

# Marcel G.A. van der Heijden interview: mycorrhizal biodiversity and functioning, applications, and IMS future

**By:** César Marín<sup>1, 2\*</sup>

<sup>1</sup>Center for Research and Innovation for Climate Change, Santo Tomás University, Chile.

<sup>2</sup>Amsterdam Institute for Life and Environment (A-LIFE), Section Systems Ecology, Vrije Universiteit Amsterdam, the Netherlands. \*E-mail: [cmarind@santotomas.cl](mailto:cmarind@santotomas.cl)

The 12<sup>th</sup> International Conference on Mycorrhiza (ICOM12) will occur in Manchester, United Kingdom, on 4-9 August 2024. After ICOM12, the current Vice President of the International Mycorrhiza Society (IMS), Justine Karst, will become the new President of the IMS, and Marcel G.A. van der Heijden will move to Past President. At the IMS, we are very thankful to Marcel for the immense work done these past four years. His vision, kindness, and strong work ethics has undoubtedly contributed significantly to our Society. And, of course, I think many worldwide mycorrhizal communities are very grateful to Marcel for his outstanding contributions to mycorrhizal ecology.

Prof. Dr. Marcel G.A. van der Heijden is Professor at the Department of Plant and Microbial Biology at the University of Zürich, Switzerland, he heads the Plant-Soil-Interactions Research Group at Agroscope, Switzerland and he is Professor of Mycorrhizal Ecology at Utrecht University, the Netherlands. Marcel obtained his PhD at the University of Basel in Switzerland in 1999 under the supervision of Ian R. Sanders, Andres Wiemken, and Thomas Boller. Marcel has supervised 19 PhD students (currently 6) and 22 postdocs since 2000. Eight of his postdocs are now Professors. He has been the Principal Investigator of 19 projects that amount a total of > €7.5 millions. His productivity is impressive, with more than 185 peer-reviewed publications. At the moment of writing this interview, in his



Google Scholar profile Marcel had 76 publications cited more than 100 times, and 10 cited more than 1000 times! In addition, Marcel has strong collaborations in over 20 countries, with a wide range of researchers.

I think his early (1998) contribution, together with John Klironomos, has been fundamental for soil ecology and the whole field of community and ecosystem ecology in general. It showed, using experimental microcosms, the causal relationships between mycorrhizal fungal biodiversity, plant biodiversity, and ecosystem productivity. I teach community and ecosystem ecology to PhD students in

Chile, and Marcel's work is very often used and discussed in my classes. I find two further studies fascinating and helpful for teaching. One was published in *Nature Communications* in 2019 with Cameron Wagg as the first author; the other was published in *Science of The Total Environment* in 2023 with Ferran Romero as the first author and Marcel as the senior author in both cases. In addition to worldwide measurements of soil biodiversity and ecosystem functioning (by people like Manuel Delgado-Baquerizo), these studies showed a positive relationship between soil biodiversity and ecosystem functions and services. His many highly cited contributions on this topic testify to Marcel's colossal impact. He also has dabbled in mycorrhizal applications over the last decades, with a recent study published in *Nature Microbiology* (first author: Stefanie Lutz) showing that the main predictor of mycorrhizal inoculation success is the abundance of pathogenic fungi in the soil before the inoculation. Although more research is needed (i.e., more crops, climates, consortia, or species of mycorrhizal fungi used), this finding, of course, can have significant implications for (an intelligent) agricultural management based on the application of arbuscular mycorrhizal fungi (AMF) bioinoculants.

I am thrilled to present this interview with Marcel to our readers.

### **When did you start to study mycorrhizas?**

I did my Master thesis (1994) at Utrecht University on mycorrhizal fungi, specifically testing whether mycorrhizal fungi alter competitive relationships between two plants.

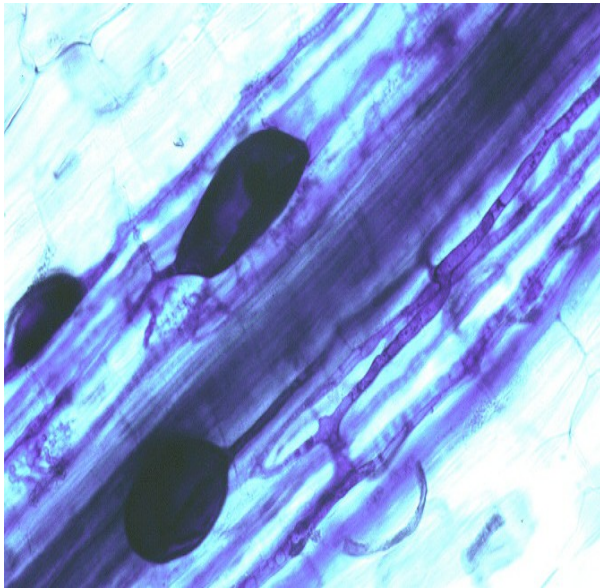
### **What do you think is your biggest contribution to mycorrhizal research, or more broadly, to soil ecology?**

That is a difficult question. In my PhD we investigated the impact of arbuscular

mycorrhizal fungi (AMF) and AMF diversity on plant productivity and ecosystem functioning. This work, together with John Klironomos and others was published in *Nature* (1998) and got a lot of attention. I also very much like the work done by Cameron Wagg, for sure one of my very best PhD students, demonstrating the link between soil biodiversity and ecosystem multifunctionality (Wagg *et al.* 2014, PNAS). This work not only included AMF, but the whole soil community. I also really like our recent work demonstrating that inoculation with mycorrhizal fungi can promote crop yield. This possibly will have the biggest impact, as it provides a tool to make agriculture more sustainable and help plants grow (or protect themselves) (Lutz *et al.* 2023, *Nature Microbiology*). With our team we move on in this research field and I look forward to see how this develops. Finally, I have been writing a number of reviews on mycorrhizas and soil microbes with Sam Banerjee, Francis Martin and others, and that has been fun (e.g. Banerjee *et al.* 2018, *Nature Reviews Microbiology*; Banerjee & van der Heijden. 2023, *Nature Microbiology*; Martin and van der Heijden 2024, *New Phytologist*).

### **How much have we advanced in our understanding of the correlational and causal relationships between soil biodiversity and ecosystem functioning? What are the knowledge gaps on this subject?**

An increasing number of studies shows that soil biodiversity is linked to ecosystem functioning. However, experimental evidence, especially from the field is still poor, and there is still a large knowledge gap. It is obvious that soil life plays a key role in ecosystems. The question is to which extent can we influence this to promote plant yield, soil health or ecosystem sustainability. I am very happy that there is so much interest for soil health (among farmers, land managers, policy makers, etc.), and I do hope that we manage to make agriculture more



Clover (*Trifolium pratense*) root colonized by arbuscular mycorrhizal fungi (in blue). Hyphae and vesicles (blue black balloons) are shown.  
**Photo:** Marcel G.A. van der Heijden.

sustainable, e.g. through field inoculations with beneficial microbes or by enhancing crop cover, crop rotation or reducing soil disturbance.

### **What attracted you in the first place to the study of the relationship between soil biodiversity and ecosystem functioning?**

I have always been fascinated by the interaction between soil biota and plants. Mycorrhizas obviously play a key role and I have been intrigued by them since my Biology study in Wageningen, the Netherlands.

### **How do you define “success” and “happiness” in science?**

Difficult question. Happiness in science is about joy, fun, exciting results, teamwork, nice exchange with others. Success is difficult to measure. Obviously, well cited and novel scientific discoveries are, in my opinion, a strong indicator for scientific success. The application of scientific discoveries to the real world is very useful as an indicator for success (including the path to development). Success is usually team-work; for sure in my case as I had

the luck to work together with many gifted people, who complemented me in an excellent way. Also, the importance of teaching should not be underestimated. For me personally, it is fun to give lectures and talks and motivate people for research, especially on mycorrhizas, microbes, soils and sustainable agriculture.

### **Which is your favorite conference to attend and why?**

There are many nice conferences and I often like the smaller ones where there is the opportunity to exchange with many/most of participants. Since 1998 (Uppsala, Sweden), I went to almost all (except one I believe) international conferences on mycorrhiza (ICOM).

### **Who were your most influential mentors?**

The work by David Read has been very influential to me. Also, I had various mentors at a management level (or science management), such as Bernhard Schmid or Willy Kessler. There are obviously many other people who have been very important for my scientific career, fun in the lab and the daily work, including friends and family.

### **What is your favorite fungi?**

*Rhizoglyphus irregularis*, the AMF we use for our field experiments.

### **Your research has shown that many AMF-based bioinoculants do not work. How do you see the past, present, and future of AMF bioinoculants? Was there too much hype in the past (ie., when you started)? How is it now? Is there hope for the future?**

Yes, of course there is hope for the future. There are some good products on the market and I assume that over time the bad products will disappear. Also, regulations are improving. I recommend every producer to test that their





Marcel in the Colombian Amazonas, 2023.

mycorrhizal product actively colonizes plant roots. With such a test, bad products will be selected out automatically, and for the long-term persistence and economic benefit of companies this is a must. So if you are an AMF bio-inoculant producer reading this, and you do not yet do this, please consider it! The field of biostimulants and biologicals is developing rapidly and I hope that broad-scale application of mycorrhizal fungi and other beneficial microbes to agriculture will be widely practiced in the future.

### **What would you recommend to PhD students in general?**

Motivation, enthusiasm, hard work, and drive for research is most important. That is something that comes from inside. Make sure your experimental design and the research questions you tackle are good and have novel aspects. Talk with other people about questions you have related to your research or career. Many scientists are very open minded and give their opinion for “free”. Also, it is beneficial and rewarding to cooperate with others! Ask

good questions on how to solve scientific or other problems. I have a (long) list of ideas and potential experiments I like to do. It is always useful to have such a list. Be patient and be persistent. If you are a non-native speaker – read good scientific literature and analyze how others write good papers. For scientific success, it is not only important to make that unique discovery, but also ensure that your study is appealing when people read it or listen to your talk (science is also about marketing). During my PhD, I always read papers from David Read because they are so beautiful written (my English was terrible when I started my PhD). It helped a lot.

### **You are obviously very productive in terms of publishing articles. Can you give us some general tips on how to increase or sustain writing productivity?**

I collaborate with many people, we have an excellent and collaborative research team, I have many ideas for papers and projects and we have an excellent infrastructure at my research institutes.

### **How do you see the near and not-so-near future of mycorrhizal research in general, and specifically of mycorrhizal ecology? Which topics need to be addressed?**

There are a number of key areas including mycorrhizal genomics, interactions with other microbes (mycorrhiza helper bacteria, food webs), use of mycorrhizas for sustainable agricultural and forestry. It is always appealing to explore global patterns and search for general mechanisms including recognition and molecular cross-talk and exchange of plants with mycorrhizal fungi.

### **And what about the future of the International Mycorrhiza Society (IMS)?**

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Mycorrhizal research is vibrant, appealing and every year novel discoveries are being made. So I foresee a successful future. I would be pleased if researchers within the different research directions (e.g. ecology, agriculture, molecular biology, taxonomy, etc.) are united and actively exchange and support each other within the Society. I really like the IMS Newsletter and also the new IMS Seminars, and hope we manage to further engage and activate people from the different research fields to join the Society and contribute actively.



Arbuscular Mycorrhizal Fungi collection.

**Photo:** Fritz Oehl.