XI International Workshop on Edible Mycorrhizal Mushrooms

IWEMM ELEVEN
PATAGONIA ARGENTINA

"Rescuing biodiversity and multiculturalism for local development"

BOOK OF ABSTRACTS

April 22nd – 26th, 2024

Esquel, Chubut, Argentina

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Rescuing biodiversity and multiculturalism for local development

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Melipal Center
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The Municipality of Esquel, extended a special recognition to the organizers and participants of the IWEMM11 International Workshop on Edible Mycorrhizal Mushrooms for their commitment to environmental care throughout the event.

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1972

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INTACT
INnovation in Truffle cultivation, preservAtion, proCessing and wild truffle resources managemenT

INDEX

Preface 1
Program 3
Opening Conference 10
Biodiversity. Evolution. Taxonomy and distribution. Genetics and genomics 12
- Conferences 13
- Oral presentations 14
- Posters 19

Ecology and physiology 26
- Conferences 27
- Oral presentations 28
- Posters 30

Cultural and economic importance. Traditional knowledge 31
- Conferences 32
- Oral presentations 34
- Posters 38

Climate change. Conservation and sustainability 40
- Conferences 41
- Oral presentations 43
- Posters 45

Cultivation and management. Habitats, productivity, and micosilviculture.
Novel species cultivation 48
- Conferences 49
- Oral presentations 52
- Posters 62

Biotechnology. Bioactive compounds. Food security and health 69
- Conferences 70
- Oral presentations 72
- Posters 76

Mycotourism and mycogastronomy 78
- Conferences 79
- Oral presentations 80
- Posters 82

Author Index 83

PREFACE

The IWEMM11 organization was a time of mixed emotions and intense efforts. Since 2019 when, at the IWEMM10 in Japan, we presented Patagonia – Argentina as the next destination for the Workshop, the world was about to be shaken by the terrible COVID-19 pandemic. We lost friends, family, and colleagues but continued with our lives and passion for our work.

Also, since last year, Argentina research community, as other workers, are in despair. We watch as the Argentinian System of Science and Technology, despite its worldwide recognition, approaches a dangerous precipice, and we are desperate at the consequences that this situation could have for our Nation. We repudiate this situation. Nevertheless, we continued moving forward with the organization of this beautiful event that we enjoy. And amidst this sadness, we value even more the individual and collective efforts to achieve it, firmly believing in the richness of people. Because it is these people who make things possible. As the great Uruguayan writer, Eduardo Galeano, said "Each person shines with their own light among all others. There are no two fires alike. There are big fires and small fires and fires of all colors". Within this train of thought, we want to express our gratitude.

Our Forest Research Center CIEFAP, from management and throughout our partners, administrative staff members, PhD and postdoc interns, researchers, and communication staff, all contributed their time, energy, and advice, being essential to achieve this event. The Chairs of the Workshop Organizing Committee are deeply grateful for the countless hours and the dedication, persistence, and attention to myriad details.

Our thanks to the Secretary of the IWEMM International Scientific Committee, Alexis Guerin-Laguette, for his commitment and support, and to the Committee Members for their review comments and advice along the way. We are particularly grateful to the following for their help and personal initiative: Jesús Pérez Moreno (México), Gregory Bonito (USA), Asunción Morte (Spain), Roberto Flores Arzú (Guatemala), Akiyoshi Yamada (Japan), David Pilz (USA), Paul Thomas (UK), and sponsors Trufas La Esperanza, Society for the Protection of Underground Networks (SPUN), Mycological Association Carlos Spegazzini (AMCS), Mycotree and Robin Pépinières for their invaluable support.

A special thanks to all others who provided insights, leadership, advice, and assistance to our planning efforts: Paula Peris (Rio Negro province), Jonatan Uribe (Neuquén Province), Ariel Montoro (Comahue University), Danilo Hernández Otaño (Los Alerces National Park) and Milagros Falvella (ISETP - Rio Negro Province).

We also wish to thank the more than 100 colleagues worldwide who presented their work, served as moderators of oral and poster communications, whose efforts ensured a high-quality and successful Workshop scientific program. Also, to producers, artisans and companies that joined the workshop in this extraordinary possibility of closeness between academia and the productive sector. We deeply hope that sharing this event helps us all to truly rescue our biodiversity and multiculturalism to foster local development in our countries.

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La organización del IWEMM11 fue un período de emociones encontradas y esfuerzos intensos. Desde el 2019, cuando, en el IWEMM10 en Japón, presentamos la Patagonia - Argentina como el próximo destino para el Workshop, el mundo fue sacudido por la terrible pandemia de COVID-19. Perdimos amigos, familiares y colegas, pero seguimos adelante con nuestras vidas y nuestra pasión por nuestro trabajo.
Además, desde el año pasado, la comunidad científica Argentina, al igual que otros trabajadores, se encuentra en desesperación. Observamos cómo el Sistema Argentino de Ciencia y Tecnología, a pesar de su reconocimiento mundial, se acerca a un precipicio peligroso y estamos desesperados por las consecuencias que esta situación podría tener para nuestra Nación. Repudiamos esta situación. Sin embargo, continuamos avanzando con la organización de este hermoso evento que disfrutamos. Y en medio de esta tristeza, valoramos aún más los esfuerzos individuales y colectivos para lograrlo, creyendo firmemente en la riqueza de las personas. Porque son estas personas las que hacen posibles las cosas. Como dijo el gran escritor uruguayo, Eduardo Galeano: "Cada persona brilla con luz propia entre todas las demás. No hay dos fuegos iguales. Hay fuegos grandes y fuegos chicos y fuegos de todos los colores". Dentro de esta línea de pensamiento, queremos expresar nuestro agradecimiento.
Nuestro Centro de Investigación Forestal CIEFAP, desde la dirección y a lo largo de nuestros colaboradores, personal administrativo, doctorandos y postdoctorandos, investigadores y equipo de comunicación, todos contribuyeron con su tiempo, energía y consejo, siendo esenciales para lograr este evento. Los Presidentes del Comité Organizador del Workshop están profundamente agradecidos por las incontables horas y la dedicación, persistencia y atención a una multitud de detalles.
Nuestro agradecimiento al Secretario del Comité Científico Internacional del IWEMM, Alexis Guerin-Laguette, por su compromiso y apoyo, y a los Miembros del Comité por sus comentarios de revisión y consejos a lo largo del camino. Estamos especialmente agradecidos con los siguientes por su ayuda e iniciativa personal: Jesús Pérez Moreno (México), Gregory Bonito (EE. UU.), Asunción Morte (España), Roberto Flores Arzú (Guatemala), Akiyoshi Yamada (Japón), David Pilz (EE. UU.), Paul Thomas (Reino Unido), y los patrocinadores Trufas La Esperanza, Society for the Protection of Underground Networks (SPUN), Asociación Micológica Carlos Spegazzini (AMCS), Mycotree y Robin Pépinières por su invaluable apoyo.
Un agradecimiento especial a todas las personas de CIEFAP que conformaron el comité organizador proporcionando ideas, liderazgo, consejos y asistencia para nuestros esfuerzos de planificación: Paula Peris (provincia de Río Negro), Jonatan Uribe (provincia de Neuquén), Ariel Montoro (Universidad del Comahue), Danilo Hernández Otaño (Parque Nacional Los Alerces) y Milagros Falvella (ISETP - Provincia de Río Negro).
También deseamos agradecer a los más de 100 colegas de todo el mundo que presentaron su trabajo, sirvieron como moderadores de comunicaciones orales y pósteres, cuyos esfuerzos garantizaron un programa científico exitoso y de alta calidad. También, a los productores, artesanos y empresas que se unieron al taller en esta extraordinaria posibilidad de cercanía entre la academia y el sector productivo. Esperamos sinceramente que compartir este evento nos ayude a todos a rescatar verdaderamente nuestra biodiversidad y multiculturalismo para fomentar el desarrollo en nuestros países.

Dra. Carolina Barroetaveña
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Sunday 21st

17:00 - 19:00	Reception and registration
19:00 - 22:00	Informal welcome reception

Monday 22nd

8:00 - 9:00	Reception and registration of the attendees
9:00 - 9:30	IWEMM11 Opening ceremony

Opening Conference

9:30 - 10:30	**Jesús Pérez Moreno** - Global funga, multiculturality, food security, and sustainable development
10:30 - 10:50	Coffee break

Biodiversity. Evolution. Taxonomy and distribution. Genetics and genomics

11:00 - 11:35	**Alexander Bradshaw** - Perspectives on emerging molecular techniques in mycology for studying the biology of edible ectomycorrhizal mushrooms
11:35 - 11:50	**Andrea C. Rinaldi** - Restinga ectomycorrhizae: More than meets the eye
11:50 - 12:05	**Roberto Flores Arzú** - Mycorrhizal fungal diversity in Sierra de las Minas, Guatemala. Rapid analysis of one of the main hotspots in the world
12:05 - 12:20	**Viviana Salazar-Vidal** - Diversity and geographic distribution of ectomycorrhizal edible fungi present in the Nahuelbuta mountain range, Biobío, Chile
12:20 - 14:00	Lunch
14:00 - 14:15	**Beatrice Belfiori** - Revision of misassigned barcoding sequences in public databases, the case of internal transcribed spacer in whitish truffles
14:15 - 14:30	**Alex Somrau** - Main edible fungi present in the pine plantations of the Argentine Mesopotamia and their potential as non-timber forest products
14:30 - 15:00	Closing session

Ecology and physiology

15:00 - 15:35	**Pablo Martín-Pinto** - Ectomycorrhizal fungi play a key role in wildfire prevention and restoration of fire degraded areas
15:35 - 15:50	**Yaron Sitrit** - The microbiome structure of the symbiosis between the desert truffle *Terfezia boudieri* and its host plant *Helianthemum sessiliflorum*
15:50 - 16:05	**Marwa Oikrim** - Desert truffles and truffles in Morocco
16:20 - 17:30	Posters presentation and coffee
16:05 - 16:20	**Alexis Guerin-Laguette** - Tribute to Pierre Sourzat

Tuesday 23rd

Cultural and economic importance. Traditional knowledge

9:00 - 9:35	**Soledad Molares** - Traditional vs. non-traditional and a conceptual turn in the study of local mycological knowledge in Patagonia: Memory and flexibility in times of change
9:35 - 9:50	**Dejene Tatek** - Ethnomycological notes from Yayu Coffee Forest, southwest Ethiopia
9:50 - 10:05	**Felipe Ruan-Soto** - Myths, beings, and beliefs behind wild mushroom use in mesoamerica
0:05 - 10:20	**Ruth Rajchenberg** - Serifungrafía Patagónica (re)presentation of fungi in culture
10:20 - 10:40	Coffee break
10:40 - 11:15	**Alexis Guerin-Laguette** - From scientist to consultant: Mycotree supports edible mycorrhizal fungi cultivation in New Zeland while maintaining an international collaboration
11:15 - 11:30	**Paula Peris and Chelsea Jallosh** - From science to the table: Patagonian mycoculture capacity building through community-based educational workshops
11:30 - 15:30	Sierra Colorada / Laguna La Zeta mycotrail. Optional event

Climate change. Conservation and sustainability

15:30 - 16:05	**Paul Thomas** - Edible ectomycorrhiza, climate change, and sustainability
16:05 - 16:20	**Claudia Perini** - What's about the Italian porcino?
16:20 - 16:35	**Mara Rondolini** - Restoration strategies for enhancing *Tuber borchii* Vittad. production in abandoned olive groves: A metagenomic approach
16:35 - 17:10	**Domizia Donnini** - Environmental conservation and sustainable management: What future for *Tuber magnatum* Picco?
17:10 - 18:10	Posters presentation, coffee and craft fair

Wednesday 24th

8:00 - 18:00	**Field trip to Los Alerces National Park** - Trails to identify local mushrooms, *asado* in the wild

Thursday 25th

Cultivation and management. Habitats, productivity, and micosilviculture. Novel species cultivation.

9:00 - 9:35	**Akiyoshi Yamada** - Cultivation studies of edible ectomycorrhizal mushrooms: Successful establishment of ectomycorrhizal associations *in vitro* and formation of fruiting bodies
9:35 - 9:50	**M. Belén Pildain** - Soil fungal community composition and *Tuber melanosporum* mycorrhiza abundance under productive and not productive trees of *Quercus* spp. in Argentina
9:50 - 10:05	**Antonella Amicucci** - The effect of bacterial inoculation on *Tuber melanosporum* Vittad. root colonization and *Quercus ilex* seedling growth
10:05 - 10:20	**Mei Yang** - Cultivation status and challenges of truffles and other high-value edible fungi in Panzhihua, Sichuan
10:20 - 10:40	Coffee break
10:40 - 10:55	**Claudia Delard** - Effect of *Tuber borchii* inoculation on stone pine (*Pinus pinea* L.) growth, by analyzing three consecutive years of plant establishment
10:55 - 11:10	**Ignacio Sanz-Benito** - Effects of fuel reduction treatments on the sporocarp production and richness of a *Quercus*/*Cistus* mixed system
11:10 - 11:25	**Dejene Tatek** - Tree retention to conserve edible sporocarps in short-rotation plantations of Ethiopia
11:25 - 12:00	Closing session
12:00 - 14:00	Lunch
14:00 - 14:35	**Sergio Sanchéz Duran** - Present and future challenges for black truffle cultivation
14:35 - 14:50	**M. Eugenia Salgado Salomón** - Mapping of areas suitable for black truffle farming in Patagonia, Argentina
14:50 - 15:05	**Pedro Marco Montori** - Volatilome study of cultivated black truffle (*Tuber melanosporum*) to distinguish geographical origin
15:05 - 15:20	**Iván Franco Manchón** - Influence of different irrigation systems on black truffle yields
15:20 - 15:35	**Robin Pépinieres** - Robin Nurseries. Production of truffle plants, mushrooms plants, and high performances mycorrizal plants
15:35 - 16:10	**Asunción Morte** - Unravelling biological and environmental factors for desert truffle sustainable cultivation
16:10 - 16:25	**Khabar Lahsen** - Wild truffles and desert truffles in Morocco: Geographical distribution, soil characteristics and ecology
16:25 - 17:00	Coffee and craft fair
17:00 - 18:00	Argentinian truffle producers presentation
	Gala dinner

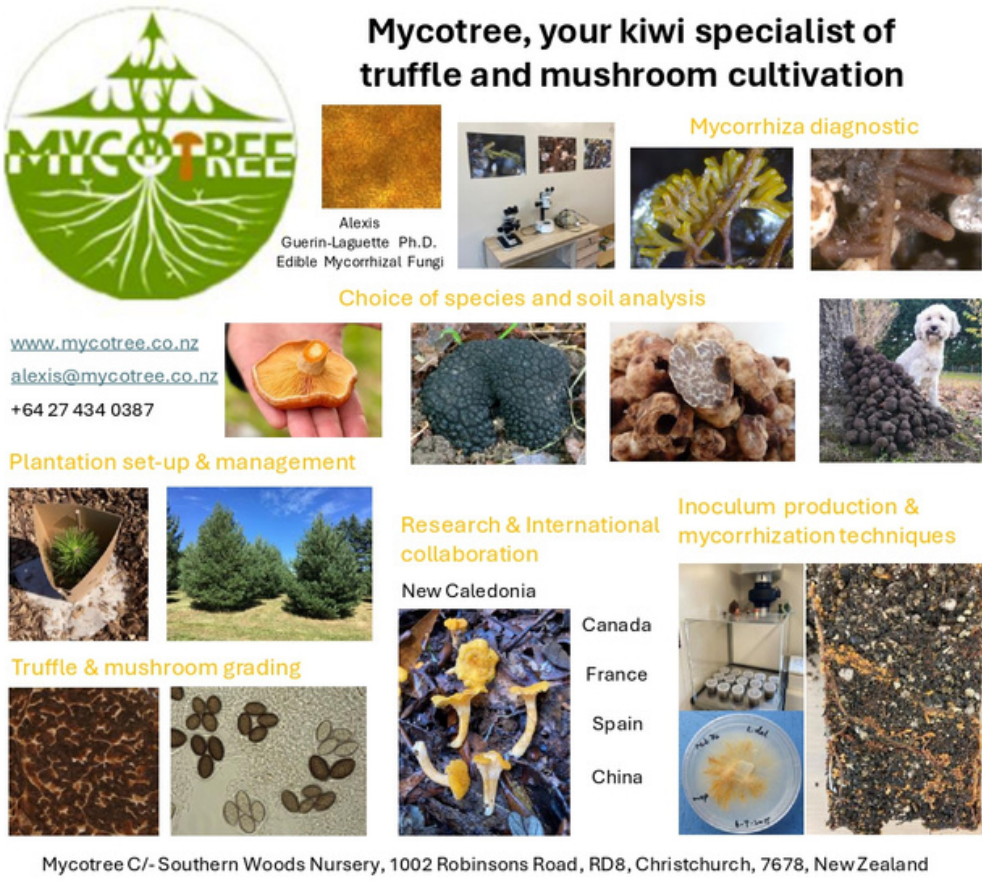
Friday 26th

Biotechnology. Bioactive compounds. Food security and health

9:00 - 9:35	**Pedro Marco Montori** - Exploring the bioactive potential of mushrooms: modern analysis techniques and applications
9:35 - 9:50	**Maximiliano Rugolo** - Wild ectomycorrhizal mushrooms from Patagonia as an edible resource: Nutritional composition, antioxidant capacity and antimicrobial activity
9:50 - 10:05	**Andrés Del Vigo** - Are the species of *Amanita* present in the Argentinian Patagonia toxic?
10:05 - 10:20	**Gabriela González** - *Ramaria patagonica:* Post-harvest conservation of an endemic mushroom of gastronomic and cultural interest
10:20 - 10:40	Coffee break
10:40 - 10:55	**Romina Belén Parada** - Evaluation of the toxicity of *Gyromitra* sp. and *Morchella* sp. through *Artemia salina* bioassay
10:55 - 11:30	**Gregory Bonito** - Volatile compound analysis of diverse North American truffle species
11:30 - 12:00	Closing session
12:00 - 14:00	Lunch

Mycotourism and mycogastronomy

14:00 - 14:35	**Carolina Barroetaveña and M. Belén Pildain** - Between mate, meat and football: R&D with edible fungi in the Patagonian Andes of Argentina
14:35 - 14:50	**Sara Di Lonardo** - Protecting and valorizing wild truffle ecosystems while sustaining rural tourism on the Tratturo: A case in Molise region (Italy)
14:50 - 15:05	**Jesús Pérez Moreno** - Development of mycotourism and mycogastronomy in México
15:05 - 15:30	Coffee break
15:30 - 17:00	IWEMM12 opportunities. Closing ceremony



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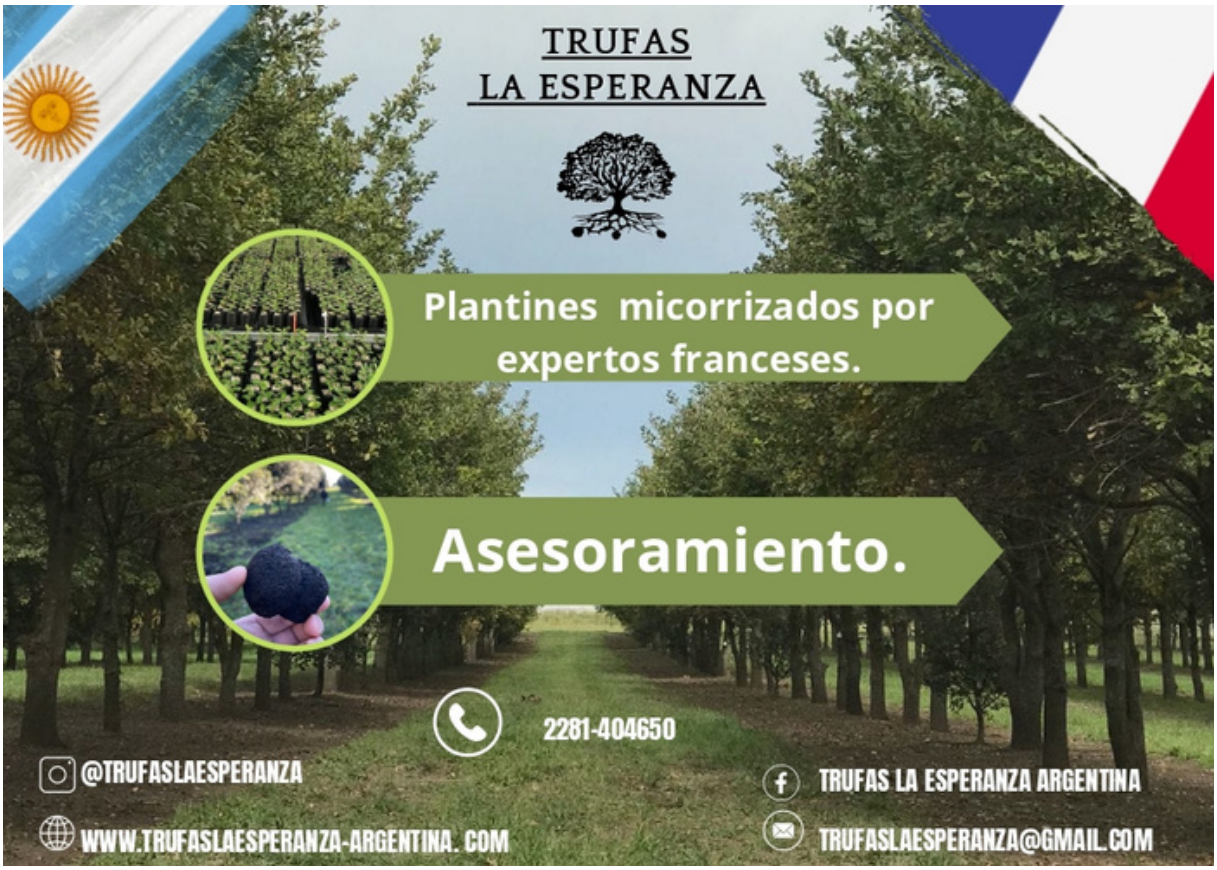
Granted scholarships:

- Alex E. Somrau
- Lahsen Khabar
- Marwa Oikrim
- Maximiliano Rugolo
- Ruth Rajchenberg
- Tatek Dejene



Asociación Micológica
Carlos Spegazzini

¿Quiénes somos?

La Asociación Micológica Carlos Spegazzini es una asociación civil sin fines de lucro fundada el 15 de febrero de 2010 cuya misión y objetivos son fomentar y apoyar el avance en el conocimiento de la micología en todas sus ramas en Argentina. A tal fin apoya la organización de actividades educativas tales como seminarios, cursos, talleres y reuniones científicas que estimulen el intercambio entre los miembros de la Asociación y con terceros interesados en el avance de la disciplina. La visión de la AMCS es incrementar el número de socios a fin de en forma cooperativa fomentar el avance en el conocimiento de la disciplina e interaccionar a nivel Latinoamericano e internacional con otras asociaciones que compartan los mismos intereses.

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GLOBAL FUNGA, MULTICULTURALITY, FOOD SECURITY, AND SUSTAINABLE DEVELOPMENT

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Key words: Mycological resource, global challenges, conservation, edible mushrooms, IWEMMs, holistic approach, interculturalism

The funga has been defined as “the fungi which exist in an specific region, habitat or geological period”. Currently the paradox, and big challenge that we face is how to preserve the habitats where fungi live and at the same time to ensure human survival. This issue has been in the core of the International Workshops of Edible Mycorrhizal Mushrooms (IWEMMs) held in 10 countries in the 5 continents, since its inception in 1998. Despite the fact that the IWEMMs have been focused in a particular type of fungi, i.e. mycorrhizal mushrooms and truffles, the addressed concepts apply for global funga. Any fungal conservation strategy, which did not include the sociocultural, economic and environmental local conditions is doomed to fail. The human society is by definition not only multicultural but intercultural. Boosting interculturalism by promoting dialogue and interaction between cultures would be crucial for facing nort only conservation but all current global challenges, including for example climate change, sustainble development and food security. During the last 26 years, the IWEMMs have been an encouraging environment to exchange not only ideas, but practical experiences around the world related to the intrincated relationships between mushrooms, humans and nature. In the last 35 years we have been trying to develop strategies to nurture strategies in Mexico related to the sustainable use of the mycological resource, embracing both the huge mycological diversity, including edible mycorrhizal diversity, and the great ethnic diversity comprised by 71 ethnic groups. Recently, with the finantial support of the CONAHCyT Project 316198 we have developed an initiative related to Food Security and mycological local resources. The challenges, achievements and learnings, including the social impact of this initiative is a modest, but inspiring, example of how some practical strategies can boost armonic relationships between humans, mushrooms and nature.

PERSPECTIVES ON EMERGING MOLECULAR TECHNIQUES IN MYCOLOGY FOR STUDYING THE BIOLOGY OF EDIBLE ECTOMYCORRHIZAL MUSHROOMS

Alexander J. Bradshaw[1], Etienne Brejon Lamartinière[2], Giuliana Furci[3], Sariah VanderVeur[1], Keaton Tremble[4], Bryn T.M. Dentinger[1]

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Key words: Molecular mycology, genomics, population genomics, third generation sequencing, evolution, conservation, *Butyriboletus loyo*

Mycological science has been at the forefront of molecular biology due to the mass diversity and cryptic nature that Fungi present. Ectomycorrhizal Fungi, those that form symbiotic relationships with most plants on Earth, are of particular interest due to their role in ecosystem health and as targets of commercial harvesting for food. As time has passed, molecular techniques for studying Fungi have advanced greatly from traditional DNA barcoding for taxonomic description to genomic-based studies of evolution and beyond. Here I will discuss topics of current and emerging molecular techniques being used in fungal biology and how they may be leveraged to understand their unique biology. To illustrate this, I will discuss past and current projects using these techniques to provide pragmatic information for studying the biodiversity, evolution, taxonomy, and distribution of ectomycorrhizal Fungi, including conservation efforts of the threatened prized Chilean edible ectomycorrhizal mushroom "*Butyriboletus loyo*".

RESTINGA ECTOMYCORRHIZAE: MORE THAN MEETS THE EYE

Ariadne N.M. Furtado[1], Marco Leonardi[2], Ornella Comandini[3], Maria Alice Neves[1], Andrea C. Rinaldi[3]

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Key words: Atlantic Forest, Brazilian fungi, diversity, ectomycorrhiza, fungal conservation, mycorrhizal symbiosis, Neotropics

The Brazilian Atlantic Forest is one of the most biodiverse ecoregions of the world. Among its constituents, restinga vegetation makes a particular case, acting as a buffer zone between the oceans and the forest. Covering some 80% of Brazilian coastline (over 7,300 km in length), restinga is a harsh environment where plants and fungi interact in complex and so far, largely unknown ways. Ectomycorrhizal symbiosis, in particular, plays an ungauged and likely underestimated role. We recently described the morpho-anatomical and molecular features of the ectomycorrhizae formed by several basidiomycetous mycobionts on the host plant *Guapira opposite*, including those of the native *Amanita viscidolutea* and the threatened *Austroboletus festivus*. Based on particular characteristics, such close connections between the layered ectomycorrhizal mantle and cortical root cells, absence of a Hartig-net and other fungal elements in the cortex, we proposed the name 'Guapirioid ectomycorrhiza' for this new ectomycorrhizal morphology. To obtain a broader view of restinga mycorrhizal and ecological potential, we compiled a comprehensive and up-to-date checklist of fungal species reported or supposed to establish ectomycorrhizae on restinga-inhabiting host plants, mainly on the basis of field observations. Our list comprises some 726 records, 74 of which correspond to putative ectomycorrhizal taxa specifically associated with restinga. These include several members of Boletaceae, *Amanita*, *Tomentella/Thelephora*, *Russula/Lactifluus*, and *Clavulina*, as well as hypogeous fungi, like the recently described *Longistriata flava*. Our survey reveals a significant diversity of the restinga ectomycorrhizal mycobiota, indicating the importance of this ecosystem from both the ecological and conservation point of view.

MYCORRHIZAL FUNGAL DIVERSITY IN SIERRA DE LAS MINAS, GUATEMALA. RAPID ANALYSIS OF ONE OF THE MAIN HOTSPOTS IN THE WORLD

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Key words: Ectomycorrhiza, arbuscular mycorrhizal fungi, Neotropic, endemic species, phylogeny

Two recent projects, one supported by SPUN and another by University of Utah, allowed to make long field trips for collecting ectomycorrhizal fruit bodies and DNA from soil samples (rhizosphere), in two distant localities (70 km from each other) and three different altitudinal gradients (947 masl to 2590 masl) in Sierra de Las Minas. Sierra de las Minas is considered the most biodiverse ecosystem in Guatemala due to its geological history, altitudes, latitude, vegetation, and strong influence of the Atlantic Ocean. This natural barrier can be considered the limit of distribution of two well differentiated mycobiotas in Mesoamerica, as was proposed recently. However, there is a clear predominance of Eastern North American macrofungal genera, whose distribution is spread to the southern countries in Central America and the Caribe. Preliminary results showed the presence of novel species in Boletaceae, Russulaceae and Gomphaceae by traditional taxonomy and sequencing of sporocarp 'tissues. On the other hand, good amounts of fungal DNA were obtained from soil samples with exception in two particularly rich in organic material (abundance of humic acids) and despite the presence of diverse mycorrhizal basidiomes. Protocol modifications were applied, and massive sequencing was carried out in until March 2024. Results will be presented at the IWEMM 11, including the first records of arbuscular mycorrhizal fungi in soil samples. This is the first time in which is compared diversity of sporocarps vs fungal DNA in soil samples in Guatemala. Fungal diversity from fruitbodies was analyzed from collections and sequences obtained in previous studies.

DIVERSITY AND GEOGRAPHIC DISTRIBUTION OF ECTOMYCORRHIZAL EDIBLE MUSHROOMS PRESENT IN THE NAHUELBUTA MOUNTAIN RANGE, BIOBÍO REGION, CHILE

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Key words: Biodiversity, distribution, fungi, ectomycorrhizae, Nahuelbuta

The Nahuelbuta mountain range is an ecosystem with significant relevance, characterized by a humid Mediterranean climate, where the dominant species in the canopy are *Nothofagus dombeyi*, *N. obliqua* and *Araucaria araucana*, resulting in a high degree of biodiversity and endemism that includes fungi. Given the frequent human intervention in this mountain ecosystem, it is of utmost importance to protect the species of edible ectomycorrhizal fungi (EEM) that maintain a close association with the roots of native trees. It is essential to educate the community about the practices of recognizing and sustainable harvesting of this resource, especially those fungal species classified according to their conservation status. During the autumn-winter seasons of 2022 and 2023, EEM sporomes collections were carried out in the areas of Trongol Alto, Piedra El Puma, and Cuesta de Caramávida, located in the high parts of the Nahuelbuta mountain range, Biobío region. The main objective of this study was to know the diversity and geographic distribution of EEM in this place, as well as support population monitoring over time and design conservation strategies. The specimens collected were documented in the field through *in situ* photographs and georeferenced data before being taken to the laboratory for taxonomic determination, which allowed the elaboration of a detailed list of EEM and their geographic distribution in part of the Nahuelbuta mountain range, including background information obtained from databases and bibliography.
Funding: Rufford Fund 36833-1 "Knowledge biodiversity for environmental education and conservation of macrofungi present in the Nahuelbuta's mountain range"

REVISION OF MISASSIGNED BARCODING SEQUENCES IN PUBLIC DATABASES, THE CASE OF INTERNAL TRANSCRIBED SPACER IN WHITISH TRUFFLES

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Key words: *Tuber borchii*, BLASTn, misidentification, molecular taxonomy, morphology

Taxonomy of *Tuber* has advanced significantly in recent years, mainly thanks to the massive use of barcoding sequences such as the Internal Transcribed Spacer (ITS) of rDNA. The number of ITS sequences of *Tuber* specimens deposited in public databases such as GenBank is about 4200 entries. Among *Tuber* spp., some groups such as the "whitish truffles species complex" are rich in species that share high morphological similarity and are difficult to identify. This has generated the accumulation in the databases of sequences from specimens not accurately identified. The main reason that led to this situation is the absence of a taxonomic review procedure, given that the reliability of GenBank taxonomic information depends only on the validity of data provided by the researchers. The presence of barcode sequences from wrongly classified specimens in GenBank limited the utility of powerful tools for quick species identification such as BLASTn search and increased the risk of propagating taxonomic errors to new-deposited sequences. With the aim of contributing to mitigate such problems (i.e. by proposing corrections for wrongly identified specimens), we performed an inventory of all ITS sequences from *Tuber* specimens classified in the whitish species complex. We retrieved approximately 1400 sequences from GenBank, belonging to the main clades "puberulum", "maculatum", "gibbosum" and "latisporum". Based on phylogenetic analyses we identified terminal nodes containing specimens with contrasting species names, as probable cases of incorrect species attribution (approx. 15%). The main criteria we followed to identify reference specimens with reliable species attribution were sequences cited in valuable taxonomic studies and sequences belonging to type specimens. Further, we are doing ITS sequencing and morphological examination of specimens collected by ourselves, to obtain additional reference samples.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101007623.

MAIN EDIBLE FUNGI PRESENT IN THE PINE PLANTATIONS OF THE ARGENTINE MESOPOTAMIA AND THEIR POTENTIAL AS NON-TIMBER FOREST PRODUCTS

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Key words: Introduced species, added value, fungal diversity, Sclerodermataceae, Russulaceae, Suillaceae, Amanitaceae

Forest production in Mesopotamia Argentina is mainly based on pine plantations, which have a great diversity of introduced ectomycorrhizal fungi (EMF). Some of these may represent a non-timber forest product (NTFP) with little exploitation due to lack of knowledge. The objective was to analyze the diversity and abundance of edible ectomycorrhizal fungi as NTFPs. Different forest species, management types and stand ages were considered. For this purpose, systematic sampling was carried out, recording all the sporomes present in 3 cultivation situations during one year. It was found that the mycorrhizal diversity was mainly represented by 4 families, with Sclerodermataceae being the most abundant regardless of the forest characteristics; the other best represented families were Russulaceae, Suillaceae and Amanitaceae. Species of gastronomic interest, such as *Suillus sp.* and *Lactarius sect. deliciosi*, which, due to the characteristics of the region, fructify between the end of fall and the beginning of winter. However, these species were found only in stands older than 15 years and in smaller proportions in plots with several crop cycles. Some edible species of *Russula sp.* and *Amanita sp.* were also found, but due to the difficulty of their identification in the field and the presence of toxic species, their consumption is not recommended. Considering that the optimal time for logging in the region is between 12 and 20 years of the stand, the use of edible sporomes within a typical forest cycle is not very feasible, but it would be possible in forestations with other purposes.

ADVANCES IN THE STUDY OF *Morchella* DIVERSITY FROM DISTURBED PLANTATIONS AND NATIVE FORESTS OF CENTRAL-SOUTHERN CHILE

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Key words: Elata clade, fire, growth rate, molecular identification, Nothofagaceae

The diversity of the wild edible fungus *Morchella* in Chile has been poorly explored, resulting in frequent misidentifications that have hindered a full understanding of its ecological role and potential for artificial cultivation. The recent discovery of two new species (*M. andinensis* and *M. aysenina*) in Patagonia, along with the first records of *M. eximia*, *M. importuna*, and *M. tridentina* in the country, indicates a significant advance in *Morchella* knowledge. Nevertheless, our understanding of the genus within the territory is still in the early stages. For this reason, our objective was to study the diversity of *Morchella* species in a geographical area of central-southern Chile with a predominance of forest plantations, and evaluate the isolates based on their *in vitro* growth and morphology. During the 2022 and 2023 seasons, the ascocarps collected were identified by ITS sequencing. Consistent with previous identifications, including RPB1, RPB2, and EF1-α regions, four species were found. *M. eximia* and *M. importuna* were always found in forest plantations, affected by recent megafires or logging, whereas *M. tridentina* and *M. andinensis* were consistently associated with Nothofagaceae native forests, suggesting a particular affinity for less disturbed environments. All these species belong to the Elata clade, but preliminary results indicate the presence of a species associated with urban environments, which would correspond to *M. rufobrunnea*. In vitro characterization revealed two distinct groups of isolates according to mycelial growth rate (fast and slow). These results could allow to advance in the field management or artificial cultivation of morel in Chile.

NOVEL FUNGAL SPECIES IN BOLETACEAE DISCOVERED IN GUATEMALA

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Key words: Ectomycorrhyzal, endemism, Neotropic, Central America, phylogeny

Information about diversity in Boletaceae in Guatemala is presented, according to molecular and classic taxonomy analyses. Guatemala is considered one of the most biodiverse countries in the World due to its singular geographical position, North American origin, Subtropical latitude, and main climatic changes that affected the original and migrating biotas. Those factors contributed to the establishment, permanence, disappearance, evolution, and genetic changes in ectomycorrhizal fungi, including shifts to other vegetal symbionts and evident phenotypical plasticity in some genera and species. Surprisingly, the richest area in genera and species in Boletaceae has been the East zone of the country, which was also considered mycophobic and constitutes a refugee for some ectomycorrhyzal plants. There are genera related to Eastern North America, the Caribe and apparently disjunt taxons as *Amoenoboletus*, *Alloboletus*, *Aureoboletus*, *Austroboletus*, *Baorangia*, *Boletellus*, *Caloboletus*, *Calostoma*, *Cyanoboletus*, *Harrya*, *Fistulinella*, *Leccinellum*, *Neoboletus*, *Phlebopus*, *Phylloporus*, *Phylloporopsis*, *Pisolithus*, *Retiboletus*, *Rubroboletus*, *Strobilomyces*, *Suillus*, *Tylopilus*, *Veloporphyrellus* and *Xerocomus*. The central zone, considered a transition but also an old zone, contains cryptic species in *Boletus*, *Boletinus*, *Butyriboletus*, *Cyanoboletus*, *Exsudoporus*, *Gyrodon*, *Gyroporus*, *Heimioporus*, *Hortiboletus*, *Imperator*, *Neoboletus*, *Phlebopus*, *Phylloporus*, *Porphyrellus*, *Rubroboletus*, *Scleroderma*, *Tapinella*, *Tylopilus*, *Xerocomellus*. The Western zone, the oldest geologically, has cryptic and related North American species in *Alpova Boletus*, *Butyriboletus*, *Chalciporus*, *Leccinum*, *Gyrodon*, *Melanogaster*, *Porphyrellus*, *Rhizopogon*, *Suillus*, *Suillellus*, *Sutorius*, *Scleroderma*, *Veligaster*. However, there are still areas that remain poorly studied despite their rich vegetation- as happens in Sierra de Los Cuchumatanes and Sierra de Chamá, which contain vegetal endemism and notorious original living cultures.

CRYPTIC DIVERSITY IN *Ramaria*: NEW PERSPECTIVES FROM PATAGONIA USING MOLECULAR CHARACTERS

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Key words: Changles, edible mushrooms, Gomphales, Nothofagaceae, South America, two new taxa

Ramaria sensu lato species are some of the most visually striking due to their coral-like, medium-sized, and colorful fruiting bodies. The genus was recognized as paraphyletic and is currently divided into four subgenera: *Ramaria*, *Laeticolora*, *Lentoramaria*, and *Echinoramaria*. Eighteen species have been reported from Patagonia (Chile & Argentina), bases on morphology and anatomical features; however, their diversity and phylogenetic relationships are largely unknown. The most frequent and widespread are the endemic *R. patagonica* and the cosmopolite *R. botrytis*. In this study we analyzed the diversity of *Ramaria* species in Nothofagacea forests of Patagonia (Argentina) using an integrative approach combining phylogenetic, morphological, and ecological data. The phylogenetic analyses revealed the presence of six *Ramaria* species in Argentinian Patagonia: *R. patagonica*, *R. botrytis*, *R. inedulis*, *R. paraconcolor*, and two new phylogenetic groups proposed as novel species: *R. flavinedulis* and *R. dendrophora*. Phylogenetic analysis based on ITS and LSU sequences showed the six species grouped within the subgenera *Ramaria*, *Laeticolora*, and *Lentoramaria*. *R. patagonica* formed a distinct phylogenetic lineage and could potentially represent a new genus. *R. flavinedulis* has brightly yellow or yellow-orange fruiting bodies with a fused, twisted compound stipe, simple-septate basidia, and ellipsoid to cylindrical basidiospores. On the other hand, *R. dendrophora* has pale yellow to pale pink fruiting bodies and basidiospores ornamentation with conspicuous and irregular warts. Most species showed association with Nothofagaceae forests, but no host specificity. The study increased knowledge on *Ramaria* taxonomy, phylogeny, and biogeography in southern South America. However further surveys are needed, especially in Chile.

MOLECULAR DIVERSITY AND TOXICITY OF *Gyromitra* sp. (FALSE MOREL) IN THE ANDEAN-PATAGONIAN FOREST REGION

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Key words: Hydrazine, neurotoxicity, *G. antarctica*, gyromitrin

The genus *Gyromitra* in the order Pezizales comprises many distinct species, varying across different geographical regions. Referred to as "false morels". *Gyromitra* species exhibit cerebriform or discoid apothecia. Distinguishing *Gyromitra* species only based on morphological traits is challenging, making DNA barcoding a valuable tool for accurate identification. Some *Gyromitra* species are characterized by containing gyromitrin, which is a dangerous neurotoxic derivative of hydrazine. The present study aimed to evaluate the molecular diversity and the hydrazine concentration in *Gyromitra* sp. specimens distributed in the Patagonian forest. The DNA region Internal Transcribed Spacer region (ITS) and the Large Subunit (LSU) of the *Gyromitra* samples have been sequenced for phylogenetic analysis. Reference sequences were downloaded from GenBank and aligned with Clustal W. Neighbor-joining analysis was conducted for both datasets with Mega 11.0.10 using the Tamura-Nei model and 1000 bootstrap replicates. The study to detect hydrazine concentration was based on the condensation of hydrazine with vanillin in an acidic medium to form a yellow Schiff's base having a maximum absorbance at 400 nm. Analyses of data sets revealed that Patagonian "false morels" belong to the Esculenta Clade. All specimens were identified as *G. antarctica*, species described for Argentina and Chile. We detected hydrazine in all tested specimens, reaching 20 to 80 mg equivalent hydrazine for kg fresh. Gyromitrin was also detected in *G. antarctica* native to Chile using the UHPLC analytical method. This study confirms that *G. antarctica* is distributed in Patagonia-Argentina and contains the toxin gyromitrin. Consequently, pretreatment is recommended for safe consumption.

DIVERSITY OF *Cortinarius* AND *Amanita*, 2 GENERA ECLECTIC OF *Nothofagus* FOREST IN PATAGONIA

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Key words: *Amanita* spp., *Cortinarius* spp., molecular techniques, morphological features, diversity gaps

Seventeen ectomycorrhizal fungi species have been reported as edible for South American Nothofagaceae forests, 8 *Cortinarius* species, 6 of *Ramaria*, 2 of *Amanita*, and *Tricholoma fusipes*, approximately the 4% of total reported taxa. Notwithstanding, South America is still a highly under-explored biodiversity hotspot, where studies are needed in order explore the real species richness and to better understand the phylogenetic relationships. This also makes meaningful species delimitation very difficult and the identification of environmental sequences from these habitats nearly impossible. Results of our studies will tell three stories about unraveling the taxonomy identification of edible or potentially edible fungi belonging to *Cortinarius* and *Amanita* genera. *Cortinarius magellanicus* represents a complex of species composed different phylogenetic lineages, each with strong regionalism and distinct host associations. On the other hand, *C. xiphidipus*, *C. pugionipes* and *C. austroturmalis* variability are a single species with wide range sizes and habitus. Variables as layer of context, spore size, light properties, and lamella color seem to be the best taxonomic features. *Amanita* species associated to South American Nothofagaceae forest are poorly studied and BLAST searches of these sequences from type material did not give any results with similarities higher than 95% indicating the possibility that there are new species to be discovered. Considering the gaps of reference molecular data about ectomycorrhizal taxa from Patagonia, the assessment of the real ectomycorrhizal diversity and host specificity deserves further studies combining phylogenetic analysis based on wide ecological surveys.

MICROORGANISMS ASSOCIATED WITH THE QUALITY OF THE BLACK TRUFFLE (*Tuber melanosporum*) PRODUCED IN ARGENTINA

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Key words: Black truffle, saprophytic fungi, bacteria, food preservation

Among biotic factors influencing the development of truffles, soil microorganisms may contribute to their quality after harvest. Previous studies identified some bacteria involved in their premature decomposition, however some specific Proteobacteria may also produce volatile compounds contributing to their particular aroma. For instance, we aimed to characterize the microbial populations (fungi and bacteria) of *Tuber melanosporum* ascocarps at harvest and after a storage time. Healthy and deteriorated truffles were received from a truffles producer. From the first group, total mesophilic microorganisms, Enterobacteriaceae, moulds and yeast counts were determined. From the second group, moulds were isolated from under a stereomicroscope. Mesophilic aerobic bacteria ranged from 10^4-10^8 CFU/g, showing lower counts in fresh truffles than in those having 15 days of storage. Fam. Enterobacteriaceae counts ranged from <10-10^4 CFU/g. No moulds and yeast were observed in fresh truffles, but in storage conditions the counts were <10^2-10^3 CFU/g. Up to now, from the peridium of healthy fresh truffles were identified strains of the genera *Cephalotrichum*, *Cosmospora*, *Exophiala*, *Fusarium*, *Lecanicillium*, *Sarocladium*, and *Phialophora*. From the gleba were isolated *Fusicola violaceae*, *Aspergillus* sp., *Fusarium* sp., and *Pseudomonas* sp. In deteriorated truffles *Clonostachys rosea*, *Cladosporium* sp., *Fusarium* sp. and *Mucor* sp. were recovered. Our preliminary results indicate an interesting and diverse microbial community among the peridium and the gleba tissues. Further analysis on these communities will be focused on determining whether the identified microorganisms can promote differential effects on the decomposition (consistency and aroma) of truffles during storage.

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CONSERVATION AND POPULATION GENOMICS OF THE ENDANGERED CHILEAN MUSHROOM *Butyriboletus loyo*

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Key words: *Butyriboletus loyo*, ectomycorrhizal, endangered, population genomics, conservation, harvesting

'Loyo' (*Butyriboletus loyo*) is a highly valued wild, edible mushroom endemic to southern Chile, and is an ectomycorrhizal mutualist of *Nothofagus* trees, especially in the Valdivian rainforest. This species has culinary and cultural value to the indigenous Mapuche people of southern Chile and is sold throughout the country. However, in face of overharvesting, habitat degradation, and climate change, populations of *B. loyo* have declined by 70% over the last 20 years with harvested sporocarps becoming smaller on average. Further, population genomic studies have provided data indicating that inbreeding is occurring within these populations, which could contribute to local or total extinction over time. This stark decline in population size and evidence of inbreeding has resulted in an acknowledgment of its endangered status. Loyo is now listed as an officially endangered species by the IUCN and Regional Red List in Chile. In order to conserve this species, scientists and local communities need to work together to re-inoculate the forest, protect loyo habitat, and educate people on more sustainable harvesting strategies.

ECTOMYCORRHIZAL FUNGI PLAY A KEY ROLE IN WILDFIRE PREVENTION AND RESTORATION OF FIRE DEGRADED AREAS

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Key words: Ectomycorrhizal fungi, wildfire, fungal diversity, added value, fire prevention, restoration

Wildfires are significant ecological disturbances with widespread socio-economic consequences. Understanding the intricate connections between fire and ecosystems is essential for effective wildfire management and ecological restoration. Among the various organisms affected by fire, Ectomycorrhizal (ECM) fungi play pivotal roles in both wildfire prevention and shaping post-fire ecosystem dynamics.
The effects of fire on ECM fungi are complex and multifaceted, encompassing alterations in community structure, functional diversity, and symbiotic interactions with host plants. Fire-induced changes in soil properties, such as nutrient availability and pH, can profoundly impact ECM fungal communities, thereby influencing ecosystem resilience to subsequent disturbances. Furthermore, the adaptive strategies employed by ECM fungi in response to fire, including spore dormancy and rapid colonization of burned substrates, underscore their resilience in fire-prone environments. The added value generated by ECM edible appreciated fungi, provide also significant economic incentives for local communities, fostering their engagement in forest conservation efforts. By highlighting the ecological importance of forests for fungal habitat and sustainable harvesting practices, communities become more invested in wildfire prevention to safeguard these valuable resources. Mycoselviculture, prioritizing appreciated edible mushrooms while mitigating wildfires, holds promise for optimizing forest management in fire-prone regions. By fostering resilient ecosystems through enhanced fungal diversity and proactive wildfire prevention measures, it offers a sustainable approach to safeguarding forests against the looming threat of wildfires. Beyond prevention, ECM fungi offer promising avenues for the restoration of fire-affected landscapes. Leveraging their symbiotic relationships with host plants, ECM fungi facilitate post-fire vegetation recovery by enhancing nutrient acquisition, stress tolerance, and ecosystem productivity. Furthermore, their ability to form mutualistic networks enables the establishment of diverse plant communities, accelerating ecological succession and fostering ecosystem resilience. In conclusion, by elucidating the dynamic interplay between fire and ECM fungi, we can advance innovative strategies to mitigate wildfire risk and promote the ecological recovery of fire-prone landscapes.

THE MICROBIOME STRUCTURE OF THE SYMBIOSIS BETWEEN THE DESERT TRUFFLE *Terfezia boudieri* AND ITS HOST PLANT *Helianthemum sessiliflorum*

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Key words: Bacterial diversity, desert truffles, *Helianthemum sessiliflorum*, mycorrhiza helper bacteria, *Terfezia boudieri*

The desert truffle *Terfezia boudieri* is an ascomycete that forms ect-endomycorrhiza in roots of Cistaceae species. It forms hypogeous edible fruit bodies. Mycorrhizas support plant development by increasing minerals acquisition, and resistance to biotic and abiotic stresses. Truffles are colonized by microbes, that contribute to truffles and host plants development. The diversity and composition of the community in the Negev desert was unknown. This research studies the contribution of the rhizosphere microbial communities to the establishment of the mycorrhizal symbiotic association. The bacterial community was characterized in *T. boudieri* fruit bodies, mycorrhizal roots colonized by *T. boudieri* and mycorrhizosphere soil. Next generation sequencing meta-analyses of the 16S rRNA gene, discovered concealed diverse bacterial communities of fruit bodies differing from those of the roots and rhizosphere soil. The core microbiome consists of groups whose biological role are important traits for plant and fungus development. How plants shape the microbiome through root-exudates is not clear. Some secreted metabolites are specifically functioning as chemoattractants. Root-secreted nucleosides were detected in various plants that inhabit diverse ecological niches, and mycorrhized *Helianthemum sessiliflorum*. Nucleosides induced positive chemotaxis in plant beneficial bacteria, pathogenic rhizobacterium, and *E. coli*. In a soil-plate assay nucleosides diffused to substantial distances and evoked chemotaxis under conditions as close as possible to natural environments. This study implies that root-secreted nucleosides are involved in the assembly of the rhizosphere bacterial community by inducing chemotaxis towards plant roots and fungus. Indicating that chemotaxis signaling by nucleosides is a conserved universal mechanism that encompasses living kingdoms and environments.

DESERT TRUFFLES AND TRUFFLES IN MOROCCO

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Key words: Terfess, *Tuber*, mycorrhizal fungi

Truffles are the edible hypogeal Ascomycota (Pezizaceae) fruiting bodies produced by the genera *Terfezia*, *Delastreopsis*, *Balsamia*, *Delastria*, *Leucangium*, *Mattirolomyces*, *Phaeangium, Picoa*, *Tirmania*, and *Tuber*. Truffles are fungi that spend the majority of their life cycle in symbiotic association with the roots of certain higher plants, such as pines. Desert truffles are mycorrhizal fungi native to the Mediterranean region's dry and semi-arid environments. The Mamora woodland in Morocco's northwestern region, the plains of the highlands in the east, and the Sahara in the south and south-east are very favorable environments for desert truffles. These diverse climatic conditions and host plant associations contribute to the development and expansion of the diversity of Terfess species in Morocco. The purpose of this study is to present the different Terfess and *Tuber* species collected in Morocco as well as their geographical distribution.

SHORT-TERM EFFECT OF HISTORICAL MEGA-FIRE IN SIERRA DE LA CULEBRA ON SOIL FUNGAL COMMUNITIES

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Key words: Forestry, fire ecology, mycology, biodiversity, Spain

The 2022 Sierra de la Culebra mega-fire was the largest disaster of its nature in the history of Spain. Within 3 days almost 30000 hectares of forests were destroyed and between the months of July and August a total of 65000 ha burned down, eliminating habitats of countless species of flora, fauna, along with its associated fungal communities. In this study we analyze how these soil fungal communities were affected one year from the fire. We compared 3 sites which presented both completely burned areas (test) as well as areas which were entirely unaffected by the mega-fire (control). We took samples from both control and test areas and analyzed their composition from a mycological viewpoint by extracting and sequencing all DNA associated with fungal communities. Several guilds, phylum, and individual species of fungi either suffered greatly or gained favorable conditions for growth after the fire. Consistent with our expectations, we found that ectomycorrhizal communities were decimated in the burned plots, while saprophytic species increased exponentially in quantity.

CULTURAL & ECONOMIC IMPORTANCE
TRADITIONAL KNOWLEDGE

TRADITIONAL VS. NON-TRADITIONAL AND A CONCEPTUAL TURN IN THE STUDY OF LOCAL MYCOLOGICAL KNOWLEDGE IN PATAGONIA: MEMORY AND FLEXIBILITY IN TIMES OF CHANGE

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Key words: Social economy, neglected and underutilized species, hybrid knowledge, Mapuche-Tehuelche, food sovereignty, Patagonia

The interaction of traditional and non-traditional components could lead to hybrid forms of mycological knowledge that are more resilient in the face of processes of change. Mapuche-Tehuelche inhabitants of NW Patagonia collect 17 wild mushrooms for self-consumption and/or trade, including three commercial species with no records of historical use: *Suillus luteus*, *Morchella* afin *septimelata* and *M.* afin *tridentina*; and the native *Cyttaria hariotti* for self-consumption. Twelve other species of past importance are currently but occasionally collected to eat *in situ* as snack while other activities are carried out in the field; these NUS (neglected and underutilized species) are retained by memory in biocultural refuges as part of identity and attachment to the land. Knowledge transfer by technical and scientific institutions, as well as links with the market society, facilitate partial connections for learnings towards innovation of sustainable harvesting practices and value addition of commercial species, in particular among young women with multi-employment. The ethnomycological approach makes visible the flexibility of local knowledge to respond to socio-environmental and economic issues, and highlights the importance of intercultural dialogue for the co-development of culturally sensitive plans for food sovereignty and social economy.

FROM SCIENTIST TO CONSULTANT: MYCOTREE SUPPORTS EDIBLE MYCORRHIZAL FUNGI CULTIVATION IN NEW ZEALAND WHILE MAINTAINING AN INTERNATIONAL COLLABORATION

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Key words: Edible mycorrhizal fungi, cultivation, truffière, nursery seedling, soil, New Zealand, New Caledonia

The sustainable cultivation of edible mycorrhizal fungi (EMF) offers multiple benefits, namely, healthy food, annual income, carbon sequestration, soil and habitat development, mycotourism. It is also a very young activity in human cropping history with several challenges to overcome before becoming a widespread and more successful agricultural practice. After 26 years of research on EMF cultivation, I had the opportunity to establish Mycotree, a small consultancy business to help with the development of this field in New Zealand and overseas. I will present the range of activities carried out by Mycotree and explain how knowledge and science are the best way to reduce risks while starting EMF orchards and continually improve their success. Some diagnostic services (microscopy combined with DNA) determine the potential of seedlings, or established trees, to produce valuable edible fungi crops. Other activities assess the potential of a given land to cultivate EMF, using soil analyses and modification as well as local geo-climatic conditions. Mycotree also provides planting and management recommendations based on an up-to-date understanding of the biotic and abiotic conditions favoring the establishment and fruiting of EMF trees. Education of various stakeholders, from nurserymen to growers and the general public, is also a key activity. Mycotree maintains an international collaboration with academic organizations, from the co-supervision of doctoral students to research/development particularly with Asia, Europe and Canada. Mycotree is also partnering with the Institut Agronomique Néo-Calédonien to contribute to an ongoing scientific and ethnomycological survey of New Caledonia's native edible fungi.

ETHNOMYCOLOGICAL NOTES FROM YAYU COFFEE FORESTS, SOUTHWEST ETHIOPIA

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Key words: Ethnomycology, ethnotaxa, coffee biosphere forests, mushroom, non-timber forest products

The ethnomycological survey was conducted within the Yayu Coffee Biosphere Forests Reserve area in Southwest Ethiopia. The aim was to collect information about the community's traditional knowledge of wild mushrooms. The methodology involved semi-structured interviews, focus group discussions, and key informant interviews, engaging a total of 1189 households. Furthermore, forest excursion was conducted to identify valuable wild mushroom species in the region. We documented 51 wild mushrooms, of which 21 were edible. Notably, *Agaricus campestroides*, *Macrolepiota africana*, *Termitomyces* sp., and *Schizophyllum commune* were popular among locals. Despite a relatively small number of ethnotaxa, seven vernacular names for fungi were recorded. While 51.6% of participants demonstrated familiarity with mushrooms and knowledge of their medicinal and food uses. Only 34% of respondents engaged in random mushroom gathering, primarily for food, during the main rainy season, with women and children being the primary collectors. Knowledge of mushroom habitats among respondents was observed, such as natural forests, home gardens, farmlands, plantation forests, and grasslands. Respondents identified seven distinct substrates for mushroom growth across these habitats. Notably, while the majority (61.2%) recognized the toxic effects of wild mushrooms, some community members possessed expertise in distinguishing between mushrooms based on color, smell, and texture. About 84.3% believed that wild mushrooms had declined, attributing this decline to deforestation, grazing, fire, and settlements. These results help us to understand the community's knowledge and customs regarding wild mushrooms and can promote sustainable practices contributing to the preservation of both mycological knowledge and the biodiversity.

MYTHS, BEINGS, AND BELIEFS BEHIND WILD MUSHROOM USE IN MESOAMERICA

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Key words: Ethnobiology, ethnomycology, bioculturality, traditional mycological knowledge, cosmovision

Mesoamerica is a cultural region that has been traditionally deemed mycophyllous. Across time, diverse anthropological and ethnomycological studies have documented varied aspects of the relationship between local human groups and funga. This includes lists of used edible species, local names and local classification systems, ample traditional mycological knowledge regarding mushroom ecology, phenology and other features, selling practices, and their role in local medicine and as an element that keeps the natural order of the universe. However, it is still necessary to understand the role of these organisms in the universe and the association they have with other beings to understand the different ways in which they are used. Here, I present some examples of how mushroom use can be conditioned by how these organisms are understood by different human groups and by their role in origin myths and beliefs. These include a) the origin of mushrooms in Lacandon Maya and Tsotsil myths as a way to explain local systematics and usage, b) beings associated to *Clathrus cruspus* in Mayan rainforests and presages they represent, and c) beliefs about mushrooms among the *mestizo* population of the state of Tabasco.

SERIFUNGRAFÍA PATAGÓNICA (RE)PRESENTATION OF FUNGI IN CULTURE

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Key words: Visual arts, culture, silk-screen print, education, fungi

"Serifungrafía Patagónica" is a Project that articulates art and science, and proposes producing and reproducing mushrooms images using the silkscreen technique. In an initial stage we began to track photographs and illustrations of fungi generated from mycological field research at CIEFAP (Esquel, Argentine) and images found in specialized literature, with the aim of take them as a resource for their resignification in an artistic use. The scientific field contains a visual archive that is normally accessed only by the specialists. We aim to promote the circulation of visual productions and scientific knowledge related to native fungal species and to address their relationship with the population and culture that inhabits and develops in the region. Thus, contributing to scientific dissemination by sharing knowledge through visual culture. The Project has a perspective of Comprehensive Environmental Education that values the natural environment, and promotes a transversal and interdisciplinary view of the relationship between society and the environment. It interacts in the convergence between the fields of art and science, betting on artistic research in the fungal world. In this presentation we give examples of fungal species and print material to be developed by the project. As part of this research – production journey, an approach to the way in which fungi are present and represented in the visual culture of our region is proposed.

FROM SCIENCE TO THE TABLE: PATAGONIAN MYCOCULTURE CAPACITY BUILDING THROUGH COMMUNITY-BASED EDUCATIONAL WORKSHOPS

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Key words: Mycoculture, Patagonian edible mushrooms, small-scale production

We discuss the evaluation of community-based capacity building workshops delivered as part of *From Science to Table* program, a *Patagonian Mycoculture Project*. The workshop objectives were to: 1) share information about the nutritional benefits of edible mushrooms; 2) showcase how to sow, grow, and harvest mushrooms for personal use and/or as small-scale business opportunities. The theory of change underlying the workshops was that active experiential learning, such as the multi-sensory experience of observing/smelling/tasting the mushroom dishes, and the hands-on experience of sowing mushrooms, would foster participant interest in edible mushrooms and achieve workshop objectives. Two two-day workshops took place in October 2022, and two two-day workshops in May 2023. Workshops were held in low-income urban areas in the city of Bariloche and in low-income rural towns in the province of Río Negro (Río Chico and Río Manso). A multidisciplinary team of researchers, health professionals, agricultural producers/experts, and chefs, facilitated the workshops. The workshops were documented, systematized, and evaluated. In total, 293 participants attended the workshops; 85 participants responded to surveys. Among the major findings were: 85% said they learned “a lot” about the nutritional benefits of mushrooms; 84% said they “really liked” tasting the mushroom dishes, and 85% of respondents indicated it was “very good” to gain hands-on experience sowing mushrooms. Respondents unanimously supported expanding the workshop to other locations. Moving forward, sustained efforts are warranted to support workshop participants to incorporate mushrooms into their diet and/or continue to grow mushrooms for personal or commercial purposes.

INTACT RISE-MSCA PROJECT TO SUPPORT TRUFFLES AROUND THE WORLD

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Key words: truffles, research consortium, transnational cooperation

The INTACT project: "Innovation in truffle cultivation, preservation, processing and wild truffle resources management" aims at establishing a multi-lateral network of research and innovation staff active in the sustainable use of both wild and cultivated truffles, including the cultivation, pre-treatment, preservation, and processing of the truffles. Particular attention it is paid at issues related to the juridical and normative framework for traceability legislation for each country involved and to rules on collecting wild truffles in Europe. The research capacities are strengthened through the exchange of knowledge and expertise on a shared research and training program providing a stronger transnational cooperation and better connections between actors committed to research and production on the truffles value chain. The joint Intersectoral and Interdisciplinary exchange program involves 19 Beneficiaries and Partners, with a range of scientific activities from technical skills exchange and training to methodological development and planning of future new research. It involves more than 100 people including researcher, young researcher, administrative, manager and technical staff and will have a sizable impact above and beyond those involved in the exchanges. The consortium is coordinated by the National Council of Research of Italy and the program will run over 4 years, until the 31st December 2025.

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MARKET ANALYSIS OF PRODUCTS BASED ON WILD AND CULTIVATED EDIBLE MUSHROOMS IN ESQUEL AND TREVELIN STORES

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Key words: Demand, supply, value added, *Morchella* spp, *Suillus luteus*

The Patagonian region has the possibility of commercializing several wild and cultivated edible mushrooms. However, the consumer market is incipient in Argentina, with the recent incorporation of activities associated with mycogastronomy and mycotourism. To inquire about the quality, diversity, origin, value added and some characteristics of the demand for edible mushroom-based products, the most present and locally known wild mushrooms were surveyed: *Suillus luteus* and *Morchella* spp, and the cultivated: *Agaricus bisporus*, *Pleurotus* spp and *Lentinula edodes*. Thirty eight purchasing managers from stores in Esquel and Trevelin were interviewed using a semi-structured survey. It was found that these products are sold in 76% of the stores, with a greater presence of *Suillus luteus* and *Agaricus bisporus*, with a greater diversity of products with different levels of added value. *Suillus luteus* is sold dry in bulk, divided into bags of up to 100 grams or combined with other ingredients, in some cases made in other regions of Patagonia; the presence of imported consignments from South American countries was detected. *Morchella* spp has a low presence in stores, offered dried, fractionated in bags up to 60 grams, with local prices that double *S. luteus*; although, its value chain appears oriented towards bulk exports to Europe, where it is sold at higher prices. Merchants associated the behavior of demand for these products with that of goods with greater added value or high cost. Tourists are the ones who demand them the most in stores, considering them a regional product. Local consumers usually collect and dry them in an artisanal way.

EDIBLE ECTOMYCORRHIZA, CLIMATE CHANGE AND SUSTAINABILITY

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Key words: Climate change, mycorrhiza, truffles, sustainability, land-use conflict, mycoforestry, conservation

Climate is a key driver in the distribution of many edible ectomycorrhizal fungi (ECM) species and weather influences the fruiting time, duration and quantity of fruit bodies produced. This interaction underpins the observed response of many species to advancing climate change. Post-industrial changes to climate have already had an impact, such as the increased variation of annual production for many *Tuber* species and the continued fruiting of *Tuber melanosporum* within areas north of its previously accepted range. Using historical data of *T. melanosporum* and *T. aestivum* to project forwards, the likely impacts of different climate-change scenarios are very significant and although a northwards expansion of suitable climate zones is evident, this is within the envelope of a predicted severe contraction in the Mediterranean basin. The vulnerability of ECM to climate change is clear but perhaps they may also help with mitigation strategies, where successful ECM cultivation can incentivise afforestation and reduce the food-forestry land-use conflict. Analysis from 637,000 ground plots and 707,561 waveform light detection and ranging (LiDAR) observations shows high potential for epigeal ECM cultivation, with a sequestration rate of 6.1 t CO_2 -eq $ha^{-1}y^{-1}$ in temperate ecosystems. The carbon sequestration rate for each kilo of protein produced can reach 858 kg CO_2 -eq, in contrast to all other food groups which emit CO_2 in their production. With additional food security, biodiversity, conservational and rural socioeconomic potential, ECM cultivation demands urgent development.

ENVIRONMENTAL CONSERVATION AND SUSTAINABLE MANAGEMENT: WHAT FUTURE FOR *Tuber magnatum* PICCO?

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Key words: *Tuber magnatum* Picco, natural truffle sites, conservation, management strategies.

Tuber magnatum Picco is undoubtedly the best known and most desired truffle species among truffle hunters and truffle lovers. The fascination of production and its research and harvesting is a typical element of rural territories that are rich in tradition and history in Italy. 'Truffle hunting and extraction in Italy, traditional knowledge and practice' has been inscribed in 2021 on the Representative List of the Intangible Cultural Heritage of Humanity of UNESCO. Therefore, it is necessary to conserve the growth environment, which is characterized by considerable floristic and vegetational complexity and a soil environment that is very much linked to water. The study of the natural production environment in terms of biological and physical factors has been related to truffle farming in the natural environment that is sometimes applied to achieve truffle production. Fungal and bacterial communities are certainly affected by drought, but also by the accumulation of water in the soil when it cannot drain fast. Studies on microbial communities have shown significant differences between sampling years at some natural sites, demonstrating a possible relationship between precipitation and Firmicutes and Actinobacteria. Further studies of microbial communities are underway to investigate the possible relationship between productive seasons and the soil microbiome and consequently in relation to the management of natural truffle sites. Preserving the production environment of *Tuber magnatum* is moreover a moral duty to future generations and to the biodiversity and historical cultural heritage that this truffle represents in the world.

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WHAT'S ABOUT THE ITALIAN PORCINO?

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Key words: *Boletus edulis*, forest management, alien trees, Italy

Boletus edulis sensu lato, a globally distributed ectomycorrhizal mushroom, is a premier culinary delicacy for Italian culture. During ancient Roman times it was considered as a gastronomic delight. For some local people the Italian term "fungo", denoting mushroom, is synonymous with the Porcino group. In recent years, the culinary significance has become so relevant that the "IGP-Fungo di Borgotaro" certification was created, which sets standards for the Porcino group, requiring adherence to specific characteristics and collection within the designated geographic area. However, this precious fungal group has undergone a decline and a study on non-traditional forest management was specifically developed to investigate the impact of tree canopy and the presence of leaf litter. This mycosilviculture activity showed that moderate thinning increases productivity of Porcino and the presence of litter does not interfere with the fruiting of *B. edulis* s.l.. It is well-known that land-use and climate changes are increasing threats to the environment and to the diverse aspects of life. Another problem could be the propagation of invasive allochthonous species taking precedence over the native Italian forests. An example of this phenomenon is the presence of *Robinia pseudoacacia*, introduced from North America in the 17th century, that is quickly invading the native Italian forests, becoming dominant. Biodiversity changes dangerously with the presence of this alien species and also our beloved Porcino, designated as a species of least concern by IUCN criteria, could be at risk of survival. Conservation guidelines are urgent to safeguard its existence in specific regions!

RESTORATION STRATEGIES FOR ENHANCING *Tuber borchii* Vittad. PRODUCTION IN ABANDONED OLIVE GROVES: A METAGENOMIC APPROACH

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Key words: *Tuber borchii* Vittad., metagenomic sequencing, natural truffles sites, management strategies

The cultivation of *Tuber borchii* Vittad., commonly known as the Bianchetto truffle, presents a promising economic opportunity in regions with suitable environmental conditions. However, the natural habitat of *T. borchii* has faced challenges due to land abandonment resulting in decreased truffle productivity. Understanding the microbial dynamics in soil ecosystems is crucial for successful land restoration efforts aimed at enhancing truffle production. Several studies have investigated the communities of ectomycorrhizal fungi in the growth environments of *T. borchii*. In this study, we want to expand the knowledge of the connections with all fungi and bacteria because they are closely involved in the reactions that determine the ideal characteristics for truffle ascocarp development. In particular, this study investigates the impact of restoration techniques on bacterial and fungal communities in an abandoned olive grove, focusing on *T. borchii* cultivation. Field surveys documented vegetation changes before and after cutting, providing insights into the ecological shifts accompanying restoration efforts. Metagenomic analysis of soil samples revealed significant alterations in bacterial and fungal diversity and composition following restoration. Our findings underscore the importance of employing metagenomic approaches to monitor microbial responses to restoration practices, offering valuable insights into sustainable land management strategies for promoting *T. borchii* production in abandoned areas. This research contributes to the advancement of ecological restoration practices while facilitating socio-economic development and biodiversity conservation in agroecosystems.

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PIONEER PRESCRIBED BURNING UNDER SCOT PINE IN SPAIN, IS A MYCOFRIENDLY FIRE PREVENTION TOOL

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Key words: Ectomycorrhizal fungi, forest management, mycology, wildfire, saprotrophic fungi

The Mediterranean region is well-known for its natural vulnerability to wildfires. In recent times, this risk has become more pronounced due to various factors, such as climate change and rural depopulation. Castilla y Leon emerges as one of the most severely affected by rural migration. This evolving scenario underscores the need to implement forest management strategies to mitigate the escalating threat of wildfires, with a particular emphasis on reducing fuel loads. While prescribed burns offer an effective and economical means of wildfire prevention, they remain a topic of debate in Europe. This study aims to examine the effects of prescribed fires on the soil fungi population of *P. sylvestris* forests. Quite a unique study because of the low adaptability of *Pinus sylvestris* to wildfires. Fungi not only contribute significantly to rural economies but also play a pivotal role in maintaining the equilibrium of forest ecosystems. To assess the short-term effects of prescribed fires on soil fungal communities, we collected soil samples from burned and unburned plots 12 months post-burning, conducting thorough genomic DNA analyses. Expected outcomes indicate that, due to the controlled intensity of the prescribed fire, the impact on the fungal community is expected to be minimal. Specifically, a reduction in saprotrophic fungi is anticipated, primarily influenced by the reduction in organic matter. Conversely, ectomycorrhizal fungi are expected to benefit from decreased saprotrophic fungi.

MOSAIC FOREST MANAGEMENT: PROMOTION OF MYCOLOGICAL PRODUCTION AND REDUCTION OF WILDFIRE RISK

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Key words: Mycological potential, sporocarps, *Cistus ladanifer*, *Quercus*, forest succession

The Mediterranean region harbors species of great diversity and fungal productivity that depends on the structure and age of the stand. One of the most extensive ecosystems are oak (*Quercus*) forests alternating with *Cistus* scrublands, where valuable fungal species appear and can be an important source of local economic benefits. The high flammability of the scrub and the accumulation of old scrub promotes, in increasingly extreme climatic conditions, high intensity forest fires that threaten the conservation of the ecological and economic value of these areas. We evaluated the mycological potential of this ecosystem in terms of production, diversity and composition of the fungal community in order to determine the most appropriate management practices. Sporocarps of ectomycorrhizal and saprophytic fungi were collected during four consecutive years (2012-2015) in plots of young *Cistus* (1 m tall), old *Cistus* (2 m tall) and *Quercus*. Results showed sporocarp production, diversity and richness to be influenced by host and its age, with significantly higher production in young *Cistus* plots. Diversity was higher in *Cistus* plots. Fungal community composition evolved throughout the succession, from a large and diverse community in *Cistus* to a smaller and less diverse one in *Quercus*. Old *Cistus* plots showed an intermediate composition, acting as a bridge species in the succession. Applying a landscape-scale mosaic model is suggested to allow the interconnection of the different successional stages and their respective communities and fungal diversity while favoring cover diversity and reducing the amount of available fuel and, consequently, the occurrence of large wildfires.

ANTHROPOLOGICAL IMPACTS DETERMINE THE SOIL FUNGAL DISTRIBUTION OF MEDITERRANEAN OAK STANDS

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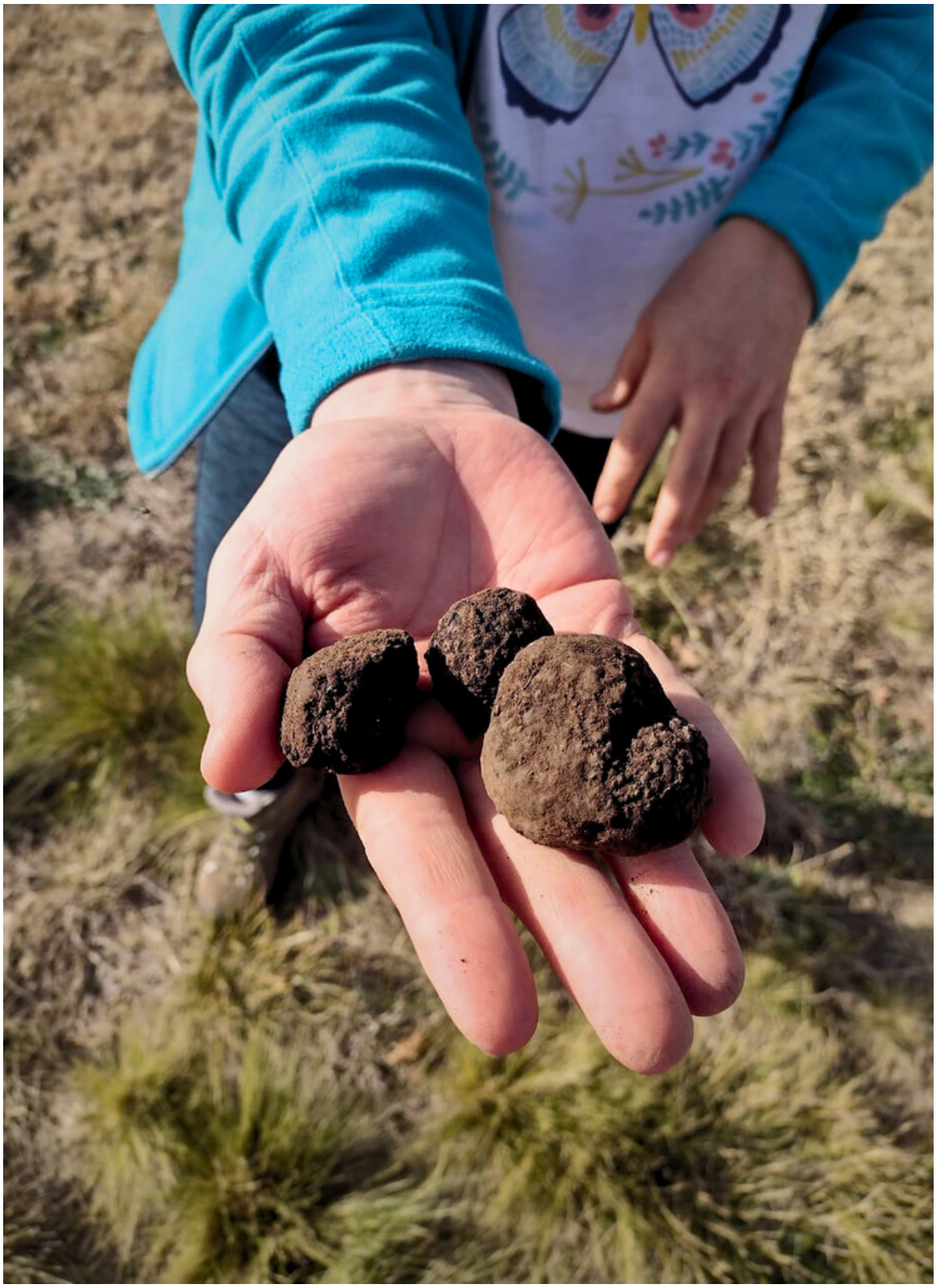
Key words: Forest disturbance, fungal metabarcoding, fungal community ecology, mediterranean ecosystem, beta diversity

Quercus pyrenaica-dominated forests are very widely distributed in Mediterranean ecosystems. Traditional forest use, such as coppicing to obtain firewood or livestock grazing under silvopastoral systems, and the current social abandonment of the rural environment have given rise to forest structures of different ages and at different stages of development. In addition, previous studies have suggested that the production of economically valuable edible mushrooms is negatively impacted by silvicultural management. To determine the effects of land management on these ecosystems, we analyzed the soil fungal communities associated with coppice stands (i.e., high-density coppice), high forest stands (i.e., low-density coppice that received silvicultural management 15 years ago to reduce the risk of wildfire), and old stands (i.e., dehesas) to assess their potential ecological roles in their conservation and the diversity of edible mushrooms. We also analyzed the edaphic variables associated with these systems (carbon, pH and the carbon/nitrogen ratio) to understand the dynamics of these fungal communities. We observed two distinguishable communities: Pathogen-, parasite-, and endophyte-dominated dehesas, and saprotroph- and ectomycorrhizal (ECM)-dominated coppice stands, with a mixed composition in high forest stands. ECM fungi correlated with stand age and structure, showing higher richness levels in high forest stands, particularly ECM fungi with short hyphal exploration type. Finally, the influence of stand age and structure due to land management significantly affected the variety of some edible genera, such as *Boletus*, *Tuber* or *Terfezia*.



CULTIVATION STUDIES OF EDIBLE ECTOMYCORRHIZAL MUSHROOMS: SUCCESSFUL ESTABLISHMENT OF ECTOMYCORRHIZAL ASSOCIATIONS *IN VITRO* AND FORMATION OF FRUITING BODIES

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The cultivation of edible ectomycorrhizal mushrooms (EEM) is a challenging issue for the sustainable use of forest fungal resources, carbon-sequestering land use, and conservation of forest biodiversity. However, with the exception of truffles, little is known about practical techniques for the cultivating EEM. Here, I present several examples of ectomycorrhization and fructification under laboratory conditions, focusing mainly on *Tricholoma matsutake* and *Cantharellus anzutake*. *In vitro* ectomycorrhization of *T. matsutake* with *Pinus densiflora* is an available technique for this fungal cultivation practice. Although fruiting bodies of this fungus have not yet been produced under controlled laboratory conditions, the shiro structure of ≈1 L in volume can be provided in two years of incubation. Competition between *T. matsutake* genets on the root system of a host bring higher mycorrhization level, i.e., competitive activation, may be a key how we control this fungus for cultivation. Competitive activation of *T. matsutake* would also work by competing with *Suillus bovinus* on a pine host root system *in vitro*. The Japanese yellow chanterelle, *C. anzutake*, develops ectomycorrhizae on *P. densiflora* and *Quercus serrata* hosts and provides basidiomata within 1–2 years of incubation in potting soil. One of the strains, C-23, has been released with its complete genome data and has shown repeated fruiting on pine hosts. The single-spore isolates of this fungus, which show a bipolar mating system, provide evidence of a quantitative effect on ectomycorrhizal growth based on their genetic background. Therefore, crosses are desirable to advance the practical cultivation of this fungus.

PRESENT AND FUTURE CHALLENGES FOR BLACK TRUFFLE CULTIVATION

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Key words: *Tuber melanosporum*, orchard management, *Leiodes*, truffle nests, weed management

Modern cultivation of the black truffle (*Tuber melanosporum*) began in the early 1970s. In these 50 years of history, the perfect synergy between applied and basic science together with the practical experimentation of producers, has led to establishing crop standards: seedling quality, edaphoclimatic conditions of the site and adequate management both in establishment and production phases in the field. In this way, the black truffle is successfully cultivated within the species´ natural distribution area in southern Europe and has spread throughout the world. However, the future sustainability of truffle production will depend on facing new challenges in the coming decades: Quality, effects of climate change and pests. Quantity of yield has been the goal for many years but today our efforts must go towards increasing quality, in a “field to fork” strategy. All pre- and post-harvest techniques and technologies must be validated and refined within this new framework. Global warming is causing a loss of yield in traditional production areas, which cannot be completely solved with irrigation strategies. It is necessary to save the water itself, as a resource, so it is possible that the actual irrigation frequencies and doses can no longer be maintained. The last threat, pests like the truffle beetle, is punishing the most successful growing areas. There is still a lot of work to do.

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UNRAVELLING BIOLOGICAL AND ENVIRONMENTAL FACTORS FOR DESERT TRUFFLE SUSTAINABLE CULTIVATION

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Key words: Desert truffle, *Terfezia claveryi*, turmiculture, drought, bacteria

Desert truffles are hypogeous edible fungi mostly harvested in wild arid and semirarid areas for hundreds of years. Land-use changes coupled with shifts in precipitation patterns have led to a decline in their wild production. Due to their high nutritional value, domestication efforts began more than 20 years ago. Most efforts started primarily with *Terfezia claveryi*, an ascomycete that establishes ectendomycorrhizae with Cistaceae species. The present work analyses how symbiosis and fruiting are affected by abiotic factors, including drought and high CO_2, and biological factors, such as soil fungal diversity, bacterial traits associated with the symbiosis and fungal heterothallism. Regarding abiotic factors, our results show that the aridity index and soil water potential are the agroclimatic parameters that mostly influence the annual truffle yield. Moreover, high CO_2 concentrations help mycorrhizal plants to cope with the adverse effects of progressive drought during Mediterranean springs by improving net carbon assimilation, intrinsic water use efficiency and species dispersal through increased flowering events. Concerning biotic factors, desert truffle productivity was driven by different patterns of fungal species composition in soil and roots. Productive roots were positively associated with ectomycorrhizal and negatively to arbuscular mycorrhizal guilds, while non-productive roots were linked to fungal parasite-plant pathogens. The bacterial community associated with mycorrhizal plants showed a seasonal trend aligned with their PGPR traits, and P-solubilizing rhizobacteria were harboured in the mycorrhizosphere during truffle fruiting. Finally, we have revealed that *T. claveryi* is a heterothallic species, a crucial input for designing new cultivation strategies.

SOIL FUNGAL COMMUNITY COMPOSITION AND *Tuber melanosporum* MYCORRHIZA ABUNDANCE UNDER PRODUCTIVE AND NOT PRODUCTIVE TREES OF *Quercus* spp. IN ARGENTINA

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Key words: *Quercus robur*, *Q. ilex*, slope, fungal contaminants, ITS metabarcoding

The edible ectomycorrhizal fungus Périgord black truffle (*Tuber melanosporum* Vittad.) is a highly priced non-wood forest product. In Argentina its production relies on *Quercus ilex* and *Q. robur* plantations where it is common to have productive and non-productive trees in the same orchard. We studied the relation of *T. melanosporum* mycorrhization with host, productive - non productive condition and slope in a 20 years orchard. *Tuber melanosporum* mycorrhization was evaluated by morphotyping and sequencing of root tips while the soil fungal communities were characterized by means of ITS metabarcoding. We found a higher mycorrhization level in *Q. robur* than in *Q. ilex* roots, where a high relative abundance of non-*T. melanosporum* EcM fungi was observed. High slope and non productive trees were associated with low percentage of root mycorrhization. Based on a high-throughput sequencing approach, soil fungal community showed a predominance of members of the phylum Ascomycota. *Tuber melanosporum* was the main species, except for *Q. ilex* in medium slope soil,, where *Peziza* spp. were more abundant. Host species was the strongest driver of fungal community structure and composition, while slope status was the weakest. The diversity patterns inferred through the metabarcoding analysis were not concordant with those obtained through morphotyping for productive and non productive status, being the latter more accurate. Twenty years after establishment, no signs of loss of *T. melanosporum* were observed in soil, indicating that *T. melanosporum* can colonize and dominate the surrounding soil in mature *Quercus* plantation even if the production of truffles is low. Further investigations should be carried out to determine whether truffle mycelium growth and mating types presence and distribution in the soil may affect orchard productivity.

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THE EFFECT OF BACTERIAL INOCULATION ON *Tuber melanosporum* Vittad. ROOT COLONIZATION AND *Quercus ilex* SEEDLING GROWTH

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Key words: Bacteria, *Tuber melanosporum, Bradyrhizobium, Pseudomonas, Quercus ilex,* mycorrhization

Tuber melanosporum is an ascomycete that forms ectomycorrhizal (ECM) symbioses with a wide range of host plants, producing edible fruiting bodies with high economic value. The quality of seedlings in the early symbiotic stage is essential for successful truffle cultivation. Numerous bacterial species have been reported to take part in the truffle biological cycle and influence the establishment of root symbiosis in plant hosts and the development of the carpophore. In the present study, we report the experimentation carried out on *Quercus ilex* seedlings mycorrhized with *T. melanosporum* and inoculated with selected bacterial species, to evaluate the effects of bacteria to stimulate *T. melanosporum* root colonization and growth of young seedlings of *Quercus ilex*. *Tuber melanosporum* colonization was assessed using morphological and molecular methods. Shoot growth and root parameters were analyzed. In the early stages of ectomycorrhizal symbiosis on roots, the results showed a higher ECM colonization in the proximal section (closer to the collar) of the roots apparatus than in the distal one. Moreover, a significant effect was observed on roots co-inoculated with *Pseudomonas* spp., increasing the truffle inoculation rates of root tips by more than 5% compared with seedlings that were untreated. Our work suggests that the role of bacteria in the early symbiotic stages of ECM colonization involves both the mycorrhizal symbiosis rate and plant root development processes, both essential for improving the quality of truffle-inoculated seedlings produced in commercial nurseries.

CULTIVATION STATUS AND CHALLENGES OF TRUFFLES AND OTHER HIGH VALUE EDIBLE FUNGI IN PANZHIHUA, SICHUAN

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Key words: Cultivation, truffle, host plant, *Tuber panzhihuanense*, yields, *Phlebopus roseus*

Panzhihua's climatic conditions and vast forest resources gave rise to diverse and unique wild edible fungi that provided germplasms for domestication. Truffle cultivation in China is recent, although natural truffle areas are discovered every year. Due to unscientific practices, truffle habitats have been damaged, and production has declined sharply. We researched tree species and established ecological reserves in dry, hot valleys. Soil modification, mulching, spore traps, biological control of underground pests and rodent damage control have improved truffle yields on 5 different host plants, *Corylus heterophylla*, *Castanea mollissima*, *Carya illinoinensis*, *Pinus armandii*, *Quercus aliena* in 5 plantations with different soils, altitudes, and climatic conditions. The Gesala plantation has been producing truffles for 5 consecutive years. The maximum yield per tree was 2136.4 g, the largest truffle was 650 g, 73.1% of the trees were damaged by rats, 38.6% produced truffles and 1.9% did not. The most expensive Chinese white truffle, *Tuber panzhihuanense*, was cultivated for the first time. Current challenges of truffle cultivation include preventing mice from harming truffières, stabilizing truffle yields, and harvesting truffles efficiently. We also discovered *Phlebopus roseus*, an edible mushroom found only in a narrow area of Panzhihua, 24 hectares of abandoned loquat fields. The yield is low, about 20-150 kg/yr. Like *Phlebopus portentosus*, *Phlebopus roseus* associates with scale insects and plant roots. Collecting strains and screening substrates laid the foundation for its cultivation research. The results demonstrate that research on cultivation and harvesting can contribute to developing fungal resources sustainably while protecting their environment.

EFFECT OF *Tuber borchii* INOCULATION ON STONE PINE (*Pinus pinea* L.) GROWTH, BY ANALYZING THREE CONSECUTIVE YEARS OF PLANT ESTABLISHMENT

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Key words: Mycorrhization, stone pine, Borch truffle, plantation establishment, plantation growth, truffle, pine nut co-production

Stone pine, *Pinus pinea* L., is a characteristic tree species of Mediterranean areas. It is one of the most important nut species worldwide. In Chile it shows vigorous growth and high fruiting, making it an interesting and emerging crop. *Tuber borchii*, called Bianchetto, is a mycorrhizal Ascomycete that produces edible truffles. It is becoming increasingly renowned on the market and it is adaptable to different environmental conditions and possible to cultivate it. This mycorrhiza has symbiotic root association with stone pine. The aim of this paper is to analyze the impact of inoculated plants and of the interaction of the inoculation with environmental effects related to spatial variability and inter annual variability on stone pine growth. A multi-environment trial (MET), involving three sites, was established in Chile. The trial was repeated in three consecutive years, and was annually monitored for growth, vigor and health, and evaluated for mycorrhization level. Significant differences were found for height, RCD, crown diameter and vigor in relation to the plantation site and year, inoculation and their interaction. Plant survival was affected by the environment but not by inoculation. We found a significant negative correlation between growth and maximum temperature, spring hydric index and potential evapotranspiration. Root mycorrhization with *T. borchii* was high in all sites and in all plantation years without statistical differences among them. *Tuber borchii* quantity was positively correlated with mean temperature. Our results suggest the feasibility of co-production of Bianchetto truffle and pine nuts in different environments of Chile.

EFFECTS OF FUEL REDUCTION TREATMENTS ON THE SPOROCARP PRODUCTION AND RICHNESS OF A *Quercus/Cistus* MIXED SYSTEM

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Key words: Wildfires, forest management, fungal production and richness, *Boletus*, non-wood forest products

Wildfire is a recurrent factor that shapes and influences Mediterranean ecosystems where mixed oak (*Quercus*) forests with a rockrose (*Cistus*) understory are broadly represented. These ecosystems are also associated with large and diverse fungal communities. These fungal communities play essential ecological roles and provide a source of income. Fuel reduction treatments are applied to reduce the risk of wildfire; however, their potential impact on fungal communities is unclear. Thus, the aim of this work was to investigate the effect of different fuel reduction treatments on fungi associated with *Quercus* and *Cistus*. Sporocarps were sampled over a five-year period in stands dominated by mature or coppiced *Quercus pyrenaica* and accompanied by *Cistus ladanifer* understory. These stands had been subjected to different fuel reduction treatment levels involving moderate- or high-intensity thinning, for *Q. pyrenaica*, or clearing, for *C. ladanifer*. The goal was to determine sporocarp production, species richness, and taxonomic composition. Sporocarp production and fungal richness were drastically affected by the fuel reduction treatments but only when *C. ladanifer* was included in the treatment. Taxa composition was strongly correlated with the treatments applied to the rockrose understory. This was probably due to the large range of associated ectomycorrhizal fungi of *C. ladanifer* and their high capacity to recolonize an area after disturbances. Based on our results, we conclude that the implementation of moderate-/high-intensity fuel reduction treatments is compatible with the conservation of the fungal community present in these systems.

TREE RETENTION TO CONSERVE EDIBLE SPOROCARPS IN SHORT-ROTATION PLANTATIONS OF ETHIOPIA

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Key words: Edible fungi, conservation, edaphic variables, fungal community, *Pinus radiata*

This research was conducted within short-rotation *Pinus radiata* (Don) plantations located in Ethiopia. Weekly collections of sporocarps were carried out in plots (100 m²) situated in young, medium-aged, and mature *P. radiata* stands. The fungal richness, diversity, and sporocarp yields were estimated from each stand. Additionally, composite soil samples were collected from each plot to identify significant edaphic variables explaining taxa composition. A total of 92 fungal taxa (26% were edible) were identified across the entire stands, with 8% categorized as ectomycorrhizal. Taxa richness and diversity were notably higher in mature stands. Sporocarp yield displayed an increasing trend towards mature stands. Organic matter and carbon-to-nitrogen ratio significantly influenced fungal composition and sporocarp production. Thus, the intentional preservation of mature trees in patch formations, rather than clear-felling of the plantations, could prove beneficial in conserving and enhancing fungal diversity and production, particularly of valuable taxa like *Morchella*, *Suillus*, and *Tylopilus* in older stands. This approach has important implications for forest floor microhabitats, which are important for macrofungal occurrence and production. Thus, this strategy could improve the economic outputs of these plantations in the Afromontane Region, while the mature trees could serve as a bridge for providing fungal inocula to the new plantations.

MAPPING OF AREAS SUITABLE FOR BLACK TRUFFLE FARMING IN PATAGONIA, ARGENTINA

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Key words: *Tuber melanosporum*, potential trufficulture, maps, Chubut province, regional scale

Black truffle production is an intensive crop introduced a decade ago in Argentina, principally in Buenos Aires province and Patagonia, with some pioneer, small and disperse experiences in the latter. Truffle farming requires site selection regarding climatic and edaphic features, along with irrigation planning, mainly in areas with low summer precipitation as Patagonia. In this sense, Patagonia Argentina have 1,060,631 km^2 with huge climate gradients and the abundant presence of microclimate spots including temperate to cold, cold humid, semi-arid and desert climates. The presence of diverse vegetation as native, subantarctic forests, ecotonal areas to the east and costal steppes or scrubland in Eastern Patagonia, determines a wide range of soil types, that suppose the presence of wide areas suitable for black truffle requirements. In this context, the promotion of trufficulture as a profitable, against season crop for marginal and idle land in this region, requires accurate identification and quantification of suitable areas on a regional scale. For this reason, two truffle aptitude maps considering edaphic, climatic and irrigation requirements were developed for Patagonia Argentina, a regional map (scale 1: 10,000,000), and another for Chubut province (scale 1: 40,000) with field ground truth points. The potential truffle growing area with appropriate soil and climatic conditions and considering irrigation is 2,680,000ha, while in Chubut totals 489,877ha, both maps including microclimatic spots. These maps are pioneering for Argentina and Patagonia, constitute a powerful decision-making tool to diversify the productive matrix in Patagonia incorporating this novel a profitable crop in vast areas.

VOLATILOME STUDY OF CULTIVATE BLACK TRUFFLE (*Tuber melanosporum*) TO DISTINGUISH GEOGRAPHICAL ORIGIN

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Key words: Aroma, olfactometry, *Tuber melanosporum*, geographical origin, traceability

Truffles are worldwide-appreciated hypogeous fungi due to their distinctive aroma. They contain more than 200 volatile molecules, including sulfur compounds (dimethyl-sulfide (DMS) and dimethyl-disulfide (DMDS)), alcohols (1-octen-3-ol and 2-methyl-1-propanol), and other important compounds such as 3-octanone, 1-octen-3-one, and 3-methylbutanal. The variability of these molecules, and consequently their impact on aroma, can be influenced by a range of factors including climatic conditions, host tree, cultivation practices, soil microbiome, and others. In this study, a total of 33 black truffles (*Tuber melanosporum*) from Spain (8 locations), France, and Italy were collected and immediately cleaned and cooled (4 °C). Twenty-four hours after harvesting, volatile organic compounds (VOCs) from the truffles were extracted using solid-phase microextraction (SPME) and analyzed by gas chromatography-olfactometry (GC-O). The analysis was conducted by five judges, with each sample analyzed in triplicate. The overall results revealed slight differences based on geographical origin. Over 20 VOCs were identified, with DMS (truffle odor), DMDS (dark chocolate odor), 2,3-butanedione (buttery odor), methyl 2-methylbutanoate (apple odor), and ethyl-2-methylbutanoate (strawberry odor) being the most prevalent across all origins. Truffles from Spain exhibited a higher modified frequency of key truffle compounds, especially DMS and DMDS, compared to France and Italy. Few differences were found among Spanish locations, although gas chromatography-mass spectrometry (GC-MS) would be necessary to detect greater variations. GC-O, recognized as a valuable tool for discerning postharvest treatments applied to truffles, could also be employed to differentiate geographical origins. Consequently, it could allow for the characterization of the aromatic profile of each productive region.

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INFLUENCE OF DIFFERENT IRRIGATION SYSTEMS ON BLACK TRUFFLE YIELDS

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Key words: Micro-sprinkler irrigation, drip irrigation system, *Tuber melanosporum*, truffle harvesting, truffle crops

The black truffle (*Tuber melanosporum* Vittad.) is a highly economically important fungus due to its gastronomic value. Its cultivation, usually associated with holm oaks (*Quercus ilex*), depends on the availability of water. Therefore, implementing an irrigation system that optimizes the amount of water applied with no losses is essential to ensure the profitability of production. In this study, it was proposed to compare the efficiency of two irrigation systems, drip and micro-sprinkler, in terms of production, diversity, number of truffles and quality (according to truffle size). This study was carried out in a plantation established in 2013 located in Burgos, northern Spain. There were no differences between the different irrigation systems in these parameters. However, drip irrigation presents less water losses than micro-sprinkler irrigation, which makes it a more suitable system both economically and environmentally, in addition to facilitating land management. For the first time, this study validates the use of drip irrigation in truffle plantations, with a lower water consumption, in a scenario of global warming where the amount of water resources can be limited by droughts.

WILD TRUFFLES AND DESERT TRUFFLES IN MOROCCO: GEOGRAPHICAL DISTRIBUTION, SOIL CHARACTERISTICS AND ECOLOGY

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Key words: Truffles, desert truffles, soil properties, climate, vegetation, geographic distribution, Morocco

The climate, soil, and vegetation conditions have an impact on the distribution and abundance of the different truffle species. The cultivation of the promising species requires the establishing of these features. Here, we discuss the ecological traits of Moroccan truffles and desert truffles as well as their relationships with host plants. We also analyze the climate and soil characteristics to better understand the geographic distribution and fructification of truffles and desert truffles in Morocco. Desert truffles are found in semi-arid and arid regions of Morocco, as opposed to truffles, which are found in sub-humid settings. *Helianthemum* species are frequently associated with the spread of desert truffles in Mamora forest and eastern regions of Morocco, although *Quercus ilex* and *Q. faginea* are necessary for the survival of truffles (*Tuber* spp.) in the Middle Atlas. The fructification of truffles and desert truffles is primarily dependent on the frequency of precipitation. The two main desert truffles of Mamora forests, *Terfezia arenaria* and *Tuber oligospermum*, need an average of 435 mm of rain annually and a slightly acidic soil. While *Terfezia boudieri*, *T. claveryi*, and *Tirmania* spp., which are found in the oriental and Highland deserts, require a high $CaCO_3$ content and an average annual precipitation of 123 to 267 mm. As an alternative, there is *Tuber aestivum*, which is only found in humid areas with rainfall rates of more than 650 mm. It grows in calcareous soil that is rich in organic matter and is surrounded by possible host plants like oaks, cedars, and pines. Our findings suggest that by comprehending the biological requirements of desert truffles in Morocco, it may be possible to successfully cultivate truffles and create a market for them.

MONITORING OF NATURAL TRUFFLES SITES IN UMBRIA REGION (ITALY) AND IDENTIFICATION OF MANAGEMENT STRATEGIES

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Key words: Natural truffles sites, *Tuber magnatum* Picco, *Tuber melanosporum* Vittad., monitoring, management strategies

In Italy there is a severe decrease in the natural production of precious truffles, with serious socio-economic and environmental consequences. Natural truffles diffusion suffered negatively from excessive exploitation of production sites, climate change and poor/no hydraulic-forestry management. In order to face this worrying decline and to conserve the local truffle biodiversity, a careful management of the natural production sites is necessary, with practices capable of encouraging, increasing and safeguarding the truffle resource. For this purpose, the University of Perugia together with the CNR - Institute of Biosciences and Bioresources (IBBR) of Perugia are conducting a monitoring and are developing experimental strategies on some study areas of natural truffles in the Umbria region. Two of these, are suited to the production of *Tuber magnatum* Picco, while the other two are suited to the production of *Tuber melanosporum* Vittad. Project activities include a preliminary analysis and monitoring of environmental parameters (such as rainfall, temperature and humidity), an identification and monitoring of host plants and a management of plant and soil cover. Thanks to the qualitative-quantitative analysis of the truffle mycelium present in the soil, it is possible to monitor the current state of the truffle sites and evaluate the effect of the management practices. The goal of this monitoring is the development of a model for the recovery, improvement and sustainable management of these study areas, to the benefit of the regional truffle heritage.

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CANKER DISEASE IN A PATAGONIAN TRUFFLE ORCHARD

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Key words: fungal pathogen, *Tuber*, *Quercus*, *Diaporthe*, *Paraconiothyrium*

Truffle orchards are relatively new in Patagonia. Monitoring is esential to detect emerging sanitary issues. Canker symptoms were observed in a truffle orchard in Rio Negro Province. A survey was conducted in November 2023 to estimate incidence, severity and the etiology of the disease. Trees (N=231) were assesed regarding total height, DBH, presence/absence of cankers and a visual estimation of severity. Isolates from affected tissue were grouped in 10 morphotypes characterized with molecular methods (ITS region). Overall incidence was above 60% and severity was 38% (±28) on average. Seven taxa were identified: 5 are considered saprobes and the other 2 were identified as *Diaporthe araucanorum* and *Paraconiothyrium hekeae*. These were selected for further phylogenetic analysis and preliminary pathogenicity trials. *Diaporthe araucanorum* was described causing foliar discoloration and necrosis on *Araucaria araucana*. This species is related to other pathogenic species associated to native hosts. This results could indicate that a local *Diaporthe* species has jumped from *Araucaria* or, more likely from *Drymis* or *Aristotelia*, to *Quercus*. *Paraconiothyrium hakeae* was described from *Hakea* sp. (Proteaceae) in Australia. The ecology of this species is not fully understood. Pathogenity trials will hopefully confirm the causal agent and further molecular characterization will clarify its identity. Besides correct pruning practices (time of the year, tool disinfection, affected tissue disposal, control of open wounds using BioACT®) management and control teqniques will vary considerably if the pathogen is present in local sorrounding forests or if it was introduced with the planting material.

NATURAL ENVIRONMENTS WHERE THE EDIBLE WILD MUSHROOM *Morchella* FRUCTIFIES IN CENTRAL-SOUTHERN CHILE

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Key words: Forest fire, morel, *Nothofagus*, pine plantations, soil properties

The genus *Morchella* includes edible mushrooms of high commercial value that are mainly obtained by wild collection, as their artificial cultivation is complex and unpredictable. Morels (common name) have been identified in a variety of environments, including those with significant levels of disturbance, but the factors that trigger their fruiting in these natural environments are not fully understood. Therefore, the objective of this study was to characterize the habitats of *Morchella* spp. in an area that includes the regions of Ñuble, Biobío and La Araucanía in central-southern Chile, where commercial forest plantations dominate. In 2023, four natural morel sites were selected with different levels of disturbance (burned and harvested forest plantations and native forest) and soil origin (volcanic and granitic). Control sites were defined adjacent to the study sites, but without morel fruiting. All sites were evaluated for edaphic properties (chemical and physical), dominant vegetation, and climatic conditions. Morel showed abundant fruiting in pine plantations affected by recent fires and logging, higher than that observed in native forest dominated by *Nothofagus* spp.. Preliminary results indicate that factors such as rainfall may affect the fruiting, and variables such as pH and organic matter may differ between soils with and without morels. Statistical analyses will be conducted to establish relationships between morel presence/absence and various edaphic, vegetation, and climatic habitat variables. These results are expected to provide relevant information on the ecology of *Morchella* in its natural environment, providing information for its conservation and responsible use of the resource and its habitat.

INTERCROPPING OF AROMATIC PLANTS IN TRUFFLE ORCHARDS: SHORT-TERM EFFECT ON EXTRARADICAL TRUFFLE MYCELIUM AND AROMATIC PLANT GROWTH

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Key words: Edible mushrooms, mycorrhizal fungi, aromatic plants, *Tuber melanosporum*, truffle cultivation

Intercropping of truffle-producing trees with aromatic plants is used to improve profitability of truffle orchards during the initial 4–7 years. However, after that period the viability of this system is challenged by the appearance of brûlés, an area around host tree characterised by scarce plant cover where the fungus exhibits allelopathic activity. We aimed to investigate the ecological interactions between both crops (aromatic plant-host tree) and between their associated mycorrhizal fungi in adult truffle plantations. In this study, we simulated two intercropping systems: truffle oak – lavender and truffle oak – rosemary in their adult stage. We analysed and compared aromatic plants and soil samples inside and outside the brûlés during the first year of aromatic plants development in the field. A strong negative relation of brûlés with the growth of the aromatic plants was found, although not a decrease in the arbuscular mycorrhizal colonization of their roots. The essential oil yield and composition of aromatic plants was affected by brûlés. The extraradical truffle mycelium was not significantly affected by the presence of aromatic plants. In conclusion, the growth and yield of aromatic plants were impaired during their first year growing in brûlés, whereas no negative effect of aromatic plants on truffle fruiting potential was found. The study improves our understanding of the mechanisms influencing the viability of the truffle tree – aromatic plant intercropping and the possible technical challenges.

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HARNESSING THE HIDDEN POTENTIAL OF ETHIOPIAN FORESTS FOR EDIBLE MUSHROOMS: NEW INSIGHT FOR MYCOSILVICULTURE BASED-FOREST MANAGEMENT

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Key words: Edible mushrooms, non-timber forest products, climate-smart forestry, Ethiopian forests

Despite the recognized importance of mushrooms in maintaining ecological balance and a substantial supplementary source of income for local communities, the prospects of mushrooms in Ethiopian forests are not well understood. Our study aimed to elucidate the practices and prospects of edible mushrooms and identify the factors influencing mushrooms production. Specifically, the study sought to (i) assess the potential for edible mushroom production in Ethiopian forests, and (ii) uncover the biotic and environmental factors driving mushroom production as subsistence forest ecosystem services. Our research employs ecological sampling across wider spatial scales, including sporocarp sampling and edible fungi community analysis. The findings from the study revealed a substantial contribution of Ethiopian forests to edible mushrooms (n = 64 mushroom species) in terms of species richness. The average annual total fresh weight production was estimated to be 2097.57 kg ha^{-1} in plantation forests and 731.18 kg ha^{-1} in natural forests. Spatial factors like latitude, soil organic matter, and minimum daily temperature were identified as relevant explanatory factors. Our results provide additional insight into mushrooms' responses to environmental factors and allow for better decision-making related to forest management in the face of climate change. Furthermore, area-specific information on edible mushrooms in Ethiopian forests should serve as a basis for further studies in Ethiopian forests to optimize forest management based on non-timber forest products and help to understand what actions are needed to manage the forest landscape level.

PRECISION SOIL MAP OF A WHITE TRUFFLE (*Tuber magnatum*) PRODUCING FOREST IN HUNGARY

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Key words: *Tuber magnatum*, soil map, soil classification, Hungary, white truffle

In our study, we have produced a precision soil map of one of the best white truffle (*Tuber magnatum*) producing forest in Hungary and characterise the soils of the truffle-growing areas in the forest. The white truffle is the most valuable and rarest truffle with a narrow geographical distribution, limited to the Balkan and Apennine peninsulas. The southern counties of Hungary are the northernmost known major production areas of this species. A detailed survey of Istrian truffle-producing areas in the region has not yet been carried out. The soil of the known growing areas in Italy are calcareous from the surface and have high pH values (pH 7.8-8), but in the Western Balkans and Hungary many production areas, including the present study area, have typically low in lime topsoils with lower pH values (pH 6.5-7.5). We conclude that in forest we have multiple soil classes that belong to *Luvisol* and *Gleysol* and different texture loose sediments as parent material classes. WRB classification does not distinguish the well producing soils, but the differences can be described by specifiers (epi-, endo-), and qualifiers. We have recorded the sites of occurrence *T. magnatum* on GPS. To compare the data with the soil map, our result shows that the calcareous horizon in the productive areas is at shallower depth the soil profiles (0-50 cm) than in the non-productive parts, and that groundwater level was closer to the surface - 60-80 cm deep - in the productive areas than in the non-productive parts.

I'M RETIRED. PORCINI IS NOT - PROGRESS OF GROWING *Boletus edulis*

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Key words: Porcini, Oak, Chestnut, mother plant technique, cultivation, New Zealand

Boletus edulis was introduced from Europe to New Zeland by British immigrants. Successful cultivation of this wonderful mushroom is a dream for mushroom lovers. Research on porcini has been carried out in New Zealand since 1990s. Several trials have been setup in the the field. Pine and oak seedlings mycorrhized by porcini using the Mother plant method were used to establish experimental plots in 2012. No mushrooms have been produced from the plots so far. Six experimental plots of field inoculation of established trees with porcini spores suspension have been set up in 2003. The inoculated trees were 2-yr-old seedlings of pine, oak, silver birch and chestnut, and 20-yr-old chestnut trees. I retired from Plant and Food Research in 2015. However, the six plots are not retired and have been well looked after by our mother nature since. A few porcini were produced fron the inoculated chestnut trees at the plot #4 in 2021 and the following years. The plot #4 is located behind a parking compound wall and surrounded by big oak trees. This microenvironment and climate may provide suitable growing conditions for porcini in the dry and windy Canterbury region of New Zealand.

EXPLORING THE BIOACTIVE POTENTIAL OF MUSHROOMS: MODERN ANALYSIS TECHNIQUES AND APPLICATIONS

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Key words: Mushrooms, bioactive compounds, hypogeus fungi, extraction methods, instrumental analysis

Mushrooms have been widely used by our ancestors. The first gastronomic evidence dates to 18.700 years ago (“El Mirón” cave, Spain). Subsequently, 5.300 years ago, Ötzi the Iceman (Ötztal Alps, Italy) carried *Fomitopsis botulin* possibly for medicinal purposes, followed by the Maya used genera *Psilocybe* and *Strofaria* in their rituals, calling them "teonanacalt" or "flesh of God". However, the most mycophilic cultures located in the East Asia are the ones that have progressed the most in the medicinal use of mushrooms, attributing them anti-inflammatory, antimicrobial, or immunomodulatory properties, among others. Today, the Species Fungorum lists about 34.000 species with gastronomic, technological, and/or medicinal properties, of which 14.000 are macrofungi. Bioactive compounds are molecules found in natural products that have the potential to positively impact our health, which in mushrooms are primarily attributed to β-glucans, chitins, phenolic compounds, organic acids, and sterols. In this regard, it has been a growing research interest evidenced by the publication of 1317 articles in the last decade. The use of new extraction technologies, such as supercritical fluids, pressurized liquids, ultrasounds, or microwaves, along with novel chromatographic and spectrometric analysis techniques, has deepened the knowledge of the bioactive properties of mushrooms. In contrast to epigeous fungi, hypogeous fungi have traditionally been valued just for their culinary potential. However, the implementation of these new technologies has succeeded in revaluing them for their bioactive potential as well. This advancement has sparked the interest of the functional foods and pharmaceutical industry, which, until now, had developed its drugs from microfungi.

VOLATILE COMPOUND ANALYSIS OF DIVERSE NORTH AMERICAN TRUFFLE SPECIES

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Truffle fungi fruit belowground and have evolved independently across most major lineages of fleshy fungi. North America has many endemic species of truffles. Of these, species of *Tuber*, *Leucangium* and *Kalapuya* are harvested from the wild and sold through regional brokers and cottage industries. Their market price is largely the result of their unique aroma, perishability and limited seasonal supply. Despite this, there remains a gap in fundamental knowledge about the volatile compounds produced by North American truffles, and how they vary and compare to each other or other truffle species. To address this, we sought to assess the volatile profile of diverse species of fresh truffles through head-space solid phase microextraction sampling technique coupled with gas chromatography and mass-spectrometry. Starting in 2023, fresh North America truffles were harvested from the wild with the assistance of truffle dogs, including species of *Tuber*, *Genea*, *Leucangium*, *Pachyphlodes*, *Imaia*, *Choiromyces*, *Fischerula*, *Kalapuya*, *Hymenogaster*, *Melanogaster*, and *Russula*. Truffles were cleansed of soil and kept cool prior to analyzing their volatiles, within one week of sampling. They were then identified based on morphology, ITS rDNA sequencing and phylogenetic analysis. A glimpse of this research, these truffles, and preliminary results will be presented, including variation of volatile compounds detected between truffle collections, species, and genera.

WILD ECTOMYCORRHIZAL MUSHROOMS FROM PATAGONIA AS AN EDIBLE RESOURCE: NUTRITIONAL COMPOSITION, ANTIOXIDANT CAPACITY AND ANTIMICROBIAL ACTIVITY

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Key words: Bioactivity, non-timber forest products, *Nothofagus*, *Pinus*

The *Nothofagus* spp. forests and *Pinus* plantations of the Andean Patagonian region are home to numerous species of wild edible mushrooms (WEM) that constitute an abundant non-timber forest product. Main ectomycorrhizal mushrooms with consumption records are *Cortinarius magellanicus*, *C. xiphidipus*, *Lactarius deliciosus*, *Ramaria botrytis*, *R. patagonica*, *Rhizopogon roseolus*, *Suillus lakei,* and *S. luteus*. Its culinary and commercial value is mainly due to its organoleptic properties, nutritional and medicinal qualities. The sporomes were extracted to analyze the proximal composition according to AOAC methods. Fatty acids, sugars, organic acids and phenolic compounds were identified and quantified by chromatography. Antioxidant activity was evaluated from TBARS and OxHLIA assays. The extracts were tested against eight bacteria and two fungus to check the antimicrobial power. The highest value of fat was observed in *C. magellanicus* (4.40 g/100 g dw), while protein and carbohydrates were detected in *R. patagonica*. Due to the high contribution of linoleic acid, PUFAs were the main group of fatty acids in *S. lakei* (45.29%), *S. luteus* (45.95%) and *C. xiphidipus* (43.00%), MUFAs were the main group in *R. botrytis* (43.91%) and *R. patagonica* (39.37%), (with high levels of oleic acid). High amounts of oxalic and citric acid were also detected in all samples. The most effective extracts regarding the TBARS antioxidant capacity were those of *Ramaria*. Extracts from *R. botrytis* (MIC 0.3 mg/mL and MIC 1.25 mg/mL) exhibited a good inhibitory activity against *Staphylococcus aureus* and *Yersinia enterocolitica*, respectively. These studies demonstrated the importance of these WEM species, resulting in an invaluable source of food and bioactive compounds.

ARE THE SPECIES OF *Amanita* PRESENT IN ARGENTINIAN PATAGONIA TOXIC?

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Key words: Chemometrics, HPLC/MS, secondary metabolites, *Nothofagus*, *Pinus*

The genus *Amanita* contains more than 800 species, some of which are appreciated for culinary purposes (e.g., *A. caesareoides*), while others are highly toxic and can cause severe illness or even death if ingested (e.g., *A. phalloides*), and are responsible for approximately 95% of fatalities resulting from mushroom poisoning. At least 10 native species have been described in the forests of Argentinian Patagonia, but to this date, there are no reports of toxicity or edibility associated with them. There are also reports of the invasive species *A. muscaria*, toxic and allucinogenic, introduced with *Pinus* plantations. The aim of this work was to make an initial assessment of the species found in Patagonia by evaluating the presence of known toxins, such as ama-, phallo- and virotoxins, and other bioactive compounds. For this purpose, *Amanita* spp. basidiomes were collected in *Nothofagus* and *Pinus* forests, located between the cities of Bariloche (Río Negro) and Esquel (Chubut). A total of 25 basidiocarps were obtained, with 20 belonging to at least three different native species and 5 to *A. muscaria*. The samples were processed using organic solvents, and the resulting crude extracts are currently undergoing analysis via HPLC/MS. These results will be utilized for a chemotaxonomic analysis, which will be correlated with a phylogenetic study in the future. Preliminary examination of the results showed the absence of known toxins in some of the native *Amanita* species.

Ramaria patagonica: POST-HARVEST CONSERVATION OF AN ENDEMIC MUSHROOM OF GASTRONOMIC AND CULTURAL INTEREST

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Key words: Edible mushroom, changle, drying, antioxidant activity, total phenol compounds

Ramaria patagonica (Gomphales) known as “changle” is an endemic edible fungus from Patagonia, associated with Nothofagaceae, fruiting exclusively in autumn. Recent studies have demonstrated that this species has low fat content and high levels of proteins and carbohydrates. Moreover, it is rich in phenolic compounds, exhibits excellent antioxidant activity and is characterized by a sweet and pleasant taste and a crunchy texture. It is harvested and consumed fresh or dried (sun-dried or over the embers of a fire) by native rural people of Patagonia, representing a Non-Timber Forest Product (NTFP) with significant socio-cultural value. Drying is a widely and commonly practiced preservation technique that is cost-effective. However, the drying process can impact on the levels of bioactive compounds. This study aimed to assess the effects of different drying methods on the total phenolic content (TPC) and antioxidant activity (AA) in the basidiomes of *R. patagonica*. The analysis included fresh-frozen, those dried at 50, 60, and 70°C, and freeze-dried samples. The TPC was significantly higher in fresh-frozen and those dried at 60°C (14.78 and 13.67 mg GAE/mg of extract, respectively). Additionally, fresh-freezing, freeze-drying, and the 60°C method exhibited the highest inhibition of free radicals. The AA and TPC were higher in fresh-frozen and freeze-dried samples. A drying temperature of 60°C is recommended, considering drying time and bioactivity. This information can be used to optimize postharvest preservation and maximize the potential applications of this mushroom.

EVALUATION OF THE TOXICITY OF *Gyromitra* sp. AND *Morchella* sp. THROUGH *Artemia salina* BIOASSAY

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Key words: Wild mushrooms, brine shrimp, food safe, lethal dose, lethal concentration

The popularity of consuming wild mushrooms has surged in recent years, but not all are edible. *Gyromitra* involves some highly poisonous species that have caused severe poisonings and even deaths, while *Morchella* sp. has scarce and contradictory reports on their toxicity. Therefore, conducting studies to know their toxicity is essential. *Artemia salina* is used in toxicity bioassays, including fungi toxins. The present study aimed to evaluate the toxicity of *Gyromitra* sp. and *Morchella* sp. on cysts and nauplii juvenile of the *A. salina*. Water extracts were prepared with dried and fresh mushrooms collected from the Patagonia region. Different concentrations of the extracts were assayed to test their toxicity. Potassium dichromate and artificial seawater were the positive and negative controls, respectively. Moreover, *Agaricus bisporus* was used as a toxic negative control. *Gyromitra* sp. and *Morchella* sp. did not show toxicity over nauplii shrimps in concentrations ≤1 and 15 mg/ml for water extract dried and fresh, respectively. In contrast, cysts' hatching ware inhibited for both mushrooms. Values of LC_{50} 318.76±57.33 µg/ml and 20.68±3.75 mg/ml were exhibited for water extract dried and fresh *Gyromitra* sp., respectively. *Morchella* sp. water extract dried and fresh displayed values of LC_{50} of 408.86±92.47 µg/ml and 22.34±3.80 mg/ml, respectively. The LC_{50} values were superior to those detected using a potassium dichromate pattern and similar at *A. bisporus*, in all cases. The results could indicate that the bioactive metabolite of the mushrooms studied has moderate toxicity on *A. salina* cysts, recommending a pretreatment for safe consumption.

IS *Ramaria patagonica* A SPECIES WITH ANTIBACTERIAL AND ANTIVIRAL ACTIVITY PROPERTIES?

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Key words: Bioactive compounds, secondary metabolites, edible mushrooms, Patagonia, cytotoxicity, diketopiperazines

The biochemical analyses of *Ramaria patagonica* have highlighted its potential as a functional food and a source of bioactive compounds. In this study, the antibacterial activity of *R. patagonica* extracts against 14 bacterial strains was evaluated by inoculating a known volume of culture medium supernatant into a medium containing each bacterium at a known concentration. Absorbance at 600 nm was measured using a microplate spectrophotometer at 0 and 24 hours at 31°C. The organic extract's cytotoxicity (CC_{50}) was estimated with different concentrations ranging from 300 to 0.9 µg/ml using the crystal violet technique. Additionally, the antiviral activity of the extract against herpes virus (HSV-1) and polio virus (PV-1) was evaluated using serial dilutions in the medium up to a concentration of 30 µg/ml. Vero cells were used and infected at a standard concentration of each virus (MOI = 0.01). At 48 hours post-infection, cytopathic effect was observed. Finally, the metabolic profile of the extract was analyzed using HPLC-MS. As a result, the bacteria showing the greatest growth inhibition were *Staphylococcus aureus*, *Bacillus subtilis*, and *B. sphaericus*. The compound also inhibited, to a lesser extent, the growth of the human pathogenic species *Salmonella enterica* and *Klebsiella pneumoniae*. The CC_{50} was found to be 51 µg/ml. The concentration used to estimate antiviral activity did not yield positive results. In the future, these concentrations could be increased, taking into account the obtained cytotoxicity value. The HPLC-MS revealed the presence of diketopiperazines, which have been reported as antibacterial and antiviral.

DEVELOPMENT OF A SMART PACKAGE FOR THE SHELF-LIFE EXTENSION OF BLACK TRUFFLE (*Tuber melanosporum*)

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Key words: Black truffle, gelatine, shelf-life, aroma, package, smart

Different technologies have been applied to extend the shelf-life of fresh truffles maintaining their freshness and characteristic aroma, such as modified atmosphere packaging or edible coatings. In this work, an edible smart package able to extend the shelf-life of black truffles and trap the aromas released by the truffle was evaluated. The smart package consisted of a gelatine hydrogel matrix covering the truffle that showed an extraordinarily high oxygen permeability, allowing enough gas exchange to avoid anaerobic conditions in the truffle. The shelf-life extension of the truffle stored in the smart package was assessed through physical properties, and microbiological analysis. The aromatic profile was evaluated for both the truffle and the gelatine hydrogel by gas chromatography-mass spectrometry and sensory analysis. Truffle preservation in smart packages was compared to that in macroperforated packages. The microbial growth in truffles stored in the smart package was reduced and aroma compounds were retained, compared to truffles packaged in macroperforated packages after 21 days. However, firmness loss at day 28 of truffles stored in smart packages was considered high, indicating a spoilage behaviour. The smart package trapped key aroma compounds from the fresh truffle and maintained good microbiological quality through storage (<4 log CFU·g^{-1} after 28 days). Thus, the estimated shelf-life of the truffles stored in the smart package was about 21 days, obtaining fresh truffles with high quality, and an edible gelatine hydrogel with truffle aroma that can be useful for culinary purposes.

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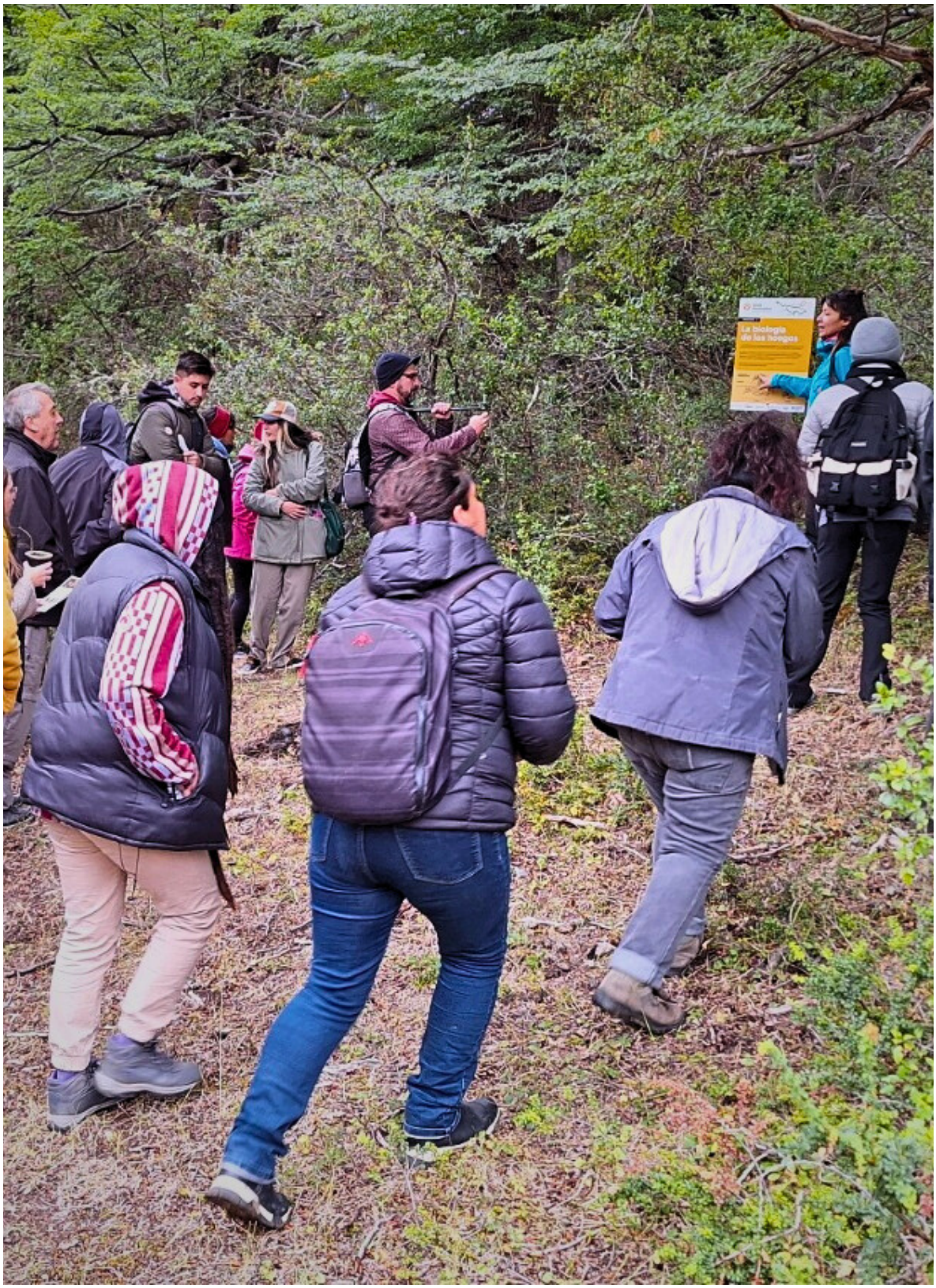
La biología de los hongos

BETWENN MATE, MEAT AND FOOTBALL: R&D WITH EDIBLE FUNGI IN THE PATAGONIAN ANDES OF ARGENTINA

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Key words: Wild edible mushrooms, mushroom cultivation, non-wood forest products, food sovereignty, *Nothofagus* forest, mycotourim, mycogastronomy

Wild edible fungi are a highly appreciated food in different parts of the world, but in Argentina they are still not widely consumed. Even if they are one of the most characteristic and diverse non-wood forest products from native and planted forest environments and grasslands in the Patagonian Andes. Through the technological and scientific platform “Patagonia Fungi, trails and tastes®”, we work to promote mycotourism and mycogastronomy as sustainable, identity and inclusive economic and educational activities that promote local development. Our main objectives are to define novel edible species and evaluate them for sustainable uses, including: environmental characterizations of their fruiting niches and ‘mycosilvicultural’ managements to increase their productivity; documentation and analysis of the ancestral uses and their processes of change; determination of the nutritional and nutraceutical profiles; studies of molecular genetic diversity; protocols for the domestication of wild species; evaluation and selection of lignocellulosic substrates for cultivation; economic aspects related to the marketing and use in local gastronomy; evaluation of postharvest preservation techniques; safe consumption and identification of toxic or edible species with prior treatment. Most relevant actions include the design and implementation of mycotourism trails, the promotion of an identity mycogastronomy; the inter-institutional management of protocols for sustainable harvesting and food safety practices; the incorporation of fungal species in the Argentinean Food Code; technical assistance to truffle orchards management. We also work for food sovereignty through a spawn production laboratory fostering edible and medicinal fungi cultivation through courses and assistance to producers.

PROTECTING AND VALORIZING WILD TRUFFLE ECOSYSTEMS WHILE SUSTAINING RURAL TOURISM ON THE TRATTURO: A CASE STUDY IN MOLISE REGION (ITALY)

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Key words: Truffle preservation strategy, local heritage valorisation, ecotourism, mycotourism, territorial natural resources, sheep trails

The development and the promotion of territorial products by territorial marketing strategies significantly increase the tourist, recreational and investment attractiveness, leading to improvements in socioeconomic aspects and local livelihoods. These products are often rooted in local culture, arts, and the environment. Currently, the landscape and natural resources play an important role in attracting tourists to rural areas, mainly if linked to gastronomy. Molise is a small region in Southern Italy, mainly affected by population ageing, outmigration, and a decreasing economy, deputed to rural and slow tourism for its natural attractions and preserved historical and cultural resources. One of this treasure is the presence of a total of seven well-conserved sheep trails, called tratturi and tratturelli, to which mushrooms and truffles are connected and contributes to local economy and culture. In this work we focus on the potentiality of tratturo valorisation in supporting a sustainable rural tourism development strategy linked to wild truffle and its preservation. A reproducible joint action involving 59 Municipalities and one Consortium has been funded and aims to co-create tratturo-related activities in these areas, such as myco- and truffle tourism (e.g. itineraries, paths, or guides to identify mushrooms) and various linked events like show-cookings and festivals. These activities, designed to identify mushrooms, truffles, and other local products, not only contribute to rural economies but also preserve cultural traditions. Moreover, the approach ensures immediate involvement of local inhabitants, emphasizing a possible consortium's role in truffle valorization that could be a driving force for the small local economies.

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DEVELOPMENT OF MYCOTOURISM AND MYCOGASTRONOMY IN MEXICO

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Key words: Forest conservation, rural development, edible ectomycorrhizal mushrooms, sustainable development, legal regulation, traditional mycogastronomy, food security

Mycotourism is defined as a sustainable development strategy that has as guiding axes the collection of mushrooms, trying to minimize the disturbance of natural habitats and the improvement of the well-being of local populations. Given the enormous biocultural diversity of wild mushrooms in Mexico, and the 71 ethnic groups that inhabit the country, the development of mushroom tourism has a high potential to benefit rural and indigenous communities. During the last decade, Colegio de Postgraduados has induced innovations for the development of mycotourism and mycogastronomy in various parts of Mexico. Mycogastronomy is the practice and study of dishes preparation that include edible ectomycorrhizal mushrooms, ranging from traditional foods to gourmet cuisine. Based on the objectives of the Nagoya Protocol regarding access to genetic resources and the fair and equitable distribution of the benefits derived from their use, studies have been carried out on the diversity, ecology, distribution, phenology and biocultural knowledge of the mycological resource, as well as as investigations related to the structure of the landscape with the purpose of adapting sustainable trails and mycological visits. In the *Tlahuica-Pjiekakjoo* region in the state of Mexico; in Piedra Canteada in the Firefly Sanctuary, Tlaxcala; and in various native towns in northern Mexico in Durango, successful actions have been achieved. Additionally hiking activities, mycological trials and mycogastronomy have also been encouraged in 20 rural localities in 8 Mexican states, with the support of CONAHCyT Project 316198. Then, currently, mycotourism and mycogastronomy have boosted in different regions of Mexico. However, there is lack of legal regulation, which is an urgent need, in order to maintain the sustainability of these important activities.

THE USE OF SUMMER (*Tuber aestivum*) AND BLACK TRUFFLE (*T. melanosporum*) TO ELABORATE KOMBUCHA BEVERAGE

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Key words: Truffle, kombucha, fermentation, aroma

Kombucha beverages are considered healthy-foods due to their biological activity. Recently, a wide catalog of kombucha beverages with different foodstuffs has been produced. Truffles are globally valued for their organoleptic properties and some of them contain bioactive compounds. These fungi are divided into commercial categories depending on their physical aspect (UNECE-Standard FFV-53). Therefore, truffle products elaboration might be interesting for those non-commercial truffles. To investigate the production of the beverage, three different symbiotic cultures of bacteria and yeast (SCOBYs) were selected. The kombuchas were elaborated with freeze-dried summer and black-truffles (*Tuber aestivum* and *T. melanosporum*, respectively). During the fermentation (21 days), physicochemical (pH and viscosity), biochemical (ethanol, sugars, proteins, and phenolic compounds) and sensory (volatile organic compounds) parameters were monitored. The studied beverages displayed a decrease in pH value and protein degradation and increased their sugar content as fermentation progressed. A total of 51 VOCs (18 esters, 13 acids, 8 alcohols, 2 aldehydes, 4 alkanes, 4 ketones, and 2 hydrocarbons aromatics) were detected in truffle kombucha beverages. The production of acids, especially acetic and nonanoic acid, and some acetates (ethyl acetate, phenethyl acetate, ethyl isovalerate, and ethyl laurate) increased in all kombuchas. Apparently, the black-truffle kombuchas showed a higher number of VOCs, and the principal component analysis showed more complexity than those fermented with summer-truffle. The molecules hexane, acetic acid, acetoin, and some acetates were selected as markers to control truffle kombucha elaboration. As a result of this study, a new beverage made with black and summer-truffles has been designed.

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AUTHOR INDEX

A

Alba, S. 60
Amicucci, A. 53
Andreu-Ardil, L. 51
Angius, F. 71
Arehart, E. 25
Arenas, F. 51
Arguiano, C. 23
Ayala-Vásquez, O. 81

B

Baciarelli Falini, L. 42, 44, 62
Bagi, I. 67
Balbuena-Carrasco, S. 81
Balzarini, M. 55
Baquero-Aznar, V. 77
Barak, H. 28
Barak, Z. 28
Barou, V. 65
Barroetaveña, C. 21, 22, 23, 39, 52, 58, 63, 72, 73, 74, 75, 76, 79
Beaudry, R. 71
Belfiori, B. 17, 24, 38, 52, 62
Ben-Dov, E. 28
Berdejo, D. 59
Bertocci, D. 30
Biketova, A. 20
Bonito, G. 71
Bradshaw, A. J. 13, 25
Bragato, G. 42, 44
Brejon Lamartinière, E. 13, 25
Bufacchi, M. 38, 80

C

Cabrera, G. M. 73
Calderón, D. A. 76
Carrión, N. N. 63
Casas, A. 56
Castelli, I. 53
Cenci, M. 17
Chaimae, M. 29
Chávez, D. 19, 64
Chiappini, D. 38
Cippitani, R. 38
Comandini, O. 14
Conti L., L. 43
Coppi, A. 43
Cuberos Sánchez, N. 45

D

Dam, A. D. 42, 62
Dawson, H. 71
de Errasti, A. 63
de la Fuente Nieto, L. 82
Dejene, T. 34, 46, 57, 66
del Río, R. 55
Del Vigo, E. A. 73
Delard, C. 55
Dentinger, B. T. M. 13, 15, 20, 25
Di Lonardo, S. 80
Dobos, E. 67
Donnini, D. 38, 42, 44, 62

E

Elso, M. 19
Escobar, T. 64
Eyassu, A. 34

F

Farías, V. 37
Félegyházi, F. 67
Fernández, M. V. 39
Figueroa, R. 15, 20
Flores Arzú, R. 15, 20
Franco-Manchón, I. 60
Friedman, M. 71
Furci, G. 13, 25
Furtado, A. N. M. 14

G

García, C. C. 76
Garcia-Barreda, S. 50, 59, 65, 70, 77
Gardin, L. 80

Gebeyehu, D. 34
Geml, J. 47
Gerding, M. 19
Giorgi, V. 53
Girón Tena, M. 59
Gómez-Molina, E. 50, 65
González, G. C. 21, 74, 76
González-Buesa, J. 77
Gracia Alquezar, A. P. 59
Gregori, G. 55
Guarnizo, Á. L. 51
Guerin-Laguette, A. 33, 54
Guillén, Y. 19
Gutiérrez, A. 51

H
Hernández-Rodríguez, María 46

J
Jalloh, Chelsea 37

K
Kagan-Zur, V. 28
Keren, G. 28
Kewessa, G. 66
Khabar, L. 29, 61
Kong, L. 54
Kovács, K. 67
Kushmaro, A. 28

L
Lakkakula, S. 28
Landi, L. 53
Lefevre, C. 71
Lemmond, B. 71
Lengyel, D. 67
Leonardi, M. 14
Liu, C. 54
Loewe-Muñoz, V. 55

M
Machuca, A. 19, 64
Magarzo, A. 46, 60
Marco, P. 38, 50, 59, 70, 77, 82
Marqués-Gálvez, J. E. 51
Martínez, P. G. 50
Martínez-Cerón, D. M. 81
Martínez-Reyes, M. 81
Martín-Pinto, P. 27, 30, 34, 45, 46, 47, 56, 57, 66
Matteucci, G. 80
Mazza, I. 43
Mediavilla, O. 46, 56, 60
Mignone, J. 37
Miralles Orduña, A. 59
Mohr Bell, D. 58
Molares, S. 32
Morales, D. 82
Morell, María, L. 76
Morte, A. 51
Murat, C. 38

N
Navarro-Rocha, J. 65
Navarro-Ródenas, A, 51
Neri, D. 53
Neves, M. A. 14
Niveiro, N. 18
Notartomaso, G. 80
Nouhra, E. 24

O
Oberschelp, G. P. J. 18
Oikrim, M. 29
Olaizola, J. 60
Oliach, D. 38
Oria-de-Rueda, J. A. 46, 47, 56
Ortiz-Santana, B. 20

P
Parada, R. 22, 75
Parladé, J. 65
Peintner, U. 23

Pérez Berdor, I. 59
Pérez Moreno, J. 11, 81
Pérez-Gilabert, M. 51
Perini, C. 43
Peris, P. 37
Peroni, C. 53
Pildain, M. B. 17, 21, 22, 23, 39, 52, 58, 63, 73, 74, 75, 76, 79

R

Rajchenberg, R. 36
Ramírez-Carbajal, E. 81
Ranocchi, B. 53
Rennick, B. 71
Riccioni, C. 17, 24, 38, 52, 62
Rinaldi, A. C. 14, 15
Romanazzi, G. 53
Romero, S. M. 24
Rondolini, M. 42, 44, 62
Ruan-Soto, F. 35
Rubini, A. 17, 24, 38, 52, 62
Rugolo, M. 72, 74

S

Salazar-Vidal, V. 16
Salerni, E. 43
Salgado Salomón, M. E. 23, 58
Salvador, M. L. 77
Sánchez, S. 50, 59, 65, 70, 77
Santos, M. 47
Santos-del-Blanco, L. 60
Sanz, M. Á. 65, 77
Sanz-Benito, I. 46, 47, 56
Sanz-Rocha, M. 19
Seibl, C. 23
Sferra, A. 80
Simonini, G. 20
Sitrit, Y. 28
Smith, K. 25
Smith, M. 71
Soler-Esteban, L. 50
Somrau, Alex E. 18
Sow, A. 71

T

Tadesse, W. 34
Tang, P. 54
Tejedor-Calvo, E. 50, 59, 70, 77, 82
Teshome, U. 34
Testa, A. 80
Thomas, P. W. 41
Townsend, M. 71
Tremble, K. 13, 15, 20

U

Utrera, F. 24

V

Van Wyk, J. 71
VanderVeur, S. 13, 25
Vega-Diez, S. 77
Velasco, V. 64
Vitale, R. 37
Vizzini, A. 20

W

Wang, Y. 54, 68
Warner, D. 71
Worku, E. 57
Wu, G. 15, 20

Y

Yamada, A. 49
Yang, M. 54
Yehezkel, G. 28
Yohanis, Y. 34
Yu, F. 15, 20

Z

Zagal, E. 64
Zambonelli, A. 53