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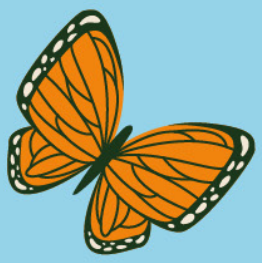
Biodiversity PhD Day



June 3-5
2024

University of Padua
Botanical Garden of Padua

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Telmo Pievani
Chiara Anzolini
Fabio De Pascale

Robert M. Waterhouse
Environmental Bioinformatics Group, SIB Swiss Institute of Bioinformatics

Biodiversity genomics to catalogue, monitor, and explore the richness of life on Earth
Biodiversity research is an extremely broad field as it spans so many different scales - from studying a single species to whole ecosystems or even global patterns. It also encompasses many different taxonomic groups - from charismatic megafauna to the innumerable species of arthropods or even other so-called “dark taxa” such as fungi. It also relies on many different research approaches - with rich data collection characterising targeted studies while larger-scale efforts necessarily focus on measuring a smaller number of key variables. The unifying theme is the recognition that biodiversity is critical for the health of our planet and human activities are causing unprecedented biodiversity declines that threaten the provision of ecosystem goods and services upon which human society depends. To protect and restore biodiversity we need to understand it, this is why biodiversity research, across all its dimensions, is so important. Molecular sequencing technologies are increasingly being employed to support biodiversity research, a key reason being the power molecular technologies have in overcoming the taxonomic biases which are inherent in biodiversity observations made by traditional methods, and which are often particularly challenging amongst megadiverse phyla of invertebrates. Increasingly these molecular sequencing technologies are high throughput, with individual field experiments generating very high volumes of sequence data, of a variety of types. Molecular sequencing initiatives are producing reference catalogues of genetic and genomic biodiversity, which need to be connected to biodiversity research infrastructures that are aggregating knowledge from scientific collections, human-made observations, and the literature. As biologists, we have a responsibility to contribute towards ongoing and future global efforts to understand arthropod biodiversity and help mitigate the effects of human-induced changes on one of the most important animal groups contributing to maintaining healthy ecosystems.

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Climate-induced sex-based differences in aquatic and terrestrial ecosystems
In the Anthropocene, effective strategies for reversing the loss of biodiversity rely on knowledge of how marine organisms, populations, and communities respond to environmental change. A fundamental but often overlooked biological characteristic of organisms is sex, which is distinct from sociocultural gender. Sex describes differences in sexual characteristics within living organisms that go beyond their reproductive functions and affect appearance and physiology, neuroendocrine, behavioural, and metabolic systems [1]. Although integrating sex into research design and analysis has produced new insights and solutions in biomedicine, artificial intelligence, and other disciplines, this has yet to occur for marine biology. Here, drafting from examples from [2,3] and initial evidence from the Mediterranean Sea, I argue that studying sex-based differences from organisms to populations and communities may generate new insights into resilience and vulnerability to climate stressors that may otherwise not be recognized. In my talk, I will introduce why sex is a key biological characteristics of living organisms; then I will introduce evidence of sex-specific responses to climate change and discuss the potential consequences of sex-based differences in species interactions.

Sex as a key biological characteristics. Through a review of marine biological research into sex-based differences I revealed that sex broadly affects the morphology, physiology, behaviour, and distribution of organisms and populations across taxa, with evidence of sex-specific differences in survival to thermal stress, timing of biological mechanisms, and energetics [2]. Sex analysis is most commonly applied at the scale of organisms and populations, but not communities. In 90% of studies that explicitly considered biological sex, physiological, morphological, and behavioural mechanisms were found to be influenced by sex.
Sex-specific responses to climate-change. The response of aquatic and terrestrial organisms to climate change can depend on biological sex [3]. At the organismal level, individuals can display sex-specific responses to climate stressors that affect body size, growth rates, and other life-history traits that influence reproductive output and population dynamics and persistence. Population sex ratio can also change as an effect of different thermal performance between males and females. Females and males tend to respond differently to climate-induced environmental changes in species where females and males have different energetic requirements, foraging behaviours or habitat preferences. Consequently, sex-specific sub-population responses to climate change can impact meta-population dynamics by disrupting interactions between sexes.
Community-level consequences. Sex-specific responses at the species and population levels may impact community dynamics and energy transfer throughout food webs, with consequences for the benefits that humans derive from ecosystems. Sex can partly explain community variability among other factors, like body size. Trait-based ecology has investigated how trait variability drives community stability. Sex is a major source of individual heterogeneity in communities, and can be used to explain species interactions and intra-specific interactions.
Concluding remarks. A key challenge is to unravel the interactive effects of sex and climate change at the individual and population levels and the cascading effects on communities. This new understanding is essential to improve climate adaptation and mitigation strategies. Researchers can address the many unanswered questions about biological mechanisms influenced by sex and climate change across species and systems. Researchers have begun to show that climate change can induce sex-specific responses both in the presence and absence of pre-existing sex-specific physiological, metabolic or behavioural differences. To facilitate further integration of sex into biological research, I synthesise current approaches, discuss methodological and logistical challenges, and lay out guidelines for future research. Considering sex in research design and analysis of the results is essential for taking action to reverse biodiversity loss.

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[3] Gissi, E., Schiebinger, L., Hadly, E. A., Crowder, L. B., Santoleri, R., & Micheli, F., 2023. Exploring climate-induced sex-based differences in aquatic and terrestrial ecosystems to mitigate biodiversity loss. Nature communications, 14(1), 4787.

John N Griffin
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Marine restoration, foundation species, and biodiversity

We are in an era of ecosystem restoration, underlined by UN's decade Ecological Restoration 2021-2030 with an ambitious goal to restore an area the size of China by 2030. Many coastal ecosystems such as seagrasses, marine forests, and saltmarshes have been historically degraded or lost, but as many local stressors have been abated, these areas now offer an opportunity for ecosystem restoration to recover biodiversity and ecosystem services including coastal protection, fisheries support, and carbon storage. Restoration in marine and coastal environments depends critically on the successful establishment of foundation species – habitat-formers such as corals, oysters, seagrasses, or large seaweeds. However, many restoration projects suffer poor success rates as foundation species struggle to establish in the often environmentally harsh and degraded conditions of restoration sites. In this presentation, using examples from salt marshes and rocky reefs, I argue that fundamental ecological research demonstrating key interaction networks involving foundation species can provide valuable insights for restoration.

I first show how, in southeastern US saltmarshes, the main foundation species, cordgrass, is engaged in a crucial mutualistic interaction with mussels. In a first study, we found that mussels support not only cordgrass growth, but also provide habitat for herbivorous, detritivorous, and predaceous crabs that in turn drive a multitude of ecosystem processes. Even more importantly, in a second study, we show that the small aggregations of mussels, despite only covering <2% of the marsh surface, substantially increase overall ecosystem resilience in the face of drought. Cordgrass survival was substantially higher when associated with mussels, leaving an otherwise denuded marsh landscape dotted with surviving patches post-drought. Modelling showed that these patches were then crucial for marsh recovery, serving as distributed nuclei of vegetative propagation that substantially reduced projected recovery time from >50 to <10 years. Integrating positive interactions such as the cordgrass-mussel mutualism will be crucial to restoring multifunctional and resilient coastal ecosystems.

Moving from US salt marshes to UK rocky reefs, I next show how interaction between the abiotic – not just biotic – environment can profoundly influence the establishment of foundation species, wider biodiversity, and ecosystem functions. In a field experiment, we show that topographically complex or heterogeneous substrates trigger a cascade of species interactions that ultimately enhance biodiversity and functionality. Specifically, heterogeneity inhibits a key grazer while supporting several foundation species that in turn support diverse functional groups and their associated functions. The role of heterogeneity was further underlined and generalised in the results of a meta-analysis. This work, synthesising studies on rocky reefs worldwide, showed that three-dimensional structural heterogeneity - generated by rough rocky substrates or the organisms that grow upon them – drives strong saturating responses of diversity and abundance, especially for smaller-bodied and vertically mobile marine organisms and under environmentally stressful conditions. We propose that physical complexity, while often overlooked in restoration contexts, should be considered as an important aspect of mitigating physical and biological stress and increasing niche diversity to support ecological recovery and restoration. Finally, using several image and public exhibit-based experiments, we show that people generally prefer scenes with higher biodiversity of marine organisms, whether in the context of rockpools, or on seawalls. These findings suggest that integrating biodiversity into restoration or ecologically-friendly engineering of our coastal environments could have benefits that extend beyond the ecological to support cultural services or even human wellbeing. To conclude, I discuss how restoration ecology has yet to fully capitalise on the rich history of studies on biodiversity and ecosystem functioning, and that fundamental ecological studies point to a range of important ecological interactions acting on and responding to foundation species that should be integrated into restoration practice.

Please see here for links to publications: https://scholar.google.com/citations?user=Y1ekf1oAAAAJ
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Historical botanical collections and (ancient-)DNA to reconstruct the history of introduction of Tulipa sylvestris in Europe

Access to historical archives has long been limited due to the fragile nature of old documents, which have been hidden in libraries for centuries for the sake of their protection. As a result, historical knowledge on the introduction of plants has been fragmented and incomplete, and sometimes even inaccurate. To tackle the problem of inaccessibility of historical archives, generous efforts have been made in the last decades by numerous libraries and herbaria worldwide to digitise their historical collections and make them publicly available online. The increasing availability of historical resources now allows for convenient and remote examination of numerous historical documents without the necessity to travel or the risk of damaging them. Additionally, the conventional approach of screening historical archives can now be complemented with DNA analysis of historic plant specimens preserved in herbarium collections. Extracting DNA of sufficient quantity and quality from historic specimens has long been difficult due to the degraded state of ancient DNA. But the rapid advancements in genome sequencing is now increasingly overcoming this obstacle, allowing us to obtain reliable genomic data from old herbarium material.

When it comes to the history of botany, archival information from the 16th century is of particular importance. Also known as the botanical Renaissance, the 16ht century saw the birth of botany as a distinct scientific discipline. During this period, an interest in natural history emerged. For the first time in history, scholars turned to nature to find the plants that the ancient authors had described. While doing so, they discovered new plants and travelled to collect plants and introduced them to Europe, organising the earliest known botanical expeditions. They attempted to describe in detail this growing plant diversity around them, paying tremendous efforts to produce books that would contain all known plants, with more accurate descriptions and illustrations than ever before. They also produced herbaria, i.e. collections of plants press-dried and mounted into books.

In this period, many ornamental plants were introduced to Europe, among which also tulips. Tulips came to Europe from the Ottoman Empire around the middle of the 16th century. The provenance of Ottoman tulips has been extensively documented in literature, but one tulip species, Tulipa sylvestris L., followed a different, less well known introduction path. T. sylvestris is a small yellow-flowered tulip that was introduced to northern Europe around the same period as ornamental tulips. Unlike the rest tulips that came from the east, T. sylvestris came from the south, from the Mediterranean region, and it subsequently successfully naturalised in historical gardens and in the wild. Linnaeus described it as “wild” in 1753, and by then, it was growing across central and northern Europe.

The latest taxonomy of T. sylvestris recognizes three subspecies, two of which are native in Europe, namely the diploid subsp. australis and the tetraploid subsp. sylvestris. In some floristic accounts these two subspecies are regarded as distinct species. Subsp. australis, found in mountainous regions from the Mediterranean and up to Central Asia, grows in poor soils and grasslands. Subsp. sylvestris, native to Italy and surrounding areas, is naturalized across much of Europe in rich soils, gardens, fields, and orchards. Although an alien plant, it is valued for its cultural significance, such as in the Netherlands’ so-called “stinzenflora.” A third subspecies, the diploid subsp. primulina which is also sometimes treated as a distinct species, grows locally in northern Africa. Combining historical research with population genomics we follow the journey of introduction of T. sylvestris from the Mediterranean region to northern Europe, highlighting the specific locations, dates, and botanists involved. The species’ complex taxonomy is discussed in the light of historical findings. The historical approach focuses on original 16th-century sources, including botanical books, illustrations, historic herbaria and archives. The genomic approach includes median network analysis using rDNA and complete chloroplast genomes, and genomic repeat profiling.

DNA samples were collected from both native and naturalized T. sylvestris populations across Europe, as well as from historic herbarium specimens, including a specimen from the 16th-century Rauwolf herbarium collected in Northern Italy in 1563.

The earliest historical evidence of T. sylvestris comes from Italy. The Codex Kentmanus, a manuscript of plant watercolors compiled by German physician Johannes Kentmann who studied medicine in Padua between 1547 and 1549, features the oldest known depictions of the species. It contains two illustrations of T. sylvestris, the one showing a plant grown in the botanical garden of Padua. The Swiss botanist Conrad Gessner borrowed Kentmann's manuscript and wrote about T. sylvestris, attributing its name to its resemblance to a Dalmatian cap. Melchior Wieland, a Prussian botanist, also known as Luigi Anguillara, who was at that time director of the botanical garden of Padua, sent seeds of T. sylvestris to Gessner, marking the first event of introduction of the species, between 1554 and 1559. These seeds were probably not further distributed in Gessner's network, as Gessner died soon after. Other important scholars, such as Leonhart Fuchs and Pietro Antonio Michiel, contributed to documenting T. sylvestris through their illustrations and manuscripts. The Flemish botanist Rembert Dodoens provided the first scientific description of T. sylvestris in 1568 in his book Florum. Another Flemish botanist, Matthias de Lobel, described in 1571 the plant's origins in southern France, reporting to have dug out bulbs from the Cevennes, a mountainous area north of Montpellier, and sent them to the Low Countries, probably around 1565. A few years later, in 1576, De Lobel also described another form of T. sylvestris, which originated from Bologna. Carolus Clusius, a key-figure in tulip history, reported receiving T. sylvestris from Bologna, from the renowned professor of botany Ulisse Aldrovandi, in the 1570s. According to Clusius, this material originated from the Apennine mountains. Clusius also received T. sylvestris from Montpellier, and probably widely distributed both the Bologna and Montpellier tulips, the two main forms of T. sylvestris known at that time, within his network of correspondents in Europe. Another path of introduction through Spain is also reported by Clusius, but these bulbs apparently did not survive in northern Europe. These early botanical explorations and exchanges laid the groundwork for understanding the distribution of T. sylvestris in Europe.

Examining this historical context alongside the current taxonomy and distribution of T. sylvestris reveals intriguing insights. According to the species' current subspecific classification, the tulips naturalised across Europe are of the tetraploid subsp. sylvestris, while those native to the Mediterranean region are of the diploid subsp. australis. Subsp. sylvestris is also native to Italy. However, our historical findings show that not only the tetraploid subsp. sylvestris but also the diploid subsp. australis was introduced to northern Europe. In specific, historical literature points to various origins for T. sylvestris: the Cevennes mountains near Montpellier, Bologna and the Apennine mountains in northern Italy, and Aranjuez in central Spain. But only the tulips around Bologna belong to subsp. sylvestris, while those in the Cevennes, Apennines, and Aranjuez belong to subsp. australis. Interestingly, de Lobel's observations highlighted differences between the Bologna tulip (subsp. sylvestris) and Montpellier tulip (subsp. australis), including size, fragrance, and vigour. De Lobel reported the Bologna tulip as being a larger plant with occasionally double flowers, a habit that fits the tetraploid nature of subsp. sylvestris, vs. the Montpellier tulip which is more slender and with single flowers, a habit that fits the diploid subsp. australis. Both these two forms were introduced to northern Europe, indicating that the common belief that subsp. sylvestris is a tetraploid naturalized in N. Europe and subsp. australis a diploid native in the Mediterranean region is not supported by the European history of introduction of T. sylvestris. Therefore, the distinction between subsp. sylvestris and subsp. australis is challenged based on historical accounts, and a re-evaluation of the taxonomy of the species is needed. To further elucidate the history of introduction and the complex taxonomy of T. sylvestris, genomic research was carried out. Preliminary results support the historical findings outlined above and indicate that subsp. sylvestris and subsp. australis do not merit to be recognized as distinct species.
Interdisciplinary research combining botanical, genomic and historical studies is essential for understanding the complex origin and taxonomy of cultivated plants that have a past of human-mediated introduction. Digitization of historical archives and herbarium collections facilitates remote access to valuable botanical heritage, significantly aiding research on the complex history and taxonomy of introduced and naturalised ornamental plants.

Oral Presentations

Monitoring 1

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The correlation between varying degrees of urbanisation and soil antibiotic resistance
Davide Bongiovanni, Simon Masson, Matteo Chialva, Luisa Lanfranco, Irene Stefanini

The excessive use of antibiotics in healthcare, agriculture, and livestock fosters the development of antibiotic resistance. Environmental stressors, such as pollutants, exacerbate this issue. While monitoring of antibiotic resistance is biassed towards certain sectors, little is known about the resistome in other environments. Urban park soil, exposed to both natural and human-induced stressors, presents a potential hotspot for the acquisition and transmission of antibiotic resistance. To address this gap, we examined the bacterial soil resistome in 10 parks in Turin with different grades of urbanisation. Metagenomic analysis revealed that less disturbed environments harboured a greater abundance of antibiotic-resistance genes compared to urban parks. In undisturbed areas, antibiotic efflux was the predominant mechanism of resistance, while urban soils exhibited enrichment in genes associated with antibiotic inactivation, target alteration, and replacement.
Additionally, the degree of urbanisation influenced antimicrobial resistance, with less urbanised areas displaying heightened resistance against naturally occurring fungal antibiotics. Correlating resistance genes abundance with microbial taxonomy, land use patterns, and soil characteristics, shed light on factors contributing to resistance acquisition. This research may inform the development of more sustainable urban parks through a “one-health” approach.

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Exploring spectral and thermal response of forest habitats through satellite imagery
Chiara Bottaro, Giovanna Sona, Maria Laura Carranza, Michele Finizio, Michele Innangi

Satellite image repositories hold vast archived data documenting Earth’s dynamic processes. Monitoring how ecosystems respond to human impact is crucial for devising conservation and management strategies. This study delves into the spectral and thermal response in time of various forest habitats in the Molise Region, Italy. The main objective is to assess whether the spectral and thermal information retrieved from satellite images varies across the different habitats and, if so, whether these variations reflect ecological characteristics. Data from ‘Carta della Natura’ facilitated forest habitat selection. Utilising Landsat 8 and 9, with 30 m resolution and 16-day revisit time, we derived Land Surface Temperature (LST) and few vegetation indices. We collected 2022 Landsat images and extracted pixel values at multiple sampling points per habitat. Statistical analysis aimed at assessing variance across habitats. Future work includes expanding the analysis temporally and exploring the impact of increased spatial resolution on thermal and spectral response, enhancing multiscale understanding.

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Differential expression of genes involved in biotic and abiotic stress in raphanus plants collected in urban and extra-urban areas
Angela Carfora, Serena Aceto

Urbanisation significantly affects biodiversity through habitat loss and fragmentation. Despite plants being immobile, they've evolved cellular, molecular, and biochemical strategies to counter aggressive environmental challenges. Not all defence and resistance strategies plants implement under continuous stresses are fully understood. Bridging these knowledge gaps is crucial to gaining insights into urban biodiversity, and improving our understanding of the ecology and evolution of species in urban environments. Raphanus raphanistrum, a Brassicaceae family member, is notable for its capacity to survive in urban habitats and to thrive in diverse environments under various conditions. It's an ideal model for studying how urban stress affects natural conditions and gene expression in plants. To evaluate the possible pathways involved in abiotic and biotic stress, samples of R. raphanistrum leaves were collected in eight sites in the province of Naples with three different levels of urbanisation (agricultural, semi-natural, and urban) and feature different soil types (limestone, tuff, or lava). Furthermore, the level of herbivory was taken into consideration for each individual. All samples were stored in RNA-later and leaf RNA was subsequently extracted to conduct in-silico differential expression analysis. RNA-seq analysis revealed differential gene expression between individuals based on the biotic and abiotic stress.

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Plankton biodiversity in the Mediterranean Sea: a trait-based model
Francesco Dattilo, Cosimo Solidoro

In marine ecosystem, an enormous number of different plankton species interacts with one another, competing for survival and, at the same time, providing sustenance for the entire ecosystem. Plankton organisms present also a highly expressed functional diversity, varying in morphology, size, nutrient uptake, and more.
In this study, we want to explore how functional diversity influences the food web structure in the plankton community, in a realistic oceanographic context.
To do so, we have implemented a 3D trait-based biogeochemical model, for the entire Mediterranean Sea. The model represents all the physics processes in the water (advection, diffusion, upwelling and downwelling, etc.) at 1/12 degree of resolution, by taking into account also external forcings such as wind stress, rain, river runoff and light. The flexible biogeochemical compartment, made with DARWIN package, allows to represent the plankton community with different setups, from a few to thousands of plankton functional types (PFTs).
In our experiment, we have created two different ecological setups, one with 13 PFTs and the other one with 50 PFTs, while monitoring for each configuration how the stability of the food web is affected.
This is the first model able to describe plankton functional diversity (including mixotrophy) in the Mediterranean Sea, while maintaining a strong oceanographic realism. This method can be used to explore and monitor plankton biodiversity trends in Climate projections.

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Integrating morphological, physiological, and molecular approaches to monitor photosynthetic biodiversity in the Venice Lagoon
Filippo Drigo, Chiara Stefanelli, Riccardo Trentin, Davide De Battisti, Gabriele Sales, Isabella Moro, Cristiano De Pittà

The Venice Lagoon is one of the largest lagoon systems in the Mediterranean Sea. As a transitional environment, it possesses the characteristics necessary to qualify as a biodiversity hotspot. An analysis of photosynthetic biodiversity records spanning from the 1800s to 2023 revealed the presence in this environment of 902 species, with 375 reported between 2000 and 2023. There was a significant decline in charophytes and heterokontophytes, less pronounced decline of chlorophytes and an increase in rhodophytes. Tracheophytes exhibited no variation from the 1800s to the 2000s. Furthermore, when considering different ecological indexes (EEI and MaQI), there was a decline in species with high ecological valence during the analysed period. During the summer 2023 and spring 2024, a survey carried out on 73 sites comprising salt marshes and wooden poles (briccole) revealed the presence of 20 higher plant species, including 16 halophytes and 4 phanerogams, along with 15 rhodophytes, 13 heterokontophytes, and 17 chlorophytes.
The Venice Lagoon is additionally recognized as a hotspot for invasion. It is documented that 33 non-indigenous macroalgal species are present, and among the higher plants the invasive species Sporobolus anglicus has been observed and is currently outcompeting the native S. maritimus. Investigating the distinct responses of these two species to a heatwave event can provide insights into invasion mechanisms and help predict scenarios under global climate change.

Monitoring 2

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Developing a comprehensive biodiversity index for sustainable forest ecosystem management
Roberta Ferrante, Cristina Vettori, Cesare Garosi, Donatella Paffetti

This study aims to develop a comprehensive index for quantifying biodiversity in all its components in forest ecosystems to preserve and monitor biodiversity. Genetic and forest verificators were assessed across stands of Fagus sylvatica L., Abies alba Mill., Pinus nigra J.F Arnold, Pinus pinea L., and Quercus robur L. located in Italy, Croatia, and Slovenia, comparing management and unmanagement conditions. We calculated verificators related to stand structure, deadwood volume, species diversity, and species evenness. Meanwhile, for genetic indicators, we decided to use verificators to determine genetic diversity within species, and populations. Results revealed that unmanaged forests exhibited greater structural complexity, microhabitat diversity, and deadwood volume compared to managed forests. The spatial genetic distribution of stands demonstrated that unmanaged forests showed greater structural complexity and more clusters than managed forests. These preliminary results provide a tool for assessing and monitoring biodiversity in forest stands. The information obtained will be used to develop a unified index correlating forest and genetic indicators, which will serve as input to a predictive model for adaptive management under climate change.

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Advances in the modelling of ecological communities: a theoretical physics approach
Francesco Ferraro, Sandro Azaele, Christian Grilletta, Amos Maritan, Samir Suweis

Ecological communities are the simplest level of collective organisation in an ecosystem. Understanding their patterns and the dynamical processes that underlie them has long been at the heart of ecology, and remains an urgent priority for global change research. Recently, it has been realised that some tools developed by theoretical physicists can be also proficiently employed in uncovering patterns in the static and dynamical properties of large ecological communities. In this talk I will give a brief review of the most important results on this topic, which will be followed by a selection of recent results by my research group stemming from the study of the Generalised Lotka-Volterra equations, the most popular model in community ecology. It will be highlighted how the alarming rate of diversity loss means that ecology is in urgent need of a theoretical framework capable of making realistic predictions.

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Microbial responses in Venice lagoon salt marshes: diel insights
Irene Gregori, Riccardo Frizzo, Alberto Barausse, Fabio De Pascale, Lorenzo Archetti, Francesco Martino, Lorenzo Zane, Alessandro Vezzi

Salt marshes are exposed to daily tidal changes and therefore experience fluctuations in salinity and dynamic nutrient concentrations. They play an essential role in maintaining a healthy ecosystem, acting as sediment storage and coastal erosion buffers, and serving as important habitats and nurseries for many plant and animal species. Microorganisms play a crucial role in maintaining ecosystem health in any environment, but their responses to changes in salt marshes are still poorly explored. This study aims to investigate the taxonomic profiling and gene expression dynamics of microbial communities in salt marsh sediments at four diel time points. Twenty-four sediment samples were collected from two different salt marshes in the Venice Lagoon. Sampling spanned four time points to capture variations in light conditions and changes in nutrient concentrations such as dissolved oxygen, nitrogen, and salinity. Taxonomic profiling was performed using DNA metabarcoding, while metagenomics and metatranscriptomics analysis might provide insights into functional potential variations influenced by changing nutrients. Metatranscriptomics analysis can reveal nutrient-driven changes in metabolic pathways, thus providing an understanding of active functional processes within microbial communities. This study will improve our understanding of microbial biodiversity and ecosystem functioning in salt marsh environments, with implications for ecosystem management and conservation efforts.

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Biodiversity of neglected animals: taxonomy and distribution of a lineage of soil centipedes
Roberto Magnolini, Lucio Bonato

The understanding of taxonomy and geographical distribution are inadequate for many animals, especially for some invertebrate taxa. This kind of information is fundamental to any effective plan of monitoring.
The current taxonomy of soil centipedes (Chilopoda: Geophilomorpha) is largely inadequate. This holds also for many evolutionary lineages inhabiting the Western Palearctic, including Italy, even though the fauna of this country has been more studied than others.
I will present the preliminary results of a revision of morphology and geographical distribution of a lineage of soil centipedes, whose number and delimitation of species have never been revised since the early '80s. I performed an exhaustive search of the literature from the year 1800, digitising all information regarding both morphology and distribution of these centipedes. Moreover, I examined more than 400 specimens from different scientific collections, retrieving morphological data that permits us to distinguish all the species. About 20 different species are recognized within this lineage. Furthermore, at least 7 species inhabit Italy, including one that is new to science.
My case study could be extended in other invertebrate taxa that are still inadequately known and neglected.

Monitoring 3

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Identify sources, sinks and pathways of microbial pathogens and antibiotic resistance in aquaculture environments and aquaculture settings
Naomi Massaccesi, Marco Basili, Stefano Amalfitano, Marco Melita, Stefano Goffredo, Andrea Di Cesare, Raffaella Sabatino, Elena Manini, Gian Marco Luna, Grazia Marina Quero

The global exponential growing demand for aquatic food over the last 10 years has resulted in a shift of aquaculture practices from extensive to semi-intensive and intensive systems to maximise the speed of growth and obtain greater yields. However, production intensification have led to potential cascading negative impacts on farmed fish resulting in pathogen outbreaks and the consequent (over)use of antibiotics.
Antibiotics, which are used for both prophylactic and therapeutic purposes, are discharged directly or through secondary sources into the water and soil environments, making fish farming a potential source and sink of antibiotic resistance.
The main mechanism driving the spread of antibiotic resistance is represented by Horizontal Gene Transfer (HGT), a process in which mobile genetic elements (MGE) can be mobilised among microorganisms. As a result of HGT, new genetic elements may be incorporated in the genome of bacteria living in the aquaculture environment, thus contributing to the spread of new antibiotic-resistant bacteria.
Understanding the occurrence and the sources of antibiotic resistance is of primary importance to design strategies aimed to improve fish farm practices and to assure a safer food production, higher environmental protection and effective guide to tackling the antimicrobial resistance threat to human and animal health.

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Novel citizen science methods for freshwater quality monitoring
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Threats to freshwater habitats and resulting loss of biodiversity are well documented but a coordinated action to reverse this decline is lacking. Monitoring is essential to understand, reverse and prevent the further degradation of our lakes, rivers and wetlands. Citizen Science (CS) is a powerful approach to overcome the traditional challenge related to limited spatial and temporal data coverage. Within the CS4rivers (NBFC, activity 3.5), citizen scientists are trained to take measurements of water and habitat quality using a standard methodology, calibrated tool kits and a common open database. This allows them to acquire information on the chemical, optical, hydrological and ecological conditions of a study river and the related different temporal and spatial changes. In addition, we are developing a low-cost open-source sensor with a standard RGB light source and photoresistor (LDR) detectors, using Raspberry Pi as a sensor controller and data transmitter. We show the dynamics of a range of rivers monitored by citizen scientists in central Italy and within the two NBFC case studies. The results show the seasonal dynamics typical for nutrients.

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Monitoring pollinators to enhance biodiversity in Italian cities
Rosa Ranalli, Andrea Galimberti, Massimo Labra, Paolo Biella

In the last decades, a global decline in biodiversity has been taking place due to the strong impact of anthropogenic activities. However, in large cities, refuges for pollinators persist and, from a One-Health and urban sustainability perspective, it is pivotal to implement suitable green areas to support biodiversity. The research occurred within the Spoke 5 activities of NBFC, and aims to assess pollinators' diversity providing valuable information on pollination networks in urban ecosystems. Monitoring activities have been implemented across six major Italian cities to characterise pollination services, selecting sites according to different green area sizes and fragmentation. Over 6,000 samples of wild bees and hoverflies and their interactions have been collected. Integrative techniques to identify the insects and their interactions (i.e., pollen) have been applied. Based on early findings, experimental sites have been established to reinforce and enhance biodiversity. These initiatives encompass the installation of artificial nests for diverse urban wildlife taxa and the introduction of trophic resources. The reinforcements will be actively monitored to assess their effectiveness. The study sheds light on the complex relationship between the environment and regulating ecosystem services, contributing to the development of policies regarding the management and implementation of resources for pollinators, for a more sustainable and healthful urban environment.

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Monitoring and modelling of pathogen spillover from honey bees to bumblebees and wild bees
Jorge Sánchez Navarro, Alberto Satta, Robert Paxton, Antonella Soro, Panagiotis Theodorou, Ignazio Floris, Michelina Pusceddu

Managed honey bees (Apis mellifera) are known to affect wild bees in three ways: direct competition for finite resources, driving changes in plant communities, and what is the aim of this project: transmission of pathogens. For that matter, we developed a three-part study in which we will establish, characterise and model the spillover of pathogens from honey bees (social model) to bumblebees (social model) and wild bees (solitary model) using molecular analysis of the samples. The first part of this project includes the active sampling throughout Sardinia of 20 specimens of the aforementioned bee groups, as well as the evaluation of the flora visited by these pollinators as possible infection hotspots through the sampling of 15 flowers of 3 selected plant species. This recollection will be carried out in selected sites characterised as low-density-of-beehives or high-density-of-beehives during the spring of 2023 and 2024. The samples will then be analysed to detect hive pathogens in all bee groups. The last step in this experience consists in the statistical analysis that will be performed in order to create pathogens spread models. The possible pathogen-vector role of honey bees can create an issue within the plant-pollinator networks of Sardinia, and therefore, their ecosystems as a whole. With this study we hope to be able to take a leap in pollinator communities' conservation.

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Changes in foliage-dwelling spider communities along an urbanisation gradient
Anna Piquet, Elena Piano, Marco Tagliabue, Marco Tolve, Marco Isaia

Urbanisation affects landscape structure, functions and local environmental conditions, with major impacts on biodiversity and related ecosystem services. To assess the effects of urbanisation on biodiversity we focused on spiders, renowned regulators of trophic chains and sensitive bioindicators. We analysed the response of foliage-dwelling spiders to urbanisation in Turin (Italy), by sampling their communities in urban green areas along an urbanisation gradient and in a natural park (control area) a few kilometres from the city. We tested their response in terms of taxonomic (i.e. species richness and abundance) and functional (diversity, abundance, number of feeding guilds, abundance of pollinator feeding spiders) diversity. Species richness and abundance, along with functional diversity, decreased in the city compared to the control area and along the urbanisation gradient. Notably, this pattern was mostly due to the loss of specialised foraging guilds. By evaluating species dissimilarity among sampling sites, we highlighted that species turnover predominantly explained differences in species composition among urban green areas, due to the high frequency of stochastic events. Conversely, urban communities emerged as subsets of semi-natural ones, suggesting an environmental filter favouring species preadapted to urban conditions. Our findings underscore the role of urbanisation in shaping spider communities, favouring generalist species and specific functional traits.

Conservation

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Agricultural intensity and local factors affect plant diversity of farmland ponds
Silvia Cannucci, Claudia Angiolini, Rossano Bolpagni, Gianmaria Bonari, Tiberio Fiaschi, Simona Maccherini, Emanuele Fanfarillo

Wetlands are among the world's most vulnerable ecosystems. Moreover, permanent farmland ponds hold significant conservation value in heavily human-modified landscapes like the Mediterranean basin. Despite this, plant diversity in various agricultural systems, notably in Italy, remains inadequately studied. We conducted a survey of 45 farmland ponds (in Tuscany, Italy) across three agricultural areas with varying agricultural land-use intensity. Our study assessed the impact of agricultural intensity and local pond-related factors on aquatic and riparian plant communities. We found that while agricultural intensity affects plant diversity, local factors such as pond characteristics and plot position within the pond have a greater influence. Ponds with lower agricultural intensity hosted richer plant communities, highlighting the importance of conserving these semi-natural habitats. Local factors, including management practices and environmental gradients, play a more significant role in shaping plant diversity in ponds than agricultural land use.

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The problem of invasive alien plants in Italian cities: the role of the floriculture industry
Giulia Daniele, Nicole Sebesta, Elena Barni, Federica Larcher

Italian cities are hotspots for the introduction, growth, and subsequent spread of invasive alien plant species (IAPs). Ornamental horticulture is recognized as a primary pathway for the global introduction of IAPs, with certain ornamental plants such as Buddleja davidii Franch., Ligustrum sinense Lour, and Prunus laurocerasus L. displaying invasive tendencies in urban green areas. The purpose of this research is to understand the role of the Italian floriculture industry in the spread of IAPs. Given the challenge of obtaining official sales data for IAPs, a survey of 94 catalogues of floricultural industries was conducted. The survey focused on the identification of market-prevalent IAPs selected from a pool of target species common to the cities of Turin, Milan, and Rome. In addition, a questionnaire was disseminated, via printed QR code and e-mail, aimed at horticultural sector operators to assess their knowledge, perception of impacts, and management efforts of invasive plants in the city. The 140 responses showed that banning the sale of some invasive species is impractical for addressing the problem of IAPs. Instead, proposing specific alternative species would be an effective solution, and in this regard, a trial has been underway since March to study two possible alternatives to L. sinense (IAP): L. vulgare L. (European native) and L. japonicum Thunb. 'Texanum' (non-invasive ornamental cultivar). These were compared in their responses to salt and water stresses.

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Ex situ conservation of plant biodiversity with an innovative and integrated approach. Orchid germplasm conservation in a seed bank
Aya Mortada, Elisabetta Sgarbi

Ex-situ conservation is crucial in biodiversity conservation especially through genebanks. Genebanks collect, classify, evaluate, utilise and conserve plant biodiversity, with cryopreservation emerging as a solution for long-term storage, especially for species with recalcitrant seeds or vegetative propagation.
The aim of my research is to establish the first seed bank for ex-situ conservation of wild plant biodiversity in Emilia-Romagna Region and to study wild populations of orchids and other threatened plant species.
First, a new database for storing the information on collected- and future new samples has been prepared, establishing a new code. A new approach has been used for a better management of old seed accessions found in UNIMORE. Analyses have been carried out to test seed viability in orchid seed samples conserved at 5 ˚C for more than 5 years.
The results showed that out of 138 orchid seed samples were conserved and 6.1% were a duplication. Of 130 accessions belonging to 48 species, only 3.1% germinated. These are 4 accessions of 2 species, stored in the fridge since 2013, Anacamptis pyramidalis and Gymnadenia conopsea. They gave 48% and 75% germination, respectively. 38 new orchid seed accessions were added to UNIMORE seedbank in 2023, plus seeds of another threatened species, that is Allium angulosum. Seeds were subjected to viability and germinability tests with a high rate of positivity (89%) and they were stored at -21 °C.

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The ecological dynamics of italian protected areas network project: updates, ongoing activities and future developments
Jacopo Iaria, Roberto Cazzolla Gatti

Protected areas play a crucial role in biodiversity conservation, yet their effectiveness across different protection levels remains unclear. My PhD project aims to evaluate the trends at a national level of plant biodiversity in protected areas in the last few decades and assess the role of different levels of protection in plant conservation using a resurvey approach. Vegetation resurvey involves sampling again vegetation reveles retrieved decades ago to evaluate changes in community composition due to ecological processes and anthropogenic drivers.
In the past year, we established a network of 42 national experts responsible for resurveying more than 2500 past vegetation plots in 35 Italian national and regional parks.
Through meetings and individual collaborations, we identified the critical issues of the approach and produced aiding documents including a common survey protocol for location identification and sampling.
A further collaboration has been established with NBFC Spoke 3 ‘resurvey of coastal habitats’ regarding data sharing with the construction of a shared data platform with standardised plot information. Finally, our ongoing efforts involve developing an analysis workflow for the results of incoming surveys and drafting a systematic literature review paper on the methodology of past resurvey studies in Europe.

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Does long-term exposure to neodymium affect marine diatom populations?
Marisa Spampinato, Antonietta Siciliano, Mariagioia Petraretti, Anna Federico, Edith Guadalupe Padilla Suarez, Lorenzo Saviano, Antonino Pollio, Antonios Apostolos Brouziotis, Marco Trifuoggi, Marco Guida

Rare earth elements (REEs) use is growing steadily for green technologies production, due to their remarkable electrochemical, magnetic and optical properties. It can be a significant risk to the environment and human health because of their linear life cycle, meaning that large amounts of these pollutants are found in the environment, making organisms subject to both acute and chronic exposures.
The aim of this study was to obtain a fuller picture of the effects resulting from REEs prolonged exposure of the marine diatom Phaeodactylum tricornutum to concentrations closer to the environmental ones.
The algae were exposed to geometric concentrations of neodymium (Nd) for 72 hours, from which the median 10% growth inhibition concentration (EC10) values of 5.18 mg/L were obtained and used for the subsequent 21-day exposure of the algae to Nd in semi-static conditions, in which growth inhibition and morphological changes were measured every 7 days. The EC10 concentration had a slight stimulating effect on algal growth over the 21-day exposure period.
Microscopic observations showed that the algal populations in the control group maintained a consistent biovolume ranging from 4 to 5 microns. Contrary, the algae exposed to Nd displayed a noticeable increase in biomass, ranging from 5 to 6 microns.
Based on these results, additional studies are warranted to elucidate the underlying mechanisms responsible for tolerance induction in P. tricornutum.

Restoration

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Assessment of biodiversity metrics for restoration of macroalgal forests
Giulia Bellanti, Fabio Rindi

Macroalgal forests are habitats of critical importance in coastal areas especially because of the ecosystem services they provide, since they are habitat formers, nursery areas, primary producers and bioindicators. In the Mediterranean, most macroalgal forests consist of Cystoseira sensu latu populations. These ecosystems are seriously threatened by multiple stressors, both natural and human induced, and retracted in the last decades with consequent habitat fragmentation; the decline of these communities may lead to loss of ecosystem services and biodiversity thus making conservation and restoration actions necessary. Two key objectives of this Ph.D. are to understand the possible causes impairing the success of macroalgal forests restorations and to identify patterns in the associated community structure that may allow the definition of standardised indicators of the conservation status for these ecosystems.
Manipulative experiments have tested hypotheses concerning factors that may affect recruitment and viability of Gongolaria barbata juveniles, since early life stages are more sensitive to stressors than adults and their loss affects the long-term persistence of canopies.
The epiphytic vegetation is an important component of macroalgal forests communities and was investigated implementing both traditional and molecular methods (barcoding and metabarcoding) from 5 sites of the Conero Riviera hosting populations of G. barbata in different conditions of conservation.

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Building ecological pedagogies: landscape architecture as a translator
Thomas Cabai, Matteo Poli

As the world confronts escalating rates of biodiversity loss and ecological degradation, the imperative for effective environmental action becomes increasingly critical.
This research focuses on the role of landscape architecture in this context, not only as a form of environmental intervention but also as a pedagogical and translational tool. The study explores the historical and theoretical underpinnings of biodiversity management, examining how landscape architecture has evolved in response to changing ecological and societal needs.
It addresses the central importance of cognitive biases in the perception of the current sixth mass extinction, emphasising the pedagogical potential of landscape architecture to bridge the gap between scientific understanding and public perception of ecological issues. A selection of case studies will demonstrate how landscape architecture can communicate complex ecological dynamics effectively, facilitating a deeper public engagement and understanding of biodiversity issues.
By situating landscape architecture at the confluence of ecological science, cultural interpretation, and spatial design, the study aims to contribute significantly to the discourse on sustainable environmental design and management. This approach seeks not only to mitigate the impacts of ecological crises but also to enhance the resilience of both human and non-human communities in the face of ongoing environmental change.

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Fungi in action against hexachlorocyclohexane: a focus on biosurfactants from fungal biodiversity
Alessandra Riga, Andrea Ceci, Veronica Spinelli, Anna Maria Persiani

Hexachlorocyclohexane (HCH) is a highly persistent organic pollutant of global concern, involving severe risks for human health and ecosystem functioning. Mycoremediation represents a feasible nature-based solution for the restoration of soils polluted by HCH thanks to the ability of fungi to tolerate, bioaccumulate and degrade it. Known for its insecticidal properties of one of its isomers (γ-HCH), it has been used for a long time in European soils and despite the ban in the Stockholm Convention, high concentrations exceeding the threshold values have been found in many areas. One of these is the National Priority Site “Bacino del Fiume Sacco” within the Metropolitan City of Rome that has been selected as a study area. Soil cores up to 1 m of depth, divided in topsoil and subsoil samples, were collected from 2 plots. To isolate fungi able to utilise HCH as the sole C-source, an isolation in enrichment conditions was carried out providing an high concentration of isomers’ mixture (α-, β-, γ- and δ-HCH). A total of 49 fungal strains was isolated, mostly belonging to Fusarium and Alternaria genera. To evaluate the ability of these fungi to produce biosurfactants, metabolites that enhance HCH biodegradability, three tests were carried out: oil emulsification activity test, oil displacement test and drop collapse assay. The results of the assays showed the ability of some strains to produce biosurfactants, making them suitable candidates for further investigation.

Valorisation

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Valorisation of the Italian biodiversity: specialised metabolism in the Rosid clade
Leonardo Bisson, Stefano Negri, Mauro Commisso, Gianluca Zorzi, Fabio Pietrolucci, Valentina Dusi, Carolina Ramos, Fabio Pinzauti, Sebastiano Nigris, Barbara Baldan, Sebastiano Andreatta, Daniele Zanini, Roberto Fiorentin, Maria Carmela Caria, Alfredo Maccioni, Emmanuele Farris, Simonetta Bagella, Francesco Sgadari, Rosario Schicchi, Anna Geraci, Alfredo Carratello, Emanuela Martino, Nicola Ardenghi, Francesco Bracco, Valeria Cavalloro, Alice Fossati, Linda Avesani, Flavia Guzzo

Plants are exposed to abiotic and biotic stimuli by producing phytochemicals classified as specialised metabolites. To date, more than 400,000 different specialised metabolites have been identified in plants, and this number might be underestimated since only a few species have been analysed so far. The largest part of the world's global flora is still chemically underexplored, constituting a precious source of novel secondary metabolites. This project aims to valorise the Italian biodiversity flora by using a bio prospecting strategy on the Rosid cluster, in order to gain insights on how plant secondary/specialised metabolic pathways have spread, evolved, and diversified within this clade. The Italian flora include more than 12,000 species and 2427 species belonging to the Rosid clade, representing 20% of the total. Rosid clade can be further split in two main branches, as suggested by the recent APGIV classification. In Italy, most of the species belong to the Malvids crown clade, representing 54.3% of total Rosid, whereas Fabids include less species (45,0%). Based on these data, we decided to sample 169 Rosid species (102 belonging to the first branch and 65 to the second one). Bioprospection has been performed by sampling plants in nature, in botanical gardens, and in nurseries. In particular, bioprospecting in nature was carried out in Sicily, Sardinia, Lombardy, and different areas of Veneto. Untargeted metabolomics analysis based on UPLC-HRMS is still in progress.

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Collecting key information for the management of mediterranean bioinvasions: insights from a doctoral research
Marina Chiappi, Pierluigi Strafella, Manuela D'Amen, Fernando Ferri, Patrizia Grifoni, Ester Napoli, Sonia Smeraldo, Noemi Biancone, Giuseppe Scarcella, Carmen Ferrà, Francesca Luzi, Stefano Guicciardi, Giorgio Mancinelli, Alessio Bonaldo, Antonina De Marco, Francesco Paolo Fanizzi, Beatrice Fracasso, Sara Mancarella, Sara Bonanomi, Carlotta Mazzoldi, Filippo Piccardi, Simone D'Acunto, Ernesto Azzurro

The increasing pressure posed by biological invasions underscores the importance of advancing both our understanding and management capabilities, yielding ecological and socio-economic advantages.
Within the framework of my PhD, I am contributing developing a suite of initiatives designed to provide scientific support to the adaptive management of non-indigenous species, which invaded the Mediterranean basin. Firstly, a continuous revision of the scientific literature to update the www.ormef.eu website, the most complete and accurate interactive geoportal providing occurrence records of non-indigenous fishes across the Mediterranean, Marmara, and Black Seas. The second study focuses on Anadara transversa and A. kagoshimensis, two invasive bivalves that have historically colonised the Adriatic Sea. We have documented

their abundance and spatial distribution from 2008 to 2023, undertaken stock assessments, and performed analyses to evaluate nutritional values. The third initiative, which is about to commence, aims to investigate the invasion of the blue crab Callinectes sapidus through the Local Ecological Knowledge (LEK) of small-scale fishers in three invasion hotspots. For this aim, I will employ the scientific protocols developed by the GFCM programme. This project involves fishers in scientific efforts to effectively manage the invasive species. Together, these initiatives form a multi-faceted approach to manage biological invasions.

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Economic valuation of ecosystem services in the waste management framework
Giovanni Felici

Ecosystem services, the diverse array of benefits that nature provides to humanity, are harnessed for various purposes. While their significance to society is widely acknowledged, their quantification remains a challenge. Consequently, there exist a multitude of techniques aimed at assigning economic values to ecosystem services. Recognizing the intricate interplay between these services and human well-being, ongoing efforts seek to refine our understanding of their value, promoting more informed decision- making for the sustainable management of our natural resources. The aim of this study is to investigate (i) the role of ecosystem services in our society and in our economy; (ii) the different methods for giving an economic value to ecosystem services and; (iii) an application of those techniques to a case study of waste management: the project Acquanova. The Acquanova project, which is a virtuous example of a decentralised waste management system, essentially provides two outputs: biogas production and phytoremediation. Therefore, the study will focus on how to determine the ecosystem services associated with biogas and phytoremediation and how to provide an economic value to them. The study will delve into the methodology employed to quantify the economic benefits derived from these ecosystem services, examining the costs, benefits, and trade-offs associated with their implementation.

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Biodiverse public space: collaborative processes, design attitudes, and hybrid practices for more-than-human communities
Michele Porcelluzzi, Jacopo Leveratto

The doctoral research deals with biodiversity in public spaces through the lens of architectural design.
In European countries, urban biodiversity is regulated by a legislative framework that defines a set of parameters and indicators, according to which a project is assessed only through numeric values and quantitative data (number of species, and similar). This research seeks to introduce a qualitative dimension in the discourse, emphasising factors that include spatial quality, social interactions, and community-driven dynamics. By reading biodiverse public spaces as green urban commons, it is possible to recognize their central role in collective life: these spaces have indeed a relevant potential from the perspective of social interaction, health/wellbeing, and education for all the involved generations.
Architects play a crucial role in this process, with the responsibility to move beyond traditional design approaches to engage in a dialogue with local communities. The objective is to use biodiversity to strengthen community bonds, offering the residents opportunities for expression and new interactions in public spaces. This collaborative approach extends not only to human stakeholders but also to non-human actors. The aim of the research is to present the design of biodiverse public spaces as an ongoing and

dynamic process and to identify the processes and the design attitudes that can support the work carried out by designers, public institutions, and activists.

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Which plants would you choose to study for new drug discovery? A pipeline for a phylogenetic approach
Elisa Toini, Giovanni Zecca, Massimo Labra, Fabrizio Grassi

With nearly 400,000 known plant species, each one containing its wide range of molecules, the use of a strategic approach to identify the plants to investigate is crucial to efficiently discover therapeutic compounds. One approach is the phylogenetic one, as closely related plant species tend to share biochemistry and medicinal properties. The aim of this work is to apply different phylogenetic methods to construct a pipeline useful for the selection of plants with high potential for drug research. Thus, a phylogenetic tree containing 32.223 species was taken from literature and five monophyletic subtrees were extracted for the analyses. Lists of medicinal plants correlated with 12 diseases and 12 biological activities were downloaded respectively from the CMAUP database and the Dr. Duke's Phytochemical and Ethnobotanical databases. For each, the phylogenetic signal was measured using different methods. In the presence of phylogenetic signals, subsequent analyses were done to determine the exact position of phylogenetic clumping by identifying the hot nodes. The trees containing the species descending from the hot nodes were extracted, and those with more than 14 tips were plotted. These trees contain information about the plants identified by the method as having high potential in treating the disease. This work was able to apply a pipeline of different phylogenetic methods that can be used for the selection of potential plants for drug discovery.

Poster Presentations

Session 1

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Molecular biomarkers for contaminants of emerging concern in Stenella coeruleoalba and Balaenoptera physalus
Antonino Vincenzo Alessi, Limonta Giacomo, Panti Cristina, Fossi Maria Cristina

There is not much information in literature regarding the effect of contaminants of emerging concern (CECs) on cetaceans, thus the aim of this project is to evaluate the toxicological effects of CECs identified as high priority during the WP1 within the Acitivity 1.2. “Zero-pollution”. Skin biopsies of Stenella coereuloalba and Balaenoptera physalus were treated with realistic environmental concentrations of the chosen CECs: Ibuprofen, Valsartan, Carbamazepine, di-2-ethylhexyl phthalate (DEHP), Bisphenol A, a mix of phthalates (which is a mix of the 9 most found phthalates), a mix of pharmaceuticals (which contains ibuprofen, carbamazepine, valsartan) and a super mix (which comprehends mix pharmaceuticals, mix phthalates and bisphenol A). Each biopsy was divided into longitudinal slices and incubated in a culture medium with a single compound or a mix of the chosen compounds for 24 hours. Gene expression of selected target genes was evaluated in both Stenella coeruleoalba and Balaenoptera physalus’s organotypic cell cultures exposed to the mix of pharmaceuticals, phthalates and bisphenol A. Preliminary results show no significant alteration of the molecular endpoints analysed was found for both species. On the contrary, the exposure to the mix phthalates and bisphenol A alters the expression of VAMP4, PPARα and PPARγ genes. The overall results of the ex-vivo experiment will drive the selection of target genes to be evaluated in these species in the field.

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Galdieria sulphuraria cell disruption by bead milling: kinetic model assessment and process optimization
Elena Aurino, Luigi Marra, Francesca Raganati, Antonio Marzocchella

Galdieria sulphuraria is a unicellular red alga of significant biotechnological interest. It can accumulate valuable compounds such as proteins, phycocyanin and carotenoids, making it a promising candidate for various applications, including pharmaceuticals and nutraceuticals. The breakdown of cell walls is a crucial step in the downstream process of microalgae, especially for those with tough cell walls like G. sulphuraria. The kinetic behaviour of wet G. sulphuraria biomass disruption has been estimated by batch bead milling tests in water. Protein, phycobiliprotein, and carbohydrate release into water was monitored over time while studying the effect of varying solid loading (vbeads/vsolvent) and starting biomass concentrations. This analysis aimed to identify the optimal combination of the two considered operating variables. The experimental data showed a constant metabolite concentration (plateau behaviour) after 20 minutes of milling. The impact of solid load at extended milling times (30 minutes) has been investigated, revealing an optimal solid loading of 33%. The kinetic study indicated a time behaviour resembling a Chrastil-like model. The experimental data collected at various biomass concentrations showed a maximum achievable concentration of metabolites, limiting the recovery at high biomass concentrations. Using the predicted model, the best value of biomass concentration to maximise productivity was set at 5 gDW/L, ensuring a maximum protein recovery of 80%.

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Indoor green walls for improving air quality and human well-being
Alessandro Campiotti, Elisabetta Ricciardi, Giuseppina Spano, Laura Dominici, Elena Comino, Roberto Riggio, Francesco Pitasi, Laura Ribotta, Silvia Barbero, Giovanni Sanesi, Carlo Calfapietra, Chiara Baldacchini

A case study to prove the environmental and social benefits of indoor green walls as an example of Nature based solutions (NbS) has been developed, implemented, and assessed in a primary school in Turin (Italy), through a collaborative process involving the school's pupils and teachers, staff from the municipality, and academia. The impact of the wall on air quality and human well-being has been monitored across time. The air gaseous pollutants' concentration has been measured before and after the wall installation and the amount of particulate matter (PM) removed by the wall over one year has been assessed as a function of the plant species. The benefits provided to children were evaluated through questionnaires focusing on their pro-environmental attitude and behaviour. Results showed positive impact of the green wall in removing PM, but no impact on air gaseous pollutants' concentration was observed. A positive impact on pupils have been obtained, but lower than expected. The study allowed to highlight how challenging monitoring in school is, also including the role played by the mitigation measures adopted in school contexts after the COVID-19 outbreak, and lessons learned for the development of future assessment methods are presented.

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The development of an impact evaluation framework to explore the Nature-based Solutions potential of Photovoltaic Farms
Marta Cotti Piccinelli, Caroline Nash, Stuart Connop, Carlo Calfapietra, Chiara Baldacchini

This study investigates the value of Photovoltaics (PV) farm as a Nature-based Solution (NbS). With the global imperative for renewable energy amid climate change concerns, the transition to photovoltaic technologies is crucial. Conventional PV installations have raised environmental concerns, necessitating innovative approaches to mitigate their impacts. Drawing upon the principles of NbS, this research aims to address the multifaceted challenges posed by PV farm while promoting biodiversity, ecosystem services, and sustainable development. Through a comprehensive analysis using Miradi-Adaptive Management Software, environmental threats associated with PV farm were classified, and mitigation strategies were proposed. Result chains were developed to illustrate the theory of change and present a set of key performance indicators addressing societal challenges within the context of PV farm. This study establishes a standardised framework applicable across diverse bioregions, facilitating implementation and comparisons of effectiveness across various sites. Overall, this research contributes to the discourse on integrating renewable energy technologies with nature-based approaches, offering valuable insights for practitioners and researchers dedicated to enhancing energy system sustainability while conserving ecosystems.

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The monitoring of ascidian biodiversity in the Venice Lagoon
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Studying biodiversity is essential for protecting our environments and their species, especially in sensitive areas like the Venice Lagoon. My project focuses on assessing the diversity of ascidians, the main fouling organisms in the Lagoon. As part of the PNRR project, I aim to identify ascidian species in the Lagoon, incorporating historical data in my analysis. This involved analysing literature from the 18th century to nowadays and conducting fieldwork at six sites near Chioggia (Southern Lagoon) and one site in Venice (Central Lagoon). Sampling occurred in Venice in May 2023, in Chioggia in October 2023, in Chioggia in February 2024 and in Venice in March 2024. Samples were preserved in 4% formalin for morphological analysis and 99% ethanol for molecular studies targeting the CO1 mitochondrial gene fragment. Initial analysis shows ascidians have been documented in the Venice Lagoon since the 18th century. Various scientists described them over time; the last comprehensive survey was in 1979 by Prof. Brunetti, listing 10 species across 26 sites in Chioggia. During my sampling, I identified 12 species, six overlapping with Brunetti's findings (including Ciona intestinalis, now C. robusta). Additionally, I confirmed the presence of invasive species (Botrylloides violaceus (1998), Styela clava (2022)), and of Botryllus gaiae (2020). Notably, I discovered three new species records for the Venice Lagoon. Future sampling will further explore the Lagoon's ascidian diversity.

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Integrated approach for urban soil monitoring: Plant-Microbe interactions and Antibiotic Resistance in Milan (Italy)
Luca Di Stasio, Annamaria Gentile, Gianmaria Oliva, Dario Nicola Tangredi, Paolo Piccolo, Francesco Guarino, Angela Cicatelli, Werther Guidi Nissim, Giovanni Vigliotta, Stefano Castiglione

The rapid urbanisation, population growth and anthropogenic pressures over the past decades have led to concerning consequences for urban soil ecosystems; moreover, they are contributing to the presence and increase, in urban soils, of Antibiotic Resistant Bacteria (ARB). The restoration of degraded and/or contaminated urban soils by safe green technologies is the challenge of the near future. In this regard, the combined use of plants and microorganisms represents a promising, economical and eco-friendly Nature Based Solutions (NBS) approach.
Our study focusing on two main aspects, Plant Growth Promoting (PGP) activities and antibiotic-resistance of 300 bacterial strains isolated from a contaminated urban area of Milan (Italy). We found that 28% of microorganisms produced siderophores, 56.2% solubilized phosphates and 40.0% produced about 8 µg mg-1 (dry weight) of indole-3-acetic acid (IAA). Furthermore, 47.6% was highly resistant to at least one of tested antibiotics (ampicillin, rifampicin, tetracycline, gentamicin, vancomycin) and 13.6% of these was multi-resistant to at least 3 antibiotics. Finally, 69.2% of resistant bacteria and 75.0% of multi-resistant ones show PGP features.
Our research underlines how the abundance of ARB in urban soils poses a significant understudied threat to public health and identifies potential PGP-Bacteria that could be included into the soil managing strategies for urban site restoration.

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Extinction time statistics in metapopulations with finite carrying capacity
Alice Doimo, Amos Maritan, Sandro Azaele

Spatial metapopulation models play a crucial role in theoretical ecology, allowing the study of landscape structure's impact on global dynamics, as well as dispersal between habitats and colonisation events. This study extends the traditional metapopulation framework by introducing stochasticity, inherent in natural meta-communities. We investigate how stochasticity affects population persistence and dynamics, focusing particularly on the effects of finite size of local populations within the metapopulation system. Our starting point is a deterministic spatial metapopulation model developed by G. Nicoletti, P. Padmanabha, et al., which generalises Hanski and Ovaskainen's classical model by incorporating landscape structure through a network of interconnected habitat patches. Adopting a bottom-up approach, we derive the Fokker-Planck equation from individual-based microscopic processes. Under suitable approximations, we analytically study the scaling of survival probability in the vicinity of the critical transition between survival and extinction regimes. Our findings suggest that the introduction of stochasticity does not produce new effects in metapopulation dynamics. Instead, we observe a collapse of survival probability curves close to the critical point, demonstrating consistency with finite size scaling predictions.

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Ecological traits of coastal macroalgal species in a touristic area: case study of Schiacchetiello Bay (Gulf of Naples)
Rosa Donadio, Ermenegilda Vitale, Giovanni Libralato, Simonetta Fraschetti, Carmen Arena

Tourism on coastal ecosystems is becoming a growing concern, mainly when recreational activities interact with vulnerable habitats. This study aimed to compare the ecological characteristics of a brown (Dictyota sp.), green (Chladophora sp.), and red (Jania sp.) macroalgal species in the "Schiacchetiello" beach (Naples), affected by significant tourism during summer to assess the capability of the three species to utilise the habitat resources. We monitored environmental (water quality, temperature, pH, salinity, irradiance) and algae eco-physiological variables by field surveys and laboratory analyses, including photosynthesis, pigment composition, and thallus antioxidant properties. The preliminary results showed higher photochemical efficiency and carbohydrate production in Dictyota and Chladophora than Jania, which exhibited higher thallus dry matter content than Dictyota. These differences among species suggest a different environmental resource utilisation, indicating a higher carbon investment in structural defences by Jania and Dictyota than Chladophora, suggesting different adaptations to impacted conditions probably also triggered by the water quality of the touristic site.

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Toward the identification of novel natural extracts against Tyrosinase-related pathologies
Alice Fossati, Valeria Cavalloro, Simona Collina, Emanuela Martino
Tyrosinase is the key enzyme responsible for the production of melanin in skin cells and neuromelanin in substantia nigra dopaminergic neurons. Tyrosinase dysregulation can lead to two different pathological conditions: (i) melanoma, an aggressive skin cancer[1], and (ii) Parkinson's disease (PD), a progressive, chronic neurodegenerative disease associated with movement disorders[2], [3]. Moreover, recent literature evidenced the co-occurrence of the two pathologies[4]. Accordingly, the goal of this study is to identify plant extracts that can alleviate symptoms and outcomes of tyrosinase-related pathologies.
Plants belonging to different botanical families were selected via a taxonomic approach during the NBFC project. Subsequently, methanolic extracts were prepared, and their phytochemical profile was drawn. A preliminary screening was performed on 27 different extracts after chlorophyll removal. Anti-tyrosinase, anti-acetylcholinesterase and antioxidant activities have been evaluated, being linked to neuroprotective properties. Carissa macrocarpa (Eckl.) A.DC. and Adenophora lilifolia (L.) Ledeb. ex A.DC. extracts emerged as the most promising. Further in vitro investigations are ongoing to evaluate their potential to counteract melanoma and PD.
1) Arnold M. et al; 10.1001/jamadermatol.2022.0160
2) Dorsey E.R. et al; 10.1001/jamaneurol.2017.3299
3) Jin W., Stehbens S.J. et al.; 10.1093/jpp/rgad107
4) Bose A., et al.; 10.3233/JPD-171263

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Mind the Gap: developing new eDNA primers and collection method enhancements to deepen the biodiversity of tardigrades in leaf litter
Federica Frigieri, Elia Lo Parrino, Michele Cesari, Ilaria Giovannini, Gentile Francesco Ficetola, Lorena Rebecchi, Roberto Guidetti

Leaf litter exhibits optimal microclimatic conditions to host a high faunal biodiversity, including tardigrades. However, the latter biodiversity in soil-related environments is often overlooked due to time-consuming extraction procedures. Environmental DNA methods offer a solution but require specialised primers and extensive reference libraries. Therefore, nine primer pairs for the COI gene and seventeen for the 18S gene reported in literature were tested in-silico, highlighting one suitable pair for COI but none for 18S. Consequently, a new primer pair for 18S was designed, specific for the Eutardigrada, the only tardigrade class present in leaf litter at our latitudes. Several samples belonging to three types of leaf litter (beech, white fir and mixed beech/white fir/maple) were collected from Parco Nazionale Foreste Casentinesi (Tuscan-Emilian Apennines). Animals extracted from samples are utilised to implement reference libraries and will be used to assess primer suitability through in vivo testing. Additionally, a preliminary investigation of the influence of leaf litter thickness and fragmentation on tardigrade extraction efficiency with Berlese-Tullgren funnels was carried out in Tuscan-Emilian Apennines samples. This study represents a significant step towards a better understanding of tardigrade biodiversity and ecology, utilising new molecular approaches.

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Assessing the protection effectiveness of Marine Protected Areas in space and time along the Italian coasts

Sara De Benedictis, Alberto Colletti, Erika Fabbrizzi, Luca Licciardi, Simone Maria Santo Musumeci, Chiara Silvestrini, Simonetta Fraschetti

Since the 1970s, the European Community and the European Union have promoted a series of legislative measures to improve the protection of biodiversity. Marine Protected Areas (MPAs) represent one of these instruments, which through the elimination and mitigation of anthropogenic impacts, have the priority objective of conserving biodiversity and promoting and ensuring sustainable management of environmental resources. Our study aims to assess the protection effectiveness of 14 Italian MPAs through underwater photographic sampling of benthic communities of hard substrate. Sampling is carried out in fully and partially protected zones and in control areas outside the MPAs to assess whether the exclusion or mitigation of anthropogenic activities can change the distribution and composition of the communities. The experimental design and sampling sites correspond to those considered in Aphrodite-Venere project (2001), to evaluate and monitor over twenty years the change of the benthic communities from a structural and functional point of view. The historical data set of 14 MPAs could be a useful tool for management entities, providing an overview of the biodiversity state at national level.

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Chemical characterisation and analysis of variation in Sb speciation in brake dust as a source of potentially toxic elements

Elisa Di Martino, Silvia Canepari, Andrea Ceci

In urban areas, the brake systems of rail vehicles are a source of pollution for potentially toxic elements (PTE) with Cu, Fe, Mo, Mn, Sn, Sb and Zn being the main constituents of brake wear particles. Sb is the most abundant element in brake dust (BD); in the environment, it occurs in two different chemical species: antimoniate (Sb-V) and antimonite (Sb-III), and its environmental effects depend on its oxidation state. Since the aim of the PhD project is on fungal interactions with Sb and its chemical species, occurring in complex matrices such as BD and BD-enriched soils, a chemical characterisation of two types of BD was carried out. The sampling site falls within the SIN 'Bacino del Fiume Sacco' and is in Colleferro, within the Metropolitan City of Rome. The Colleferro-Scalo railway station is a source of deposition of BD in soil and is adjacent to the two soil sampling plots. Consequently, the chemical characterisation of two types of BD was carried out: the BD was sieved (≤ 63; 50 µm), and its elemental concentrations (2, 5, 10, 20 mg g-1) were analysed by ICP-MS, both in soluble and insoluble fractions. The method for Sb speciation by HPLC-AFS was also optimised, it will be used for future analysis.
Thanks to this characterisation, it will thus be possible to fortify and characterise the soils sampled with BD and to perform screening and tolerance tests on the fungal strains isolated from the soil sample for subsequent applications, as planned in the research project.

Session 2

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Microbial consortia as biodiverse alternatives for plant protection
Carmen Cimminella, Rachele Isticato, Stefany Castaldi, Marina Papaianni, Gelsomina Manganiello, Sheridan L. Woo

EU restrictions are in place to reduce the ecosystem and health risks from the use of chemical products for disease control in agriculture, thus the search for sustainable alternatives is an imperative. Microorganisms play a key role in biodiversity crucial for preserving environmental resources and consumer well-being. This work aims to develop an innovative formulation using selected Bacillus species, applied individually or in consortia, to control Pseudomonas syringae pv tomato, a pathogen causing severe tomato crop losses. Bacillus gibsonii, B. vallismortis, B. amyloliquefaciens were isolated from extreme environments, sand samples from salt pans. They showed compatibility when cultured together, suggesting potential use in consortia to enhance application efficacy. In vitro and in planta assays on tomatoes infected with P. syringae, previously treated with Bacillus spp. by inoculation or soil watering, were used to determine antibacterial properties. Symptoms evaluations were expressed by measuring Disease Incidence (DI%) and Disease Severity (DS%). No reduction in DI% was observed for any treatments compared to the infected untreated control. However, Bacillus consortia exhibited a better control capacity demonstrating a 10% decrease in DS% compared to each single species, and a 20% decrease in compared to the infected untreated control. These results suggest that bioformulations consist of multiple beneficial microorganisms to enhance biocontrol effectiveness.

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Integrated approach for urban soil monitoring: Plant-Microbe interactions and Antibiotic Resistance in Milan (Italy)
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The rapid urbanisation, population growth and anthropogenic pressures over the past decades have led to concerning consequences for urban soil ecosystems; moreover, they are contributing to the presence and increase, in urban soils, of Antibiotic Resistant Bacteria (ARB). The restoration of degraded and/or contaminated urban soils by safe green technologies is the challenge of the near future. In this regard, the combined use of plants and microorganisms represents a promising, economical and eco-friendly Nature Based Solutions (NBS) approach.
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show PGP features. Our research underlines how the abundance of ARB in urban soils poses a significant understudied threat to public health and identifies potential PGP-Bacteria that could be included into the soil managing strategies for urban site restoration.

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Long-term landslide biodiversity monitoring: the case of Pomezzana, Tuscany
Emanuele Giachi, Federico Preti, Carlo Viti, Andrea Dani, Marco Cabrucci, Francesca Decorosi

The use of plants as construction materials extends the multifunctionality of plants in engineering structures and responds to the growing societal demand for more environmentally friendly approaches to structural design. EU policies and regulations mandate the use of nature-based solutions such as Soil and Water Bioengineering (SWBE) practices. These techniques manage natural hazards by using plants as living material in conjunction with inert natural material to achieve two primary objectives: soil stabilisation and environmental mitigation, thereby initiating natural ecological processes. The research aims to evaluate the technical and ecological effectiveness of a SWBE intervention for rehabilitating shallow landslides following the 1996 Versilia floods. The project aims to monitor vegetation development and evaluate soil microbial composition by comparing the intervention-restored area with surrounding regions. Field sampling and analysis will be carried out on two landslide sites resulting from the same extreme rainfall event: the first site was restored using SWBE techniques and the second site was a naturally evolving landslide. A multifaceted methodology will be developed to assess differences and correlations between ecological processes and the technical effectiveness of the landslide restoration intervention.

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Ecological and microevolutionary impact of climate change on mountain hares (*Lepus timidus*)
Elisabetta Soi, Massimo Scandura, Marco Apollonio, Laura Iacolina, Roberta Chirichella, Caterina Vascelli, Andrea Mustoni, Marco Armanini

Climate change poses significant challenges to mountain biotas. Under the pressure of increased mean temperatures and changed precipitation regimes, animal species are forced either to move or to quickly adapt. Our project deals with the biological response of mammals adapted to high elevations in the Alps. Ongoing genetic and ecological impacts of climate change on the mountain hare (Lepus timidus) are under investigation in the Adamello-Brenta Natural Park. With the aim to detect mountain hare (MH) altitudinal shifts and its overlap with the more thermophilic brown hare (Lepus europaeus), a non-invasive genetic survey, based on faecal sampling and genotyping, is carried out. This approach is also aimed at verifying the extent of induced hybridization between the two species and potential signature of adaptive introgression in MH. During the first year a total of 252 faecal samples were collected in plastic tubes containing silica beads along transects located between 938 m and 2548 m a.s.l., and stored at room temperature until their transfer to the genetic laboratory. Genotyping of the collected samples is in progress. Camera trapping data gathered by the park in the last two years are going to be analysed as an additional source of information on species distribution and melt phenology in MH. The data collected through the above-mentioned research will be invaluable in understanding the possible changes that alpine mammal communities will undergo in a global warming scenario.

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The effect of nature-based solutions on human nutrition and food security in urban settings
Aliki Kalmpourtzidou, Hellas Cena

Increased land use as a result of urbanisation is one of the most rapid human-driven causes of biodiversity loss. Nature-based solutions (NbS) for sustainable food production in combination to lower land and water use are essential for the reduction of biodiversity loss and human.This systematic review aims to assess the effects of NbS on human health and wellbeing in urban settings worldwide.In this analysis results related to nutrition and food security will be presented.The PRISMA guidelines are followed. Full-length articles in English language, published as of 2010 are included. Both quantitative and qualitative studies are eligible. The quality assessment with diverse studies (QuADS) tool was used for the quality assessment of studies. PubMed, Web of Science and scopus were searched.After duplicates removal, 8730 titles and abstracts were screened. After full text screening, 273 papers were included.Most of the studies took place in urban gardens (63%). Urban farming (13%), parks (3%) and farmers' markets followed (3%). Less studied NbS were the green roofs, urban forests and blue spaces. Gardening has been shown to be beneficial for the wellbeing and nutrition populations. Due to high land use for the feeding of urban populations, alternative food production techniques without soil use are important.Soil-free rooftop farms and vertical farming could increase the vegetable and fruit production in cities and improve the diet quality of citizens.

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Neuroprotective effects of plant extracts on eukaryotic models of Parkinson's disease
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Ageing and age-related neurodegeneration are among the main challenges in modern medicine (https://doi.org/10.18632/aging.104069) and Parkinson's disease (PD), which is associated to the misfolding of α-synuclein protein, affects about 10 million people worldwide (https://doi.org/10.1038/s41531-021-00203-9). Plants are historically recognized as a source of bioactive molecules useful for several applications in the fields of medicine, cosmetics and food industry. In recent years, the protective effects of a number of bioactive compounds have been highlighted on a wide variety of diseases such as diabetes, cardiovascular and neurodegenerative diseases (https://doi.org/10.3390/molecules23123283). Among the purposes of the National Biodiversity Future Centre is the valorization of the huge flora biodiversity. Then, to identify still unexplored bioactive molecules with potential neuroprotective properties, the extracts of 63 Italian endemic plants were screened on eukaryotic models of Parkinson's disease expressing human α-synuclein.
We assessed the effects on cell growth, cellular longevity and ROS levels, as well as protein aggregation, all phenotypes associated with α-synuclein-dependent toxicity and we selected 7 plants which are now under investigation to elucidate the underlying mechanisms that contribute to the prevention and inhibition of α-synuclein aggregation.

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What aids and what hinders: the effects of forest structure and composition on saproxylic beetles community
Alice Lenzi, Francesco Chianucci, Simona Maccherini, Alessandro Campanaro

Saproxylic beetles are one of the main components of the forest fauna, showing a high diversity both in terms of species and ecological roles. In the current scenario of climate crisis and biodiversity loss, the knowledge of community composition, as well as how environmental variables can influence it, is highly needed. In this context I present an ongoing study on saproxylic beetles as part of my PhD project at the University of Siena and CREA - Research Centre for Plant Protection and Certification of Florence, and in the framework of a multi taxonomic research which includes a number for collaborators from different institutions.
The main objective is to investigate how the abundance and diversity (taxonomic and functional) of saproxylic beetles, as well as of other taxa (i.e., bryophytes, lichens, land snails and slugs and vascular plants), can be influenced by forest characteristics and environmental variables. The study is carried out in two areas in Tuscany: State Reserve “Belagaio”, characterised by a holm oak and an extrazonal beech forests (350-250 metres a.s.l.), and “Alpe di Catenaia”, hosting mountainous beech forests (1200-1300 metres a.s.l.) under different silvicultural regimes. This given, biodiversity data are coupled with forest inventory and management information of the selected areas, including dead wood volume and typology, canopy cover and stand attributes, tree-related microhabitats, all collected at forest plot level.

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Assessment of Phthalate concentrations in four edible fish species along the Italian coast
Andrea Maccantelli, Maria Cristina Fossi

Phthalates (PAEs) are an emerging contaminant of concern due to their widespread use in industrial activities and potential release into the environment, but little is known about their presence and accumulation in marine organisms. The aim of this study is to assess PAEs burden in commercial fish species caught in five macro-areas along the Italian coast (North and Center Adriatic Sea, Sardinian Sea, Ligurian Sea and Tyrrhenian Sea). The levels of 11 PAEs of environmental relevance were evaluated in the muscles of B. boops (n=104), E. encrasicolus (n=90), M. barbatus (n=68) and S. pilchardus (n=97) using a specific analytical method. DPrP was <LOD in all species and in all areas investigated, whereas DEHP, DIBP and DBP are the most frequently detected PAEs with highest concentrations. Statistically significant differences were observed between sampling areas and between species, both for the total amount of PAEs and for the concentrations of individual substances. Higher levels were observed in S. pilchardus, especially in the Ligurian study area, with a mean Σ-PAEs value of 332.70 ± 165.33 ng/g ww. The results of this study improve the understanding of PAEs accumulation in Mediterranean species. Furthermore, the known endocrine disrupting properties of the PAEs detected and the commercial value of the species analysed highlight the need for specific additional studies to better understand the potential impact on the food web and human consumption.

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Characterization of new bioactive molecules for the treatment of neuroinflammatory and neurodegenerative diseases
Pallab Majumder, Enrica Caterina Pietronigro, Vittorina Della Bianca, Eleonora Terrabuio, Alessandro Bani, Nikolaos Vareltzakis, Gabriele Angelini, Antonella Calore, Gabriela Constantin

Alzheimer's disease (AD) is a neurodegenerative condition known for its gradual cognitive deterioration and neuropathological aspects such as amyloid-beta deposits and neurofibrillary tangles. Project aim is to identify new bioactive extracts with anti-inflammatory and neuroprotective effects for treating AD. In vitro, we did an MTT test to evaluate toxicity of 23 extracts on murine neuronal and microglial cell lines and primary microglia. Results found no cellular toxicity in Althea Officinalis, Adenophora Lilifolia, Dianthus Superbus, Succisa Pratensis, Typha Laxmannii, Acalypha Virginica, Verbascum Thapsus and Actinidia Deliciosa. The anti-inflammatory properties of safe extracts were tested on microglial cell lines and primary microglia. Althea, Adenophora, Dianthus, Succisa, Typha, and Actinidia reduce nitrite levels on LPS-treated cells. We also found that Althea Officinalis, Dianthus Superbus, and Actinidia deliciosa protect neuronal cell lines against glutamate-induced damage. In our in vitro experiments, plant extracts showed neuroprotective and anti-inflammatory properties relevant to brain neurodegenerative and neuroinflammatory illnesses. In future, plant extracts effects on pro-inflammatory cytokine release in microglia cells exposed with LPS will be measured by ELISA, and their neuroprotective effects in neuronal primary cells will be examined.

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Unravelling the pathogenesis of the mortality events affecting marine organism of the Mediterranean Sea
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In the last decades MME events affected different marine taxa across 8 phyla, extending for thousands of kilometres along the coastline of Greece, Spain, France, Italy, and Croatia. Different components have contributed to the mortalities, making the phenomena multifactorial and complex, involving infectious and non-infectious factors related to the individual, the causal agent and the environment. For many of the species affected we still have scarce information on their biology and, subsequently, establishing disease pathogenesis is challenging. In marine vertebrates and invertebrates, IHC has recently found a renaissance regarding its applications in morpho-pathology microscopic-based methods. The use of commercial antibodies originally developed for mammals and targeting proteins involved in different pathways of the pathogenic process, such as markers of cellular stress (Hsp70, Hsp90, p53), inflammation (TNFα), and markers of cell death, has raised concerns since they have been used in marine species not testing their real effectiveness. In this work we aim to study, and systematically validate, the reactivity of some IHC markers to describe disease pathogenesis in different vertebrate and invertebrate species affected by mortality in the Mediterranean area, such as Mullus barbatus, Paracentrotus lividus, Mytilus galloprovincialis and Pinna nobilis.

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Soil microbial diversity in Italian urban parks under different vegetation covers
Simon Masson, Matteo Chialva, Cristina Votta, Teresa Mazzarella, Valentina Fiorilli, Elena Barni, Davide Bongiovanni, Federica Larcher, Irene Stefanini, Luisa Lanfranco

Urban green areas represent crucial components of cities as they can provide many ecosystem services. In this work, we aim to investigate the taxonomic and functional biodiversity of urban soils focusing on the microscopic component and assess their relationships with plant coverage and physico-chemical soil features, with the long-term aim to support the design of urban greenspaces more resilient to climate changes and restoration programs.
In autumn 2022, we sampled soils under two different plant coverage (tree and grassland) from three historical and five recent parks (established after 2000) in the city of Turin and from two close less disturbed environments as control. A shotgun metagenomics approach was performed using Illumina sequencing. At first, reads were assigned with Kaiju to profile microbial community diversity and structure. The Shannon alpha-diversity index showed a greater diversity for prokaryotes and fungi in urban parks compared to less disturbed environments. Moreover, beta-diversity analysis revealed a significant impact of the age of the park and the vegetation type on both communities studied. While functional annotation of sequenced metagenomes is currently ongoing, functional predictions was performed using FAPROTAX and FUNGuild softwares: this analysis revealed less prokaryotes linked with the nitrogen cycle, more fungal pathogens and less fungal symbionts (also confirmed by the relative abundances of arbuscular mycorrhizal fungi) in urban parks.

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Evaluation of anti-glycative and hypoglycemic properties of twelve edible plant extracts
Giulia Moretto, Raffaella Colombo, Adele Papetti

Advanced glycation end products (AGEs), generating in the non-enzymatic reaction between reducing sugars or dicarbonyl compounds (methylglyoxal - MGO, glyoxal - GO) and the side-chain amino groups of lysine or arginine of proteins, are involved in various diseases [G. Vistoli et al, Free Radical Research 2013, 47, 3–27]. Therefore, the aim of our study is to evaluate both the anti-glycative properties of twelve edible extracts and their hypoglycemic activities by inhibiting α-amylase (a potential approach to control blood glucose levels). Different model systems have been set up to evaluate the extracts' activity at the different stages of the glycation. By using NBT (blue nitrotetrazolium chloride), the extracts' capacity to inhibit the formation of Amadori products in the first stage was tested. In the intermediate step a glycative agent (MGO) and a protein (bovine serum albumin) were incubated with extracts at 37 °C, pH 7.4. In addition, extracts' ability to trap MGO and GO has been investigated [M. Maietta et al, Food Function 2018, 9, 1545–1556]. The hypoglycemic effects of the extracts were evaluated by an in vitro enzyme system consisting of Type VI-B porcine pancreatic α-amylase and starch, incubated at 37°C in the presence of extracts [L. Ferron et al, Molecules 2020, 25, 1958]. All extracts had anti-glycative properties at the intermediate stage of the reaction, high MGO and GO trapping capacity and hypoglycemic properties due to a reduction in starch hydrolysis.

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Extraction, structural characterization, and in vitro antioxidant and anti-inflammatory effects of alginate from Ligurian Ericaria amenatcea var. strica
Maha Moussa, Valentina Asnaghi, Silvia Vicini, Mariachiara Chiantore, Sonia Scarfi

Sodium alginates (SA) were extracted and purified from the ex-situ cultivation-apices waste of restoration steps of Liguirian brown seaweed Ericaria amentacea var. stricta. SA has employed hydrothermal-Basic extraction (HBE), undergone a thermal-depolymerization process called sodium alginate oligosaccharides (SAO). The structural characterization of both crude SA and SAO were obtained by FTIR. The bioactive properties of these extracts were also investigated, in terms of in vitro antioxidant activities and of anti-inflammatory properties in LPS-stimulated macrophages by evaluation of inhibition of inflammatory cytokines and mediators. The FTIR analysis of both crude SA and thermal treated SAO exhibited O-H, C-H, and COO- stretching which are represented by bands at 3301 cm−1 , 2926 cm−1 , and 1597–1408 cm−1 , respectively, compared to commercial alginate. SA and SAO exhibited important DPPH radical-scavenging activity (94% inhibition at a concentration of 1 mg/ml) and considerable ferric reducing potential (84% reducing potential at a concentration of 1 mg/ml). Indeed, the two extracts were able to strongly inhibit LPS-induced inflammatory mediators, such as IL-1b, IL-6, MCP-1, and TNF-a gene expression in MO-THP1 macrophages. These results pave the way for the future use of E. amentacea metabolites in industrial and biomedical applications.

Session 3

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The agricultural soil as a sink in circular economy: presence and fate of microplastics
Ateh Ndiforngu, Raffaello Cossu, Maria Cristina Lavagnolo

The Agricultural sector plays a crucial role in sustainable development and food security. Consequently, the adoption of circular economy principles in the agricultural sector has become increasingly important to ensure long-term sustainability. This translates to the utilisation of organic soil amendments such as compost, sludge, and digestate in fields where microplastics have emerged as a prominent contaminant and have acquired significant consideration as far as the use of these amendments is concerned. Their migration in the soil can occur both vertically and horizontally as their transport pattern in soil mimics that of other particles of similar size. Moreover, microplastics demonstrate the capability to adsorb, transport, and create matrices with various compounds, thus potentially exacerbating their environmental impact and facilitating their bioaccumulation within the food chain. In soil organisms, plants, animals, and humans, various micro and nano-range plastic polymers have been detected and associated with some negative health effects. Nevertheless, there is still a lack of comprehension of the extent to which agricultural soils could act as sinks to these contaminants as well as a pathway back into the food chain. These voids underscore the urgency for thorough research to evaluate the magnitude of microplastic contamination in agricultural soils and its consequences for food safety and human health as it aligns with the holistic principles of One Health.

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Fuzzy dunes: applying fuzzy approaches to map Natura 2000 and EUNIS habitats on coastal dunes from WorldView-3 imagery
Emilia Pafumi, Claudia Angiolini, Giovanni Bacaro, Emanuele Fanfarillo, Tiberio Fiaschi, Duccio Rocchini, Simona Maccherini

Mapping habitats on coastal dunes, crucial yet highly vulnerable ecosystems, requires objectivity and repeatability. Although remote sensing offers promising solutions, the effectiveness of distinguishing Natura 2000 habitats on coastal dunes from satellite imagery remains uncertain. Fuzzy approaches to image classification could enhance habitat mapping but have never been applied to coastal dunes for this purpose. Here, we compare crisp and fuzzy classification approaches to map coastal dune habitats in two Parks of Tuscany (Italy). Vegetation data from 244 plots were classified into Natura 2000 and EUNIS habitats. Using field data as a reference, we classified WorldView-3 images with crisp and fuzzy methods, comparing results through overall accuracy (OA) and Mantel tests. EUNIS habitats exhibited the highest OA (0.90), due to their simpler classification scheme, with dune scrubs and white dunes generally performing best. Fuzzy approaches, while less accurate than crisp ones (mean OA = 0.40 vs 0.58), provided a more realistic representation of vegetation patterns (mean R = 0.36 vs 0.32), highlighting the fuzzy nature of vegetation in coastal dunes. Despite challenges related to image resolution and habitat heterogeneity, combining satellite imagery with field surveys proved valuable for producing a detailed cartography, suitable for monitoring dune habitats, in accordance with the requirements of the Habitats Directive.

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Forty-year coastal vegetation dynamics in the Castelporziano Presidential Estate: an analysis of biodiversity changes
Simona Sarmati, Silvia Del Vecchio, Letizia Di Biase, Marta Gaia Sperandii, Alicia TR Acosta

Despite their ecological importance, coastal dunes are among the most threatened ecosystems in Europe. Assessing their degradation and loss along with identifying and monitoring key trends is crucial for their conservation. The Natural Reserve "Castelporziano Presidential Estate" is an ideal model for analysing long-term temporal changes in a well-preserved Mediterranean coastal dune system.
By resurveying 78 historical plots, we tracked changes in plant species occurrence and cover over the last 40 years. Temporal changes were analysed through ordination methods (DCA), species rarefaction curves, and Indicator Species Analysis. Moreover, we calculated an ecosystem function index concerning the "erosion control" service.
We observed a significant decrease in the typical species of embryonic dunes in favour of the species of fixed dunes. The xerophytic garrigues dominated by Cistus salvifolius evolved into holm-oak forests. Species richness decreased only for woody fixed dunes, while focal species cover decreased in all communities. In particular, the lower coverage of pioneer dune species may worsen coastal erosion control.
Given the low human pressure in the area, we hypothesise that natural succession drives the observed differences in species composition. Moreover, this work demonstrates how resurveying methods efficiently uncover insights into vegetation dynamics, providing a solid basis for effective conservation strategies.

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Palynology for the long-term plant biodiversity changes in Italian natural areas
Cristina Ricucci, Assunta Florenzano, Anna Maria Mercuri

This PhD project aims to reconstruct the plant biodiversity changes that characterised Italian natural/protected areas during the last thousands of years.
Palynological analyses on fossil records offer a comprehensive, long-term perspective often overlooked in traditional biodiversity studies. This perspective enables an exploration of the evolving human-nature relationship over time, assessing the plant biodiversity influencing factors and offering key information to support its protection.
To achieve this goal, 3 sites were selected due to their natural value and historical evidence of human presence: Lao Lake (Regional Natural Park of the Ligurian Alps, CN), Burano Lake (Natural Reserve and WWF Oasis, GR), and STAPE site (Pollino National Park, PZ).
Sediment cores were collected in the selected sites and sub-sampled. Palynological analyses are integrated with stratigraphic descriptions, age-depth models elaborations and microcharcoals analyses, in an interdisciplinary approach.
First results from the STAPE site in the Pollino National Park detail the dynamics of forest biodiversity over the last ~450 years. The high-resolution pollen record highlights the contribution of anthropic activities in the transition from the vulnerable association of Abies alba-Fagus sylvatica to the current beech-predominance, offering information on the local forest biodiversity history supporting the protection of a priority habitat in Europe.

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Wildfire risk assessment in nature-based solutions planning
Simona Rinaldi, Laura Sandra Leo, Silvana Di Sabatino

Wildfires pose significant threats to ecosystems, lives, and infrastructure. On the other hand, and unlike other natural hazards, fire may be seen as a positive factor if properly managed and controlled, as it contributes to specific evolution patterns of biodiversity, the shaping of some species, and the creation of a favourable environment for some others. Many factors contribute to increasing fire risk, including highly flammable vegetation encroachment or implementation. Therefore, it is necessary to gain an advanced understanding and predictive capabilities to keep people and ecosystems safe. This research project aims to explore phenomena involved in wildfire dynamics, especially those related to the influence of atmospheric and environmental conditions on wildfires, to examine the pivotal role of meteorological drivers in dictating fire behaviour, propagation rates, and spatial extent. To better understand the relationship between these two drivers in the wildfire context, some preliminary analysis will be presented and discussed. The findings of the final research project will help contribute to enhancing wildfire management strategies, particularly concerning nature-based solutions, including management, restoration and conservation actions carried out in fire-prone regions.

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Development and application of molecular markers for the description and informed management of the genetic biodiversity of Italian endemic or endangered species
Chiara Samassa, Elena Catelan, Elisa Boscari, Alessandro Grapputo, Leonardo Congiu

The present PhD project focuses on managing the genetic biodiversity of Italian endemic and endangered species through three key research lines: Firstly, it involves the comprehensive genetic characterisation of the critically endangered Adriatic sturgeon (A. naccarii) and extinct-in-the-wild Beluga sturgeon (H. huso) to support conservation plans. Secondly, it includes a population genetic study of six threatened fish species in the Po basin, in collaboration with the LIFE-Minnow project, aiming to provide scientific foundations for future restocking activities and conservational efforts. Thirdly, the project aims to evaluate the suitability of Introns as molecular markers to distinguish species and detect hybridization events by using the MIPs (Multilocus Intron Polymorphisms) approach. Overall, the project will contribute to the conservation and management of Italian fish biodiversity by informing evidence-based conservation strategies and aiding in the preservation of endangered species affected by environmental and anthropogenic factors.

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A systematic review of the toolbox for cleaning vascular plant species point-occurrence data
Diletta Santovito, Riccardo Testolin, Alessandro Chiarucci, Francesco Santi, Duccio Rocchini

The emergence and continuous improvement of global-scale biodiversity databases (e.g., GBIF) has opened new opportunities for the development of species distribution models at wide geographical scales, a powerful tool for guiding evidence-based conservation decisions. However, pulling the most out of this huge amount of data, the so-called 'biodiversity big data', is a challenge. Point-occurrence records often contain taxonomic, spatial and temporal uncertainties, potentially leading to biassed results and ill-informed decisions.
We tested a set of different tools for cleaning vascular plant species occurrence data obtained from public databases. After integrating the data, several R packages and workflows for taxonomic harmonisation and coordinate correction were assessed. All methods were compared with the aim of establishing a set of good practices and developing a robust and straightforward protocol when dealing with data from heterogeneous biodiversity data sources.
This study - addressing each step of biodiversity data cleaning in detail for the first time - helps navigate the enormous landscape of tools for the cleaning of point-occurrence data, a critical and time-consuming process that is often overlooked.

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Investigate the occurrence of microplastics in urban environments and their impacts on soil microarthropods
Marco Scaramelli, Maria Agnese Sabatini, Daniela Prevedelli, Elisa Bergami

Microplastics (MP, <5 mm) are ubiquitous in terrestrial environments, being found in soils subject to different anthropogenic pressures. Their widespread occurrence is cause of concern as it may harm soil health, functions, and affect biodiversity. Acquiring data on MP occurrence and effects on target soil species is thus urgent to understand their whole impact on soil ecosystems. During the first year of PhD, an efficient laboratory protocol to extract MP from soil samples was set up (recovery efficiencies of 96.7±1% for PET and PS, and 98.9±0.6% for PP sub-millimetric fragments). This was applied to samples collected from a parking lot in Reggio-Emilia (Italy) as a model for urban environments. High MP levels were observed, ranging from 100,000 to 260,000 N/kg, derived from weathered plastic parking grids. The toxicity of the most abundant MP found was evaluated through a chronic test with Folsomia candida (Collembola). Synchronised juveniles were exposed to increasing MP concentrations (up to 1000 mg/kg), and effects on mortality were recorded after 28 days. The first results show a mortality rate of 56.7±5.8% in springtails exposed to the highest MP concentration.
Finally, to evaluate MP toxicity on species representative of Emilia-Romagna soil biodiversity, springtails were extracted from natural soils, identified and selected. Currently, parthenogenetic populations of different genera are maintained in the laboratory for molecular characterization and future toxicity tests.

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Nature as a common heritage of European people: a legal assessment of the EU biodiversity conservation framework
Irene Sicignano, Federico Casolari

The research project will critically analyse the legal regime for biodiversity protection in the European Union, trying to investigate the way in which it has managed nature so far and how it could be improved for the common good of present and future generations. The main goal is stressing the need to take a solidaristic and cooperative approach between Member States and rethink the principle of sovereignty over national resources with regards to planetary natural heritage in light of its transboundary and mobile nature, which makes any domestic conservation strategy ineffective if not strictly coordinated with other States' action. Instruments for realising such a model are already available in the EU and the sustainable development principle mandates such a vision, for the benefit of present and future generations. In this context, the Natura 2000 network represents a great opportunity for investigation of a transnational legal regime for natural habitats; it will thus be critically examined to understand its achievements and deficiencies. With Member States gaining awareness of the issue and integrating nature conservation in their constitutional values, this historical moment represents a great opportunity for sharing a vision of biodiversity as a common heritage of European people to be preserved and restored for our civilization to thrive. This way Europe, through its influence power, can stimulate positive change worldwide, making sustainable development possible.

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Nature-Based Solutions and Urban farming: the impact of Green Barriers on Air Quality, Soil Health and Food safety
Linda Signorini, Domenico Toscano, Antonio Giandonato Caporale, Simonetta Giordano, Paola Adamo

Urban agriculture offers social, economic, and environmental benefits. However, the potential risks associated with the cultivation of edible crops in urban areas have been overlooked in many studies. This study aims to assess air quality near urban gardens, evaluating the effectiveness of green barriers (Platanus occidentalis; Nerium oleander) in containing the spread of particulate matter within the green zones designated for urban gardening. The investigation focuses on barriers' ability to reduce the deposition of airborne particles on soil and plants, mitigating the potential risks of assimilation and accumulation. The feasibility of leaves as biomonitors to intercept particulate matter and associated pollutants is explored. Soil sampling was conducted both outside and inside the green barrier, and soils were analysed to determine their geochemical profiles by acid mineralization and ICP-MS. Air quality was monitored by a condensation particle counter for fine particles and by a charger dosimeter for ultrafine particles. The leaves forming the green barrier were categorised into washed/unwashed samples, which were analysed for potentially toxic metals and polycyclic aromatic hydrocarbons. This study provides insights into the efficacy of green barriers in mitigating urban air pollution. The findings shed light on the risks associated with urban agriculture, emphasising the importance of considering both the benefits and challenges of urban agriculture.

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CS4Rivers: a Citizen Science project for monitoring the biodiversity of riverine ecosystems
Chiara Vitillo, Stefano Loppi

Freshwater ecosystems are essential for life on our planet. Although freshwater is only 2.5% of all water on Earth, it is the habitat of 10% of all known species. In recent decades, most freshwater ecosystems have undergone negative changes. Monitoring and assessing the river habitats quality have proven essential to preserve (or restore) riverine ecosystems. In this context, Citizen Science (CS) is increasingly adopted for environmental monitoring. Among the numerous advantages, the involvement of volunteers allows for greater data collection.
CS4Rivers is a CS project developed by the University of Siena, within the NBFC to monitor the quality of habitats and biodiversity of the Ombrone river and tributaries (Tuscany, Italy).
Among the activities, we mention the monitoring of macroinvertebrates and riparian vegetation. Each activity includes a simplified protocol, the data quality of which is verified through comparisons with expert assessment data. Preliminary results concern the percentages of coverage of plant species collected by citizens.
Support materials and initial training have been developed for each activity. Biodiversity monitoring will start in 2025 with a focus on avifauna and molluscs.
An experiment to biomonitor the River Merse using moss bags is underway.
In the Idice river basin (Emilia Romagna, Italy), a pilot project involves 1 school and 3 groups of citizens who monitor the macrobenthic community in 7 stations and the riparian vegetation in 20.

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Global warming and expansion of Oriental Hornet (Vespa orientalis) in urban areas of the Campania region
Claudia D'Emilio, Carmine Vitagliano, Rosario Sica, Roberta Santopietro, Paola Maiolino

V. orientalis, is a eusocial hymenoptera of the Vespidae family, native to southern Italy, now also present in central and northern Italy (Graziani and Cianferoni, 2021). Being one of the most important honey bee predators in southern Italy is particularly known to induce serious damages in apiaries. Recent reports indicate a significant expansion in urban areas, due to the urban heat island effect and the presence of undeveloped green spaces, domestic gardens, urban agriculture, beekeeping, which provide abundant resources and refuges (Jones & Leather, 2012). This expansion harms both honey bees and humans. To monitor and control the presence of V. orientalis in Campania in 2022, the "Emergenza Vespa orientalis in Campania -EVOC'' project was born. The project involved the placement of traps "Tap Trap". The analysis of the traps content revealed only 82 specimens out of 239 traps. Additionally, to assess the knowledge of citizens of honey bee and V.orientalis were administered of the questionnaires. The results showed that citizens had difficulty identifying various species of hymenopterans, 38% unable to recognize the V. orientalis and 86% associated it with Xilocopa violacea. In conclusion, the present study, revealed that the traps "Tap trap" were not effective in capturing V.orientalis, and offers hope for future Citizen Science actions as a valid support to increase awareness of the presence of V. orientalis in Campania.

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Paramuricea clavata forests support biodiversity and ecosystem functioning
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Coralligenous habitat is a biogenic temperate reef. The iconic species Paramuricea clavata is an ecosystem engineer which increases the spatial complexity of the habitat, developing animal forests that support the persistence of other species. In the last decade, P. clavata suffered the increase of multiple stressors which led to mass mortality events with substantially unknown consequences on associated benthic assemblages. We tested the hypothesis that P. clavata has the role of increasing local biodiversity. The study was carried out in the Gulf of Naples, where benthic communities inside vs outside the forests were compared in terms of β-diversity (partitioned in its two components nestedness and turnover) and functional richness. P. clavata forests, mainly represented by small size classes, show a wide range of both density (27 - 65 colonies/m2) and biomass (100 - 505 g dry weight/m2). The assessment of benthic assemblages reveals P. clavata forests support distinct communities, characterized by higher compositional and functional richness. The analysis of functional groups reveals that P. clavata prevents the spread of algal species, favouring the growth of sessile invertebrates. Comparing β-diversity, the turnover component is statistically significant at both taxonomical and functional level with higher values within the forest, highlighting the important role of P. clavata in modifying local environmental conditions and driving local species distribution.

First year PhD projects

First year PhD projects

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Population genomic analyses of endangered and endemic plant species

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Importance of seamounts and upwelling systems for mesopelagic biodiversity and related trophic web in sustaining pelagic top predators

Edoardo Asquini
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University of Udine
Upscaling the effects of global changes on plant diversity at different ecological scales

Matteo Battiata
University of Palermo
Monitoring flow-biota interaction in water bodies: identification of peculiar bio-indicators

Giulia Bressan
University of Palermo
Interactions in complex predator communities and their implications for marine biodiversity conservation and management

Laura Buonafede
University of Palermo
University of Milan - Bicocca
eDNA and advanced sensor technologies as novel integrated methods for effective biodiversity monitoring of urban environments

Elena Cini
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Analysis of temporal changes in Italian most threatened habitats using remote sensing

Giuditta Codogno
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University of Florence
Rock around the clock: how biological invasions alter the circadian clocks of native species

Andrea Coppola
Polytechnic of Milan
Ecological interactions within and between green areas in cities: spatiotemporal models of urban metacommunities

Alessandra Cosma
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University of Genoa
Taxonomy and Ecology of shallow and deep-water Mediterranean scleractinians

Maria D'Elia
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Nutritional therapies and development of natural plant-based ingredients for appropriate supplementation in the management of non- communicable diseases

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Ecological role of microbial communities around seamount systems: study of biodiversity of prokaryotic communities through multi-omics approaches and bioinformatic tools

Ylenia Fabietti
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Emerging contaminants in the marine environment: new biomonitoring approaches and future challenges

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Ecology and restoration of chemoautotrophic-based ecosystems

Hannelore Fellin
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The understory vegetation of coniferous plantations of non site-native trees: the case of Cupressus sempervirens forests in Italy

Leonardo Girlanda
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Global warming now and then: the speed and load factors affecting the success or failure of a range expansion

Alessia Granata
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Co-occurrence biodiversity data analysis through statistical models

Giovanna Guadagnin
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Assessment of coastal biodiversity response mediated by different levels of environmental predictability following extreme events

Vincenzo Maria Lapiccirella
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Biodiversity scientific impact in Italy: the role of social sciences

Laura Limonciello
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Long-term monitoring of medium- and large-sized mammals in urban contexts

Gabriella Lo Cicero
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CNR - Institute for the study of Anthropic impact and Sustainability in the marine environment
Definition of habitat suitability models in prediction of the effects induced by various stress factors and climate change on small pelagic species populations and their habitats in the Mediterranean

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Integrative Taxonomy and Biogeography of Halictidae and Megachilidae (Apoidea) of Italian fauna

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Apoidea (Hymenoptera: Apoidea: Anthophila) as biodiversity indicators in urban and peri-urban environment and vegetation management favouring pollinators in lowland riverbanks

Lucia Therese Marcianò
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Effects of in vivo/in vitro exposure to Propranolol and Polypropylene in the model organism Mytilus galloprovincialis

Thomas Martinoli
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Monitoring habitats and biodiversity in urban environments, and assessing urban ecosystem services to define the link with urbanisation processes

Irene Mazza
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Fungal diversity in the Biancana Badlands both above and below ground

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Macroecological assessments of biodiversity to prioritise species monitoring in Italy

Francesca Necci
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A multispecies approach to marine habitat restoration to promote species interactions, emergent properties, and community recovery

Giovanni Andrea Nocera
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Studying the resilience of seagrass habitat: integrating OE data and LCA methodology for enhanced monitoring and assessment of ecosystem goods and services

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Structure and adaptation of intertidal invertebrate communities through the lens of multiple stressors

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Benthic community resilience in coastal areas under environmental stress

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Yann Toso
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Monitoring changes in the Mediterranean marine biodiversity: NIS, climate change, and novel opportunities

Marika Ubaldi
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Study of phytoplankton communities and their long term interannual variability through traditional and innovative tools

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Innovative approaches for marine biodiversity mapping and monitoring

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Omic-based approaches to assess the biodiversity and the functioning of planktonic microbes in the Southern Ocean