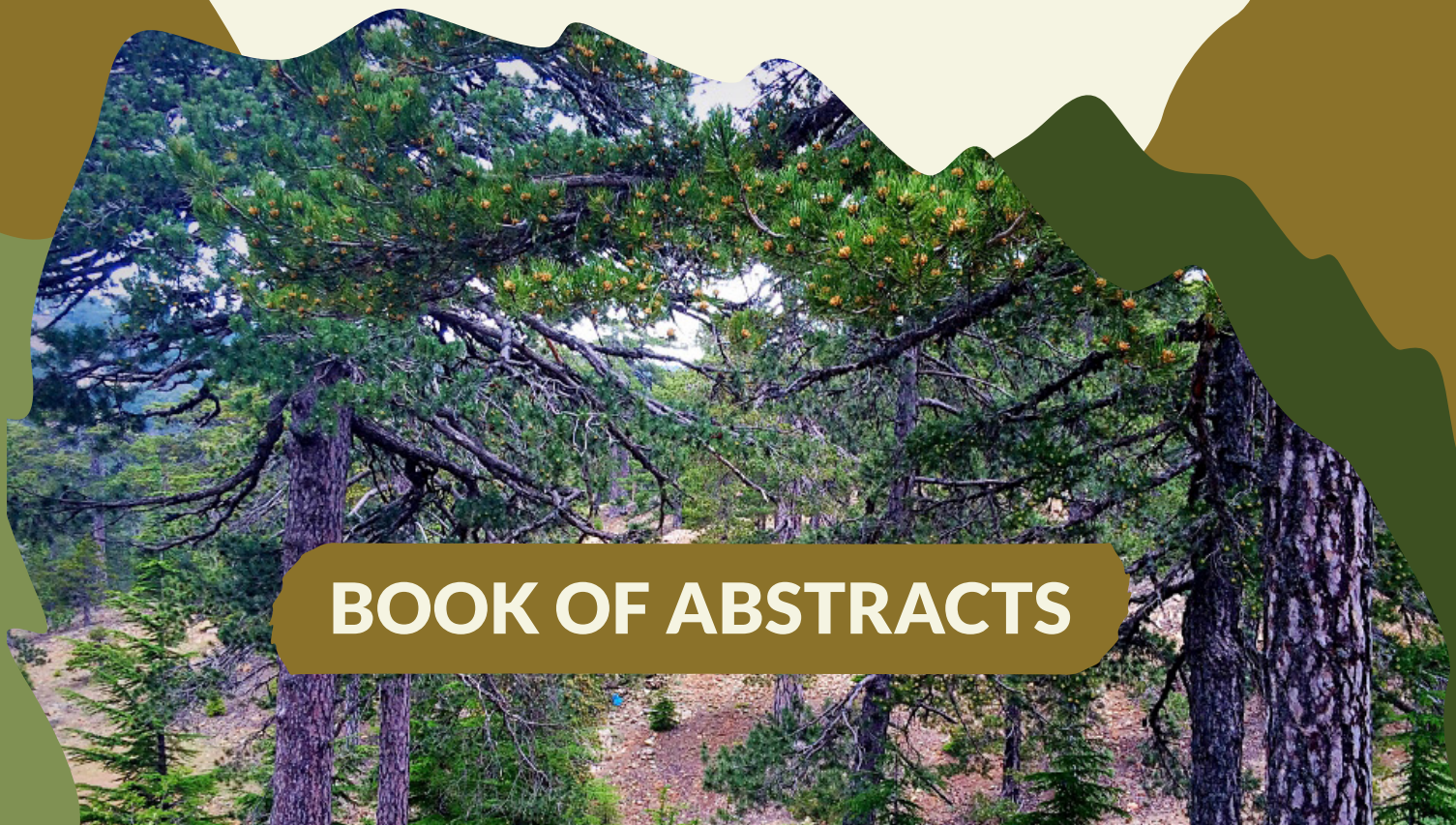
5MPCW CY-2025

5TH MEDITERRANEAN PLANT CONSERVATION WEEK

Building alliances for plant diversity conservation in the Mediterranean

April 07-11, 2025 • Limassol, Cyprus

Editors
Marios Andreou, Frederick University (CYPRUS)
Costas A. Thanos, National and Kapodistrian University of Athens (GREECE)



BOOK OF ABSTRACTS

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The 5th Mediterranean Plant Conservation Week (5MPCW) will be held from April 7 to 11, 2025, at St. Raphael Resort & Marina in Limassol, Cyprus. This congress aims to bring together specialists and enthusiasts in the research and management of nature, focusing on the conservation of wild plants and their habitats around the Mediterranean.

The 5MPCW aims to build alliances for plant diversity conservation in the Mediterranean.

The 5MPCW follows a highly successful series of similar conferences organized successively in Montenegro (2016), Valletta (Malta, 2018), Chania (Crete, Greece 2021), and Valencia (Spain, 2023). The 5MPCW will be held in the beautiful city of Limassol, Cyprus, from April 7 to 11, 2025!

The 5MPCW will also serve as a forum for sharing experiences from different regions around the Mediterranean, fostering future cooperation projects among specialists from Southern Europe, North Africa, and the Middle East. It will showcase research and experiences through oral presentations and posters, covering topics such as plant and ecological sciences, citizen science, ethnobotany, local involvement, and sustainable management of plant resources.

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The Flora of Cyprus

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The formation of Cyprus flora is mainly the result of the geographical position and size of the island, the diverse geology and geomorphology, the climatic conditions, the habitat diversity, the long history of human presence, dating back 12,000 years, as well as the fact that Cyprus has always been an isolated island, since its emergence above sea level 20-23 Ma.

The vegetation of the island is chiefly composed of Mediterranean plant communities, consisting of 42 Annex I habitat types (Directive 92/43/EEC) and 11 habitat types of Cypriot interest.

The Cyprus flora is primarily composed of Mediterranean species accounting for about 50% of the flora, however other phytogeographical groups such as Irano-Turanian, Euro-Siberian and the Saharo-Arabian are also important for the composition of the flora.

The flora of Cyprus consists of 1649 indigenous *taxa* of Spermatophytes and Pteridophytes, 276 naturalised alien *taxa* and 46 hybrids, while 83 *taxa* remain with unclear status. This plant diversity is comparable to the rest of the large Mediterranean islands, where the overall range of flora ranges between 1500 to 2500 *taxa*.

The endemic flora consists of 146 *taxa*, whereas the endemism rate at species and subspecies level is 7.4% and 8.85%, of the indigenous flora, respectively. These figures are within the rate of endemism (5.5-10%) of the Mediterranean islands. Troodos Range as well as Pentadaktylos Range are highlighted as the principal centers / hotspots of endemism in Cyprus. The central part of the igneous Troodos Range, hosts the highest concentration of endemics, where serpentine endemism is highly developed; Pentadaktylos Range, mainly composed of hard limestones, is characterised by inhabiting mainly endemic chasmophytes.

The “Red Data Book of the Flora of Cyprus”, published in 2007, identified 238 threatened *taxa* (Critically Endangered, Endangered and Vulnerable). From 2007 until today, the number of threatened *taxa* increased to 258, as a result of new data; nineteen of the threatened plant *taxa* are also included in Annex II of the Habitats Directive (92/43/EEC).

For the protection and conservation of the important habitats and flora, a network of protected areas has been established, according to the National Forest Legislation and the Habitats Directive (e.g. Natura 2000 sites, Nature Reserves, National Forest Parks and Plant Micro-reserves), encompassing 20% of the area under the effective control of the government of the Republic of Cyprus.

Keywords: Mediterranean flora, habitats, endemism, threatened species, biodiversity conservation, protected areas

Small reserves: A new breath of life for wild plants

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For more than a century, since the beginning of policies on protected areas worldwide, these have been substantially dedicated to guaranteeing the conservation of large areas and landscape units, necessary to ensure the conservation of large vertebrates or the main types of vegetation. Since the 1980s onwards, various initiatives from the fields of science, conservation NGOs and nature managers, advocated the need to complement these networks of large, protected areas with an extensive range of microsites or small reserves, especially in the case of plants and other sessile organisms. The reasons have been various, among others:

1) The realization that only a small number of species are abundant – most of them are rare, and therefore with a generic tendency to be threatened - and that those that need large conservation areas are really few. Consequently, a substantial part of plant biodiversity may be insufficiently protected by networks of large natural spaces.

2) The tendency of many species with the greatest conservation value – particularly the rarest and most endangered endemic species – to concentrate in microhabitats occupying small areas.

3) The lack of specific conservation management for endangered plant species living in microhabitats, when these are located within large, protected areas, designed for the protection of macrofauna, large plant formations or macrohabitats. They are forgotten or scarcely attended with appropriate conservation measures, despite often being more threatened than the species that motivated the protection of these areas.

4) The progressive tendency towards the bottom-up management of the natural areas, proposed and led by NGOs or local communities. These social actors have the human and economic resources to manage proportionally small sites, so they often do not request protection of large areas.

5) The need to establish networks for scientific monitoring of biodiversity and changes in the natural sites in the long term, which can only be guaranteed by creating a multitude of protected micro-areas to ensure that these sites will not be easily altered, being at the same time representative of the elements of biodiversity to be studied.

In response to these needs, initiatives arose which, in the case of wild plants, focused on a new figure, Plant Micro-reserves (PMR). Formerly, a few *ad hoc* conservation legal figures had existed previously in some countries - Czech Republic, Slovakia, Bulgaria, UK, etc. - for the protection and management of small areas, but having no specific names, and being usually names as subtypes for plants or vegetation within nature reserves, natural sites of scientific interest, etc. In this context, the official legal name “Plant Micro-reserve” was proposed in the Valencian Community (Spain) in the late 1980s, supported by the EU’s LIFE program since 1992, and generating a regional model that could be exported to other regions and countries worldwide. The Valencian network currently holds 312 PMRs that protect 29,083 populations of 2,051 species, representing 53.8% of the diversity of Valencian vascular plants in just 0.1% of the regional surface area. This model has been formally extended to other countries that have adopted it in their laws at a general level, such as Cyprus or Latvia, or to entire regions of some countries, such as Crete in Greece and several Spanish regions. The Valencian model has sparked interest in countries on all continents, extending under various approaches to other areas of the planet. There are currently national initiatives to include them in their legislation in other countries such as Chile, where they have been proposed for preferential protection zones under a Mediterranean climate. Within the Mediterranean Region, it has been adopted officially, or through natural areas effectively managed for conservation by NGOs, in countries such as Lebanon, and there are important initiatives and scientific proposals to adopt them in others such as Portugal, or in specific regions of Egypt, Slovenia, etc. Today, PMRs, or small reserves for wild flora in general, constitute an emerging conservation model, a new vital breath for wild plants.

Keywords: small reserves, plant micro-reserves, Mediterranean region, Endemism, Rareness

KEYNOTE LECTURE

Integrated Approaches to Plant Diversity Conservation in the Mediterranean - Bridging In Situ and Ex Situ Strategies: the case of Greece

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The Mediterranean region is a global biodiversity hotspot, hosting a remarkable diversity of plant species, many of which are endemic to the area and under threat from habitat loss, climate change, and human activities. Effective conservation of this unique flora requires a synergistic application of in situ and ex situ strategies, complemented by integrated approaches that combine science, technology, and community engagement. This presentation explores the critical role of integrated plant diversity conservation in Greece, offering practical insights and case studies that highlight successes, challenges, and opportunities for future efforts.

In situ conservation remains the cornerstone of plant diversity preservation, focusing on the protection and management of natural habitats. Mediterranean ecosystems are increasingly vulnerable to anthropogenic pressures and climate change. Effective in situ conservation requires adaptive management practices that include ecological restoration, invasive species control, and habitat connectivity enhancement. Examples of such initiatives will be presented, emphasizing the importance of collaborative actions in safeguarding plant diversity.

Ex situ conservation serves as a complementary strategy to in situ efforts, providing a vital safety net for species at risk of extinction while also serving as a valuable resource for research, education, and habitat restoration. Seed banks and botanical gardens play a pivotal role in preserving genetic diversity and ensuring the availability of plant material for future restoration and research. Case studies of successful seed banking efforts in Greece will be shared, demonstrating how these resources can support long-term conservation goals.

Integration of in situ and ex situ approaches offers a pathway to more holistic and resilient conservation outcomes. Coordinated efforts can address the biology of plants, from seed collection and propagation to habitat restoration and population monitoring. This presentation will highlight projects that bridge the gap between these strategies, including reintroduction efforts.

The presentation will also examine the implications of climate change for plant conservation in the Mediterranean as modified or shifting temperature and precipitation patterns are altering plant phenology, functions and distributions, necessitating proactive conservation planning. Finally, the role of technology and citizen science in advancing plant conservation will be explored. The use of geographic information systems (GIS) and drones are revolutionizing the way we monitor and manage plant diversity. Engaging local communities through citizen science initiatives not only enhances data collection but also fosters a sense of stewardship and participation in conservation efforts.

Keywords: in situ & ex situ conservation, reintroduction, restoration, seed banks, climate change

Integrated Conservation approach for endemic species in Lebanon

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According to the last published flora of Lebanon that was completed in the early sixties, floristic richness of Lebanon is estimated at 2607 vascular plant taxa, of which 93 are strictly endemic to Lebanon.

Conserving species rely primarily on their In-situ conservation. In Lebanon, a new categorization system for protected area that defines criteria for the establishment and management of each category has been prepared in 2012. Four categories were proposed and the first draft of the protected areas law was based on this system. These four categories are: Nature reserve, Natural Park, Natural site and monument and Hima (community based natural resources management under the supervision of the municipality). These 4 categories differ by their surface area, landownership, the strictness of the protection and by how these protected areas are managed. The most rigorous conservation mode is the natural reserve status where land use practices are restricted and buffer zones of at least 500 m are to be secured.

The endemic species that we usually protect are usually geographically restrained and are spread in an areas that are less than 20 ha. Our approach was very similar to the Plant Micro-Reserves (PMRs) concept that was a pioneer project in the Valencian Region – Spain. PMRs are small sites with a high degree of naturalness and legally protected to ensure the conservation of rare, endemic or threatened plant species. Therefore, the Biodiversity Conservation Initiative (BCI) team through the Saint Joseph University, has drafted a law to include a new category of Protected Areas in Lebanon: The PMRs whose main aim is a single species conservation.

Conservation strategies are varied and necessary for the protection and preservation of the biodiversity in every ecosystem. In-situ techniques focus on conserving the selected species directly in their natural habitat, where Ex-situ approaches focus on taking plant material outside their localized areas to be tested in specially designed conservation laboratories.

Many plans have been made using one of these techniques taking them into consideration when applying conservation action plans on threatened and endangered species, but rare are the studies made using both techniques together. Hence the importance of the quasi in-situ technique, which combines both approaches of plant conservation to create a technique that accompanies the endangered species during all of its natural life cycle using conservation protocols both on-site and in botanical laboratories.

The BCI has been implementing a Quasi-In situ technique that focuses on a reintroduction into the archeological site from Ex-situ genetic resources, some endemic plant species compatible with the presence of ruins and belonging to the same bioclimatic zones will be implemented These are herbaceous species (geophytes) without a deep root system. The areas where these plants were reintroduced with the agreement in partnership with the managers of the DGA, under their responsibility. These introductions will have a twofold objective: the conservation on already protected sites of these plants species which would not require a constraining maintenance since they would develop under the same abiotic conditions as their place of origin, and which would allow at the same time the awareness of the big public and local community to these endemic plants that are an integral part of our cultural heritage.

Keywords: Conservation, Reintroduction, Quasi-In situ conservation, Seed bank, Plant microreserve, endemic species

Acknowledgements: This project was implemented by the Biodiversity Conservation Team of Saint Joseph University, in collaboration with Jozour Loubnan NGO, which provided access to their seed bank, and the Directorate General of Antiquities, responsible for managing archaeological sites in Lebanon. We extend our gratitude to these partners for their invaluable support and contributions.

Floral Biodiversity and conservation of wetlands in the Jordan Valley

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The Northern part of the Great Rift Valley include the lowest point on earth (near Lake Lot/Dead Sea). The valley is rich in wetlands and the floral elements include Sudanian-Ethiopian, Irano-Turanian and Saharo Arabian elements. Here we used the usual field survey methods to assess flora in two wetlands one near springs of Ain Fashkha and the other seasonal marshlands of Al-Mallaha. The two wetlands fall respectively in the newly reformulated protected areas (PAs) of respectively Dead Sea PA and Al-Ghor PA (AGPA). The data show that 171 plant species were recorded in the two PAs of which only 24 species are shared by both PAs. Most of the plants we noted in the areas are not categorized by IUCN (65 of 82 species in AGPA or 80% and 86 of 114 in AGPA or 75%). The rest were listed as LC by IUCN globally. 50% of the plants were classified as rare (for Palestine) and from those 90% were restricted to only one of the two protected areas. Seven species are on the way to extinction (O), 27 are very rare (RR), 23 are rare and one species is extinct. We recorded 87 species of plants in AGPA and 111 in DSPA. Various threats affect the flora within the DSPA and AGPA including invasive species, climate change, habitat destruction, pollution, and overexploitation.For example as marshes in AGPA areconverted into agricultural areas, this reduced the amount of land suitable for halophytes such as the endangered endemic *Suaeda palaestina*.

Keywords: Protected areas; marshlands; conservation; rare plants.

Acknowledgements: We are grateful to the Critical Ecosystem Partnership Fund (CEPF) for support provided via BirdLife International.

The restoration of Mediterranean habitats passing by an integrated conservation approach: the case of *Limonium strictissimum*

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The Mediterranean Basin is the third richest hotspot in the world in terms of plant and habitat diversity and Sardinia, the second largest island of the Mediterranean Sea, hosting a large part of this diversity that is threatened by several factors of anthropogenic origin. Hence, an integrated approach of *in situ* and *ex situ* strategies for the conservation of threatened species and for the restoration of their habitats is recommended and allows bringing together different expertise to solve the issues from different points of view, especially in very sensitive areas.

This approach is also followed in international projects, like PROVIDUNE (LIFE07/NAT/IT/000519; 2009-2014), RES MARIS (LIFE13 NAT/IT/000433; 2014-2018) and the latest SEEDFORCE (LIFE20 NAT/IT/001468) "Using SEED banks to restore and reinFORCE the endangered native plants of Italy". The aim of this project is the improvement of the conservation status of 29 endangered plant species from Italy, France, Malta and Slovenia. Within SEEDFORCE, the Centre for Conservation of Biodiversity (CCB) and Sardinian Germplasm Bank (BG-SAR) focused their efforts on six target species: *Astragalus verrucosus*, *Centranthus amazonum*, *Limonium strictissimum*, *Linaria flava* subsp. *sardoa*, *Linum mulleri* and *Ribes sardoum*.

In the framework of SEEDFORCE activities, the study case of *L. strictissimum* is here presented. This *taxon* is endemic to Corsica and Sardinia, where only one population is present at Caprera (La Maddalena Archipelago, Northeast Sardinia). It is an endangered (EN) species of priority Community interest, included in Annex II and IV of Directive 43/92/EEC. The integrated approach was undertaken, starting from preliminary monitoring and followed by the collection of germplasm which was tested through germination tests in order to obtain the efficient germination protocols. These are fundamental steps for the continuation of project activities within the plant propagation by seeds. However, the presence of invasive alien species like *Carpobrotus* spp. threatens the survival of *L. strictissimum*. Therefore, to achieve the best results in its conservation, site preparation by manual eradication of *Carpobrotus* spp. has been carried out in 3100 m^2 in several occasions since 2021 and also eliminating individuals born from seed after the first eradication. The latter was pivotal to prepare the site for plant translocation and achieve optimal results in the conservation of *L. strictissimum* and its habitat.

The first results obtained from the abovementioned actions show that *L. strictissimum* has a good germination capability (more than 60%), despite the production of a high number of empty seeds. Germination tests allowed the multiplication of plants obtaining a large number of seedlings transplanted in standard soil under nursery conditions. After the approval of the translocation plan by the Regional Environment Department, we translocated c.a 130 one-year-old plants to the mother site during the winter season with the collaboration of several regional and local authorities. In order to raise awareness, the activities were disseminated to the local population and schools.

In conclusion, the integrated approach permits not only the conservation sensu stricto of a threatened species but is also necessary for the maintenance of suitable ecological conditions.

Keywords: habitat restoration, Mediterranean flora, Life program, seed germination, plant translocation.

Acknowledgements: This research was funded by LIFE SEEDFORCE—LIFE20 NAT/IT/001468, Using SEED banks to restore and reinFORCE the endangered native plants of Italy

Ex situ seed conservation of the native flora of Greece

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Greece boasts a rich and diverse flora, comprising approximately 6,900 taxa across 135 families, including around 1,500 taxa endemic to the country and another 500 classified as range-restricted (subendemics). Ex situ seed conservation is essential for preserving plant biodiversity through long-term germplasm storage. Between 2022 and 2024, a collaborative project between the National and Kapodistrian University of Athens (NKUA) and the Millennium Seed Bank (Royal Botanic Gardens, Kew, UK) resulted in the collection and storage of 580 seed lots, representing 545 taxa from 70 families.

Notably, approximately 25% of the collected seed lots (153 lots representing 144 taxa) are endemic to Greece. The collections covered a wide altitudinal range, from sea level up to 2,315 meters. The Caryophyllaceae and Lamiaceae families were particularly well-represented, each contributing over 10% of the collected species, with 62 and 59 seed lots, respectively. The seed collections originated from 16 distinct habitat types, with the three most common being phrygana (30.1%), Mediterranean grasslands (16.2%), and cliffs (15.5%). Approximately 22% of the collected plants are annuals (therophytes); among perennials, the majority are hemicryptophytes (40%) and geophytes (16%). Remarkably, 23 of the collected taxa are classified as threatened, including 7 critically endangered (CR; 2 of them are the rediscovered 'lost' species *Consolida samia* and *Allium calamarophilon*), 6 endangered (EN), and 10 vulnerable (VU) species, according to the IUCN criteria.

Seed processing entailed drying plant material under controlled conditions (~15–25% RH and 14-17 °C) for 1–2 months, followed by seed extraction. Afterwards, seeds underwent an additional drying period of 1–6 months before being stored, as duplicates, at -20 °C in the NKUA and MSB Seed Banks for long-term conservation.

To assess collection quality, germination experiments were conducted based on a thorough literature review. Germination tests were performed at constant and alternating temperatures, under light and dark conditions, depending on seed availability. Necessary pre-treatments were applied as required for specific species. So far, germination results have been finalized for approximately 400 seed lots (representing 380 taxa). Of these, 67% achieved final germination above 70%. Germination levels between 40–69% were recorded for 12% of the collections, while 21% exhibited germination percentages below 40%.

This study consolidates data on the seed collections, germination outcomes, and further insights from the three-year project. Additionally, a gap analysis at the family level will be presented, highlighting areas for future focus. This research underscores the importance of seed banks in preserving Greece's unique, native flora and provides a foundation for future biodiversity conservation efforts.

Keywords: Seed Bank, Seed Conservation, Seed Germination, Seed Storage

Acknowledgements: The research was funded by the Project «Conserving the Flora of the Balkans: Native Plants of Greece» (NKUA Seed Bank and MSB, RBG Kew, UK).

Ex situ Conservation Actions in Cyprus; Current Status and Future Priorities

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Mediterranean islands are considered as biodiversity hotspots worldwide, characterized by a high rate of endemism. Furthermore, the proximity of Cyprus to the fertile crescent and the center of domestication of important crop species constitutes the island as an agrobiodiversity hotspot. Throughout the centuries, evolutionary procedures stimulated by the variability in habitats, soil, geological and climatic conditions and human intervention resulted to the formation of high species richness and substantial genetic diversity within taxa.

Currently, 1649 taxa (species and subspecies) are considered indigenous of Cyprus, out of which 146 are endemic and 19 are listed in the Annex II of the Habitat Directive. A considerable number of taxa (15.95%) are threatened with extinction according to IUCN criteria. It should be noted that 45 threatened taxa are endemic, thus, the conservation of these species should be considered as regional responsibility. A large proportion of the indigenous taxa have actual or potential use as food and in agriculture. For example, indigenous species are known for their medicinal properties, some can be used as ornamentals, or as wild edible plants. A category of particular importance are the crop wild relatives, species that are genetically close to the cultivated crops and are consider as a valuable source of gene donors in breeding programs to confer resistance to biotic and abiotic factors. A large number of diverse local landraces were developed over the years as a result of Cyprus position over the cross roads of the ancient world, the long history of farming, and soil and climate heterogeneity.

The genebank of the Agricultural Research Institute was established in 1978 with the mandate to conserve local landraces and indigenous plants of the flora of Cyprus. The genebank also constitutes the main gate for access to genetic material for research purposes or for reintroduction activities through *in situ* and *on farm* actions. Currently, they are conserved over 14000 accessions from at least 575 taxa. The number of accessions for endemic and threatened species are 324 and 327 respectively, and the respective number of species are 111 and 160. Many landraces conserved at the genebank have been abandoned by farmers, therefore, they are conserved only *ex situ* or they have been gone through extensive genetic erosion. Further to conservation, efforts are made for the genetic and phenotypic characterization of the genetic material which allows to optimize conservation actions and to promote its sustainable use.

Depside the significant progress made over the last years, more efforts are need in the future to close the gaps in *ex situ* conservation and to address the challenges arising from a changing world and the climate change. The scope of this work is to present (1) the major achievements of the recent projects, (2) the main goals of the ongoing projects and (3) the priorities set up for the future.

Keywords: *ex situ* conservation, Cyprus, crop wild relatives, endemic plants, threatened plants

Conservation translocation of the endangered *Anthemis aeolica* Lojac. on small islets of the Aeolian archipelago

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Anthemis aeolica Lojac. (Asteraceae) is a narrow endemic, critically endangered, species which only known population occurs on the islet of Lisca Bianca (Panarea, Aeolian Islands, Sicily). *A. aeolica* was described by Lojacono Pojero in 1903 for Bottaro, Basiluzzo and Dattilo islets, from where it is actually extinct. Despite of their small size, these islets have been exploited as seasonal pastures. Grazing and soil eutrophication, which favoured the establishment of more competitive, halo-nitrophilous, species could have brought *A. aeolica* to extinction. However, since the establishment of the Regional Nature Reserve "Isola di Panarea and Scogli Viciniori" any type of exploitation has ceased. The mentioned islets are subject to a regime of integral protection and access is allowed only for management and research purpose. In this context, a conservation translocation of *A. aeolica* was implemented in the Nature Reserve, with the reinforcement of the extant population in Lisca Bianca and the reintroduction of the species in Bottaro. In May 2022 and 2024, drone surveys were made in Lisca Bianca to assess the population size and distribution of *A. aeolica*. Contextually, a patch of the invasive alien species *Carpobrotus acinaciformis*, that covered 446 m^2 on Lisca Bianca, competing with the native vegetation, was manually removed. Plants of *A. aeolica* were produced from seeds collected from the wild population and stored at the Seed Bank of the University of Catania. The plants were incubated for the first month in a growing chamber at the alternating temperature of 20/10°C and then moved outside for acclimatize for further two months. Three months old plants were used for the translocation in the intervention sites. A factorial experimental design was set up in Lisca Bianca to assess the best condition for the translocation of *A. aeolica.* Three factors were taken in account: 1) the season of translocation (May 2023 or October 2023), 2) the allelopathic effect of *C. acinaciformis* (plants were translocated both in areas previously invaded and in areas never colonized by *C. acinaciformis*); 3) the addition of a hydrogel obtained from the cladodes of *Opuntia ficus-indica*, used as amendment to increase the water retention capacity of the soil. Outside of the experimental design, both in Lisca Bianca and Bottaro, more plants were translocated in October 2023 and planted in different microsites. Finally, in July 2023, the effectiveness of direct seed sowing was tested both in Lisca Bianca and Bottaro. In *A. aeolica* two main types of seeds can be recognized: light colored and with thin seed coat, dark colored and with thick seed coat. The second type possess some degree of dormancy. For this reason, an equal proportion of the two types was used. The two types of seeds were marked and kept separated, to assess their germination phenology in the field. To avoid losing them, each single seed was glued on a toothpick. Seed germination, plant survival, flowering and fruiting were periodically monitored for one year. The factorial experiment demonstrated that planting season influenced the survival and the flowering capacity, being the percentage of flowering plants higher among the ones translocated in autumn. Fruiting was instead higher in the plots from were *C. acinaciformis* was removed. The addition of hydrogel in the soil did not have a significant impact on plant survival, unless its interaction with the other factor is considered. Of the plants introduced outside of the factorial experiment, 32% fruited but only 7% were still alive after one year in Lisca Bianca. A similar trend was observed for Bottaro, were 21% of the plants fruited but only 3% (2 individuals) were still alive after one year. Only 8.4% of the seeds sown in Lisca Bianca germinated and produced seedlings, which were recorded in January 2024 (4.9% from light seeds and 3.5% from dark seeds). However, none of these seedlings survived to the flowering stage, due to the competition with annual species and to the extensive drought of summer 2024. The seed plots placed in Bottaro were destroyed by the local roosting colony of seagulls. In conclusion, translocation of plants rather than direct seed sowing resulted in some plants flowering and fruiting. However, the right timing of translocation and the microsite selection are pivotal for the success of the intervention. In order to avoid the effects of summer drought, *A. aeolica* should be implanted in autumn, favouring sites which are partially shielded from direct exposure to the sun and protected from excessive heating.

Keywords: conservation translocation, habitat restoration, invasive alien species, Mediterranean small islands

Acknowledgements: SiMaSeed PLUS - Salvaguardia dell'ambiente e protezione del patrimonio naturale in Sicilia e Malta attraverso la conservazione dei Semi e ripristino di specie/habitat della Rete Natura 2000 - INTERREG V-A Italia-Malta - call 3/2022 - Project code: C3-3.1-2.

Propagation of the "Extinct in the Wild" *Limonium intermedium* (Guss.) Brullo and planning of its potential reintroduction in Lampedusa Island (Italy)

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The species categorized, according to the IUCN protocol, "extinct in the wild" (EW) represent those ones whose future persistence is really uncertain and fully linked to ex situ conservation actions, generally performed by botanical gardens or, more rarely, by private collections. Currently, about 500 plant species are considered extinct in the wild, including some Mediterranean taxa. In order to prevent the definitive extinction of these species, plant propagation protocols followed by translocation actions may represent a useful tool, even not sufficient for ensuring the survival of the species. Actually, it is crucial to assess both the abiotic and biotic causes that brought a given species so close to the extinction and consequently try to localize potential growing sites which are deemed suitable for a successful reintroduction. In particular, it is really important defining the ecological requirements of the target species, as well carefully planning the whole reintroduction process.

Limonium intermedium (Guss.) Brullo (*Plumbaginaceae*) is the only Italian plant species categorized as EW. Main aim of our study is to evaluate its potential reintroduction into its original habitat. This chamaephyte is a narrow endemic to the Lampedusa island (Italy), and it was discovered by the Italian botanist Giovanni Gussone in the 1832 in the salty marshes of the south-eastern coast of the island, very close to the harbour. 150 years after its discover, only few plants were found by Bartolo et al. (1988) who reported the total destruction of the natural stands where this species lived due to the construction of a soccer field. Luckily, some plants obtained from few seeds collected by Salvatore Brullo are currently cultivated at the Botanical Garden of the University of Catania. Thanks to these plants, during the late summer and autumn of 2024, 81 seeds were collected in order to propagate the species and thus producing some individuals to be used for the reintroduction in Lampedusa. In particular, a germination protocol was defined, testing different substrates (filter paper moistened with distilled water, 1% and 0.7% agar) and incubating the seeds at 15°C/12 hours of light. The seedlings were transplanted in cell trays on universal standard soil and the survival and growth of the plants was monitored. Aim of this study, conducted at the Seed Bank of the University of Catania, is to develop a protocol for the cultivation of the species and to identify the suitable ecological niche for its reintroduction in its native area. A rather tricky issue for the reintroduction of *Limonium intermedium* is the selection of the most suitable sites in an extremely human-disturbed area. The environmental parameters of the potential sites (e.g. soil salinity and humidity, light intensity, etc.) were measured and evaluated. Thus, a propagation protocol for *Limonium intermedium* is here presented, together with a translocation plan considering the niche suitability of its native site or alternative introduction sites. The involvement of the management authority of the island protected areas, of the landowners and of the local authorities is essential for a successful reintroduction of *Limonium intermedium*.

Keywords: narrow endemic, Mediterranean flora, de-extinction, botanical garden, *in situ* conservation.

Acknowledgements: The authors are very grateful to Salvatore Brullo for the information provided on the ecological requirements of *L. intermedium* in its original habitat.

How can we help a threatened plant species to survive – a case study of *Cardamine serbica*

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Cardamine serbica Pančić (Brassicaceae) is a neglected plant species from the Balkan Peninsula. Although it was described at the end of the XIX century from Western Serbia by Josif Pančić, the taxonomical status of the species was fully accepted less than two decades ago after detailed morphological and molecular studies. This investigation, lead by botanists from Slovakia, also revealed that the species *C. serbica* includes not only population from the *locus classicus* in W Serbia, but also plants from E Bosnia and Herzegovina and N Montenegro previously described under the name *C. maritima* var. *maglicensis* Rohlena. Distribution of the species is limited to a few scattered localities within total area of less than 2000 km^2. Longtime unresolved status resulted in omitting of the species from the Red Lists or official lists of protected plant species, removing the species from conservation focus.

The most stable populations are those from Montenegro, while the only population in Serbia in 2018 was reduced to one reproductively mature individual and less than 20 juveniles. This raised a red flag in the National Park Tara where the population is situated that something must be urgently done. Thus, in 2019 the implementation of various *in situ* and *ex-situ* conservation measures began including removal of the surrounding vegetation, seed bank formation, plant propagation and translocation. At the same time, a comparative ecological research of the species habitats throughout the range was undertaken comprising climatic, soil and vegetation characteristics. Special attention was dedicated to the ecological characteristics of the population in Serbia, including phenology, flower and seed production, pollen production and viability. Finally, population genetic analyses (microsatellites and ddRADseq) were applied to test the genetic structure and diversity of *C. serbica* populations throughout the range of the species, as well as the impact of conservation measures on the population in Serbia.

Measures implemented since 2019 resulted in the improvement of habitat quality and increase in the number of individuals and seed production. Collecting seeds for seed banks proved to be very important, especially in the years with extreme weather conditions. Ecological studies revealed some novelties in the phenology of the species, and differences among localities. Genetic analysis pointed to specificity of the population from Serbia, probably as a consequence of strong bottleneck and genetic drift in the small population. Conservation measures for now did not show stronger influence on genetic diversity in this population, but the real impact will probably be more noticeable in the future.

Keywords: translocation, reinforcement, conservation, population genetics

Acknowledgements: The research was supported by the Ministry of Environmental Protection of the Republic of Serbia and the National Park Tara through project "Revitalization of population of *Cardamine serbica*", COST Action CA18201 ConservePlants, and by the Slovak Research and Development Agency (APVV-21-0044).

Restoration of populations of *Acis nicaeensis*, an endangered endemic species of the Riviera (France, principality of Monaco, Italy)

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The coastal region of the Riviera (France and Principality of Monaco), between Nice and Menton, is among the most highly urbanized areas of the Mediterranean coast, still seriously threatened today by urban sprawl and the fragmentation of natural environments. However, this region is home to many species shaped by the biogeographical history of this territory, including the snowflake, *Acis nicaeensis* (=*Leucojum nicaeense*), a plant species with very high conservation concerns, listed in the Bern Convention and directly impacted by changes in land use. Emblematic of a highly urbanized territory, some populations still persist in particularly reduced natural environments. The management and restoration practices implemented on the most vulnerable populations contribute more broadly to the preservation of a large number of other species and environments.

The conservation and restoration actions carried out on the most vulnerable populations of this species therefore prove to be a priority. The restoration actions were carried out within the framework of the national action plan relative to the French Riviera, the action plan relative to the snowflake in the Principality of Monaco and the European program LIFE Seed Force.

The objective is to boost population dynamics by strengthening the numbers in vulnerable sites. Initial reinforcement and reintroduction were carried out in 2020 in the Principality of Monaco, with very encouraging results. It was therefore possible to carry out new operations in other stations in France, until a sufficient number of individuals was obtained.

Multi-year harvests have achieved minimum number for small populations in order to limit the effects of variations in reproductive success that occur during years when conditions are least favorable for flowering. The harvested seeds were grown at the CBNMed *ex situ* conservation center on the island of Porquerolles. The seedlings raised in the nursery were then planted *in situ* in the initially identified sites. Individuals are monitored annually.

2,134 individuals grown from seeds that were cultivated at the CBNMed *ex situ* conservation center on the island of Porquerolles, were transplanted during the 18 translocation operations, including 6 in the Principality of Monaco and 12 in France. Thus, 10 of the populations that were particularly threatened and identified as vulnerable were able to be restored (2 in the Principality of Monaco and 8 in France), as well as one in Italy. Today, around 1,400 individuals from these restoration operations still persist, and for the 3 operations implemented in 2020, the natural dynamics of the populations has already improved.

Keywords: Habitats Directive, translocations, action plan, *ex situ* conservation, *in situ* conservation

First systematic assessment of germination requirements in an endemic quillwort *Isoetes malinverniana*

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Quillworts (genus *Isoëtes*) are iconic but understudied wetland plants suffering severe declines globally, because of alterations in their habitats. Knowledge gaps in distribution, biology, ecology, population genetics and reproductive biology hamper proper conservation actions. In particular, spore germination requirements and cultivation protocols are unknown for most species. In this study, we present for the first time a systematic assessment of spore germination requirements for a critically endangered quillwort, the Italian endemic *Isoëtes malinverniana*.

Macro- and microsporangia of *I. malinverniana* were collected at maturity from randomly selected plants cultivated ex situ at the Botanic Garden of the University of Pavia. After disinfection with an 2% alcohol solution, macro- and microspores were extracted by cutting the sporangia with a scalpel.

Spore germination tests were performed at 5°C, 10°C, 15°C, 20°C, 25°C, 30°C and 25/15°C. Each treatment consisted of sowing three replicates of 15 macrospores in petri dishes filled with 1% agar. A distilled water suspension of microspores was added to the petri dishes, which were then placed in temperature-light controlled incubators according to the abovementioned temperature and light regime of 16h light/8h dark. Additional tests at 20°C were performed 1) by placing a petri dish in a aluminum bag to test the ability of spore to germinate in the dark and 2) without fertilization with microspores to test for apomixis.

Spore opening and germination (emission of shoot and rootlet) were scored once a week for three months. The first germination event occurred after one month. Spore germination was highest at 20°C, reaching values of about 90%, followed by 30° (XXX %) and 25/15°C (XXX %). Germination also occurred in the dark at 20°C but was slower than in light conditions. No germination occurred in non-fertilized spores, showing that the species is not apomictic. Spore neither germinated nor opened at 10°C after three months.

This first study of the spore germination requirements in an endangered quillwort showed that optimal germination conditions can be quite narrow, which may affect conservation both in situ and ex situ. This study will be particularly useful for optimizing ex situ cultivation conditions and for selecting suitable site for translocation for *I. malinverniana*. A systematic assessment of germination conditions in other endangered quillworts may help understanding causes of rarity and/or vulnerability to habitat changes.

Keywords: ex *situ* conservation, quillworts, spore germination, wetland-dependent plants

Acknowledgements: the present study was performed by the students of the course of “Reintroduzioni di specie vegetali rare e minacciate” of the Master’s course in Biodiversity Conservation of the University of Pavia.

Lichen translocations for conservation purposes in Mediterranean environments: the project BioCon*Lobaria*

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Plant translocations require the application of specific protocols and techniques that account for a variety of factors, including species biology, habitat characteristics, site selection, interactions with other organisms, and climatic and soil conditions. For lichens, successful translocation can involve establishing permanent transplants using symbiotic propagules, thallus fragments, or whole thalli. Given the limited research on lichen translocation for conservation purposes in Mediterranean ecosystems, the project BioCon*Lobaria* aims to explore how habitat features and lichen responses affect translocation success, using the forest lichen *Lobaria pulmonaria* as a model species.

Lobaria pulmonaria (also known as the lung lichen) is a foliose, broad-lobed macrolichen, that has experienced a widespread decline across Europe, in particular due to air pollution and intensive forest management. It is actually considered as threatened in several European countries and regarded as an umbrella species for the conservation of other understudied taxa.

Our project focuses on three distinct forest habitats – mixed oak, chestnut, and beech forests – which serve as primary habitats (including their substrates) for the model species within the Mediterranean region. The main goals include: 1) assessing whether the season of translocation, alone or in relation with forest type, influences translocation success, thereby affecting the effectiveness of conservation strategies; 2) assessing whether the stage of the population impacts the success of translocation; 3) accounting from a methodological point, the role of genetic diversity in populations as it related to biodiversity conservation and translocation efforts; 4) identifying patterns related to receptor sites suitability, which can help elucidate factors influencing translocation success or failure and, more broadly, the survival of lichen communities of conservation interest.

To this purpose sterile meristematic and vegetative thallus fragments – as well as different seasons –for the translocation experiment were considered, with the goal of improving translocation techniques for more effective conservation outcomes. Our research simulates seasonal translocations by transplanting the model species from control sites into 1) mature, undisturbed oak, chestnut, and beech forests, and 2) disturbed environments, such as logged areas with isolated trees of the same forest types, during spring, summer, autumn, and winter. This experimental setup has been replicated across three distinct geographical areas in Italy.

The initial results reveal differences in growth rates, water-holding capacity, photosynthetic performances, and chlorophyll content across depending on population stage, translocation season, forest type and grazing effects by terrestrial gastropods.

Keywords: Conservation measures, Lichens, Mediterranean habitats, Threatened species, Translocations

Acknowledgements: National Recovery and Resilience Plan (NRRP) – Mission 4
Component 2 Investment 1.1 – "Fund for the National Research Program and for Projects of National Interest (NRP)"
Italian Ministry of Education call PRIN 2022 PNRR. Project P2022LJMCC.

KEYNOTE LECTURE

Agriculture, pastoralism and forest management in plant conservation

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Sustainable forest management is critical in addressing biodiversity loss and environmental degradation while ensuring the long-term viability of native flora. Forest ecosystems provide essential ecological services, including carbon sequestration, water regulation, and habitat stability, all of which are crucial for maintaining plant diversity. However, increasing pressures from deforestation, land conversion, and unsustainable resource extraction threaten these functions. To mitigate these impacts, sustainable forest management strategies must integrate conservation principles with socio-economic considerations. A key aspect of this approach is the active involvement of local communities, whose traditional knowledge and land-use practices can contribute to effective resource stewardship and biodiversity conservation. Community-based management models and participatory decision-making that promote sustainable harvesting and land-use planning are essential for balancing ecological integrity with human needs. Additionally, while forest management remains the central pillar of conservation efforts, complementary practices such as agroforestry and pastoralism can further enhance landscape resilience by improving soil health, regulating hydrological cycles, and promoting plant diversity. By fostering synergies between these sectors, we can develop holistic land management strategies that support both human livelihoods and ecosystem sustainability, ultimately ensuring the long-term conservation of plant biodiversity.

Revisiting a small Mediterranean island: how vegetation has changed in the last 15 years

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Resurveying historical vegetation plots has become a fundamental methodology in ecological research, as it provides a unique opportunity to estimate vegetation and environmental changes over time. Small islands are among the ecosystems where the effects of anthropogenic processes might be more detectable and less predictable. This research aims to evaluate how the different types of vegetation occurring on the island of Pianosa (Tuscan Archipelago, Italy) have changed over the last 15 years, both in terms of species and functional composition and to relate these changes to dominant land cover dynamics. The resurvey of a total of 63 georeferenced vegetation plots took place in spring 2023, ensuring a strong correspondence between the location of the old and the new sampling points. The plots were characterised in terms of the process detected (i.e., regression, dynamism, alien species or none), taxonomic and functional composition and turnover was calculated. Parallelly, Normalised Difference Vegetation Index (NDVI) changes were assessed on satellite images retrieved in correspondence with the date of the first survey and the date of the resurvey. Moreover, two high-resolution orthophotos of 2007 and 2023 were used to classify land cover types into three classes: bare soil, grass and woody vegetation and assess changes in land cover types within a buffer of 20 m radius around the plots. We tested for significant differences between vegetation types and the type of process detected for taxonomic and functional turnover, NDVI distances and land cover changes. The main drivers of taxonomic and functional turnover were found to be the encroachment of grasslands by typical shrub species and the shift towards higher leaf area and height in rocky cliffs communities, probably driven by the establishment of seagull colonies. Our results shed light on the main drivers of changes occurring in small island contexts and might provide pivotal information for the conservation of habitats in the Tuscan Archipelago.

Keywords: functional traits, resurvey, NDVI, land cover change, functional turnover, taxonomic turnover

Acknowledgements: The authors acknowledge the support of NBFC to the University of Florence, funded by the Italian Ministry of University and Research, PNRR, Missione 4 Componente 2, "Dalla ricerca all'impresa," Investimento 1.4, Project CN00000033.

CAROLINA project: preliminary results on plant diversity from the first year of sampling

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Grasslands represent species-rich plant communities in Europe and their loss is one of the primary causes of terrestrial biodiversity depletion in the Mediterranean Basin. In Italy the abandonment of agro-pastoral activities has an important role in this process, leading to the wood encroachment and to the reduction in grassland cover. Furthermore, one hypothesis is that grazing makes the system climate-resilient by diversifying the ecological niches.

The project CAROLINA (ClimAte Resilience Over Landuse change In semi-Natural grAsslands) aims to explore the potentiality of the grassland's extensive management under different climate conditions in terms of biodiversity conservation and C sequestration and to examine changes in ecosystem resilience to climate change with land-use variation. The study took place in two different Mediterranean semi-natural grasslands: a Coastal-Mediterranean pasture (San Rossore, Massaciuccoli, PI) and a Mountain-Mediterranean pasture with warm and dry climate (San Venanzo, Orvieto, TR). The project foresees a manipulation experiment used to evaluate the impact of grazing abandonment and climate change.

During 2024, portions of the grasslands at San Rossore and San Venanzo sites have been excluded from grazing through the installation of fences and portions of these areas are object of climate manipulation with structures that lead to a reduction of precipitation, to simulate the future climate trends. Periodic soil microclimatic data of soil water content and soil temperature were collected in these manipulation areas. Between May and June 2024, we conducted the first floristic vegetation surveys and measurements of functional traits in the areas subject to climate manipulation.

Climate data show that plots covered by structures exhibited the lowest soil water content, confirming the effectiveness of the precipitation exclusion treatments in reducing soil moisture availability.

The preliminary analyses carried out concern taxonomic and functional diversity. Species richness is significantly higher at San Venanzo and there is no significant difference between the 3 manipulative layers, exclusion of grazing and reduction of rainfall, exclusion of grazing and control, in terms of diversity. The analysis of functional indices shows that functional richness has similar values in the same treatments of different sites. Other indices such as Rao's quadratic entropy, functional divergence, functional dispersion are significantly higher in San Rossore.

By implementing the calculated functional traits with traits obtained from databases (LEDA Traitbase), we carried out the trait analysis and the calculation of functional diversity indices, and opposite trends emerged compared to the analysis considering only the traits measured this year.

The data collected and analyses carried out in the year 2024 are at the zero point and need to be supplemented and compared with surveys and measurements of functional traits that will take place in 2025.

Keywords: Climate resilience, Plant functional traits, Grasslands

Acknowledgements: The authors acknowledge the support of the Project "Carolina: Impact of land use change on climate resilience of semi-natural grasslands" funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.1 - Fondo per il Programma Nazionale di Ricerca e Progetti di Rilevante Interesse Nazionale (PRIN), CUP B53D23023490001 financed by the European Union - Next Generation EU".

Conservation, Protection and Valorization Efforts of Plant Agrobiodiversity in Sardinia

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Plant agrobiodiversity is crucial element for the sustainability and resilience of the traditional Sardinian agriculture systems, as it contributes to ecological stability and diversified production. The key resources are local plant varieties, listed in the Regional Register of Agrobiodiversity, which represent an invaluable heritage for biodiversity and food security.

In Sardinia (Italy), the Regional Germplasm Bank for Agriculture and Food (BRGAgriS) was established since 2022 with the aim to conserve *ex situ* the genetic resources of agronomic interest. The BRGAgriS operates under Regional Law n°16/2014, which establishes procedures for the managements of the conservation network. The BRGAgriS is structured into different operational sections, including the Sardinian Germplasm Bank (BG-SAR) of University of Cagliari, Interdepartmental Centre for Plant Biodiversity Conservation and Enhancement (CBV) of University of Sassari, the Institute for Animal Production System in Mediterranean Environment (ISPAAM) and the Institute of Sciences of Food Production (ISPA) of National Research Council of Sassari, which are recognized by The Food and Agriculture Organization (FAO).

These BRGAgriS sections, are equipped with laboratories, greenhouses, and conservation fields, and they conserve plant germplasm resources while also implementing applied research projects.

The *ex situ* conservation performed by these sections, managed by Agris Sardegna, is essential to protect local varieties from genetic erosion and ensure the availability of these materials for future breeding programs, addressing challenges such as climate change, resistance to biotic and abiotic stresses, and varying consumer preferences.

The BRGAgriS sections also collaborate with professionals and custodian farmers, whose work helps preserve and renew local varieties over time through on-farm seed and plant conservation.

Many custodian farmers involved in the *in situ* conservation and in the promotion of the genetic resources will be recognized this year as members of the Community for the Protection and Food of South-Western Sardinia.

The BRGAgriS conservation network ensures a continuous monitoring system of conserved resources, making it available to local farmers, future generations, and their use in recovery and valorisation projects. By promoting synergies between research, sustainable agriculture, and local communities, the BRGAgriS network aims to serve as a model for protecting Sardinia's agrobiodiversity and establishing a regional reference for the conservation and valorisation of plant genetic resources.

Keywords: Agrobiodiversity, Sardinia, Regional Germplasm Bank, *ex situ* conservation.

Acknowledgements: this project was funded by Regione Autonoma della Sardegna.

PHENOTYPOS project - Screening and Characterization of Potential Carob Rootstocks within the Cypriot Indigenous Feral Germplasm

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5 ATLANTIS Perivallon kai Kainotomia LIMITED
6 CY.R.I.C Cyprus Research and Innovation Center LTD
7 Alion Vegetables & Fruits Co Ltd

The PHENOTYPOS project aims to create a state-of-the-art, unique to the Mediterranean, research facility to provide plant phenotyping services and research to Cypriot and international users. As part of the implementation process, three pilot projects are being performed. The first pilot project aims to screen indigenous carob feral germplasm and select promising genotypes to be used as rootstocks.

Carob feral populations constitute an indigenous genetic resource with a long history of adaptation to the edapho-climatic environment of Cyprus. The assessment of indigenous genetic resources for selecting genotypes with desirable agronomic traits is a prerequisite for revitalizing the local carob industry under a changing climate. However, the exploitation of these resources until recent decades has been limited to selecting phenotypes bearing desirable pod characteristics as propagative clonal material (scions) for grafting onto carob seedlings. Notwithstanding the importance of improving scions, the genetic basis of carob rootstocks has remained entirely unexplored. Although the effects of rootstocks have been thoroughly demonstrated with respect to the performance and quality traits of numerous tree crops, carob rootstocks have undergone no characterization, evaluation, or screening so far. Feral genotypes are of critical interest with respect to their impact on yield and quality traits, but also for their ability to sustain plant performance under adverse abiotic conditions of limited precipitation in marginal environments.

A survey of indigenous feral carob populations has been conducted with the purpose of identifying promising genotypes to serve as seed sources of potential rootstocks for selecting carob scions. The first step was the survey of feral carob populations across different edaphoclimatic microenvironments of Cyprus. One hundred trees were selected and have already been molecularly characterized using microsatellites. Pods from these trees were parallelly characterized morphologically, and their pod pulp was evaluated for compositional characteristics.

Focusing on discrete carob classes, around 20 diverse genotypes will be selected, and 200 young trees originated from the selected genotypes (progenies) will be screened for drought resistance employing the PHENOTYPOS platform. The young trees will be further genotyped by Next Generation Sequencing (NGS) technologies. Genome-wide Association Studies (GWAS) will be performed to link the genotypic markup with biochemical, physiological, and morphological traits. The best-performing young trees will be transplanted to the field to establish an *ex-situ* collection.

Keywords: drought stress, feral carobs, genetic diversity, High-throughput Plant Phenotyping, rootstock selection

Acknowledgements: The project PHENOTYPOS (STRATEGIC INFRASTRUCTURES/1221/0200) is implemented under the programme of social cohesion “THALIA 2021-2027” co-funded by the European Union, through Research and Innovation Foundation.

Effects of anthropogenic drivers of change on the taxonomic and functional diversity of local plant communities in chestnut groves on the island of Elba, Tuscan Archipelago, Italy

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Chestnut groves have a long history in Europe. They have been cultivated and managed for centuries for their suitability for wood and fruit production, as well as for their landscape and natural value. In Italy, chestnut grove products have been the mainstay of the diet of many local populations, especially in the mountains. Initially, many chestnut groves were planted well outside the climatic optimum for the species but were managed and cultivated in such a way that they thrived for a long time. However, the socio-cultural changes of the last century have led to a gradual decline in chestnut cultivation and the abandonment of chestnut groves. In Tuscany, there are 32 thousand hectares of chestnut groves, more than half of which have been abandoned. In addition, the depopulation of the mountains and the outbreak of aggressive phytopathologies such as American cortical cancer and Chinese gall are the most frequent reasons for abandonment.

This study examines the consequences of the stresses potentially caused by the abandonment of chestnut groves on the island of Elba, in the Tuscan Archipelago. The presence of chestnut trees on the island is of anthropic origin and is mainly located on the northern slopes of Monte Capanne. Despite their often-compromised health status, chestnut groves have an important ecological and naturalistic value. Understanding how anthropogenic and climatic stresses, as well as abandonment or current management, can influence the development of these environments will help to preserve their naturalistic value and understorey biodiversity. To these ends, we combined remote sensing analysis correlated with floristic and functional characterisation of abandoned areas through ground surveys to assess the conservation status of Elba's chestnut groves.

By correlating the calculation of the Enhanced Vegetation Index (EVI) with the vegetation map of the island, it was possible to delineate the chestnut groves on the northern and eastern sides of Monte Capanne and to assess their cumulative vegetative stress. We then surveyed the chestnut groves on the island using a probabilistic sampling design to represent the different levels of stress identified in the areas analysed. 10 x 10m plots were sampled to estimate the presence and relative cover of species in the understorey layers. An assessment of plot stress was also carried out, with stressors including damage caused by Chinese gall and/or cortical cancer, management status of the area (abandoned or not), and damage to vegetation and topsoil caused by ungulates. Results indicate that the level of species richness varies with the degree of site disturbance and that the phytosanitary value is significantly correlated with taxonomic and functional diversity from a numerical perspective. From an ecological perspective, managed plots show a slight trend towards more competitive species, while abandoned plots are more heterogeneous. From a remote sensing perspective, the EVI index is lower when the phytosanitary index is higher.

This suggests that taxonomic and functional diversity may be related to the health status of the chestnut grove, but not to its management on the island of Elba.

Keywords: remote sensing, land abandonment, plant ecology, Mediterranean chestnut groves

Threats and conservation strategies for wild flora in Trentino related to land management

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Among the various actions outlined in the LIFE Seedforce project (LIFE20/NAT/IT/001468 - Using SEED banks to restore and reinFORCE the endangered native plants of Italy) is the restoration of natural habitats. Numerous species are threatened by landscape transformations that result, among other consequences, in the loss of their natural habitats. Traditional practices, such as coppicing and mowing, historically played a crucial role in maintaining open environments like meadows and clearings, allowing them to persist over time. These environments served as vital habitats for species such as *Gladiolus palustris*, *Dracocephalum austriacum*, and *Himantoglossum adriaticum*.

Even species not typically associated with meadows, such as *Adenophora lilifolia*, *Saxifraga tombeanensis*, and *Liparis loeselii*, appear to be adversely affected by the encroachment of shrubland caused by the lack of management.

On the other hand, populations of the same species found in areas where proper habitat management is implemented appear to benefit from it, achieving significantly higher numbers of individuals.

For this reason, the project includes habitat restoration through various strategies and plans to establish agreements with local stakeholders to develop effective measures for the protection of such fragile environments.

Keywords: Habitat Directive, in situ conservation, habitat restoration, habitat management.

Acknowledgements: Life Seedforce received funding by the Life Programme - The European Union funding instrument for the environment and climate action, under contract LIFE20/NAT/IT/001468.

From plant biodiversity to the use of resources: an integrated approach for the conservation of the seminatural dry grasslands of Umbria region (central Italy).

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Seminatural grasslands are an invaluable treasure trove of biodiversity, especially for plant species, and are protected under Annex I of the Habitats Directive (92/43/EEC), the cornerstone of European biodiversity conservation. Nevertheless, they are under severe threat in a large part of Europe and worldwide, mainly due to changes in their management, that is both underuse/abandonment of their extensive use by grazing animals and land-use intensification.

The phenomenon of progressive abandonment of traditional agro-pastoral activities affects particularly the mountainous areas of the Apennine chain (central Italy), leading to a decline in seminatural grassland extension, changes in species composition and a decrease in species richness.

Within this presentation, we aim to show the results of an integrated approach, developed in the frame of the LIFE Integrated “IMAGINE” Project (LIFE19 IPE/IT/000015), that combines plant biodiversity, animal husbandry, and geo-informatics to accurately manage and preserve seminatural grasslands in Umbria region, central Italy.

We investigated the regional grasslands biodiversity through the collection of more than 650 published and unpublished phytosociological relevés, mainly concerning Annex I habitat types 6210* - Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) and 6230* - Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe).

Uni- and multivariate statistical analyses were performed to identify the main grassland vegetation types, their indicator species and the ecological–environmental characteristics that underpin this differentiation.

In order to define the optimal load of grazing animals necessary for the maintenance of each type of seminatural grassland identified, we calculated the pastoral value (PV); on this ground we developed Grazing Plans, including the application of rotational grazing for a balanced use of pastures (Action C14).

In addition, a Web-GIS app based on Sentinel-2 satellite data and harmonic modeling of the EVI (Enhanced Vegetation Index) was developed in Google Earth Engine, allowing users to monitoring grassland’s vegetation and optimize livestock management.

Field investigations allowed us to gain an in-depth knowledge of the grassland’s variability, and contributed to the elaboration and implementation of Action Plans, driving to site- specific concrete conservation measures (Action C15) carried out with the support of the Regional Forest Agency (AFoR), such as interventions of shrub removal for contrasting the encroachment processes.

Keywords: Grassland management, conservation measures, pastures, Habitats Directive

KEYNOTE LECTURE

Ecological Restoration in the Mediterranean Region: Living the Tipping Point

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Ecological restoration in the Mediterranean region stands at the crossroads of opportunity and complexity. This region, a globally recognised biodiversity hotspot, is also rich in cultural heritage, traditional land uses, and archaeological landscapes, leading to overlapping protection regimes and intricate governance structures. These factors, combined with global pressures such as climate change and land degradation, pose significant challenges to restoration efforts. Administrative hurdles, fragmented governance, and inconsistent data on habitat and species conservation status further complicate the implementation of effective strategies.

This keynote examines the evolving paradigm in biodiversity conservation, shifting from protection to active restoration, as reflected in the recently adopted EU Nature Restoration Regulation. Restoration requires moving beyond predefined protections to dynamic, context-specific and holistic actions aimed at achieving "favourable conservation status." This involves balancing ecological functionality with resilience to climate change and human pressures while fostering dialogue among diverse authorities and triggering sustainable socio-economic development.

Existing international guidelines, such as the SER Principles and Standards and BGCI Global Biodiversity Standards, alongside region-specific protocols and tools that leverage ecological indicators, modern technology and participatory frameworks, are introduced. Emphasis is placed on the need for interdisciplinary collaboration and the development of case-specific standards that integrate ecological priorities with cultural and administrative realities.

Opportunities for progress are framed around the growing momentum for restoration driven by the Nature Restoration Law and the forthcoming challenge of drafting National Restoration Plans (NRPs). These plans aim to prioritise degraded habitats, establish baselines, and coordinate actions across Member States but must be based on the widest consultation process possible. Platforms like the Biodiversa+ BiodivRestore Knowledge Hub and emerging National Restoration Hubs in the Mediterranean countries are crucial to provide critical support for these efforts by fostering collaboration and capacity building.

Drawing on over a decade of hands-on experience, the presentation shares failures and lessons learned from practical restoration efforts in Mediterranean habitats, emphasising adaptive management and innovative solutions. It seeks to promote discussion among researchers and practitioners on bridging the gap between theory and practice, developing robust and context-sensitive restoration frameworks that align the Mediterranean ecosystem's need with global and EU biodiversity goals.

Keywords: Mediterranean Ecosystems, Habitat Restoration, Interdisciplinary Collaboration, Nature Restoration Law, Standards of Practice

Improving the soil health before native plant reintroduction: a pipeline for the restoration of plant habitats

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Soils are the fundament of terrestrial ecosystems, playing a key role in habitat formation and maintenance. Soils host a huge variety of life forms (bacteria, fungi, protozoa, and animals), many of which establish close relationships with plants, the most represented taxa in soil. The interactions between plant roots and soil create favorable physical and chemical conditions, which are essential for both plant growth and reproduction, and for soil health maintenance. Such a relationship depends on the plant community composition, and environment disturbance may easily bring to the disruption of such an equilibrium. Plant conservation is tightly connected with the conservation of habitats, so the success of restoration actions largely depends on the restoration of a rich and diverse belowground life, which in turn is sustained by a healthy soil in terms of mineral nutrients, organic matter, and bearable presence of xenobiotic substances. Actions for an efficient plant conservation should thus start from the requalification of soil health. The maintenance or restoration of over-exploited soils according to ecological principles has been recognized a pillar for future agriculture and large efforts have been dedicated to developing sustainable soil and crop management practices and identifying the most appropriate and measured inputs of either organic or mineral fertilizers. The European Soil Mission defines 'healthy' the soil with a continued capacity to support ecosystem services and indicates the improvement of soil structure and concentration of the stable soil organic carbon as necessary to enhance habitat quality for soil biota and crops. The restoration of soil in natural ecosystems pose special challenges, because of the need to limit soil disturbance, to reduce the input of xenobiotic and to avoid or limit the introduction of alien organisms, primary plants, which could become direct competitors of the target species or change habitat conditions.

We present here a pipeline of actions developed for the establishment of native trees on a degraded sandy soil, which starts from the restoration of soil health and the establishment of a ground vegetation cover prior the transplanting of target shrubs and trees. Preliminary actions should assess the soil physical, chemical, and biological properties, and the abundance and composition of the soil seed bank, in order to obtain information on nutrient availability and recruitment potential. In addition, the potential vegetation should be assessed through literature, when available, or the floristic inventory of close areas. As degraded soils generally lack in organic matter and the soil seed bank is poor or contains undesired ruderal and alien species, external inputs are often necessary. In natural ecosystems, soil amendment with manure is not to recommend because it may contain foreign seeds. Thus, better options are either litter and composted vegetation debris collected in close areas, or inert products like biochar. In case the seed bank is not sufficient for recruiting a ground cover vegetation, artificial seeding should be performed with seeds of species collected in the surroundings, preferably grass and legume mixtures, because the former reduce erosion and leaching, and the latter increase soil nitrogen through biological N_2-fixation. To foster symbiosis, seeds should be mixed with the soil collected where legume species were growing. The transplanting of shrubs and finally trees should proceed once an herbaceous ground cover has established. To spare time and to overcome difficulties in seed collection, the first ground cover could be obtained also with commercial mixtures of annual species, which should, however, be overthrown before seed production, thus improving the input of organic matter into the soil, without the risk of introducing foreign seeds.

This pipeline demonstrates that, because of the huge complexity of ecosystems, the conservation of plants within their natural habitats needs a multidisciplinary approach, and the cooperation with the agricultural sector is essential because of its deep know-how in the techniques for soil health improvement and plant management. Within this framework, the SHARIng-Med project (PRIMA foundation) may provide a useful tool to estimate the level of soil degradation and guide the steps of restoration, as it has the objective of developing a standardized database of soil information for the Mediterranean area which integrates data on soil and land management with environmental indicators.

Keywords: Habitat restoration, soil management, potential vegetation, seedbank, soil health

Aknowledgments: This work was supported by the SHARInG-MeD project (GA n 2211, PRIMA)

The LIFE Phoenix Project: Restoring and improve the Priority Habitat 9370* "Palm groves of *Phoenix*" in Crete

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The LIFE Phoenix project aims to improve the conservation status of Priority Habitat 9370* ("Palm groves of *Phoenix*") in Crete, Greece, and Gran Canaria, Spain, by addressing critical threats such as climate change, pests, invasive species, and human activities. This habitat, characterized by the endemic palm species *Phoenix theophrasti* in Crete and *P. canariensis* in Gran Canaria, is protected under Annex I of the EU Habitats Directive due to its ecological and genetic significance.

In Crete, the project targets six Natura 2000 sites, encompassing the entire EU-designated habitat of *P. theophrasti* (27.26 ha). Key actions include habitat restoration through erosion control, fire risk prevention, and removal of invasive species; pest management to mitigate *Rhynchophorus ferrugineus* infestations; and hybridization monitoring to preserve genetic integrity. Innovative measures such as genetic analyses, GIS-based pest surveillance, and community engagement are integrated into a comprehensive conservation strategy.

Initial findings underscore the need for robust management plans to counteract anthropogenic pressures, including overgrazing, tourism, and urban development. Despite challenges, the genetic integrity of *P. theophrasti* remains intact, emphasizing its resilience and the necessity of continued monitoring. The project highlights the importance of adaptive management, combining scientific research with practical interventions to safeguard this priority habitat and its unique biodiversity.

Keywords: Habitats Directive, conservation, endemism, Mediterranean habitats, genetic hybridization, pest control

Restoring the priority habitat "Coastal dunes with *Juniperus* spp." in Portugal, conservation practices in the Zimbral for LIFE project

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The priority habitat 2250* - Coastal dunes with *Juniperus* spp. - is an extremely vulnerable habitat, that occupies a limited ecological space, that is very attractive to some economic sectors, especially tourism, forestry and agriculture. In Portugal this habitat is constituted by two juniper species: *Juniperus turbinata* Guss., a species distributed throughout the mediterranean basin, and *Juniperus navicularis* Gand., an Iberian endemism, with more than 95% of his populations located in Portuguese territory. Despite its importance and protection status, this habitat has been for a long time subjected to several pressures and threats that leaded to its degradation. As a result, is classified with the conservation status unfavourable-inadequate in Portugal – and in the Mediterranean as a whole – with a decreasing trend (2250* in Habitat Directive 92/43/CEE). Thus, to improve this habitat conservation status in Portugal, Zimbral for LIFE was created.

The Zimbral for LIFE project addresses the main factors that are preventing the improvement of the habitat's ecological condition. The project acts on local and national scales. Locally, with three intervention areas, distributed along the southwest coast of Portugal, in three Special Areas of Conservation (SACs) – Comporta-Galé, Costa Sudoeste and Ria Formosa/Castro Marim. After identifying the main pressures on this habitat at the areas, interventions were and are being implemented. These consist of the removal of exotic and invasive species (*Acacia* spp. and *Carpobrotus edulis*), reduction of the pine cover, improvement of juniper populations and other species of 2250* habitat and, from contiguous habitats, through sowing and transplant of young seedlings. At national level, covering all SACs in mainland Portugal where the habitat occurs, the project aims to improve knowledge as well as communication and dissemination work in order to develop a national conservation plan for this priority habitat.

Keywords: Ecological restoration, National action plan, Mediterranean flora, Sand dune junipers, Special Area of Conservation

Enhancement and creation of suitable habitats for pollinators through the selection of seeds of native Mediterranean species

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The Cariverona Habitat Project (2023-2025) "Seeds&Bees" (hereafter S&B) aims to counter the pollinator crisis, with particular attention to Apoidea (both honeybees and wild bees), by restoring their habitats within the Conero Natural Regional Park, Marche Region, central Italy. The project is led by the Ente Parco del Conero, with Università Politecnica delle Marche (UNIVPM) and the Botanical Garden "Selva di Gallignano" - a center for plant conservation within the Ribes Network of the Marche Region – serving as scientific coordinators of various monitoring and production activities. Within this framework, the Botanical Garden "Selva di Gallignano" is tasked with identifying wild Mediterranean species in the Conero area that provide food resources for pollinating insects. The goal is to define mixtures of herbaceous species that can be used in the restoration ecology actions planned within the project.

The target environments for restoration actions are secondary grasslands belonging to the priority habitat 6210*, which have become impoverished in characteristic species and invaded by shrubs and trees due to abandonment. Additionally, the restoration ecology actions also target agricultural margins and other semi-natural environments within agroecosystems not directly involved in agricultural practices except for mowing. In these areas, the enrichment of species that are useful for pollinators promotes both pollinator communities and overall agricultural biodiversity.

The target species selected for secondary grassland restoration include: *Centaurea jacea* L. subsp. *gaudinii* (Boiss. & Reut.) Gremli, *Convolvulus elegantissimus* L., *Lotus dorycnium* L. subsp. *herbaceus* (Vill.) Kramina & D.D.Sokoloff, *Lotus hirsutus* L., *Sixalix atropurpurea* (L.) Greuter & Burdet, *Trifolium angustifolium* L. subsp. a*ngustifolium.* For the creation of seed mixtures designed to restore grassland, *Bromopsis erecta* (Huds.) Fourr. is also considered, as a characterizing species, although it is not directly of interest to pollinators. Target species for enriching agricultural margins include *Calendula suffruticosa* Vahl subsp. *fulgida* (Raf.) Guadagno, *Echium vulgare* L., *Hyoseris radiata* L., *Lotus ornithopodioides* L., *Malva sylvestris* L., *Nigella damascena* L., *Salvia verbenaca* L., *Sixalix atropurpurea* (L.) Greuter & Burdet.

The Botanical Garden "Selva di Gallignano" focuses on evaluating the productive characteristics of the selected species (seed production, harvest yield, ease of seed cleaning and extraction from fruits) and germination traits, especially for species with limited bibliographic data. To test the production potential of the target species, a preliminary autumn sowing trial was conducted in 2024, and a spring sowing trial is planned for 2025.

Keywords: Mediterranean flora, Mediterranean habitats, *in situ* conservation, restoration ecology, pollinators

Acknowledgements: The Seeds&Bees project is carried out with the support of Fondazione Cariverona.

Building alliances for conservation of nature and mitigation of natural risks linked to water through Nature-based solutions. A Mediterranean perspective

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Water is often under the spotlights, whether for its excesses (recurrent floods) or its lack (droughts). This is particularly true in the Mediterranean context. It is thus at the heart of the concerns of decision-makers, managers and practitioners. They seek to identify preventive and natural solutions for sustainable water management.

Among them, Nature-based solutions are applications of co-benefit projects, with a gain for biodiversity and a gain for society. Biodiversity gains are achieved through the restoration, management and/or conservation of ecosystems. The gain for society is a reduction in natural water-related risks. The question then is how to build alliances for nature conservation and flood and drought risk mitigation through Nature-based solutions. The application of this objective to the Mediterranean context is questioned.

On degraded or abandoned land, the expectations of practitioners are real, but they are hampered by lack of know-how. Some confidence in Nature-based solutions is still needed due to lack of knowledge and tools. This requires a better acculturation and appropriation of the concept by decision-makers. This involves: i/ a semantic analysis, ii/ an identification of communities of actors and the decision chain linking them, iii/ a strengthening of links between researchers and practitioners, iv/ a development of practical tools: panel of Nature-based solutions, decision tools, and decision trees for the selection and design of the best solutions.

The case of the conciliation between ecological restoration of degraded environments and prevention of natural risks related to water through bioengineering solutions in the catchment area of the Durance, in the French southern Alps under Mediterranean climate, is presented as an illustration.

Keywords: Floods, Drought, Ecological engineering, Ecological restoration, Plant conservation

Acknowledgements: INRAE, SONADES project

Biotechnical Properties of Mediterranean Plant Species for Soil and Water Bioengineering: Database Development and Applications in Technique Design.

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The Spanish Association of Soil Bioengineering (AEIP) is developing a comprehensive database on the biotechnical properties of key autochthonous plant species used in soil and water bioengineering (SWB) projects across the Mediterranean region. As part of this initiative, a guide for estimating root reinforcement in plant-based materials utilized in such projects has also been developed. This guide serves as a fundamental tool for assessing work stability, providing essential parameters either directly or through allometric relationships.

These resources address a critical gap in the short- and long-term calculation and justification of SWB interventions. The primary objective of this initiative is to provide a solid theoretical and practical foundation to encourage the adoption of SWB techniques in projects focused on slope stabilization and riverbank restoration. Additionally, the database and methodological framework enable a realistic representation of the evolution of SWB structures over time, including the progressive reinforcement transfer process between the initial engineering structures and the developing vegetation.

This initiative is expected to enhance the scientific rigor and practical applicability of SWB techniques, ultimately contributing to more sustainable and resilient environmental management strategies in Mediterranean landscapes.

Keywords: Riparian restoration, root morphology, soil bioengineering, natural based solutions, ecological restoration, Mediterranean species.

Elaboration and implementation of a conservation strategy targeting habitats in the Mediterranean region: example of the south of France

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The RESEDA-Flore network groups 22 organizations involved in the conservation of Mediterranean flora in the South of France (mainland and Corsica). One of the network's objectives is to have people work in synergy to improve knowledge and conserve Mediterranean natural habitats in mainland France and Corsica in a context of global change. This common goal emerged from a demand from conservation stakeholders to work at a bigger scale and not being focused only on species-centred studies. Habitat conservation is now specifically and repeatedly featured in strategic documents related to biodiversity.

After a general survey on the needs and problems encountered locally, a methodological review on how to develop a strategy applied to habitats as well as several preliminary works, this study aims to approach habitat conservation from several working aspects (focus?): improving knowledge, conserving habitats but also communicating and raising awareness. These three working aspects were broken down into concrete actions tailored to habitats. They constitute the core of the RESEDA-Flore habitat conservation strategy and will be presented alongside measurable indicators.

To date, a large number of actions has already been carried out as part of this strategy, including a ranking of habitats by level of conservation responsibility (scoring system). Analysis was performed on habitats of community interest and on phytosociological alliances. Each alliance was also allocated a conservation goal according to various criteria such as threats, already existing protection or lack of knowledge (decisional tree). An overview of the results of this prioritization work will be presented with concrete examples of actions now in place in the network (mediterranean temporary ponds, salt meadows vegetation, dunes vegetation).

Key words: conservation, strategy, habitats, cooperation, global change

Acknowledgements: all RESEDA-Flore members

A predictive occupancy model for vascular plants in temporary freshwater rockpools (TFRs)

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Temporary freshwater rockpools (TFRs) in the Mediterranean region are dynamic habitats characterised by seasonal drying and inundation. These biotopes are colonised by a suite of species tolerant of their ecological gradients, and which are, in some cases, exclusive to these habitats. Effective conservation and restoration of these habitats is sometimes hampered by their transient nature, as the temporary absence of the characteristic wet-season flora may lead to inaccurate expectations of the phytocoenosis in a given TFR. Previous work had suggested that hydroperiod characteristics are an important discriminant for TFR occupancy by a given species and we therefore focused on this aspect during the present study. This study aims to construct a predictive tool that could estimate the probable composition of the phytocoenosis of a single TFR based on its physical characteristics, as these are primary determinants of hydroperiod, if climatic factors are kept relatively constant across sites. We focused on the niche characteristics of seven target species: *Damasonium bourgaei*, *Elatine gussonei*, *Callitriche truncata*, *Crassula vaillantii*, *Ranunculus saniculifolius*, *Zannichellia melitensis*, and *Lythrum* spp. to determine the impact of environmental variability on their distribution.

We surveyed the occurrence of the target species in 170 TFRs across the Maltese Islands (Central Mediterranean), recording the water depths at which each target species was found at the time of maximum inundation in each TFR. The lengths of primary and secondary axes, surface area to volume ratio, and sediment depth of each TFR were also measured.

We used Orange Data Mining software to construct binary occupancy models for each species and parameter combination, using a logistic regression classifier. The models were trained using 80% of the available data and tested against the other 20%. The models utilised a nomogram to indicate the absolute importance of the parameters contributing to the model's decision. This was subsequently additively extended to whole assemblages. The results indicated that, for all species, water depth contributed more to the classification decisions than sediment depth. The occupancy models for *Elatine gussonei* and *Zannichellia melitensis* returned a Classification Accuracy (CA) of 89% and 77% respectively, suggesting that these models could be an effective tool for conservation and restoration of these habitats by accurately predicting which species would colonise a TFR of specified water depth and sediment depth.

Keywords: Temporary freshwater rockpools, Hydroperiod, Occupancy models, Logistic regression, Conservation and restoration

Old-growth forests and flora conservation in Menorca (Balearic Islands)

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Old-growth forests and primary forests are of conservation interest on a global scale for their biodiversity, for the complexity of their habitats and for what they represent as natural systems without anthropic intervention. The knowledge about these plant formations is still low in the Mediterranean region and especially in islands, in these, being limited and where the anthropic influence can cover the whole territory, the presence of these forest formations should be even more critical.

There is some confusion about the criteria that determine the identification of a forest as an old-growth forest or a primary forest. Thus, analyzing the studies that have been carried out in Sicily, Sardinia or in certain regions of the Iberian Peninsula, it can be seen how the selection has been made using criteria that are not completely coincident.

In 2023, the European Commission published a document defining more precisely and with clearer criteria what can be considered an old-growth forest and a primary forest. Based on this updated information, in Menorca, at the initiative of the Department of Environment of the Consell Insular de Menorca, a first study has been carried out to determine the existence of forests that can meet the criteria to be considered as old-growth forests or primary forests. With this localization work, a first characterization has also been made.

On the island, as in other Mediterranean regions, there is a process of forest vegetation expansion. While the forest surface increase can cause a decrease in certain plant communities, for example ruderals and those in cultivated fields, it is also observed how populations of endemics of forest environments have significantly increased their area of occupation . Sometimes, occupying habitats where they were not known until now. Thus, species such as *Asplenium balearicum* Shivas, *Cyclamen balearicum* Willk., *Paeonia cambessedesii* (Willk.) Willk. or *Teucrium asiaticum* L. are now more frequent and abundant, they are often related to forests that meet the criteria to be considered as old-groth forests.

The characterization of old-growth forests also shows the importance of other groups. In well-preserved oak groves, without anthropic influence from decades ago, ferns form an important part of the herbaceous layer and even grow like epiphytes. Other times, the old forests have species whose presence on the island was doubtful or unknown.

All this shows the importance of the floristic richness and the presence of endemic or threatened species as an indicator for the identification of old-growth forests, as well as it can also mark their management guidelines.

Keywords: old-growth forests characterization, Mediterranean islands, endemics, management, *in situ* conservation

Acknowledgements: The study for the identification and characterization of old-growth forests in Menorca has been funded by the Consell Insular de Menorca.

Adapting the Dense-Evergreen Miyawaki Forest Methodology to Drier Climates

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The “Miyawaki Method” is a process for creating potentially stable forest environments in open as well as smaller, even densely built-up areas. This generally involves six basic steps: 1) Understanding the local potential natural forest vegetation and its long-term canopy dominant species; 2) Preparing and planting pot-grown saplings of these species, with root systems already well developed; 3) Planting on a prepared, usually slightly raised site, with imported better soil if necessary; 4) Planting mixtures of perhaps 6-15 local canopy tree species, plus a few understorey species; 5) Planting at a high density, which promotes rapid, light-seeking upward growth that creates a shady, humid forest microclimate and minimizes invasion by light-demanding weeds; and 6) Mulching immediately after planting, to hold water and prevent weeds.

The aim is to create stable natural forests quickly, without going through all the usual successional stages (which may need 50 years or more). This is done by planting mainly the potential canopy-dominant (“climax”) tree species, which in Japan are evergreen trees with dark green (shade-tolerant) broad leaves, as from the laurel and oak families. These are the most shade-tolerant and thus the natural end stage of succession. Though more demanding, their saplings will grow well if they have well-developed root systems and the soil is well-prepared. This scheme works in the humid warm-temperate climate of Japan because the climax species all grow at somewhat similar rates, thus steadily raising an intact canopy and preserving enough shade to keep out faster-growing competitors.

The idea of “Miyawaki forests” has suddenly caught on in many parts of the world, where the climates may have cold winters, a dry season, or be drier overall. Different climates require some adjustment in the methodology, and site preparation depends entirely on the natural substrate. Outside Japan, plantations have been established in tropical Brazil, India, Indonesia, Kenya. Malaysia and Thailand; in mainly eastern North America; in China and Southeast Asia; in some parts of Europe; and in Nepal. Most now have at least 8-10 years of growth and a few more than 30 years – old enough to be showing results that may provide insight even for other climatic situations. Summer-dry Mediterranean climates present a special challenge. One trial was done in Türkiye, with planting in late autumn, just before the winter rains, and with planting density increased from three to four individuals per square meter for trees with less spreading branches. We do not have all the answers. As a result, these plantings outside the benign climate of Japan all need to be monitored closely and problems communicated to others, in order to improve adaptation of the methodology to Mediterranean and other drier situations.

Keywords: climax species, drier climates, intact canopies, Mediterranean forests, shade tolerance

Creation of Miyawaki Forests in Mediterranean Istanbul

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The first Miyawaki forest in Istanbul, Turkey, was established at the SANGO Otomotiv Urunleri Sanayi ve Ticaret A.S./ Turkey site on Dec. 6, 2011 (trial) and Oct. 19, 2014, after growing seedlings from the natural forest.
The ecological, so-called Miyawaki plantation method uses: 1) Potted seedlings/ saplings with well-developed root systems; 2) Planted in dense, random species mixes, for rapid growth by competition and shade tolerance; 3) Mulching with rice straw/mowed weeds/dropped leaves to keep the soil moisture, feed soil animals, and prevent soil erosion and weed growth; 4) Planting by many people together; and 5) No management after three years.
The first field work was done in October 2011, to survey the potential natural forest around Istanbul, mainly at Fethi Pasa Korusu. Quercus coccifera forest had remained and was described by the phytosociological method (Braun-Blanquet 1964). The seeds of trees and shrubs were gathered and sown in the factory to grow saplings: Quercus coccifera, Laurus nobilis, Phillyera latifolia, Arbutus unedo, Myrtus communis, Vaccinium artostaphys, Ruscus hypoglosum and Hedera helix (evergreen broad-leaved) plus deciduous Q. cerris, Celtis australis, Pistacia atlantica, Cercis siliquastrum, Acer campestris, Tilia argentea, Pyrus communis, Viburnum lantana and Crataegus monogyna. The numbers of saplings that could finally be used were Quercus coccifera (1800), Cercis siliquastrum (188), Acer campestris (188), Viburnum lantana (188), Laurus nobilis (188), Pyrus communis (188), Crataegus monogyna (188), Viburnum lucidum (188) and Ruscus hypoglosum (188). The saplings were planted on the slopes around the factory, at three per square meter. Soil improvement involved mixing with food leftovers, weeds and dropped leaves. Planting is continuing as more saplings become available, since open areas are still visible. Each character will be reported in the talk.

Keywords: forest restoration, Mediterranean climate, mixed plantation, Quercus coccifera, self-maintaining

Application of the Miyawaki Method for Plant Community Self-Assembly: Perspectives from Mediterranean Tiny Forests

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The Miyawaki method is a unique and relatively unexperienced reforestation approach devised by Japanese botanist Akira Miyawaki which emphasises biodiversity, sustainability, and community engagement. While the method's success in various climates is widely acknowledged, its effectiveness in Mediterranean environments—marked by challenges such as urban heat islands and biodiversity decline—has not been extensively explored.

The aim of this research is to understand the behaviour of species and the ecological processes that govern the selection and adaptation of the most suitable species assemblages to provide more fitting insights into the threats and needs posed by urbanisation, climate change, deforestation, and biodiversity loss in our cities. The experimental design thus involves gathering responses regarding interspecific competition among plants.

The work involved a sowing strategy in plots measuring 10 meters by 20 meters, resulting in an area of 200 square meters each. Within each plot, the area was subdivided into cells measuring 1m^2, accommodating two seedlings per cell and totalling 400 seedlings per plot. To ensure consistent water distribution to each seedling, an automated drip irrigation system was installed for every plot. Phytosociological characteristics of the planting sites and the Mediterranean Bioclimatic Region were used to select a diverse mix of native shrub and tree species to create a multi-layered canopy within the pilot areas.

Preliminary results from five such urban forests show promising plant establishment and growth, with monitoring planned for at least five years to identify optimal species combinations and gain insights into the ecological processes influencing their adaptation. This will help address challenges related to urbanization, climate change, deforestation, and biodiversity loss.

The initiative has a prominent experimental purpose, as it aims to gather direct scientific evidence on the capacity of the Miyawaki Method to select and promote the development of plant communities that are more adapted to the urban contexts. The Miyawaki method offers an innovative solution to urban greening and reforestation in the Mediterranean and beyond, improving urban sustainability and quality of life. By standardising the approach for Mediterranean urban environments, this study aligns with the global momentum towards urban forestation, aiming to create a lasting impact through long-term monitoring and adaptation.

Keywords: Afforestation, ecological restoration, Mediterranean urban areas, potential natural vegetation

theOtherForest: a nature-based tool for ecological and social regeneration

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Scientists have sounded the alarm for not one, but three major crises of our times: unprecedented biodiversity loss, rapid climate change and social inequity. We believe that the climate change crisis is getting more spotlight because its impacts are more tangible, but we also believe that both crises are intertwined and must be addressed in tandem. theOtherForest; a nature-based tool for ecological and social regeneration, stems out of our belief that we can (and should) tackle these crises together. We build regenerative habitats across species; forests which restore habitats for all of earth's creatures, in the heart of cities.

In addition to our urban regeneration efforts, we focus on building ecological literacy and implementing regenerative design projects across the MENA region, to restore biodiversity, promote healthy soil and mitigate climate change through the urban built environment. Working primarily with the Miyawaki method of afforestation, we are empowering communities to reclaim degraded urban spaces and catalyze ecological & psychological healing, providing a shared habitat for humans, birds, beneficial insects and underground microorganisms to flourish in these dead areas. We are also working with private landowners to replace high-maintenance conventional landscaping with native landscapes to increase biodiversity and eliminate maintenance.

In 2019, we planted Lebanon's first Miyawaki forest in Lebanon, on the banks of the concrete, sewage-filled canal of the Beirut River. Beirut's RiverLess Forest grew from a pilot project of 200 square meters by the banks of the river 800 trees 17 native species and we had a survival rate of 74%. We're now at around 3,000 square meters, more than 7,000 native saplings, and having engaged more than 1,600 community members. We work across scales and disciplines, weaving ecosystem regeneration across residential to commercial and public spaces, architecture, landscape and urban design, as well as planting urban forests to regenerate degraded urban areas. On August 4, 2020, the Beirut blast happened. The blast destroyed a lot of educational establishments within the city, as well as traditional architecture. Along with our partners, we came up with this idea of the Back to Play Forests, which involved going into schools that were heavily damaged by the blast and using that as an opportunity to remove parts of the concrete playgrounds, and start installing small forests with the students. In our latest school, we depaved 250 square meters of concrete and engaged more than 800 students, aged 3 to 16 years, in the preparation of the compost, the soil and planting. We also engaged the school staff, from the president and the board to the security guards, integrating this into their nature-based curriculum and outdoor classes. The goal was to bring everyone together, leveraging Adib's training as an architect and drawing inspiration from biomimicry to transition concrete landscapes into multi-ecosystem habitats.

The results of our work demonstrate that nature-based solutions, when rooted in community engagement and ecological integrity, have the power to address the intertwined crises of biodiversity loss, climate change and social inequality.

Keywords: Miyawaki, EcoLiteracy, Biodiversity, Biomimicry, and Urban Regeneration

Acknowledgements: SUGi and theOtherForest supporters globally

The Eco-Pedagogical Microforest Project in Rome: methodology and results

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The Eco-Pedagogical Microforest Project aims at declining urban forestry on a local scale, framing the experimentation within a strategy of renaturalization of the city and social inclusion, making young people and very young people responsible through the proactive involvement of the school community, high school students and Sapienza students, involving the most vulnerable subjects too.

The authors reflect on the adopted methodology for the eco-pedagogical process and illustrate the obtained results. The achievements of the project are divided into the sustainability dimensions (economic, socio-cultural and environmental) and a special focus is devoted to the relevance with respect to the context of reference, the added value for beneficiaries. Moreover, scientific, organizational and management contribution of the proposing structure are addressed to highlight how the Project has been able to build a multi-stakeholder, intergenerational, multidisciplinary community, generating a process of continuous exchange with and between different actors.

The first Microforest in Rome is located in the Parco dei Caduti, a complex and contested space. The space is tenanted by the inhabitants, the children of the school and the homeless. Just a few months after its creation, places and behaviors changed. The small oasis of biodiversity does not encounter acts of vandalism or theft of plants and the area that welcomes it from an off-limits zone becomes a shared space. During the warmer months, the elderly of the nearby center meet, the young people of the local associations dedicated to watering. The trees and shrubs planted, applying the Miyawaki method, immediately act as an ecosystem, vivifying the soil and the air of the park where new forms of life find refuge.

In 2024, the Microforest becomes the flagship project of the Urban Regeneration Program for the 15-minute city and the Italian Capital is the first European city to include a social, pedagogical and ecological project in the urban planning tools dedicated to regeneration.

Starting from the San Lorenzo project, the Microforest spreads to 5 other Municipalities of Rome, increasingly characterizing itself as an urban and “eco-social” centrality. Integrated into the neighborhood green infrastructure, the Microforest is configured as a new form of nature-based solution (EU, 2015) that aims to actively involve users, increasing their environmental awareness. Thanks to these specificities, in San Lorenzo, as requested by the Municipio II (2024), the project to transform the Microforest into a nature classroom is underway; in Labaro, at the request of the Municipio XV and the Pascal High School, the arrangement of the Microforest is aimed at creating a meeting place for young people (2024); in Casal del Marmo the microforest becomes the “climate-mitigating” background for a new square dedicated to young people (2025).

Thus, the Microforest project has become all together a scientific observatory of biodiversity, a place-making tool, an opportunity for young people to act for a better future within the Agenda 2030 principles framework.

Keywords: Eco-Pedagogical Microforest, Miyawaki method, mediterranean context, renaturalization, social inclusion

Acknowledgements: Roma Capitale, Regione Lazio-Progetto Ossigeno

KEYNOTE LECTURE

The climatic crisis and its impact on plant diversity in the Mediterranean Basin

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The Mediterranean Basin is a global biodiversity hotspot, characterized by a unique combination of climate, geography, and rich diversity of endemic plant species. The region is exceptionally vulnerable to the impacts of the climatic crisis, facing rising temperatures, prolonged droughts, and shifts in seasonal rainfall patterns, which are intensifying the decline of plant diversity. These changes threaten the area's ecosystems, which are critical for carbon sequestration, soil stability, and sustaining diverse animal and human communities.

Climate-induced habitat loss, the spread of invasive species, and phenological mismatches are intensifying pressures on endemic plant species. Additionally, extreme weather events such as heatwaves and wildfires are causing widespread damage to vegetation. Mediterranean ecosystems, including woodlands, maquis, and coastal wetlands, are particularly at risk, with their long-term resilience being uncertain.

Urgent conservation measures are needed, including habitat restoration, the preservation of genetic diversity through seed banks, and sustainable land-use practices tailored to the region's specific challenges. Strengthening regional cooperation and integrating climate adaptation strategies into biodiversity conservation policies are vital for safeguarding the Mediterranean's plant diversity and the essential services it provides to ecosystems and human societies.

Climate change is expected to significantly affect (among others) the reproductive biology of plants. The reproductive biology of plants includes all stages of a species reproduction and is essential for the conservation and management of plant diversity. In particular, the seed germination is an extremely critical stage of the reproductive biology.

The presentation also presents information on the seed germination from work carried out in Cyprus, where a total of eleven plant species were studied, including possible changes in the demographics and the geographical distribution of these taxa, as a result of the possible impacts of climate change (projected temperature increase) in their germination behaviour.

Keywords: Mediterranean Basin, climatic crisis, plant diversity, biodiversity hotspot, habitat loss, reproductive biology, germination.

Shifting Shores: Future Habitat for *Kosteletzkya pentacarpos* (L.) Ledeb.

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The ability to predict habitat suitability is an essential step in conservation planning, mainly for coastal habitat, where climate change plays a leading role in shoreline dynamism and represents one of the main threats to plant survival. The urgency of integrating climate resilience into translocation projects is one of the key drivers of reinforcement and reintroduction actions of *Kosteletzkya pentacarpos* in the northern Adriatic coastal areas. *Kosteletzkya pentacarpos*, a halophytic species of significant ecological and conservation value, is one of the 29 threatened species whose unfavorable conservation status Life Project SeedForce aims to improve through in situ and ex situ interventions.

Among the preliminary actions, including genetic diversity and trophic dependencies studies, a comprehensive analysis of the current and projected habitat suitability, under various climate change scenarios was carried out. Using georeferenced presence points spanning a study area of 2730 km^2, including 4 Natura 2000 sites (Penisola del Cavallino: biotopi litoranei, IT3250003; Valle Vecchia - Zumelle - Valli di Bibione, IT3250041; Bosco di Volano, IT4060007; Bosco della Mesola, IT4060015), we modeled the species' ecological niche. The analysis incorporates bioclimatic and topographic variables to determine the key environmental drivers of habitat suitability and predict range shifts under future climate conditions. High-resolution models were trained using presence points, pseudoabsence data, and background points, achieving exceptional predictive performance (AUC values up to 0.996).

Current projections identified areas of high suitability within and adjacent to Natura 2000 sites, providing a baseline for assessing the impacts of future climate change.

Future scenarios, based on SSPs (Shared Socioeconomic Pathways) 126, 370, and 585, revealed substantial range shifts. These scenarios represent different trajectories of greenhouse gas emissions and societal development: SSP 126 describes a sustainable pathway with low emissions and significant global efforts toward mitigation. SSP 370 represents a medium-to-high emission scenario with regional rivalry and limited mitigation efforts. SSP 585 illustrates a high-emission, fossil-fuel-intensive future with minimal global cooperation. In the broader study area, suitable habitat was projected to increase significantly, with expansions of up to 460% of its current best range under SSP 370 by the period 2071–2100. Conversely, within the IT3250041 and IT3250003 protected Natura 2000 areas suitability often declined, with losses of up to -59.79% under SSP 126 during mid-century projections, although inside IT3250041 (Valle Vecchia - Zumelle - Valli di Bibione) the habitat suitability for the species seems to remains stable and optimal. These range shifts may be attributed to several interacting factors. Expanding suitable habitat under higher emission scenarios could result from increases in coastal salinity or temperature regimes that enhance the species' ecological niche at the edges of its current distribution. However, losses within Natura 2000 sites likely reflect the inability of these areas to accommodate future environmental changes, such as shifts in precipitation patterns, sea-level rise, or altered competition dynamics with other species. The uneven impacts highlight the complex interplay of climate, topography, and ecological factors in determining range dynamics.

By identifying areas of high conservation priority and regions at risk of habitat loss, these findings offered valuable guidance for adaptive management strategies and, together with other preliminary analysis, suggested selecting the location of Valle Vecchia instead of Cavallino site for successful translocation actions.

Keywords: Habitats Directive, climatic change resilience, habitat suitability, conservation priority

Brewing crisis: Forecasting the future of endemic Mountain Tea (Sideritis sect. Empedoclia) under global change

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Sideritis L. (Lamiaceae) comprises approximately 163 species predominantly found in the Mediterranean Basin. Its taxonomic structure includes two subgenera and seven sections, with section *Empedoclia* (Raf.) Bentham containing numerous perennial taxa distributed across the eastern Mediterranean Basin. These taxa extend through Italy, the Balkan Peninsula, Crimea, and Asia Minor, with Anatolia as the primary diversity centre. The members of the section are often (steno-)endemic taxa, and they are commonly known as 'mountain tea'—economically valuable medicinal and aromatic plants (MAPs) that are both cultivated and wild-harvested.

Global biodiversity faces mounting pressures from climate and land-use changes, particularly affecting medicinal plants. These environmental shifts are expected to diminish suitable habitats for MAPs worldwide, affecting their secondary metabolite composition and, consequently, their therapeutic properties. As worldwide demand for effective medicines and herbal products increases—driven by demographic changes, health consciousness and disease patterns—understanding the future distribution of MAP-rich regions becomes essential for adapting management strategies to preserve their ecosystem services.

The eastern Mediterranean region lacks sufficient research examining how climate and land-use changes affect economically important plants. We address this knowledge gap by examining *Sideritis* section *Empedoclia* as a model system. Our methodology combined species distribution models with climate projections and dynamic land-use data across three periods, incorporating two Representative Concentration Pathways and three Shared Socioeconomic Pathways. This approach enabled us to forecast range shifts, habitat fragmentation and biodiversity patterns for 43 endemic taxa through 2100. We also mapped current and projected future endemism hotspots in the eastern Mediterranean, incorporating both taxonomic and phylogenetic data. Furthermore, we conducted preliminary extinction risk assessments for these taxa using IUCN Criteria A and B.

Our results demonstrate marked range contractions and increased habitat fragmentation across all studied taxa, with Greek and Turkish endemics showing elevated vulnerability, although land-use changes partially moderate these effects. All species are projected to experience substantial changes in their suitable habitat distribution by mid-/long-term, including probable altitudinal shifts. The heightened extinction risk predicted for several species in the coming decades indicates the urgent need for in-situ and ex-situ conservation strategies.

Keywords: conservation, Lamiaceae, medicinal plants, Mediterranean flora, mountain tea, species distribution models

Paradise at stake: Human pressure on local endemic plant taxa in Greece's holy mountain (Mt Athos) under climate change scenarios

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The Athos peninsula, known as "The Holy Mountain", lies in Central Macedonia, Northern Greece. This 350 km^2 area extends 50 km northward to southward, culminating in Mount Athos at 2,033 m. Forests cover more than 90% of the peninsula, establishing it as one of Greece's most forested regions. The peninsula's historical dedication to monastic communities has largely preserved it from intensive urban, infrastructure and agricultural development. This unique circumstance, combined with its geographical isolation, altitudinal range, and varied geological, topographical and climatic conditions, has fostered a diverse vegetation mosaic.

The flora of Athos includes approximately 1,469 species and 248 subspecies across 610 genera and 131 families. The peninsula exhibits remarkable endemism, harbouring 22 local, 35 Greek, and 79 Balkan endemic taxa. Of the local endemics, 12 have undergone extinction risk assessment according to the IUCN Criteria. The peninsula represents a crucial hotspot for endemic species richness and corrected-weighted endemism in Greece and is also classified as an extinction risk hotspot.

Global biodiversity faces increasing threats from climate change and land-use alterations, with (pen-)insular ecosystems being particularly vulnerable. This research examines the effects of these anthropogenic pressures on local endemic plants in the Athos peninsula. Whilst previous studies have examined climate change impacts on the Mediterranean flora, none have specifically addressed how climate change might influence extinction risk in local endemic taxa within an area largely undisturbed by human activity.

Our methodology employed species distribution models that integrated climate projections with realistic dispersal constraints. We examined three time periods (through 2100) and two Representative Concentration Pathways to forecast range shifts, habitat fragmentation and biodiversity patterns for 14 local endemic taxa. The models incorporated abiotic variables, including bioclimatic, topographical, soil and hydrological factors. We also mapped current and projected future endemism hotspots within the peninsula, considering both taxonomic and phylogenetic data.

The results indicate low to moderate range contractions and increased habitat fragmentation across all studied taxa. *Isatis tinctoria* subsp. *athoa* and *Onosma paradoxa* are projected to face more severe impacts, whilst *Crocus athous* and *Centaurea peucedanifolia* demonstrate greater resilience.

Keywords: Local endemics, species distribution modeling, IUCN, extinction risk, climate change

Unraveling the Influences of Edaphic and Topographic Factors on High-Mountain Plant Communities: first results from the MO.MO.ME. Project

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The Project 'Monitoring Network for Studying the Effects of Climate Change on Mediterranean High-Mountain Grasslands in Natura2000 Sites (MO.MO.ME.)' aims at analyzing the differences in plant communities, microclimate, and topography across various study areas. The main goal is to improve understanding of the biotic and abiotic factors regulating the assembly of high-mountain communities, focusing on the functional and structural dynamics of Mediterranean grasslands.

We present the first results of our analysis focused on the role of edaphic and topographic gradients on vegetation patterns above 1900 m a.s.l. on Pizzo Carbonara (Madonie Mountains, Northern Sicily), a carbonate massif shaped by karst erosion, resulting in a system of sinkholes and windy ridges across the summit plateau. We sampled 42 vegetation plots, georeferenced using sub-metric GPS. Various topographic variables were derived from Sicily's regional technical map (2 m resolution) using QGIS. Additionally, chemical and biochemical soil parameters were analyzed for each plot.

Plant species were classified into three life-form groups: chamaephytes, hemicryptophytes, and therophytes. Data were analyzed using three response variables: species richness, vegetation cover, and species composition. For the first two, we applied a Generalized Linear Model (GLM), while compositional data were processed using distance-based redundancy analysis (db-RDA) with variation partitioning.

The results indicate that life forms are differentially filtered by edaphic and topographic variables. The topographic factors influence the relative performance of co-occurring vascular plant species, shaping the structure and composition of local plant communities.

Keywords: Plant communities, Life-forms, Mediterranean mountains, Soil, Topography

Acknowledgements: The funds of the CNR-IBBR Project DBA.AD002.679 'Monitoring network for the study of the effects of climate change on Mediterranean upland grasslands in Natura2000 network sites (MO.MO.ME.)' are gratefully acknowledged.

How climate relict trees cope with the Mediterranean climate: the importance of refugial settings and plant adaptive ability

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Climate relicts, once widespread over large regions of the globe, are nowadays restricted to refugial areas, where the persistence of single species results from processes that should be analysed from both ecological and evolutionary perspectives. In turn, the physical characteristics of refugia, at both macro- and micro- scales, are key drivers of the environmental adaptability and fitness of such species.

In order to investigate these issues, two congeneric relict trees, *Zelkova sicula* from Sicily (Italy) and *Z. abelicea* from Crete (Greece), were selected as model species because of their strong affinity in terms of taxonomy, biogeography and evolutionary history. Growth traits and growth form were analysed comparatively with respect to altitudinal and geographical range, microtopographic patterns, and response to main climatic drivers.

The results revealed that although the two species share several morphological/physiological traits that facilitate their adaptation to the Mediterranean environment, they show differential responses in terms of growth performance and fitness. In the case of *Z. sicula*, convergent topographies are basic determinants of hydrological microrefugia in arid environments, playing a key role in decoupling from regional climate and supporting the target species to cope with an unsuitable climatic envelope. For the Cretan relict, an “elevation effect”, involving a significant attenuation of environmental constraints, can be identified as the main offsetting driver for the differential functioning mechanism of low vs. high altitude refugia. Our findings are of major concern for the implementation of in-situ conservation and management action plans of relict plant species.

Keywords: dendroecology, growth patterns, hydrological microrefugia, marginal habitats, topographic attribute analyses

Acknowledgments: This work was partially supported by the Fondation Franklinia by a grant to L. Fazan, D. Ghosn, I. Remoundou, and S. Pasta, and the Programme LIFE+, Project LIFE10 NAT/IT/000237 Zelkov@zione (http://www.zelkovazione.eu/).
The permits to study the *Z. abelicea* plant materials were granted by the Greek Ministry of Environment under permits n°110051/1286, n°124068/1323, n°138579/840 and n°155924/1184.

Paleoclimatic projections from JSDMs refine those of SDMs, outperforming them in rare species.

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Predicting how biodiversity responds to non-analog environmental conditions is a major challenge in ecology, particularly in the context of global change. Past environmental changes provide essential references for studying biodiversity responses. Emerging tools, such as paleoclimatic reconstructions (e.g., Paleoclimate Modelling Intercomparison Project) and fossil pollen databases (e.g., Neotoma Paleoecology Database), are valuable for studying the biogeographical history of plant species and ecosystems. Species Distribution Models (SDMs) link species' presence to environmental conditions but face limitations in capturing interactions among species and other complex factors. Incorporating biotic interactions, functional traits, and phylogenetic relationships, Joint Species Distribution Models (JSDMs) outperform SDMs projections but are little used in paleoecological studies.

In this study, we used Hierarchical Modelling of Species Communities (HMSC) to fit SDM and JSDMs for conifer and broadleaf forest species in the Western Mediterranean. Models were projected to the Last Glacial Maximum (LGM; 21ka-present) at 100-year intervals and validated using fossil records from the Neotoma Paleoecology Database.

Results show JSDMs refine SDMs projections, particularly for rare species, demonstrating their advantages. Although evaluation metrics revealed smaller differences (both average AUC around 0.7) for abundant species, distribution maps differed notably (e.g., SDMs predicted 16,262,926 ha more than JSDMs as suitable for *Pinus halepensis* in 6 ka BP). This highlights the fossil record's uneven spatial distribution, especially its scarcity in North Africa. JSDMs predictions were generally more restrictive but identified suitable areas missed with SDMs. This insight is crucial for understanding species' biogeographical history, identifying long-term refugia, and informing conservation strategies.

Keywords: Ecoinformatic, Mediterranean flora, Joint Species Distribution Models, biogeography, paleobotany.

Funding:
-UCO pre-doctoral contracts of the Own Plan of Research of the University of Córdoba.
-Project (TED2021-132631B-I00) funded by MCIN/AEI /10.13039/501100011033 and by the European Union NextGenerationEU/ PRTR

Elaboration of pharmaceutical properties of endemic plants in Cyprus

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Cyprus, an island located in the eastern Mediterranean, is home to a rich variety of endemic plant *taxa* found nowhere else on Earth. Its unique geography, climate, and history of isolation have allowed for the evolution of many species that are adapted specifically to the island's habitats. The Cyprus flora includes a comparatively high proportion of endemic plants counting to 146 or 8,85% of the total number of native plants. Among these are the Cyprus cedar (*Cedrus brevifolia*), one of the four cedar species occurring worldwide, Cyprus Cyclamen (*Cyclamen cyprium*), the national plant of Cyprus and Cyprus St. John's-wort (*Hypericum repens*), a plant notable for its medicinal properties.

These plants contain several bioactive compounds, naturally occurring chemical substances that seem to play a significant role in plant defense mechanisms, growth, and reproduction, while many of them have been found to exhibit therapeutic effects on human health. These bioactive compounds, which are often classified based on their chemical structure or their biological effects, include alkaloids, phenolics, flavonoids, terpenoids, tannins, glycosides and carotenoids. They offer a wide range of health benefits, including antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Understanding the variety and functions of plant bioactive compounds is essential for their potential use in medicine, nutrition, and agriculture. Many of these compounds have been used for centuries in traditional medicine and are now being studied for their therapeutic potential in modern science.

Chemical analysis of different extracts from these endemic plants was performed using LC/Q-TOF/HRMS and the majority of compounds identified belonged to the flavonoids family. All extracts were rich in terms of secondary metabolites such as phenolics (in terms of gallic acid) and derivatives of catechin, rutin and quercetin. The extracts were also studied for their antioxidant activity using a combination of free radical scavenging assays. Specifically, the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) method was assessed with all extracts demonstrating significant antioxidant activity, with low IC_{50} values as compared to a potent antioxidant control. The antioxidant activity was partly expected due to their high content of flavonoids and phenolics. Additionally, their antimicrobial activity was evaluated by determining the minimum inhibitory concentration (MIC) against gram positive (*Staphylococcus aureus, E. faecalis*) and gram negative (*E.coli, Salmonella enteritidis*) bacteria. All extracts demonstrated antibacterial activity against all types of bacteria with low MIC concentrations.

Several endemic plants are rare and face threats from habitat destruction, climate change, and over-exploitation. Their unique chemical profiles, developed through adaptation to local environments, make them an important resource in the field of pharmacology and medicine. For these reasons, conservation of these plants is crucial to preserving their potential benefits, as well as maintaining biodiversity. The study of endemic plants helps conserve the natural environment and also paves the way for new therapeutic agents, enhancing our ability to combat a range of diseases and improve public health. The loss of endemic plants could mean the loss of unique bioactive compounds that might otherwise lead to breakthroughs in medical treatments.

Keywords: endemic, phenolics, flavonoids, antioxidant, antimicrobial.

KEYNOTE LECTURE

Plant conservation in the Mediterranean: drawing strength from its rich past to sustain the present and shape a resilient future

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The Mediterranean, poetically described by historian F. Braudel as stretching «along the Saharan shores of the Inner Sea, from the Near East to the Pillars of Hercules,» transcends its geographical boundaries. It embodies a living tapestry of historical, cultural, and natural heritage. This dynamic and ever-evolving narrative is etched into its monuments, traditions, and, most strikingly, its uniquely rich and diverse ecosystems, particularly its flora.

The Mediterranean Basin is a floristic and evolutionary mega-hotspot, playing a vital role in global plant conservation. It hosts an estimated 25,000 vascular plant species, 10% of the world's total, over half of which are endemic to the region. However, this extraordinary biodiversity is under severe threat from anthropogenic pressures and climate change, leading to habitat degradation and significant plant diversity loss. Alarmingly, 28% of assessed plant species (approximately 1,784 taxa) are classified as threatened with extinction, listed as Vulnerable, Endangered, or Critically Endangered on the IUCN Red List.

To counter these challenges, Important Plant Areas (IPAs) have been identified as key components of global and regional biodiversity conservation strategies. A total of 888 IPAs have been recognized across the Mediterranean, selected based on rigorous scientific criteria to highlight areas of exceptional plant conservation value.

Protected areas (PAs) serve as a critical complement to IPAs by safeguarding nature, preserving indigenous and local knowledge of biodiversity, and maintaining ecosystem services. When IPAs overlap with existing PAs, such as national parks, conservation efforts are significantly bolstered. Nonetheless, significant gaps remain where high-priority IPAs lack formal protection, underscoring the urgent need to expand conservation networks.

Key priorities for plant conservation in the Mediterranean include enhancing the IUCN Red List to identify and update conservation priorities, integrating IPAs into national and regional PA networks, and mapping plant diversity to pinpoint unprotected areas. Equally important are efforts to restore degraded habitats, reintroduce native species, and manage invasive ones. Engaging local communities, aligning conservation efforts with broader biodiversity goals such as those outlined in the Kunming-Montreal Global Biodiversity Framework, adhering to IUCN Green List principles, and fostering regional collaboration to share knowledge and best practices are also critical. By serving as catalysts for innovative conservation strategies, IPAs can bridge science, policy, and community action across the Mediterranean.

In conclusion, plant conservation in the Mediterranean is not merely a regional priority or an optional endeavour, it is a global responsibility. It is essential for safeguarding ecological resilience, preserving cultural heritage, and sustaining livelihoods worldwide. Within the philosophy of the '3Ps' : Plants, People, and the Planet ; a fourth 'P' emerges as indispensable: Priorities. This addition highlights the urgency of focused conservation actions to address the complex challenges we face today.

Keywords : Mediterranean hotspot, important plant areas (IPAs), protected areas (PAs), IUCN Red List, conservation priorities, governance

Harnessing Plant Diversity to Advance Key Biodiversity Areas in the Mediterranean

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The identification of Key Biodiversity Areas (KBAs), the sites contributing significantly to the global persistence of biodiversity, is central to halting biodiversity loss and achieving the 2030 milestones of the Kunming-Montreal Global Biodiversity Framework (GBF). The Mediterranean region, renowned for its rich biodiversity and endemic plant species, is a critical focus area for the identification and conservation of Key Biodiversity Areas (KBAs). This presentation will highlight three critical aspects: the foundational principles of the global KBA Standard, the current state of KBAs in the Mediterranean, their degree of overlap with Important Plant Areas (IPAs) and the untapped potential of plant diversity in the region to catalyze the confirmation of existing sites and the identification of new KBAs.

Plants offer immense potential for improving KBA networks. By leveraging plant data, stakeholders can more effectively address GBF Target 1 (spatial planning) and Target 3 (protection and management of critical biodiversity areas). Plant-focused KBA assessments can help identify ecosystems of high ecological integrity and species at risk, facilitating restoration efforts and ensuring better connectivity and resilience.

This work emphasizes the need for comprehensive biodiversity assessments, engaging local and regional stakeholders, and integrating plant-based data into spatial planning to accelerate progress toward the GBF's overarching goals of halting biodiversity loss by 2030.

Keywords: Mediterranean biodiversity, Important Plant Areas, GBF Targets, IUCN Red List.

National plant conservation priorities for protected areas network in Lebanon

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The STEP4Nature Project proposes a strategic framework for sustainable management of nature reserves (NRs) in Lebanon, centralizing national sampling efforts and establishing a network among managing entities. The study covered all 18 current NRs, spanning 22,248 ha, and was conducted from 2022 to 2023 in three phases: (1) mapping natural habitats within NRs, (2) conducting vegetation surveys to develop a plant species checklist, and (3) creating integrated, site-specific monitoring plans to prioritize endemic and endangered species conservation. Among Lebanon's 190 habitat types, 42 were identified within the NRs, representing all the vegetation belts from coastal to oro-Mediterranean levels. Of Lebanon's estimated 3,000 plant species, 736, approximately 24% of native floral diversity, were documented in the reserves. Three types of evergreen and deciduous oak woodlands of Quercus calliprinos, Q. look, and Q. infectoria dominated, covering over 45% of the total NR area. Notably, 90 of the 173 endemic species in the Mount Lebanon, Anti-Lebanon, and Mount Hermon ranges, as well as 52 of the 108 nationally threatened species, were recorded in NRs. Using criteria such as IUCN global status, endemism, rarity, and ecological roles, the project developed integrated management plans for target species. These plans included optimized survey designs and data collection schedules for designated locations within NRs. While additional protected areas are necessary to cover underrepresented regions, habitats, and species, the implementation of tailored conservation measures at a national level offers a robust approach to safeguarding Lebanon's threatened plant species.

Keywords: endemic, endangered, nature reserve, management plan, Levant flora

Acknowledgements: The authors acknowledge the United Nations Development Programme (UNDP)- "STEPping up Nature Reserves Capacity – STEP4Nature" project funded by the Ministry of Foreign Affairs and International Cooperation of the Italian Republic through the Italian Agency for Development Cooperation (AICS) implemented in coordination with the Ministry of Environment of Lebanon for contributing to the study.

Representativeness of the Palestinian terrestrial ecosystems in its protected areas networks – strategic recommendations for biodiversity conservation

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Palestine is home to a rich diversity of ecosystems, yet the effectiveness of its protected areas (PAs)—established over 50 years ago—remains questionable. This study evaluates the 2015 and 2023 Protected Areas Networks (PAsN) using systematic conservation planning and GIS tools, benchmarking them against global biodiversity standards such as the Aichi Biodiversity Target of 17%. Indicators including ecosystem representation percentages, the Biodiversity Conservation Index (BCI), and the Comparison Index (CI) were employed to assess the networks' ability to conserve key ecosystems and vegetation types.

The findings reveal critical shortcomings. While ecosystems like Evergreen Mediterranean Maquis (2.15%) and vegetation types such as Maquis and Forest (2.11%) and Park Forest (5.40%) are severely underrepresented, others like Desert Salines (46.37%) and Desert Vegetation (43.06%) significantly exceed protection targets, indicating an imbalanced conservation approach. Moreover, 93% of the network's expansion is concentrated in Area C, where limited access for adjacent Palestinian communities undermines the feasibility of effective implementation. Despite expanding PAs coverage to 10.8% of Palestine, the 2023-PAsN remains inadequately distributed, particularly in western ecosystems, which face intense anthropogenic pressures. These imbalances result from structural flaws in the 2023 assessment, including poor research design, incomplete biodiversity data, unreported findings, biased reporting, and methodological errors. Such issues underscore how limited conservation research resources can be wasted, producing outputs inadequate to guide policy or practice.

To address these challenges, the study advocates for a paradigm shift in conservation planning. Recommendations include redesigning the PA network to ensure equitable ecosystem representation, reinstating omitted high-value conservation areas, and creating micro-reserves for unique habitats and threatened species. Furthermore, fostering transparent, high-quality reporting and robust methodological frameworks is essential to prevent resource wastage and inform evidence-based policy. By adopting globally aligned, science-driven conservation strategies, Palestine can transform its protected areas network into a model for efficient and effective biodiversity preservation, contributing meaningfully to regional and international conservation goals.

Keywords: Protected Areas Network (PAsN), Systematic Conservation Planning, Biodiversity Conservation, Ecosystem Representation, Palestine Protected Areas, Overall Biodiversity Conservation Index (OBCI).

The vascular flora of conservation interest in Sicily: a multistep procedure aimed at identifying the priority targets for risk assessment and plant conservation

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Without prioritisation of risk assessment targets based on objective and explicit criteria, we risk to protect "too much" on paper, yet too little in practice.

To create a more effective priority list, besides of the standard criteria related to distribution, rarity, and degree of threat, we considered the following four ones: (1) biogeographic interest (e.g., narrow endemics, highly disjunct taxa, populations at the edge of the species range), (2) conservation interest (e.g., taxa found only in Sicily within the Italian territory), (3) legally protected and (4) subject to IUCN assessments, whilst we suggest to rule out the endemic taxa shared with neighbouring regions, those belonging to poorly studied genera or resulting from apomixis, and the archaeophytes.

IUCN criteria can hardly be applied to all rare plants: for example, annual plants typical to ephemeral swards, as well as pioneer and wandering plants related to disturbed habitats, can be easily overlooked. Moreover, the high amount of "data deficient" taxa underlines the need to intensify field activities.

Although a more rigorous assessment procedure has allowed to downscale the risk level for many taxa, yet the number of regionally extinct plants is higher than previously reported, emphasizing the need to reduce human impact especially on the most threatened habitats linked to wetlands and dune ecosystems.

Keywords: conservation priorities, field monitoring activities, IUCN criteria

Assessment of the effectiveness of Natural Protected Areas for the conservation of cliff flora in Spain

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The identification of priority areas for conservation and the existing gaps in the network of Natural Protected Areas (NPAs) is a cornerstone of conservation biology. This study focuses on identifying priority areas for the conservation of cliff flora in Spain, whose richness, singularity, fragility and rareness make it of great value for conservation.

First, we analysed the spatial distribution of 1,398 rock-dwelling plants across the study area using a 1 x 1 km grid. Occurrence data were downloaded from the Global Information Biodiversity Facility (GBIF). Second, priority areas were identified following two criteria: (1) high rock-dwelling taxa richness and (2) the presence of threatened cliff-specialist plants (VU, EN and CR categories of the IUCN in Spain). Subsequently, we performed a gap analysis by overlapping priority areas and their hosted taxa with the existing NPA network, thus identifying which priority areas and which endangered rock-specialist taxa are currently outside protected areas. Finally, we propose an expansion of the NPA network to ensure coverage of the richest areas and the inclusion of each threatened rock-specialist in at least one NPA.

Most of the priority areas were located within major mountain ranges, such as the Cantabric Mountains, the Pyrenees, the Coastal-Catalonian Mountain Range and the Baetic System. Results show that NPAs, and specially the mountain National Parks (NNPP) network, play a crucial role for the conservation of cliff flora. NPAs host approximately 95 % of the cliff plants, while NNPP, having much more reduced surface, host 50 % of all the cliff-specialists and contain priority areas across much of their extent. The gap analysis showed that the conservation potential of NPAs could be enhanced through a strategic expansion of some areas such as those located close to the mountain NNPP and at the lower basin of the Ebro river. In other regions new NPAs would be needed to protect their cliff flora. (e.g. on the northern coast of Galicia, the north of Alicante, the islands of Ibiza and Menorca and in some scattered areas in the interior of the Iberian Peninsula).

Despite NPAs in Spain cover a large proportion of its territory and play a crucial role in the conservation of biodiversity, their expansion is essential to better protect some particular and very valuable components of its biodiversity, such as the cliff flora.

Keywords: Cliff Flora, Gap Analysis, Natural Protected Areas, Priority areas.

What's new about Important Plant Areas identification in northern Algeria?

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In 2009, PlantLife, the IUCN Mediterranean Center for Cooperation and the WWF initiated the process for identifying Important Plant Areas (IPAs) in northern Algeria, including capacity building, data review, and help for publication. The first step was the edition of a first IUCN report on "Important plant areas of the south and east Mediterranean region" in 2011. At this stage, 21 IPAs had been identified in northern Algeria, and the process more detailed in an international publication by Yahi et *al*. in 2012, adding a 22nd at the same time.

Then, a national dynamic started and few new IPAs were added opportunely, until a new editing process supported by IUCN and the MAVA foundation that permitted the publication of a second report in 2018 on "Conserving wild plants in the south and east Mediterranean region". At this stage, northern Algeria totalized 39 Key Biodiversity Areas for plants (i.e. IPAs).

At national level, Algerian botanists pursued their field inventories and the identification process of new IPAs. At end of 2024 more than 40 IPAs are identified and several others are already on their way thanks to targeted field studies, PhD thesis and their corroborated scientific publications through diverse areas of the country.

From a methodological point of view, three generations of Algerian IPAs are parallelly developed and progressively incremented. The first generation was created based on historical bibliography, aiming to generate a first list of trigger species. The second generation was based on frugal field surveys aiming to rediscover and confirm the occurrence of trigger species. The third generation, now beginning, both aims to redefining the trigger species list based on a revised taxonomy and to redelimiting the IPA perimeters based on a concrete terrain mapping. These new ambitions face various difficulties which will have to be addressed and gaps which will have to be filled.

From a conservational point of view, NGOs and administrative services are gradually taking ownership of this informative but non-binding classification and are using it to support their requests for the classification of natural sites and the creation of protected areas.

Keywords: biodiversity mapping, capacity building, decision support, field surveys, in situ conservation, taxonomical shortfalls.

From Taxonomy to Conservation: Can We Conserve Plants We Don't Fully Know? Taxonomic Ambiguities in the Mediterranean *Juniperus phoenicea* Complex, with a Focus on *J. turbinata* from Algeria

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Taxonomic clarity is a cornerstone of effective plant conservation. The *Juniperus phoenicea* complex, widespread across the Mediterranean region, exemplifies the challenges posed by taxonomic ambiguities. In Algeria, the distinction between *J. phoenicea sensu stricto* and *J. turbinata* Guss. has historically been overlooked, leading to misidentifications and gaps in conservation strategies.

This study employed a multidisciplinary approach, integrating morphometric analyses and chemotaxonomy, to elucidate taxonomy and geographic variation within the complex. Our findings confirm the presence of *J. turbinata* in Algeria as a taxonomically distinct entity from *J. phoenicea* s.s. Furthermore, we identified two distinct varieties of *J. turbinata* in Algeria, highlighting the Maghreb region's unique ecological context. Notably, this region is the only area where *J. turbinata* inhabits both coastal and continental environments, showcasing its remarkable ecological adaptability and importance within Mediterranean ecosystems.

The implications of these findings extend beyond taxonomy, emphasizing the critical role of addressing taxonomic uncertainties to guide conservation planning. Accurate species delimitation is fundamental for identifying conservation priorities, particularly in the face of habitat degradation and climate change. This case study advocates for a comprehensive revision of the *Juniperus phoenicea* complex across the Mediterranean and highlights the necessity of integrating taxonomic research into regional conservation frameworks.

Keywords: Mediterranean Flora, Algeria, *Juniperus phoenicea*, *Juniperus turbinata*, Biometry, Chemotaxonomy, Plant Conservation.

Deciphering the diversity of floral species and butterflies (Lepidoptera) within four valleys in Al-Arqoub- South of Jerusalem, West Bank- State of Palestine

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Habitat destruction and fragmentation, climate change, pollution, invasive species, and overexploitation are global causes of biodiversity loss. Area-based conservation measures that take into account connectivity are critical. It is extremely challenging to conserve isolated or fragmented areas. The area of the South Jerusalem Hills includes several villages collectively called the Al-Arqoub area (Al-Khader, Battir, Husan, Al-Walaja, and Wadi Fukin) with several valleys that was proposed in 2023 as a new protected area by EQA. The area is rich in cultural and natural heritage. The challenges reported in the conservation of the area warranted serious consideration of how to do effective conservation measures. Two groups (vascular plants and butterflies) (Lepidoptera) were selected to identify key challenges resulting from urbanization and habitat destruction. 387 floral species belonging to 79 families were identified, of which 53 are rare, while 54 are considered very rare. We recorded 63 medicinal and herbal plants, 5 parasitic plants, and 10 introduced invasive species. 44 butterfly species were demonstrated within the targeted region. Their distribution within four poorly connected areas comprising the four valleys in the study areas suggests isolated populations, which will make protection difficult for the whole area. We suggest that despite the near impossibility of ensuring a connected eco corridor in the area, key plants and associated key butterflies in each of the four areas (as small reserves) ought to be protected. Such studies can be implemented in other fragmented areas of the State of Palestine.

Keywords: Fragmented habitats; Species distributions; Connectivity; eco-corridors.

KEYNOTE LECTURE

The NEXTGENDEM bioinformatics platform: Providing biodiversity managers with Science-based indicators to conserve biodiversity in Macaronesia…and beyond?

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Gran Canaria is a considerably old oceanic island (ca. 15.5 Mya) in the Canarian archipelago, which is made up by seven major islands that lie barely 100 km off the NW coast of Africa. Despite its small size (about 1,560 km^2), Gran Canaria contains a remarkable plant diversity, which is largely explained by the island's great geographical and ecological complexity and the overall fast evolutionary turnover of the Canarian endemic flora. The complex geographical and biological setting of Gran Canaria, and the additive impacts of about four million tourists per year, more than 900K residents, and numerous invasive species, pose daunting challenges for the environmental management of the endemic plant biodiversity and the Protected Natural Areas.

In this investigation, we use data on 95 biotic and abiotic variables (including genetic and phylogenetic diversity) for each 500x500m territorial cell of the island of Gran Canaria to address two interrelated questions. First, which are the key environmental drivers in the evolution of the endemic Angiosperm flora of Gran Canaria? And second, what natural areas of this island are less resilient to environmental change and may require most urgent conservation action? The great natural complexity of Gran Canaria makes it an ideal first study-case to derive lessons for similar analyses planned in other Canarian and Macaronesian islands.

Because all the variables used and the species distribution ranges were compiled and analysed with the information system created by the NEXTGENDEM project (https://www.nextgendem.eu/es, https://plataforma-nextgendem.com/), the lecture will start by describing the basic characteristics and objectives of this bioinformatics tool. Our overarching aim is also to exemplify how genetic tools and bioinformatics may guide plant conservation providing decision makers with evidence-based indications to help preempt environmental problems, and tackle pressing concerns on the conservation of endemics. Therefore, this presentation will also serve as a basis to interact with Biodiversity researchers and managers in me Mediterranean biogeographical region potentially interested in transferring the system to their territories.

Keywords: Gran Canaria, Conservation measures, Bioinformatics, Supercomputing, Macaronesian species and spaces, Mediterranean region, *in situ* conservation

Acknowledgements: We thank the Cabildo de Gran Canaria, the Instituto Tecnológico de Canarias and GESPLAN for continued support of the multidisciplinary research at the JBCVC-CSIC, and the PCT Interreg-MAC 2014-2020 for funding project NEXTGENDEM (MAC2/4.6d/236). We also acknowledge complementary support of the 'Fundación Canaria Amurga-Maspalomas.

An Integrated Approach to Conserving Portugal's Most Endangered Tree: *Quercus canariensis* Willd.

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The Algerian oak (*Quercus canariensis*), classified as Critically Endangered (CR) in mainland Portugal, faces significant threats primarily driven by land-use changes. Its habitats, typically confined to valley bottoms and often associated with riparian vegetation, are further jeopardized by hybridization with the Portuguese oak (*Q. faginea*).

To address these challenges, seven oak forests containing individuals with Q. canariensis morphological traits, alongside two reference Q. faginea populations, were selected for comprehensive molecular and morphometric analyses. Samples were collected from 12–18 individuals per population, and acorns were opportunistically gathered for propagation. Techniques included seminal multiplication, grafting, and in vitro micropropagation to produce genetically pure individuals for the establishment of acorn-producing orchards. Additionally, unmanned aerial vehicles (UAVs) equipped with multispectral sensors and LiDAR were employed to collect spectral and structural data. These datasets were integrated with ground-based observations to evaluate the conservation status of each forest patch, including their flora diversity, composition, structure, disturbances, and micro-habitats.

Molecular analyses utilized whole genome re-sequencing (WGS) of 80 individuals across nine populations, followed by bioinformatics to assess population structure. Results revealed a geographical gradient of hybridization, with the Monchique core population showing minimal introgression, while peripheral northern and western populations exhibited higher hybridization rates with Q. faginea. Propagation efforts have successfully germinated approximately 1,558 plants for restoration initiatives and meta-collections in botanical gardens and arboreta.

This study represents Portugal's first national plant conservation initiative combining genomic tools with remote sensing and horticultural methodologies to safeguard a critically threatened forest tree species. The integration of high-purity genotype propagation, biogeographical assessments, and innovative restoration techniques lays the foundation for creating acorn-producing orchards, conducting targeted restoration, and establishing meta-collections. This multidisciplinary approach offers a replicable model for conserving rare Mediterranean forest ecosystems and ensuring their long-term resilience.

Keywords: Mediterranean forests, hybridization, *ex-situ* and *in-situ* conservation, biogeography, habitat restoration; horticulture

Acknowledgements: Work supported by National Funds through FCT-Fundação para a Ciência e a Tecnologia - UIDP/50027/2020; FUI Base UIDB/50027/2020 and Agenda Transform, project number C644865735-00000007, following the Mobilization Agendas for Business Innovation (Notice No. 02/C05-i01/2021), supported by the Recovery and Resilience Plan (PRR) and European Funds NextGeneration EU.

Are Mediterranean mountain endemics threatened by hybridization with widespread congeners? Cautionary case studies on *Cardamine apennina* and *C. rivularis*

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Endemic plants of the Mediterranean region face an increased risk of population decline and extinction due to habitat loss, fragmentation and reduction in population size. The persistence of small and isolated populations can lead to a loss of genetic diversity through increased selfing or clonality, resulting in lower adaptability to climatic and environmental changes. Narrow ecological niches further increase the vulnerability of species to stochastic events and habitat disturbance. Additionally, hybridization with closely related, widespread congeners may pose another significant threat to the integrity of endemic species, which is the focus of our study. The availability of genome-wide SNP data and recent developments of analytical methods to detect gene flow have improved our ability to identify and monitor patterns of genetic diversity and introgression.

Here, we investigate two endemic species of the genus *Cardamine* (Brassicaceae) growing in wetland mountain habitats of the central Apennines (*C. apennina*) and southeastern Europe (*C. rivularis*) that are suspected to hybridize with more widespread congeners. Using genome size estimates by flow cytometry and analyses of genome-wide polymorphisms through RADseq, we assess patterns of cytotype and genetic variation, as well as the extent of introgression across several populations. In the central Apennines, a single hybrid individual reported in 2004 contrasts sharply with numerous triploid hybrids found between 2019 and 2023 at four localities in the Abruzzo and Umbria regions, where diploid *C. apennina* grows sympatrically with tetraploid *C. amporitana*. In the Vitosha and Rhodope mountains, we detected hybridization of *C. rivularis* with up to three different congeners at seven localities. Notably, pure *C. rivularis* was either absent or represented by very few individuals at four of these localities. Triploid hybrids comprising a *rivularis*-derived subgenome (*C. matthioli* x *C. rivularis*, *C. acris* x *C. rivularis*, *C. amara* x *C. rivularis*) appear to be of high vigour and occupy niches typical of *C. rivularis*, likely replacing the parental species. This study demonstrates the power and efficiency of flow cytometric and genomic monitoring in assessing the extent and risk of interspecific gene flow to local endemics. Nevertheless, it remains unclear what factors forced the secondary contacts between the species and the resulting gene flow, and what conservation measures should be taken to mitigate the risk of extinction of these affected endemics. Ultimately, our findings highlight the profound impact of hybridization on the survival of Mediterranean endemics and underscore the need for effective conservation strategies to protect these vulnerable species from genetic erosion and ecological displacement.

Keywords: endemic, hybridization, genetic diversity, introgression, extinction risk

Acknowledgements: Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V04-00489 (to J.Z.-L.)

Conservation genetics of the Adriatic endemic *Centaurea ragusina* L. (Asteraceae)

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Centaurea ragusina L. (Asteraceae) is an Adriatic stenoendemic species that grows as a typical chasmophyte mostly on inaccessible sea cliffs. It is represented by two subspecies: the typical *C. ragusina* subsp. *ragusina*, which is distributed from northern to southern Dalmatia, while *C. ragusina* subsp. *lungensis* occurs only on few northern Dalmatian islands. We used amplified fragment length polymorphisms (AFLPs) and chloroplast sequences (cpDNA) to determine genetic diversity, differentiation and structure within and among populations across the entire distribution range. In addition, we aimed to test the taxonomic validity of the two subspecies. Finally, we used species distribution modelling (SDM) to identify current and Last Glacial Maximum (LGM) habitat suitability for the target species.

Results of analysis of molecular variance based on AFLP data showed that 36.09% of the genetic variation was due to differences among populations. We also detected significant isolation-by-distance (IBD) between population pairs. Population genetic structure analyses revealed two main genetic groups based on STRUCTURE, while BAPS identified six genetic groups. Based on cpDNA data, we detected eight distinct chloroplast haplotypes. The predicted current potential distribution of *C. ragusina* corresponded mainly to known occurrences, with some newly discovered areas of suitable habitat. In addition, SDM suggested that suitable habitats during the LGM occurred only in the southern Adriatic.

Our study implies that the previous taxonomic infra-specific concept of *C. ragusina* is artificial, and according to our results, there is no clear genetic evidence supporting the existence of the two subspecies. Our combined results suggest a highly fragmented distribution of *C. ragusina,* which may be a consequence of its evolutionary history and colonisation of vertical coastal rocky cliffs during Pleistocene sea-level changes. We hypothesise that the species may have survived in the southern Adriatic refugium along the paleo-coastline and on the exposed mainland during the sea-level drop in the LGM. We provide here a new IUCN assessment and recommendations for the conservation of the endemic *C. ragusina*.

Keywords: Mediterranean chasmophyte flora, *in situ* conservation, AFLP, SDM, genetic diversity

KEYNOTE LECTURE

Pre-service teacher´s awareness of plants. An approach through mental maps

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Understanding pre-service teachers' awareness and perception of plants is key to fostering their plant literacy and addressing Plant Awareness Disparity (PAD). This study examines their conceptualizations of plants through mental maps, a tool that reveals cognitive structures and associations related to botanical knowledge. The participants, future primary school teachers, created mental maps as part of a didactic activity aimed at enhancing their understanding of plant diversity and significance for ecosystems and human life.

The creation of mental maps served as an initial opening activity within an eight-session teaching-learning sequence framed in Education for Sustainability (ESD). This sequence emphasized the role of plants in mitigating and adapting to climate change, using them as central teaching resources. It included classroom activities, outdoor education experiences, artistic creation, and attentive observation sessions, such as drawing plants, to ensure that pre-service teachers develop the skills to design multidisciplinary teaching proposals. These approaches aim to increase student motivation while integrating art and science into their educational strategies.

Preliminary findings reveal that pre-service teachers often possess limited and fragmented knowledge about plants, focusing primarily on their utilitarian and aesthetic roles while neglecting ecological and evolutionary dimensions. Commonly represented concepts include "trees," "flowers," and "oxygen production," whereas critical aspects such as plant reproduction, adaptation, ecological interactions, One Health concept and ecosystem services are frequently absent. These results highlight the need for more comprehensive plant-related educational strategies in teacher training programs.

This study underscores the effectiveness of mental maps as both diagnostic and pedagogical tools to identify knowledge gaps and misconceptions. Furthermore, they serve as a foundation for designing targeted didactic interventions. These findings contribute to the broader goal of integrating plant awareness into teacher education, equipping future educators to convey the importance of plants in fostering sustainability and biodiversity awareness among their students.

Keywords: Plant Awareness Disparity, mental maps, teacher education, biodiversity, sustainability

Acknowledgements: Cátedra CCC

Raising Awareness Among Italian Students About the Pollinator Crisis and Habitat Conservation: A Case Study from the Marche Region, Central Italy

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The Botanical Garden "Selva di Gallignano" of Università Politecnica delle Marche (UNIVPM) spearheaded and managed the project "NextGen4POLLINATORS - The contribution of new generations to the protection of biodiversity through actions promoting the spread of pollinators" (hereinafter NG4P). The project aimed to address the pollinator crisis and the need to protect biodiversity by educating younger generations and raising awareness among citizens. The NG4P project was co-financed by the Cariverona Foundation as part of the Format Call for the years 2023 and 2024. The project was coordinated by the Botanical Garden "Selva di Gallignano" in collaboration with the 4 research groups (Botany, Entomology, Algology and Information Engineering (DII) of Marche Polytechnic University). The partnership was composed by the Geen School Network of the Province of Ancona, 5 Environmental Education Centers, The Cooperative Company HORT, the Ancona section of UILDM (Italian Union for the Fight against Muscular Dystrophy) and the Municipality of Ancona.), alongside other partners, such as the schools of the Green Schools Network of the Province of Ancona, the Environmental Education Centers (CEAS) of the Conero area, the Cooperative Company H.O.R.T., the Municipality of Ancona and the Ancona section of UILDM (Italian Union for the Fight against Muscular Dystrophy). Over a two-year period, students from partner schools participated in classroom lessons on botany and entomology delivered by UNIVPM experts, as well as outdoor activities focused on observing pollinator activity and plant phenology of spontaneous plants. The project involved students from Primary Schools (PSs), Lower Secondary Schools (LSSs), and Upper Secondary Schools (USSs). To evaluate the impact of the program, pre- and post-lesson tests were administered to assess students' knowledge levels. The results, currently being published, indicate that students' baseline knowledge decreased as the school level increased. However, the classroom lessons had a notable positive impact, particularly for USSs and for students who initially demonstrated lower knowledge levels. The project's outreach extended beyond the participating students through the development of a free smartphone app, NG4P (available at Google Play and Apple Store) designed for Citizen Science activities. The app allows users to upload images of plants and insects, access information about key pollinators and wild plants native to the Central Marche Region and find instructions for constructing bee hotels. As part of the NG4P project, some facilities were established to promote pollinators habitat, good practices and knowledges about pollinators conservation. All classes involved in the training activities received a "pollinator kit," containing seeds of native herbaceous plants and natural materials to build a small wooden bee hotel. These kits served as practical tools to support wild pollinators by spreading native plants and providing nesting sites, even in urban areas. Flowering edges in Ancona urban area were enriched with native flowering herbaceous species beneficial for pollinators and agreements are made with Ancona municipalities to preserve certain semi-natural areas for mowing and seeds collection. At the Botanical Garden "Selva di Gallignano", a "Garden for Pollinators" was created, featuring herbaceous and shrubby plants native to the Marche Region as food sources for pollinators, and the "BeeSpy" educational apiary.

Keywords: environmental education, pollinators, mediterranean flora, urban wild species

Acknowledgements: The NG4P project was carried out with the support of Fondazione Cariverona.

The Code of Conduct, avoid the trade and use of invasive non-native plants. A first step towards more aware and responsible gardening.

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The LIFE medCLIFFS project, an EU-funded initiative, seeks to address the growing threat of invasive alien plant species (IAPS) along the Costa Brava, the northern coast of Catalonia (NE Spain), focusing on the protected habitat of community interest 1240 - Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp. The project actions encompass prevention measures, monitoring of IAPS through two citizen science networks, spatial invasion risk assessments, and IAPS control efforts—including species like *Carpobrotus* aff. *acinaciformis*, *Opuntia ficus-indica*, *O. stricta*, and *Gazania rigens*—through different assays to develop effective control and eradication protocols.

One of its key components is the creation of a comprehensive Code of Conduct for stakeholders, particularly those in the ornamental plant sector, such as plant selling or distribution businesses, gardeners, and landscaping schools. This voluntary code encourages adherence to best practices, including a commitment to (1) know, stay updated and comply with the law and regulations regarding IAPS, (2) disseminate the project IAPS and non-invasive species lists, (3) remove all invasive species from their collections and catalogues, (4) ensure the identification of their plants on sale in search for possible invasive species alternative names, (5) promote of non-invasive alternatives, (6) inform about the situation to clients, colleagues and all users involved and (7) adopt environmentally responsible gardening practices (i.e., xeric species in dry areas). It contains resources specific for the Catalan region, such as a consensus list of invasive species (including, additionally, species already prohibited by law), a watch list of potentially invasive species, and a white list of non-invasive alternatives.

The project further promotes a new initiative: "Plant Another One!" a booklet to help transition to safer plant options. It will provide detailed information on harmless plant alternatives for each problematic species, encouraging the use of native or allochthonous plants with a low risk of invasion (when no autochthonous alternatives are available). Through these actions, LIFE medCLIFFS emphasizes the importance of public awareness, collaboration, and responsible plant trade and use to safeguard biodiversity, prevent the further spread of IAPS, and ensure sustainable ecosystem management.

Keywords: Code of conduct, invasive alien plant species, native plant species, prevention measures, stakeholder engagement

The role of Citizen science in monitoring and characterizing the habitat of the Annex II-IV target species *Himantoglossum adriaticum* H. Baumann

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Effective global biodiversity conservation requires consistent and comprehensive monitoring of plant and animal species. Among various approaches, citizen science has proven to be a valuable and cost-effective tool for collecting data on biodiversity. This study, carried out in the frame of the LIFE19 IPE/IT/000015 "IMAGINE" Project (www.lifeimagine.eu), combined data gathered through citizen science with existing records from research institutions, online databases (e.g., iNaturalist), new unpublished data and scientific literature to improve knowledge on the distribution of *Himantoglossum adriaticum* in Umbria, Italy, as well as to characterize its biological habitat. This terrestrial orchid is of high conservation interest, being listed under Annexes II and IV of the EU Habitats Directive (92/43/EEC) and Appendix II of CITES. While its conservation status is classified as "Unfavourable-Inadequate" at the European level, the species is generally assessed as "Favorable" in Italy, except in Alpine regions where it has a negative trend.

To engage citizen scientists we created and distributed a simple flyer featuring detailed images showing the orchid's unmistakable floral morphology, coupled with clear instructions for submitting georeferenced records and images of the species. The species' popularity among nature enthusiasts and its distinct appearance facilitated broad participation. Records provided by citizens were then validated by way of both the supporting images and random field surveys.

Data were integrated with existing datasets and new original investigations, and analyzed using land cover classifications (ESA WorldCover 2021, Corine Land Cover, Carta della Natura) and geomorphological features (slope, elevation, aspect), using the software QGIS to obtain a comprehensive distribution map. In order to understand the ecological preferences of the species, we specifically examinedthe proximity of occurrence sites to transitional ecosystems, in line with the species' known ecological preferences. Seeds from the detected populations were collected and stored in the Perugia University Germplasm Bank (FAO Code: ITA363).

The participatory monitoring effort yielded significant results, with the number of Lambert cells hosting *H. adriaticum* more than doubled compared to those reported in the IV Report ex Art. 17 of the Habitats Directive. The new findings are contributing directly to the ongoing V cycle of Reporting (2019–2024). Additionally, our approach provided deeper insights into the ecological and environmental preferences of *H. adriaticum*, confirming its affinity for calcareous dry grasslands, open woodlands, forest margins and secondary habitats, including traditional orchards, agricultural edges and grassy roadsides.

This study demonstrates the potential of citizen science to complement traditional monitoring methods, particularly for species with distinctive characteristics like *H. adriaticum*. It also highlights how participatory monitoring can enhance data collection efficiency, reduce costs, and foster public engagement in conservation. These findings suggest that similar approaches could be widely applied in biodiversity monitoring programs, especially for taxa that are easily identifiable by non-specialists.

Keywords: Adriatic lizard orchid, germplasm bank, Habitats Directive, plant conservation

KEYNOTE LECTURE

Strengthening the Role of Civil Society in Preserving Threatened Flora in the Mediterranean Basin

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In the realm of nature conservation, the preservation of plant species often receives less attention from mainstream civil society organizations compared to other environmental issues. This oversight is compounded by the botanist community's focus on scientific research and taxonomy, which sometimes limits their engagement in active conservation efforts. Additionally, many civil society organizations (CSOs) lack the necessary capacities and knowledge in botany, and there is often a lack of interest in plant conservation. However, CSOs have the potential to play a pivotal role in plant conservation, working in collaboration with governmental authorities, protected area management bodies, ministries for the environment, local governments, and academic institutions.

Recognizing this potential, the Critical Ecosystem Partnership Fund (CEPF) launched a funding initiative in 2017 specifically aimed at supporting plant conservation projects in the Mediterranean Basin. Initially planned with a budget of $900,000, the financial envelope has nearly doubled over the years due to high demand, reflecting the urgent need and interest in this area. Based on the interest raised and the outcomes of this initial investment, a new envelope has been secured for 2025-2030, with increasing funding.

This session will showcase a diverse range of projects implemented by CSOs in the Mediterranean region, supported by CEPF and other initiatives. CSO representatives will present their initiatives, highlighting the innovative approaches and significant achievements made in plant conservation. The session aims to not only celebrate these accomplishments but also to inspire future collaborations between European Union (EU) and non-EU countries, as well as between CSOs and academia.

By sharing these success stories and fostering dialogue, we hope to highlight the important role of civil society in plant conservation in the region, and to gather valuable feedback on future directions for CEPF and other donors' support in plant conservation. This session will serve as a platform to strengthen the network of stakeholders committed to preserving the region's unique and threatened flora, ensuring that these vital efforts continue to grow and thrive.

We invite all participants to join us in this important discussion, to learn from each other's experiences, and to contribute to shaping the future of plant conservation in the Mediterranean Basin.

Keywords: Mediterranean flora, Mediterranean habitats, *in situ* conservation, Civil Society Organizations, Funding mechanisms

TOPIO project enhance environmental public awareness in Akamas Peninsula

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The European project "TOPIO" aims to promote the sustainable management and conservation of protected areas, with a particular focus on the Natura 2000 network and the Akamas region of Cyprus. A key objective is to enhance local communities' understanding of the value of plant biodiversity and foster a sense of responsibility toward preserving their natural heritage. The methodology employed in the TOPIO project combines scientific research, field surveys, and participatory approaches to ensure the effective conservation of key plant species and habitats in the Akamas Peninsula and other Natura 2000 areas. This includes mapping and monitoring biodiversity, assessing ecological value and threats, and collaborating with stakeholders to develop targeted conservation actions. These efforts are integrated with environmental education and outreach programs, creating a comprehensive framework for promoting sustainable management and raising awareness about the importance of plant biodiversity.In the context of the TOPIO project actions in the Akamas region, civil society refers to a diverse network of stakeholders, including local communities, conservation organizations, governmental bodies, and project partners, who collaboratively engage in the conservation process. This collective approach is integral to addressing the complex ecological challenges faced by the Akamas area. Through structured participatory methods such as community surveys, workshops, and citizen science initiatives, the project integrates local knowledge with scientific data, enhancing the understanding of biodiversity dynamics and conservation needs. Local residents, landowners, and visitors contribute to monitoring efforts, while conservation organizations and governmental entities provide technical expertise and policy support. This multi-stakeholder collaboration ensures that conservation strategies are both scientifically robust and socially relevant, fostering community ownership of conservation actions. By strengthening partnerships and encouraging shared responsibility for the region's natural heritage, the project ensures that conservation actions are not only scientifically sound but also socially supported, promoting long-term sustainability and the preservation of the Akamas area's unique biodiversity.

To engage civil society in the conservation of Akamas, educational workshops are organized by TOPIO to introduce the participants to the ecological significance of the Akamas region's flora and the role of conservation in safeguarding biodiversity. They provide participants with the opportunity to actively associate with the survey through specialized questionnaires and participating in dynamic activities designed to offer both informative insight and direct involvement to conservation initiatives. Interactive field visits and guided tours are offered to provide hands-on learning experiences, helping participants recognize the importance of native plant species and their habitats. The project also empowers communities by integrating Citizen Science, Geoinformatics (EO and GIS), Artificial Intelligence, and Public Participation, enabling them to play an active role in decision-making and sustainable development. By collecting and ensuring that data is FAIR (Findable, Accessible, Interoperable, Reusable), TOPIO supports ongoing research and conservation efforts. Through these efforts, the TOPIO project aims to bridge the gap between scientific knowledge and public understanding, encouraging active participation in conservation initiatives. By promoting knowledge transfer and fostering a strong connection between communities and their natural environment, the project aspires to cultivate a lasting commitment to environmental stewardship and ensure the long-term sustainability of conservation efforts in the Akamas region.

Keywords: Natura 2000 areas, Citizen Science, Mediterranean Biodiversity, Environmental Education, Akamas region.

Acknowledgements: The project is funded by the European Union under the scheme HORIZON TMA MSCA Staff Exchanges. Grant agreement ID: 101131109.

Conservation challenges for the Flora of Santo Antão Island - Cape Verde

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Santo Antão is the Cape Verdean island with the highest endemic biodiversity in terms of flora. The Terrimar terrestrial conservation program actually includes two main projects: *"Endemic Plant Conservation Project in the Topo de Coroa Natural Park"* and *"Conservation Project for Carex antoniensis, a critically endangered specie, in the CovaKBA*. Both initiatives aim to improve the conservation status of the island's endemic plants.

These projects were implemented in Natural Parks with distinct climatic and ecological conditions - one more humid and the other relatively dry, with scarce water availability. However, both face significant challenges due to threats to the local flora. The key objectives of these initiatives include conducting an inventory of endemic plant species, raising awareness about the importance of their conservation, and promoting their coexistence with local activities such as agriculture, livestock farming, and tourism. Additionally, the projects seek to increase the populations of these endangered species.

Each project follows three main phases: first, the inventory of the flora within the Natural Parks target of the project and other areas of interest; second, awareness-raising activities within local communities; and finally, the planting of seedlings grown in nurseries. All phases are adapted to the specific needs of each park and involve the active participation of the communities that share these natural spaces.

This presentation highlights the challenges encountered throughout the projects, the strategies implemented to mitigate threats to endemic plants, and the progress achieved in their conservation.

Keywords: Biodiversity, Conservation measures, Endemic flora, Sustainability, Community

Improving knowledge of the flora of the island of Djerba and the conservation status of its heritage species.

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Djerba, is the largest island off the North African coast, classified UNESCO World Heritage Site and contains four Ramsar sites. It is characterized by a rich flora with the presence of nationally or regionally endemic species and/or those recognized as threatened and/or of high cultural value and it's classified as a Key Biodiversity Area (KBA) and an Important Plant Area (IPA), but does not currently benefit from any direct action to conserve the heritage species that thrive there. The island has a major interest in terms of conservation, which motivated the implementation of the project coordinated by REACT and financed by Critical Ecosystem Partnership Fund (CEPF); Improving knowledge on the flora of the island of Djerba and the conservation status of its heritage species.

The main activities carried out within the framework of this project, from 2019 to 2022, have enabled the improvement of public knowledge on the flora and ethnobotany of the ZIP island Djerba; awareness-raising and training of stakeholders, in particular local associations and civil society, on the interest of conserving the plant heritage of the island; the conservation of the strictly endemic plant of the island, Limonium formosum (monitoring of its habitat and the evolution of its population, ex and in situ conservation, etc.); the development and adoption of a participatory plan for its protection in collaboration in particular with local national stakeholders and organizations involved in the field of biodiversity protection; and the development and adoption of a participatory plan to integrate the protection of heritage plants (rare, threatened, endemic) into the country's forest code.

The impact of the project in terms of conservation of the habitat of *L. formosum*, a large part of which is attached to the maritime public domain, is the intervention, if necessary, of the Agence de Protection et d'Aménagement du Littoral (APAL) to prohibit any action representing a threat of this habitat and the start of a national action for the updating of the list of threatened plants in the Tunisian forest code.

The scientific impact of the project is the discovery of a new taxon for science, endemic to Tunisia: *L. steppicum* Sefi, Ghrabi-Gammar & Brullo; the defense of a doctoral thesis, the publication of two scientific articles, the distribution of an illustrated leaflet of the botanical tour of the island and the development by botanists involved in the project of a research program on the genus *Limonium* in Tunisia and the publication of a scientific article describing its taxonomy, biogeography and conservation.

Keywords: Djerba, participatory conservation, *Limonium formosum*.

Acknowledgements: REACT would like to thank the CEPF team, in particular Mrs Awatef Abiadh & Mrs Salwa Elhalawani, as well as all our partners for their encouragement and support during the implementation of project.

KEYNOTE LECTURE

Entangled Destiny: Trees & People of the Mediterranean

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Mediterranean culture is profoundly linked to its natural resources, yet the traditional custodians of these resources are gradually disappearing, resulting in the erosion of generational knowledge and practices that have sustained the region's ecosystems for millennia. This ongoing decline not only jeopardizes cultural heritage but also undermines ecological resilience, as younger generations become increasingly disconnected from the natural systems and traditional wisdom critical to their conservation.

Entangled Destiny project addresses this cultural and ecological loss by investigating the enduring relationship between three emblematic Mediterranean tree species—the olive (*Olea europaea*), the carob (*Ceratonia siliqua*), and the stone pine (*Pinus pinea*)—and the communities that have historically managed and shaped their existence.

Through a multidisciplinary framework combining genetic research, archaeological analysis, and ethnographic storytelling, we are documenting. the intertwined natural and cultural heritage of these species. These tree species are not only keystones of the Mediterranean landscape but also living markers of human influence, with their genomes and distributions reflecting millennia of cultivation, trade, and adaptation.

Genetic studies explore their domestication and diversification, tracing their origins and examining how successive civilizations left indelible imprints on their evolution and geographical spread. Archaeological evidence and historical records will further illuminate the socio-cultural significance of these trees throughout Mediterranean history.

Today, with increasing land abandonment and the erosion of cultural practices, we risk losing both the genetic diversity nurtured by human stewardship and the historical narratives embedded within these landscapes.

This project seeks to address the critical question: what forms of conservation are required to safeguard these iconic species and the cultural legacies they represent?

By integrating scientific insights with the stories of past and present stewards, we aim to inform conservation strategies that honor the deep connections between humans and the Mediterranean's natural heritage.

Keywords: Mediterranean trees, conservation measures, Mediterranean landscape, archeology, domestication, genetics, history, natural heritage, intangible heritage, olive (*Olea europaea*), carob (*Ceratonia siliqua*), stone pine (*Pinus pinea*).

Acknowledgements: This project is funded by National Geographic Society

Morphometric Analysis in Archaeobotany: Bridging Plant Conservation and Cultural Heritage

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Morphometric analysis has lately become a powerful tool in archaeobotanical research, offering a quantitative alternative and/or extension to conventional archaeobotanical procedures.

By enabling precise characterization of plant macro-remains, it facilitates identification beyond the limitations of conventional comparative approaches, which rely on reference collections from germplasm banks or seed atlases. Advances in automated image-based systems, incorporating computer vision technologies, have significantly improved the capacity to measure biometric traits with accuracy. These advancements have enhanced taxonomic discrimination, enabling the identification of both wild and domesticated plant species and archaeobotanical remains.

Complementary to molecular methods, morphometric analysis provides fresh insights into plant domestication processes, particularly in understanding the role of landraces during the early stages of agriculture. This integrative approach addresses previously understudied aspects of archaeobotany, offering new perspectives on the evolution of agricultural systems and plant biodiversity.

In the context of Sardinia, recent applications of morphometric analysis have yielded significant results in the study of plant macro-remains, such as charred and waterlogged seeds recovered from archaeological sites. Notable findings include insights into the domestication history of *Vitis vinifera*, indicating the presence of early grape cultivars during the Bronze Age, the earliest evidence of *Prunus domestica* in the Western Mediterranean, and the identification of *Olea europaea* during the Phoenician-Punic period.

The successful application of morphometric analysis in these contexts highlights its critical role in reconstructing human-plant relationships across millennia. By bridging plant conservation with cultural heritage, this approach not only informs the history of agriculture but also enhances our understanding of biodiversity dynamics within historical civilizations. These findings contribute to the ongoing dialogue between archaeology, history, and plant conservation, fostering a multidisciplinary perspective on the interdependence between plants and human societies.

Keywords: Archaeobotany, Digital Image Analysis, Morphometry, Plant remains.

The role of archaeological sites in plant conservation: a first look at the Mediterranean panorama

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The **Mediterranean Basin**, a globally recognized biodiversity hotspot, harbors exceptional plant diversity, including numerous endemic and threatened species. Archaeological sites in this region are not only cultural landmarks but also **potential refuges for plant biodiversity**. Our research, conducted under the Italian National Biodiversity Future Center project (NBFC PNRR 2022 - CN033), aims to evaluate the floristic richness of selected archaeological sites from Mediterranean countries and their conservation potential. By documenting flora of conservation interest and assessing the interplay between cultural and ecological values, our study highlights how archaeological areas can act as unique reservoirs for biodiversity in landscapes dominated by anthropogenic pressures.

To create **a first database** of case studies, published and grey literature, along with unpublished data on wild flora and vegetation in archaeological sites, was reviewed. A maximum of six studies per country was set to ensure homogeneity across nations with varying sizes, bioclimatic zones, numbers of archaeological sites, and availability of floristic data.
When more than six studies were available for a country, the following selection criteria were applied:
1) Bioclimate: studies were chosen from different bioclimatic zones within the country.
2) Land use: a balanced representation of sites in urban, peri-urban, and natural areas was prioritized, considering varied contexts such as residential, industrial, agricultural, and natural habitats.
3) Site size: preference was given to larger sites within each bioclimatic and land use category to maximize the diversity and relevance of the data.

Preliminary results reveal that the selected sites harbor a rich array of species (nearly 3000 taxa), including endemic and threatened taxa. The coexistence of native, alien, and threatened plants within archaeological sites underscores their role as semi-natural ecosystems. Notably, some study cases are emblematic of how flora identification and integrated management are key for in situ conservation of threatened plants. For instance, Galasso et al. (2011) documented the presence of *Hieracium australe* Fr. subsp. *australe*, an endemic taxon, on the ancient walls of Castello Sforzesco in Milan, Italy. This finding also underscores the potential of urban archaeological sites to serve as refuges for rare endemic species, benefiting from the unique microhabitats provided by historic structures.

Our research emphasizes the **need for an integrated legal framework** and precise terminology to protect both cultural and natural heritage within archaeological sites. Developing specific management guidelines can ensure sustainable conservation practices that address biodiversity loss while maintaining the cultural integrity of these sites. Archaeological sites should be recognized as essential components of in situ conservation strategies, bridging the gap between natural and cultural heritage conservation.

Keywords: Mediterranean flora, biodiversity conservation, endemic species, cultural heritage, archaeological site management

Acknowledgements: Fernando Lucchese, Simona Ceschin, Emanuela Cicinelli, Gabriele Galasso, Pietro Minissale, Francesco M. Raimondo, Marjol Meco, Badia Siab-Farsi, Nermina Sarajlić, Vedran **Šegota**, Ioannis Vogiatzakis, Soliman Mohammad Toto, Maria Panitsa, Merav Lebel, Dietmar Brandes, Rhea Kahale, Sandro Lanfranco, Mitko Kostadinovski, David Draper, Leopoldo Medina D. for contributing to this research.

Cited articles: - Galasso, G., Gentili, R., Gilardelli, F., Sgorbati, S., Cappelli, C. I., & Bandi, E. (2011). Flora delle mura del Castello Sforzesco di Milano (Lombardia, Italia). Dati preliminari. *Pagine Botaniche*, 35, 3–25.

Conservation actions for rare and threatened plants found in archaeological sites - Examples of actions on the island of Crete - Greece.

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The preservation and protection of archaeological sites, from very early in the history of the Greek state, had a beneficial effect on the conservation of biodiversity. The legal protection of antiquities prevented, in most cases, activities that were negative for biodiversity, such as unplanned construction, hunting, and extensive groundwater exploitation or soil pollution from intensive agricultural practices. Thus, many archaeological sites functioned as an effective umbrella for the protection of local fauna and flora.

On the island of Crete, many archaeological sites are located within or outside the Natura 2000 Network or other protected areas. It is noteworthy that almost the entire population of the Vulnerable species *Dianthus xylorrhizus* is located within the archaeological site of Polyrrinia (West Crete), which is not part of any other biodiversity protection area. Therefore, the quality of its habitat depends exclusively on the measures taken by the Ephorate of Antiquities of Chania.

Recently, the Mediterranean Plant Conservation Unit of MAICh has collaborated with the Ephorates of Antiquities of Crete for the protection of endangered plant species and has contributed to the recording of the flora of important archaeological sites. The conservation actions concern 10 threatened plants located in 7 archaeological sites. The conservation actions consist of habitat fencing, subpopulation mapping, enhancement of natural populations, removal of invasive plants, seed storage at the MAICh Seed Bank, development of germination protocols, monitoring of pressures and threats, etc.

The results show that the systematic mapping and documentation of plant diversity within the archaeological sites can constitute another tool for the protection of rare biodiversity under the auspices of the Hellenic Ministry of Culture.

Keywords: archaeological sites, conservation actions, Crete, Mediterranean flora

Acknowledgements: For the implementation of the conservation actions MAICh received funding mainly from the MAVA Foundation, and the Hellenic Green Fund

Unearthing Biodiversity: A Meta-Analysis of Vascular Flora in Urban Cemeteries

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Cemeteries, as unique urban green spaces, have increasingly garnered attention for their potential role in biodiversity conservation. These sites represent islands of relative stability within rapidly changing urban landscapes, potentially harbouring a diverse array of vascular plant species. Despite their ubiquity and ecological potential, a comprehensive understanding of the vascular flora in cemeteries across different geographical and cultural contexts remains limited.

To address this knowledge gap, we conducted a meta-analysis aimed to synthesise and analyse the existing body of research on vascular flora in cemeteries, with the goal of identifying patterns in species diversity, composition, and ecological significance. By consolidating findings from multiple studies, we aimed to provide a broader perspective on the role of cemeteries in urban plant biodiversity conservation.

Our methodology followed the PRISMA 2020 framework for systematic reviews. We conducted a preliminary literature search, initially using Web of Science that yielded a final set of 17 papers for in-depth analysis. These studies, spanning from 2005 to 2023, formed the core dataset for our meta-analysis. The analysis focused on several key aspects: species richness and diversity indices, life form spectra, and native versus exotic species composition.

Preliminary results indicate that the majority of studies, with the exception of one conducted in Angola, focused on the Palearctic region, particularly in Turkey (approximately 35%) and Poland (approximately 18%). Cemeteries have been shown to host a substantial number of vascular plant species, with reported species abundance ranging from 150 to nearly 19,000 species. Notably, 29% of the studies focused on orchids, revealing a wide variability in orchid presence, from no orchids to as many as 127 orchid taxa. The proportion of native species also varies significantly among cemeteries, with non-native components comprising 16% to 60% of the total flora. These findings highlight the ecological importance of cemeteries as reservoirs of plant biodiversity and emphasise their potential role in conservation efforts.

Keywords: Cemeteries, Urban green spaces, Vascular flora, Meta-analysis, Conservation

Diversity, Conservation and Untapped Potential of Levantine Edible Plants

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The Levant, a historic cradle of agriculture, is home to a rich diversity of Wild Food Plants (WFPs), which hold great potential for diversifying food systems and enhancing resilience to environmental and socio-economic challenges. In the face of climate change, resource scarcity, and over-reliance on a few staple crops, WEPs offer sustainable solutions by providing nutrient-rich, locally adapted alternatives. However, habitat loss and the erosion of traditional ecological knowledge threaten these invaluable resources.

This study systematically documents 414 WEP taxa from 61 plant families in the Levant, emphasizing their taxonomic diversity, uses, and conservation status. Leaves were the most commonly consumed plant part (57%), while 53% of species also had medicinal uses. Key species include *Malva sylvestris* L., *Gundelia tournefortii* L., and *Cyclamen persicum* Mill. Lebanon emerged as a hotspot, with the highest number of locally used WEPs (254) and unique plant uses (178), significantly contributing to the region's rich diversity.

Despite their importance, only 144 species have been assessed for extinction risk, and gaps in *ex situ* conservation remain. While 386 taxa are present in global seed collections, only 282 originate from the Levant, and few are adequately represented. Promising WEPs such as *Gundelia tournefortii* highlight the potential for future crop development, but challenges like overharvesting and limited cultivation data call for urgent research and conservation efforts.

Keywords: Levantine Useful Plants, Seed Banking, In situ & Ex situ Conservation, Dessiccation Tolerance, Traditional Diets, Wild Food Plants

Ethnobotanical Heritage and Flora Conservation in the Barroso Ecoregion: Sustaining Traditions in Transboundary areas

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The Barroso region, located in northern Portugal near the Portugal-Spain border and adjacent to Galicia, is recognized for its rich ethnobotanical heritage, with around 100 plant species utilized for medicinal, culinary, and agricultural purposes. Part of the Eurosiberian Region, specifically the Cantabro-Atlantic Province, the region's flora is dominated by the families Asteraceae, Fabaceae, and Poaceae, which together account for a significant portion of the cataloged species—Asteraceae making up 25%, Fabaceae 18%, and Poaceae 15%. These families are integral to the region's traditional knowledge and practices, and are used for their medicinal properties, Fabaceae species like *Medicago* and *Trifolium* for agricultural practices, and *Poaceae* species like *Agrostis*, *Arrhenatherum*, *Poa* and *Festuca* contributing to pasture and meadow ecosystems. Despite this botanical richness, several species face significant conservation threats, including *Pinus sylvestris* (EN), *Valeriana officinalis* subsp. officinalis (EN), *Sorbus aria* (CR), *Polygonum bistorta* (CR), *Selinum broteri* (VU), *Arnica montana* subsp. *atlantica* (NT), and *Veronica micrantha* (NT). The border with Galicia hosts populations of some of the most endangered species of the Iberian northwest, such as *Klasea legionensis* (CR) or *Thymelaea broteriana* (EN), which have one of their main threats in the massive human depopulation and the loss of traditional management knowledge that affects this mountain border area. Additionally, the region harbors some of Portugal's best-preserved yew woodlands (habitat 9580), and large areas of mixed *Quercus pyrenaica* and *Q. orocantabrica* forests (habitat 9230), riparian *Betula celtiberica* woodlands (habitat 91E0) and hay-meadows (habitat 6510). Half of the territory's surface consists of communal property, covered by a diverse mosaic of mountain mesic heathland (habitat 4030), humid heathlands (habitat 4010 and 4020), perennial herbaceous grassland (including *Nardus stricta* grassland, habitat 6230) and minerotrophic mires (habitat 7140). This complex landscape is maintained through a traditional grazing system featuring the Barrosã cow, an indigenous bovine breed.

Empirical knowledge surrounding these species is deeply embedded in the cultural identity of local communities. However, habitat degradation and the decline of traditional agricultural and pastoral practices threaten both biodiversity and the preservation of ethnobotanical knowledge. Barroso is currently the Portuguese region with the highest number of fire ignitions and the highest ratio of annual wildfire area to total area. Conservation efforts are essential to sustain Barroso's distinctive landscapes and habitats, including oak forests, high-altitude meadows, heathlands and mires, which support a range of endemic and endangered species. Geobotanical studies highlight the importance of specific plant communities in maintaining ecological balance and cultural heritage. The traditional land-use practices of northern Portuguese mountains play a crucial role in conserving these habitats. Traditional (indigenous) fire practices or, its substitute, official prescribed fires, and the maintenance of hay meadows (Habitat 6510) are critical for the preservation of peripheral habitats, including oak and birch woodlands and peatlands. These culturally rooted systems integrate traditional knowledge with modern conservation approaches, enhancing biodiversity, reducing wildfire risks, and preserving the cultural landscapes that define Barroso.

The Barroso-Galicia transboundary region exemplifies a complex interplay between ethnobotanical richness and conservation challenges. A comprehensive understanding of the area's biogeographical and cultural characteristics, combined with sustainable management practices, is essential to address these issues effectively and secure the long-term preservation of biodiversity and traditional knowledge.

Keywords: Ethnobotanical heritage; Biodiversity Conservation; Traditional land-use practices; Mediterranean flora; Landscape management and conservation

Acknowledgments: With the financial support of the Fundação Belmiro de Azevedo (project SIPAM-Barroso).

KEYNOTE LECTURE

Winning the battle against invasive alien plants: strategies for action

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Invasive alien plants (IAP) threaten biodiversity, ecosystems, and economies globally, requiring comprehensive management strategies. The management of IAP has evolved beyond traditional control methods, with new techniques and strategies in continuous development. The aim is to identify and highlight the best approaches and techniques to mitigate the impacts of IAP. This presentation summarizes and provides a number of recent advances and some examples of the most effective methodologies for managing the most problematic invasive plants (sensu EU Regulation no.1143/2014), focusing on key strategies such as prevention, early detection, control and containment in the Mediterranean region.

Prevention, the basis of IAP management, relies on horizon scanning tools, robust border controls, biosecurity frameworks, and expert monitoring to limit the introduction and establishment of invasive alien species. Early detection of new outbreaks, to evaluate eradication, control and containment priorities, by trained professionals, is a strategy that ensures a cost-effective reduction of long-term ecological damage. Additionally, collaborative efforts, including cross-border surveillance, research partnerships, and community involvement, increase early detection and response capabilities. Some well-studied approaches include citizen science initiatives and technology-supported stakeholder engagement such as mobile apps and geographic information systems (GIS), allowing individuals to actively participate in IAP monitoring and management. Control and containment strategies are then supported by advances in remote sensing, high-resolution mapping, and predictive modeling to prioritize areas with high ecological vulnerability. Case studies highlight the integration of invasive species control with conservation actions, such as habitat restoration and the reintroduction of native species, to enhance ecosystem resilience and post-eradication monitoring techniques ensures that management efforts lead to long-term ecological stability.

This presentation synthesizes current methodologies and findings that underline the importance of collaborative efforts and technology-driven solutions to improve the efficiency of IAP management. Despite notable advancements, significant challenges remain, particularly in bridging the gap between research and practical application. Future research must focus on understanding the relationship between invasive species, native ecosystems, and environmental changes. By adopting interdisciplinary approaches and enhancing conservation strategies, it is possible to address the threats posed by invasive alien plants and safeguard biodiversity in the Mediterranean and elsewhere.

Keywords: biodiversity conservation, habitat management, invasive alien plants management, prevention and early detection strategies, technological tools.

Aliens among us - Cape Pyla Sustainable management of *Acacia saligna* with a focus on post clearance habitat restoration

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Acacia saligna, a regulated invasive alien species (IAS), is considered amongst the most chalenging alien species in Europe. It poses a serious threat to native flora by forming dense canopies and outcompeting other vegetation for nutrients, space and sunlight. In Cyprus, *A. saligna* was intentionally introduced at the beginning of the 20th century for the production of firewood, for soil erosion control, as an ornamental, as fodder and for forest protection from overgrazing. It was also introduced together with *Eucalyptus* spp. for draining purposes for malaria control at Larnaca and Limassol salt lakes and stabilising dunes at Salamis and Agia Eirini. *A. saligna* has also been extensively planted and irrigated, by illegal bird trappers at Cape Pyla, to create suitable habitats for trapping migratory birds with mist-nets. Since 2015, acacia management operations were undertaken in Cape Pyla area, using a combination of different tactics, with the aim of restoring the local vegetation and controlling the illegal bird trapping, resulting in the reduction of dense acacia patches. These included amongst others, the removal of illegal irrigation pipes from within the acacia plantations and chemical control. In addition, during the summers of 2019 and 2020 wildfires took place, which coincidentally resulted in further substantial reduction in acacias' stands.

In the context of this work, we conducted an extensive literature review on acacia post-clearance management methods, for restoring natural vegetation and limiting its regrowth. From the methods identified, four were promoted, to pilot assess their effectiveness. The methods selected were a) *indirect seed bank management* which included grazing, chemical treatment, and revegetation with indigenous species and b) *direct seed bank management* which included pilot soil solarisation plots of varying intensity polyethylene sheet, with and without soil inversion.

Based on our surveys, it was shown that 88% reduction of acacia seedlings was achieved with chemical treatment, 75% with the combination of revegetation and chemical treatment and 22% with the grazing. In terms of the soil solarization (SH) approach, a 34% reduction was achieved at the high intensity SH plots, 70% reduction at the medium intensity SH plots and 71% at the low intensity SH plots. It was noted that grazing and revegetation act as complementary tools for the management of acacia post clearance. They provide the conditions to suppress the growth and reduce the production of seeds and they are sustainable as a means of pre-invasion restoration. In terms of soil seed bank, the post- treatment germination rate at SH plots, was reduced from 96% to 56%. Even though the results of the soil solarization approach, support the activation of the seed bank and enable the easier removal of seedlings, these can be only considered as preliminary, due to the small size of the dataset.

The effectiveness of the approaches, must be closely monitored, supplying a feedback loop of assessments, adjustments and actions. Monitoring is essential throughout the implementation of management approaches, as it is providing information not only in terms of effectiveness, but also in terms of financial and technical efficacy. Acacia management requires adequate knowledge of the subject, that feed the setting of tangible and smart goals. Cooperation amongst institutions, stakeholders and further research are both needed for its management. Evidently, any results -positive or negative- on the management works undertaken, should be reported in a clear and transferable manner, so that practitioners, scientists, decision makers, and stakeholders can benefit from the shared experience.

Keywords: *Acacia saligna*, post clearance management, soil solarization, chemical control.

Acknowledgements: This work was funded by the Darwin Plus 141 project: Habitat restoration and wise use for Akrotiri and Cape Pyla (2021-2024). Implementing partners were BirdLife Cyprus (leading partner), Environment Department of the Sovereign British Areas Administration, Terra Cypria, and Royal Society for the Protection of Birds. The conservation works were conducted with support from the Department of Forests, Agricultural Research Institute, and Mohamed, the local shepherd, to whom we are deeply grateful.

New Technique for the Control of Alien Invasive Tree Species in Natural and Protected Habitats in Mediterranean and Arid Regions

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Controlling alien invasive tree species in natural and protected areas is a challenge for stakeholders since most invasive trees cannot be treated mechanically as they resprout vigorously. Large quantities of herbicides cannot be sprayed because of the risks of non-target impacts on local species. Similarly, control steps inducing local disturbances are prohibited since they enhance and facilitate the establishment of more invasive species. Yet, the control management of invasive trees is utterly necessary due to their severe impacts on local ecosystems.

Over the past 10 years several control protocols have been developed and successfully implemented in Israel natural areas to remove invasive tree species such as: *Acacia saligna*, *Acacia salicina*, *Acacia victoriae*, *Ailanthus altissima* and *Prosopis juliflora*.

The control method is based on the targeted direct application, with the hack & squirt technique, of very small volumes of a new herbicide, aminopyralid (Milestone©), characterized by its high ecotoxicological profile and its high effectiveness in controlling these tree species. This control technique is very easy to apply, based on low-tech gear, and does not involve cutting down or uprooting the targeted trees. Mature trees can be treated very rapidly, in any field condition, thus enabling the control of large quantities of specimen within a limited time. Since the herbicide is directly applied to the cambium, without cutting down the targeted tree, the herbicide is readily translocated throughout the root system and up to treetop foliage. This technique prevents the development of root suckers as it kills the targeted tree within few months whereas the surrounding vegetation remains unharmed.

The application steps are similar for most species but herbicide doses and preferred seasons of control differ according to the tree species targeted.

This technique is now widely implemented in Israel nature reserves and national parks where it proved to be “game-changer“ in the control management of invasive trees. Since invasive tree species such as *Acacia saligna*, *Ailanthus altissima* and *Prosopis juliflora* are listed among the worst invasive tree taxa in Mediterranean and arid regions, the control technique developed in Israel for these species could be very relevant for land managers and stakeholders in many countries of the world.

Keywords: Control management, Alien invasive plants, Control protocols in protected areas

The escape of alien plants from the *Hortus Botanicus Karalitanus* (HBK) of Cagliari: the role it plays in the introduction of invasive species in the natural habitats of Sardinia (Italy).

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Botanical gardens have historically played a role in introducing alien species for agronomic, medicinal, and ornamental purposes, but they also act as sources for plant invasions. The Botanical Garden of Cagliari, known as Hortus Botanicus Karalitanus (HBK), is a historic botanical garden established in 1866, as an acclimatization arboretum for tropical plants, by the University of Cagliari.

During the same period, other Mediterranean botanical gardens, such as Naples, Palermo, Catania, as well as Barcelona, Valencia, and Algiers, were created with the same purposes and functions, while a first acclimatization of species from the Americas typically occurred in the Canary Islands or Malaga.

However, some of these species escaped the gardens' fences and as a result, botanical gardens have significantly contributed to the introduction and spread of several invasive alien taxa.

The study explores the presence of invasive alien plant species in one of Italy's oldest botanical gardens and the current and potential impact that these taxa have on Sardinia biodiversity. This investigation aimed to create an inventory of alien plants in HBK, analysing key traits such as status, origin, life form, introduction pathways and reproductive strategies. Furthermore, the natural habitats affected by these species were analyzed. Field surveys from 2015 to 2024 identified 146 alien taxa, primarily neophytes (83%) and naturalized species (45%), of which 12% were invasive. The most represented families were Asparagaceae and Poaceae, with phanerophytes and therophytes being the dominant life forms. The American component was the most represented chorological form (38%) followed by the Asian one (13%). Our study highlighted that ornamental plants were the main contributors to the spread of alien species in HBK, accounting for 70% of introductions, while accidental taxa accounted for more invasive species (hitchhikers and weeds, 61%). Reproduction by seeds is the most common method employed by the alien flora at HBK (41%). The study highlights the importance of early detection and monitoring of alien taxa, providing valuable insights for managing future biological invasions in Sardinian habitats, particularly in wetland and coastal areas. By identifying potential invasive species early, this research supports efforts to mitigate biodiversity loss in the region through sharing inventory information.

Keywords: biodiversity, biological invasion, botanical gardens, invasive plants, Mediterranean area, ornamental plants, prevention, priority-lists, wetlands

Acknowledgements: We acknowledge financial support under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.5 - Call for tender No.3277 published on December 30, 2021, by the Italian Ministry of University and Research (MUR) funded by the European Union – NextGenerationEU. Project Code ECS0000038 – Project Title eINS Ecosystem of Innovation for Next Generation Sardinia – CUP F53C22000430001- Grant Assignment Decree No. 1056 adopted on June 23, 2022, by the Italian Ministry of Ministry of University and Research (MUR).

Life Tetide project, first steps in the management of invasive plant species in Mediterranean island ecosystems

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EU LIFE program aims to make the conservation of habitats and species feasible by funding projects for the environment and climate action. The LIFE TETIDE project, *"Turning Eradication Targets Into Durable Effects"*, is a collaborative initiative involving Malta, Italy, and Croatia. It aims to preserve habitats and native species by managing invasive alien species (IAS) and actively engaging island communities in conservation efforts. The University of Florence is primarily involved in work packages (WPs) 2, 3, and 10, which aim to implement surveillance strategies and improve the conservation status of seven Natura 2000 habitats on Capraia Island (Tuscan Archipelago, Italy). This is achieved through the control and eradication of invasive exotic plants (*Opuntia stricta*, *Opuntia ficus-indica*, *Zantedeschia aethiopica*, *Nicotiana glauca*, and *Chasmanthe floribunda*), drafting biosecurity protocols, and actively involving the local community.

To achieve the objectives of WPs 3 and 10, in collaboration with Company NEMO srl, we created a detailed map of the current distribution of target invasive species. For *O. stricta*, the most widespread invasive plant, drone flights were employed for additional mapping precision. Experimental trials were conducted to manage *O. stricta* waste material effectively, using integrated techniques such as manual removal combined with mulching and mechanical removal with a brush cutter. Additionally, we produced a sampling design for monitoring Natura 2000 habitats impacted by *O. stricta*, by randomly installing 25 permanent plots of 100 m^2, each containing two 4 m^2 subplots. For WP2, as part of a citizen science initiative, we set up an iNaturalist project to collect reports of alien plant species in the Tuscan Archipelago, the Pontine Islands and Tavolara, ensuring a continuous update of their distribution and enabling timely interventions.

Mapping revealed that invasive species are most prevalent in areas with higher levels of anthropogenic pressure and disturbance, with *O. stricta* being the only species to spread into natural habitats. The invasion extends over approximately 182 hectares (9.42% of the island's surface), with *O. stricta* accounting for nearly all the affected area. Around half of this invaded area falls within Natura 2000 habitats, among which the most threatened are, respectively: 1240 "Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.", 6220* "Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*", 5330 "Thermo-Mediterranean and pre-desert scrub", 8220 "Siliceous rocky slopes with chasmophytic vegetation", and 5320 "Low formations of *Euphorbia* close to cliffs". To enhance awareness of the invasive species issue, future efforts should focus on training the local population in the use of the iNaturalist application, making it a more efficient surveillance tool for reporting new occurrences.

Keywords: conservation project, habitat, insular ecology, *Opuntia stricta*

Acknowledgements: the authors acknowledge the support of the EU funded project "LIFE TETIDE - Turning Eradication Targets Into Durable Effects" (101113950 - LIFE22-NAT-IT-LIFE TETIDE). Michele Mugnai acknowledge the support of NBFC to University of Florence, funded by the Italian Ministry of University and Research, PNRR, Missione 4 Componente 2, "Dalla ricerca all'impresa", Investimento 1.4, Project CN00000033.

Mistreated native plants or overlooked invaders?

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Scientists agree in considering plant invasions as one of the worst threats to conservation of wilderness as well as to human health and economy. However, the efforts against invasions are too often frustrated by the uncertainty in assessing the native status of a plant. In fact, especially in countries that have a long history of human presence and are fully industrialized, it is almost impossible to recognize with certainty introduced plants from native ones, when they appear by then completely adapted to the wild. This problem is especially serious in south-western Europe and in Italy, where the number of the so-called "doubtfully native" (otherwise called "cryptogenic") plant taxa is high. In many cases, our knowledge of the native status of a plant is very poor, while phytogeographical and floristic data give evidence that the native or alien status of several species needs to be clarified, especially for biodiversity conservation and the management of possible impacts.

Some species of uncertain origin are often regarded as naturalized, or even as invasive aliens, and are therefore considered as a threat to biodiversity. Various of these putative aliens, however, when subjected to a careful scrutiny, may reveal themselves as fully indigenous and sometimes worth of protection. On the contrary, some species which are traditionally indicated as rare natives may be later discovered as deliberately or accidentally introduced. Evidently, any re-assessment of the native status can strongly improve allocation of efforts and resources in both controlling aliens and protecting native plants when needed.

A project funded by the University of Naples "Federico II" (UTOPIAN: Unravelling Timespan and Origin of Plants in Italy: Aliens or Natives?) is focused on cryptogenic plants and is based on the study of selected model species. In the framework of this project, we are studying three different cases based on three vascular plants occurring in Italy: an invasive aquatic perennial, which might be on the contrary native to the Mediterranean region (*Hydrocotyle ranunculoides* L.f., Apiaceae); an annual species almost univocally regarded as native to Italy but possibly accidentally introduced (*Cephalaria joppensis* (Rchb.) Coult., Caprifoliaceae), and an ornamental woody species of much debated origin (*Styrax officinalis* L., Styracaceae).

Hydrocotyle ranunculoides is generally regarded as native to Americas and reported among the most aggressive invasive species of the fresh waters in the Old World. However, according to some authors, the species would be native to the Mediterranean. Historical documents report its presence in southern Italy since the early XVII century, where it was later known as *H. natans* Cirillo and, until few decades ago, was considered a very rare and endangered plant. *Cephalaria joppensis* infrequently occurs in southern Italy and Sicily in man-managed environments, especially fields margins. The plant is more common in the Eastern Mediterranean Basin with a completely disjunct areal: some authors suggested that this plant was introduced in Italy in conjunction with crops. Finally, *Styrax officinalis* has an E-Mediterranean distribution (Balkans and W Minor Asia), with scattered localities in western Central Italy, where it has been often regarded as a native (possibly as a relic of Pleistocene glaciations). According to a different interpretation, however, it was possibly introduced into Italy in Roman Age and naturalized as an archaeophyte.

The work is being carried out by field investigations, which include collection of voucher specimens and associated information on vegetation and ecology. Herbarium specimens from worldwide herbaria have been obtained for molecular investigations (Sanger sequencing). Data analysis will focus on identifying rare haplotypes and ribotypes to develop phylogenetic and phylogeographic inferences.

Keywords: Alien taxa, Cryptogenic plants, Mediterranean flora, Molecular analysis

Acknowledgements: A heartfelt acknowledgment goes to the herbaria and colleagues that, to date, have provided the samples for the analyses and dedicated their time to addressing the requests.

Conservation of endangered endemic plant species via invasive species adaptive management using a livelihood approach in a small-island developing state context

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Abstract
Small-island developing states (SIDS) face unique challenges in conserving their endemic biodiversity, which is often threatened by invasive species. This study focuses on Brava, Cabo Verde, where the pervasive spread of *Lantana camara* has caused significant ecological, social, economic, and cultural impacts. The invasive species has displaced endemic flora, degraded agricultural land, and created barriers to traditional land-use practices.

Our research employed a multidisciplinary approach combining botanical surveys, drone mapping, and extensive community consultations to assess the extent of *Lantana camara* coverage and its impacts. The invasive species was removed using the Cut Root Stock Method, a mechanical removal technique, followed by ecological substitution to stabilize and restore affected ecosystems.

Preliminary results demonstrate promising recoveries of several endangered endemic plant species, highlighting the ecological benefits of adaptive management. Additionally, the integration of local artisans in utilizing *Lantana* biomass for producing artisanal products provided an alternative livelihood opportunity, fostering community support for conservation efforts.

This study underscores the importance of adaptive invasive species management paired with livelihood approaches to achieve long-term conservation goals in SIDS. It also offers a scalable model for balancing biodiversity conservation with community engagement and economic sustainability.

Keywords: Invasive species, *Lantana camara*, Mediterranean flora, Mediterranean habitats, *in situ* conservation, reduction of risks, conservation measures, citizen science

1

Evaluation of Conservation Efforts for 20 Priority Medicinal and Aromatic Plants in Morocco: Towards a Typification of Conservation Actions

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The conservation of medicinal and aromatic plants (MAP) has become a critical concern for the sustainability of natural resources in Morocco. These plants, which are essential to traditional medicine and the local economy, are facing increasing pressure from over-exploitation, habitat loss and the effects of climate change. In response to these threats, the Moroccan government has intensified its efforts by allocating substantial resources to ensure the preservation of species and ecosystems. This has resulted in the consolidation of the legal framework with the enactment of new laws and decrees, as well as the ratification of international conventions for the protection of species and their habitats. In addition, the network of national parks and biological reserves has been expanded to enhance habitat protection.

An assessment of current conservation initiatives, protection measures and the effectiveness of these actions is therefore important to ensure their preservation.To this effect, 22 interviews were conducted with 12 organisations, 86.4% of which were public sector bodies. Within this context, 22 interviews were carried out with 12 organisations, 86.4% of which were public sector bodies. The typification of actions enables the proposal of specific interventions adapted to the needs of each priority species. The analysis revealed that 75% of the 20 species studied required conservation action, including taxa classified as vulnerable, of minor concern, near-threatened and insufficiently documented. In addition, 25% of the species required targeted action to acquire additional knowledge.

The results of this study underscore the urgent need for collective and coordinated action to protect MAPs. These plants are crucial not only for maintaining ecosystems but also for preserving the traditional knowledge and cultural practices that contribute to the richness of Morocco's heritage.

Keywords: Medicinal plants, conservation measures, decision tree, priority species, Morocco.

2

Distribution Patterns of Characean Species Across Aquatic Habitats with Varying Salinity in Cyprus

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During the Characeae Meeting 2024 in Cyprus, numerous field surveys were conducted to document the occurrence and distribution of characean species across a variety of aquatic environments, spanning from saline lakes to freshwater reservoirs and rivers. The surveys included both natural and artificial water bodies, focusing on notable locations such as Paralimni and Oroklini Lakes, Achna Dam, Ezousa and Dhiarizos Rivers, Akrotiri wetland complex including the salt lake, Akrotiri marsh, gravel pits and Bishops Pool, as well as Larnaca Salt Lake. Each site represented a unique set of ecological conditions, providing a comprehensive overview of the habitats in which characeans can thrive.

Key findings included the presence of *Chara connivens* and *Chara aspera* at Paralimni Lake, which is part of the Natura 2000 network and showcases biodiversity in saline conditions. The record of characean taxa, supports the presence of the priority habitat type 1150*-coastal lagoons in the saline/ brackish water bodies surveyed. In contrast, the freshwater systems of the Ezousa and Dhiarizos Rivers revealed species such as *Chara vulgaris* and *Chara globularis*, while the rare *Lamprothamnium papulosum* was exclusively found in the saline conditions of the ditches and marshlands near Limassol Salt Lake. These observations underline the adaptability of characeans to diverse salinity levels, although species composition varies markedly between saline and freshwater habitats.

This work, enhances the understanding of the ecological distribution patterns of characeans within Mediterranean ecosystems and provides valuable baseline data for conservation strategies, particularly within protected areas. The insights gained, underscore the importance of habitat-specific management for conserving the biodiversity and ecological functions of characeans in these sensitive and diverse habitats.

Keywords: Characean distribution, saline and freshwater habitats, Mediterranean ecosystems, aquatic vegetation

Acknowledgements: EU-CONEXUS, Deutsche Gesellschaft für Limnologie, Arbeitsgruppe Characeen Deutschlands

3

Mitigating Pressures and threats on Coastal Dunes: A Conservation and Restoration Example in Cyprus

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Coastal dune ecosystems are critical biodiversity hotspots providing ecosystem services, yet they face increasing pressures mostly from human activities. The project LIFE CALLIOPE (LIFE17 NAT/IT/000565) was implemented in Italy and Cyprus and focused on the restoration and conservation of degraded coastal dune ecosystems. In Cyprus, it was implemented within the Natura 2000 (N2000) site 'Periochi Polis – Gialia' (CY4000001) and this presentation concerns the methodology followed for the mitigation of pressures and threats that targeted species and habitat types face, as well as measures implemented for the conservation of their population and ecological restoration, respectively.

At the site above, the project targeted the endemic plant taxon *Maresia nana* var. *glabra* (Meikle) Christodoulou & Hand (=*Malcolmia nana* var. *glabra* Meikle) which is characterised as Critically Endangered (CR, IUCN criteria: B1ab(iii,iv)+2ab(iii,iv) C2a(ii)) and four habitat types: 1210 – Annual vegetation of drift lines, 1310 – *Salicornia* and other annuals colonising mud and sand, 2110 – Embryonic shifting dunes and 2230 – *Malcolmietalia* dune grasslands, included in Annex I of the Habitats Directive (92/43/EEC).

The project's actions also included: mapping of the habitat types and update of the site's Standard Data Form (SDF); establishment of permanent plots for monitoring; implementation of interventions to minimize human access and activities on the dunes and reduction of their negative impact on the vegetation; seed collection, germination experiments and preparation of a 'Germination Protocol for the growth and outplanting of *Maresia nana* var. *glabra;* seed dispersal of native species and eradication of invasive alien plant species of European Union concern. Apart from these, the project's partners disseminated its actions and outcomes mainly via social media and communication media, with electronic and printed deliverables.

Keywords: Habitats Directive, conservation measures, Mediterranean flora, coastal and halophytic habitats, coastal sand dunes

Acknowledgements: Co-funded through the EU LIFE Programme

4

The rare, the expanding and the moo Red list flora of Akrotiri Marsh- Facts and a Toolbox of conservation actions

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Akrotiri Marsh (AM) is the only remaining lowland wet grassland in Cyprus, covering an area of ~150 ha. It is dominated by a reedbed and surrounding wet meadows. It is an important botanical hotspot, supporting an appreciable number of plant taxa, some of which have very narrow national distribution.

Conservation actions were established for four floral species -*Mentha aquatica, Euphorbia hirsuta, Ipomoea sagittata* and *Schoenoplectus tabernaemontani* for a 3-year period. Their selection was based on their Red list classification, as well as on the fact that the species best-established population in the island, is hosted at AM.

AM, is Crown Forest land within the Sovereign Base Areas in Cyprus, traditionally grazed by the Cyprus' cattle breed and for collection of raw material for basketry. Adjacent land use changes, in the last decades, resulted in alterations of the hydrological regime of the marsh, which was reflected in the expansion of reeds and tamarisks and subsequent habitat loss. The alarming changes led to the implementation of conservation actions, in an attempt to enhance the biodiversity richness, by restoring the marsh to a mosaic of habitats. At the same time, these actions aimed at promoting the economic viability of conservation grazing, improving the recovery and status of the target and other species and ecological communities, as well as, increasing public awareness, education, research and eco-tourism opportunities.

Grazing was used as a primary, sustainable, long-term conservation tool in the marsh. The grazing capacity of the marsh was estimated and managed grazing was promoted, with a recommendation of repeated evaluation every 3 years. In- situ conservation actions, consisted of plant reinforcements and/or introduction to new areas, but also actions like passive defense measures, such as fencing, controlled access, managed grazing patterns spatially and temporally, controlling competing plants and restoring the natural vegetation within or around the area of interest. Ex-situ conservation actions included seed collection, curation and storage for germplasm conservation. Moreover, active collection of the target plants took place, for (a) the implementation of in situ actions (b) the availability of plants for use in population reinforcement actions and (c) for outreach activities. Plants were produced from seeds, rhizome or cuttings. *Soft* conservation actions, which safeguarded the long-term viability of the actions implemented, included networking and building bridges with the involved stakeholders, as well as public awareness raising.

This work has set the foundations for long-term conservation of the threatened target species, by providing updated information on their population and distribution at AM, as well as by applying in-situ, ex-situ and supplementary management measures and actions. We got our hands muddy and really enjoyed it, while at the same time we have established that grazing -as a key conservation tool in the area- requires systematic monitoring and seasonal adaptations to the target species needs. The cattle herds provide opportunities for the threatened species to occupy new areas, but at the same time, they potentially exert a number of pressures (grazing, trampling, soil compacting, alteration of soil eutrophic status etc.). A sustainable conservation approach entails the operation of an informed management body, that considers in a holistic manner the needs of the area, in terms of biodiversity sensitivity (flora, habitats, fauna), but also socio-economic factors, recreation and agro-tourism.

Keywords: Akrotiri Marsh, conservation measures, in-situ conservation, ex-situ conservation

Acknowledgements: This work was implemented in the framework Darwin Plus 141 project: Habitat restoration and wise use for Akrotiri and Cape Pyla. Implementing partners were BirdLife Cyprus (leading partner), Environment Department of the Sovereign British Areas Administration, Terra Cypria, and Royal Society for the Protection of Birds. The conservation works were conducted with support from the Department of Forests, Agricultural Research Institute, Akrotiri Community, local graziers, scientists, conservationists, other stakeholders and the local cattle breed to whom we are deeply grateful. The results of these efforts were also promoted by John Ellerman Foundation Project (2023-24) through providing clear recommendations for future management of Akrotiri Peninsula.

5

Akrotiri Marsh – A Unique Wetland under Restoration

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Akrotiri Marsh is the only remaining lowland wet grassland in Cyprus, covering an area of 150 ha. It is part of the of the Akrotiri wetland complex, the largest natural wetland complex in Cyprus. The site lies within Cyprus Sovereign Base Area (British Overseas Territory) on state land. The wetland is protected under Ramsar Convention, recognized as Important Bird Area (IBA), designated as a Special Protection Area (SPA) for birds and a Special Area of Conservation (SAC) for habitats and species of wild flora and fauna, equivalent to the EU designation, according to the mirror legislation in the Cyprus Sovereign Base Areas. It is an important breeding site for birds, resting site for migratory birds and it is also important for its flora, as the site hosts some rare and threatened plant species.

Traditionally, the site had been used by the locals of the nearby Akrotiri village for grazing with Cyprus cattle breed and for collection of raw material for basketry. In the last couple of decades, changes of land use in the wetland's catchment area resulted in changes in the hydrological regime of the site. Additionally, on-site grazing had been in decline and in combination with hydrological changes, led to the rapid over-expansion of reeds, resulting in biodiversity degradation on site. From 2015 to 2017, the Darwin Plus project "Akrotiri Marsh Restoration: a flagship wetland in the Cyprus SBAs" took place in order to enhance the biodiversity richness of the wetland, by restoring Akrotiri Marsh to a mosaic of habitats, similar to the state it was in some decades ago. From 2021 to 2024, in the framework of the Darwin Plus project "Habitat Restoration & Wise Use for Akrotiri & Cape Pyla", actions took place to promote the economic viability of conservation grazing, conserve important plant species and increase public awareness. Grazing had been a traditional activity at Akrotiri Marsh, with the site grazed by Cyprus cattle, a traditional breed that gets subsidised for its preservation. Both projects funded by Darwin Plus aimed at reviving the traditional activity of grazing by the local cattle breed which gets government subsidies to ensure its preservation.

Livestock grazing is an effective and sustainable tool for reed management. Cattle can limit reed expansion by grazing and can damage the reed's rhizome by trampling. Before 2015, those who still had grazing animals on site were very few and cattle were tethered. To maximize cattle grazing effectiveness, the Darwin Plus project (2015-2017) funded locals to purchase cattle and built cattle sheds with feeding and water stations. Additionally, the site was fenced to allow free-range grazing and control visitor access to reduce disturbance. A marketing plan for the wildlife-friendly Akrotiri Marsh beef was elaborated (under Darwin Plus project, 2021-2024) to further contribute to the economic viability of graziers.

Through mechanical reed cutting and creation of pools (during 2015-2017), suitable habitat was created for key bird species, such as Ferruginous Duck. At the same time, key drainage channels were restored and water level control structures were installed to facilitate managed drainage of the site. Additionally, through systematic vegetation surveys (2021 to 2024), rare plant species are identified and monitored. Suitable areas were fenced for planting target plant species, promoting managed grazing and supporting and enhancing existing plant population. Moreover, bird-watching hides were constructed and information signs were placed at key points. Public awareness events were organised to promote this unique wetland as a wildlife friendly destination.

The support for conservation grazing resulted in an increase in grazing area from 13 (2015) to 27 ha (2023) due to cattle grazing clearing the dense reeds, creating open spaces and promoting habitat diversity. Through targeted conservation actions, the population of rare plant species within the Marsh increased within the range of 25-50%, Since the start of the first Darwin Plus project in 2013, waterbird populations at the Marsh are thriving and breeding population of the Spur-winged Lapwing is rapidly increasing by more than 10% each year. Akrotiri Marsh is increasingly recognized and perceived by the public as a unique and important wetland, where visitors come from Cyprus and abroad to birdwatch, admire the landscape and experience one of the few areas in Cyprus where cattle graze freely.

Keywords: Akrotiri Marsh, wetland restoration, conservation grazing

Acknowledgements: This work was implemented in the framework of Darwin PLUS funded projects "Akrotiri Marsh Restoration: a flagship wetland in the Cyprus SBAs" (2015-2017) & "Habitat restoration and wise use for Akrotiri and Cape Pyla (2021-2024). Implementing partners were BirdLife Cyprus (leading partner), Environment Department of the Sovereign British Areas Administration, Terra Cypria, Akrotiri Environmental Education Centre and Royal Society for the Protection of Birds. The results of these efforts were also promoted by John Ellerman Foundation Project (2023-24) through providing clear recommendations for future management of Akrotiri Peninsula.

6

Temporal Comparison of Habitat Mapping in Natura 2000 Wetlands of Cyprus: Insights from Local Surveys and CORINE Land Cover Data

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Wetlands are dynamic ecosystems critical for biodiversity conservation and ecosystem services, particularly those designated under the Natura 2000 network. This study examines temporal changes in habitat types across three Natura 2000 wetland sites of Cyprus (Alykes Larnakas – CY6000002, Limni Oroklinis – CY6000010 and Limni Paralimniou – CY3000008) using detailed habitat mapping conducted in two different periods (1999 and 2023). The mapped data were analyzed to assess spatial and compositional changes in habitat types and compared with CORINE Land Cover data to evaluate the consistency and accuracy of broad-scale datasets in capturing local habitat dynamics.

Our results highlight significant shifts in habitat composition, with notable transitions between wetland vegetation types, driven by a combination of ecological succession, climate change-induced droughts, the spread of invasive species, and anthropogenic pressures, such as land-use changes and water management interventions. In particular, local mapping detected fine-scale changes, such as shifts in reedbeds and marshland extent, that were either misclassified or overlooked in CORINE datasets (the minimum polygon size in CORINE is 25 ha and minimum changes in land cover is 5 ha). The mismatch between CORINE classifications and ground-based surveys was most pronounced in transitional habitats, where discrepancies in habitat classification thresholds and spatial resolution were evident. These findings underscore the importance of integrating high-resolution, site-specific data with broader-scale monitoring frameworks like CORINE to enhance the accuracy of habitat assessments.

The study emphasizes the need for regular and detailed monitoring of Natura 2000 wetlands for better understanding ecosystem trajectories and support adaptive management strategies in response to anthropogenic pressures and climate change. The discrepancies between CORINE and high-resolution mapping underscore the need for complementary approaches to improve the reliability of ecological monitoring. Our comparison provides valuable insights into the benefits and limitations of existing land cover datasets for tracking habitat dynamics in protected wetlands.

Keywords: Natura 2000, wetlands, habitat mapping, CORINE Land Cover, temporal analysis

Acknowledgements: The current work was implemented within the framework of LIFE Integrated Project PHYSIS - LIFE18 IPE/CY/000006, co-funded through the EU LIFE Programme.

7

Observation of morphological and anatomical features of needles of *Cedrus brevifolia* Henry: A Tool for better understanding their population structure

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Cyprus cedar (Cedrus brevifolia) is an important endemic coniferous tree of the Cyprus flora. The species is listed as vulnerable in the Red Data Book of the Flora of Cyprus, and its habitat type (9590*) is designated as a priority habitat under the Habitats Directive. The species is characterized by narrow distribution in an area of 263.4 ha (~2.6 km2), which constitutes less than 0.2% of high forest vegetation in Cyprus. C. brevifolia occupies a single forest that is distributed in an altitudinal range of 900 m to 1362 m, in the highest hills of the Paphos forest. However, this sole population of C. brevifolia is non-continuously distributed in its occupied area and is fragmented into five patches. Recent studies have shown that the species is characterised by high genetic variation and significant genetic differentiation between these five subpopulations (patches).

The current study was the first in-depth investigation of the needles' morpho-anatomical properties and the needle diversity patterns within the natural population of C. brevifolia, at the population level. Thus, the ultimate goal of the current study was to extend the knowledge on the ecological adaptation processes developed by this precious and vulnerable species in response to different geographical locations. Therefore, any significant geographical pattern on the morpho-anatomical traits on C. brevifolia needles, is expected to reflect the demographic and ecological forces on the species throughout its survival in different micro-environmental conditions.

For the purposes of the present study, 16 sampling plots were established within the five subpopulations, covering the natural and ecological boundaries of the species' distribution. From each plot, plant tissue was collected from 20 adult cedar individuals; from each individual 10 needles (3-year-old) were selected for conducting morphological and anatomical measurements. For each needle, 24 morphological parameters and 8 anatomical parameters were studied; the results were analysed using statistical measurements for extracting relevant conclusions.

The outcomes from this study demonstrated that morpho-anatomic features vary more within patches than between patches. Further, despite the small distribution of Cyprus cedar, significant differentiation among the five patches was observed, and needle phenotypes were developed. The changes observed between patches indicate that this species' morpho-anatomic traits are adaptive within its single population, most likely owing to gene diversity and micro-environmental circumstances.

Keywords: needle traits, narrow species, Mediterranean habitat

Acknowledgements: The study was carried out under the frame of the research project DIDAKTOR/0609/13, that was co-financed by the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation.

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Elaboration of an Action Plan for the conservation of *Phlomis brevibracteata*, an Endemic Species of Cyprus

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Phlomis brevibracteata is an endemic plant species of Cyprus, listed in Annex II of Directive 92/43/EEC. The species is distributed across seven subpopulations with an Extent of Occurrence of 256 km^2 and an Area of Occupancy of 79 km^2. Approximately 47% of its population is represented within the Natura 2000 network, and specifically in the sites “Cha-Potami” (CY4000002), “Kokkinokremmos” (CY5000002), “Periochi Asgatas” (CY5000007), and “Periochi Lefkaron” (CY6000005). The total estimated population is 18,500 mature individuals and currently the species is classified as Least Concern (LC), based on IUCN criteria. However, anthropogenic pressures such as land-use changes, road construction, fires, and grazing after fire events, alongside ecological factors like pollinator availability, constitute significant threats to its long-term survival.

To ensure the conservation of *Phlomis brevibracteata* in the long term, an Action Plan has been developed, focusing on three core objectives:
(A) Conserving and/or increasing the population to secure the species’ survival.
(B) Ensuring adequate habitat suitability within its range.
(C) Identifying critical zones and enhancing connectivity among subpopulations.

The Action Plan proposes measures to strengthen existing subpopulations, identifies and designates a new site within the Natura 2000 network, and explores potential new locations to increase the population to a Favourable Reference Population of 20,000 individuals. Additionally, connectivity between subpopulations will be improved to maintain the Favourable Reference Range at 60 km^2.

The successful implementation of this plan will depend on habitat restoration efforts, fire management strategies, grazing control, and increasing knowledge about the reproductive biology of this species. Monitoring programs and collaboration among stakeholders will be vital for adaptive management, ensuring the long-term viability of *Phlomis brevibracteata* and its habitats. This action plan will serve as a guide for safeguarding this unique element of Cyprus’ biodiversity and will contribute towards the achievement of the goals set by EU Habitats Directive.

Keywords: Action Plan, Habitats Directive, conservation measures, Mediterranean flora, *in situ* conservation

Acknowledgements: The current work was implemented within the framework of LIFE Integrated Project PHYSIS - LIFE18 IPE/CY/000006, co-funded through the EU LIFE Programme.

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Wheat yield is not affected by the co-occurrence of arable weeds *Agrostemma githago* and *Centaurea cyanus*: implications for conservation

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After 1950, wild arable plants (hereafter arable species) underwent a dramatic decline due to the rapid intensification of agriculture. In most cases, arable species are considered as weeds and, for this reason, they have been systematically eradicated in conventional farming systems. Arable species extirpated even in sustainable agricultural systems are no longer able to recolonize their former range. Therefore, the reintroduction of arable species within agroecosystems has been proposed to improve their conservation status. Unfortunately, farmers are often reluctant to accept the reintroduction of endangered plants to their lands, as they could reduce crop productivity through competition. Therefore, it is important to understand if farmers' fears of a reduction of crop productivity are grounded in evidence, to engage them to promote coexistence between crops and rare arable species.

We studied the mutual competitive effects between two iconic arable species, Agrostemma githago L. and Centaurea cyanus L., and wheat (Triticum aestivum L., variety Palesio) in two densities (5% and 10%) in an open field experiment at the SemeNostrum company (Udine, Italy) in 2022/2023.

Chlorophyll content, SLA, LDMC, root/shoot ratio in A. githago and C. cyanus were negatively affected when these species were cultivated in combination with wheat, at different densities. T. aestivum, instead, was not significantly effected in terms of biomass, SLA, chlorophyll content or yields (1000 seeds weight) by the presence of A. githago and C. cyanus, suggesting that wheat is not affected by competition from the two arable species.

This first comparative analysis evidences a plausible model of coexistence of arable species and crops. This will provide the baseline for future translocation protocols of threatened species in agricultural contexts.

Keywords: agroecosystems, arable species, competition, crops, in situ conservation, threatened plant species

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Photic Barriers to Plant Migration in the Mediterranean: Implications for Assisted Migration Strategies under Climate Change

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Photoperiod (the daily duration of light and dark) is a key seasonal signal for plants, influencing physiological and phenological processes such as photosynthetic efficiency, bud burst, flowering, growth cessation, senescence and dormancy. Photoperiod will not change as the climate warms, leading to potential asynchrony in these functionally paired cues. Global mean air temperature increases of up to 4.5 °C are predicted by the year 2100. In particular, in the Mediterranean, climate change-driven species loss and migration have already been recorded on the main mountain chains, including the Apennines, the Sierra Nevada, Crete.

Recently, climate change attributable to human influence has been recognized as among the most important contemporary forces driving species' distribution ranges. Our review highlights that plant communities are shifting their ranges northward or to higher elevations in response to climate warming, but photoperiodicity and other non-climatic factors, on top of habitat fragmentation, may limit the success of these migrations, as species with highly photoperiod-dependent responses may encounter "photic" barriers to their movement. Despite its importance, there is a lack of extensive literature regarding the role of photoperiod on the response of plant species and communities to the ongoing climate crisis.

Wide-spread and artic-alpine species adapted to different latitudes show variable responses to photoperiod, influencing their migration potential. Different photoperiodic sensitivity of species within a community may alter the competitive ability across species and latitudes in a warmer climate. For example, short-day species that may reach high latitudes through long-distance dispersal events may survive in the new environment but may be unable to flower and reproduce. Changes in flowering time might have negative implications for the survival of these species, as a mismatch between time of flowering and pollinator activity might also occur. Moreover, species that rely on shorter days in autumn for the induction of senescence, might not benefit from improved climatic conditions and a longer growing season at mid latitude. Changes in phenological traits are among the most obvious responses to global warming, yet photoperiod and temperature influence these events in complex ways, with strong variations based on species and latitude. A clear example is represented by the time of bud burst, which represents a compromise between a spring frost avoidance and a sufficiently long growing season. Understanding the role of both photoperiodic and temperature cues on different physiological/phenological traits is therefore crucial to understand how different plant communities and species will be affected by climate change in the near future, especially regarding their migration potential. Disentangling the effects of photoperiod and temperature in plants' response to climate change is therefore essential to identify the best conservation solutions. If photic barriers can actually hinder species' natural range shift, finding ecotypes or genotypes specifically adapted to a given location would be of great use for conservation actions, such as assisted migration for in situ conservation that could be planned in the next future.

Keywords: climate change, photoperiod, assisted migration, conservation

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Coordinated action for invasive species: A cohesive approach to IAS management across the southern regions of France

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The Mediterranean region of France harbors a diverse and unique flora due to its mild climate, varied topography, and rich ecological history. In recent decades, the region has witnessed the emergence of factors such as urbanization, land use change, tourism, and global trade that have facilitated the introduction and spread of invasive species. Today, biological invasion emerges as a significant challenge to conservation efforts within this biodiversity hotspot.

Recognizing the urgent need to address this threat and establish a cohesive approach to invasive alien species (IAS) management across the southern regions of France, the Conservatoire Botanique National Méditerranéen (CBNMed) was requested to develop a regional strategy and an action plan adapted to the environmental, social, economic and political realities. In 2014, a first regional strategy and an action plan was published for the Provence-Alpes-Côte d'Azur region.

The objectives of this strategy were multifaceted, aiming to develop a scientific reference list of IAS and potential IAS, assess ongoing regional initiatives targeting IAS, gauge stakeholder expectations, and propose methodologies and an actionable plan. Moreover, beyond merely cataloging species at administrative regional levels, a nuanced analysis was conducted across different geographical scales, to take into account the specific floristic characteristics related to the distinct biogeographical regions. For each species identified as an IAS or potentially invasive, a rigorous risk analysis was conducted, encompassing biogeographical and ecological parameters to ascertain their local invasive potential.

To fulfill its mission of raising awareness, communicating with stakeholders, and supporting managers CBNMed administers a platform about mediterranean invasive plants (INVMED-Flore), that serves as a direct link between scientific research and practical field management approaches.

In 2023, similar efforts have been undertaken by CBNMed for the Occitanie region, reflecting a steadfast commitment to harmonized invasive species management practices across France's Mediterranean territories.

Keywords: invasive alien species, strategies, Mediterranean, coordination

12

Exceptional plants under threat: conservation actions at the Botanical Garden of the University of Valencia

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Exceptional plants are defined as those that do not produce seed, survive seed bank conditions (15% relative humidity and -20°C), remain viable over a reasonable length of time at such conditions, or germinate and produce plants upon removal from the seed bank. These taxa require alternative *ex situ* conservation approaches via living plant, tissue culture, or cryopreserved collections. Examples of exceptional plants in the Mediterranean can be found in all *Quercus* taxa, *Castanea sativa*, and *Aesculus hippocastanum* (recalcitrant seeds), diverse *Salix* and *Acer* species as well as many ferns (short-lived seeds or spores), and iconic taxa with unique genotypes and nil seed production such as the highly threatened *Cistus heterophyllus* subsp. *carthaginensis* in Valencia.

Diverse actions for the conservation of exceptional plants are being performed in the Botanical Garden of the University of Valencia, involving a multidisciplinary team. These actions include: (1) cultivation of living plants in greenhouses and living collection of the gardens (e.g., *C. heterophyllus*, *Asplenium marinum*, *Quercus* ssp, *Aesculus* ssp); (2) research on reproductive biology in order to break up seed production barriers (e.g., *C. heterophyllus*); (3) seed germination research in highly dormant species (e.g., *Reseda hookeri*); (4) low (-20°C) and ultra-low temperature (-80°C) storage of fern spores and *Quercus* sp. pollen in the germplasm bank; (5) fundamental and applied research for the cryopreservation (storage at liquid nitrogen temperatures: -196°C) of fern gametophytes and *Quercus* embryonic axes; (6) research on phylogeography of the fern *Pteris vittata*, fingerprinting technology for *Quercus* sp., and genomic sequencing of *R. hookeri*, and (7) herbarium preservation to document specimens for species identification and as records for germplasm bank and garden collections. These conservation efforts are complemented by public engagement initiatives, including educational activities, exhibitions, and dissemination programs to raise awareness about the importance of exceptional plant taxa conservation.

Keywords: *ex situ* conservation, cryopreservation, seed germination, reproduction biology, exceptional species

Acknowledgements: Funding supporting these activities has been provided by the International Oak Society (Global Oak Pollen Bank Project), Fundación Biodiversidad and MITECO (project Bases para la conservación de la jara de Cartagena), MCIN/AEI/ 10.13039/501100011033 and the “European Union NextGenerationEU/PRTR” (project POPEYE, PID2022-139455NB-C33), and Generalitat Valenciana.

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MONALISA Project: Case Study for the Implementation of Nature Restoration Actions in Asterousia Area, Crete, Greece

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The Horizon Europe "MONALISA" Project on "Monitoring and Assessing Prevention and Restoration Solutions to Combat Desertification" (Project: 101157867 — MONALISA — HORIZON-MISS-2023-SOIL-01) is being implemented since September 2024 (its duration is 48 months). Coordinator of the project is the University of Sassary – National Research on Desertification (UNISS – NRD; Italy) and it involves 20 partners from Italy, Greece, Spain, Denmark, Romania, Serbia, France and Tunisia, as well as 2 Affiliated Partners from Switzerland.

MONALISA's overall objectives are to: a) identify, showcase and promote the expansion of innovative, tailored and socio-economic and environmentally effective solutions to prevent and reverse Land Degradation and Desertification (LDD); and b) identify, showcase and promote the expansion of innovative, tailored and socio-economic and environmentally effective solutions to prevent and reverse LDD.

Work Package 2 (Innovative Practices for Avoiding / Restoring LDD in Case Studies) aims to demonstrate the social acceptability, economic viability, and environmental effectiveness of innovative practices for preventing desertification and land degradation. It will co-design, implement, test, and evaluate a methodology for co-creation and adoption of restoration practices in 6 selected Case Study (CS) areas (Berchidda-Monti [Italy], Los Pedroches [Spain], Alta Murgia [Italy], Medenine [Tunisia], Bait Dajan [Palestine], and Asterousia [Greece]), integrate biophysical and social knowledge in the co-designed solutions and identify technical barriers and opportunities for the solutions. In addition, MONALISA project will produce recommendations on co-design and co-implementation of innovative solutions in agriculture, agroforestry and natural ecosystems.

In the Asterousia area, Crete, Greece, the following Nature-based Solutions (NbS) on restoration will be implemented for combating LDD:

- Conservation agriculture: The Asterousia CS will implement conservation agriculture practices in olive orchards: minimum tillage, strip-tillage; legume-based cover crops; establishment of semi-natural / uncultivated strips in olive fields. Three (3) selected farmers will test these technologies and provide the assessment of the effectiveness and practicality of technologies ranging from farm to different levels up to the policy and international framework.
- Natural ecosystem and agro-ecosystem restoration systems: A series of green infrastructures will be tested in the Asterousia CS, such as stone piles, brush piles-wooden trunks, stone walls, small ponds etc.

Stakeholders already engaged in the Asterousia CS activities and who will be assigned for co-design and co-implementation of relevant NbS implied are the following: Region of Crete – Directorate of Environment & Spatial Planning, Municipality of Archanes-Asterousia, Municipality of Faistos, Inspectorate of Forests Policy Implementation of Crete, Livestock Association of Asterousia, Farmers' Cooperatives of Asterousia, Geotechnical Chamber of Greece – Crete's Branch, General public of Asterousia Mountains' Area.

Keywords: MONALISA project, Land Degradation and Desertification (LDD), Restoration Solutions, Nature-based Solutions (NbS), Agroforestry, innovative solutions, natural ecosystems.

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An everlasting tug-of-war: Pressures, threats & conservation actions at protected habitats

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Under Articles 11 and 17 of the Habitats Directive, EU Member States are required to monitor and report every 6 years the conservation status of natural habitats and species. This task, which is integral to habitat management, demands robust methods, as well as training and consistency. Monitoring not only fosters cooperative efforts but is also an essential tool for acquiring the knowledge to make informed management decisions and implement effective conservation actions.

In Cyprus, in the context of the Natura 2000 network monitoring scheme, data on the pressures and threats affecting 39 non – marine habitat types, are systematically collected from more than 950 sampling plots – located within 40 Special Areas of Conservation (SAC). This process evaluates the timing, scope, and degree of influence of the various pressures and threats exerted on the habitat types. Furthermore, information on specific conservation measures and the associated efforts imposed is recorded. The data are collected consistently, using the standardized checklists provided under Article 17 reference material and are stored in a dedicated national database.

The analyses highlight the most frequently recorded pressures and threats, along with their impacts on the different habitat groups (i.e., forests, scrublands, grasslands, freshwater systems, dunes, and coastal habitats), while also offering a comparative assessment of the alleviation achieved through conservation actions.

Integrating site- and habitat-specific monitoring provides the data necessary to assess the future trends in the structure, functions, and area of each monitored habitat type. Moreover, it provides insights into the integrity, conservation degree and status of the protected habitats. This approach establishes a feedback loop by providing accurate geographically referenced information to the competent authorities, enabling a better understanding of activities occurring within the SACs, and facilitating the development of specific management actions, to mitigate or reduce the impact of pressures and threats.

Keywords: Habitats Directive, pressures, threats, conservation actions, monitoring

Acknowledgements: This work was performed within Contract No. DE 2/2023 “Provision of Services for the recording and collection of data on habitat types and species of the Directive 92/43/EEC and preparation of the 6-year report for the period 2019-2024 of Article 17 of the Directive 92/43/EEC”, which is co-financed by the European Regional Development Fund through the “THALEIA 2021-2027” Programme under the Project “Management of NATURA 2000 Sites” and by national resources.

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Morphological and flow cytometry analysis reveals a significant cytotype diversity within the *Allium* spp. Cypriot germplasm

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Cyprus, the third largest Mediterranean island, has a relatively high floristic diversity, which is primarily the result of its geographical position and size (9,251 km2), the varied geology and geomorphology, the climatic conditions, the habitat diversity, the long history of human presence and the isolation. The indigenous flora consists of 1650 species and subspecies of which 8.85% are endemic.

The genus *Allium*, including wild garlic and onions, is particularly interesting diverse. Twenty-five *Allium* species and subspecies have been reported on the island, with seven being endemic and one near-endemic. These species have a unique genetic markup and many auto- or allopolyploid forms, but they remain largely unexplored and unmapped.

A study was initiated to characterize and unravel the complex evolutionary history of *Allium* spp. using flow cytometry and C-values assessment. The Cypriot *Allium* germplasm was found to be highly diverse, with all species clearly identified using morphological descriptors. The genus *Allium* exhibits a diverse range of ploidy levels, which significantly influences its ecological distribution and evolutionary adaptations. The study found substantial differences in genome sizes among diploids, triploids, tetraploids, and pentaploids, especially in the A. *ampeloprasum* complex. Further phylogenetic and karyotypic analyses of the Cypriot *Allium* germplasm are expected to further pinpoint the specific genomic attributes of this important genus.

Keywords: Crop Wild Relatives, *Allium* species, Genome Size, Phylogenetic analysis, Karyotypic analysis

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AI for biodiversity monitoring to support decision making: the GUARDEN project and Cyprus' case study

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The GUARDEN project is an ambitious project which mainly aims to use environmental observations to monitor the status and trends of biodiversity and the supply of multiple ecosystem services. To achieve this, the project (1) has activated multi-stakeholder partnerships for improved governance of biodiversity and ecosystem services monitoring, (2) delivers methods and tools to quantify and characterize change in biodiversity and related ecosystem services, as well as quantify impacts of the main direct drivers of change and (3) is in progress to deliver a set of ICT tools and tailored decision support applications that transform scientific outputs to actionable knowledge, tailored to the needs of the end users.

The project is implemented in four regions (France & Madagascar, Greece, Spain, Cyprus) with a different case study in each one. The Cyprus case study aims to support informed decision-making to minimize the negative impact on ecosystems, biodiversity and the environment during the implementation of Vasilikos Area Spatial Master Plan (VASMP), which foresees the expansion of the industrial activities of the energy center and the creation of new infrastructure. For the successful execution of the Cyprus' case study, the GUARDEN tools used include Pl@ntNet, Bird Sound Identification, Future Scenario Tool and Dashboard (Decision Support Application).

To reach its goals and achieve the project's KPIs, the Cyprus' partners followed a specific plant plot protocol to enable the collection of multiple information on plant communities. The protocol mainly included the recording of plant taxa in five-meter-transects. This resulted in the implementation of three transects along two (different) natural habitat types (9320 - *Olea* and *Ceratonia* forests and 5212 - Arborescent matorral with *Juniperus phoenicea*) and the recording of 57 plant taxa. At the same time, a full floristic catalogue of the entire target area based on bibliography and observations was put together, which resulted in a list of 201 plant taxa that included endemics, plants of the Red Data Book of Cyprus, plant species of community interest (Habitats Directive), invasive alien species and others.

Keywords: Mediterranean ecosystems, monitoring biodiversity, ICT tools, artificial intelligence, decision-making

Acknowledgements: The GUARDEN project is funded by the European Union under the Horizon Europe Programme.

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The distribution of Invasive Alien Species (IAS) in West Bank, State of Palestine

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Invasive alien species (IAS) have become one of the major environmental issues in the 21st century alongside climate change, water scarcity, pollution and natural resource depletion. IAS pose significant threats to ecosystems and human health. This study evaluated IAS in the West Bank (occupied Palestinian Territories) including examining the number of introduced invasive species, their methods of dispersal, establishment, and distribution. The data was gathered from literature and field observations (including GIS mapping), utilizing historical information such as indigenous local knowledge and herbarium specimens, along with targeted field GPS surveys and collections. 29 IAS species were recorded and their distribution mapped. Six IAS were documented for the first time in the West Bank: *Araujia sericifera* Brot., *Euphorbia graminea* Jacq., *Euphorbia nutans* L., *Helianthus annuus* L., *Heterotheca subaxillaris* (Lam.) Britton & Rusby, *Xanthium italicum* Moretti. The distribution of seven other invasive plant species was updated: *Bidens pilosa* L., *Cyperus involucratus* Rottb., *Eleusine indica* (L.) J.Gaertn, *Euphorbia heterophylla* L., *Oxalis corniculata* L., *Verbesina encelioides* (Cav.). We then assessed potential threats to ecosystems and suggested means of management/control.

Keywords: Invasion biology, Protected areas, Imperial Species, Mediterranean Basin hotspot, habitat destruction.

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Revealing cryptic diversity and evolutionary processes in *Erysimum* species endemic to the western Balkan Peninsula

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Erysimum (Brassicaceae) is a genus of extensive species diversity and evolutionary complexity, characterized by recent and rapid diversification, remarkable karyological diversity, instances of cryptic speciation and hybridization within certain groups. A significant proportion of species in Europe are endemics restricted to Mediterranean regions. In the absence of comprehensive phylogenetic analyses at the genus level, species are taxonomically circumscribed and informally grouped into species complexes based largely on morphological traits, without a clear understanding of their evolutionary relationships and histories. One such group is the *E. odoratum* complex, which comprises up to ten species distributed across central and southeastern Europe. Our phylogenomic reconstructions reveal that this complex is polyphyletic and is divided into distinct Carpathian and Balkan lineages. In this study, we focus on the Balkan lineages, which comprise five endemic species of the western Balkan regions that are largely allopatric and occur from Slovenia in the north to the Peloponnese in the south. While only the diploid (*E. carniolicum, E. vitekii, E. kuemmerlei, E. pectinatum*) and hexaploid (*E. croaticum*) cytotypes have been reported thus far, our flow cytometric screening uncovered significant variation in genome size within each species. We identified up to three different genome size classes (potential cytotypes) per species, some of which showed geographic structuring. By integrating cytogenetic and phylogenomic analyses (Hyb-Seq, RADseq), we aim to identify and explore potential sources of this variation, such as cryptic species diversity, polyploidy, endopolyploidy, or repetitive DNA proliferation. Our study illustrates how in-depth genomic studies can reveal hidden diversity, unique cytotypes or even cryptic taxa within geographically restricted endemics, which need to be recognized for proper biodiversity assessments and conservation efforts.

Keywords: genome size, western Balkans, endemics, cryptic speciation

Acknowledgements: Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V04-00494 (to M.Š.) and the Grant Agency VEGA, Bratislava, Slovakia (project No. VEGA 2/0010/25)

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Capsules for the future: safeguarding genetic resources

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Within the framework of the project 'SOMOS AGUA II: Research Applied to the Development and Diversification of the Bioeconomy Associated with Traditional Knowledge and Other Endogenous Resources of the Biosphere Reserve of Omaña and Luna Valleys (RBVOyL)', funded by the Biodiversity Foundation of the Ministry for Ecological Transition and the Demographic Challenge (MITECO) within the framework of the Plan for Recovery, Transformation, and Resilience (PRTR), funded by the European Union - NextGenerationEU, the indigenous resources of this area are being compiled and re-evaluated.

To this end, the work is being carried out by an interdisciplinary team from the University of León (ULE), the Biofuels and Bioproducts R&D&I Centre of the Agricultural Technological Institute of Castilla and León (ITACyL), and the Biosphere Reserve of Omaña and Luna Valleys (RBVOyL). The project is divided into six actions, each coordinated by one of these entities.

Within Action 'A2. Capsules for the Future: Wild Plants and Ancestral Crops', botanical researchers from the ULE are evaluating different areas within the territory of the RBVOyL to assess their potential for establishing future genetic reserves. A genetic reserve is defined as an area with minimal management requirements that guarantees the active conservation of certain species in the long term.

In this sense, the guidelines established in the National Strategy for the Conservation and Use of Crop Wild Relatives (CWR) and Wild Harvested Plants (WHP) are followed, and the botanical species included in this strategy are proposed for conservation within genetic reserves. The aim is to preserve a genetic pool to enhance the biodiversity of agricultural crops and protect the phytogenetic resources of the country.

As part of the SOMOS AGUA II project, the goal is to inventory and evaluate 40 plots as potential areas for establishing genetic reserves within the RBVOyL.

In this work, preliminary results of Action 'Capsules for the Future: Wild Plants and Ancestral Crops' are presented, highlighting the progress made in evaluating potential areas for the establishment of genetic reserves in the Omaña and Luna Biosphere Reserve.

Keywords: Genetic reserves, Crop Wild Relatives, Wild Harvested Plants, conservation, biodiversity

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LIFE TEIXERES: Monitoring seed dispersal and wildlife interactions using camera trapping in *Taxus baccata forests of eastern Spain*

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The project LIFE TEIXERES aims to improve the conservation status and resilience of the priority Natura 2000 habitat Mediterranean *Taxus baccata* forests in the Valencian Community in Spain. *Taxus baccata* has been classified as a priority conservation habitat in Europe (Habitat 9580* in Directive 97/62/EC). Hence, different restoration management and monitoring techniques are being carried out in 55 locations across 10 Natura 2000 sites throughout the Valencian region, with the northernmost and southernmost work sites separated by around 400 kilometer.

One of the key ecological processes in the distribution of yews and their abundance is the dispersal of their seeds, which requires wildlife interactions. For this reason, LIFE Teixeres has designed a wide wildlife monitoring plan, including installing 10 cameras in potential seed dispersion hotspots, distributed across the Valencian territory –5 in Castelló, 2 in València and 3 in Alacant for one year–. The exact locations of the cameras have been determined by identifying the specimens showing the highest seed production.

The data collection and analysis are divided into two main categories. Firstly, seed spreading. So far, considering potential seed dispersion, several birds of the genre *Turdus* have been filmed, such as *Turdus Philomelos, Turdus Torquatus, Turdus Merula and Turdus Viscivorus,* among others. Also, some mammals have been caught on camera spreading seeds, like *Sciurus Vulgaris* and *Apodemus Sylvaticus.*

Secondly, herbivory and animal interactions are monitored to study the potential damage to yews. *Capra Pyrenaica* and *Capreolus Capreolus* were filmed eating and using the yews for territorial behaviour.

These interactions with yews will continue to be filmed for a whole year, so we can get information on variations during the different seasons.

Keywords: LIFE Programme, Taxus baccata, camera trapping, wildlife monitoring, conservation actions

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Biogeographic assessment of the Mediterranean *Jubaea chilensis* palm groves of La Campana National Park (Chile)

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The Chilean palm (*Jubaea chilensis*) is a vulnerable, endemic, and relict species, living in Mediterranean-climate areas. In recent years, it has experienced a significant decline in both its distribution area and population numbers in Chile. Through the International Research Network for the Study of Mediterranean Biodiversity Micro-Reserves Project, a biogeographical assessment was conducted using the LANBIOEVA (Landscape Biogeographical Evaluation) methodology in various palm groves within its distribution range. The main objective of the present study is to evaluate another population of *Jubaea chilensis*, this time within a protected area—La Campana National Park.

A systematic and randomized inventory was conducted using 10 plots, where taxa within the palm grove were listed, and their coverage across different strata was assessed. Based on these inventories, various criteria of phytocoenotic, territorial, ecological, structural, heritage, and cultural significance were considered, leading to the calculation of a conservation index. The resulting values were then multiplied by the global threat coefficient, yielding a final value that determines the conservation priority.

The results indicate high levels of phytocoenotic values, though these are somewhat diminished by the naturalness criterion. Territorial values are exceptionally high due to the abundance of endemic species, as are ecological and structural values. The conservation interest for this population is therefore very high. However, since the palm grove is located within a protected area, the level of threats is relatively low compared to other palm groves in non-protected areas. Consequently, the conservation priority is not as critical as in those unprotected patches.

Keywords: Biogeography, palms, inventories, endemics, threats

Acknowledgment: This study was supported by the Chilean FOVI 230119 project, to which we express our sincere gratitude.

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Micro-reserves as key strategies for biodiversity conservation in fragmented Mediterranean landscapes

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Biodiversity faces increasing threats due to landscape fragmentation and the loss of ecological connectivity, heightening the risk of extinction and genetic deterioration. As a strategy to address these challenges, small natural areas strategically located, known as micro-reserves, have emerged as key solutions for conservation in the context of climate change. This study focuses on identifying global criteria to define micro-reserves in the Mediterranean ecoregion of Chile, especially as this concept is incorporated into the new national biodiversity law.

The research methodology is based on a systematic review of 190 scientific articles from Web of Science, Scopus, Google Scholar, and PubMed. Exclusion criteria were applied to filter out studies focusing on larger protected areas or those not aligned with the keywords. The PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) were followed to ensure standardized and transparent presentation of results, and GraphPad Prism was used to create high-quality graphs and figures for data visualization.

The findings highlight key criteria for defining micro-reserves: they provide refuge for species vulnerable to climate change, enhance landscape connectivity and genetic dispersal in fragmented environments, protect endemic species and marine habitats, and conserve biodiversity in highly specialized areas that lack formal protection or representation. Additionally, their proximity to local communities positions them as socio-ecological hubs, promoting sustainable management and participatory conservation practices, especially involving children and adolescents.

Global research predominantly focuses on Mediterranean biomes, where micro-reserve areas generally do not exceed 20 hectares, though in other biomes, these areas may surpass 1,000 hectares. Micro-reserves are thus ecological refuges that preserve genetic diversity and evolutionary processes in fragmented Mediterranean habitats, ensuring ecosystem resilience and the *in situ* conservation of endemic species.

This study presents partial findings from a collaborative network of researchers from Chile, Spain, and Costa Rica, supported by the Chilean FOVI 230119 project.

Keywords: micro-reserves, climate change, micro-refuges, small protected areas, Mediterranean ecoregion.

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Communication and environmental education strategy of the Centre for Forestry Research and Experimentation (Valencian Community, Spain)

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The Centre for Forestry Research and Experimentation (CIEF) is a public centre, created by the Generalitat Valenciana by Decree in 2005. It is a unique centre in Spain due to its characteristics and size that integrates in the same facility a seed bank of forest species and a threatened flora germplasm bank, as well as nursery plant production for forestry and conservation purposes, among other areas. Likewise, the CIEF plays a pivotal role in the Valencian regional strategy of conservation, reforestation and ecosystem restoration, as it offers a solid infrastructure to guarantee the supply of plants in enough quantity, quality and diversity, to ensure the success for these goals.

The CIEF's communication strategy focuses on a couple of big purposes, on a hand, making its work known to public so that its fundamental role in the conservation and protection of Valencian biodiversity is understood. And, on the other hand, contributing through communication to raising awareness and dissemination in the field of nature conservation. To obtain this goal, a Communication Plan has been drawn up, concisely addressing its most relevant issues, from the communication objectives, the main messages, audiences and even the communication channels used to reach them.

In the mid-term, different actions aimed at achieving these two global objectives have been carried out. In this communication, some examples of actions in the field of public awareness and participation (visits and workshops at the CIEF for training centres; permanent and transportable exhibition space; thematic calendar of monumental trees, visits LIFE project) and in the corporate sphere (renewal of all the centre's graphic supports and signage, preparation and printing of information leaflets, and content strategy on social networks, press releases to the media, among others) will be addressed in detail and with results.

Keywords: Social involvement, Environmental education, Corporate communication, Forestry, Plant conservation

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Towards sustainable landscaping in Mediterranean climates: a study of adaptations of two *Mesembryanthemum* spp to water stress conditions

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In the context of climate change and increasing urbanisation, the decline of urban green spaces and vegetation cover presents significant challenges for mitigating environmental crises. Developing and preserving green areas is essential, yet high maintenance costs, particularly in arid regions such as the Mediterranean, limit such initiatives. Xeriscaping with species capable of tolerating water stress and possessing aesthetic value offers a promising solution. This study examines two species of the *Mesembryanthemum* genus (*M. crystallinum* L. and *M. nodiflorum* L.), which are adapted to water and saline stress conditions. The objective is to evaluate their germination responses, growth performance, and biochemical parameters under water scarcity, with emphasis on their ornamental potential and resilience to adverse conditions.

Water stress in the germination phase was simulated using PEG 6000 to create osmotic potentials between -0.10 and -1 MPa. Germination percentage, mean germination time, base water potential and hydrotime (Ψb, and ΘH) were calculated. Additionally, three different watering treatments were applied in juvenile plants, and growth data were recorded. Photosynthetic pigments, osmolytes and antioxidants were also analysed.

Both species exhibited a germination threshold at -0.4 MPa, with germination rates not exceeding 50% beyond this point. However, they displayed a reduced hydrotime, indicating adaptation to rapid germination when water is present for a short time, such as after rainfall. In terms of growth, both species demonstrated notable resilience to water stress, with *M. crystallinum* showing superior physiological and morphological stability under severe drought. Typical halophytic responses to water stress, including increased proline accumulation and reduced water content, were observed. Furthermore, in the light of biochemical analyses, both species appear to possess efficient mechanisms for scavenging reactive oxygen species (ROS).

The findings suggest that *M. crystallinum* and *M. nodiflorum* are highly suitable for xeriscaping due to their resilience to water stress in the different stages studied, and low maintenance requirements, making them ideal candidates for sustainable landscaping in arid Mediterranean regions.

Keywords: xeriscaping, germinative response, growth response, water stress tolerance, climate change

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Heard it Through the Grapevine: A Phytolith Study of Roman and Modern Vineyards to Identify the Hidden Diversity of Plant Assemblages

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Vineyards represent an ancient and widespread anthropogenic landscape in the Mediterranean. Depending on how these landscapes are managed, there is allowance for diverse spontaneous plant assemblages to propagate among the vines. However, these sites are often problematic to study using conventional archaeobotanical methods like palynology, as they do not provide ideal conditions for pollen preservation. Nonetheless, other proxies such as phytoliths, can be utilised.

This study seeks to apply phytolith analysis to elucidate past plant diversity in Roman vineyards and compare it to present plant diversity in analogous habitats, to understand how these managed agricultural settings may have acted as a reserve for segetal species among the vines. This was done by the comparison of phytoliths extracted from eight vine trenches at two known Roman sites in the Maltese Islands, with those from active vineyard sites. The extracted phytolith assemblage from the Roman trenches included forms which were consistent with *Vitis vinifera*, and others which indicated an assemblage of grasses and other flowering plants growing between the vine ranks. This is very similar to what is found in active vineyards, where grass phytoliths dominate, and other forms derive from segetal plants.

This study suggests that ancient vineyard sites may serve as valuable repositories of data, providing insights in the absence of anecdotal floral documentation. Additionally, this study represents a positive step forward for archaeobotanical studies in calcareous island settings, as it is the first successful attempt at phytolith extraction from the Maltese Islands. Further work needs to be done to discriminate the plant sources of the forms documented, particularly to identify which native species may have been conserved among the vines.

Keywords: Phytolith analysis, Archaeobotany, Roman vineyards, Plant assemblages, Calcareous island settings

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Review of Flora of Syria: FSOL as a tools

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Studies of Syria's flora date back to the 17th century, recognizing its significance within the broader Levant region. Today, the Flora Syria Online (FSOL) platform consolidates data from foundational works by George Post (1889) and Paul Mouterde (1966-1984), alongside modern databases such as Kew, GBIF, and EuroplusMed. FSOL provides an updated checklist of the country's flora, cataloging 3,372 species, belong to 1,024 genera and 150 families which includes 856 newly accepted names and 134 species newly recorded for Syria.

The flora of Syria includes about 130 species of trees, shrubs, and subshrubs; 123 biennials; 1,450 annuals; 510 geophytes (149 bulbs, 360 rhizomes, and tuberous); 850 perennial herbs; and around 300 species of various other forms. Despite this biodiversity, the flora is under significant threat from habitat destruction, human activity, and ongoing conflict. FSOL serves as a critical resource for tackling these challenges, laying the groundwork for research, conservation, and policy development.

Key words: flora Syria, web portal, Mediterranean flora, habitats, protected areas

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Flora of Maghreb, efloramaghreb.org - A WEBSITE TO SHARE INFORMATION

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Despite ongoing efforts, a lack of knowledge about the Maghreb's flora still persit, especially regarding species distribution. Moreover, many existing identification tools are becoming obsolete, limiting their effectiveness in plant conservation.

The Flora of the Maghreb project is aimed at providing a platform to share information about species distribution and to offer accessible up-to-date identification tools. Our pursuit is to join forces in order to obtain an overview of the biodiversity and to propose conservation measures accordingly. Additionally, fostering knowledge exchange and mentoring young scientists are key components to this initiative. Tools such as iNaturalist are excellent, but they are not useful for data analysis and do not include historical information. Similarly, tools like GBIF are very useful but remain aggregators that need to be used very carefully.

The publication of a Synonymic Index of the Flora of North Africa (Dobignard & Chatelain) marked an essential first step, that let us compare and merge the botanical information regarding the southern Mediterranean Basin. The most important work remains to be done and documented; this is the critical next phase of our project.

The flora of the Maghreb is remarkably rich, encompassing ca. 6891 taxa. This number could be significantly augmented by adding infraspecific taxa (c. 1890) described between 1920s and 1960s. However, their status requires careful evaluation, as some may correspond to accepted taxa. Continued study of the Flora of the Maghreb is essential to achieving a solid understanding of its plant diversity.

Currently, efloramaghreb.org provides distribution data from both historical herbarium collections (Geneva, Barcelona, Algiers, Rabat, Paris, Montpellier) and recent fieldwork, encompassing over 100,000 records. While much work remains, the available data already allows us to identify remote areas for exploration and species known only from single collections. Defining research priorities and key areas of interest is now mandatory.

Our ultimate goal is to map species distributions comprehensively, uncover their ecological contexts, and support the community with open access to herbarium specimens, photographs, descriptions, maps, identification keys, and nomenclature. This collaborative effort will be pivotal in conserving the rich biodiversity of the Maghreb.

Keywords: Vascular flora, distribution, Maghreb, knowledge sharing, conservation

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Halophytes and xerophytes: 'adaptations' or 'responses' to proximal stress?

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'Halophytes' and 'xerophytes' may represent a continuum of morphological, anatomical, and physiological variability, where certain traits are the outcome of long-term evolutionary processes, while others are context-dependent responses expressed under conditions of abiotic stress. This study aims to test that hypothesis by focusing on the morphological and anatomical traits of 12 species, equally distributed to be either classified as halophytes, xerophytes, or as 'relatively generalist' to act as a control group. By comparing plants of the same species along 10 different sites in Malta (Central Mediterranean) this will be targeted. While adaptive traits would tend to show less variability independently of the habitat, the site-specific responses to environmental stress should form a wide range of adaptations. A number of traits considered adaptive for halophytes and xerophytes were identified from the literature. The adaptive traits included stomatal dimensions and density, trichome length and presence or absence of salt glands. Other traits not considered specific to these strategies were also identified as a control. These included leaf chlorophyll content, epidermal thickness, and leaf area index.

The ten individuals from each species were collected from a range of sites in Malta, both coastal and inland, and the interspecific and intraspecific variation in the adaptive traits and control traits was determined. The variability in the standardised traits was evaluated using ANOVA and multivariate statistics.

Preliminary results suggest that the intraspecific variability in the size of stomata is higher in 'xerophytes' and 'halophytes' relative to 'generalists', suggesting that this trait may be subject to proximal environmental influence in the 'specialised' plants. Work on variability in other traits is ongoing. The implication is that morphological variation in selected traits, when combined with other data, such as local vegetation composition, can indicate the level of environmental stress that an individual plant is subject to.

Keywords: Halophytes, Xerophytes, Morphological variation, Adaptive traits, Environmental stress

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The first inventory of Sardinian mining vascular flora

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Mining activities and associated waste materials pose significant environmental challenges, including soils, waters, and air contamination, along with serious health risks to nearby populations.

Despite the adverse conditions of metal-enriched soils and nutrient-deficient substrates, different vascular plants, termed metallophytes, exhibit remarkable adaptability to these unfavourable conditions and thrive in these environments.

This study investigates the vascular flora of Sardinia's abandoned mining sites, which was one of the most important European mining centres until after the Second World War, focusing on the identification of metallophytes (obliged and facultative) and their potential applications in phytoremediation. A comprehensive floristic inventory was assembled through a combination of literature review, field surveys, and herbarium specimen analyses.

The results show that of the 655 *taxa* identified, 49% were metallophytes, with the majority categorized as facultative. Notably, 27% of metallophytes were identified as suitable for phytostabilization, while 20% showed potential for phytoextraction. The study also highlighted the presence of endemic and endangered species, emphasizing the need for conservation efforts. The findings suggest that native metallophytes can play a key role in the ecological restoration of mining sites, avoiding the use of invasive species in order to prevent the ecological disruption.

This research provides valuable insights into the biodiversity of Sardinian mining sites and the potential for sustainable remediation strategies using native plants. The integration of phytoremediation activities with biodiversity conservation offers a promising pathway for the restoration of degraded ecosystems while preserving endemic plant diversity.

Keywords: Environmental pollution, Environmental restoration, Mediterranean flora, Metallophytes, Phytoextraction, Phytoremediation, Phytostabilization.

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Evaluating the socio-economic and ecological impacts of conservation and awareness-raising activities at the Troodos National Forest Park, Cyprus

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The Troodos National Forest Park (TNFP) is a 93 km^2 protected natural area located in the heart of the Troodos Mountain range in Cyprus. It was established as a National Forest Park in 1992, and as one of the most important forest ecosystems much of it has been part of the Natura 2000 network since 2004. The park is renowned for its biodiversity, particularly for hosting the highest concentration of indigenous and endemic plant species in Cyprus. This includes over 740 plant *taxa*, which accounts for 45% of the island's total flora, with 72 species endemic to Cyprus (out of which 46 are local endemics), including 21 IUCN-listed threatened species, indicating its importance in Mediterranean biodiversity conservation. This research assesses the socio-economic impacts of conservation and awareness-raising projects of iLiFE-TROODOS project on local communities' economic conditions, as well as the perceptions and public willingness to pay for the conservation of TNFP.

The methodology employed combines quantitative and qualitative data through structured telephone surveys, comprehensive in-depth interviews, and targeted online surveys, capturing a broad spectrum of responses regarding environmental awareness and engagement. The telephone survey sampled 480 residents from communities within and around TNFP, focusing on changes in awareness and attitudes towards the Natura 2000 network over a three-year period, i.e., initial (before the awareness raising campaign), mid-term, and final phase (after the end of awareness raising campaign). In-depth interviews were conducted with stakeholders, including local business owners and government officials, to gather qualitative insights into the socio-economic impacts. The online surveys, which reached between 929 and 3,245 respondents per post, evaluated the public's recognition of ecosystem services provided by TNFP and gauged the effectiveness of the iLiFE-TROODOS project's promotional activities.

Results from this multi-faceted approach indicate significant positive shifts in local and visitor attitudes towards conservation (for the TNFP), with reported increases in visitation motivated by recreation and education about the area's natural values. Economic impacts were also found to be substantial. In particular, conservation efforts, sustainable land use practices and eco-tourism have enhanced income for local communities, and generated combined revenues exceeding €1×10^6/year, while the management cost of TFNP is in the range of €2.2×10^6/year. The park's ecosystem services, such as carbon sequestration (estimated at 1,188 kt CO_2 eq./year), were also highly valued. The willingness to pay for continued conservation was evident among a substantial segment of the population, indicating strong public support for such initiatives.

Overall, the socio-economic impact assessment underlines the positive implications of conservation and awareness-raising efforts not only on biodiversity but also on enhancing the socio-economic fabric of surrounding communities. The results can facilitate ongoing and future policies and targeted action plans to maintain this momentum. This can be achieved with continued investment in biodiversity conservation, supported by robust public awareness and engagement strategies, to sustain the ecological and economic benefits derived from such unique Mediterranean forest ecosystems.

Keywords: Natura 2000, biodiversity conservation, stakeholder engagement, socio-economic impact, willingness to pay

Acknowledgements: This study was conducted as part of the iLiFE-TROODOS project (LIFE16 GIE/CY/000709), co-funded by the European Union through the LIFE programme.

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Challenges in Conserving a Long-Lived Relict Species in a Rapidly Changing Environment: The Case of *Taxus baccata* in Eastern Spain.

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Mediterranean yew forests in the eastern Iberian Peninsula are relict plant communities with highly reduced and fragmented spatial presence, making them extremely vulnerable to disturbances. The main species of this habitat, the yew tree (*Taxus baccata*), faces particularly complex conservation challenges due to several factors, including the very small number of reproductive individuals within populations and their severe fragmentation over many years. Consequently, the rapid climate changes driven by global warming pose a highly uncertain outlook for their survival, raising important questions about their management and conservation strategies.

In the coastal mountain ranges of the Valencian region, two distinct scenarios can be observed. In the north, the populations of the Eastern Iberian System are more extensive and continuous, allowing for more active genetic flow among them. In contrast, the southern populations have remained spatially isolated for seemingly long enough periods to develop specialized genetic traits adapted to their environment. However, the small number of reproductive individuals in these isolated and genetically less diverse populations also results in weaker seedlings produced in nurseries compared to those from less isolated populations with greater intrapopulation genetic diversity.

This situation presents a conservation dilemma: on the one hand, it is essential to preserve the genetic uniqueness of populations that have remained isolated for millennia and have developed adaptive traits to local conditions. On the other hand, the high degree of inbreeding within these populations, due to the extremely small number of reproductive individuals, must be addressed. In this context, the fact that yew is a dioecious and long-lived species further increases the risk of genetic uniformity.

This communication presents the yew conservation strategy implemented in the LIFE Teixeres project (LIFE20NATES001128). The strategy primarily involves creating quasi-in-situ controlled populations from as many reproductive individuals as possible from isolated populations. These individuals are propagated vegetatively to reach reproductive age more quickly, thus establishing seed-producing nuclei with greater vigour than the isolated mother plants in natural populations. This approach seeks to mitigate the urgency of the climate emergency.

Keywords: Taxus baccata, conservation, inbreeding, seed dispersal, adaptative traits, climate change

Acknowledgements: María Mayol, Arantxa Prada and Lluis Serra for taking part as external experts for the developing of the conservation strategy.

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Global monitoring of Plantaginion crassifoliae vegetation (mediterranean salt Meadows) in France: protocol elaboration and implementation

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The network for the conservation of Mediterranean flora (RESEDA-Flore) brings together 22 organizations working in the south of France and Corsica with common objectives. Working at a habitat scale and more precisely conserving typically mediterranean habitats was identified as a priority. In that sense, a conservation strategy targeting phytosociological alliances was published in 2023, allowing to prioritize vegetations for future conservation actions. This prioritization study highlighted salt meadows as vegetation types of high conservation value, due to their vulnerability to global change and various disturbances.

This presentation will describe the monitoring protocol (and first results) on the *Plantaginion crassifoliae* alliance, included in the habitat of Community interest 1410, mainly found between dunes and lagoons. In the South of France, this alliance typically includes species like *Plantago crassifolia, Schoenus nigricans, Artemisia caerulescens, Lotus jordanii, Limbarda crithmoides, Limonium virgatum, Ditrichia viscosa, Scirpoides holoschoenus* (with variations between Mainland and Corsica). The protocol is designed to be cost-effective, implemented on the long term, and with a collaborative perspective in the network.

The monitoring protocol was divided in three parts (site inventory, regional site surveys and site monitoring): the first objective is to carry out a “site inventory” in order to identify whether the alliance has disappeared from part of the territory since it was first documented. To do so, all known sites were visited to carry out botanical surveys. Field work across mainland and Corsica allowed to produce a 10x10 km grid-scale map documenting presence/absence of *Pantaginion crassifoliae* on the study territory. The alliance was still present in at least twenty-three grid cells across territory. In six grid cells, *Plantaginion crassifoliae* seems to be no longer present. In most cases, urbanization seems to be the main cause. Field work is still currently ongoing. Results will be presented, supported by maps and local site details (observed species, potential local threats).

The second objective is to monitor the general trends in the alliance’s distribution over the long term across a “regional site survey”. In order to do so, a range of cells will be visited every ten years to evaluate whether the alliance is still present. Finally, the third objective is to monitor changes in the floristic composition and structure of the alliance across “site monitoring”. Field visits and botanical surveys will be carried out every year, so as to analyze variations. Correlations with disturbance indicators or changes in local environmental conditions will be researched.

Key words: *Plantaginion crassifoliae*, salt meadows, monitoring, RESEDA-Flore, global change

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Exploring the role of botanical gardens in promoting plant awareness: insights from Marimurtra Botanical Garden.

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Botanical gardens are uniquely positioned to address the global challenge of plant awareness disparity by fostering deeper connections between people and the plant world. At Marimurtra Botanical Garden, with almost 200,000 visitors annually, a systematic methodology has been implemented to maximize educational impact across diverse audience segments.

This approach integrates several key elements: (1) audience segmentation, categorizing visitors into distinct groups to tailor educational content and experiences; (2) content and activity adaptation, designing hands-on, experiential learning opportunities suited to each group; (3) diverse knowledge levels, crafting programs that accommodate varying degrees of knowledge and skills; (4) specialized team, engaging experts in biology, botany, and natural sciences to ensure activities meet the needs of each audience; and (5) ongoing evaluation, collecting feedback and conducting assessments to refine and improve educational activities.

Through these strategies, Marimurtra offers a range of activities tailored to different audiences, including schools, universities, vocational training groups, environmental technicians, and families. Formats such as guided tours, interactive workshops, and thematic routes aim to enhance plant knowledge and bridge the plant awareness gap.
Preliminary data show increased engagement, particularly among younger visitors, with interactive and experiential formats proving effective in fostering a deeper connection with plant biodiversity and conservation. Long-term initiatives, such as school projects and collaborations with other botanical gardens, further strengthen Marimurtra's role as a hub for botanical education.

This work highlights the pivotal role botanical gardens play in inspiring visitors to appreciate and protect the natural world. By combining traditional knowledge with innovative methodologies, Marimurtra continues to expand its reach and impact in promoting plant awareness.

Keywords: plant awareness, education, botanical garden, biodiversity, conservation.

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Flora of archaeological sites in Malta

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The Maltese archipelago harbours numerous archaeological sites dating from between the Neolithic to Late Medieval periods. Whilst the perceived societal value of these sites is predominantly archaeological, they also support a rich vascular flora. The protection afforded to these sites promotes a relatively stable habitat with few and infrequent large-amplitude disturbances, facilitating the development of climax phytocoenoses in these areas. Although several surveys of these sites have been conducted, few have been published, and none of them integrate the flora of archaeological sites with the prevailing environmental conditions. We therefore aimed to fill this knowledge gap by collating the available data about the flora of archaeological sites and relating this to the abiotic context.

Field surveys were conducted across nine archaeological sites in Malta during the period November 2024 to January 2025, with the intention being to extend up to March 2025. A number of 24 m2 relevés were taken in each site, and the presence, life-form, and Braun-Blanquet abundance of vascular plants recorded. Similar surveys were conducted in adjoining areas to serve as a 'control'. Abiotic conditions (rock type, soil type, soil depth, land uses, type of archaeological site) were also recorded.

The results collected so far indicate the presence of approximately 400 unique species (almost half the indigenous flora) across all sites with species richness of 130 to 250 species in each site. From these species, 16 are narrow endemics, 57 are national Red List species and 8 are listed in the EU Habitats Directive. Although the species richness of archaeological and control sites was not significantly different, the archaeological sites comprised higher proportions of chamaephytes and nano-phanerophytes whilst the control sites supported more therophytes and hemicryptophytes.

These areas create microhabitats that insulate species from urbanisation and agricultural activities elsewhere on the islands. However, these phytocoenoses still experience pressure from increased visitor flow, site maintenance practices lacking ecological considerations, and encroaching development. The study underscores the necessity for integrated conservation strategies that recognise the dual importance of archaeological sites as cultural and ecological assets. By highlighting the botanical significance of these sites, the research aims to inform policymakers, conservationists, and the public about the critical need to safeguard Malta's combined cultural and natural heritage.

Keywords: Archaeological sites, Vascular flora, Species richness, Plant conservation, Cultural heritage

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Agrobiodiversity Conservation: Genomic Insights into Sardinian Common Bean Landraces

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In Sardinia, numerous local varieties (landraces) of common bean are still cultivated by farmers, primarily in the Island's internal areas, effectively contributing to the *in-situ* conservation of these valuable genetic resources. Since the early 2000s, we have undertaken research activities to collect, conserve ex-situ, and study these materials to assess their genomic diversity, structure, and potential origins. To achieve this, we analyzed 159 accessions - mainly landraces - collected in Sardinia and compared them with a broader common bean collection of 216 accessions from the Americas and Europe. A genome-wide association study (GWAS) was also conducted to explore various phenotypic traits, including flowering time, growth habit, flower color, pod size, and seed size and color. Our results revealed a heterogeneous genetic structure among the Sardinian materials, predominantly associated with the A3/Chile race. Additionally, Sardinian landraces showed higher genetic similarity to landraces from Italy, the Iberian Peninsula, and the Balkans, consistent with Sardinia's position at the center of the Mediterranean Basin.

We also identified genomic regions associated with key adaptation and quality traits, reflecting the tendency of landraces to adapt to the agro-ecosystems in which they evolved through both anthropic and natural selection. These findings highlight the valuable role of the Sardinian genetic resources in future breeding programs, while also underlining how genomic research can promote the utilization and valorization of these materials and support both *in-situ* and *ex-situ* conservation efforts.

Keywords: agrobiodiversity, common bean, genomic diversity, GWAS, *in-situ and ex-situ* conservation.

Acknowledgements: This study was funded by: i) Ministry of University and Research under the PRIN 2017 call; ii) European Union within the Regional Operational Programme 2014-2020 and European Social Funds, Priority Axis 3 "Education and Training" – Thematic objective 10 – Investment priorities 10ii – Specific objective 10.5.12; iii) Fondazione Banco di Sardegna (Progetti di ricerca di base dipartimentali - 2018-2020 e 2021); Regione Autonoma della Sardegna within the "Programma di Sviluppo Rurale 2007–2013" – Misura 214, azione 214/4 – "RISGENSAR project".

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Plant and soil indicators for relating land management to plant conservation

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In the Mediterranean area, the use of land for agriculture and pastoralism dates to the Neolithic and the land surface devoted to these activities represents roughly 40% of the total available area. In central Italy, similarly to other zones, common feature of the present landscapes is a high environmental fragmentation, with a mosaic of unmanaged semi-natural areas encircled by agricultural land and highly anthropized areas. The contiguity of natural and disturbed areas creates a huge amount of edge effects, which poses great challenges for plant conservation. In this framework, policy decisions on agroecosystems considering the issues of plant and biodiversity conservation are required, and an assessment of habitat overall quality is essential. Soil seed banks play an important part in defining healthy ecosystems, containing seeds dropped from standing vegetation, so as those survived from past vegetation, or dispersed from surrounding habitats by wind, animals, and human activities. In fragmented landscapes the composition of soil seed banks may significantly differ from that of the standing vegetation, thus reducing ecosystem resilience. On the other hand, storing seeds for more than a decade, seed banks allow us to study the history of the soil, providing relevant information on the soil's health over the years. Soil properties can be analysed through expensive physical and chemical analyses, whereas seed bank analyses require good botanical competence but are cheaper.

Our study, within the SHARInG-MeD project, aims to create a tool for farmers to assess soil health using seed bank composition indicators, and to set standards of certification for policy makers. In the present experiment we estimated the potential flora present in the viable seed bank of soils collected from different land uses within a highly fragmented agroecosystem.

Differences in the abundance and functional composition of species among the seed bank communities were investigated by means of the seedling emergence method and related to land management and disturbance. The analyses focused also on identifying species or functional traits that could be used as a proxy for assessing soil health, specifically regarding nitrogen quantity and other chemical physical parameters.

Soil samples up to 20 cm in depth were collected in summer 2024 in three contiguous land uses from central Italy: farmland under conventional management, abandoned land previously used for agriculture, and an un-managed semi-natural forest. Soil samples from nearby evergreen and deciduous forests were also included for comparison. For each land use we sampled soil in 16 different points which were merged in four replicates. After being stored in a refrigerated room for three months to enhance seed germination, the soils were sieved with a 4 mm mesh and then spread in a thin layer (2 cm max) into germination trays filled with expanded clay up to a half. Seed trays, four replicates for each land use, were placed in a greenhouse and regularly irrigated. The number of emerged seedlings was determined at week intervals, and after eight weeks, the abundance of the seed bank expressed as the number of seedlings emerged per unit soil surface and the composition in species and functional groups, were determined. Open agricultural fields in general allow seed to travel easier than dense woods, thus abundance of seeds and the biodiversity of species could be higher in the agricultural or uncultivated land uses, despite lack of rare species and high proportion of invasive weeds. In forest or rewilded areas, habitat specialist species could be more present. However, due to fragmentation seeds of ruderal species may accumulate in these soils.

Keywords: Agroecosystem, seed bank, functional traits, land use, biodiversity indicators

Acknowledgements: This work was supported by the SHARInG-MeD project (GA n 2211, PRIMA).

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Evaluating conservation efforts in coastal dune habitats: a plot resurvey in La Maddalena National Park (Italy)

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Coastal dunes are valuable ecosystems that support a high level of biodiversity and offer essential provisioning, regulatory, cultural, and supporting services. However, they have experienced severe degradation in recent decades, primarily due to human-induced changes and the rapid expansion of tourism and associated activities. This degradation has led to significant alterations in habitat structure and composition, with typical psammophilous species being replaced by opportunistic ones that fail to fulfil the same ecological functions.

Long-term surveys of permanent plots tracking changes in vegetation composition are valuable tools for evaluating the effects of conservation efforts and adjusting strategies as necessary.
The objective of this study was to monitor vegetation dynamics in the coastal dune system of La Maddalena National Park (Sardinia, Italy) through historical plot resurveys, assessing temporal shifts to evaluate the success of conservation measures. In 2023 (T1), we revisited six coastal dune sites, resurveying 238 plots distributed across 40 georeferenced transects, covering the entire coastal dune system. The survey replicated the methods used in 2011 (T0).

As a proxy for conservation status, we focused on the dynamics of characteristic dune species versus ruderal species and examined shifts in habitat types (defined according to the 92/43/EEC Habitats Directive) through an alluvial diagram. Additionally, we analyzed potential plant community composition and structure changes using dissimilarity indices based on presence/absence and abundance data.

In T1, we identified 43 species, marking a 30% loss in species richness compared to T0. While the characteristic species per site generally increased in T1, their coverage decreased. The Jaccard index indicated medium-high dissimilarity at all sites due to empty plots and high turnover. We observed negative shifts in almost all habitats, particularly in habitat 2110-Embryonic shifting dunes, which disappeared in 36% of the plots. The resurvey revealed a generally negative trend for all proxies considered, except for habitat 2120-Shifting dunes along the shoreline with *Ammophila arenaria*, which is currently expanding.

These findings suggest that the conservation efforts are insufficient to guarantee the long-term preservation of these coastal dune systems, and new strategies are necessary, mainly focusing on the most vulnerable habitats locally.

Keywords: dissimilarity indices, Habitats Directive, Mediterranean habitats, permanent plots

Acknowledgements: The authors acknowledge the support of NBFC to University of Sassari, funded by the Italian Ministry of University and Research, PNRR, Missione 4, Componente 2, “Dalla ricerca all’impresa”, Investimento 1.4 Project CN00000033.

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Inter-Population Diversity in the Endangered Plant Species *Primula palinuri Petagna*: Insights from the Population Structure

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Studies in population genetics offer insights into the genetic diversity and structure of populations, which are crucial for shaping conservation strategies. As part of the LIFE SEEDFORCE project (LIFE20 NAT/IT/001468), we examined the genetic diversity of *Primula palinuri* Petagna, an endemic species found in Southern Italy, to support planned conservation initiatives.

A total of 91 individuals of *Primula palinuri*, representing seven distinct populations, were analyzed using double-digest Restriction Associated DNA sequencing (ddRAD-seq) and 99,014 Single nucleotide polymorphisms (SNPs) were identified.

Low levels of heterozygosity (0.08-0.12) and high levels of kinship (0.20-0.30) and inbreeding (0.34-0.49) were detected in all study populations. Kinship computed irrespective of population was low, suggesting that the level of inter-population relatedness is low. Analysis of the genetic structure showed that the populations were differentiated from each other and formed three major clusters, broadly corresponding to the geographic sampling locations. We identified the SNPs mostly contributing to the separation in population clusters, and we identified a reduced set of 40 SNPs that can successfully discriminate between the three population clusters.

Despite an estimated total size of around 18,500 individuals, high inbreeding and geographical fragmentation limit gene flow between populations, which are divided into three main clusters, as evidenced by PCA analysis, dendrograms and Mantel's test (r=0.83, p=0.001).

Genetic differentiation is driven by geographical distance and potentially mediated by generalist pollinators (e.g. *Anthophora plumipes, Bombus terrestris, Macroglossum stellatarum*), which are however limited by habitat fragmentation. Forty diagnostic SNPs were identified that are useful for discriminating clusters, with possible future applications in conservation.

Although the main focus of this work was not to define a conservation strategy for *Primula palinuri*, detailed genetic characterization can inform future translocation plans. Our study's findings can aid in making informed decisions on these plans.

The low intra-population heterozygosity and high genetic differentiation observed suggest local adaptations, which require careful selection of source material for translocation. The high intra-population relatedness and low inter-population relatedness imply that mixing individuals from different populations could increase genetic diversity and reduce genetic impoverishment. However, significant genetic differentiation indicates that some populations may be well adapted to local conditions, increasing the risk of breeding depression, as seen in *Primula veris*. A balanced approach is essential to avoid introducing ecotypes that are poorly adapted to new environments. Our results highlight the urgency of conservation actions to increase genetic diversity in *Primula palinuri*, with proposed scenarios needing further investigation.

In conclusion, our study shows that the sampled *P. palinuri* populations have low heterozygosity, low intra- population variability, and high inter-population variability.

Keywords: Endemic species, *Primula palinuri*, population genetics, ddRAD, genotyping

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Invasive Alien Plant Species in a Mediterranean botanic garden: identification, characterization and management

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Botanical gardens, as collections of living plants that can contain a high taxonomic diversity from different regions of the world, can be easily hotspots of introduction of invasive alien plant species. It is a fact that in the surroundings of their facilities there is a proliferation of non-native flora. While the ex-situ cultivation of allochthonous species is fully justified for scientific and dissemination reasons, it is also true that botanic gardens must be responsible in the knowledge and management of those species that can be invasive, not only because of legal prerogatives, also as an example of good policy in the conservation of biodiversity and the natural environment.

The Marimurtra Botanical Garden was created about a hundred years ago. From the very beginning the main component of its plant collections have been allochthonous plant species, given that the objective for which it was created was to serve as a space for studying the flora of warm and arid regions of other continents, so European botanists don't have to travel long distances.

The taxonomic catalogue of Marimurtra is made up of more than 4,000 taxa (https://marimurtra.cat/taxons/), from this database have been identified taxa that due to the behaviour observed in the garden or through existing information in publications or other resources are classified as invasive or potentially invasive. For each one main groups of individuals have been located, both in the cultivation areas and populations that have been generated spontaneously. This has made possible to identify the species with a more aggressive behaviour, with a greater ability to disperse, those that are affecting the native vegetation. Among these are species well known as invasive: *Arundo donax* L., *Cenchrus clandestinus* (Hochst. ex Chiov.) Morrone, *Senecio angulatus* L.f., others that do not have this consideration, for example a group of species of the genus *Delosperma* N.E. Bro. with unclear taxonomy, but with worrying invasive behaviour. On the other hand, species classified as invasive in the garden do not show as this.

With all this information and from some first experimental control actions, a management plan for invasive plants in the botanical garden can be drawn up. This planning must not only serve to comply with the current regulations on the control of invasive species, but it must also provide information on their management that may be widely useful.

Keywords: Invasive Alien Plant Species, botanic garden, Mediterranean region, characterization, management planification

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Strategies for the Conservation of *Berberis hispanica* Valencian Community (Spain): An approach to increase genetic diversity and team collaboration

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The conservation of *Frangula alnus*, a riparian endangered species in Valencian Community, has achieved remarkable success through a collaborative approach involving associations, foundations, natural parks, municipalities, educational centers, and private companies. The isolation and small population size in Valencian Community increased its vulnerability and reduced viability, necessitating the management and the introduction of material from another region to enhance genetic variability. These efforts have led to the successful inclusion of this once endangered species in various restoration projects within the Júcar River basin, resulting in its reclassification as vulnerable from endangered.

Building on this success, we propose extending the conservation strategy to another threatened species, *Berberis hispanica*, which inhabits mountain ecosystems. Our proposal includes the production of 5,000 specimens for planting in at least 20 locations, supported by various collaborating entities. Due to low genetic variability, material from the Calares del Mundo and Sima Natural Park (Albacete, Castilla-La Mancha Community, Spain) has been used. The production phase has already begun, with over 99% seed germination success, with a total of 8,500 seeds germinated.

To ensure the success of these conservation efforts, we have employed "assisted migration", a technique that involves relocating species to more suitable environments. This approach allows threatened species to adapt and thrive under changing conditions, such as those induced by climate change, by moving populations from their natural habitats to new locations.

This strategy highlights the importance of inter-institutional cooperation in biodiversity conservation and ecosystem restoration, offering a replicable model for managing threatened plant species in diverse geographical contexts.

Keywords: *Frangula alnus*, *Berberis hispanica*, conservation translocations, genetic variability, assisted migration, endangered

Acknowledgements: Thanks to Service of Natural Parks of the Valencian Region, Environmental Agents GIA, and to all those people who have been involved in the conservation of the Valencian flora from an open and progressive perspective.

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Could a change in the ecological niche requirements account for the anomalous decline of *Crepis pusilla* (Sommier) Merxm.?

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Crepis pusilla (Asteraceae, Cichorieae) is "Critically Endangered" in the Maltese Islands and elsewhere in the Mediterranean. It is a small plant that occurs naturally on shallow and compacted calcareous Terra Rossa and clay soils, usually appressed to the substratum, rarely rising more than a few centimetres above the ground. Its habit is therefore very similar to plants of trodden paths such as *Plantago* species (*Plantago lagopus, P. serraria,* and *P. coronopus*) with which it usually coexists. In Malta, this species is restricted to less than 50 individuals in a single 60 m country path. Although the plant has never been abundant or widespread, its distribution in Malta a century ago was much broader, suggesting a restriction of its range. Our own unpublished research on its reproductive effort shows that the achenes of this species break dormancy easily and germinate readily. Furthermore, fertile plants produce large amounts of achenes in hard, capsule-like, glomeruli. This anomalous situation suggests that the reasons for the decline of this species are extraneous to its fecundity.

We hypothesise that this decline may be attributable to changes in modes of transportation and the reduction of trampling by husbanded animals over the past century. The plant lives in compacted soil that is also colonised by several opportunistic ruderal and segetal species. Because of its small size, it can be easily outcompeted by syntopic ruderals, reducing its fitness. Moderately trampled ground may suppress ruderals and reduce competition for light and other resources. If the ecological niche requirement for shallow compacted soil combined with absence or suppression of competing ruderal species is satisfied, then the species should once again thrive on marginal, moderately trampled, ground.

To test this hypothesis, we set up a field experiment on a section of the country path where *Crepis pusilla* is growing, to mimic trampling effects including suppression of ruderals and dispersion of achenes from glomeruli. The experimental was constructed as a systematic chequerboard design with alternating 'treatment' and 'control' segments. The results are still being processed. A significant increase in the number of plants growing on the treatment segments, would support our hypothesis.

Keywords: *Crepis pusilla*, Plant conservation, Malta, ecological niche

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Proposal of a new vulnerability index for the eradication of *Ailanthus altissima* (P. Miller) Swingle

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The spread of invasive alien plant species (IAPs) remains one of the biggest threats to plant conservation and habitat restoration efforts worldwide but especially so in the Mediterranean. One such invasive alien plant that has spread in the Mediterranean lands is *Ailanthus altissima* (Simaroubaceae). The dioecious species tends to spread through seed dispersal if both male and female trees are present but is far more invasive through clonal spread. Clones are usually unisexual, which may be an advantage for the environmental manager since this reduces further spread by sexually produced propagules.

The control of *Ailanthus altissima* stands is considered difficult and expensive with chances of recurrence being high where non-chemical control methods are applied. One approach that has been successfully applied in Malta has targeted a key vulnerability for the spread of this species. Close observation of clonal formations of *Ailanthus* show a linear arrangement of progressively younger shoots spreading away from the oldest specimens. It is indeed well known that the clonal spread is through subsurface transverse adventitious shoots that help to nourish new growth. A key vulnerability is that the new shoots that arise at intervals are poorly rooted in one plane only and as a result are vulnerable to quick and effortless removal by repeated swinging of the shoot over a 180° plane to the main line of spread. This action, not only uproots the individuals but torsions and damages the adventitious shoot, thereby helping to severe the main source of nutrients to younger clones. The technique has been successfully applied to a site in Malta and another eradication process related to a conservation project is currently underway. Species with root fragmentation and formation of adventitious shoots had previously been assigned into a low vulnerability category and given a vulnerability index of 3-4. This research has indicated that at least for this species, eradication can be assigned to a medium vulnerability category with an index value of 5-6. Further details of the techniques used in the eradication process and data with regards to the success of the eradication, will be presented.

Keywords: *Ailanthus altissima*, invasive alien species IAPs, eradication, adventitious shoots, vulnerability index

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Preliminary assessment of the threat category of *Muscari parviflorum* Desf. in Spain

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Muscari parviflorum Desf. (Asparagaceae) is a bulbous plant with a circum-Mediterranean distribution, included in the subgenus *Pseudomuscari* (Losinsk.) D.C.Stuart. One of its main characteristics is its autumn flowering, a unique phenomenon within the genus but present in other nearby genera, such as *Scilla*. This species is present in the countries of North Africa, the Near East and the northern shore of the Mediterranean basin, with the exception of France, where the populations of the Gulf of Liguria seem to be allochthonous. The Spanish populations seem to be more closely related to the Algerian ones from Oran than to those from the centre and East of the Mediterranean.

The two major Spanish population centres of this species correspond to the coast and inland area of the province of Málaga on the mainland, and to the plain north of the city of Palma de Mallorca, in the Balearic archipelago. No vectors or current or past processes have been identified that allow us to assume gene flow between these two groups, or with other populations nearby in their Mediterranean area of distribution.

Although the IUCN assigned in 2017 the lowest possible threat category (LC) to this species in its global assessment, the Spanish populations are in a highly threatened situation that makes it advisable to undertake its specific assessment in this territory, with the intention of generating a set of updated information for the protection and conservation of this species. In addition, this information would make it possible for the Spanish public administrations to include this species in the national and regional red lists and in the legislation on threatened species.

The preliminary assessment of the degree of threat in Spain was established based on data collected during field work carried out by the "Bulbous Research Group" of the Real Jardín Botánico, CSIC (Madrid) in collaboration with the Jardín Botánico El Castillejo (Andalucia) and the Jardí Botànic de Sóller (Mallorca). Some other information provided through the application GeoCat was taken into account after applying quality filters for the purpose of data refinement.

The preliminary results show that the two Spanish population centres in Mallorca and Málaga have most of their individuals in secondary habitats, with strong anthropization, a significant decline in the populations in Málaga in recent years, and with an inferred threat of disappearance between 75 and 90% of the individuals in the short to medium term. In both cases, this phenomenon of population decline can be mostly attributed to the occupation of the habitat for urban development purposes.

Keywords: *Muscari*, IUCN Assessment, threat category, bulbous Asparagaceae, West Mediterranean flora.

Acknowledgements: To all amateur botanists who continue to share their knowledge with professional botanists in order to work together for the conservation of the Mediterranean flora.

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Progress in assessing the conservation status of the Greek flora under Article 17 of the 92/43/EEC Habitats' Directive

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* Thirty-two Greek botanists contributed to field surveys and the evaluation of plant species during the 2019-2024 reporting period

The core strategy for nature conservation in the European Union (EU) is based on the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC). The Habitats Directive aims to protect 233 habitat types, and 1,389 fauna and flora species of EU importance. EU Member States are obliged to maintain or restore the favorable conservation status of habitats and species listed in the Annexes II, IV and V of the Directive. Every six years, Member States report on the conservation status and trends of these habitats and species to the European Commission, in accordance with Article 17 of the Habitats Directive, ensuring the effectiveness of conservation policies and progress toward the Directives' goals. Four Greek National Reports under Article 17 have been delivered to the European Commission so far, and the fifth National Report will be submitted within 2025.

As part of the fifth National Report of Greece, 64 plant taxa (species and subspecies) were monitored, including 62 vascular plants, one fern, and one bryophyte. *Aldrovanda vesiculosa* was a new entry for Greece, following its recent discovery in Prespa National Park. *Colchicum cousturieri* was proposed for removal from Annex IV, as it is now recognized as a heterotypic synonym of the widespread Mediterranean *Colchicum cupanii* subsp. *cupanii*. A total of 753 monitoring protocols were completed, covering the vast majority of all known populations of the studied species (with the exception of the widespread *Ruscus aculeatus*, for which only presence was confirmed). Seven taxa - *Botrychium simplex*, *Centaurea immanuelis-loewii*, *Consolida samia*, *Gladiolus palustris*, *Lindernia procumbens*, *Pontechium maculatum* subsp. *maculatum*, and *Tozzia carpathica* - were assessed for the first time in Greece, while new populations were recorded (both within and outside the Natura 2000 network) for several taxa. Notably, *Consolida samia* was rediscovered since its type collection in 1962, and the presence of *Pontechium maculatum* subsp. *maculatum* in Greece was confirmed.

This report presents the progress in assessing the conservation status of Greek flora under the 92/43/EEC Habitats Directive for the fifth National Report. It highlights significant differences from previous National Reports, and identifies key pressures and threats to plant species. A preliminary comparison of the findings with the recent IUCN-based Red List of Greek Flora is also presented.

Keywords: Greek National Report, conservation, Mediterranean flora, monitoring, pressures and threats

Acknowledgements: This research was funded by the Ministry of Environment and Energy.

45

Conservation status, distribution patterns, and ecological characteristics of Campanulaceae in Greece

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The Campanulaceae Jussieu is a diverse plant family distributed worldwide, including approximately 84 traditionally defined genera and ca. 2,400 species, which vary notably in morphology and ecology. The subfamily Campanuloideae Burnett predominates in temperate regions of the Old World with diversity hotspots in Eurasia, especially the Mediterranean Basin. Greece represents one of the plant diversity hotspots in the Mediterranean and an important center of endemism. The Campanulaceae belongs to the top20 of the most speciose families of the Greek flora hosting 102 species. More than half of these species are endemic to Greece while 21 taxa are included in the "Red Data Book of Rare and Threatened Plants of Greece" (1995, 2009).

In the frame of the "Compilation of Red List of Threatened Species of Plants of Greece" project funded by the Natural Environment & Climate Change Agency, all the species of Campanulaceae were assessed against the IUCN criteria and assigned to IUCN threat categories. The gathering of distribution and ecological data from literature and the study of specimens from the UPA herbarium, was followed by their analysis, resulting to the distribution patterns of Campanulaceae across the phytogeographical regions of Greece and their ecological characteristics.

Our results from the assessment against IUCN criteria show that almost 30% of Campanulaceae in Greece are threatened, while the remaining species are Least Concern (LC) except three characterized as Data Deficient (DD). The percentage of threatened species is significantly higher among endemic Campanulaceae compared to non-endemic ones. The taxonomic and ecological diversity of Campanulaceae in Greece, their habitat preferences and the distribution patterns throughout Greek area are also presented in relation to their threat category. Overall, this study summarizes the current knowledge on the conservation of Campanulaceae in Greece and highlights the significance of incorporating additional distributional and ecological analyses towards a more complete approach for the protection of Greek flora.

Keywords: IUCN, Greek flora, Campanula, Campanuloideae, conservation measures

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Diversity, endemism and conservation status of the genus *Verbascum* L. in Greece

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Including approximately 440 species, *Verbascum* is the largest genus of the predominantly northern temperate tribe Scrophulariae (Scrophulariaceae); its natural range extends from Cape Verde to China and from the equatorial Africa to just below the Arctic Circle in Scandinavia. The major diversity center of *Verbascum* is the East Mediterranean including the S Balkans, Anatolia and the Levant. Among the most biodiverse countries in this genus, Greece has the highest species number per square km, comprising 78 species. More than half of the Greek species (48 spp.) are range-restricted including 23 endemics, whereas *Verbascum* ranks in the top 20 lists of the most species-rich, most range-restricted-rich and most endemic-rich vascular plant genera of Greece. Moreover, cases of paleo-endemism and taxonomical isolation of *Verbascum* spp. in the Greek territory are also of particular interest.

To estimate the extinction risk of the Greek species, the IUCN Red List Criteria were applied. The analyses indicated that 8 species are Near Threatened (NT), and 15 species are threatened, of which 6 Vulnerable (VU), 5 Endangered (EN) and 4 Critically Endangered (CR). Importantly, 10 of the threatened species are endemic (4 VU, 3 EN and 3 CR), including 2 paleoendemics. These data collectively pinpoint Greece as an important terrain for the evolution and diversity of both old- and new- lineages of *Verbascum* and furthermore indicate the need of prioritization in conservation plans for the threatened species.

Keywords: biodiversity; Greek-endemic; range-restricted species; threatened species

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New conservation and genetic data for the Greek endemic *Campanula papillosa* Halácsy

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Campanula papillosa belongs to the very diverse and speciose genus *Campanula* (Campanuloideae, Campanulaceae). The genus, as traditionally circumscribed, includes ca. 400 species distributed across the circumboreal region. Greece is an important diversity hotspot in the Eastern Mediterranean region hosting ca. 96 *Campanula* taxa of which ca. 60 are Greek endemics. *Campanula papillosa* is one the most rarely found Greek endemic species, growing on high altitudes of Mt. Taigetos (Peloponnisos) with scarce information about its taxonomy, ecology, and phylogeny. Since the description of the species (1908), it was not further studied until its rediscovery in 2008. Regarding its conservation status, *C. papillosa* has been included in the Presidential Decree no 67/81, in "Red Data Book of Rare and Threatened Plants of Greece" (2009) as Critically Endangered (CR) whereas lies within Protected Area of Natura 2000 network (site code: GR255006). The main goals of the current study are to revise the conservation assessment based on updated data and to estimate genetic diversity of *C. papillosa* and its phylogenetic relationships with other species.

During extensive field work, we estimated the population size, recorded the threats and collected plant material of *C. papillosa* for genetic analyses. The conservation assessment follows IUCN criteria. The genetic diversity of the species was estimated using ISSR markers whereas for the phylogenetic analyses the Maximum Likelihood (ML) method was performed using markers from the chloroplast (*NADHS-2*, *rpoC1-1*, *rpoC2-1*, *rpoC2-2*, *rpoC2-3*, *trnT-L*) and nuclear genome (*2017561*, ITS).

The results of the field studies confirm the existence of three subpopulations of *C. papillosa* in a small area of Mt. Taigetos. New data for population size and threats are provided and used to revise species' assessment against IUCN criteria leading to a new threat category. According to the genetic data produced until now, the subpopulations of *C. papillosa*, although geographically close, seem genetically distinct with little gene flow between them. All individuals used from the subpopulations of *C. papillosa* for the phylogenetic analysis constitute a monophyletic group within the phylogenetic tree including most Greek *Campanula*. The outcomes of the current study provide a valuable basis for suggesting measures for the protection and conservation of the species while the genetic analyses contribute to a better understanding of its evolution. Furthermore, the integrative approach for the study of *C. papillosa* could serve as key axes at global, European and national levels for the conservation and protection of rare and endangered species.

Keywords: Campanulaceae, conservation genetics, endemism, Greek flora, IUCN

Acknowledgements: The project was supported by the National Environment & Climate Change Agency (N.E.C.C.A.) under the Call "Actions to protect, conserve and promote biodiversity. Field studies of endemic, endangered and nationally important species of Greece»" (Project Number: 14887).

1

Abies cephalonica: a 10-year monitoring study of cone production in Parnitha National Park (Attica, Greece)

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Abies cephalonica is a strictly Mediterranean fir, forming extensive forests in the mountainous regions of central and southern mainland Greece, as well as on the islands of Cephalonia and Euboea. This long-lived, monoecious tree is a late-succession, shade-tolerant species that establishes climax plant communities. Its populations are typically found at elevations ranging from 900 to 1400 m above sea level, although it can occasionally occur as low as 400 m and as high as 1800 m. Several Greek fir forests have been previously designated as National Parks and are part of the NATURA 2000 European Network.

Despite forming extensive forests and classified as a habitat of national interest under code 951B, Greek fir forests have experienced dieback in various regions over recent decades. These forests face significant threats from natural disturbances, particularly by wildfires. A substantial portion of the Greek fir forest in Parnitha National Park (GR3000001) was severely reduced by a wildfire during the summer of 2007.

A. cephalonica is a non-fire-resilient species with its developing cones and their enclosed immature seeds typically destroyed during wildfires. Given the species' low potential for postfire regeneration, understanding its reproductive cycle is essential for effective conservation efforts and forest restoration initiatives.

A distinctive feature of *A. cephalonica* is its masting behavior, characterized by years of abundant cone production alternating with years of low or absent cone production. The study, conducted over a decade (2013-2024) across 13 monitoring plots in Parnitha NP, has provided valuable insights into the species reproductive traits. Ten mature *A. cephalonica* trees per monitoring plot (130 trees in total) were randomly selected and marked. Cone production (cones per tree) was measured annually, in the autumn, and initial measurements of tree height and diameter were recorded in the first year.

The study identified a consistent masting cycle for *A. cephalonica*, with high cone production observed in 2015, 2020, and 2024. This represents the first long-term study confirming a 4-5 year cone production cycle. However, a relative decline in cone production during masting years was also noted, which can be attributed to the increased frequency of droughts in recent years. Climatic data from the region suggest that prolonged dry conditions may adversely impact the reproductive capacity of *A. cephalonica*, further complicating its ability to regenerate in the face of climate shifts.

The present study gathers and analyzes the available morphological traits of fir individuals along with the available time series of the cone production under the evidence of climate shifts in the area of Mt. Parnitha.

Keywords: Cone production, Climate impact, Greek Fir, Masting

2

Enhancing Resilience of the Akrotiri Salt lake ecosystem - The ARISE project

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The Akrotiri Salt Lake (ASL) is the most important coastal wetland in Cyprus, providing critical habitat for rare plants and hosting important species of breeding and migratory birds and insects. The wetland also provides unique ecosystem services, many of which are exclusive to the ASL due to its rich biodiversity and ecological functions. However, despite its ecological importance, urbanisation, ongoing land use changes, and increased economic activities in the area resulted in the formation of an “isolated natural patch” within a human-dominated landscape-a “pressure zone”- with a diverse and unknown degree of impact on biodiversity and ecosystem services. Adding to these challenges, climate change impacts, such as prolonged droughts and reduced precipitation, are contributing to the wetland’s degradation. With mechanisms and measures to protect this fragile ecosystem currently insufficient, urgent action is needed to safeguard this vital wetland.

In response to these growing pressures, the Arise project was launched in 2024 with a three-year duration aiming at enhancing the ecological resilience of the ASL through evidence-based strategies and targeted restoration efforts. A key focus of the project is the spatial prioritization, which involves identifying key areas within the “pressure zone” that are critical for restoration. One innovative restoration approach being implemented is the biological soil crust restoration in degraded areas, where mulching with locally collected dead plant material and cyanobacteria inoculation will be used to stabilize the soil and improve nutritional conditions, thereby supporting the survival of native plant communities.

Additionally, the Arise project aims to establish more than five plant micro-reserves to protect at least ten red-listed flora species. These micro-reserves aim to ensure rare and endangered plant species survival in the face of ongoing pressures. The project also includes measures to manage access and regulate visitation to the ASL, minimizing the human impact on the wetland. To ensure that these efforts are based on scientific evidence, a sustainability appraisal will be conducted to analyze environmental drivers and assess their effects on the ecosystem. At the same time, stakeholders will be actively engaged through consultations, focus groups, and workshops to foster collaboration among local communities, policymakers, and conservationists while raising awareness of ASL’s ecological importance.

By integrating ecological restoration, public awareness, and improved governance, the Arise project seeks to mitigate the ongoing pressures on the ASL, restore key habitats, and implement sustainable practices to ensure the long-term conservation of the wetland’s unique biodiversity and ecosystem services.

Keywords: Akrotiri Salt Lake, restoration, biological soil crust, ex-situ conservation, threatened plants

Acknowledgements: This work is implemented in the framework of Darwin Plus 204 project: Enhancing Resilience of the Akrotiri Salt lake ecosystem. Implementing partners are the Open University of Cyprus, DICE - Durrell Institute of Conservation & Ecology/University of Kent, and the Cyprus Sovereign Base Areas Administration Environment Department.

3

Conservation and Evaluation of Fruit and Forestry Tree Genetic Resources in Sardinia (Italy)

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Fruit and forestry tree genetic resources of Sardinia Island have been studied and collected since 1978. Actually, most of the accessions previously characterized are part of the Regional Germplasm Bank for Agriculture and Food (BRGAgriS). Many Institutions collaborate to maintain the field collections and to promote further research on the accessions: the University of Sassari (by means of the Interdepartmental Centre for Plant Biodiversity Conservation and Enhancement), the AGRIS regional agency for research in agriculture, the regional extension service (LAORE), the National Research Council, and the regional forestry agency (FORESTAS).

The following species are the object of the safeguard program: apple, pear, apricot, prune, peach, almond, cherry, fig, grapevine, olive, citrus, cactus pear, green oak, and cork oak. Collection fields are replicated twice or more in various locations of the regional land in order to avoid any risk of accession lost. In vivo collections are localised in four sites strategically distributed in the Island along the North-South direction: Agliadò (40°48'30.42" N; 08°28'34.87" E), Surigheddu (40° 36' 0" N; 8° 23' 0" E), Fenosu (39.8996 Longitude: 8.5933), and Villasor (39°22'51" N; 8°56'19" E). More than seven hundred accessions are stored and studied as the object of many research projects aimed to the genetic characterization, the evaluation of some potentially positive characters, and the agronomic value of the accessions. Some special programs are on the quality of products of obtained from olive, grapevine, and almond.

More research is dedicated to the genetic resources of the wild relatives of the cultivated species and some collections of oleaster and wild grapevine have been realised. Cork oak variability of accessions in mainly focused of the cork quality of accessions.

Keywords: Mediterranean plant germplasm, *in vivo* conservation, fruit tree biodiversity, forest species variability.

Acknowledgements: this project was funded by Regione Autonoma della Sardegna.

4

Rare and threatened plants of arable land: results from a recent study in the plains of Thiva (Central Greece)

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Several vascular plant taxa adapted to arable habitats are considered among the most vulnerable habitat-specific groups in European and Mediterranean countries. The intensification of agricultural practices (including the use of heavy farm machinery, deep tillage and dense sowing), the common use of herbicides, and an excessive use of synthetic fertilizers, as well as the invasion of alien taxa pose serious threats to traditional, arable weed communities.

We selected the plains of Thiva (central Greece) to investigate rare or threatened plants of arable land keeping in mind that the area has a history of practicing agriculture for more than 2,500 years. Nowadays modern practices prevail in the area but a few, traditionally cultivated land parcels are still present. Field work took place in 2022 and 2023. A minimum of 114 localities were investigated and several field notes were also made. For comparison reasons, an equal number of 114 plots measuring 25 m^2 each (dimensions of 5x5 m, 2x12.5 m, or 1x25 m) were also selected to represent spots with high species richness. Within each plot, we identified all plant taxa, together with altitude, co-ordinates, orientation and cultivation type, focused primarily on crop edges rather than field cores.

Eleven taxa (*Anchusa stylosa* subsp. *spruneri*, *Cerastium dichotomum*, *Ceratocephala falcata*, *Leontice leontopetalum* subsp. *leontopetalum*, *Malope malacoides*, *Malvella sherardiana*, *Scolymus maculatus*, *Silene longipetala*, *Silene muscipula*, *Turgenia latifolia, Vaccaria hispanica* subsp. *hispanica*) have been recorded as threatened plants of arable land in the area. Several of them were assessed as CR, EN, or VU for Greece, in the past. *Cerastium dichotomum, Malope malacoides, Scolymus maculatus* and *Turgenia latifolia* have recently been characterized as NT or LC but at least for some of them (e.g. *Scolymus maculatus*) a revision may be necessary. *Anchusa stylosa* subsp. *spruneri, Ceratocephala falcata*, *Malvella sherardiana* and *Silene muscipula* were found in only one locality each, making them the rarest arable plants in the area. Each of *Cerastium dichotomum, Scolymus maculatus* and *Vaccaria hispanica* subsp. *hispanica* were recorded three times, but remain very local and form small populations in the plains.

Cereal fields host most of the rare or threatened plants in the area (16 records) as opposite to vineyards (3 records) and legume plantations (1 record; it represents, however, the very rare *Anchusa stylosa* subsp. *spruneri* found in a *Lens* field). Field margins facing south prevail in numbers of rare weeds (9 records), in contrast to margins facing west (1 record). The altitude of our records varies between 89 m and 367 m, with most of the rare plant occurrences found between 257 m and 367 m.

Although searched for, we failed to rediscover *Astragalus graecus* and *Brassica cadmea*. The former, a weed of cultivated land, was last seen in the plains of Thiva in 1967. The latter has not been recorded since its original collection close to Thiva, in 1885. They are both presumably extinct in Greece.

Keywords: Agriculture, cultivated land, conservation, IUCN categories, weeds

5

In situ and *ex situ* plant conservation in the Aegean Archipelago

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The Aegean Archipelago is one of the largest archipelagos of the world characterised by high environmental heterogeneity, complex palaeogeography, high diversity and endemism. 62% of the endemic taxa growing in the Aegean are regional and 42.4% are Single Island endemics. The first round of conservation status assessments (by HBS in collaboration with IUCN) showed that 50% of the endemics are categorised as threatened (CR, EN, VU), most of them facing high extinction risk, uplifting the in situ and ex situ conservation of these plants to an urgent national target. It is remarkable that ten out of the TOP50 critically endangered Mediterranean plant taxa, and 44% of the plant taxa of Annexes II, IV & V of the Directive 92/43/EEC are found in the Aegean. The Aegean Archipelago also hosts 38% of the Greek NATURA2000 sites, governed by 7 Management Units of Protected Areas; currently, in situ conservation measures for protected or endangered plants are taken mainly within these protected areas. In addition, Plant Micro-Reserves have been established for 7 taxa and one habitat type in Crete while 5 new ones are about to be established in Rhodes, Karpathos and Kastellorizo. Ex situ conservation actions include numerous taxa stored in Seed Banks along with compiling germination protocols and developing plans for in situ population reinforcements. This work, apart from presenting the progress made during the last decades in knowledge building and conservation initiatives, aims to reveal and prioritise the gaps of plant conservation in the Aegean Archipelago.

Keywords: conservation measures, ex situ conservation, in situ conservation, plant micro-reserves, seed banks, threatened plants.

6

Biological control of *Opuntia ficus-indica* by means of the dispersion of *Dactylopius opuntia* in the Cap de Creus Natural Park - LIFE medCLIFFS project

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Opuntia ficus-indica is a plant native to Central America with a high potential for invasiveness in the Mediterranean basin. It is widely distributed along the Mediterranean coast, and it has negative impacts on the landscape, the habitats and the native flora of coastal ecosystems. Until recent years, the control methods were limited to using chemical products, which are difficult to apply and imply risks for the applicator and the ecosystem. The arrival of a specific biological agent, *Dactylopius opuntiae*, to the Iberian Peninsula, offers new expectations for the control of *Opuntia ficus-indica.*

Through the project "*Towards an integrative management of Invasive Alien Plant Species in Mediterranean sea cliffs of European Interest*" (**LIFE medCLIFFS-LIFE20 NAT/ES/001223)**, aimed at the maintenance of the floristic diversity of the Mediterranean cliffs, a pilot test is under way in the Cap de Creus Natural Park for the biological control of *Opuntia ficus-indica.*

The objectives are to test the effectiveness of *Dactylopius opuntiae* as a biological control agent of *Opuntia ficus-indica*, to assess the real possibility of translocating the biological control agent in large areas of the territory occupied by the invasive species, and to develop an operational protocol that enables the export of this experience to other natural areas facing the same issue.

The prospection of the sectors with *Opuntia ficus-indica* colonised by *Dactylopius opuntiae*, and of the areas where it had not yet arrived, was carried out in spring 2023. At a later stage, the dispersion works of *Dactylopius opuntiae* were initiated, distributing it in the sectors of the coast with unaffected prickly pears.

One year later, a control was carried out in the previously treated locations to analyse the results of the dispersion of *Dactylopius opuntiae*. The results show that *Dactylopius opuntia* has expanded successfully in all treated populations. The degree of affectation of *Opuntia ficus-indica* is variable, and it depends on the moment when *Dactylopius opuntiae* arrived, the environmental conditions and the location of the populations.

After one year, the infected prickly pears exhibit a full coating of *Dactylopius*, but still maintain the pads and the capacity to produce fruits. The degree of decay of the prickly pears is higher in the areas where *Dactylopius* arrived a longer time ago.

South facing and warmer locations with steep slopes are more affected than the rest.

The drought in summer 2023 has favoured the dispersion and development of *Dactylopius* due to the lack of the washing effect of rain.

Secondary colonization processes are observed towards populations of prickly pears which are hundreds of meters away from those treated in 2023.

Keywords: conservation of Mediterranean flora, invasive alien flora, biological control, *Opuntia ficus-indica, Dactylopius opuntiae*.

7

Multi-metric analysis of *Hypericum* - taxonomic, phylogenetic and functional diversity in Greece

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The genus *Hypericum* represents a widespread group of medicinal and aromatic plants, comprising 36 sections and more than 480 taxa, which provide essential ecosystem services. Within Greece, the genus includes 45 taxa, with three recent additions to the scientific literature: *H. icaricum* Kit Tan, *H. cycladicum* Trigas and *H. intricatum* Zografidis et al. Whilst H. perforatum exhibits a broad distribution, 18 taxa show restricted ranges, including 17 Greek endemics. One species, H. *aciferum*, merits special protection under Annexes II and IV of the Directive 92/43/EE. Geographical analyses indicate that northeastern Greece harbours the highest number of different *Hypericum* taxa, whilst the Kriti-Karpathos region contains the largest concentration of range-restricted species.

This research examines the spatial distribution of taxonomic, phylogenetic and functional diversity of *Hypericum* across Greece. The analysis draws upon open-source data from GBIF, combined with a carefully curated database containing 100 functional traits for each *Hypericum* taxon. Both weighted and unweighted diversity metrics were employed, including community-weighted mean (CWE), phylogenetic endemism (PE), species richness (SR), phylogenetic diversity (PD) and functional richness (FRic). For Greek endemic taxa, Mount Psiloritis in Crete exhibited the highest SR, PD and FRic values, whereas Mount Zireia in the Peloponnese and Mount Dirphys on Evvia showed the highest CWE and PE values. Regarding native *Hypericum* taxa, Lesvos demonstrated the highest SR and PD values, whilst Mount Psiloritis showed maximum values for FRic, CWE and PE.

Keywords: functional traits, vegetative traits, medicinal species, ecosystem services, biodiversity patterns

8

Functional and Biological Diversity of Wild Edible Plants in Italy: Insights from the FuD WE PIC Project

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Wild edible plants (WEP) have been vital resources for humans since the Palaeolithic era, and their significance endures today in the context of sustainability and food security. While most scientific literature has focused on the nutraceutical and ethnobotanical aspects of WEP, and several regional-scale checklists are available, ecological studies on WEP remain underexplored. Studies utilizing big data to analyze WEP on broader scales are still lacking.

In this study, we used the Italian WEP checklist AlimurgITA, which assembled data from the most comprehensive scientific literature on Italian ethnobotany during the period 1918-2024. We integrated the AlimurgITA species list with Italian vegetation plots from the European Vegetation Archive (EVA) to pursue two main objectives: (i) model WEP richness and identify diversity hotspots and (ii) explore the relationships between WEP diversity and their preferential habitat types.

Keywords: AlimurgITA, EUNIS, European Vegetation Archive, habitat, Italy, species richness

Acknowledgements: The funds of the Ministry of University and Research, Project PNRR M4.C2.1.1; CUP: B53D23011830006 ‘Functional and biological Diversity and habitat assessment of Wild Edible Plants in Italy under different Climate and land-use change scenarios (FuD WE PIC).

9

Sideritis lurida J.Gay ex Lacaita locally named "té de monte": more knowledge for best conservation.

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The Lamiaceae family is one of the largest families of flowering plants. It comprises 7000 species across about 236 genera. Many species, such as *Lavandula*, *Thymus*, and *Salvia* (=*Rosmarinus*), are widely known for their medicinal properties and ethnobotanical uses. Another important genus of this family is *Sideritis*, which comprises more than 179 taxa. It is represented mostly by annual or perennial aromatic herbs (or shrubs) that are found in tropical and temperate regions of the northern hemisphere and mainly in the Mediterranean area. In the Iberian Peninsula, 34 species have been described.

Sideritis lurida is a taxon that includes a group of rhizomatous plants found in the high siliceous mountains of the central-western and northwestern Iberian Peninsula (=*Sideritis borgiae*; *Sideritis borgiae* subsp. *relegata*; *Sideritis hyssopifolia* var. *relegata*; *Sideritis lurida* subsp. *borgiae*; *Sideritis lurida* subsp. *relegata*; *Sideritis lurida* var. *relegata*). Locally known as "té de monte", it is a perennial plant measuring 17-57 cm in height, with a woody base and stolons. The stems are simple or occasionally branched, slightly hairy, and have lanceolate to elliptical leaves (18-42 mm long) that are softly toothed and sparsely hairy. Its inflorescence forms yellowish, cylindrical spikes made up of 3-12 clusters, each with six flowers. The calyx is 6.5-10 mm long with spiny teeth, and the corolla is yellow or brown-spotted, measuring 8-10 mm. The nutlets are small, smooth or rough, and range from light to dark brown.

This species is listed in the Catalog of Protected Flora for the "Castilla y León" province under the category of "Preferential Attention". Regional environmental authorities are required to actively ensure its conservation, taking measures to prevent its decline and guarantee the persistence of its populations.

The main aim of this research is to map the species' locations, assess its conservation status, and document its ethnobotanical knowledge. This approach is particularly relevant in this region, where the species is widely used to flavor alcoholic beverages. By gaining a better understanding of its cultural uses, it will be possible to propose conservation strategies that have the support and active participation of local communities.

According to our preliminary studies, the species is found in different localities, some of them with stable and well-preserved populations, while others have disappeared from previously known locations due to factors such as changes in land use. Surprisingly, populations in hard-to-reach areas do not always show the best conservation status, suggesting that additional biotic or abiotic factors influence the development of this species. Therefore, this study aims to investigate the threats affecting the viability of its populations.

Additionally, the germination percentage of different populations will be evaluated to determine their germination requirements, both for conservation in seed banks and for cultivation trials. These efforts aim to support the creation of a conservation network involving local communities. Finally, the essential oils will be analyzed, along with their antioxidant and antimicrobial activities.

In conclusion, we emphasize the motto, "Learn more to conserve better." While this species is not currently in a critical state of conservation, it would be highly beneficial to further analyze its biological factors and explore cultivation strategies. Such efforts could also foster small rural businesses through the sustainable use of endogenous resources.

10

Impact of pine forest soil and herbivory on *Quercus ilex* L. acorns: a case study from Giglio Island (Tuscany, Italy) within the LIFE LETSGO Giglio project

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In recent years, the restoration of natural ecosystems has become a major global objective, in which plants and forests play a crucial role in the fight against biodiversity loss and climate change. *Quercus ilex L.* is a key component of Mediterranean vegetation and can be instrumental in the recovery and restoration of forests in this region. Its ability to adapt to difficult conditions (drought, sun exposure) has ensured its success in the Mediterranean climate, despite its germination success might be compromised by interactions with other species, such as conifer litter and predation by herbivores.

On many islands, holm oak forests have been significantly reduced over time due to various human activities, such as agriculture and grazing. Giglio Island (Tuscan Archipelago, Italy), where the holm oak forest represents the climax stage, is an example of Mediterranean context where these activities has caused relevant vegetation changes, together with reforestation with pine trees altering soil conditions. Furthermore, the introduction of invasive species, such as rats and rabbits, has contributed to further changes in the island's ecosystem.

For this reason the LIFE LETSGO Giglio project aimed to reduce the biomass of pine tree plantations and promote their renaturalisation.

Our study wants to evaluate the germination and emergence rate of *Q. ilex* seedlings in the presence of pine forest soil and litter and under the effect of predation by rodents and rabbits on Giglio Island. For this, we conducted two experiments: one *ex situ* and one *in situ* at the Botanical Garden of Florence. For the *ex situ* study, seedling germination and emergence tests were carried out in the laboratory to assess the influence of pine litter and soil type on the acorns (a total of 384 acorns). In the *in situ* experiment, we selected five areas on Giglio Island, where we created three different treatment conditions: a closed cage excluding rat and rabbit predation; an open cage excluding only rabbit predation; and a control, unfenced subplot. Within each of the 5 areas, 60 acorns were sown (20 for each treatment), which were monitored for 357 days to observe germination and seedling emergence.

The laboratory results showed that the rate of seedling emergence was significantly higher in the trays containing Giglio Island soil than in the controls with neutral soil (90.6% in Giglio soil vs 70.83% in neutral soil). The pine litter seems not to have a significant effect on seedling's emergence. The results of the *in situ* experiment showed a significant negative effect of predation on seedling germination and emergence. In particular, both cages (closed and open) significantly increased the seedling emergence rate compared to the control treatment (81-72% in the cages versus 29% in the control), thus reducing the effect of predation.

From the results of our study, we can conclude that the reduced regeneration of holm oak forests in pine plantation on Giglio island is mainly due to predation by rats and rabbits and not due to the pine forest soil prorpieties, helping to optimize the management and conservation of biodiversity within the natura 2000 network.

Keywords: Mediterranean habitats, *in situ* conservation, ecosystem restoration, germination

Acknowledgements: LIFE Nature and Biodiversity project LIFE LETSGO GIGLIO "Less alien species in the Tuscan Archipelago: new actions to protect Giglio island habitats" (LIFE18 NAT/IT/000828)

11 Raising awareness of plant diversity conservation and sustainable development in Greece: case studies

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Greece is characterized by richness of plant and habitat diversity and a high rate of endemism. Citizen science has emerged as an effective way for monitoring biodiversity on a large scale but there is only a small number of studies concerning plant diversity of Greece and plant conservation. The purpose of this study is to investigate on one hand, the opinions of Greek citizens regarding biodiversity, plants and plant diversity in an attempt to assess the public's neutral, positive or negative disposition towards their conservation as well as their eventual participation in environmental citizen science programs. On the other hand as a case study, we assess the willingness of a local community to consider its area as a potential ecotourism destination, highlighting at the same time the value of biodiversity conservation and the public awareness for the area's environmental wealth. Ecotourism is oriented towards the environment and supports its development in three fundamental dimensions: the conservation of the natural environment of a destination, environmental education and finally, sustainability. By creating two questionnaires, it was investigated whether the participants recognize the importance of plants, plant and habitat diversity and conservation as also the value of their ecosystem services. The results showed that they have a great sensitivity towards biodiversity and its loss, and they understand the need to preserve the natural elements. The participants have developed positive attitudes and perceptions about the natural environment and ecotourism, as well as that they are positively disposed towards citizen science although most of them were informed about it through the questionnaire.

Keywords: plant diversity, protection, citizen science, ecotourism, environmental management

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Integrated Approaches to Landscape Conservation: The Case of Massiccio del Monte Cairo, Italy

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Landscapes, shaped by the interplay of natural and human factors, are vital components of territorial sustainability, influencing environmental, cultural, social, and economic dimensions. The European Landscape Convention (2000) underscores the importance of assessing landscape quality to inform sustainable management and protection policies. However, contemporary challenges such as land fragmentation, uncontrolled urbanization, and environmental degradation demand integrated approaches to landscape conservation.

Within the framework of the TOPIO HORIZON-MSCA project, this research evaluates landscape quality in seven study areas across Europe, employing an innovative combination of geoinformatics, Earth Observation (EO), and participatory GIS methodologies. A particular focus is given to the case study of Massiccio del Monte Cairo, located in Frosinone, Italy. This Natura 2000 site has experienced significant degradation, driven by historical human activities, including war-related destruction and subsequent reforestation efforts.

Using multitemporal satellite imagery, field surveys, and advanced deep learning classification techniques, the study analyses land use and land cover changes, ecosystem restoration processes, and the impacts of climate change. Complementary assessments of landscape sensitivity and character are conducted to evaluate the site's vulnerability and its potential for restoration actions.

The findings of this research aim to enhance landscape management practices, directly supporting European landscape policies and fostering citizen engagement in territorial planning. By integrating scientific methods with local knowledge, the project offers a comprehensive, spatially informed framework for the conservation and sustainable development of Mediterranean landscapes.

Keywords: Landscape Conservation, Mediterranean Habitats, Ecosystem Restoration, Geoinformatics, Natura 2000 Sites

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Silene conglomeratica, *in situ* and *ex situ* conservation actions for a geo-specialized taxon

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The local endemic *Silene conglomeratica* is *a* "Critically Endangered" species, growing exclusively on conglomerate rocks at 800-1200 m a.s.l., around the Mega Spilaio Monastery, in the Vouraikos gorge, a designated geosite due to its special combined geological, natural and cultural value (Chelmos–Vouraikos National Park, UNESCO Global Geopark Helmos-Vouraikos, North Peloponnese, Greece). *Extinction* risk assessment showed that the species will face serious decrease of its potential distribution and is projected to face large range contraction under any climate change scenario. A Micro-Reserve (PMR) for the species has been established on the GR2320003 Natura 2000 site for the protection and conservation of both the plant and its habitat and supervised by the Management Unit of Chelmos-Vouraikos National Park and Protected areas of N. Peloponnese. A monitoring plan has been elaborated for the PMR, and the necessary conservation actions are proposed. The relation of the species with the conglomerate substrate is of high significance and the study of the special geological characteristics of the conglomerate rocks is closely linked to the protection efforts.

A monitoring process has been applied for the last four years covering population size, plant community and habitat type characteristics, their structure and functions and current pressures and threats. During the last year, data provided by temperature and relative humidity data loggers that have been established on the main conglomerate rock giving refuge to most of the species' individuals, showed significant increase of the temperature and decrease of humidity during this period. The results of this study include detailed information on the species exact locations and population size and highlight that in situ and ex situ conservation of the species is of high priority. *Ex situ* conservation efforts are combined with the enrichment of the natural population. Efforts for the *in situ* enrichment are implemented by planting seeds, individuals or young shoots after treatment, to strengthen the unique existing population. In vitro germination of the plant has also been implemented aiming to the establishment of in vitro cultures of the species. The presence of large cracks in rocks shielded from direct sunlight seems to favor the development of *S. conglomeratica* individuals. Additionally, its numbers increase in areas with sandstone lenses.

Keywords: conglomerate rocks, endangered species, in vitro germination, in vitro propagation, plant protection

Acknowledgements: The authors thank the Natural Environment and Climate Change Agency for funding.

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Centaurea spinosa communities' conservation status in the Aegean area (Greece)

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The coastal zone of the Mediterranean areas and islands including beaches, white dunes, cliffs, grey dunes and coastal shrubs and forests, is one of the most intensively frequented areas by humans. During the last century, tourism has increased enormously, adding an extra pressure to all coastal areas that suffer from many more pressures such as climate change, urbanization, recreational overuse by people, non-native species invasions, agricultural intensification and abandonment, hydrological modifications and erosion. *Centaurea spinosa* is an eastern Mediterranean perennial plant forming dense, silvery hemispherical cushions up to 100 cm in diameter. It dominates on rare, relict formations on coastal sands and gravels of some of the Aegean islands (Egina, Euboea, Skyros, Samos, Lesbos, Khios, Kos, Lemnos, Samothrace, Samos, Syros, Sifnos, Leros et al.), Attica, Crete, the Sea of Marmara, the Dardanelles and western Anatolia, sometimes accompanied by *Sarcopoterium spinosum* or *Euphorbia acanthoclada,* forming maritime eastern Mediterranean spiny phrygana. Under favourable conditions these communities are developed sporadically on the sea facing slopes of semi fixed dunes that are characterized by high native species richness and prevalence of native shrubs and herbaceous species and contribute to the stabilization of the communities in the mosaics of the dune landscape. Although the taxon is not an endemic one, the communities it forms are threatened because of the intense pressures affecting their habitats. In the framework of a project concerning the Aegean islands and based on extensive field work and all available literature, this study presents the current geographical distribution of the communities with *Centaurea spinosa*, the significant decrease of the areas covered by these communities and the changes of their plant species composition. Anthropogenic interventions have significantly reduced the spread of *Centaurea spinosa* communities, making the protection of these remnant habitats critical for the conservation of biodiversity in the Aegean region.

Keywords: coastal areas, dunes, conservation, coastal phrygana, maritime habitats

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Propagation of endangered species for the translocation of individuals into the wild

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The currently running LIFE Seedforce project (LIFE20/NAT/IT/001468 - Using SEED banks to restore and reinFORCE the endangered native plants of Italy) aims to save 29 species in unfavorable conservation status from extinction. Among the various project actions, the propagation of new individuals for translocation into the wild plays a key role. MUSE is working on the propagation of 4 species listed in Annex II of the Habitats Directive. These species are: *Saxifraga tombeanensis*, *Gladiolus palustris*, *Dracocephalum austriacum*, and *Adenophora lilifolia*.

This presentation aims to describe the work carried out during the propagation activities in the MUSE greenhouses, presenting the different methodologies implemented for the various species and the management of plants within the greenhouses.

Given that there was limited data or protocols available for these species, the best strategy for each species was determined through trial and error. Each species requires a specific procedure both for germination and for management within the greenhouse. Therefore, within the framework of the project, species-specific protocols were developed for the proper propagation and management of the different species.

Keywords: Habitat Directive, *ex situ* conservation, greenhouse, endangered species.

Acknowledgements: Life Seedforce received funding by the Life Programme - The European Union funding instrument for the environment and climate action, under contract LIFE20/NAT/IT/001468.

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Tunisia: A small treasure trove of endemic vascular flora within the Mediterranean

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As vividly described by J. Braun-Blanquet, Tunisia is a land of striking contrasts. With its pre-Saharan steppes and desert in the South, it also boasts extensive mountain massifs in the North, including the Tunisian Tell, part of the Kabylies-Numidia-Kroumiria hotspot, and the Jbel Zaghouan/Cap Bon composite refuge; home to a flora marked by a predominance of Mediterranean elements and, secondarily, Euro-Mediterranean ones. Several species are unique or exceptionally rare in North Africa. Endemic taxa, in particular, display significant biogeographical and conservation issues. However, much of the knowledge regarding these taxa in North Africa is outdated, necessitating renewed research efforts.

In light of recent advancements in taxonomy, the pervasive impacts of climate change, and escalating anthropogenic pressures, it is imperative to update the understanding of Tunisia's endemic flora. Over the past 15 years, regular botanical surveys across various regions have allowed us to inventory Tunisia's flora, focusing on heritage taxa (endemic, rare, or threatened) that remain insufficiently documented.

Our work has included identifying threats to fragile and high-risk conservation biotopes. Under the aegis of the the International Union for Conservation of Nature (IUCN), we have contributed to the Mediterranean Red Lists of freshwater wetland plants, as well as the Tunisian Red List of Monocotyledons, Gymnosperms, and Pteridophytes. Additionally, we have been involved in identifying Key Biodiversity Areas (KBAs) and Important Plant Areas (IPAs).

By integrating new field data with the latest publications, we have compiled an updated and reliable checklist of Tunisian vascular endemics. The geographical scope of this study extends beyond Tunisia, encompassing neighboring territories: westward to Morocco and Algeria ; eastward to Libya and Egypt ; and northward to Malta, the Tyrrhenian islands of Corsica, Sardinia, and Sicily, as well as the southern mainland regions of Italy.

These findings underscore that, within the vast Mediterranean Basin, Tunisia holds a remarkable concentration of endemic taxa. This highlights the urgent need for focused conservation efforts to protect and preserve this invaluable natural heritage.

Keywords*:* Mediterranean vascular flora, endemics, conservation prioritization, North Africa, data sharing

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A tale of 50 years: the conservation of *Maytenus senegalensis* subsp. *europaea* habitat in SE Spain

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Maytenus senegalensis subsp. *europaea* is an Ibero-North African shrub catalogued as "Vulnerable" and legally protected in Spain. This species is present in coastal areas of southern and eastern Iberia peninsula, and the scrublands that *Maytenus senegalensis* subsp. *europaea* and/or *Ziziphus lotus* create furthermore characterize the priority habitat (HCI) 5220* of the Council Directive 92/43/EEC. During the last 50 years, such habitat has suffered a regression over 30%, mainly due to agricultural and urban development. Because of its biogeographic and ecosystemic importance *M. senegalensis* subsp. *europaea* is considered an umbrella species for the preservation of coastal ecosystems in the southeastern Iberian Peninsula. The aim of this study was to reach holistic management solutions for the resilience of ecosystem goods and services of these plant communities, compatible with socioeconomic development and in the face of global change scenarios. In the Anthropocene it is necessary to activate multidisciplinary networks between territorial managers, scientists, socioeconomic promoters, NGOs and other stakeholders. In view of the challenge to ensure the conservation of biodiversity in areas of great socio-economic development, a scientific-technical workshop was held within the framework of the MAYTENUS.org initiative, which gather technicians from the administration, representatives from town councils, scientists, nursery technicians, environmental research companies and representatives from NGOs. The methodology followed was to propose common management strategies for the species and its habitats among the various environmental administrations involved, and to contribute to the design of sustainable territorial planning in accordance with conservation goals. The level of scientific knowledge, the management tools available for conservation and restoration, and the priority actions to reconcile conflicts between socioeconomic activities and preservation were reviewed. Initiatives such as MAYTENUS.org can act as an interactive nexus of knowledge, meeting and debate of ideas and proposals for the conservation of biodiversity and a sound development of the society.

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Germination ecology and salinity tolerance of an Ibero-Balearic restricted species

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Seed germination is a crucial stage in the population regeneration, especially in species annual species with restricted distributional ranges. This study focuses on the germination ecology of *Diplotaxis ibicensis* (Pau) Gómez-Campo, an annual or biennial herb that inhabits coastal areas, often small islets, cliffs, rocky slopes, and roadside scrublands, always on calcareous soil. It is an Ibero-Balearic endemic, located in Mallorca, Cabrera islets, Ibiza and its islets, and in Alicante (western Mediterranean Basin).

Controlled germination experiments were conducted to study (i) the optimal germination conditions (photoperiod 12 h light / 12 h dark vs. total darkness, and constant temperature 5, 10, 14, 16, 18, 20 and 23°C), (ii) the effects of salts resulting from the combination of the ions and cations with the highest concentrations in seawater (NaCl, $MgCl_2$, $MgSO_4$, and Na_2SO_4 at concentrations ranging from 0.1 to 0.4 M) under optimal germination conditions, and (iii) the possible ameliorating effect of KNO_3 under saline conditions using NaCl.

Optimal germination temperature ranged from 18 to 23°C with 12 h light / 12 h dark, reaching 68% at 20°C, whereas the germination percentage at lower temperatures (5-14°C) reached germination percentages ca. 30%. Seed germination began less than two days after sowing, with a mean T_{50} of 2.19 (±0.28) days at 20°C. In total darkness conditions, germination was much lower, reaching 23.10% at 10°C, but with no significant differences among the studied temperatures. Thus, the optimal germination conditions were with photoperiod at a temperature of 20°C.

Salinity significantly inhibited seed germination, with notable reductions at low concentrations (0.1 M). Different salts showed consistent effects, with Na_2SO_4 having the strongest impact and $MgSO_4$ the least. The comprehensive findings reveal that *D. ibicensis* has restricted salinity tolerance. Besides, the recovery (i.e., germination of the non-germinated seeds of the salt treatment cleaned with distilled water) was very low in all salt conditions, suggesting that the salts kill the embryo and that ion toxicity is primarily responsible for the inhibition of germination. The ecological meaning of this results is that seed germination is favored in autumn amid lower soil salinity and increased rainfall, but it is also possible to find seedlings in late winter or spring.

Regarding the effect of KNO_3, the presence of KNO_3 showed an increase in germination, reaching nearly 90% under conditions with only KNO_3, and also helping to alleviate the toxic effects of the NaCl, obtaining a final germination of 45% at a concentration of 0.2 M NaCl.

In conclusion, the presence of nitrogen favors the germination of this species and alleviates the toxic effects of the NaCl, which is consistent with the fact that *D. ibicensis* is commonly found in areas with colonies of seabirds.

Keywords: seed germination, seedling recruitment, *Diplotaxis ibicensis*, Balearic Islands, western Mediterranean Basin

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Long-term influence of municipal solid waste compost on the fertility, functionality and biodiversity of a soil contaminated with potentially toxic elements

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The use of organic amendments to restore the functionality and biodiversity of sites contaminated by potentially toxic elements (PTEs), such as abandoned mining lands, represents one of the most modern eco-sustainable strategies. Laboratory-scale studies have shown that compost from municipal solid waste (MSWC) can reduce PTEs mobility and increase soil fertility, functionality, and plant growth. However, its long-term impact in the open-field has been poorly evaluated. To this end, different biochemical and microbial endpoints and plant diversity were evaluated six years after the addition of a MSWC at different rates in a PTE-contaminated mine soil (i.e., Sb 416 mg kg-1; Pb 2,653 mg kg-1 and Zn 7,666 mg kg-1). Increasing concentrations of MSWC were added at a depth of 0-30 cm (i.e., 0%: control (T0); 1.5%, 3.0%, and 4.5% w/w: T1, T2, and T3, respectively). The addition of MSWC increased microbial respiration (e.g. +5.1-fold in T3 compared to T0), selected enzyme activities (i.e. dehydrogenase + 12.5-fold, β-glucosidase + 11.2-fold and urease + 3.5-fold in T3 compared to T0, respectively), and had a significant impact on the diversity of the bacterial and plant communities. Sequencing of the V4-5 region of 16S rRNA gene, i.e. the microbial communities of MSWC-treated soils, showed a higher Shannon a-diversity index compared to T0. Surveys of the vegetation in the field identified 56 plant species, with therophytes as the dominant life form (61%). Non-metric multidimensional scale and Permanova analysis revealed significant differences between the vegetation of the amended and control plots, but not between the differentially amended plots with MSWC. Overall, MSWC addition can be an effective and long-lasting environmental management strategy to improve soil fertility and promote the biological functionality restoration of PTEs-contaminated soils.

Keywords: Soil restoration, Organic amendment, Enzymatic activities, Basal respiration, Microbial diversity, Plant community composition

Acknowledgements: The authors acknowledge the support of NBFC to University of Sassari, funded by the Italian Ministry of University and Research, PNRR, Missione 4, Componente 2, “Dalla ricerca all’impresa”, Investimento 1.4 Project CN00000033 and the support of the PRIN 2017 Rizobiorem project.

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CromoCat chromosome database as useful tool for Plant Conservation in Catalan Countries

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CromoCat, the Chromosome Database of the Vascular Flora of the Catalan Countries, is an online repository of karyological data covering the taxa of vascular plants of the Catalan Countries, including the Regions of Valencia and Catalonia, the Balearic Islands, Andorra, and the Northern Catalonia (France). CromoCat is designed as an independent database, managed by a team based at the University of Barcelona directed by J. Simon, available from its own webpage (http://www.cromo.cat/) and from the Flora section of the Catalan Biodiversity Database – BDBC (http://biodiver.bio.ub.es). CromoCat contains at present (January 2025) more than 71,500 records of karyological data belonging to more than 5000 taxa.

Among the derivative applications of chromosomal databases, since the inception of CromoCat, we have sought to provide information useful for Conservation Biology in several aspects. Our aim was to document and catalogue genetic biodiversity (i.e., chromosomal, coupled to molecular in a parallel module called GenoCat), that is, the level of infraspecific diversity, in a manner that would be useful for researchers, but also for users, planners, stakeholders, or administration technicians, who are not necessarily experts in interpreting plant genetics.

Some particular examples of application of chromosomal data contained in the database to conservation issues are given, as:

–To prioritize conservation measures of rare or endangered cyto-types as ESU (Evolutionary Significant Units)
–To identify and conserve chromosomal strains of distinct productivity phenotypes (e.g., in the chemical, pharmaceutical, or food domains).
–To provide identification of populations or population groups to be protected when legal frameworks allow for infraspecific entities measures.
–To be used as criteria of diversity to select populations to be collected and stored in germplasm collections
–To be employed as parameter to monitor maintenance of characteristics and fitness both at the botanical gardens as well as after release in the field in recovery programs.
–To merge intraspecific diversity in recovery plans.
–To better understand the biological process of endemism.
–To monitor reproductive interference of exotic and invasive flora.
–To long-term prospecting the future: the role of chromosome diversity in the evolution of flora in a changing world.

Thus, we conclude that improved genetic diversity targets and indicators in the CBD post-2020 Global Biodiversity Framework must include chromosomal diversity which has to play a role within.

Keywords: Chromosomal database, Chromosome number, Plant conservation, Biodiversity management, Infraspecific diversity.

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University gardens as tools for plant conservation and education at the University of Barcelona

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The ornamental and leisure gardens that surround the university buildings, in addition to providing an aesthetic beautification of the environment, can also become resources for integration of environment concepts and plant conservation in the training curriculum of students.

For ten years, the GIBAF (Teaching Innovation Group in Botany Applied to the Pharmaceutical Sciences) has launched a series of projects aimed at incorporating these university gardens into ordinary teaching, as a resource for training in the knowledge and rational use of plant biodiversity in a university degree (Pharmacy) in which future graduates will take professional decisions that may favor or compromise the conservation of flora as a source of medicines and products of the pharmaceutical industry.

The projects carried out in two gardens of the Universitat de Barcelona (Ferran Soldevila Garden of the Historical main building of the university and Garden of the Faculty of Pharmacy and Food Sciences) are presented. These include 25 activities that have been organized as part of pedagogical innovation projects for students of Botany in the Pharmacy degree during the period 2014-2024. Projects have been integrated into the evaluation processes.

Areas covered in the activities with students include: a) Curricular environmentalization: integration of the value of plant biodiversity in teaching plans (via videos, apps, etc.); b) Sustainable Development Goals (SDGs): incorporation of concepts related to goals 2, 3, 6, 11, 12, 13, and particularly 15, focusing on biodiversity as a source of health within the One Health context and the need for plant conservation; c) Promotion of the heritage value of the campuses gardens: conservation of listed and protected individuals at local level; d) learning and practice of TIC tools (GPS positioning, 360º photography).

Innovative teaching proposals have been oriented to active learning by:
a) Service-Learning context: development of botanical guides, labelling with QR codes providing information on species (nomenclature, description, distribution, uses, etc.), dissemination through faculty and UB websites, organization of guided botanical tours, and publication of student works in the UB Digital Repository; b) Significative learning of disciplinary content: Organography and botanical morphology of spermatophytes (creation and publication of an illustrated glossary in the UB Digital Repository, prepared by the students themselves); c) Development of educational resources for students: creation and use of collaborative e-Textbooks in self-assessment and peer-assessment processes.

Our experience highlights the effectiveness of using plant resources from university campus gardens as a valuable educational tool in fostering biodiversity awareness and conservation practices among future health professionals, usually less committed to biodiversity conservation than their counterparts in biological and environmental sciences.

Keywords: University gardens, Higher education, Teaching innovation, Plant conservation,

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Molecular diversity of *Scilla madeirensis* (Menezes) Speta

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Scilla madeirensis Menezes (≡*Autonoe madeirensis* (Menezes) Speta; Hyacinthaceae), a bulbous geophyte, is a rare endemic on the islands of Madeira, Porto Santo, and Desertas, with an endemic variety in the Selvagens archipelago, *Scilla madeirensis* Menezes var. *melliodora* Svent. The taxonomic recognition of this Selvagens endemism is not consensual, and there are even records of *S. latifolia* Willd. (native to Canary Islands, Morocco, Western Sahara), for the Selvagens. The present study investigates the molecular variability of *Scilla* in the Madeira and Selvagens archipelagos using nucleotide sequence variation in six chloroplast markers (matK, psbA-trnH, trnC-ycf6, trnK-matK, trnS-trnG, trnG). Preliminary results of phylogenetic analysis support a molecular differentiation of *S. madeirensis* from the islands of Madeira, Porto Santo and Selvagens. Furthermore, the molecular markers of *S. madeirensis* var. *melliodora* differs from those of *S. latifolia*. The genetical and taxonomical differentiation of these geographically separated populations have clear implications on the evaluation of the conservation status.

Keywords: Endemics**,** Hyacinthaceae, Macaronesia, phylogeny, plastid genes

Acknowledgements: This study was co-financed by the European Regional Development Fund (ERDF) through the INTERREG MAC Operational Program 2014-2020, under the MAC2/4.6d/386 project - MACFLOR2. Collecting permits were obtained from the Instituto das Florestas e Conservação da Natureza, IP-RAM.

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Was Dumortier right? Deciphering the subspecies puzzle of *Musschia aurea* (L.f.) Dumort. (Campanulaceae), an endemic species of the Madeira Archipelago (Portugal)

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The bioclimatic contrast and diversity of habitats in Madeira and the Desertas Islands contribute to the morphological differentiation of vegetation, which, combined with population isolation, drives the emergence of endemic species. The Madeira archipelago endemic genus *Musschia*, which shares a Mediterranean ancestor with *Campanula peregrina* Hoffm. & Link and *Campanula latiflora* M. Bieb., is a clear example of adaptive radiation. *Musschia aurea* (L.f.) Dumort is a perennial chamaephyte found on rocky cliffs at low altitudes and in some deep valleys of Madeira and the Desertas Islands. In 1815, Ker Gawler observed that populations from the deep valleys of Madeira had narrower leaves (β *angustifolia*) compared to the wider form of leaves (α *latifolia*). Later Dumortier (1822) described these narrower-leaved populations as *Musschia angustifolia* Dumort. Recent authors do not recognize this taxon at any rank. In this study, we performed a biometric analysis of 47 specimens collected from 33 georeferenced populations, evaluating 67 quantitative morphological characters. Exploratory analyses, including clustering based on Average Taxonomic Distance (DIST) and Pearson Correlation (CORR), as well as UPGMA tree construction and ordination methods (PCA and PCoA), support the recognition of a new subspecies based on Dumortier's original description. The recognition of this new subspecies implies the conservation reassessment of *M.aurea* subsp. *aurea* and the assessment of the new taxon and calls for stricter controls on seed use namely on reintroductions, and reinforcements, to prevent genetic mixing between distinct populations.

Keywords: Adaptive radiation, biometry, conservation, morphology, taxonomy

Acknowledgements: This work was carried out by Tiago Andrade for his Master thesis and was funded by MACFLOR2 (MAC2/4.6d/386) Project under the Cooperation Programme INTERREG MAC 2014-20. The authors thank IFCN-IP.RAM (Instituto das Florestas e Conservação da Natureza) for the license issued to collect specimens of *Musschia aurea*.

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New threat to the endemic flora of Madeira: The impact of *Heliothrips haemorrhoidalis* (Bouché, 1833) (Thysanoptera: Thripidae) on *Musschia aurea* (L.f.) Dumort. (Campanulaceae)

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The greenhouse thrips, *Heliothrips haemorrhoidalis* (Bouché, 1833) (Thysanoptera: Thripidae), is a global pest, native to tropical and subtropical regions of South America, that has been reported to infect Mediterranean vegetation (e.g., *Virbunum tinus* L., *Myrtus communis* L.) and several cultivated plants in Madeira Island (e.g., *Musa* spp., *Castanea sativa* Mill., *Anthurium* spp.). Recently *H. haemorrhoidalis* was observed on *Musschia aurea* (L.f.) Dumort., a perennial chamaephyte endemic to the rocky cliffs of Madeira and the Desertas Islands. Typical damage caused by this pest to *M. aurea*, includes white and brown patches, black spots on leaves, inflorescences and fruit, as well as severe mortality in adult plants. To analyze the extension of *H. haemorrhoidalis* in *M. aurea*, 37 populations in Madeira Island were surveyed, georeferenced, and monitored, the total number of plants was recorded, along with the number of infected and dead specimens. 10 populations were found to be infected, mainly those in the northern region of the island, which showed higher infection and mortality rates, corresponding to the putative new subspecies *Musschia aurea* subsp. *angustifolia*. Given the observed spread and lethal effects of *H. haemorrhoidalis* on *M. aurea*, it is anticipated that the infection may spread to southern populations. To prevent a decline in the number of individuals of this endemic species, urgent protection measures are needed, as well as stricter control over the introduction of any type of non-native arthropod species.

Keywords: Biodiversity, conservation, monitoring, phytopathology, thrips.

Acknowledgements: This work was funded by MACFLOR2 Project (MAC2/4.6d/386), INTERREG MAC 2014-20 Cooperation Program. Plant collections licensed by the Instituto das Florestas e Conservação da Natureza (IFCN), IP-RAM.

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Analysis of stress tolerance mechanisms of the endemic halophyte *Limonium irtaense* in support of conservation programs

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The halophyte species *Limonium irtaense* Ferrer et al., is local endemic to only found in the "Sierra de Irta," in the Valencian Community Spain. This relatively recently described species has been designated as one of exceptional interest and faces a high risk of extinction.

This study examined the morphological and biochemical responses of *L. irtaense* to different salt stress treatments and helped to discover its survival strategies. In greenhouse experiments, adult plants were subjected to different salinity levels ranging from 0 to 0.3 M NaCl over a period of 23 weeks. Morphological assessments revealed that salinity significantly impacted reproductive traits, leading to increased flower abortion and reduced seed production at high salinity levels. In contrast, vegetative growth parameters, such as root length and water content, remained stable, indicating the relative high salt tolerance of this species

Biochemical analyses showed a significant accumulation of osmoprotectants, such as proline and glycine betaine, with proline levels increasing ~30-fold at 0.3 M NaCl. The increased levels of phenolic and flavonoid compounds at moderate salinity levels suggested enhanced antioxidant protection; however, high salinity triggered oxidative stress and carbohydrate depletion. Analyses of monovalent ions content showed a gradual accumulation of sodium and chloride ions in roots and especially in the foliar tissue whereas the concentration of K^+ in roots increased significantly in plants from the 0.3 M NaCl, indicating an enhanced absorption of this ion, as a key mechanism of salt tolerance in this species.

The results of this research may help the conservation efforts for this critically endangered species but also highlight its prospective function in the rehabilitation of saline soils. Further research into the genetic and molecular mechanisms that facilitate these adaptations will be important in formulating new strategies to address global issues and biodiversity conservation.

Keywords: Halophyte, abiotic stress, conservation programs, Mediterranean flora, *in situ* conservation

Acknowledgements: The authors acknowledge the Valencian Region's "Centre for Forest Research and Experimentation" Team for their assistance with the seed study and conservation at the. D.M.M. was supported by a predoctoral contract from the Polytechnic University of Valencia, Spain.

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Interaction of the invasive grass *Spartina patens* (Ait.) Muhl. with the coastal local plant and microbiota communities

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Coastal wetlands are ecosystems of high ecological value due to both the ecosystem services they provide and the rich biodiversity they host. However, these ecosystems are threatened by anthropogenic pressures, climate change effects, and invasive non-native species. The latter are known to cause alterations in the diversity, abundance, and function of local vegetation and soil microbiota. The Albufera Natural Park, a Mediterranean wetland located on the east coast of Spain, faces the spread of *Spartina patens*, a halophytic grass native to the Atlantic coasts of North America. This invasive species forms dense mats that compete with the native plant community. However, while its invasive capacity and impact on biodiversity are known, its specific effects on soil fungi and bacteria remain largely understudied.

In this work, we investigate the impact of *S. patens* on the biodiversity of both plant communities and soil microorganisms in the Albufera Natural Park. First, we mapped the distribution of *S. patens* in five marshes and produced their phytosociological inventories to evaluate plant biodiversity in the inside and boundary of the marshes. Second, we characterised the soil microbial communities present in samples from invaded and non-invaded areas with *S. patens* by metagenomic analysis. Finally, we characterised the root fungal endophyte communities from two native species (*Phragmites australis*, which inhabits the marsh, and *Imperata cylindrica*, which lives in the boundaries), as well as from *S. patens.*

Spartina patens reduced the diversity of nearby plant communities. The metagenomic analysis revealed no clear differences in soil microbial diversity (fungi and bacteria) between the inside and the boundary of the marshes. However, *S. patens* hosted around four times more species of mycorrhizal fungi than the other grass species, which might provide a competitive advantage in colonising new areas and potentially disrupt the delicate ecosystem balance.

Keywords: Metagenomics, plant communities, root endophytes, soil microorganisms, *Spartina patens*.

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Gone with the heat?: the adaptive edge of hybridization under rising temperatures

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Hybridization between species influences biodiversity and species survival, in numerous ways, many of which depend on the fitness of the hybrid relative to the parental species. Hybrids can exhibit a range of fitness outcomes, from superior to inferior or intermediate, relative to their parental lineages, shaping their ability to adapt to new or challenging environments. Hybridization may play a critical role in fostering resilience, as hybrids combine genetic traits from multiple lineages, enhancing their ability to cope with new stressors.

In this study, we investigated the effects of temperature stress (15°C, 25°C, 37°C, and 42°C) on naturally hybridizing daffodil species (*Narcissus cavanillesii*, *N. serotinus*, and *N. miniatus*) and their interspecific hybrids. We assessed growth parameters such as plant height, fresh weight, number of leaves and flowers along with biochemical stress markers including chlorophyll content, total flavonoids, and proline levels. The experiments were conducted under controlled conditions, encompassing first- and later-generation pure and hybrid lines, to evaluate their physiological and biochemical responses to temperature variation.

Hybrids demonstrated superior temperature tolerance up to 37°C compared to their parental species. This resilience was linked to their enhanced ability to regulate ion transport and osmolyte biosynthesis, key processes for managing cellular stress. At these temperature levels, hybrids showed better growth parameters, such as greater plant height and fresh weight, compared to parental lines. Biochemical responses, including higher levels of chlorophyll, flavonoids, and proline, were more pronounced in hybrids, indicating stronger physiological mechanisms to mitigate stress. At 37°C, hybrids continued to outperform parental species, suggesting an adaptive edge under high-stress conditions. Parental species displayed significant stress and reduced fitness at this threshold. At 42°C, both hybrids and parental species suffered major fitness declines, with survival rates severely impacted. This highlights the critical challenges posed by extreme temperatures, which could threaten both hybrid and parental lineages. However, the significant decline in fitness observed at extreme temperatures (42°C) underscores the limits of even the most adaptable species. This suggests that while hybridization may offer short- to medium-term resilience, the increasing intensity and frequency of climate stressors could surpass the adaptive capacity of many species, including hybrids.

This study highlights the adaptive potential of hybrid species, particularly under moderate climate stress, and their importance in maintaining biodiversity in an era of rapid environmental change. However, the stark impact of extreme temperatures on both hybrids and parental species emphasizes the urgent need for global action to mitigate climate change and preserve ecological balance. Hybridization offers a glimpse of nature's capacity for adaptation, but its success depends on the limits of environmental stress and the resilience of the ecosystems that support it.

Keywords: adaptation, ecological genetics, hybridization, physiology, stress tolerance

Acknowledgements: This research received national funds through the FCT – Fundação para a Ciência e a Tecnologia, I.P., Portugal through the project HyAdapt 10.54499/2022.01458.PTDC (https://doi.org/10.54499/2022.01458.PTDC), the research units UIDB/00329/2020 (CE3C), UID/00239 (CEF) and under the Scientific Employment Stimulus - Individual Call (CEEC Individual) - 2021.01107.CEECIND/CP1689/CT0001 (IM).

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Comparative germination strategies of annual species under varying temperature and light conditions

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Understanding the germination strategies of endemic species is essential for biodiversity conservation, particularly in regions with complex climatic patterns such as the Mediterranean. This study evaluates the germination responses of eight *Linaria* species, endemic to the Western Mediterranean, under varying temperature and photoperiod conditions.

Linaria amethystea (Vent.) Hoffmanns. & Link, *Linaria polygalifolia* subsp. *polygalifolia*, *Linaria hirta* (L.) Moench, *Linaria polygalifolia* subsp. *lamarckii* (Rouy) D.A.Sutton, *Linaria munbyana* Boiss. & Reut., *Linaria oblongifolia* subsp. *haenseleri* (Boiss. & Reut.) Valdés, *Linaria pedunculata* (L.) Chaz., *Linaria ricardoi* Cout. and *Linaria spartea* (L.) Chaz. represent a broad ecological range across the Mediterranean region, thriving in diverse habitats such as rocky hillsides, dry grasslands, coastal areas, and disturbed open fields. They occupy ecological niches in natural and disturbed environments, from scrublands to pastures, and are typically associated with sun-exposed areas. The goal was to identify ecological adaptations and optimal conditions for germination, with implications for conservation and habitat restoration strategies.

Seeds of *Linaria* species were collected from natural populations and subjected to controlled germination experiments. Temperature regimes included constant conditions (15°C, 20°C, 25°C) and alternating cycles (25/15°C), combined with a 16/8 hour light/dark photoperiod. Parameters such as final germination percentage, germination rate (T50), and uniformity (T75-T25) were calculated. Data were analyzed using one-way ANOVA to determine significant differences between treatments.

Preliminary results reveal significant interspecific variability in germination responses. While some species showed optimal germination at lower temperatures (15–20°C), others required higher temperatures (25°C) or alternating regimes, reflecting adaptations to Mediterranean seasonal cycles. Additionally, photoperiod emerged as a critical factor, with germination rates significantly enhanced under light/dark conditions for certain species. Species-specific dormancy patterns were also observed, potentially linked to seed coat characteristics and ecological niches.

These findings highlight the role of temperature and light in driving germination strategies among *Linaria* species. The variability observed underscores the importance of tailored conservation strategies that consider the ecological requirements and adaptive potential of each species. Furthermore, understanding these germination dynamics can inform seed bank protocols and ecological restoration efforts in Mediterranean habitats threatened by climate change and human activities.

Keywords: *Linaria* species, Temperature response, Germination ecology, Western Mediterranean

Acknowledgements: This research received national funds through the FCT – Fundação para a Ciência e a Tecnologia, I.P., Portugal through the project HyAdapt 10.54499/2022.01458.PTDC (https://doi.org/10.54499/2022.01458.PTDC), the research unit UIDB/00329/2020 (CE3C), UID/00239 (CEF) and under the Scientific Employment Stimulus - Individual Call (CEEC Individual) - 2021.01107.CEECIND/CP1689/CT0001 (IM).

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In situ and ex situ conservation actions on *Galium litorale*, a priority species of the Habitats Directive strictly endemic to Sicily

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Galium litorale Guss. (Rubiaceae) is a perennial rhizomatous herbaceous plant with erect to erect-ascending stems forming densely branched bushes, 6-8 verticillate linear-oblanceolate, and pointed leaves, dense axillary inflorescences with white, tetramerous, bisexual, protandrous flowers. The species produces fleshy, creamy, bicarpellate, berry-like fruits, which is rather uncommon in the genus. It is endemic to southwestern Sicily (Italy), limited to the province of Trapani, where it typically grows in coastal and inland Mediterranean shrublands dominated by *Chamaerops humilis* L. and/or *Quercus coccifera* L., at altitudes ranging from 15 to 250 meters above sea level.

Galium litorale is listed in Annex II* and IV of the EU Habitats Directive (92/43/EEC) and is classified as Near Threatened (NT) under the IUCN Red List, with an unfavorable-bad and declining (U2-) conservation status, according to the most recent Art. 17 reporting. For these reasons, *Galium litorale* was selected as one of the target species in the LIFE SEEDFORCE project (LIFE20 NAT/IT/001468) which aims to improve the conservation status of 29 EU Habitats Directive Annex II species with an 'unfavorable-Inadequate' (19 taxa) or 'Unfavorable-Bad' (10 taxa) conservation status through an integrated ex situ-in situ approach to remove the threats and improve habitat and population quality in 76 Natura 2000 network sites, where these species currently grow or have recently disappeared.

Prior to the LIFE project, knowledge of the geographic distribution of *Galium litorale* was limited to old literature, herbarium specimens and some fragmented floristic reports. No information was available regarding its reproductive biology and seed germination behavior. The activities carried out during the LIFE project allowed us to 1) check the current distribution range of this species, 2) assess the ecological requirements and population consistency, 3) investigate the plant-insects interactions and 4) understand its reproductive capacity and seed germination regulation, as well as seedling growth.

As a result, twenty new populations were discovered, most of which are outside any protected area. Four of the previously reported populations were confirmed, but 16 others have not been located to date. These findings have led to a proposal to expand the surface area of three SACs to include the new populations, covering approximately 1,700 hectares, thereby contributing to the achievement of the "30x30 target" (Target 3) of the Global Biodiversity Framework. In addition to population monitoring, in situ conservation actions also involved the translocation of plants from local wild germplasm, facilitated by propagation activities at the Seed Bank of Palermo University (*Sicilian Plant Germplasm Repository*). Despite a high percentage of aborted seeds, the germination ability of viable seeds was high, ranging between 92% and 100% across different populations, using the best germination protocol. The rooting and growth capacity of seedlings propagated from both seed and cuttings of branches or rhizomes showed variable results among different donor populations and propagation materials. Specifically, rhizome cuttings had a 100% survival rate, while germination tests showed a survival rate of 21-65%. No plants have survived from branch cuttings to date. Additional experiments are still underway to optimize the branch cutting technique and direct seed sowing in pots.

Keywords: Habitats Directive, integrated conservation, endemic plants, Mediterranean flora, plant propagation

Acknowledgements: The EU financial support by the LIFE20 NAT/IT/001468 project, SEEDFORCE - Using SEED banks to restore and reinFORCE the endangered native plants of Italy, is gratefully acknowledged.

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Biobanking and conservation of endemic threatened plant species at the National Biodiversity Future Centre (NBFC) in Italy

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The National Biodiversity Future Center (NBFC) is the first National Research and Innovation Center dedicated to biodiversity, funded by the Italian Ministry for Universities and Research (MUR) through European Union funds – Next Generation EU.

It is a consortium involving a network of 48 partners, among research centres, universities and companies, which work together for monitoring, conserving, restoring and enhancing Italian and Mediterranean biodiversity. Main goals of NBFC are (1) providing scientific knowledge and technological innovation to better understand and address drivers for biodiversity decline at marine, terrestrial and urban level and (2) valorising biodiversity by transferring to the territory the knowledge and skills needed to protect the natural heritage and make biodiversity a focal point of sustainable development.

The implementation of NBFC activities is guaranteed by its eight nodes or spokes, six of which are devoted to scientific research on three main thematic areas of the Mediterranean region, namely, marine, terrestrial, and urban biodiversity. The seventh spoke is devoted to disseminating biodiversity knowledge and NBFC research findings to the wider society, while the eighth node is dedicated to support KETs and Open Innovation.

The Seed Bank of Palermo University (*Mediterranean Plant Germplasm Repository* – MPGR/PA) collaborates to the NBFC activities within the Spoke 7, in the realization of a biobank acting as a centralized repository for archiving different kinds of biological material and vouchers. Historical and modern collections, containing zoological, botanical, geological, paleontological and paleoanthropological samples, not only account for the extraordinary Italian biodiversity but also provide relevant taxonomical, biological and geographical information useful for interpreting the responses of biodiversity to climate and environmental changes.

The MPGR/PA is preparing a first NBFC collection of plant material from rare and threatened species of the Mediterranean flora, with a special focus on the Sicilian endemics. Biobanking activities namely include 1) seed collections from wild populations and long-term germplasm storage; 2) seed morphological characterization and germination studies; 3) plant tissue collections, i.e. lyophilized leaves, for research purposes.

Currently, seed accessions from 200 taxa have been collected and duplicated at MPGR/PA as NBFC collection. At the same time, leaf samples (3-5 individuals per population) from 70 different taxa have been stored at -20°C to be later lyophilized. Data of these biological collections have been digitalized and archived according to the Darwin Core standards (DwC), which facilitate sharing biodiversity datasets. In addition, a seed atlas of the Sicilian endemic species threatened with extinction is being prepared for publication.

Keywords: biobanking, biological collections, plant germplasm, seed bank, biodiversity informatics

Acknowledgements: this work is funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4 – Call for tender No. 3138 of 16 December 2021, rectified by Decree n. 3175 of 18 December 2021 of the Italian Ministry of University and Research funded by the European Union – NextGenerationEU. Project Code CN_00000033, Concession Decree No. 1034 of 17 June 2022 adopted by the Italian Ministry of University and Research, CUP B73C22000790001, Project title “National Biodiversity Future Center – NBFC“

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A dynamic checklist of the endemic vascular flora of Lebanon mountain ranges

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Lebanon is a biodiversity hotspot in the Mediterranean, home to unique flora, including endemic vascular species. However, more data is needed on their distribution and ecological needs. Identifying priority areas for plant diversity is crucial for effective conservation. This study presents the first updated list of vascular plant species endemic to Lebanon. These species are important for research and conservation as they represent the distinctive floral heritage of the country. After a thorough review of literature and regional floras, comparison of comprehensive online taxonomic databases and examination of approximately 1,600 specimens from the herbaria of Beirut, Paris, Geneva, Kew, and Edinburgh, we compiled an updated checklist of 170 plant species endemic to the ranges of Mount Lebanon, Anti-Lebanon, and Mount Hermon. Conservation approach is presented as approximately 50% of these species are assessed as Vulnerable (15), Endangered (50) or Critically Endangered (14) according to IUCN guidelines and criteria. This list of accepted plant species is dynamic, reflecting continuous taxonomic revisions driven by genetic analyses, the discovery of new records, and potential shifts in the known distribution ranges of taxa.

Keywords: Conservation priorities, Levant flora, Eastern Mediterranean, Mediterranean flora, database.

Acknowledgements: This research was conducted as part of a PhD program and was funded by the University of Cagliari, Italy.

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National IUCN Red List Assessment of Rare and Endemic Plant Species in North Macedonia

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The assessment of plant species for the National Red List in North Macedonia follows the International Union for Conservation of Nature (IUCN) methodology. This study presents the evaluation of 31 rare and endemic plant species, highlighting their conservation status and the threats they face. Field research, herbarium records, and geospatial analysis were used to determine the species' extent of occurrence (EOO), area of occupancy (AOO), population size, habitat conditions, and threats.

Until now, an official National Red List of plants has not been prepared in North Macedonia. However, at the end of 2019, a **Preliminary Red List** of North Macedonian flora was introduced, identifying **480 plant taxa (445 species and 35 subspecies)** for future assessment. The majority of these taxa are distributed in the western part of North Macedonia, particularly in ecologically significant regions such as the **Shar Mountains, Galichica, Jakupica, and Korab**, as well as along the **Radika, Crn Drim, and Treska river gorges** and the **shorelines of Ohrid and Prespa Lakes**. Notably, **Shar Mountain harbors at least 70 taxa, Galichica 55, Jakupica almost 50, and Korab around 40 taxa**. This pattern aligns with the region's complex topography and climate, which favor species richness and endemism.

To date, **14 plant species** listed in **Annex II of the Habitat Directive and the Bern Convention** have been formally assessed using the IUCN methodology. Additionally, through various conservation initiatives, assessments have been conducted for **17 other plant species**, 12 of which are **endemic to Galichica National Park**. However, their endangered status has yet to be officially recognized at the national level.

The present study assessed **31 plant species**, classifying five as **Critically Endangered (CR)** (*Lycopodium clavatum, Angelica palustris, Astragalus physocalyx, Aldrovanda vesiculosa,* and *Thymus oehmianus*), nine as **Endangered (EN)** (*Galium rhodopeum, Menyanthes trifoliata, Echium russicum, Marsilea quadrifolia, Trapa natans, Alchemilla peristerica, Centaurea galicicae, Rindera graeca,* and *Viola allchariensis*), and eight as **Vulnerable (VU)** (*Ramonda serbica, Lindejrnia procumbens, Campanula abietina, Gentiana lutea, Salvinia natans, Centaurea tomorosii, Jurinea micevskii,* and *Viola kosaninii*). The remaining nine species are categorized as **Least Concern (LC)** or require further evaluation. Most species were assessed using **Criterion B (restricted geographic range)** and **Criterion D (small population size)**, as they exhibit **limited distributions, fragmented populations, and significant habitat loss**. Major threats include **habitat degradation due to land-use changes, climate change, overexploitation, and competition from invasive species**.

These findings contribute to national conservation efforts, emphasizing the importance of regional cooperation to safeguard North Macedonia's unique plant diversity. The data provided will serve as a foundation for **future conservation planning, legislative improvements, and integration into regional and global IUCN assessments**.

Keywords: IUCN assessment, North Macedonia, endemic plants, conservation status, biodiversity

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Community-based participatory research for the conservation of three plants endemic to Tunisia and restricted to a single site.

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Tunisia has approximately 70 endemic plant species, many of which are restricted to a single site (SSE). The conservation of these plants requires dedicated programs, especially for those growing in Important Plant Areas (IPAs) and/or Key Biodiversity Areas (KBAs) that currently lack protection. One of the main missions of Association la Recherche en Action (REACT) is to conserve biodiversity in Tunisia, with a specific focus on endemic flora and SSEs.

In collaboration with botanists and the International Union for Conservation of Nature (IUCN), REACT organized a meeting in 2016 to finalize the list of Tunisia's IPAs, followed by another in 2017 to raise awareness among decision-makers about their conservation value. Since 2019, REACT, alongside other organizations, has led or participated in three projects funded by the Critical Ecosystem Partnership Fund (CEPF). These projects aimed to conserve three SSEs, each located in private areas within a KBA with no prior conservation efforts: Garâa Sejenane (*Rumex tunetanum* Barratte & Murb), Dyr el Kef (*Trifolium squarrosum* subsp. *tunetanum* (Murb.) Maire ex Dobignard & C. Chatel.), and Djerba Island (*Limonium formosum* Bartolo, Brullo & Giusso).

These projects involved scientific activities such as field surveys, ecological studies, and ex situ conservation, alongside training and awareness-raising efforts for civil society, protected area managers, and decision-makers. A participatory conservation plan was developed for each SSE, in collaboration with local and national researchers. These efforts led to: the inclusion of Garâa Sejenane in the Ramsar site list, along with the training of young people in monitoring protocols for heritage plant species, including *R. tunetanum*; the creation of a Groupement de Développement Agricole (GDA) for the IPA Dyr el Kef and the protection of small land plots to safeguard its endemic species' habitat; the involvement of the Agence de Protection et d'Aménagement du Littoral (APAL) in monitoring the habitat of *L. formosum* in the public maritime domain of Djerba Island.

However, urgent technical and financial measures are required to ensure the long-term sustainability of these participatory action plans and to encourage local civil society to support their implementation. These strategies can also serve as models for protecting other SSEs in Tunisia and across the Mediterranean, with necessary adaptations to the specific ecological contexts of each species.

Keywords: Tunisian flora, In situ conservation, participatory conservation plan.

Acknowledgements: REACT would like to thank the CEPF team, in particular Mrs Awatef Abiadh & Mrs Salwa Elhalawani, as well as all our partners and the Direction Générale des Forêts (DGF) for their encouragement and support during the implementation of the three projects.

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Floristic Study of Ariggibba Region-Fezzan Province in Libya

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This study aims to analyze the floristic composition of Ariggibba region in Fezzan province, Libya, over two consecutive growing seasons, from January 1, 2024, to January 1, 2025. During this period, field surveys resulted in the identification and collection of **163 plant species**, belonging to **39 families**, including **34 dicotyledonous** and **5 monocotyledonous families**. The most dominant family was ***Poaceae***, comprising **30 species**, followed by ***Asteraceae* (23 species)**, ***Brassicaceae* (16 species)**, and ***Zygophyllaceae* (12 species)**. At the genus level, **Euphorbia** was the most represented, with **6 species**, followed by **Fagonia (5 species)**, **Amaranthus (4 species)**, and **Tribulus, Launaea, Eragrostis, Conyza, and Chenopodium**, each contributing **3 species**. Life-form spectrum analysis revealed that **Therophytes** were the most predominant, accounting for **98 species**, followed by **Hemicryptophytes (18 species)** and **Geophytes (12 species)**. Furthermore, Chorotype spectrum analysis indicated the dominance of **Saharo-Arabian (Sah-Ar) elements**, comprising **27 species**, followed by **Mediterranean/Iranian-Turanian elements (23 species)**. These findings provide valuable insights into the **floristic diversity, ecological distribution, and adaptive strategies of wild plant species in the Ariggibba region,** contributing to a better understanding of the region's biodiversity and conservation priorities.

Keywords: Flora, Libya, Ariggibba, Fezzan, Lifeform, Chorotype.

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Habitat Selection to Reintroduce *Iris bismarckiana* in Semi-Arid Environments

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Conservation of endangered plant species in their indigenous regions is of crucial importance, especially for those grown in semi-arid regions. The objectives of this study were to explore the Nazareth iris's (*Iris bismarckiana*) natural habitat and identify new suitable sites to initiate a reintroduction program of this endangered plant species in a semi-arid environment. The study was conducted in Dibbeen Forest Reserve, Jordan, where six zones inside the reserve [A–F] were assessed in addition to zone G outside the reserve borders that represents the area where *I. bismarckiana* still exists. Habitat selection variables (topography, soil physical and chemical properties, climatic data, and potential risks and benefits) from all zones within the reserve were cross matched with that of zone G. The results showed that climatic data of all selected sites were suitable for reintroduction; all sites are open to direct sunlight most of the day. The minimum soil depth was greater than 40 cm in all zones, while soil respiration level revealed that zone A (a recreation site) was below the recommended thresholds. The percentage of stone volume (>2 mm) in the soil profile was high in zones D and F. Zones E, C, and F were extremely steep (>40 degrees), which undermined their potential to be suitable habitats. All sites are susceptible to high human disturbance risk except zone B, which is protected and under continuous surveillance by the Reserve Botanist. Considering all measured suitability indicators, including slope degree suitability (<25), soil respiration (57–77 mg kg 1), soil stone percentage value (8.3%), tree canopy cover (open area), and human disturbance potential (low risk), zone B holds promise as a suitable site for a *I. bismarckiana* reintroduction program. Therefore, the initiation of long-term reintroduction programs within this site with timely surveillance is urgently needed to conserve and support such valuable species self-regeneration.
Keywords: *Iris bismarckiana*, plant conservation, reintroduction, habitat selection, endangered species

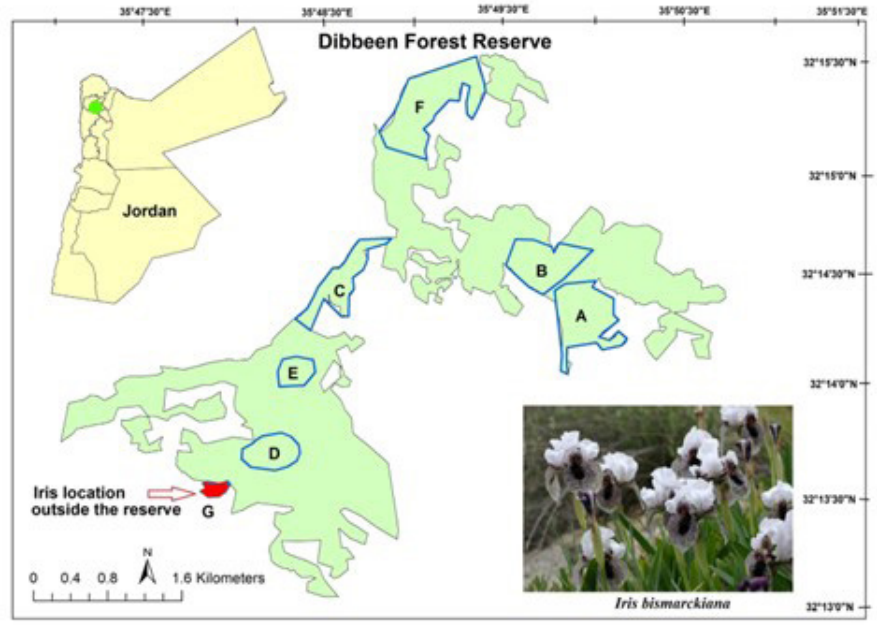

Figure 1. Dibbeen Forest Reserve and the suggested sites (A–F zones) for reintroduction of *Iris bismarckiana* within the reserve; Zone G represents the location of existing *I. bismarckiana* outside the reserve boundaries.

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Assessment of the current protection status of endemic plants in the south-east of Albanian

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The CEPF and PONT project, 'SRE of Prespa NP – Assessment, Protection, and In-situ/Ex-situ Conservation through the Involvement of Young Professionals,' aimed to support the National Agency of Protected Areas in Albania by assessing the conservation status and protecting the restricted endemics that occur near the border or share their habitat with neighboring areas of Greece and North Macedonia. The project focused on training and engaging young botanists, as well as regional staff from Protected Areas in the southeastern part of the country, in monitoring plant species and habitat types. This was carried out using the IUCN categories and criteria methodology.

During the project, 10 restricted endemic plant taxa were assessed, while in the past two years, with the support of PONT and NASRI, eleven additional taxa have been assessed, including; *Acantholimon albanicum, Acanthus caroli-alexandri, Centaurea devasiana, Crocus cvijicii, Crocus novicii, Galanthus reginae-olgae, Odontarrhena albiflora, Odontarrhena moravensis, Oxytropis dinarica subsp. weberi, Scorzonera lafranchisiana* and *Solenanthus albanicus* have been assessed or re-assessed based on new data on their distribution range and the new threats observed in the field.

For each taxon, data on population size, number of localities, AOO (Area of Occupancy), EOO (Extent of Occurrence), ecology, habitat types, and relevant threats are collected, analyzed, and assessed. Two taxa, *G. reginae-olgae* and *S. albanicus*, had previously been assessed as globally threatened. The re-assessment shows an increase in AOO, EOO, and population size for the first taxon, while *S. albanicus* has experienced a decline in both EOO and population size. Consequently, the conservation status of *G. reginae-olgae* is now assessed as LC (Least Concern), while the conservation status of *S. albanicus* has worsened compared to the previous assessment, remaining EN (Endangered), with a potential shift toward CR (Critically Endangered) if the decline in its population continues.

Based on field observations and monitoring, most of the assessed restricted endemics have been reported from Alpine and subalpine calcareous or serpentine rocky ground grasslands, as well as calcareous rocky slopes with chasmophytic vegetation habitat types. The primary and common threats to the assessed taxa include climate change and severe weather (11.1 Habitat shifting and alteration; 11.2 Droughts; 11.3 Temperature extremes) and natural ecosystem modifications (7.1.1 Increased fire frequency/intensity; 7.2 Dams and water management/use; and other ecosystem modifications).

The results of species monitoring and assessment have been presented to the local authorities of Protected Areas and National Agency of Protected Areas, where their conservation measures are proposed to be include in the Management Plans. In the frame of enlargement of the PA surface, several species now are included within the current net of PA and 4-taxa, *A. albanicum, Chamaecytisus pseudojankae, C. cvijicii* and *C. novicii* are conserved ex-situ in the Botanical Garden of Tirana and the Prespa National Park center.

Keywords: Albania, transboundary conservation, conservation status, rare and endemic plants, habitat, threats, management plan.

Acknowledgements: This work was supported by grants from CEPF, PONT, and NASRI. We are grateful to these organizations, as well as to the Ministry of Tourism and Environment of Albania, for their support and the resources provided in the field, including the involvement of the Regional Administration of Protected Areas.

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Taxonomic Reassessment of Maltese Narcissus (Amaryllidaceae): Implications for Species Delimitation and Conservation

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The genus *Narcissus*, renowned for its horticultural appeal and taxonomic intricacies, presents significant challenges in species delimitation. In section Tazeitae, and particularly with *N. tazetta*, 19th-century taxonomists frequently described new taxa based on minor morphological variations, occasionally resorting to numerical designations when epithets were scarce. In contrast, twentieth-century revisions tended to consolidate numerous taxa into single, broadly circumscribed species. For instance, according to World Flora Online, *N. tazetta* is associated with approximately 40 epithets (across various taxonomic ranks) that are currently treated as synonyms.

Preliminary investigations conducted between 2010 and 2015 on *Narcissus* populations in Malta revealed a more complex scenario than the prevailing hitherto recognition of only two taxa (*N. serotinus* and *N. tazetta*). A further study undertaken from 2020 to 2024 revisited the taxonomy of sections Tazeitae and Serotini. This investigation re-established several neglected taxa that had been presumed conspecific with well-accepted, closely related species. Notably, the small autumn-flowering daffodil, previously misidentified as *N. serotinus* or *N. obsoletus*, is now reinstated as *N. deficiens*. Furthermore, the traditional concept of *N. tazetta* in Malta, encompassing specimens flowering between October and March (with individual flowering periods not exceeding four weeks), is here redefined into two subspecies. Additionally, the autumn-flowering component of *N. tazetta* is reassigned to a distinct species, *Hermione aequilimba*, based on herbarium material collected in Malta by Herbert. Remarkably, crosses between *Hermione aequilimba* and *N. deficiens* produce a rare, sterile hybrid that represents a novel taxon.

Thus, the Maltese archipelago harbours four distinct *Narcissus* taxa rather than the two previously recognised. Ongoing investigations are assessing an additional morphotype of *N. tazetta*, characterised by its January flowering and reduced, narrow leaves, to determine whether it merits taxonomic recognition or represents an ecotypic variation.

These findings necessitate a redefinition of *Narcissus* taxa in Malta and may prompt similar taxonomic re-evaluations across Mediterranean regions. Moreover, the taxonomic clarifications have significant conservation implications. The reclassification of what was once considered a single species (*N. tazetta*) into multiple, potentially rare and restricted taxa—including a new hybrid—highlights the importance of detailed taxonomic research in identifying cryptic diversity that may be at risk and would thereby inform conservation priorities.

Keywords: *Narcissus*, species diversity, hybrid speciation, conservation measures, Mediterranean flora, Mediterranean habitats.

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Increasing the conservation value of a Mediterranean cypress forest thanks to the contribution of fungi

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The Mediterranean cypress, Cupressus sempervirens, is an evergreen coniferous tree original of the eastern Mediterranean, and it is published by the IUCN as a species of low concern (LC) at European and global level. Also called the Italian or Tuscan cypress, it has been widely planted as an ornamental plant since a long time not so far from its native area in the whole Mediterranean basin and not only, reaching other continents.

On the other hand the Mediterranean cypress seldom grows spontaneously forming forests. The ones present in Greece and Cyprus are till now recognized as natural habitat types of community interest and listed among the European Union Natura 2000 sites.

In this context to mention the Nature Reserve “Bosco di Sant’Agnese” (Siena, central Italy) showing an extended natural-reproducing forest of *Cupressus sempervirens*, that originate from an ancient plantation of about 1000 years ago. Due to its historical, landscape and naturalistic importance the area was included in the Habitat 83.3113 “European cypress and juniper plantations”. Moreover to remember that this Reserve was chosen as an Important Plant Area IPAs with code “TOS 29”, due to the presence of a relevant assemblage of rare and interesting species, in respect also to fungi.

Even if fungi are still not listed in the appendix of the Habitat Directive, the aim of the present work was to add the mycological point of view underlining the conservation value of the Mediterranean cypress forest of Sant’Agnese. The compilation of informations coming from various sources, published and not, brought to list more than 330 taxa, an interesting biodiversity.The Reserve is the *locus typicus* of 3 fungal species described as new for science, this are *Lindtneria hydnoidea, Mycena cupressina, Mycenella variispora*. In the “IUCN Red List of threatened species” *Entoloma bloxamii* and *Tricholoma apium* are published as vulnerable (VU) and *Boletopsis grisea* as near threatened (NT). Another interesting species is *Sarcosphaera coronaria,* described by Giorgio Santi in 1789 and 1795 respectively, and considered to be threatened throughout Europe. This was only an example among others, an attempt to show the importance of the third “F”, the Funga, in addition to Fauna and Flora, in increasing the conservation value of an area, awaiting that soon the mycological point of view can be officially recognized.

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Silene hicesiae: an insight into the reproductive biology of an insular endemic plant affected by pollen-limitation and seed-predation

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Silene hicesiae is a perennial plant, endemic to the Aeolian Islands, with two extant populations, one in Alicudi and one in Panarea (60 km apart). It is listed in the Annex II of the Habitat Directive and is one of the target species of the project LIFE SEEDFORCE, which aims to reinforce these two populations and to understand the ecological factors that may affect their reproductive success. Plants may evolve different reproductive strategies to optimize their offspring production. Therefore, the scope of this study is to: a) investigate the reproductive biology of *S. hicesiae*; b) evaluate its susceptibility to pollen limitation; c) evaluate its *in-situ* reproductive success and d) identify its pollinators.
The floral biology was monitored in 20 flowering plants (10 per population) propagated *ex-situ* at the Seed Bank of the University of Catania. Five pollination treatments were conducted to assess whether self-pollination occurs, or the species may be pollinator-limited. Autogamy and wind-mediated pollination (anemophily) were tested by covering with nylon-mesh bags, respectively, entire or emasculated flowers. To test the effect of pollen supply, flowers were hand-pollinated with flowers from the same plant (geitonogamy) or from a different one (xenogamy) and covered. The control treatment consisted of flowers exposed to natural pollination. Per each treatment fruit set, seed set, seed weight, and seed germinability were assessed. The pollen limitation index (PL) was calculated based on the seed set from control and xenogamy treatments. Observations aimed at identify possible pollinators were conducted in the common garden (Catania, Sicily) and in the two natural populations. The fruit set and fruit loss were estimated in the two wild populations by counting the flowers and the fruits of three stems per plant over a sample of at least 18 plants per population, both in 2023 and 2024.

The anthesis of hermaphroditic flowers started at dusk and exhibited a protandrous dichogamy. The male phase lasted two days, followed by the female phase which lasted another two days, with stigma elongation occurring on the third day of anthesis, and stigma receptivity reached on the fourth day. Pistillate flowers were also observed, which presented a smaller corolla (17.86 ± 1.02 mm) than hermaphroditic ones (26.47 ± 1.37 mm). The pollination treatments resulted in no difference in fruit and seed set between populations, except in the control, where the seed set was lower in plants from Panarea. The species could be considered not autogamous since self-pollinated flowers had minimal or no seed set. Wind-pollinated flowers never produced fruits. The seed set from the control and assisted treatments suggested that the species may be prone to pollen limitation, (PL = 0.41 for Alicudi and 0.47 for Panarea), with a significantly lower seed set for the control than the two assisted treatments, which gave almost the same results. Only diurnal generalist pollinators (Hymenoptera, Halictidae *Lasioglossum* sp.; Apidae, *Apis mellifera*) were observed both in the common garden and in the natural populations, feeding on pollen and nectar. Moreover, a nursery-predator relation was observed with *Hadena bicruris* (Lepidoptera, Noctuidae) in the common garden and in the wild populations. The mean number of flowers per stem was 68 ± 26 (2023) and 55 ± 30 (2024) in Panarea, and 25 ± 12 (2023) and 21 ± 11 (2024) in Alicudi, and the stem production ranged from 1 to 30 in Panarea, and 1 to 14 in Alicudi. The fruit set of wild populations ranged between 43.8% (2023) and 57.3% (2024) in Panarea and between 33.2% (2023) and 41.4% (2024) in Alicudi. A highly variable loss of fruits was observed in the two wild populations depending on biotic and abiotic factors. The percentage of predate fruits by *H. bicruris* ranged between 9.4% (2023) and 3.9 % (2024) in Alicudi, and 5.8% (2023) and 3.6% (2024) in Panarea. Moreover, fruits predation by ants of genus *Messor* was observed in Panarea in summer 2024.

Silene hicesiae reproductive success depends on pollinators and could be highly variable over the years. The species may suffer from pollen limitation, seeds and fruit predation. Nevertheless, the species may compensate for pollinator abundance fluctuations by allocating more resources to ovules, flowers, and stems' production or with its long flowering period. The reinforcement of the natural populations by establishing high-density patches of plants may improve the effectiveness of pollination services and reproductive success of the species.

Keywords: assisted pollination, Caryophyllaceae, flower phenology, Mediterranean plants, population reinforcement, reproductive success

Acknowledgements: LIFE SEEDFORCE "Using SEED banks to restore and reinFORCE the endangered native plants of Italy". Reference LIFE20 NAT/IT/001468

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LIFE – AgrOassis: Regenerative approaches for building climate change resilience in EU agricultural regions prone to desertification

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The LIFE AgrOassis project (2022-2026) proposes nature-based solutions and circular economy approaches for combating desertification within degraded agroecosystems of Cyprus and Greece (Thessaly and Crete). Co-funded by the European Union LIFE program, its main land management interventions focus on changing unsustainable soil management by promoting minimum tillage, no-tillage, mulching and compost application in ca. 500ha farm land as well as by creating 30 km of resilient to drought hedgerows. Through the above interventions, the project aims to revert soil degradation and upgrade soil quality by improving the soil structure, preventing soil erosion, enriching soil carbon, preserving soil water, enhancing soil fertility, while promoting soil biodiversity. Combined with the hedgerow's beneficial impacts on microclimate, windborne erosion, and local biodiversity, the interventions are expected to improve ecosystem services within the prone to desertification farmlands. On the other hand, the fixation of CO_2 into soil carbon pools, the CO_2 sequestration into woody tissues on the hedgerows, along with the avoidance of carbon losses from uncontrolled green waste disposal and the reduction of GHGs emissions, through fossil fuel savings from minimum and no-tillage, are expected to contribute towards climate change mitigation. Finally, the use of compost is expected to promote the circular economy concept within the agro-sector community. Through the exploitation of a multi partner, multi actor approach, the LIFE AgrOassis project aims to mobilize the primary food production sector towards close-to-market sustainable solutions, while seeking to identify and remove obstacles related to inappropriate governance and policies, that obstruct the implementation of the EU's Green Deal Agenda.

Keywords: Conservation agriculture, no-tillage, mulching, compost, hedgerows, biodiversity

Acknowledgements: The LIFE – AgrOassis project is funded by the EU LIFE program LIFE21-CCA-CY-LIFE-AgrOassis/101074744.

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Ornithogalum sibthorpii Greuter in Montenegro – habitat shift and conservation state-of-art

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Ornithogalum sibthorpii Greuter (Asparagaceae) is an early-flowering, dwarf species distributed widely, in Turkey and Balkan Peninsula, reaching even in Romania. Despite its broad distribution, recorded populations of the species are scattered across its range, with its presence in Montenegro documented by only a few herbarium records, some of which are nearly a century old. Originally described from southwestern Turkey, this species is distinguished by a shortened underground scape and a prominent pulvinus at the base of the pedicels. These traits differentiate it from other morphologically similar taxa, such as *O. exscapum* Ten. and *O. refractum* Kit. ex Schltdl. Historically, it has been misidentified as one of these species, and we assume that this is the reason it has not been recorded in the floristic and vegetation studies of Montenegro thus far. This study aims to confirm the species' occurrence in Montenegro and explore its distribution, habitat preferences, morphological variability, and assess its conservation status at the national level according to IUCN criteria and categories.

Based on a known historical locality in Montenegro and data from neighboring countries with similar habitats, comprehensive field surveys were conducted between 2022 and 2024 to document locations and collect key biological and ecological traits across the coastal zone and the hinterland. Combined with herbarium specimen analysis, these surveys confirmed the widespread distribution of *O. sibthorpii* in southern Montenegro, spanning an altitude range of 0 to 1000 m. A distribution map based on the collected data is provided. The species occupies a variety of habitats, including open thermophilic scrublands, dry thermophilic grasslands, calcareous rocky slopes, and anthropogenically disturbed areas. Populations in Montenegro are abundant in some regions, while in others, they are more scattered. Additionally, in most populations, the number of individuals is fewer than 250. In the Balkan Peninsula, *O. sibthorpii* exhibits notable intraspecific variability, with two main morphotypes: one with a short scape and sessile inflorescence, and another with a longer scape and fewer flowers. Plants in anthropogenic habitats, such as parks and roadsides, are generally more robust, while those in natural populations show greater variability in size and flower number. Thus far, the same pattern has been observed in Montenegro.

Following the results of this study, where we aimed to provide the first confirmed record of *O. sibthorpii* in Montenegro, rather than merely contributing new insights into its distribution, morphology, and habitat preferences, we successfully gathered data indicating that, although present at a larger number of localities in Montenegro, its populations are scattered. Additionally, the species exhibits notable morphological variability and specific habitat selection, making it of interest for further research to determine its conservation status, as well as to improve our understanding of its general biology and ecology.

Keywords: Star-of-Bethlehem, eco-morphology, Mediterranean, habitats

Acknowledgements: The authors Danijela Stešević, Marina Šoškić and Aleksa Popović express their gratitude for the financial support provided by the Ministry of Education, Science, and Innovation of Montenegro through the national project "Plant genes, species, communities" (project No. 0402-082/23-1137/7) and Excellence Scholarship Program for Doctoral Research in Montenegro. The author, Milica Rat, gratefully acknowledges the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Grants No. 451-03-137/2025-03/ 200125 & 451-03-136/2025-03/ 200125).

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Priority areas for the establishment of genetic reserves to actively protect key crop wild relative species in Lebanon

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The preservation of global biodiversity, hampered by climate change and the different anthropogenic and environmental pressures, is nowadays crucial. In particular, the conservation and sustainable use of the diversity of wild plants that are genetically related to crops, referred as Crop Wild Relatives (CWR), can also help in maintaining the sustainability of food production. Conservation of CWR diversity *in situ*, and in genetic reserve is encouraged; a genetic reserve is defined as an area dedicated to the protection and maintenance of genetic diversity for active, long-term conservation. This study aims to identify best areas for establishing a network of genetic reserves in Lebanon to achieve the *in situ* conservation of 35 targeted CWR taxa belonging *to Aegilops* L., *Triticum* L., *Avena* L., *Hordeum* L., *Cicer* L., *Lens* Mill. and *Pisum* L.

CWR occurrences were retrieved from online databases and recent field surveys, piled data were analysed using the CAPFITOGEN3 toolbox. A generalist Ecogeographical Land Characterization map (ELC-map) was initially generated and the combination of CWR taxon populations with each defined ELC category (namely “CWR-Eco unit”) was then identified and considered as main conservation target. Two different complementarity analyses were performed to identify the minimum number of sites required to conserve the maximum number of CWR-Eco units inside and outside protected areas. The gap existing in *ex situ* conservation of the target CWR diversity was estimated by comparing the unique CWR-Eco units conserved in genebanks with those occurring in the wild.

A total of 24 ELC categories were defined for Lebanon, each dictating different bioclimatic, geophysical, and edaphic conditions. The 24 ELC categories harbor 253 different CWR-Eco units representing the predicted diversity of a total of 1460 CWR populations. According to the results of complementary analysis, 22.2% of the protected areas in Lebanon (6 out 27) harbor populations of 18 different target CWR taxa (51.4% of the total). The results also indicate that only 13% of the total CWR estimated diversity is currently occurring in protected areas corresponding to 58 populations of 33 different CWR-Eco units. Results of the complementarity analysis outside protected areas show that a network of 79 cells (5x5 km each) is required for the conservation of the whole predicted diversity of target CWR taxa (i.e. not already included in the 6 identified protected areas). The top 14 cells were selected as priority conservation sites based on their potential as genetic reserves to conserve 50% of the CWR diversity. As for *ex situ* conservation, seeds of 215 CWR-Eco units (85.0% of the total) are already conserved in genebanks; the remaining 38 still require collection efforts.

Keywords: Complementarity analysis, CWR diversity, Genetic reserves, *in situ* and *ex situ* conservation, Protected areas.

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LIFE Beyond the Project: Communication Strategies for Long-Term Impact Conservation Actions

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LIFE Programme conservation projects involve a significant deployment of financial and human resources but are always of limited duration. This means that their continuation over time depends on the involvement of stakeholders and citizens, who must share and own the objectives and vision.

When designing the communication strategies for these projects, is the more the better? Should we aim to reach as many people as possible or focus on building the loyalty of a specific public?

In the case of LIFE Teixeres (2021-2026), a project that aims to improve the conservation status and resilience of the priority Natura 2000 habitat Mediterranean *Taxus baccata* forests in the Valencian Community in Spain, strategies for citizen participation and involvement are one of the main pillars for a sustainable impact, even after the project work has been completed.

LIFE Teixeres' conservation actions are being carried out in 55 different locations across 10 Natura 2000 sites throughout the Valencian region, with the northernmost and southernmost work sites separated by around 400 kilometres.

The size of the area covered makes it challenging to develop appropriate networking strategies and to reach out to local communities, who must be aware of the actions and purpose of the project to become involved.

The communication, education and dissemination actions have been designed to define and target local audiences and stakeholders, open a space for dialogue and participation, and create spaces that encourage the creation of a strong network of citizens and stakeholders. The project aims to build an autonomous network, capable of continuing and expanding its goals.

On the one hand, given the limited resources and the vastness of the area, face-to-face presence limits the possibility of reaching a wide audience. Still, on the other hand, it allows the project to be perceived as something tangible and real where people can participate. This includes meetings, visits, plantations, seminars and workshops, as well as follow-ups, where the project team can learn about the needs of each territory and interest group.

In a society where the link with the target audience is usually digital, the LIFE Teixeres communication strategy focuses on face-to-face actions, complemented by social media. Human interaction has been useful in two main ways: adapting the project's actions to each territory and effectively involving the local population.

With this strategy, LIFE Teixeres is building a network of committed collaborators throughout the territory, who actively contribute to the development of activities and show initiative to ensure that conservation actions are sustainable and successful.

Keywords: LIFE Programme, Taxus baccata, communication strategies, networking, citizen participation, conservation actions

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Introducing SeedPOD, the Seed Portal for Online Data

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Ecological restoration at the scale and quality required to meet the climate and biodiversity crises will depend upon the availability of large quantities of high-quality, genetically appropriate native seed and the ability to access and use this seed effectively. However, it is widely acknowledged that this is a bottleneck that limits the restoration of resilient ecosystems on a landscape scale.

Practical solutions are required to: connect native seed production and supply to the needs of restoration practitioners; make high quality seeds available at the point of use; identify gaps and opportunities in native seed markets; share information and expertise and connect practitioners to researchers.

To help address these issues, SeedPOD is an exciting new open access resource for restoration and research communities due for release in 2026. SeedPOD will unlock detailed field, processing, seed quantity and viability test data on wild plant species from seedbanks worldwide and will link collections banked at multiple wild seed banks to enable direct comparison of related collections. SeedPOD will disseminate germination and propagation protocols to assist the process of transforming native seed back into thriving plant communities. Significantly SeedPOD will include a point of request for seed samples from all participating native seed collection holders.

Native seed collection holders will have in SeedPOD a user-friendly, reliable platform to disseminate their seed list easily and for free, and restoration practitioners will be able to access high quality data to support restoration, and to search across multiple seed banks and seed suppliers.

The needs of restoration practitioners are at the forefront of SeedPOD design, but we need your help to make the best resource we possibly can – please tell us what you want from SeedPOD!

Keywords: Native seed supply, seed supply bottleneck, digital data, seedbank collections, germination data

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Conservation of threatened species: the role of stereomicroscopy, scanning electron microscopy and education in plant conservation

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The seed bank, together with the laboratory unit of the Real Jardín Botánico, CSIC (there for RJB, CSIC), and in collaboration with the seed bank of the Jardín Botánico Castilla La Mancha and the natural history pavilion of the University of Almería, is developing a project to raise public awareness of the need for *in-situ* and *ex-situ* conservation work in plants conservation.

The project is structured in four actions: (1) The development of a photographic exhibition entitled "Threatened seeds: a journey through the microscope" with images of seeds of endangered species included in the Spanish Red List. The images will be captured using different techniques, including stereomicroscopy and scanning electronic microscopy, and will be accompanied by taxonomic information, distribution and conservation status.
(2) To create a digital morphological atlas of seeds, accessible from the RJB, CSIC website.
(3) To produce an identification guide, available on the RJB, CSIC website and in printed form.
(4) To develop an educational programme in four secondary schools in Madrid, Spain, to help students learn about the floristic diversity of Spain and the risk of threats to wild plants; their vulnerability and the threats to their populations and habitats, as well as the need and importance of developing conservation strategies through scientific knowledge. Plants, their seeds, microscopy techniques and photography will be used as teaching resources, which will promote inquiry-based learning to develop critical thinking.

The different activities will bring together scientists, technicians, teachers and students to share knowledge and expertise about plants and their conservation. The use of techniques such as stereomicroscopy and scanning electronic microscopy will enable participants to demonstrate the diversity and multifaceted aspects of seeds (a vital plant organ) that are unknown to society and often not visible to the human eye, such as the beauty, rarity and variety of forms.

Keywords: Seed, stereomicroscopy, scanning electron microscopy, conservation, education, plant diversity, threatened species.

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High-quality genomic resources for Cannonau: towards the conservation of Sardinian agrobiodiversity

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Sardinia (Italy) is a recognized hotspot of biodiversity and agrobiodiversity, with its rich cultural heritage and agro-pastoral traditions identifying it as the primary biocultural hotspot among Mediterranean islands. Generations of farmers have preserved its significant agrobiodiversity, which includes ancient, locally adapted varieties that offer adaptability to challenging environmental conditions, high-quality products, and unique opportunities in specialized markets. This distinctive agricultural heritage makes Sardinia an exceptional setting for studying biodiversity in the Mediterranean context.

Among the island's diverse agricultural legacy, grapevine has a long tradition of cultivation, shaped by centuries of adaptation to varied environmental contexts. This has led to the development of different local varieties with distinct characteristics. Cannonau, one of Sardinia's most iconic native *Vitis vinifera* cultivars closely related to Grenache noir and Garnacha tinta (respectively from France and Spain), and renowned for its Controlled Designation of Origin (DOC) wine since 1972, reflects this heritage and exemplifies the importance of conserving agrobiodiversity.

In this study, we present high-quality haploid consensus and phased genomic assemblies for Cannonau. Comparative synteny analysis revealed substantial genetic divergence between Cannonau and the *Vitis vinifera* reference genome (cv. Pinot Noir), as well as notable variability between its two haplotypes. A recent survey identified 85 Cannonau clones with substantial phenotypic diversity in agronomic and oenological traits, further highlighting its genetic complexity.

These genomic resources provide a foundation for investigating intra-cultivar biodiversity and offer insights into the genetic heterogeneity underlying Cannonau's phenotypic diversity. By enhancing our understanding of this iconic cultivar, the findings provide a comprehensive framework for conservation strategies and innovative approaches that promote sustainable agriculture, drive market innovation, and support science-driven policies aimed at preserving and valorizing Sardinia's rich agrobiodiversity.

Keywords: agrobiodiversity, genomic diversity, Intra-cultivar variability, Grapevine genomics, biodiversity conservation

Acknowledgements: This study includes part of a PhD project carried out by Lia Obinu at the PhD School of Agricultural Sciences of the University of Sassari, funded by the University of Sassari. Lia Obinu was also supported by ERASMUS for a Traineeship program awarded to the University of Sassari. This study was carried out within the Agritech National Research Center and received funding from the European Union Next-GenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) – MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4 – D.D. 1032 17/06/2022, CN00000022- CUP J83C21000300006.

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Unlocking the secrets of reproductive biology and pollinators in the rare Musschia wollastonii Lowe (Campanulaceae) of Madeira Island.

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Understanding the reproductive strategies of flowering plants is crucial for developing effective conservation plans of rare, threatened and endemic flora. Musschia wollastonii Lowe is a rare monocarp neoendemic species, with complex reproductive biology, characteristic of caulirosette communities that occur in forest clearings, landslides, and stream beds in the Madeiran stink-laurel forest. The combination of protandry, weak dichogamy and a mechanism of secondary pollen deposition promote outcrossing whilst allowing selfing to occur. Yet, selfing capability, incompatibility system and pollinator dependency were so far unknown, although having major consequences for the plant reproductive success and conservation. To clarify the breeding system and pollinators of M. wollastonii, we conducted hand-controlled pollination treatments and flower visitor monitorizations. Results show that M. wollastonii is a self-compatible species with spontaneous delayed selfing. This, combined with the plant's outcrossing promoting traits suggest a mixed-mating system. Flower visitors of the Syrphidae (Diptera) and Nymphalidae (Lepidoptera) families, were determined to have a pollinator role, but larcenist behaviour was prevalent, with pollen thieving having an impact on reproductive success. Bird visitors were previously reported by other authors but were absent during observations in the studied population.

Keywords: Delayed selfing; Pollen thief; Self-compatible

Acknowledgements: This study was co-financed by the European Regional Development Fund (ERDF) through the INTERREG MAC Operational Program 2014-2020, under the MAC2/4.6d/386 project - MACFLOR2. Collecting permits were obtained from the Instituto das Florestas e Conservação da Natureza, IP-RAM.

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