COST ConservePlants Final Conference

Book of Abstracts

Izola, 12–13 February 2024

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EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

CONSERVE Plants

COST ConservePlants Final Conference: Book of Abstracts
Izola, 12–13 February 2024

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Welcome Address

Dear participants,

I am very pleased to welcome you to the University of Primorska, the grantee of this COST Action. The COST Action CA18201 – which we know much better simply as ConservePlants – started in fall 2019 and will end in spring 2024. With Management Committee members from 39 participating countries and over 150 official Working Group members from Academia, Research institutions and NGOs, ConservePlants is one of the large COST Actions. This means that there is a wide range of different expertise from different disciplines among the many participants, resulting in truly diverse activities carried out during the Action.

The large number of participating countries also allowed us to carry out some activities for which the participation of many participants from many countries across Europe was essential, such as setting up a database of conservation actions, checking the databases of seed banks for the quality of their collections or obtaining information on the status of Red Lists from European countries. These are of course only some of the activities, but there were many more. We are aware of the fact that none of these lists or databases are or will ever be exhaustive, as things change over time. However, they are starting points on which we can build. For this reason, I also hope and believe that this is not really the end, but that our activities will continue through new projects and collaborations. Even if the final conference is the last meeting organised by our COST Action, the lasting personal friendships and scientific relationships that have been formed will certainly allow us to meet again.

Živa Fišer
Chair of the ConservePlants Action

Conference Programme

Monday, 12 February 2024

09.00–09.10 Intro – Greeting from University of Primorska Rector Klavdija Kutnar

09.10–09.30 Ž. Fišer & G. Aronne, ConservePlants – have we made any difference?

09.30–10.15 Keynote lecture | A. Pieroni, Could ethnobotany be a tool for proposing sustainable use of plant resources?

10.30–11.00 Coffee break

Session 1 | Chair: G. Aronne

11.00–11.20 L. Camilleri, Diversity in isolation: Dissecting the drivers of endemic plant richness on Mediterranean islands and archipelagos

11.20–11.40 B. Stojanova, The resurrection method reveals contemporary evolution of arable weeds in response to pollinator decline and climate change

11.40–12.00 A. Dalla Vecchia, Exploring the resource-use strategies of endangered *Utricularia* species and *Aldrovanda* for better conservation strategies

12.00–12.20 M. Barberis, Identifying reproductive barriers between two closely related, but ecologically distinct, sages (*Salvia saccardiana* and *S. pratensis*)

12.20–12.40 D. Calabrese, The influence of nectar chemistry in the tripartite interaction with pollinators and microorganisms in the tribe *Lithospermeae* (*Boraginaceae*)

12.40–13.30 Lunch break & prerecorded poster presentations

13.30–14.30 Posters – live session

Session 2 | Chair: M. Galloni

14.30–14.50 M. Charitonidou, Floral complexity as indicator of plant vulnerability: Lessons learned from the Mediterranean Red Data Books

14.50–15.10 Ü. Birben, The role and importance of law in the conservation of biodiversity
15.10–15.30 J. Wiland-Szymańska, Popularization of knowledge about endangered flagship plant species of Europe
15.30–15.50 S. Lozada Gobilard, Children's books as a strategy for plant conservation
15.50–16.30 Coffee break & socialising
16.30–17.30 Book event | Stories on Endangered Plants. Chair: B. Prūse, participants: S. Lozada Gobilard, K. Šoln, M. Barberis, K. Hrušková
19.00–22.00 Gala dinner

Tuesday, 13 February 2024

09.00–09.15 Greeting from Scientific Officer Marco Carulli

Session 3 | Chair: E. Fantinato

9.15–10.00 Keynote lecture | S. Castro, There is nothing permanent except change: Assessing reproductive shifts in the invasive Bermuda buttercup
10.15–10.35 U. Liu, Supporting plant conservation: The database of the national Red Lists of European vascular plants
10.35–10.55 M. Lazarević, What can we learn from the Database on Conservation Actions on Threatened Plant Species in Europe?
10.55–11.15 P. Glasnović, Recognizing the gaps: Assessing the national Red Lists of European vascular flora
11.15–11.30 Coffee break & prerecorded poster presentations

Session 4 | Chair: C. Sánchez Romero

11.30–11.50 M. Fois, Wetland plants in Mediterranean Islands: A collaborative initiative to collect information for their conservation
11.50–12.10 R. Verbylaitė, Can a forest tree species progeny trial serve as an ex-situ collection? A case study on *Alnus glutinosa*
12.10–12.30 S. Godefroid, Plant translocation practices and outcomes: A Europe-wide survey and analysis

12.30–12.50 A. Ensslin, Status of European seed conservation of wild plants in seed banks

12.50–13.10 G. Albani Rocchetti, The role and use of old seed collections on plant de-extinction

13.10–14.00 Lunch break & prerecorded poster presentations

14.00–14.50 Posters – live session

Session 5 | Chair: M. Klisz

14.50–15.10 O. Barazani, Comparative genetic variation in old and naturally growing olive trees in the south Levant – a window into the history of olive cultivation

15.10–15.30 P. Aravanopoulos, Conservation of marginal Norway spruce populations: Is it worth it?

15.30–15.50 A. M. Gülsoy, Determination of drought stress variation in *Abies cilicica* (Taurus / Cilician Fir) populations by adaptive seedling traits

15.50–16.10 F. S. Baloch, Genomics for sustainable biodiversity from Fertile Crescent and some conservation strategies

16.10–16.30 M. Nonić, Assessment of adaptive genetic diversity at different scales using genomic approaches, to facilitate conservation within and outside forests

16.30–17.30 Open discussion with the Scientific Officer Marco Carulli with coffee / WRAP-UP

List of Posters

Akin M., Aravanopoulos F. A., A bibliometric analysis of research trends in tree conservation genomics

Aksoy N., Özkan N. G., Koçer N., Sargıncı M., Aslan S., The role of botanical gardens in the ex situ conservation of endemic and rare plants at regional scale role and importance: The case of Duzce University botanical garden and herbarium

Balant M., Logar R., Glasnović P., Surina B., Heterostyly in Carniolian primrose (*Primula carniolica* Jacq.)

Ballian D., Memišević Hodžić, M., The importance of preserving old common yew trees planted in villages as a potential ex-situ collection in Bosnia and Herzegovina

Cuena Lombrana A., Dessì L., Fois M., Luna B., Podda L., Porceddu M., Bacchetta G., *Astragalus* resilience: Heat shock effect on seed dormancy and germination in endangered species

Danova K., Trendafilova A., Todorova M., Ivanova V., Aneva I., Conservation of valuable germplasm and secondary metabolites production of medicinal and aromatic plants of the Balkans

El Chami M.A., Tourvas N., Kazakis G., Kalaitzis P., Aravanopoulos F. A., DNA fingerprinting chestnut cultivars from Crete using SSR markers

Ertugrul K., Uysal T., The assessments of threat categories for *Psephellus Cass.* (*Asteraceae*) taxa in Türkiye

Kull T., Jaago S., Laanisto L., Assessing endangerment status shifts in Estonian vascular plants (2008–2018)

Lopes S., Afonso A., Surina B., Loureiro J., Fatal attraction team, Castro S., Pollinator communities of threated European plants

Lozada-Gobilard S., Pánková H., Münzbergová Z., Interactive effects of light, water, soil type and competition on the endangered *Minuartia smejkalii* vary over time

Nonić M., Skočajić D., Radaković N., Identification of relict, rare, and endangered forest tree species in Đerdap National Park as a basis for the genepool conservation

Nakas G., Kougioumoutzis K., Petanidou T., Post-fire entomophilous plant communities in the Mediterranean: Short- and mid-term spatiotemporal diversity patterns

Parpan T., Cherepanyn R., The main threats for rare plant species populations of the Ukrainian Carpathians highlands

Peci D., Mullaj A., The dynamic of national vascular plants Red List: Threats and factors affecting the changing status

Prokopuk M., Modern features of *Elodea canadensis* Michx. invasions in different climatic conditions (comparative studies)

Rašomavičius V., Uogintas D., The Lithuanian example raises questions about whether protected areas effectively conserve plant diversity

Tsvetkov I., Biotechnological tools for conservation of forest trees germplasm

Keynote Lectures

Pieroni, A. (1)

Could ethnobotany be a tool for proposing sustainable use of plant resources?

Although ethnobotanical studies have exponentially increased in the past decade, there is still a scarse knowledge of the essence and 'philosophy' of local, community-centred plant practices and their sustainability. With the help of some concrete examples/case studies we will show that many cultural keystone species in many communities of the Mediterranean and the Near East are very common plants that are not threatened. The rare cases in which conservation concerns have to loudly raised refer normally to species, which are remarkably traded in recent times only and whose end use is often unknown by the local communities. This reflection proposes therefore to use community-centred ethnobotanical data as preliminary datasets for sustainable use of local plant resources.

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Castro S. (1)*, Živa Fišer (2), Mariana Castro (1), João Loureiro(1), Joana Costa (3), Staša Simčič (2), Adela Horvat (2), Rafael Matos (1), Hava Verbessem (1), Finding Bermuda buttercup team, Peter Glasnović (2)

There is nothing permanent except change: Assessing reproductive success of invasive Bermuda buttercup

Biological invasions pose a major threat to biodiversity, having ecological and evolutionary consequences both for species and communities being invaded and for invasive species themselves. Understanding invasive plants colonization strategies enable to develop habitat restoration actions more efficiently and contribute to the conservation of threatened plant species. The Bermuda buttercup (*Oxalis pes-caprae* L.) is a tristylous polyploid plant native to South Africa, having become invasive in Mediterranean regions globally. In its native habitat, populations are isoplethic having three flower morphs and sexual reproduction, while in most invaded areas, populations are dominated by the pentaploid short-styled morph that reproduce asexually. Nevertheless, new forms have been discovered in western Mediterranean basin, introducing new reproductive strategies and, consequently, new invasion contexts. We aimed at understand the current distribution of floral morphs and cytotypes within the wider region of the Mediterranean Basin, as well as patterns and changes in sexual fitness and possible breakdowns in the heterostylous syndrome. For that, within the COST Action ConservePlants we have gathered the 'Finding Bermuda buttercup' team that sampled floral morph composition, fresh leaves and fitness variables in invasive populations across the Mediterranean basin. Ploidy was determined using flow cytometry on fresh leaves, and floral morphometric analyses and quantification of pollen loads were analysed in ethanol presenved flowers. This large-scale sampling provides novel insights into the distribution of ploidy and floral morphs and reveals two distinct reproductive strategies, one through uniparental reproduction and the other throught the re-establishment of sexuality. Our finding highlight the dynamic nature of invasion processes, emphasizing that ecological and

genetic constraints inherent in the invasion process can lead to unique reproductive strategies, ultimately influencing the probability of invasion success.

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Presentations

Albani Rocchetti G. (1)*, Godefroid S. (2), Abeli T. (1)

The role and use of old seed collections on plant de-extinction

Considering the remarkable increase in biodiversity extinction rates we are witnessing in recent decades, important – yet insufficient – efforts have been made, leading to the enrichment of the toolbox of conservationists. With respect to extinct species, de-extinction is perhaps the newest and most controversial tool. Concerning plants, herbaria represent a remarkable source of material and information that can be used for de-extinction purposes. This work aims to provide the first theoretical and methodological basis for the use of material from herbaria for the conservation of at-risk species and the de-extinction of lost species. Here we present novel insight into the use of herbarium material for conservation and de-extinction purposes that represent the first step towards plant de-extinction and pair with the existing literature on animal de-extinction. On this occasion, we focus on (i) the first list of plant candidates for de-extinction and (ii) the first systematic assessment of six techniques aimed at improving the germination of seeds from herbarium specimens we obtained. The first list of plant de-extinction candidates based on the actual availability of seeds in herbarium specimens of globally extinct plants is reported. Also, the effect of exogenous melatonin in the germination medium, priming with melatonin, and osmopriming on seed germination was tested on old seeds. Significant differences in germination were observed among species in osmopriming and melatonin priming tests, which resulted to be promising techniques and a first step for the development of an optimal germination protocol for old seeds and seeds from herbaria.

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Aravanopoulos F. A. (1), Verbylaitė R. (2)*, Tourvas N. (1), Menou A. (1)

Conservation of marginal Norway spruce populations: Is it worth it?

Marginal populations should be less genetically diverse and be more genetically differentiated than core ones, as the central-marginal hypothesis postulates. While for forest trees this pattern has generally been considered to be the norm, there has been an accumulating line of evidence suggesting that an increasing number of species this hypothesis fails to be accepted. In this work, we consider the value of marginal Norway spruce populations. We have used neutral and EST-SSRs to study population genetics parameters in populations of a latitudinal gradient that includes both central populations (from Lithuania) and marginal (from Greece). Assignment of 'core' or 'marginal' population status was based on nine marginality indices that consider environmental and historical marginality, as well as peripherality. It is shown that results are generally non-concordant with the central-periphery hypothesis. Genetic diversity was generally high and not significantly different between core and edge populations, while genetic differentiation was mainly low. The roles of historical events and glaciation cycles are discussed in light of these results. Moreover, EST-SSR outliers detected, indicate further the value of those populations. It is concluded that the marginal populations of Norway spruce are indeed valuable for genetic conservation and measures are proposed to this effect.

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Baloch F. S. (1)*, Nadeem M. A. (2)

Genomics for sustainable biodiversity from Fertile Crescent and some conservation strategies

Core Area within the Fertile crescent was proposed by the Lev-Yadun based on the theme that wild einkorn and emmer from this area shows highest genetic resemblance with domesticated wheat than anywhere else and other founder crops and their wild relatives such as chick pea, lentil, barley, rye are restricted to the region of Southeast Türkiye, which include Karacadağ mountain range. In the last few decades, due to heavy industrialization, urbanization, tourism activities and climate change, there is a serious threat of the disappearance of such natural resources. To stem this loss of genetic variation, conservation and re-connaissance of existing biodiversity are fundamental. We had characterized the huge germplasm of triticum species, chickpea, lentil, bean, peanut, sugar cane, *Laurus nobilis,* pear millet, sorghum, sesame, maize, tomato, dactylus glomerata, *Cephalaria* etc using 10,000s of SNPs generated by GBS and iwhole genome resequencing and dentified novel alleles/QTLs from some traits in abobe mentioned plant species. Some QTLs/alleles have been validated and are being used for genomic selection for biotic and abiotic stress in crop plants. We are developing strategies how this big data covering the whole genome sequencing can be potentially used for conservation of precious germplasm from their area of diversity. I will provide examples about the use of whole genome sequencing data for diversity assessment and their use for developing conservation strategies and how novel QTLs/alleles identified from these precious sources could be used for food security.

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Barberis M (1)*, Balant M. (2), Fišer Ž. (3), Glasnović P. (3), Sarka G. (3), Surina B. (3,4)

Identifying reproductive barriers between two closely related, but ecologically distinct, sages (*Salvia saccardiana* and *S. pratensis*)

Plant taxa are typically reproductively isolated by many different barriers. *Salvia saccardiana* (Pamp.) Del Carr. & Garbari is narrowly distributed in North-eastern Italy, Central and South-eastern Slovenia and western Croatia. The species, differing morphologically from its sympatric congener *S. pratensis* L. for its larger leaves and flowers, greater height and specific smell, also seems to exhibit a preference for dolomitic bedrock. Morphometric analyses confirm floral size dimorphism, suggesting that hybridization doesn't occur frequently in natural conditions despite significant overlap of their flowering periods. Therefore, here we investigated the multiple reproductive barriers intervening in isolating the two taxa, ranging from pre-pollination to post-zygotic barriers.

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Barazani, O. (1)*, Ben Dor, E. (1,2), Dag A. (3), Cvikel, D. (4), Schmerler, N. (1,4)

Comparative genetic variation in old and naturally growing olive trees in the south Levant – a window into the history of olive cultivation

The olive tree (*Olea europaea*) is the most important and iconic fruit tree of the Mediterranean Basin, possessing both economic and cultural significance. The earliest evidences of olive fruits usage (table olives and oil extraction) that had been found in the southern Levant (modern Israel) indicate on the focal role of this region in olive domestication and thus on the importance of local olive genetic resources. With that in mind we study the history of olive cultivation in the southern Levant. Using molecular tools in genetic analysis of old living olive trees we detected ancient landraces and suggest on a trend in cultivar usage along history. Comparative analysis of these landraces with wild growing trees was also used to assess the status of naturally growing populations as feral or *O. europaea* subsp. *europaea* var. *sylvestris* – the wild ancestor of cultivated olives. In addition, we developed a computerized tool for integrated comparative morphometric analysis of landraces and archeo-botanical findings from the late Chalcolithic (4,000–5,000 BC) to the Islamic period (638–1099 AC). The findings contributed to the understanding of the importance of a unique germplasm that still exist in the region, and to initiate ex-situ and in situ conservation program of this threatened genetic resources.

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Birben Ü. (1)*

The Role and Importance of Law in the Conservation of Biodiversity

Biodiversity, encompassing the richness of Earth's living species and their ecosystem interactions, is a vital natural asset. Yet, conserving biodiversity often gives rise to legal challenges. This article explores the key legal issues faced in biodiversity preservation with several case examples. The first challenge is the clash between local and international laws, with conflicting provisions in international agreements and local regulations hindering effective conservation. The second issue relates to property rights, introducing complexities and disputes regarding responsibility and benefits from biodiversity resources. The third dilemma is the inadequate enforcement and monitoring of biodiversity conservation laws adopted by many countries. Additionally, legal ambiguity arises due to the intricate and subject-to-interpretation nature of biodiversity conservation laws. To tackle these challenges, measures like improved coordination, alternative dispute resolution, and better enforcement through education and guidance should be implemented. In conclusion, preserving biodiversity is essential for global ecosystems and humanity's sustainable future, necessitating the resolution of legal dilemmas through enhanced legal frameworks and effective implementation.

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Calabrese D. (1,2), Guarnieri M. (1), Nepi M. (1,2)*

The influence of nectar chemistry in the tripartite interaction with pollinators and microorganisms in the tribe Lithospermeae (Boraginaceae)

Phylogenetically distinct nectariferous species visited by the same pollinator guild may display a convergent chemistry of their floral nectar revealing a pollinator-driven selection of nectar. Cases of divergence in nectar chemistry within a restricted phylogenetic context are of particular interest since they may reveal selection pressures associated to pollinators. The diversity of pollinators also affects the nectar microbiota which in turn may shape the chemical composition of nectar for both primary and secondary metabolites. We analyzed the nectar of more than twenty Lithospermeae species revealing a heterogeneous profile of sugars, amino acids, and secondary metabolites, such as biogenic amines, that act as neurotransmitters in insects. We found biogenic amines in the nectar of species exhibiting sucrose-dominant nectar chemistry such as *Echium* spp., *Cerinthe major* and *Onosma* spp., while they are almost absent in the nectar of species with hexose-dominant nectar profile, such as *Aegonychon purpurocaeruleum,* although these three species are visited by very similar species of insects, as long-tongued bees. Biogenic Amines in nectar can be the result of endogenous production or be attributed to the metabolic activity of microorganisms such as specialized yeasts that inhabit the nectar.

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Camilleri L. (1)*, Debono K. (1), Ghose Roy R. (1), Lanfranco S. (1)

Diversity in Isolation: Dissecting the Drivers of Endemic Plant Richness on Mediterranean Islands and archipelagos

Effective conservation of island floras requires a 'benchmark' of expected relative species richness to compare results against. The framework for this process is provided by the theory of island biogeography that predicts island area and proximity to a mainland as being fundamental drivers of species diversity. The relative contribution of endemic species would then be expected to constitute a proportion of the maximum species richness, although the relationship may be non-linear between islands. Previous observations on the proportion of endemic species in several Mediterranean islands indicated a predictable trend with area but suggested an 'endemicity deficit' for some islands, such as Malta. This study aimed to refine these predictions by collecting data on variables other than the two fundamental ones. These included a re-evaluation of proximity, and also included topographic diversity and human population density. 'Proximity' to a mainland was calculated through the progressive integration of land areas at varying radii from the centre of an island whilst 'topography' was estimated by recording the variance of elevation over a systematic sample of locations within an island. This was done for Crete, Corsica, Cyprus, Sardinia, Malta, Sicily, the Tuscan Archipelago, and the Balearics. GLM models related the proportion of endemic species to the selected constraints, with results indicating that 'topography' and 'area' explained more variation in the number of endemic species than 'proximity' and 'human population density.' Contrastingly, the proportion of endemic species on an island was best explained by 'proximity' and 'topography.'

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Floral complexity as indicator of plant vulnerability: Lessons learned from the Mediterranean Red Data Books

Inspired by an earlier finding regarding the Greek flora, i.e., plants with higher floral complexity were found more prone to extinction vs. those with less complex flowers, we proceeded to explore the same hypothesis at a broader geographical scale, that of the entire European continent. We assembled a dataset of more than 25,000 records belonging to 10,111 insect-pollinated plant taxa with an assessed threat status sensu IUCN. Originated from 35 different European countries, the dataset includes information on intrinsic (floral characters, life cycle, etc.) and extrinsic (habitat, spatial elements, etc.) plant traits and is further broken down into three major geographical groups based on climatic and bee/pollinator diversity drivers: Mediterranean, North & Central Europe, and Eastern Europe & the Balkans. We hereby focus on the hyperdiverse group of the Mediterranean including 4,843 taxa from 97 plant families and aim to explore whether plant vulnerability sensu IUCN is related with the above intrinsic and/or extrinsic factors. We investigate our hypotheses at three spatial levels (entire Mediterranean, West vs. East Mediterranean), considering country and family entities. As expected, habitat type and spatial characteristics of threatened plants are constant diagnostics of IUCN conservation status. However, our results also suggest that intrinsic traits are effective predictors of plant vulnerability, especially floral characters such as floral shape and colour. We strongly believe that further analyses of the entire European flora dataset will provide a more solid basis for better understanding the importance of floral ecology in predicting plant population vulnerability.

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Dalla Vecchia A. (1), Adamec L. (2), Bolpagni R. (1)

Exploring the resource-use strategies of endangered *Utricularia* species and *Aldrovanda* for better conservation strategies

Carnivorous plants (CPs) include iconic species at the brink of extinction: about 25% of CPs are at high risk of complete vanishing due to global climate and land-use changes. This is particularly true for aquatic ecosystems, where water pollution and drought represent major threats for aquatic CPs, typical of low-nutrient habitats. However, knowledge of physical-chemical features of waters and sediments does not seem enough to elaborate effective conservation strategies for these sensitive macrophytes, suggesting the existence of hidden processes regulating CPs-environment relationships. Classical approaches need to be implemented to offer a survival chance to these extraordinary plants. In the frame of a short-term scientific mission of the Cost Action CA18201 ConservePlants, a pilot study has been launched to explore the functional traits of 8 threatened CPs (*Aldrovanda vesiculosa, Utricularia australis, U. bremii, U. intermedia, U. minor, U. ochroleuca, U. stygia* and *U. vulgaris*), focusing on the Třeboň Basin area, a protected UNESCO Biosphere Reserve. An ad hoc protocol for measuring morphological and biochemical traits has been designed for *A. vesiculosa* and aquatic bladderworts, starting the data collection. Nineteen wild populations and the collection in the Institute of Botany of the Czech Academy of Sciences in Třeboň, Czech Rep., were investigated. Preliminary results show high plasticity within species, while leaf dimension, leaf dry matter content and pigments content are driving between-species variability. This is a first functional attempt to better understand the spatiotemporal patterns of these iconic species, disentangling their eco-functional niches from which effective management strategies could then be implemented.

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Status of European seed conservation of wild plants in seed banks

Conserving orthodox seeds of wild plants through seed banking (at 15% RH and −20°C) has become a valuable tool in safeguarding threatened populations and species, supporting conservation interventions such as plant translocations, but also in conserving genetic resources for plant breeding and food security. Despite over 90% of the European flora is likely to possess bankable seeds, there is no general assessment of how many taxa are secured in seed banks, where the gaps are and whether the countries met the objectives of global conservation initiatives such as the GSPC (i.e., target 8: 75% of threatened plants conserved ex situ). Within the framework of the COST Action ConservePlants (CA18201), a European-wide survey on seed bank collections was launched to gain an overview over the current state of ex situ conservation of wild plant taxa in seed banks across Europe. After a challenging process of taxonomic harmonization, we identified over 13,000 taxa conserved in 109 institutions from 29 countries across Europe and the Middle East. We mapped the taxonomic names and the original provenance of seed lots against the respective national red lists to identify the coverage met by each country concerning the GSPC target 8. We reveal gaps in species conservation and point out future directions on how to meet global conservation targets. Our study demonstrates the importance of collaborative approach for seed banking to support safeguarding threatened plants across Europe but also highlights that its potential has not at all been fully exploited yet.

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ConservePlants – have we made any difference?

How can we measure success? The success of a research project can be measured by the amount of new knowledge, discoveries, the number of scientific articles or patents. COST Actions are not research projects and their objective is much broader than that of research projects. COST's strategic priorities include the promotion and dissemination of excellence, the promotion of interdisciplinary research for breakthrough scientific knowledge and the promotion and retention of young researchers and innovators. A brief overview of ConservePlants shows that we have addressed all three priorities. Over the past four and a half years, we have promoted interdisciplinary research by meeting and discussing at Management Committee and Working Group meetings in Brussels (BE), Pruhonice (CZ), Bologna (IT), Valleta (MT) and Coimbra (PT), and at meetings in Koper (SI), Venice (IT), Palma (SP), Valencia (SP), Brussels (BE) and Izola (SI). We organised three online trainings and five live trainings (Montenegro, Lithuania, Portugal, Slovenia and Spain) focused on different topics of plant conservation: cryopreservation, plant translocation, IUCN Red List assessment, species distribution modelling, genetic monitoring, pollination ecology and pollinator identification. We have also organised two workshops for conservation managers in Pruhonice (CZ) and in Škocjan Cave Regional Park (SI) and co-organised several others. We have published several scientific papers and many more are still in progress. We have produced various materials to disseminate the topic, which are freely available on our website, including booklets, posters, children's books and an educational video. We have also awarded 52 grants (STSM, ITC, VM, VNS DCG), mostly to young researchers from all over Europe and beyond. So have we made a difference? We hope and believe that we have.

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Wetland plants in Mediterranean Islands: A collaborative initiative to collect information for their conservation

In the Mediterranean Basin, the conservation of plants faces critical challenges due to the historic and ongoing impacts of human land use, placing biodiversity under pressure. This issue is particularly pronounced on islands, where the intrinsic fragmentation of freshwater environments is exacerbated by the limited land area. Consequently, island wetlands, which are generally smaller than their continental counterparts, are more fragile and often overlooked in conservation efforts. Therefore, addressing the need for improved knowledge of wetland plants occurring on islands is a crucial objective that remains largely unresolved. Challenges persist, including cryptic taxonomy within certain genera, and there is still a need for a comprehensive overview of the diversity, distribution and conservation status of these plants. These knowledge gaps contribute to policy and management shortcomings, hindering effective conservation or recovery efforts. This study seeks to bridge these knowledge gaps by compiling information from local experts on wetland vascular plants occurring on the approximately 10,000 Mediterranean islands and islets. Our work presents and discusses the preliminary results of a checklist of over 200 wetland vascular plants of conservation interest. Remarkably, 20% of these species are globally endangered, 50% face threats on at least one island, and available information is inadequate to assess the conservation status of 30%. The insights provided in this study can support parallel initiatives, such as the Red List Index of Mediterranean wetland plants. Moreover, they can

serve as a reference for planning targeted conservation actions and fostering public awareness about plant diversity in Mediterranean island wetlands.

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Recognizing the gaps: Assessing the national Red Lists of European vascular flora

The diversity of vascular plants in Europe is at risk, and the national Red Lists are crucial for understanding these threats. However, our study has shown that there are differences in how European countries assess and update these documents, revealing gaps in conservation efforts. We collected data from the most recent national Red Lists of vascular plants in European countries, including some from the Eastern Mediterranean. The results confirm that we do not have a complete picture of the conservation status of European plants. The state of knowledge varies across regions, with differences in Red List availability, update frequency, and assessment methods. Notably, countries assessing their entire flora have a higher proportion of threatened plants than countries that only assessed part of it. This suggests that there is a risk of overlooking the conservation status of lesser known plants when assessments are limited. Financial capacity is a key factor; countries spending more on environmental protection tend to assess their entire flora. Our study emphasises the need for consistent and comprehensive assessment across Europe. Recognising these differences is crucial for developing effective strategies to conserve vascular plants.

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Plant translocation practices and outcomes: A Europe-wide survey and analysis

Plant translocations are a conservation technique increasingly used around the world. In Europe, many initiatives have taken place without having been published, with the result that the information remains very scattered in grey literature to which access is not easy. This represents a major obstacle to the exchange of information and experience among scientists and practitioners. To help fill this gap, we launched a large-scale continent-wide survey with 39 questions relating to methods, motivations, problems encountered and outcomes, supplemented by a screening of scientific publications, grey literature and national/regional databases. This made it possible to locate and gather data on 3,220 plant translocations across the European continent carried out on 1,185 taxa in 28 countries, which represents the largest dataset ever collected globally. Target species most often were forbs from grassland habitats and they had a higher threat status nationally than globally. Practitioners mainly used plug plants (less than 100) originating from a single source (geographically closest to the target site). Weather events and plant disease were the unanticipated problems most often noticed by respondents. Monitoring revealed that most populations did not survive more than 5 years, demonstrating the challenge translocations are still representing for conservationists. However, this large database will allow us to identify the most relevant drivers of translocation outcome in terms of plant survival and recruitment that will inform future plant translocations.

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Determination of drought stress variation in *Abies cilicica* (Taurus / Cilician Fir) populations by adaptive seedling traits

Drought, a major climate change impact, significantly challenges forest ecosystems and necessitates strategies for biodiversity conservation and sustainable management. This study focuses on the drought resilience of Taurus fir (*Abies cilicica*), analyzing seedling growth and phenological traits. Genetic material from eight populations in the species' natural habitat was evaluated, with young seedlings grown under controlled drought conditions in a nursery setting. The experiment utilized a randomized block design with six replications to assess genetic diversity and adaptive traits in response to drought stress. Conducted at Olcay Forest Nursery in Konya province, the study involved eight populations, each with 20 families and four seedlings per family. Seedlings were subjected to –10.45 bar water stress upon reaching three years of age. The aim was to identify strategies vital for genetic diversity conservation and sustainable forest management. Statistical analysis focused on the adaptive capacity of the species, including genetic correlations and family heritability of adaptive traits, particularly bud burst, and growth in height and diameter before and after drought stress. The results highlighted that geographical origin and altitude significantly affect seedlings' drought adaptation. Seedlings from eastern, higher altitudes showed less growth compared to those from western, lower altitudes, indicating the influence of genetic and ecological factors on stress response. This study underscores the need for in-depth research on genetic diversity and adaptive strategies to inform future forest management and breeding programs, emphasizing the importance of leveraging the adaptive capabilities of different populations for species sustainability under drought conditions.

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What can we learn from the Database on Conservation Actions on Threatened Plant Species in Europe?

Increasing habitat and biodiversity loss requires more and more specific conservation activities supporting the survival of threatened plant species in the wild. While several databases on conservation actions already exist, they usually contain only some basic information, are not updated regularly, and are confined to specific geographic regions. Results of conservation activities are not systematically published in scientific articles, and thus often they are not publicly or easily accessible. Conversely, there is a strong need for the exchange of knowledge and experience among plant conservationists of different backgrounds. In the scope of the COST Action CA18201 ConservePlants, a Database on conservation activities on threatened plant species in Europe has been established based on a survey distributed through emails and Google Forms. Its primary objective is to offer useful information about conservation activities targeting threatened plant species, but also to enable the assessment of positive and negative aspects of completed actions, and to provide guidelines for future conservation planning. The Database contains more than 3000 inputs for over 900 plant species obtained from c. 150 conservationists from 32 European countries. It provides information about geographical distribution and types of plant-based conservation activities in Europe; types of institutions involved in it; differences in financial aspects; plant species and their habitats; types of actions implemented; success and outcome of the actions. The Database will soon be publicly available with the intention of updating it regularly, aiming to become an important source of information for future practical conservation activities.

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Supporting plant conservation: The database of the national Red Lists of European vascular plants

The European vascular flora consists of more than 20,000 species and represents 5.7% of global diversity. However, 44.9% of these species are vulnerable within Europe almost matching the global level prediction for extinction risk. One of the main aims of plant conservation, especially at country level, is to evaluate the extinction risk of each taxon through a conservation assessment by following guidelines published by the International Union for Conservation of Nature (IUCN) and establish a red list category to reflect its conservation status. Whilst there are significant gaps in conservation assessments across countries in the Europe, some assessments capture taxonomic names without scientific authorships and red list categories outside the IUCN current standards. As a result, difficulties arose when comparing red list categories across countries to determine meaningful trends and/or creating a unified list for Europe. To improve plant conservation in the Europe through a network of interested stakeholders, the Working Group 3 (WG3) of ConservePlants under the European Cooperation in Science and Technology (COST) Action 18201, developed a database capturing vascular plant taxa in the Europe which have had a conservation assessment at country or sub-country level with their designated red list categories. We introduce the version 7.0. of the European vascular plants red lists database in an end-user friendly format and open to revision by interested parties. It synthesizes data across 40 national and two sub-national or regional red lists from 39 European countries and two COST Action observer countries in the Mediterranean. We described the step-by-step method on how data were compiled, cleaned, standardised, red list categories and taxonomic names harmonised, and data integrity validated. We envision such a database has the scope to be used in various plant conservation activities and is beneficial for various stakeholders who engage in plant conservation and would help filling the gaps in conservation assessments.

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Children's books as a strategy for plant conservation

Human actions and climate change are diminishing global biodiversity. While we are knowledgeable about economically valuable plants like crops, rare threatened species remain poorly understood. These neglected plants, especially the unique and rare ones, receive less focus in conservation compared to charismatic animals. In addition, there is a big gap between basic science and its communication and application, causing inadequate conservation practices. To achieve a successful conservation strategy, the scientific community should work side by side with the general public. A long-term success depends on the awareness of the general public and their engagement. Children in particular are one of the most important demographic groups since their actions and decisions would affect the course of conservation in the future. Therefore, implementing awareness and creating empathy in them towards critically endangered plants species today, would improve the conservation status of those species tomorrow. This could be achieved through story-telling of rare plants in the format of a children book with a solid base in scientific knowledge. Here we present a collection of four independent stories about endangered endemic plants: (1) *Iris atropurpurea* (Israel); (2) *Minuartia smejkalii* (Czech Republic); (3) *Primula apennina* (Italy); (4) *Scopiola Carniola* var *hladnikia* (Slovenia). All four stories are based on scientific research and are transformed into beautiful, simple stories with vivid illustrations. They aim to entertain and educate children, their parents, and the general public.

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Assessment of adaptive genetic diversity at different scales using genomic approaches, to facilitate conservation within and outside forests

Conservation genomics has an important role in the identification of genomic regions that are of adaptive significance and particular importance for the conservation of forest genetic resources. We performed a structural literature review using the Scopus and Web of Science databases and critical analysis regarding the assessment of adaptive genetic diversity focusing on molecular genetic/genomic approaches to facilitate conservation of perennial woody species within and outside forests. Based on our filtering approach we identified 166 pertinent journal papers, but we focused specifically in 40 publications that were selected for meta-analysis, based on a set of information content criteria. The analysis included 33 species, among which 14 angiosperms (from 8 genera), and 19 gymnosperms (from 10 genera). We constructed a database that included: article information; source variables; species-related information; dataset variables; and genetic analysis statistics. Our analysis concentrated on 10 variables from the above dataset. Fst outlier loci and their relative importance in terms of strength of spatially-divergent selection are not evenly distributed in populations; no association between number of populations assessed and number/Fst value of outlier loci was found. The same holds for the extent of spatial sampling, indicating the locality of selection. No link to population genetics parameters was found either. However, increasing the sampling effort overall and sampling from populations of high genetic diversity is associated to the detection of spatially-divergent selection. These results, besides adding in local adaptation studies, can also contribute to the design of in situ conservation efforts for natural populations of perennial woody plants.

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The resurrection method reveals contemporary evolution of arable weeds in response to pollinator decline and climate change

The resurrection method is a novel approach which 'instantly' reveals the occurrence of contemporary evolution in organisms with diapause by growing side-by-side ancestral genotypes 'resurrected' from dormant propagules and their contemporary descendants. Taking advantage of material from seed repositories, resurrection assays are a powerful tool for the study of contemporary adaptation of plants in response to fast-paced, human-induced environmental changes. The aim of my research was to assess evolutionary trait shifts occurrence in populations of an annual, entomophilous, arable weed over 30 generations in response to global climate change and pollinator decline. Ancestral genotypes were grown from seeds harvested in two locations (Belgium, 1992 and Poland 2003) in a common garden with contemporary genotypes harvested from the exact same locations in 2020. Traits related to phenology, attractivity to pollinators, mating system, and fitness were measured. All plants were genotypes using ddRAD SNP markers to disentangle the effects of random and selective evolutionary processes. Results show that contemporary genotypes flowered later than ancestral ones, which is consistent with a drought-avoidance strategy in response to temperature rising over the past 30 years. The remaining data is still being analyzed. Under the hypothesis of adaptation to pollinator decline two scenarios are plausible – evolution towards more attractive flowers and floral displays to maintain the outcrossing rate in contemporary environments, or evolution towards increased self-pollination which can be accompanied with a selfing syndrome (fewer, less attractive flowers). The resurrection method can help study contemporary evolution without recurring to lengthy evolutionary experiments, or implicit assumptions of space-for-time substitution approaches.

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Can a forest tree species progeny trial serve as an ex-situ collection? A case study on *Alnus glutinosa*

Scientifically informed decisions for the long-term conservation of extant genetic diversity should combine in-situ and ex-situ conservation methods. The aim of the present study was to assess if a progeny plantation consisting of several open pol-linated (OP) families and established for breeding purposes can also serve as an ex-situ conservation plantation, using the case study of a Lithuanian progeny trial of *Alnus glutinosa,* a keystone species of riparian ecosystems that warrants priority conservation actions. We employed 17 nuclear microsatellite (Simple Sequence Repeat) markers and compared the genetic diversity and copy number of the captured alleles of 22 OP progeny families from this plantation, with 10 wild *A. glutinosa* populations, originating from the two provenance regions of the species in Lithuania. We conclude that the progeny plantation could be used as an ex-situ plantation for the *A. glutinosa* populations from the first provenance region (represented by eight genetic conservation units (GCU)). Based on the present study results we can expect that the *A. glutinosa* progeny plantation harbors enough genetic diversity of wild *A. glutinosa* populations from the first provenance region. This progeny plantation can serve as a robust ex-situ collection containing local alleles, present in at least one wild population with at least 0.05 frequency with 25 replications.

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Popularization of knowledge about endangered flagship plant species of Europe

One of scopes of WG4 activities of the COST Action 18201 is enhancing a general knowledge about endangered and protected plants in European societies. To achieve this aim three booklets and one poster were prepared in collaboration with scientists from 23 countries. There are 278 CITES plant species in Europe and roughly about 25,000 in the world. A selection of native European species of CITES plants were introduced in two publications, namely 'CITES plants of Europe' (hard copy and on-line edition) and 'National flagship CITES plant species across Europe' (on-line). In addition, 47 more plant cards were prepared. This activity completed information about 88 species prepared by 79 scientists from 22 countries. To stress the importance of protection of CITES plants, a poster about this subject was prepared and printed to be widely distributed. Some of the protected and endangered plant species are fixed in the national consciousness as unique, as they have played a significant role due to their symbolism and functional significance in a given country. Information about these unique taxa was prepared by 33 scientists for 19 countries and gathered in a booklet 'Endangered plants important for selected European countries' (on-line). All materials are available free of charge on the ConservePlants website (www.conserveplants.eu). The projects may have continuations and to include all European countries and CITES species. The goals set under the two VM Grants and the dissemination for general public were achieved.

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Posters

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The role of botanical gardens in the ex-situ conservation of endemic and rare plants at regional scale role and importance: The case of Duzce University botanical garden and herbarium

One of the most important aims and features of Botanical Gardens is to protect endemic and rare plants and to carry out scientific studies on them. Duzce University Ornamental and Medicinal Plants Botanical Garden (DUSTBB) was established to play an important role in the maintenance of plant biodiversity both in the country and in the region. Since the habitats of endemic and rare plant taxa in the Western Black Sea Region and Duzce Province are threatened by anthropogenic effects, ex-situ conservation is aimed in the botanical garden. According to the flora, vegetation and monitoring studies carried out in the province of Duzce and the Western Black Sea Region, 11 700 plant taxa are found in the DUOF herbarium and these are also recorded in the virtual herbarium. In Duzce Province, 1268 vascular plant taxa are distributed, 59 of which are endemic and 24 taxa are rare plants. According to the Flora of Türkiye, there are 210 endemic plant taxa in the Western Black Sea Region. Endemic plant habitat areas are under threat and extinction due to anthropogenic factors such as intensive forestry activities, dam construction, stone mining and unplanned tourism activities. In Duzce Province, 10 endemic plant taxa (CR (5), EN (2), VU (3)) are under threat. Ex situ conservation works are carried out in the botanical garden for the local endemic plant taxa; *Cephalaria duzceénsis, Centaurea yaltirikii, Jurinea efea* and *Lythrum anatolicum*. In addition to this, on the conservation of many endemic and rare plant taxa, whose lives are sensitive and at risk, on a regional scale; educational activities, citizen awareness and legal responsibilities are carried out in a wide range of areas, which will be a model.

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Heterostyly in Carniolian primrose (*Primula carniolica* Jacq.)

The Carniolian primrose (*Primula carniolica* Jacq.) is an endemic species of the north-western Dinaric Alps. It typically grows in cold and shady locations characterized by ecologically challenging conditions, in a region approximately 70 km long and 25 km wide to the west and south of Ljubljana. The Auricula (*Primula auricula*) is its closest related species, but with a much larger distribution area, ranging from the West Alps to the Tatra Mountains. In contrast to the Carniolian primrose, it thrives on sun-exposed habitats. However, there are a few recorded locations where both species coexist in proximity, where hybrids of the two (*Primula* x *venusta*) can be found. The objectives of this study were to: (i) establish the relationship between long-stemmed and short-stemmed flower types, (ii) determine the morphometric characteristics of flowers within individual populations, (iii) investigate whether there are morphometric differences between long-stemmed and short-stemmed flowers within and among populations, (iv) assess the stigma-stamen reciprocity within individual populations to understand the potential for auto(in)compatibility and (v) investigate morphometric differences between the two species and their hybrid. Carniolian primrose populations exhibit statistically significant differences in all four measured parameters: width (CLW) and length (CLL) of corolla lobe, corolla diameter (CD), and length of the corolla tube (TL). The lengths of stamens and pistil furrows within Carniolian primrose populations vary and often do not overlap, indicating deviations from complete reciprocity. PCA analysis revealed that *Primula carniolica, Primula* x *venusta,* and *Primula auricula* do not differ from each other in terms of flower size.

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The importance of preserving old common yew trees planted in villages as a potential ex-situ collection in Bosnia and Herzegovina

Due to the low abundance of common yew (*Taxus baccata*) trees caused by anthropogenic influence throughout history, it has been protected by law in the natural sites of Bosnia and Herzegovina since 1964. Common yew, due to its longevity, has a special meaning among people of different national and religions living in Bosnia and Herzegovina. It was used in spiritual rituals that have remained in some areas of central Bosnia to this day. Due to excessive use of yew from forests, the need for their planting emerged centuries ago. At that time, common yew seedlings could not be bought at the market, so young plants were brought from nearby forests and planted in villages. Research and recording of common yew sites in villages of Bosnia and Herzegovina was carried out from 2003 to 2020 years. There were 54 old trees registered, and their origin is, in most cases, known through oral traditions. Six areas of origin can be distinguished: the area of the middle course of Bosnia with location Pepelari; the area of Krivaja river valley (from Vozuća to Olovo); the area around the source of Mala Usora; the Ribnik area in Bosnian Krajina; the central Bosnian region of Busovača and Vitez; the area from Nevesinjsko polje to Gatačko polje. Due to the loss of yew trees in the forests, we can use reproduction material of yew trees planted in villages in the common yew reconstruction process because we know their origin, i.e. that they are from local forests.

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Astragalus resilience: Heat shock effect on seed dormancy and germination in endangered species

Many *Astragalus* species exhibit physical dormancy and understanding their seed dormancy is crucial for conservation efforts. Previous studies have revealed that impermeable seed coats inhibit germination in these species, but little is known about the ecological context of this dormancy. We focused on *Astragalus maritimus* and *A. verrucosus,* two threatened endemic species in Sardinia living in fire-prone ecosystems, to explore the ecological implications of heat shock on dormancy release and germination. We investigated under laboratory conditions the effects of different heat shock treatments (40–140°C) for varying durations (5 and 10 minutes), to simulate different fire conditions. Results showed a reduction of germination compared with control test only at high heat shock temperatures (120–140°C) in both species. Most seeds remain dormant (viable, not imbibed seed) after the simulation of fire in the soil, from 80% at 40°C – 5 min to 20% at 120°C – 5 min for *A. verrucosus.* While *A. maritimus* dormant seeds varying from 84.2% at 40°C – 5 min to 40% 100°C – 10 min. At higher temperatures of heat shock, the percentage of dead seed increases, *A. verrucosus* ranged from 55.4% at 120°C – 5 min to 99% at 140°C – 10 min and for *A. maritimus* this ranges varied from 54% at 100°C – 10min to 92% 140°C – 10 min. In conclusion, heat shock caused by fire is not able to break the physical dormancy. However, they can survival the fire pass and develop soil seed bank that persists after fires and delay germination until the occurrence of break dormancy conditions.

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Conservation of valuable germplasm and secondary metabolites production of medicinal and aromatic plants of the Balkans

Characteristic with its rich flora and high endemism, the Balkan Peninsula is considered one of the hotspots of European plant biodiversity. An important etiological factor for this phenomenon is the role of the region as a glacial refugium to many relict taxa, its topographic complexity and richness of habitat types, diversity, as well as the stability of environmental conditions. Representatives of the *Hypericum* genus, the Balkan endemic *Sideritis scardica* Griseb. and essential oil-bearing *Artemisia alba* Turra have been selected in a program for in vitro culture germplasm conservation and exploration of the capacity to produce secondary metabolites in different plant cell tissue and organ culture conditions. This work summarizes the approaches established for the targeted delivery of biologically active compounds of diverse chemical type such as hypericins, phenolics, flavonoids, as well as essential oils from different types of in vitro lines of the studied species. Plant cell tissue and organ culture were demonstrated to be a valuable and flexible tool for the supply of secondary metabolites of the selected species.

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DNA fingerprinting chestnut cultivars from Crete using SSR markers

Cretan chestnut belongs to the European chestnut or sweet chestnut and has been historically associated to rural communities, adding a significant economic and cultural value. Yet, Sweet chestnut genetic resources in Crete were rarely studied and assessed, while chestnuts are threatened by several anthropogenic factors. This study assessed the Cretan Sweet chestnut using 59 trees corresponding to the four best-known chestnut cultivars (Stroviani, Rogdiani, Koutsakera and Katharokastania), sampled from the greater Chania region. They were evaluated using seven simple sequence repeat markers (SSRs): three nSSRs and four EST-SSRs. Genomic SSRs results revealed significantly higher levels of genetic diversity in terms of expected heterozygosity, level of polymorphism and effective number of alleles. Genetic differentiation among cultivars was highly significant, although low. Furthermore, 22 different genotypes were identified, distributed between the four chestnut cultivars Three homonyms and four synonyms were also distinguished. A cluster analysis depicted two clusters, one corresponding to the Rogdiani cultivar and the other to Katharokastania, while the other two could not be assigned to a particular group. The null hypothesis of single clone genotype to cultivar correspondence was tested and could not be accepted; each cultivar presents a multiclonal variety.

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The assessments of Threat Categories for *Psephellus* Cass. (*Asteraceae*) taxa in Türkiye

In recent studies on the genus *Centaurea* sl., some monophyletic genera were segregated from the genus *Centaurea* by combined morphological and molecular data. The one of them is the genus *Psephellus* Cass. It has been accepted as a genus in some previous treatments, by Boissier, Sosnovsky, Dostal, and Gabrieljan, but has been sunk into *Centaurea* in other Floras as Flora SSSR, Flora of Türkiye, Flora of Iran and others. Finally, Wagenitz and Hellwig have presented a new concept relevant to the taxonomy of *Psephellus,* which is supported by molecular, morphological, anatomical, palynological and cytogenetical results. The genus *Psephellus* has almost 100 species and is distributed mainly in western Siberia, Türkiye, Iran, Caucasus, Ukraine, and Crimea. In Türkiye, *Psephellus* is represented by 37 taxa according to the latest descriptions. 28 of them are endemic and 4 are rare for Türkiye. Seven of which were assessed in 2007. The aim of this study is to assess the threat categories of endemic and rare 32 *Psephellus* taxa in Türkiye. The assessments were carried out by following IUCN Red List Categories and Criteria ver. 15.1 (IUCN, 2022). As a result, 12 of the endemic taxa were categorized in Critically Endangered, four in Endangered, 8 in Vulnerable, 3 in Least Concern and 1 in Data Deficient categories. 2 of rare taxa were listed in Critically Endangered and 2 in Vulnerable categories.

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Assessing Endangerment Status Shifts in Estonian Vascular Plants (2008–2018)

Estonia has maintained a Red List of local flora since the 1970s, conducting a new assessment every decade. This study aims to analyze the endangerment changes in Estonian plant species from 2008 to 2018. It specifically examines if insect-pollinated species face greater endangerment than those with other pollination forms, and analyzes how plant vulnerability correlates with their geographical distribution and habitat preference. The analysis encompassed 1316 plant species across various IUCN categories, including regionally extinct, critically endangered, endangered, vulnerable, near threatened, least concern, and data deficient. Species categorized as 'not applicable' were excluded from the study. The analysis revealed that plant species categorized from critically endangered to near threatened in 2008 experienced an increase in vulnerability, advancing by approximately half to three-quarters of a category over the decade. Interestingly, insect-pollinated plants did not show a significant increase in endangerment, and habitat preference appeared to have no substantial impact. However, species at the range borders exhibited a greater increase in vulnerability compared to those in more central part of the range.

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Lopes S. (1), Afonso A. (1), Surina B. (2,3), Loureiro J. (1), Fatal attraction team, Castro S. (1)

Pollinator communities of threated European plants

Most of the threatened plant species in the European Red List of Vascular Flora are flowering plants. Considering that 78% to 94% of flowering plants rely on animal pollination for successful reproduction, to develop integrated conservation programs for endangered plants it becomes crucial to know their pollinator communities. In this work, we aimed at gathering the knowledge available on pollinators of European threatened plants and identify current gaps. For that, we pursued two parallel approaches: one based on bibliographic searches focused on flowering plant species listed as critically endangered, endangered and vulnerable according to the European Red List of Vascular Flora; and another based on contributions of collaborators from different European countries – call 'Fatal attraction: endangered plant's lovers.' This call aimed to gather information from 'grey literature' and unpublished personal observations regarding pollinators of threatened plants at the European and national/regional levels. From over 5000 results obtained in the bibliographic search, only 4% contained pertinent information concerning endangered plant pollinators, while in 6 months, 40 collaborators provided data for 122 threatened plants with over 2000 pollinator records. A second call has been launched and new information is continuously being added. Our preliminary results highlight the lack of information for most endangered plants and the urgent need improve our knowledge about their pollinators in future studies. This information will facilitate steps towards developing integrated conservation actions that consider this critical mutualism.

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Interactive effects of light, water, soil type and competition on the endangered *Minuartia smejkalii* vary over time

Understanding drivers of species performance is crucial for their effective conservation. Despite a range of studies on the effects of single biotic and abiotic factors on plant performance, very little is known about interactions among multiple factors and their effects over time. We studied competition and abiotic interactions in an endemic species of the Czech Republic, serpentinophyte *Minuartia smejkalii,* over four years. In a full factorial experiment, we evaluated the performance of *M. smejkalii* alone, in the presence of a competitor, *Festuca ovina,* and under different abiotic conditions, including different types of soil, light exposure and water regime, and observed its changes over time. The results indicate very complex interactions among these factors. Competition had negative effects on the performance of *M. smejkalii* (1.2 times larger plants and 1.8 times more flowers in the absence of the competitor), but abiotic factors had stronger effects than competition alone. The effects of *F. ovina* on *M. smejkalii* also varied depending on whether shaded or not and soil conditions. Biotic and abiotic factors had contrasting effects on plant and number of flowers, suggesting that investment in growth and reproduction are context dependent. The size of plants grown in shaded areas was 2.7 times larger than those grown in full sun, whereas plants under full sun produced 1.7 times more flowers than those grown in shaded conditions. Type of soil did not affect plant area, but plants produced 1.5 times more flowers in non-serpentine soils. Our results suggest that the effects of competition are very complex, interact with abiotic factors and vary over time. We highlight the importance of long-term studies to identify competitive interactions and the importance of studying competition under multiple conditions. Understanding how competition might affect performance of the endangered *M. smejkalii,* under certain abiotic conditions (i.e. soil, water, shading), provides essential information for implementation of more efficient long-term conservation strategies.

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A Bibliometric Analysis of Research Trends in Tree Conservation Genomics

This study employs a bibliometric analysis to evaluate conceptual and intellectual structures describing 'genomic research on tree conservation,' as well as to map research trends. The authors collected 2777 Science Citation Index Expanded research articles from the Web of Science Core Collection on September 15, 2021. Quantitative and qualitative variables including number of publications and citations, H and G-index, author and journal citation reports, co-authorship, and co-occurrence analysis for countries, institutions, authors and keywords were analyzed using Bibliometrix package available on R statistical software. The results revealed that publications on 'tree conservation genomics' started over 30 years ago and demonstrated an increasing trend of 9.77% annual growth. The core consisted of 12 out of 384 journals publishing on this scientific discipline. Cumulative growth of publications per journal and keywords over time was detected as well. The United States has made the largest contribution on this field with 1237 publications followed by China (1090) and Brazil (970). Network analysis was performed to describe relationships between keywords, authors, countries, institutions and historical citations. Genetic diversity, conservation and microsatellites were the most critical words within the Authors' keywords network. Seven distinct subgroups of author collaboration networks were detected. The USA was the most actively collaborating country within the whole network with Argentina and Chile being the most isolated collaboration cluster within the rest of the countries. Six distinct collaboration subgroups were projected between institutions with Chinese Academy of Science and University of Sao Paolo being the most active within the collaboration subgroups. Climate change, gene flow and phylogeny were the trend topics detected for the last five years according to the thematic evolution analysis. These results are discussed in light of detecting the major research domains found and pinpoint literature gaps, as well as potential future trends for pertinent research.

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Identification of relict, rare, and endangered forest tree species in Đerdap National Park as a basis for the genepool conservation

Đerdap National Park is the largest of five national parks in Serbia, which covers a total area of 63,786.48 ha, in the northeastern part of country, on the border with Romania. It is characterized by rich biodiversity and a distinct relict character. This research aimed to identify relict, rare, endangered, and vulnerable forest tree species in Đerdap National Park, assess the degree of their endangerment, and propose measures for the conservation of available genepool. The research was conducted in selected localities with a protection regime of the first degree. By terrain reconnaissance, a total of 17 identified forest tree species belong to the categories of relict (*Juglans regia, Celtis australis, Corylus colurna, Ilex aquifolium, Taxus baccata*), rare and endangered (*Acer platanoides, Alnus glutinosa, Fraxinus excelsior, Malus sylvestris, Quercus pubescens, Ulmus glabra, Ulmus laevis, Ulmus minor*) or vulnerable species (*Prunus avium, Pyrus pyraster, Populus tremula, Sorbus torminalis*) in Serbia. Among the relict species, the particularly important is the population of Ilex aquifolium, a strictly protected evergreen species in the territory of the Republic of Serbia, which was recorded only in the nature reserve 'Šomrda,' the northernmost site of this species in Serbia. It is also significant to conserve the genepool of two relicts: a typical Mediterranean species Celtis australis and a very rare coniferous species *Taxus baccata*. The measures of active in situ conservation and monitoring of individual genotypes or groups of trees have been defined, and an assessment of the variability of genepool using morphological and molecular markers was proposed.

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The dynamic of national vascular plants Red List: threats and factors affecting the changing status

The national Red List periodic assessment is essential to determine priorities and develop effective conservation strategies on the protection of threatened species. In a time period of 25 years (1995–2020), there are conducted four Red lists assessment in national level. The most recent national Red List included 8.2% of total flora of Albania. The number of species listed in each IUCN category changed over time. An analysis of the threats and factors that might have influence the changing of the status of vascular plants, such as taxonomic evaluation, their distribution and ecological conditions of their habitats based on Ellenberg indicators was carried out in order to identify ongoing challenges and the major shortcomings in plant conservation in Albania. Our findings support the need to stimulate more effective evaluation of species classified as data deficient or in least concern concerned categories.

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Post-fire entomophilous plant communities in the Mediterranean: short- and mid-term spatiotemporal diversity patterns

In the Mediterranean, one of the most fire-prone regions in the world, wildfires are considered a key factor in vegetation distribution, structure, and function. Under certain conditions, such as severe or frequent fires, they can lead to homogenized plant communities and habitat fragmentation with significant consequences for the ecosystem and plant-dependent animals such as pollinators. Here, we present the results of a 10-year post-fire study (2013–2022) conducted on Chios Island, Greece. We explored the effects of a large-scale fire on beta diversity patterns of the flowering insect-pollinated plant communities and its turnover and nestedness components in both burned and unburned sites. In particular, we investigated whether the recorded differences in the burned and unburned plant communities resulted from species gains or losses across post-fire period. We found that burned communities displayed higher heterogeneity in species composition compared to the unburned ones in all post-fire years, as a result of higher species turnover across all study years. Species gains were highest overall in the burned sites during the second post-fire year and decreased a decade later. We conclude that entomophilous plant communities are rather fire-resilient in the Mediterranean, implying positive effects on pollinator diversity and the plant-pollinator interaction networks towards the system's post-fire self-restoration.

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The main threats for rare plant species populations of the Ukrainian Carpathians highlands

In the Ukrainian Carpathians, the territory which is 7% of the state area, grows about 28% of the Red Data Book species of Ukraine. This explains the interest in the rare flora of the Ukrainian Carpathians. The aim of the work is to research the population state of rare plant species of the Ukrainian Carpathian highlands and the main threats to them. For this, field population research methods and analytical processing of the obtained data were applied. It was found that climate changes, succession changes in natural conditions, and active development of highlands by humans often lead to unfavourable conditions for habitats and rare plant species. Active economic activity (unsustainable forestry, uncontrolled pasturing of livestock, gathering of plants) leads to a decrease in the density of rare and endangered plant species populations and disruption of vegetative or generative renewal. Such processes are observed in the following plant species: *Rhodiola rosea* L., *Gentiana lutea* L., *Arnica montana* L., *Cetraria islandica* (L.) Ach., *Dryas octopetala* L., *Anemone narcissifolia* L., *Saussurea alpina* (L.) DC. etc. The protection and restoration of populations of endangered and rare plant species requires the use of active methods of their conservation, creating new protected areas in the Ukrainian Carpathian highlands. Taking into account the recreational load in the highland, it is necessary to develop and apply a set of measures for the sustainable use of the territory and intensify the fight against poaching.

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Modern features of *Elodea canadensis* Michx. invasions in different climatic conditions (comparative studies)

Aquatic invasive plants threaten not only natural communities and rare species, but also ecosystem services. It is important to prevent and control these species, and to do this, it is necessary to study their strategies and distribution. *Elodea canadensis* is the most widespread alien aquatic plant in Europe. Preliminary observations in Ukraine have shown that increasing anthropogenic eutrophication leads to the degradation or elimination of *E. canadensis* thickets. In some water bodies, it has disappeared from the aquatic flora. In Portugal, a decline in *Elodea* populations has been noted. Therefore, the study of the current features of the invasive strategy of E. canadensis and its interaction with other macrophytes is relevant. The aim of this study was to assess the current distribution, ecology and invasive behaviour of *E. canadensis.* Field observations were carried out in water bodies of Ukraine and central Portugal using general hydrobiological methods. We sampled the phytomass, determined the size parameters of the plant, and assessed the main trophic parameters of the reservoirs. *Elodea canadensis* in some water bodies of Ukraine (from mesotrophic to polytrophic type) has moved from being a common to sporadic occurrence or has completely disappeared. 25–30 years ago, the species formed large mono-dominant thickets in these reservoirs and formed significant phytomasses. The species is often replaced by *E. nuttalli,* which is more resistant to anthropogenic pollution. Studies in Portugal have also confirmed a decline in the species population, noted in several watercourses where it forms thickets with significant phytomass (oligo-, mesotrophic water bodies). There are certain differences in morphological and productive parameters of coenopopulations in both countries (in Portugal, they form a larger phytomass, but are characterised by lower parameters of morphological traits). *Elodea canadensis* is completely naturalized, has lost its invasive features and does not cause changes in the natural flora. The species is at the stage of regressive changes in the sec-

ondary range, but the factors causing these changes still need to be studied.

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Conserving endangered plant species in Slovakia: Exploring approaches and habitat relationships

To safeguard endangered plant species, Slovakia employs diverse strategies. Some species are included in the Natura 2000 Habitat's directive, which is then incorporated into Slovakian law. Additionally, a national list of protected species is also governed by the legal system. In order to address the long-term concerns of scientists, the 'Red List of Slovak Species' was published in 2015, cataloging species at risk of extinction. However, it is important to note that these two lists do not overlap entirely. Another method for in-situ species conservation involves enhancing the area and condition of their habitats. The Habitat's directive includes a list of European habitats of interest, which are again upheld by Slovakian law. When it comes to the conservation of endangered species, it is often easier to secure funding for projects focused on revitalizing priority habitats, particularly those within protected areas. However, it is worth mentioning that some endangered species inhabit different types of habitats, while certain priority habitats may not host any protected species. In 2023, a comprehensive catalogue of habitats in Slovakia was published, providing a robust dataset on the composition of plant species within each habitat. This dataset was utilized to address several key questions: (1) Do protected and endangered species exhibit a higher occurrence in habitats of European interest compared to others? (2) Which habitat types in Slovakia have the highest representation of endangered species? By exploring these questions, we can gain valuable insights into the distribution and conservation status of endangered plant species in Slovakia.

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Biotechnological tools for conservation of forest trees germplasm

The novelties coming from the field of plant biotechnologies offer broad spectrum of tools for supporting the efforts in plant conservation. While the in situ conservation is considered a more appropriate conservation approach in terms of preserving the existing centers of biodiversity, the ex situ strategy might be the only available alternative for preservation of valuable forest trees germplasm, with the endangered species being a major challenge for long term conservation in worldwide context. The 'slow growth' is a universal methodology for medium-term preservation of in vitro cultures based on growth reduction by different means (changing the environmental conditions, media composition, etc.). As an alternative approach. the encapsulation technology might be extremely useful not only in exchange of plant material between tissue culture labs, but also for efficient germplasm conservation. The aseptic encapsulated propagules ('synthetic seeds') despite of being pathogen-free are more suitable in terms of handling, transportation and storage. The cryopreservation presents an unbeaten alternative for long-term conservation of germplasm due to its essential advantages theoretically guaranteeing an unlimited secure of plant material. The newly emerging genomic tools are supposed to improve the knowledge on understanding the control and molecular mechanisms of the adaptive capacity of forest trees, which is of crucial importance for development of modern conservation strategies.

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The Lithuanian example raises questions about whether protected areas effectively conserve plant diversity

In 2021, a new list of protected animals, plants, and fungi was released. The list comprises 566 taxa, out of which 224 are plants, including *Chara* and *Bryophytes.* The assessment of these species was carried out against the IUCN criteria, and almost 25,000 occurrence records were used for this purpose. The evaluation resulted in the following categories: Critically Endangered (CR) – 34 species, Endangered (EN) – 82 species, Vulnerable (VU) – 67 species, Near Threatened (NT) – 27 species, Least Concern (LC) – 5 species, and Data Deficient (DD) – 9 species. After analyzing the species occurrence data from the national database of protected species, we looked at their proximity to national protected areas like national parks, nature reserves, and strict nature reserves. Unfortunately, the findings were moderate, as 47% of species occurrences were found to be outside the protected areas. This makes it extremely challenging, if not impossible, to protect these species. The biggest proportion of protected species occurs in nature reserves, in total 37%, while strict nature reserves include 7% of all occurrence data. Even though, protected areas cover over 18% of the country's total area, which is equivalent to 1,200,431.9 hectares, only less than 1% of the area is strictly protected and off-limits to human activity. In all other protected sites (including nature reserves), human activities are present, and sometimes these activities can lead to the destruction of the main values of these areas. The strictly protected areas mostly comprise bog complexes with adjacent forest fringes. However, this only covers a few types of habitats and cannot ensure the protection of plant biodiversity.

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