GRAPHIC DESIGN CONTENT – DCDC

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POSTER

CONFERENCE IN THE PARK

FUNGI IN ECOSYSTEM RESTORATION

SERRALVES FOUNDATION, PORTO
25 | 26 OCTOBER 2022

PROGRAMME

FUNGI IN ECOSYSTEM RESTORATION

Fungi are key players in ecosystem functioning and the need to consider fungi in ecosystem restoration is increasingly recognized. The conference "Fungi in ecosystem restoration", to be held on 25-26 October at the Serralves Foundation (Porto, Portugal), aims to showcase the state-of-the-art scientific evidence concerning the management of fungi during restoration, and critically discuss best practices. Based on the discussions, we hope to review the scientific evidence in a scientific publication and to develop a "Serralves Declaration" to promote policies and practices to effectively manage fungi in restoration strategies to protect biodiversity, mitigate climate change, and increase livelihoods.

REGISTRATION AT WWW.SERRALVES.PT

DRAFT PROGRAM AND SCHEDULE

25 OCTOBER 2022
DAY 1

ARRIVAL / REGISTRATION
10:00

OPENING
10:30-11:00
Ana Pinho
Chair of the Board of Directors and Executive Committee of the Serralves Foundation
Helena Freitas
Director of the Park of the Serralves Foundation
Duarte Cordeiro
Minister of Environment and Climate Action
Tiago Oliveira
President of AGIF - Agency for the Integrated Management of Rural Fires
Susana C. Gonçalves
Member of the Fungal Conservation Committee from the IUCN SSC

SESSION 1 – FUNGI FOR ECOSYSTEM RESTORATION –

11:00-11:30
The importance of fungal biodiversity in global ecosystem restoration
Thomas Crowther
ETH Zürich, Zürich, Switzerland

Fungal biodiversity is critical to the establishment and stability of healthy ecosystems. But they are also essential for determining the characteristics of the ecosystems that result. I will focus on the functional biogeography of fungal biodiversity and its role in governing carbon turnover within terrestrial ecosystems. We see striking differences in terrestrial carbon accumulation and storage between distinct microbial communities across broad spatial scales. This highlights the importance of understanding the functional biogeography of fungal biodiversity in order to understand terrestrial carbon cycling. But also highlights the need to consider the health of fungal biodiversity when considering efforts to restore and manage degraded ecosystems.

11:30-12:00
COFFEE BREAK

12:00-12:30
Back to roots – The role of ectomycorrhizal fungi in temperate and boreal forests restoration
Nahuel Policelli
Boston University, USA

Forest trees rely on symbiotic soil fungi to survive, grow, and tolerate harsh environmental conditions. Whether and how these fungi can benefit temperate and boreal forest restoration projects is yet an open question. We compiled the evidence showing how actively using a group of fungal symbionts, ectomycorrhizal fungi, can help achieve promising restoration goals in sites contaminated with heavy metals, affected by soil erosion, and degraded due to clearcut logging and wildfire. Based on that evidence, we will discuss the limitations, knowledge gaps, and possible undesired outcomes of the use of ectomycorrhizal fungi in forest restoration. Even when considering these limitations, taking into account ectomycorrhizal fungi–host interactions could improve the chances of success of future restoration programs in boreal and temperate forests.

12:30-13:00
The problem of invasive mycorrhizal fungi
Anne Pringle
University of Wisconsin-Madison, USA

Urban trees are an essential infrastructure in sustainable cities, providing benefits ranging from temperature modulation to wildlife habitat. To grow well, trees require an array of beneficial microbes, including mycorrhizal fungi. Little is known about how to harness mycorrhizal fungi to promote plant growth in cities, and sometimes commercial inocula are used to inoculate seedlings. The indiscriminate use of poorly sourced fungi is a problem in part because introduced fungi can invade local forests. As an alternative, we propose and test a simple protocol to provide urban trees with effective, local symbionts. Working in the megacity of Bogotá, Colombia, we first measured how thoroughly urban trees are colonized by mycorrhizal fungi, compared to rural trees. We measured ectomycorrhizal root

colonization of urban and rural Quercus humboldtii (the Andean oak, or roble) and endomycorrhizal root colonization of urban and rural Retrophyllum rospigliosii (the romerón pine). In both species rural trees are significantly more colonized than urban trees and differences are correlated to soil nutrient levels. Next, we tested the effect of adding native soil collected from rural habitats to oak and romerón pine seedlings. Basing our experiment in the same nursery used to grow tree seedlings for the city of Bogotá, we tested four treatments: a control, the use of commercial fertilizer alone, inoculation by native soil alone, and the combination of commercial fertilizer and native soil. Surprisingly, this last treatment resulted in the greatest growth and relative growth rate (RGR) of plants, as measured by both height and stem diameter over the 21-month experiment. Our findings suggest a novel strategy to enable the growth of trees in cities, but significant unanswered questions include how to sustainably scale the propagation of native soils to meet the needs of cities, including Bogotá. Nonetheless, we cautiously suggest additional tests of the use of soil transplants as a tool in urban forestry.

13:00-14:30
LUNCH BREAK

SESSION 1 (Continued)
14:30-15:00
Arbuscular mycorrhizal inoculations in grassland restoration: which microbes to use, how to do it and long-term effects on plant communities
Liz Koziol
University of Kansas, USA

Current restoration practices cannot typically re-establish the full diversity and species composition of intact native plant communities. More and more, we learn that soil microorganisms play a central role in ecosystem function and plant community composition. Our past work has identified that native arbuscular mycorrhizal (AM) fungi amendments are the missing link that can be harnessed as a tool to improve grassland restoration quality. Exciting progress has been made in this research area within the tallgrass prairies of the Midwestern region of the United States.
In this talk, Dr. Koziol will highlight the various ways we have utilized mycorrhizal fungi to improve restoration success, including improvements in native establishment, and inhibition of weedy and non-native plants. Dr. Koziol will discuss some of the work comparting native fungi, fungi from disturbed soils and commercially available amendments. Because methods used to distribute native inocula into restorations remain to be optimized and long-term study on the effects of inoculation are rare, she will also discuss some of the most efficient application techniques that have resulted in long-term impacts on restoration quality.

15:00-15:30
Forest mycobiome composition dictates tree growth and carbon capture across Europe
Colin Averill
ETH Zürich, Zürich, Switzerland

Nearly all trees on Earth form a root symbiosis with mycorrhizal fungi, enhancing access to critically limiting soil resources. Yet, while decades of research have demonstrated particularly which fungi trees partner with can dramatically affect growth and carbon capture in greenhouse conditions, whether these findings extend to complex and diverse mycorrhizal communities

within entire forests, remains unknown. Here we assembled a paired dataset of tree growth and soil mycorrhizal fungal composition data from >100 long term forest monitoring plots distributed across continental Europe. Using this dataset, we asked IF soil mycorrhizal fungal composition and nutrient acquisition traits could predict tree growth rate, after accounting for common environmental drivers of forest productivity.
We show that the composition of the forest mycorrhizal community is linked to 3-fold variation in tree growth and carbon capture. Furthermore, multiple fungal genomic traits were predictive of these compositional effects. Forest mycorrhizal fungal communities that invested comparatively more in inorganic, compared to organic nutrient acquisition strategies were linked to faster tree growth, consistent with the hypothesis that organic nutrients are ecologically more expensive to acquire. Finally, we identify key indicator species of these effects, laying the groundwork to trial how different fungi may be applied to enhance tree growth and carbon removal. As genomic surveys of the forest microbiome become more widespread, we predict that more links between microbial biodiversity and forest function will emerge, identifying how microbial interactions ultimately ripple through an ecosystem to govern macro-scale ecological processes.

15:30-16:00
Q&A and discussion

Summing up
Merlin Sheldrake
Vrije University Amsterdam, The Netherlands

16:00-16:30
COFFEE BREAK

SPECIAL FOCUS ON PORTUGAL

16:30-17:00
Ecosystem restoration in Portugal. Constrains and opportunities to include Fungi
Alice Nunes
University of Lisbon, Portugal

In Portugal, many restoration projects have been implemented over the last decades, to promote the recovery of degraded ecosystems including terrestrial (e.g. forests and agro-systems, burned areas, quarries, mines), rivers and wetlands, coastal, marine and island ecosystems. The recognized need to evaluate their extension and impact, to share experience and knowledge and to promote communication between the various actors involved (i.e. researchers, public administration, public and private companies, NGOs, civil society) led to the creation of the Portuguese Ecological Restoration Network – ResECO -, officially launched in August 2019 as a working group of the Portuguese Ecological Society, and as an affiliated organization of the Society for Ecological Restoration Europe, having now more than 250 members from all the country.
The recovery of ecosystems is a considerable challenge due to their inherent complexity. Soils are the foundation of terrestrial systems, but their recovery is often difficult and takes a long time. The recovery of soil biodiversity, where fungi play an important role establishing symbioses with plants (mycorrhizal fungi) and as decomposers of organic matter (saprotrophic fungi), is particularly complex and challenging. In restoration actions, reintroducing key

organisms from the native plant microbiome can be critical for plant successful establishment. The most common approach using fungi consists in the inoculation of commercial or native mycorrhizal fungi along with plant seeding or planting. Some examples of restoration projects in Portugal including fungi will be given, contributing to a broader discussion on challenges and opportunities to include fungi in restoration.

26 OCTOBER 2022
DAY 2

SESSION 2 – ECOSYSTEM RESTORATION FOR FUNGI AND OTHER WILDLIFE –

10:00-10:30
Passive and active restoration of saproxylic fungal diversity– a tale of conservation success.
Jacob Heilmann-Clausen
University of Copenhagen, Denmark

10:30-11:00
Grassland restoration for CHEG fungi.*
Gareth Griffith
Aberystwyth University, Wales, UK

*Title to be confirmed

11:00-11:30
Tree inoculation with fungi for conservation
Lynne Boddy
Cardiff University, Wales, UK

Ancient and other veteran trees provide important habitat not only for fungi but also for invertebrates and vertebrates. In the UK alone rotting wood in trees is habitat for 1700 invertebrate species, including 15% of the rarest, e.g., violet click beetle (*Limoniscus violaceus*). Worldwide over 1000 vertebrate species are dependent on this type of habitat. Dead wood in standing trees is obviously important habitat for a wide range of wood decay fungi including Red List species, e.g., the rare oak polypore (*Buglossoprus quercinus*) and the tooth fungi *Hericium coralloides* and *Hericium erinaceus*. Populations of veteran trees are declining because of natural death and felling for building or perceived safety issues, but there are insufficient trees from subsequent cohorts to fill the gap, which poses a huge threat to dependent organisms. While many countries have massive tree planting programmes, you cannot plant 100-year-old trees! To mitigate this, veteranisation tries to inflict damage which

mimics natural decaying tree characteristics with the aim of creating habitat. A more targeted approach is to inoculate tree trunks with appropriate heart rot fungi to create decaying wood habitat. Rare fungal species can also be inoculated to reintroduce species to areas from which they have been lost or to bolster populations. I will consider approaches to inoculation for conservation, and progress so far.

11:30-12:00
COFFEE BREAK

12:00-12:30
Orchid mycorrhizal fungi: critical players for the conservation of their plant hosts and habitats
Mariangela Girlanda
Turin University, Italy

Orchids are significant indicators of ecosystem conservation value as their habitats are among the most biodiverse. For instance, calcareous dry to semi-dry grasslands are among the most species-rich plant communities in Europe, host a large number of rare and endangered plant and animal species and are considered a priority type only if they are important orchid sites. With orchids, perhaps more than most other plant groups, the role of mycorrhizal fungi is crucial to the establishment of self-sustaining plant populations. Dependency on mycorrhizal symbionts is indeed extreme in orchids, as they rely on the association with compatible fungi even for seed germination and seedling survival in in their natural habitats. Due to such a peculiar interaction, orchids present particular challenges for conservation. On the other hand, the lifestyle and ecology of their mycobionts are much less known than for other mycorrhizal fungi, especially in the case of photosynthetic orchids from open habitats.
Research on the environmental reservoirs of mycorrhizal fungi associating with European grassland orchids illustrates how progress in this area provides knowledge to improve conservation outcomes.

12:30-13:00
Q&A and discussion

Summing up
Merlin Sheldrake
Vrije University Amsterdam, The Netherlands

13:00-14:30
LUNCH BREAK

SESSION 3 – TOOLS TO EFFECTIVELY MANAGE FUNGI IN RESTORATION –

14:30-15:00
Can mapping mycorrhizal biodiversity aid in restoration?
Michael Van Nuland
SPUN, Society for the Protection of Underground Networks

Mycorrhizal fungi form symbioses with plant roots and build expansive underground networks. These fungi support plant growth and the health of soil systems globally, provide critical ecosystem services, and play an important role in regulating the Earth's climate. Unlike animal and plant diversity, we cannot directly observe the biodiversity of the Earth's cryptic fungal networks. Documenting this hidden diversity is urgent because different mycorrhizal fungi are associated with different ecosystem functions, like extreme carbon draw-down, enhanced plant stress tolerance, and efficient nutrient cycling. Here, we present the first efforts to map the diversity of mycorrhizal fungi at a global scale. In collaboration with the Crowther Lab (ETH Zurich) and GlobalFungi, we developed machine learning algorithms trained on a large fungal sequencing database encompassing nearly 10,000 samples. These models were used to predict underground biodiversity hotspots for arbuscular and ectomycorrhizal fungi across the planet, revealing certain regions with extraordinarily diverse communities of these network-forming fungi. We discuss how such hotspots mark high priority areas to explore, especially in the context of conserving and restoring critical fungal interactions in underground ecosystems that face intensifying threats from climate and land use change.

15:00-15:30
How can the GlobalFungi database help to manage fungi in ecosystem restoration?
Petr Kohout
Charles University-Prague, Czechia

Fungi are key players in vital ecosystem services, spanning carbon cycling, decomposition, symbiotic associations with cultivated and wild plants and pathogenicity. The high importance of fungi in ecosystem processes contrasts with the incompleteness of our understanding of the patterns of fungal biogeography and the environmental factors that drive those patterns. To reduce this gap of knowledge, we collected and validated data published on the composition of soil fungal communities in various environments including soil and plant-associated habitats and made them publicly accessible. The GlobalFungi database contains over three billion observations of fungal sequences across > 55,000 samples with geographical locations and additional metadata and represents the most comprehensive atlas of global fungal distribution. The GlobalFungi database can be used for determination of fungal species putative ecology, calculation of their ecological niches or resilience of fungal species to disturbances. Identification of these species' traits will help us to better predict the potential role of various fungal species in ecosystem restoration.

15:30-16:00
Q&A and discussion

Summing up
Merlin Sheldrake
Vrije University Amsterdam, The Netherlands

16:00
Closure
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Serralves Foundation
Elvira Fortunato
Minister of Science, Technology and Higher Education

16:30-18:00
Guided visit to the Park, including the Treetop Walk and the exhibition "The Art of Mushrooms"