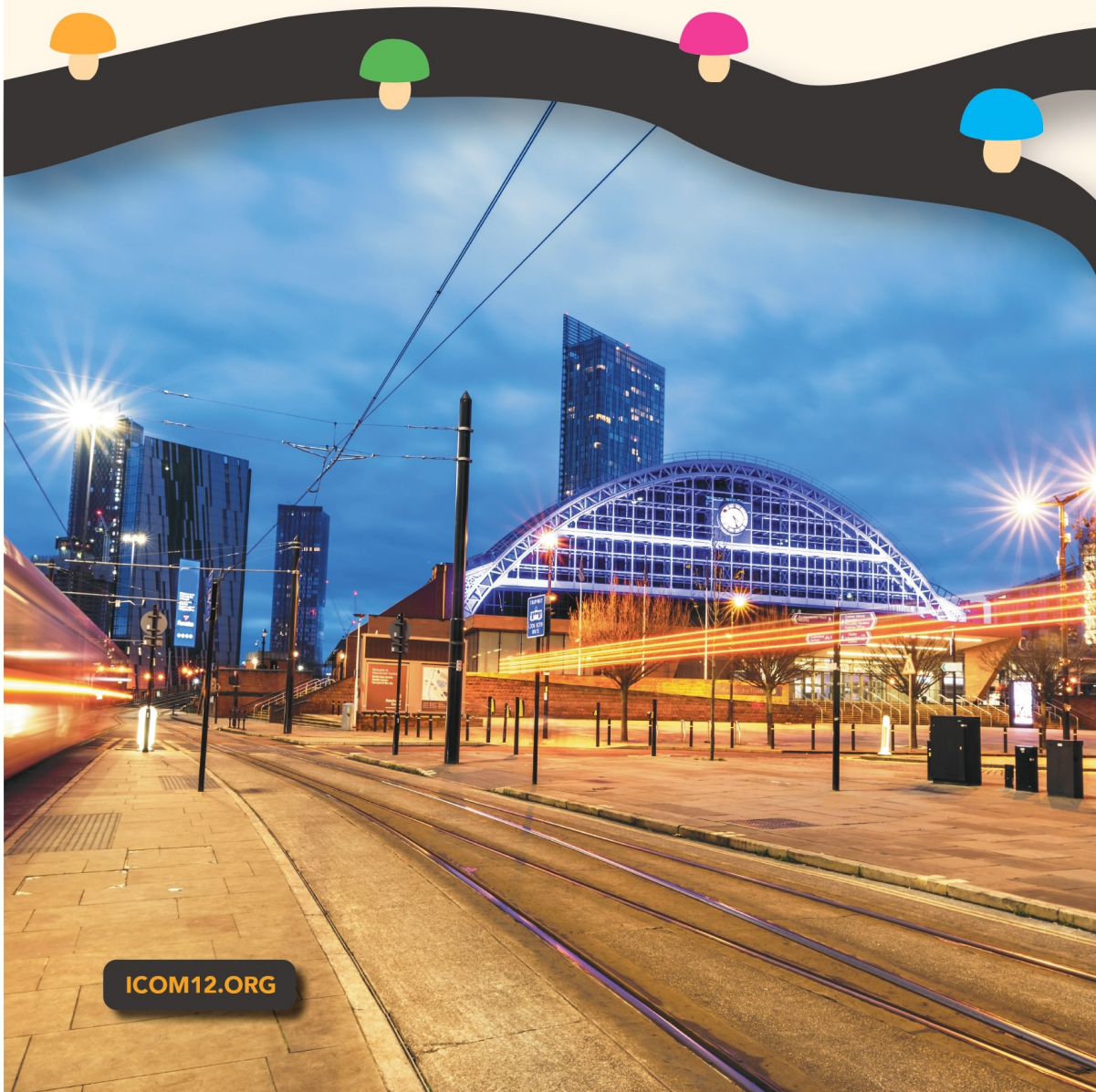
MYCORRHIZAL EVENTS:

<https://icom12.org/>



12th
INTERNATIONAL
CONFERENCE
ON MYCORRHIZA

4 - 9 August 2024
Manchester, UK



ICOM12.ORG

Events

- The 13th International Conference on Mycorrhiza (ICOM13), will take place in Cairns, Australia, in 2026. Check the next page for ICOM14 bid information.

11th International Workshop of Edible Mycorrhizal Mushroom

[Website](#)

CIEFAP, Esquel, Argentina
22 – 26 April, 2024

Organizers: CIEFAP.



MYCOLOGICAL EVENTS:

2024 MSA Annual Meeting: Expanding Networks

[Website](#)

Hilton Toronto/Markham, Markham, Canada
9 – 12 June, 2024

Organizers: Local organizers & Mycological Society of America.



45th New Phytologist Ecological consequences and of Symposium: evolutionary plant-fungal invasions

[Website](#)

University of Campinas, Campinas, Brazil
26 – 29 June, 2024

Organizers: New Phytologist Foundation.



12th International Mycological Congress

[Website](#)

MECC, Maastricht, the Netherlands
11 – 15 August, 2024



Organizers: Local & International organizers and International Mycological Association.

Call for Proposals for Hosting ICOM14

The International Mycorrhiza Society (IMS) is requesting proposals from groups actively studying mycorrhizas to host the Fourteenth International Conference on Mycorrhizas (ICOM14).

The ICOM is the premier international forum for current research on all aspects of mycorrhizal symbioses. Research results are presented as invited plenary or symposium presentations, as contributed oral presentations, or as posters. The Conference promotes idea exchange and research collaborations. **The ICOM is held every two years. Thus, ICOM14 will take place in 2028.**

ICOM is the major international event supported by the IMS. The first ICOM was held in Berkeley (USA) in 1996. It was followed by ICOM2 in Uppsala (Sweden) in 1998, ICOM3 in Adelaide (Australia) in 2001, ICOM4 in Montreal (Canada) in 2003, ICOM5 in Granada (Spain) in 2006, ICOM6 in Belo Horizonte (Brazil) in 2009, ICOM7 in New Delhi (India) in 2013, ICOM8 in Flagstaff (USA) in 2015; ICOM9 in Prague (Czech Republic) in 2017, ICOM10 in Merida (Mexico) in 2019, ICOM11 online in Beijing (China), ICOM12 in Manchester (UK), and ICOM13 in Cairns (Australia). **Attendance has averaged around 600 (range 250 to 800).**

While the IMS does not underwrite the conference financially or cover any budgetary shortfalls, the IMS will provide advice to the local organizing committee. **Start-up financial support is provided with the expectation this amount will be paid back in full to the IMS.** The Chair of the local organizing committee will serve on the IMS Board of Directors for the two years leading up to ICOM14 and the IMS will provide members to serve on the international scientific committee. The Chair of the local organizing committee must be a member in good standing of the IMS. By joining the Board, frequent and

effective communication between the local organizing committee and the IMS board is facilitated.

What to include in a proposal

The purpose of the proposal is to provide sufficient information to the IMS Board of Directors to decide where to hold the next ICOM. The following list was developed based on the experience of previous ICOM organizers and is provided to help potential organizers think about major aspects of conference organization. It is understood that the information in the proposal will be based on the best current estimates of the local organizing committee and that firm details cannot be developed until a time closer to the event. Note that IMS members get a discount for ICOM registration. The registration discount varies from \$100 USD for students to \$200 USD for full members, subject to evaluation. **IMS membership fees are collected by IMS, while registration fees are collected by the ICOM.** ICOM Registration fees cover the expenses associated with the organization of ICOM.

Proposals should not exceed 10 pages and should be submitted By **June 30, 2024**, to:

- President, Marcel van der Heijden; marcel.vanderheijden@agroscope.admin.ch
- Vice President, Justine Karst; karst@ualberta.ca
- Secretariat, Katerina Zachariasova; zachariasova@associationhouse.cz

In the 10 pages, please include:

1. Summary of major aspects of the proposal (approximately ½ page and appropriate for posting on the website); provide an overview of why this location is appealing and ideal for the next ICOM,
2. Proposed dates, with rationale,

3. A clear and realistic preliminary budget:
 - a. Please provide us with an estimate of the registration costs for the meeting, that is, today's price for organizing such an event by the hosting venue. The final price is not expected to be higher than the current price adjusted for inflation leading up to the organization of the event,
 - b. include possible sources of sponsorships,
 - c. proposed fee and anticipated attendance (with the understanding that both are very difficult to predict long in advance of the conference date),
 - d. low registration fees are attractive, but fees must be adequate to cover the costs,
 - e. which aspects of the conference the fees are expected to cover
4. Information on the facilities proposed for the meeting,
5. Other events planned (trips, visits, workshops, round table discussions, etc.); opportunities for networking and establishing collaborations,
6. People and groups who will organize the ICOM:
 - a. Will a professional conference organizer be used? (organizers of previous ICOMs recommend this),
 - b. Who would the local committee like to see serve on the international scientific committee? (the IMS can assist you by contacting these people),
 - c. Who is willing to serve on a local organizing committee?
7. Indication of the experience of the people listed in #6 with organizing international scientific meetings,
8. Major transportation routes to the host city, their cost and convenience; proposed location relative to the region in which the previous ICOM was held,
9. A general statement on visa requirements (no need to provide details for nationals of all countries),
10. Availability of a range of types of accommodation including low-cost

accommodation for students (e.g., student residences); apartments for groups,

11. Theme and format of the Conference,
12. Plans for inviting keynote speakers, to maintain the tradition of research excellence of the ICOM,
13. Plans to involve companies/industry in the activities of ICOM (some sessions on applied aspects; packages of 'benefits' can be offered to companies who sponsor various aspects of the conference),
14. Source of liability and cancellation insurances,
15. Other reasons why this location is a good location.

Once the proposals have been received by the IMS, the IMS Board of Directors will review them and solicit clarifying information from the submitters by **July 15, 2024**.

Updated proposals will be submitted to the IMS President, Vice-President, and Secretariat by **August 1, 2024**. The IMS board will select the two most appealing bids and leads of the two proposals will give a short presentation (5–10 minutes) about the venue, location, and the overall theme on the last day of ICOM12 in Manchester. Following these presentations, IMS members will vote for the location by hand-vote. The successful proposal will be announced **August 9, 2024**.

IMS Newsletter

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ICOM12 will be organised in the summer of 2024 in Manchester, United Kingdom, by Prof. Dr. David Johnson (University of Manchester) and colleagues.

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